National Natural Science Fund Guide to Programs 2021

National Natural Science

Foundation of China

Brief Introduction

The National Natural Science Foundation of China (hereinafter abbreviated as NSFC) publishes the *National Natural Science Fund Guide to Programs 2021*, in accordance with the *National Natural Science Foundation Regulations* and relevant documents on program management, to provide applicants with useful guidance on seeking support from the National Natural Science Fund. The *Guide* details NSFC's latest reform measures, application requirements, funding policies and priorities, and introduces different program types and their respective requirements. It is an important basis for the allocation of the National Natural Science Fund, and also a must-read reference for applicants.

This book can be used as a reference for researchers in universities and colleges of higher education and research institutions, and for people working in areas of S&T management and policy research.

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Foreword

As the source of scientific and technological innovation, basic research is vital to the improvement of original innovation capability, determines the process of building a scientific and technological power, and plays an important and fundamental role in achieving the two centenary goals. At present, China has shifted to the stage of high-quality development, which puts forward more urgent requirements for accelerating the high-quality development of basic research. The CPC Central Committee attaches great importance to basic research. General Secretary Xi Jinping emphasized at the forum for scientists that it is necessary to persevere in strengthening basic research. As one of the main channels of the state to support basic research, the National Natural Science Fund shoulders the glorious mission of supporting and promoting the high-quality development of basic research in China.

We shall thoroughly understand the strategic positioning of basic research. General Secretary Xi Jinping pointed out that "basic research is the source of the entire scientific system and the main trigger for solving all the technical issues", which profoundly clarified the fundamental and critical role of basic research in revealing the laws of nature, supporting economic and social development, and improving people's livelihood.

We shall accurately grasp the connotation of basic research in the new era. There are different understandings of the definition of basic research, but from the perspective of the function and role, basic research can be regarded as a research activity that proposes and solves scientific problems. Scientific problems can originate either from the curiosity of scientists and the frontiers of world science, or from major national needs, the main economic battlefield, and the urgent need to safeguard people's life and health. Basic research can contribute new knowledge to human development, solve the core scientific problems behind the key common technologies needed for economic and social development, and is an important way to cultivate innovative talents.

We shall seize the opportunity of paradigm shift in scientific research. As a new round of scientific and technological revolution and industrial transformation are evolving rapidly, the scientific research paradigm is undergoing profound changes. The content of basic research transitions from static average to dynamic structure and extends from local phenomena to system behavior; research methodology changes from qualitative analysis to quantitative prediction, evolves from single subject to interdisciplinarity, and extends from data processing to artificial intelligence; research

domains expand from the knowledge blocks divided by disciplines to the knowledge system, elevate from traditional theories to complex sciences, and develop from the pursuit of details to scale associations and multi-level disciplinary knowledge to exploring common principles. Only by conforming to the general trend of paradigm shift in scientific research can we gain an advantage in the scientific and technological revolution.

Since 2018, the National Natural Science Foundation of China has continuously been deepening the reform of National Science Funding System, in accordance with the decisions and arrangements of the CPC Central Committee and the State Council. A systematic reform plan was formulated, with identifying funding categories, improving evaluation mechanisms and optimizing layout of research areas as the core, and "strengthening three aspects, improving six mechanisms, highlighting two priorities and optimizing seven areas of funding management" as the key measures. The NSFC reform has by far been progressing smoothly, some key tasks achieving initial results. During the "14th Five-Year Plan" period, we will steadily advance and deepen the reform on the basis of the experience drawn from the pilot phase, give full play to the unique role of the science fund in the national innovation system, and consolidate the foundation of self-reliance and self-strengthening in science and technology.

Scientific nature is the foundation of science fund. Funding categories are the primary proposition of science funding agencies, and fundamentally ensure the high-quality development of basic research. We will fully implement the funding categories for the new era, steadily expand the pilot scope of the category-specific review based on the four attributes of scientific problems, i.e. "exploration and highlight originality; cutting-edge area with the development of new methodology; demand-driven bottleneck; and universal orientation and transdisciplinary convergence", and guide researchers to condense and solve scientific problems and to improve the quality of research content and proposals.

Fairness is the lifeline of science fund. Fair review is the foundation of the science funding system and a prerequisite for funding high-level basic research. We will steadily advance toward a review mechanism featuring "Responsibility, Credibility and Contribution", and strive to build one that is category-specific, scientific, fair and efficient. The review mechanism shall not only fully and objectively reflect the academic level of reviewers, guide reviewers to actively make academic contributions, and improve the quality of review, but also constantly guide reviewers to review responsibly and accumulate credibility, so as to foster a good review environment. Meanwhile, we will address both symptoms and root causes by implementing the action plan for the development of academic culture, and guiding the four parties involved in the activities of science funding (applicants/PIs, reviewers, host institutions and NSFC staff) to carry out responsible scientific research, review

and management, so as to create a good scientific culture.

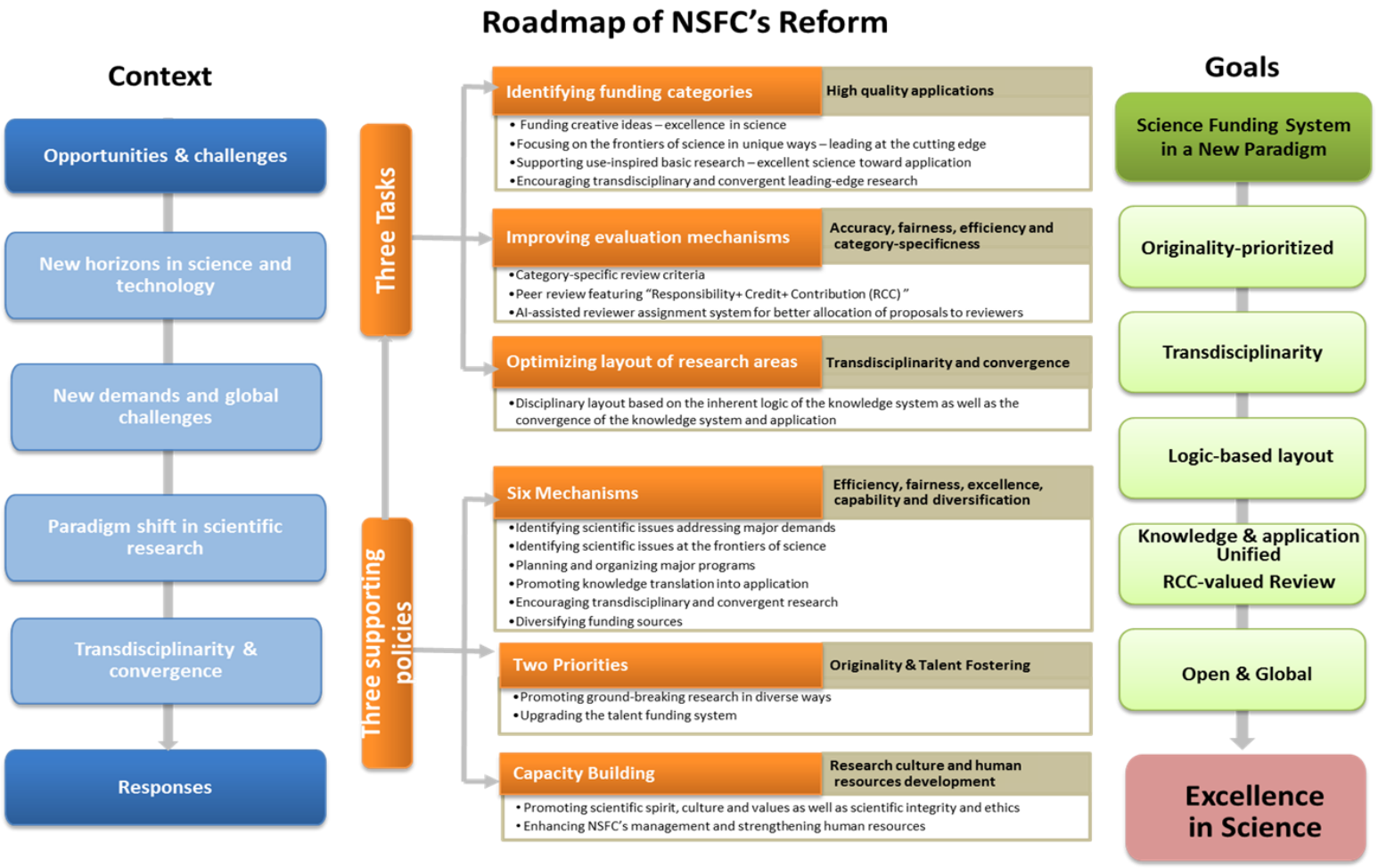
Disciplinary layout, as the soft infrastructure for scientific research, is the basis for promoting transdisciplinary convergence and cultivating original achievements, as well as a key measure to actively respond to the paradigm shift in scientific research. We will fully implement the new application code system, and steadily advance the thorough reform of the funding portfolio in accordance with the principle of "deriving from the logical structure of the knowledge system, promoting the integration of knowledge and application, and highlighting transdisciplinary convergence".

It is an important responsibility of National Natural Science Fund to enhance China's original innovation capabilities. We will implement the original exploration plan in depth, emphasize the originality of research ideas and the leading prospects of expected results, explore and improve project selection and management mechanisms that conform to the laws of basic research, and encourage and support original thinking with subversive and non-consensus characteristics, and foster major scientific breakthroughs in the future.

Cultivating innovative talents and teams is an important mission of National Natural Science Fund. We will implement a more active, open and effective talent funding policy, implement multi-level Research Fund for International Scientists for all ages, continue upgrading the talent funding system and strengthening support for young talents, leading talents and innovative teams, so as to ensure a solid foundation for the basic research talent team.

2021 is the first year for China to embark on a new journey of building a modern socialist country in an all-round way and to move toward the forefront goal of an innovative country. Guided by Xi Jinping's Socialism Thoughts with Chinese Characteristics for the new era, NSFC will fully implement the spirit of the 19th CPC National Congress and its Second, Third, Fourth, and Fifth Plenary Sessions, thoroughly implement the spirit of President Xi Jinping's important speeches and instructions on scientific and technological innovation, especially on basic research, and strengthen the commitment to the Four Consciousnesses, the Four-sphere Confidence, and the Two Upholds. NSFC is determined to promote the systematic reform of science fund, strengthen basic research, and improve China's original innovation capabilities together with host institutions and scientists, with the outstanding achievements as a tribute to the 100th anniversary of the founding of the CPC.

Editorial Committee
January 12, 2021


Roadmap of NSFC's Reform
Context
Opportunities & challenges
New horizons in science and technology
New demands and global challenges
Paradigm shift in scientific research
Transdisciplinarity & convergence
Responses
Three Tasks
Three supporting policies
Identifying funding categories
High quality applications
• Funding creative ideas – excellence in science
•Focusing on the frontiers of science in unique ways – leading at the cutting edge
•Supporting use-inspired basic research – excellent science toward application
•Encouraging transdisciplinary and convergent leading-edge research
Improving evaluation mechanisms
Accuracy, fairness, efficiency and category-specificness
•Category-specific review criteria
•Peer review featuring "Responsibility+ Credit+ Contribution (RCC)"
•AI-assisted reviewer assignment system for better allocation of proposals to reviewers
Optimizing layout of research areas
Transdisciplinarity and convergence
•Disciplinary layout based on the inherent logic of the knowledge system as well as the convergence of the knowledge system and application
Six Mechanisms
Efficiency, fairness, excellence, capability and diversification
•Identifying scientific issues addressing major demands
•Identifying scientific issues at the frontiers of science
•Planning and organizing major programs
•Promoting knowledge translation into application
•Encouraging transdisciplinary and convergent research
•Diversifying funding sources
Two Priorities
Originality & Talent Fostering
•Promoting ground-breaking research in diverse ways
•Upgrading the talent funding system
Capacity Building
Research culture and human resources development
• Promoting scientific spirit, culture and values as well as scientific integrity and ethics
• Enhancing NSFC's management and strengthening human resources
Goals
Science Funding System in a New Paradigm
Originality-prioritized
Transdisciplinarity
Logic-based layout
Knowledge & application Unified
RCC-valued Review
Open & Global
Excellence in Science

Contents

2021 NSFC Reform Measures

NSFC thoroughly studies and implements General Secretary Xi Jinping's important expositions on scientific and technological innovation and basic research, strengthens the top-level design, continues to deepen reforms, and continuously improves and constructs a new funding portfolio for National Natural Science Fund. NSFC will thoroughly implement the National Natural Science Fund reform plan by taking the following measures in 2021.

I. Advance the implementation of category-specific review

NSFC further expands the scope of pilot category-specific review focused on the four attributes of scientific problems, i.e. "exploration and highlight originality; cutting-edge area with the development of new methodology; demand-driven bottleneck; and universal orientation and transdisciplinary convergence", to Young Scientists Fund in addition to General and Key Programs which were included in 2020. The applicant shall select one of the four attributes that best suited and reflecting the characteristics of the proposal according to the scientific problem to be solved and the research content, and explain the reasons. NSFC will organize reviewers to conduct category-specific review based on the attribute of the scientific problem selected by the applicant.

II. Optimize talent program portfolio

NSFC continues to increase the number of awards for Young Scientists Fund and the funding amount of Excellent Young Scientists Fund awards, adjust the management procedures of the National Science Fund for Distinguished Young Scholars awards, optimize the evaluation mechanism of Science Fund for Creative Research Groups, and stabilize the funding model of the Basic Science Center Program.

In addition to the open-up of the National Science Fund for Distinguished Young Scholars and Excellent Young Scientists Fund to foreign non-Chinese descent applicants, NSFC is dedicated to attracting and encouraging outstanding young overseas talents to return or come to China to work. NSFC also expands the functions of the Research Fund for International Young Scientist to provide all-round support for international scholars of different levels.

III. Advance the Original Exploratory Program

In order to guide and motivate researchers to engage in original basic research, and to select non-consensual, subversive and high-risk original projects, NSFC continues the Original Exploratory Program in 2021. Based on the lessons and experience drawn from previous practice, NSFC further optimizes the requirements of grant management of the Original Exploratory Program. For details, please refer to the "Guide to NSFC Original Exploratory Program 2021" that will be subsequently released.

IV. Fully adopt the new application code system

Adhering to the "four aspects" and consolidating the results of optimizing the disciplinary layout in the first phase of the reform, NSFC fully adopts the new application code system, organizes and conducts operation evaluation, ensures wide publicity of the reform results to the scientific community through various channels, collects opinions and suggestions from the scientific community on the operation of the new application code system, and optimizes it in time.

V. Promote transdisciplinary integration and convergence

Facing the frontiers of world science and major national needs, NSFC focuses on the comprehensive and complex problems-driven multidisciplinary research, explores new paradigms of scientific research, and cultivates new disciplines. Meanwhile, NSFC addresses major national needs and major complex challenges facing humanity in a collaborative manner, improves the overall level and international impact of China's transdisciplinary scientific research, cultivates original achievements of international impact, and fosters transdisciplinary innovative talents and teams.

VI. Continue to pilot the evaluation mechanism that features "Responsibility + Credibility + Contribution" (RCC)

Adhering to the principle of positive guidance and incentives, NSFC steadily advances in piloting the RCC evaluation mechanism. Learning from the experience in 2020, NSFC addresses the problems in an effort to improve the quality of review.

VII. Encourage diversified investment and collaborative innovation

By far, 20 provinces (autonomous regions and municipalities) have joined the Joint Fund for Regional Innovation and Development, 5 enterprises have joined the

Joint Fund for Corporate Innovation and Development, and 5 industry departments have established the Joint Fund for Industries of the New Era, which has initially formed a joint funding system for the new era. It has become an important carrier for the science fund management mechanism in strengthening diversified investment and promoting collaborative innovation in the process of NSFC reform. In 2021, NSFC will seek a more diversified investment mechanism, continue to expand the scope of Joint Fund, and explore effective channels for social and individual donations to basic research.

VIII. Promote the reform of fund management

After piloting the "contract system" for the National Science Fund for Distinguished Young Scholars, the Excellent Young Scientists Fund will be included in the scope of the "contract system". Project fund will no longer be divided into direct costs and indirect costs. The applicant does not need to prepare the project budget when submitting the proposal. The fund is at full discretion of the principal investigator within the prescribed scope.

Applicants shall apply for a reasonable budget amount based on the principles of "objective relevance, policy compliance, and economic rationality", combined with the actual needs of the research. Applicants shall make reasonable decisions on the use of the fund, strive to improve the efficient use of the fund, and avoid idle fund or any waste.

IX. Further simplify requirements for application management

NSFC receives paperless application for all types of programs. When submitting a proposal, the host institution only needs to give online confirmation of the electronic application form and the attachment, and does not need to submit a paper application form (see "Information on Application" for detailed requirements). At the same time, NSFC will further simplify the submission of documents and reports.

X. Strengthen the management of host institutions

NSFC improves the entry and exit mechanism of the host institutions to maintain the dynamic management; constructs the credit evaluation system to associate the credit rating of the host institution with the verification of indirect costs and rewards and punishments; establishes a classification and categorized management system to adopt differentiated management models according to natures and scales of the host institution, so that they can better perform the main responsibilities of management and

supervision, improve service efficiency, standardize process management, and ensure the safety of funds.

XI. Strengthen scientific integrity

NSFC continues to establish a scientific research integrity system that integrates “education, motivation, regulation, supervision, and discipline”. NSFC will take education as the foundation, positive motivations as the guidance, regulation as the criterion, supervision as the starting point and punishment as the last resort, as well as consider both the long term and the short term and treat both symptoms and root causes, in order to promote research integrity and scientific spirit, culture and values during the “14th Five-Year Plan” period.

Information on Application

When applying for NSFC funds in 2021, applicants and their host institutions shall first read carefully the following documents: *the National Natural Science Foundation Regulations* (hereinafter referred to as the *Regulations*), this *Guide*, relevant guidelines for program management, *Regulations on National Natural Science Fund Management*, and notifications and announcements pertaining to application. Should there be any conflicts between guidelines for program management and *Regulations* and this *Guide*, *Regulations* and this *Guide* shall prevail. Information on Application includes eligibility of applicants and requirements on applications, application limits, requirements on scientific integrity, responsibilities and accountability of host institutions, and etc.

I. Eligibility of applicants and requirements on applications

i. Eligibility of applicants

1. As the principal investigator (PI), the applicant should comply with Article 10 Clause 1 of the *Regulations*, i.e., the applicant shall have (1) the experience of undertaking basic research program(s) or other basic research activities; (2) a senior academic rank (title) or a doctoral degree, or recommendation from two researchers who are in the same research field and have a senior academic rank (title). Besides, those who apply for certain types of programs shall meet other specific requirements. (For more information, please refer to the text of this *Guide*.)

When an applicant not employed as a full time staff member at his or her host institutions submits the applications, he or she shall truthfully state his or her position, term of employment and annual working duration at the host institution in the application.

The applicants for the Fund for Less Developed Regions should be full-time employees in the specified host institutions (for more information, please refer to the chapter on Fund for Less Developed Regions in this *Guide* to Programs), or the technical personnel following national policy and sent by the Central Organization Department on the 3-year or longer aiding mission in Xinjiang and Tibet, who should provide the supporting materials of the aiding mission issued by organization or personnel department of the aided institutions. If the unit that a researcher is working at for the aiding mission in Xinjiang or Tibet is not a registered host institution, they are allowed to apply for Fund for Less Developed Regions through the eligible host

institutions in the aided autonomous regions. Part-time employees in the specified host institutions, technical personnel from the specified host institutions affiliated to Chinese People's Liberation Army or host institutions outside the regions are not qualified to apply for the Fund for Less Developed Regions.

2. When a researcher conducting basic research satisfies the requirements as prescribed in the preceding paragraph but has no employer or whose employer is not a registered host institution, on the condition that he or she has obtained the consent from a registered host institution, he or she is eligible to apply for the General Programs and Young Scientists Fund, but cannot apply for other programs.

Under this circumstance, the applicant shall fill in truthfully personal information in the basic information page of the proposal and research experiences in CV, and sign the agreement in written form with the host institution (for more information please refer to the *Guideline on Management of National Natural Science Fund Host Institutions*). **The hard copy of the agreement shall be archived at the host institution for future reference instead of submitting to NSFC.**

Researchers with overseas identity who are not employed in any host institution shall not apply for NSFC programs as researchers with no employer or whose employer is not a registered host institution.

3. Students pursuing the postgraduate degree (not obtained by the deadline for NSFC submission) cannot apply for any fund as the PI. However, with the supervisor's consent, in-service personnel can apply for certain categories of programs through the host institution. The applicant should submit the hard copy of application with the following attachments: signed certification of the supervisor's consent which explains the connection between the dissertation and the proposal, and the guarantee of working hours and conditions after the project starts, etc. On-the-job postgraduate students whose employer is not a registered host institution is not eligible to apply for any type of programs.

4. Postdoctoral fellows can apply for the following programs only: General Programs, Young Scientists Fund, Fund for Less Developed Regions, and others to be determined by the corresponding solicitations.

5. An applicant whose host institution is one of the following eight universities, i.e., Hong Kong University, Chinese University of Hong Kong, Hong Kong University of Science and Technology, Hong Kong Polytechnic University, City University of Hong Kong, Hong Kong Baptist University, University of Macao, and Macao University of Science and Technology, can only apply for Excellent Young Scientists Fund (Hong Kong and Macao).

6. Any foreign researcher employed by a registered host institution shall not apply for projects as both domestic applicant (except for outstanding youth science fund projects (Hong Kong and Macao)) and overseas collaborator (referring to foreign collaborators in international (regional) cooperative research projects).

The PI of the Joint Research Fund for Overseas Chinese Scholars and Scholars in Hong Kong and Macao projects, and the overseas collaborator of the International (Regional) Joint Research project (including Key International (Regional) Joint Research Program and International (Regional) Joint Research Program under Agreements/MoUs) shall not apply for other types of program (except for the Excellent Young Scientists Fund (Hong Kong and Macao)) as the PI before these projects are completed.

Domestic PI who has an ongoing project shall not participate in the application for International (Regional) Joint Research Program (including Key International (Regional) Joint Research Program and International (Regional) Joint Research Program under Agreements/MoUs) as an overseas collaborator unless the ongoing project is concluded.

7. To avoid duplication of funding, NSFC's Department of Management Sciences and National Social Science Fund jointly limit applications. Please refer to the Funding Areas and Precautions under Department of Management Sciences section of this *Guide* for specific requirements.

ii. Requirements on applications

1. The proposal shall be prepared by the applicant in person and in accordance with the outline. The applicant and the main participants should fill in their CVs accordingly. **Please note that any unlawful, confidential or sensitive information shall not appear in the proposal.** The applicant shall be responsible for the authenticity and legitimacy of the proposal submitted.

2. In accordance with program types, the applicant shall make correct choice of the "funding category", "subclass introduction" and "annotation". Content that requires "choosing" can only be chosen in the pull-down menu; content that requires "filling out" can be written in words; some program's annotation attachments should be written strictly in accordance with this *Guide*.

3. **In 2021, pilot category-specific application and review based on the four scientific natures of research will be adopted for all the General and Key Programs.** Applicants shall choose one of the four scientific attributes according to the critical scientific problem aimed to solve and the research hoped to conduct, and justify their choice in the proposal. When the proposed research fits multiple scientific attributes, applicants shall choose one that best describes the characteristics of their proposed research.

4. **In 2021, applications for all types of programs will be paperless**. In process of the submission, the host institution shall only confirm the online application and the attachments, without having to submit a hard copy. After the project has been approved, the signature and seal page of the application form shall be attached to the Project Plan and submitted. The signature and seal information shall be consistent with

that of the electronic application.

5. When main participants do not work at the same host institution as the applicant (including graduate students), the employer of the main participants shall be regarded as a collaborative research institution (overseas institutions are not regarded as such). Applicants shall select online or accurately fill in the employer information of the main participants. **The information on collaborative research institution in the basic information section of the application form is automatically generated by the online application system.** The number of collaborative research institution for each application shall not exceed two (unless otherwise specified).

After the funding is awarded, the applicant and the main participants shall sign on the signature and seal page of the application form **themselves**. The overseas participants who cannot sign the page shall send a signed paper document by letter, fax, and etc., stating their consent to participate and perform the related responsibilities in the application and the research work, which will be submitted together with the signature and seal page. The collaborative research institution shall stamp the official seal on the signature and seal page, and ensure the name on the official seal is consistent with the name of the institution in the application. A collaborative research institution that has been registered as a host institution with NSFC shall stamp the official seal of the host institution; a collaborative research institution that is not registered shall stamp the official seal of the legal entity.

6. **The commitment procedures for host institutions are simplified. If the host institution applies for the project in 2021, it shall download the "2021 NSFC Host Institution Letter of Commitment for Project Application" from the ISIS system in advance, and then upload the scanned electronic copy after it is signed by the legal representative and stamped with the official seal of the host institution to the information system (only need to upload once a year). The host institution can confirm and submit the proposals only after completing the above-mentioned commitment procedures.**

7. **If the proposed research involves issues related to scientific research ethics and scientific and technological security (such as biosecurity, information security), the applicant shall strictly follow relevant national laws, regulations and codes of ethics,** and provide corresponding materials as attachment in accordance with the requirements of relevant scientific departments (a scanned copy shall be attached to the electronic application).

8. For 2021, the application code system has been thoroughly adjusted with tertiary application codes eliminated. Applicants shall select the application code accurately based on the research direction or research field they are applying for, in accordance with the "NSFC Application Code" in this *Guide*. Particular attention shall be paid to the following aspects:

(1) When choosing the application code, try to select the full code including the

secondary application code (four digits).

(2) Key Programs, Major Research Programs and Joint Funds Programs, etc., may have special requirements for the application codes. For details, please refer to the relevant sections in this *Guide*.

(3) Applicants shall accurately select "Application Code 1" and the corresponding "research direction" and "key word" when filling out the proposal form.

(4) For any questions regarding the application code, please contact relevant scientific departments.

9. Applicants and the main participants with a senior academic rank (title) shall indicate in the proposal if:

(1) They have more than one host institution when applying or participating in NSFC projects in one year;

(2) They have different host institutions for on-going NSFC projects.

10. If a research has been funded through other sources, the applicant shall specify the funding details and its difference and connection with the current proposal. Applying for funding from different funding agencies for the same research content should be avoided.

If an applicant applies for different types of NSFC programs during the same year, he or she should specify in the application the other NSFC program applications, their titles and information, and the connection and difference with the current application.

11. The start date for research in proposal shall be January 1, 2022, and the end date December 31, 20xx, depending on the funding periods (unless otherwise specified in this *Guide*).

12. The applicant and the main participants shall use the same and only document of identity for application.

When filling in names of oneself and main participants, the applicant shall make sure the names are in standard characters and exactly the same as the ones on documents of identity. Those who have received funds as applicants or main participants using other identifications shall declare and provide details in the proposal. Host institutions are accountable for verification.

iii. About application reception conditions

According to the *Regulations*, the application for NSFC funds shall not be accepted under any of the following circumstances:

1. The applicant does not meet requirements stated in the *Regulations*, this *Guide* and relevant management methods.

2. The application materials do not comply with conditions in this *Guide*.

3. The number of proposals does not comply with the Application Limit's conditions.

II. Application limit

i. Application limit in general

1. Applicants shall only apply for one type of program once in a year, excluding Integrated Program and Strategic Research Program in the Major Research Plan, Scientific Activity Program in Special Program and International (Regional) Exchange Program; for Joint Funds, the same type refers to the same program title.

2. Applicants cannot apply for the same type of program if they received funding for General Program, Key Program, Major Program, Major Research Plan Program (excluding Integrated Program and Strategic Research Program), Program of Joint Funds(referring to the Joint Fund with the same name), and Fund for Less Developed Regions as the PI in the previous year.

3. For Special Fund for Research on National Major Research Instruments (department recommendation) or Basic Science Center Program, applicants shall only apply for one project in the same year.

4. The PI of an International (Regional) Joint Research Project shall not apply as an applicant for the same type of program.

5. For International (Regional) Joint Research and Exchange Program, each researcher shall apply for as applicant and undertake as PI only one project under the same Agreement/MoU.

ii. One-year suspension from application after unsuccessful application for the General Program for two consecutive years

Applicants with unsuccessful application for the General Program both in 2019 and 2020 (including eligibility rejection) cannot apply for General Program as the PI in 2021.

iii. Restriction on the total number of projects for researchers with a senior academic rank (title) applying for and undertaking

Unless specified otherwise, projects whose funding period terminates in the year of application are not included in the total number for applying and undertaking.

1. Limit for researcher with a senior academic rank (title)

The total number of the following programs a researcher with senior academic rank (title) applies for (including as applicant and main participant) and undertakes (including as applicant and main participant) shall not exceed **two**: General Program, Key Program, Major Program, Major Research Plan (excluding the Fostering Program and Strategy Research Program), Program of Joint Funds, Young Scientists Fund, Fund for Less Developed Regions, Excellent Young Scientists Fund, National Science Fund for Distinguished Young Scholars, Key International (Regional) Joint Research

Program, International (Regional) Joint Research Program under Agreements/MoUs with direct cost of more than 2 million yuan per project (only the PI are counted, main participants are not counted), National R&D Program for Major Research Instruments (including Special Fund for Major Research Instruments and Special Program of National Major Research Instruments), Basic Science Center Program, Original Exploratory Program, and Emergency Program and Special Program with funding period of over one year (unless otherwise specified; and except for the bureau (division) ad hoc task and soft research projects under Emergency Program, and scientific activities projects under Special Program).

The projects that were granted in 2019 or before and are undertaken by researchers with a senior academic rank (title) as main participants are not included in the total number. However, the projects that researchers apply for as applicants and main participants and those awarded to researchers as PI and main participants in 2020 and beyond are included in the total number.

2. Limit for researcher without a senior academic rank (title)

(1) The total number of projects a researcher applies for or undertakes as the PI should not exceed one.

(2) Under the premise of adequate time and energy, the total number of projects a researcher applies for or undertakes as main participant is not limited.

(3) In case a researcher receives the senior academic rank (title), the projects he or she undertakes as the PI shall be counted into the total number whereas those a researcher undertakes as the major participant shall not.

3. Special requirements for some types of programs

(1) Excellent Young Scientists Fund Program and National Science Fund for Distinguished Young Scholars

At the stage of application, Excellent Young Scientists Fund and National Science Fund for Distinguished Young Scholars are not counted, but are counted before receiving NSFC's formal funding decision and after approval.

(2) Basic Science Center Program and Funds for Creative Research Group

At the stage of application, Basic Science Center Program is not counted, but is counted before receiving NSFC's formal funding decision and after approval.

Applicants and main participants shall only apply for and participate in one project for Funds for Creative Research Group or Basic Science Center Program in the same year.

The PI and main participants with senior academic rank (title) who is funded by Science Fund for Creative Research Groups shall not apply for Basic Science Center Program; however, application is allowed in the year of conclusion.

The PI and main participants (key members) shall not apply for any NSFC grants before the awarded project concludes except for National Science Fund for Distinguished Young Scholars and Excellent Young Scientists Fund, neither can they

use similar materials to apply for any S&T Programs.

Participants who withdraw from Fund for Creative Research Group or Basic Science Center Program shall not apply for or participate in the applications for those two types of programs within 2 years.

(3) Special Fund for Research on National Major Research Instruments

Researchers with senior academic rank (title) shall apply (as applicant and main participant) for Special Fund for Research on National Major Research Instruments only once in the same year.

The PI of Special Fund for Research on National Major Research Instruments grant and major participants with senior academic rank (titles) shall not apply for or participate in the application for this program before the ongoing project is approved for conclusion.

When funded, the PI shall not apply for any other NSFC funds other than the National Science Fund for Distinguished Young Scholars before the awarded project concludes.

For researchers with senior academic rank (title), the total number of Special Fund for Research on National Major Research Instruments (including Special Program on National Major Research Instruments) and the National Major Instrument Equipment R&D Program by Ministry of Science and Technology one may apply for (including as applicant and main participant) and undertake (including as PI and main participants) shall not exceed one.

(4) Original Exploratory Program

The Original Exploratory Program is not included in the scope of the total number of applications and grants at the time of application, but will be included in the scope of the total number of applications and grants after the grant is awarded (except for projects with funding period of no longer than 1 year).

Researchers can only apply for one project under Original Exploratory Program (including pre-application) in the same year.

iv. The limit on the PI for accumulated number of funding

1. For Young Scientists Fund, Excellent Young Scientists Fund, National Science Fund for Distinguished Young Scientists, and Science Fund for Creative Research Groups, the applicant can receive the funding only once.

2. Beginning from 2016, for Fund for Less Developed Regions, the applicant's accumulated number of funding cannot exceed three. Projects approved in and before 2015 are not counted.

v. Programs not subject to the total number limit

There is no number limit for Science Fund for Creative Research Groups, Joint Research Fund for Overseas Chinese Scholars and Scholars in Hong Kong and Macao,

Tianyuan Fund for Mathematics, International (Regional) Joint Research Program under Agreements/MoUs with direct cost of no more than 2 million yuan per project, International (Regional) Exchange Program, Research Fund for International Scientists, ad hoc and soft projects by bureaus and divisions under Emergency Program, scientific activity projects under Special Program, other types of program with funding period of no more than 1 year, and other programs specified in this *Guide*.

vi. Special notice

1. During the evaluation period (prior to NSFC's final decision), the application shall be counted in the total number, except for those under Original Exploratory Program.

2. In the case that applicants engaged in multiple host institutions apply for or undertake through different host institutions, the Limit is still applicable.

3. In case of an inconsistency between other management regulations and this Limit in terms of total project numbers, the latter shall prevail.

III. Requirements on scientific integrity

To enhance scientific research integrity, further strengthen basic information management and prevent scientific misconduct in science fund application, NSFC proposes instructions and requirements on scientific integrity to be followed.

i. About personal information

1. The science fund project shall be applied for by the applicant himself or herself. It is strictly prohibited to apply under another person's name, or fabricate false applicants and main participants.

2. Applicants and main participants shall truthfully fill in the personal information and be responsible for its authenticity; at the same time, the applicant shall also be responsible for the authenticity of the personal information of all the main participants. It is strictly prohibited to forge or provide false information.

3. The academic degree information of applicants and main participants shall be consistent with that on the diploma. The time of degree acquisition shall be the same as on the diploma.

4. Applicants and main participants shall faithfully and accurately fill in the title information of their formal employment at host institutions. Forgery or providing false title information is strictly prohibited.

5. Applicants who are unemployed or whose employer is not a registered host institution shall truthfully fill in the work unit and the employment information. Giving false information is strictly prohibited.

6. Applicants and main participants shall faithfully and accurately complete their

curricula vitae. It is strictly prohibited to forge or alter relevant information.

7. Applicants shall accurately provide the information of their postgraduate and postdoctoral tutors, and shall not provide false information or omit any information in that regard.

ii. About research content

1. The applicant shall fill out the body part of the proposal in accordance with the *Guide*, instructions indicated in the online application system and requirements of the outline, and faithfully fill in relevant research work and research contents. Plagiarism or fraud is strictly prohibited. Violation of law and regulations, codes of ethics and regulations regarding S&T security is also strictly prohibited.

2. When filling in the research achievements such as papers, patents and awards, the applicant and main participants shall strictly follow the requirements of the outline, list the names of all authors (or inventors) of the research results following the rules for order, mark them accurately, and shall not alter the order of authors (or inventors), falsely mark first or corresponding authors, or omit marking co-first authors or corresponding authors.

3. Applicants and main participants shall strictly abide by the research ethics and codes of conduct recognized by the scientific community, and the research involving human subjects shall be submitted for ethics review according to the requirements of relevant government departments and employer institutions. Applicants shall not include research results that are generated from scientific misconducts such as forgery, tampering, plagiarism, entrusting "third party" to compose or submit the proposal, and peer-review fraud as the basis of applying for science funds.

4. Proposals with same or similar research contents shall not be submitted by different applicants through different host institutions to apply for different types of programs simultaneously. Projects that have already been funded are not allowed to be proposed.

5. If the research content has been funded through other channels or programs, applicants shall state the funding situation and the difference and connection with the proposed project in the application. Applicants shall not submit the same research content to different funding agencies.

iii. Other relevant requirements

1. Host institutions and collaborative institutions shall implement the specific requirements of the "Several Opinions on Further Strengthening Scientific Integrity" and "Opinions on Further Promoting Scientific Spirit, Culture and Values" issued by the General Office of the CPC Central Committee and the General Office of the State Council, follow the instruction of the "*Notice of NSFC and MoST on Further Consolidating the Primary Responsibility of Institutions Undertaking National Science*

and Technology Programs (Special Projects, Funds, etc.) in Upholding Academic Culture and Scientific Integrity", establish and improve the education, management and supervision system for upholding scientific research integrity, examine and verify application materials more strictly, and eliminate exaggeration, falseness and fraud.

2. Applicants shall inform main participants of the relevant contents of the application and the scientific integrity requirements, so as to ensure that main participants fully understand the relevant contents of the application and are responsible for the authenticity, completeness and compliance of the contents involved.

3. Prior to submitting the proposals, applicants together with host institutions shall pledge not to be involved in any form of activities that will be likely to impact the fairness of review, and to strictly comply with their commitments in the process of application and review.

IV. Responsibilities of host institutions

1. Host institutions shall strictly abide by the *Regulations*, *Guide to Programs*, *Regulations on Fund Management of National Natural Science Fund Host Institutions*, other relevant notices and management methods and Funding Management Method, Budget Preparation Notes and Notes on National Natural Science Foundation of China Program Budget Form.

2. Host institutions shall implement "Several Opinions of NSFC on Further Strengthening the Science Fund Management of Host Institution", seriously fulfill the responsibilities of management, and strengthen and standardize science fund management.

3. **Host institutions shall establish a scientific research ethics review mechanism to prevent ethical and security risks.** In accordance with relevant laws, regulations and codes of ethics, host institutions shall establish and improve scientific research ethics management systems; strengthen ethical review mechanism and process supervision; improve the sense of responsibility and legal awareness of scientific research personnel with regard to scientific research ethics through publicity, education and training.

4. **Host institutions shall establish a scientific and technological security review mechanism to ensure no confidential or sensitive information appears in the proposals.** In accordance with relevant laws and regulations, host institutions shall establish and improve scientific and technological security management systems; strengthen liability system for biosecurity, information security and other scientific and technological security; improve the sense of responsibility and legal awareness of scientific research personnel with regard to scientific and technological security and etc. through publicity, education and training.

5. Host institutions are held accountable for the eligibility of applicants, and

shall examine and verify the authenticity and completeness of proposals. No confidential content shall be included in the proposal. Host institutions that allow applicants without employer or whose employer is not a registered host institution as listed in Article 10 Clause 2 of *Regulations* to apply for funds via their institutions shall bear the responsibilities listed in Article 13 of *Regulations*, and sign the written contract. The written contract shall be archived at the host institution for further reference instead of submitting to NSFC.

6. **Host institutions shall upload the electronic scanned copy of the *2021 NSFC Host Institution Letter of Commitment for Project Application* that is signed by the legal representative and stamped with the official seal in a timely manner, to ensure applicants can finish and submit their proposals online on time.**

V. Accountability

1. Host institutions that neglect management and fail to perform the duties of examining the authenticity, completeness and compliance of the application materials, or host institutions and cooperative institutions violating commitments, shall be punished depending on the severity of the situation by NSFC in accordance with the *Regulations*, "*Notice of NSFC and MoST on Further Consolidating the Primary Responsibility of Institutions Undertaking National Science and Technology Programs (Special Projects, Funds, etc.) in Upholding Academic Culture and Scientific Integrity", "Rules for the investigation and handling of scientific integrity cases (for trial implementation)", Guide to Programs* and other provisions.

2. Applicants and main participants violating the requirements and commitments stated in this *Guide* or other scientific and technological activities, once discovered, shall be punished (such as termination of review) depending on the severity of the situation by NSFC in accordance with the provisions of the *Regulations* and the *Guide.* Suspected violations of scientific research integrity requirements will be transferred to NSFC Supervisory Committee for investigation, and verified cases will be handled with seriousness.

3. Clues and whistle-blowing reports related to the violation of disciplines and laws will be transferred to relevant discipline inspection and supervision departments in accordance with management authority.

Funding Scope and Instructions

Department of Mathematical and Physical Sciences

Mathematical and physical sciences (including mathematics, mechanics, astronomy, physics I and physics II) are important foundations of natural science, and the precursor and basis for the development of contemporary science. Disciplines in mathematical and physical sciences are peculiar in characteristics, such as big differences between or among disciplines, and pure theoretical research (such as mathematics, theoretical physics) and experimental studies. Many disciplines feature "mega-science", such as particle physics, nuclear physics, astronomical physics, and high temperature plasma physics.

In their own development, mathematical and physical sciences also provide theories, methods and means for other disciplines. Research findings in mathematics and physics play a key role in promoting the progress of both basic and applied scientific disciplines.

Mathematical and physical sciences have extensive interactions with other sciences, for example, with information science, life science and management science; physics with materials science, life science, information science and chemistry; astronomy with earth science, and mechanics with engineering science, material science and earth science. The interactions produce a series of interdisciplinary and cross-boundary disciplines and new research areas have emerged, and at the same time research objects and areas in mathematical and physical sciences are also expanding.

The Department will continue to increase its support on basic research that takes as its primary goals advancing the disciplinary development, promoting original innovation and training talented researchers and meeting the needs of national long-term development, as well as interdisciplinary research within the Department and with other departments.

In 2020, the Department received 7,799 applications for General Programs, which is 902 more than that of 2019, increasing 13.08%. 1,750 projects were funded, the funding rate was 22.44%, and the funding per project was 589,100 yuan in average. The funding per project was 512,800 yuan for mathematics, 620,100 yuan for mechanics, 619,700 for astronomy, 619,800 for physics I and 618,500 for physics II.

In 2020, the Department received 7,355 applications for Young Scientists Programs, and funded 1,813. The success rate was 24.65%. The development of young scientists is particularly important for the development of mathematical and physical sciences. The Department has always been paying attention to fostering and supporting young scientists, and the funding rate of the Young Scientists Fund has always been higher than that of General Program projects.

In 2020, the Department received 1,015 applications for Less Developed Region Programs, and funded 200. The success rate was 19.70%. The funding per project was 349,500 yuan in average.

Funding in Department of Mathematical and Physical Sciences in 2020

Unit: 10,000 yuan

Divisions		General Program			Young Scientists Fund			Fund for Less Developed Regions		
		Projects	Direct cost	Success rate (%)	Projects	Direct cost	Success rate (%)	Projects	Direct cost	Success rate (%)
Mathematics	Mathematics I	237	12,153	22.61	261	6,240	24.81	45	1,440	23.08
	Mathematics II	262	13,434	22.26	299	7,144	24.45	47	1,563	17.15
Mechanics	Basic problems and methods in mechanics	6	374	24.00	5	120	21.74	1	37	25.00
	Dynamics and control	71	4,423	24.65	60	1,432	24.00	7	261	22.58
	Solid mechanics	159	9,861	22.88	169	4,016	25.61	13	485	20.31
	Fluid mechanics	85	5,261	21.09	103	2,464	25.56	5	187	17.24
	Bio-mechanics	24	1,475	22.02	23	552	23.47	—	—	—
	Explosive and impact dynamics	38	2,354	21.30	44	1,048	21.57	1	37	25.00
Astronomy	Astrophysics	47	2,881	22.93	43	1,008	25.90	6	212	24.00
	Astrometry and celestial mechanics	45	2,820	21.95	38	912	23.90	1	37	11.11
Physics I	Condensed matter physics	227	14,100	22.34	219	5,224	24.61	26	964	19.55
	Atomic and molecular physics	45	2,795	22.61	51	1,216	25.37	6	224	20.69
	Optics	140	8,654	22.47	144	3,416	24.57	15	548	19.74
	Acoustics	34	2,093	22.67	33	792	24.63	3	111	20.00
Physics II	Fundamental physics and particle physics	103	6,285	23.00	90	2,136	25.94	13	474	20.00
	Nuclear physics, nuclear technology and its applications	103	6,452	21.96	89	2,136	24.32	5	190	19.23
	Particle physics and nuclear physics experimental facilities	64	3,977	20.85	84	2,016	23.53	1	38	14.29
	Plasma physics	60	3,698	24.59	58	1,392	24.58	5	182	21.74
Total or average		1,750	103,090	22.44	1,813	43,264	24.65	200	6,990	19.70
Direct cost per project		58.91			—			34.95		

Division of Mathematics

Mathematics (A01–A06)

The Division encourages creative research on important issues in the mainstream and frontier of mathematics, explorations of new ideas, new theories and methods in mathematics and interdisciplinary applications, inter-crossing of different branch disciplines with mathematics, and applied mathematical research on practical issues. Applicants are required to have sound research background and capability. Proposal should be prepared based on deep understanding of the current

status of the research involved, main issues and relevant research methods and available approaches. The Division encourages researchers to consolidate research team, foster talents and promote academic exchanges through the funded research projects. Research direction adjustment is allowable when needed.

For basic mathematics, the funding aims at maintaining stable development of research directions where China is traditionally strong and has comparatively large-scale research capability, promoting fast development of research areas that are within the mainstream of international mathematical research but relatively weak in China, and promoting interdisciplinary research among branches of mathematics. Focus is given to algorithm, grid theory and its algorithm, geometrical method in representation theory, comparative geometry and geometric analysis in non-smooth space, application of modern harmonic analysis in number theory, associate geometry and geometric measure, random analysis method and application, and mathematical problems in quantum field theory.

The funding for applied mathematics and computational mathematics aims at improving applications in solving practical problems, and gives more emphasis on basic theory and new methods with strong practical background and sound potentials for application. NSFC encourages mathematical modeling of practical problems, analysis and computation, and statistical methods and theory for big data, supports research on mathematical physical logic, algorithm complexity, discrete probability modeling, optimal algorithm, and combinational algorithm. Focus is given to applied researches such as mathematical modeling and theory of new materials, uncertainty theory in data processing, coding theory and information security, mathematical modeling and analysis in environmental and energy sciences, bio-information and life system, pathogenesis and control of infectious disease, mathematical methods for complex bio-process and development of diseases, statistical methods in industry and medical science, statistical and optimization method in deep learning and artificial intelligence, modeling and analysis in economic prediction and financial risk management, and mathematical theory and new method for industrial, medical imaging and image processing.

Division of Mechanics

Mechanics (A07–A13)

The Division mainly supports research on dynamics and control, solid mechanics, fluid mechanics, biomechanics, physical mechanics, explosion and impact dynamics, and environmental mechanics. The Division supports projects with creative ideas in the frontiers of mechanical research on the one hand and projects closely related to the sustainable development of economy, society and national security, and the development of engineering and technology on the other hand. The Division supports interdisciplinary research and encourages experimental research using the available experimental facilities and key labs in China and advocates the research and development of engineering analysis software in computational mechanics.

Applications for research in areas of dynamics and control should pay attention to the theory, methods and experimental studies on nonlinear dynamics and control of vibration and noise in frontiers of the discipline and major national needs, strengthen research on complex systems such as non-smooth system, uncertain system, random system, new structure and flexible system, the coupling of solid, flexible bodies, and multi fields interactions. The Division encourages studies on flight mechanics and space environmental dynamics, analytical mechanics and multi body dynamics, and key issues of dynamics and control problems in major engineering projects, and encourages experimental studies on dynamics and control.

Applications in the area of solid mechanics should pay attention to international frontier and creative ideas, give more consideration to intercrossing with physics, materials science, chemistry, information and biological sciences, and strengthen on proposing and studying topics in major engineering application, expand basic theory of continuum mechanics, and promote the development of multi-scale mechanics and multi-field coupled mechanics. Proposals in such areas will be encouraged as follows: the constitutive theory of materials at macro, meso and micro scales; the theory of strength, crack, fatigue and failure mechanism; the mechanical behavior of new materials and structures; experimental measurement techniques and representation methods, new theory and method in computation mechanics and high performance computational software, structural response, optimization and completeness evaluations.

Applications in fluid mechanics should pay attention to studies on the laws and mechanisms governing complex flows. The Division encourages researches on micro-nano scale flow, rarefied gas flow, hypersonic aerodynamics, aerodynamic noise, measurement techniques in experimental fluid mechanics, flow control technique, new methods in CFD and high performance computational software, especially theory, simulation and experimental studies on high temperature, high pressure and compressible turbulent flow, high speed hydrodynamics, multi-phase complex flow, non-Newtonian flow, and key fluid dynamic problems in aerospace, energy, ocean and transportation areas.

Applications in biomechanics should pay attention to bio mechanical and mechanical biology problems related to human health and disease, life process, biomechanics and biology in sports, mechanism and transformation medicine related to diseases such as cardiovascular, bone joint and cancer, rehabilitation, tissue engineering, bio-material and bionics, medical materials and equipment, and public health related areas, and encourage experimental studies and software development on biomechanics.

Applications for explosive and impact dynamics should pay attention to frontier areas and major national needs, focusing on studies of the dynamic mechanical behaviors of materials, structural response to explosive impacts and detonation mechanisms, dynamic loading and diagnosis, strengthen mechanism of explosive energy release and encourage studies on dynamic response of material and structure in multi field coupling under extreme dynamic loading environment and protection of human bodies.

Applications for environmental mechanics should pay attention to basic theory of rock mechanics, environmental fluid mechanics, mechanics in extreme conditions and disaster damage, experimental method and numerical methods. The Division encourages studies on wind-sand and water-sand disasters water pollution, urban smog, and rock deformation, damage and mechanism of disaster formation.

The Department continues to support studies on instruments, new experimental methods and techniques with innovative ideas. The Department will keep supporting projects in computational software development, giving stress on the integration and standardization research on the development of the computational mechanics software which may produce independent or shared IPR.

Division of Astronomy

Astronomy (A14–A19)

The Division mainly supports researches on astrophysics, basic astronomy, astronomical instruments and technology. In accordance with the trend of astronomical development in the world and the present situation in China, the Division supports research proposals with emphasis on the

development of technology and instrumentation. Studies based on existing observation apparatus or facilities to be built soon in China will be encouraged. The Division promotes the combination of innovative ideas, observation and theories, and studies on new technologies and methodologies for astronomy, especially those closely related to mega-science projects under construction in China. Interdisciplinary research is strongly encouraged so as to gradually build up research teams with special features and influence in international scientific communities. International cooperation and exchange will be given much attention.

In the General Program projects funded in recent years, a good balance has been achieved between astrophysics (including galaxies and cosmology, stellar and interstellar medium, solar and planetary system), basic astronomy (including astrometry and celestial mechanics) and astronomical instruments and technology and methods. Young researchers have become the main force in astronomical research and more than half of the awardees are under the age of 40.

In 2021, in addition to strengthen continuous support for projects integrating theory and observation and projects conducted by young scientists, the Division will emphasize on interdisciplinary research with physics, space science, earth science and information science, etc., maintain support on research on advantageous directions, promote research related to using large observatory facilities in China, and foster research topics that have the potential of making breakthroughs. The Division encourages research on basic physical process of celestial bodies, celestial chemical evolution, and celestial bodies in the solar system, extra solar system planetary system, infrared astronomy, space astronomical measurement, and astronomical research that addresses the national needs. The priority will be given continuously to researches in basic astronomy, astronomical technology and methods, and to relative small scaled astronomical research institutions.

In the next few years, the Division plans to give special support to pre-research around the research based on equipment that has already been built or being built, and conceptual studies on new technologies that are urgently needed for large-scale telescope and space exploration. For applicant in these research areas, please mark “Major S&T Basic Facilities Project” or “New Astronomical Technology” in the application forms.

Division I of Physics

Physics I (A20–A24)

The funding scope of the Division covers research on condensed matter physics, atomic and molecular physics, optics, acoustics and new research areas formed between these four disciplines and other disciplines.

According to the current status and requirements of disciplinary development, the Division pays attention to study on experimental methods and techniques motivated by creative ideas, encourages researches in new computational methods and simulation software closely related to experimental physics and exploratory types, key basic physical issues serving national needs, and new physical concepts and methods in interdisciplinary areas. We encourage especially in-depth and sustained studies on important physical problems that have not become hot topics, and researches in basic physical problems on devices, and new areas and directions.

For the funding in condensed matter physics, the Division will pay attention to quantum physics in electron related systems, macro quantum phenomenon, quantum phenomena and quantum effects in various low dimensional and small-scale systems, solid state quantum information and quantum computation, strengthen self-spinning and magnetism, topological state, physics and device physics and advanced technologies and methods of characterization, structural

and physical properties of surface and interface physic in extreme conditions, and physical problems in energy transformation, transport and storage, and expand physics and application of advanced functional materials. Encouraged areas include physical issues and experimental methods related to soft matters, biophysics, and AI. The Division pays special attention to creative studies on material, device and physics having important application prospects.

For areas of atomic and molecular physics and optics, the Division encourages researchers to pay attention to atomic, molecular and cluster structures and dynamics, cold atomic and molecular physics and interactions with optical fields, interactions of atomic and molecular systems, interactions between laser and atoms, propagation process of light in new media and its characteristics, quantum frequency markers, quantum metrology, quantum information, physics and methods of precision atomic and molecular spectra and precision measurement, strengthens basic and applied research on high resolution, high sensitivity laser spectrum, micro nano photonics, optical mechanics, surface plasma exciter and optical field regulation. The Division encourages research on frontier physical issues in photonics, optical electronics and interdisciplinary subjects.

In the area of acoustics, according to the major needs, studies on key fundamental acoustic problems will be encouraged. Physical acoustics and interdisciplinary research in marine acoustics, ultrasonic and acoustic effect, noise and control, new acoustic materials and devices, acoustic energy exchanger, and issues in information technology, etc., will be in priority.

In recent years quantum science and technology are developing fast. According to the development trend, the Division adds the area of quantum regulation, so as to promote research in related material and physics, new quantum structure, quantum effect and applications. The Division encourages exploratory studies on precision measurement physics, quantum computation and communication, and quantum simulation, and research on quantum device physics and new quantum techniques. Focus will be given to condensed matter physics, atomic molecular physics and optics, and interdisciplinary research on information science and material science.

Division II of Physics

Physics II (A25–A30)

The Division mainly supports research on fundamental physics, particle physics, nuclear physics, accelerator, reactor and detector, plasma physics, and nuclear techniques and applications.

For fundamental physics, funding will be focused on original studies and interdisciplinary research with other disciplines. Stress will be given to important theoretical physical issue arising from scientific experiments and applications.

For particle physics and nuclear physics, the Division will support creative theoretical and experimental research, in particular, the combination of theoretical and experimental studies related to selected large-scale experimental facilities that are in operation, upgrading or to be completed soon both in China and abroad. Funding will be used to guide research towards the understanding of important physical rules related to the latest experimental results, such as the theory and experiments of phenomenology in particle physics and interdisciplinary research of nuclear physics under extreme conditions with nuclear astrophysics and other disciplines.

For support to nuclear technology, accelerator, reactor and detector, low-temperature plasma and synchronized radiation method and technology, it is hoped that fundamental issues should be drawn from the disciplinary development, national demands and intercrossing with other disciplines, which may facilitate a deeper understanding of physical laws underlying the development of the disciplines and important applications at the same time. Emphasis will be laid on key technologies and innovative ideas in methodology and intercrossing with other disciplines.

In addition, the exploration of mechanisms and rules governing the interaction of matter with instantaneous, high energy, high power and strong field radiation (such as charged particles, X/γ, neutron and electromagnetic fields) are key areas for funding. Attention will be given to new acceleration principles, nanometer micro-beam, high power ion beam, strong current accelerators, plasma radiation source in accelerator and detector and plasma research, and physics and key technologies of all other advanced radiation sources. The Division gives strong support to new types of nuclear detection technology and method such as large area, high counting rate, high temporal resolution, low cost and weak signals, etc., and relevant studies on nuclear electronics.

For nuclear fusion and plasma physics, more attention will be given to the exploration of new diagnostic means related to large facilities which are in operation at present or will be built soon. In particular, basic research on advanced magnetic confinement fusion and new approaches to inertial confinement fusion and related fundamental physical problems, and computer simulation and experimental studies of various kinds of plasma will be stressed.

In order to make more efficient use of limited funds, the Division encourages researchers all over China to make full use of big science facilities, small and medium equipment to conduct research, so as to achieve sustainable development in the research. The Division encourages experimental studies with innovative methods of high resolution diagnosis and detection, and, as well as the development of experimental facilities, detection and diagnosis devices which are important for the development of accelerators, detectors and gravitational wave detection. Applicants may increase the funding request in applications in these areas according to the actual needs. Projects with more young scientists involved in the research team under the same condition will be preferred.

Department of Chemical Sciences

Chemistry is the science that deals with the composition, structures, properties, reactions and transformations of matters, which plays a central role in multidisciplinary crossing and integration. Chemical engineering, involved as the unique industrial characteristic of the chemistry subject, aims to realize large-scale production by applying the principles of transfer and conversion of matters and energy, and ultimately to construct substantial foundation for essentials and sustainable development of human society.

The Department is dedicated to raise the overall quality and international status of China’s fundamental research, and the creative talents and groups with international impact in the fields of chemistry and chemical engineering. Specifically, the Department stimulates and financially supports multi-scale research on the reaction, process and function at different levels of atoms, molecules, molecular aggregation and condensed state. Studies on complex chemical systems are also encouraged to secure the precise control and logic cognition of chemical synthesis, process and function. Moreover, the Department is focused on expanding knowledge of chemistry and chemical engineering in multiple research fields, such as biology, materials, energy, information, resources, environmental science and human health, targeted at the major issues confronting economy, society, national security and sustainable development. Accordingly, the projects awarded by the Department basically focus on the frontier research in chemistry and chemical engineering through various strategies, including the combination of microscopy and macroscopy, statics and dynamics, theoretical chemistry, empirical approach and precise analytical technologies, and fundamental experiments and process engineering. In addition, innovative and interdisciplinary research works addressing new theories, technologies and achievements from other disciplines are highly encouraged.

The Department will consistently promote innovative and high-quality research in the cutting-edge fields, with a focus on in-depth and systematic research works, and a priority support to proposals on the basis of multidisciplinary crossing and integration. The Department rewards creative projects by placing emphasis on the research diversity of ideas, methods and contents, whereas research similarity and combination are highly discouraged. Besides, the Department will make every effort to support original research of a certain risk, so as to overcome innovation bottleneck that limited the rapid development of chemistry and chemical engineering in China, ultimately enabling a breakthrough from high-quantity to high-quality research. In the review process, scientific excellence is the core criterion for selection and discipline development with balance, coordination and sustainability will be comprehensively considered. The aim is to promote the fundamental research of chemistry and chemical engineering in China to the international frontier.

Funding in Department of Chemical Sciences in 2020

Unit: 10,000 yuan

Divisions	General Program			Young Scientists Fund			Fund for Less Developed Regions		
	Projects	Direct cost	Funding rate (%)	Projects	Direct cost	Funding rate (%)	Projects	Direct cost	Funding rate (%)
Synthetic chemistry	275	17,309	20.21	273	6,512	17.06	49	1,960	15.22
Catalysis and surface/interface chemistry	186	11,726	20.39	193	4,608	17.02	27	1,080	15.00
Chemical theory and mechanism	115	7,247	20.61	80	1,896	16.99	10	386	15.87
Chemical measurement	162	10,205	20.66	137	3,240	17.23	20	800	15.04
Materials chemistry And energy chemistry	333	20,983	20.45	356	8,312	17.44	42	1,680	15.16
Environmental chemistry	225	14,182	20.51	168	4,032	16.99	27	1,080	15.17
Chemical biology	145	9,142	20.39	107	2,544	17.04	21	840	14.89
Chemical engineering And industrial chemistry	374	23,580	20.35	268	6,392	17.06	39	1,560	15.00
Total or average	1,815	114,374	20.42	1,582	37,536	17.14	235	9,386	15.12
Direct cost per project	63.02			—			39.94		

For the selection of General Program projects, the Department received 8,889 proposals in 2020, an increase of 935 proposals or 11.76 % compared with the year 2019. After review, 1,815 proposals were funded with the success rate of 20.42 % and the average direct cost of 630,200 yuan per project. In 2020, the success rate decreased by 0.64 % compared with that of 2019 to guarantee the funding intensity. The proposals received and funded as well as their ratios in the main research orientations of chemistry and chemical engineering were slightly increased compared with that of 2019. There was an increase in received proposals related with the convergence research areas such as materials and energy, life health and environmental resources.

For the selection of Young Scientists Fund projects, the Department received 9,229 proposals in 2020, an increase of 1,214 or 11.76 % compared with the year 2019. After review, 1,582 proposals were funded with the success rate of 17.14 % and the average direct cost of 237,300 yuan per project. In 2020, the success rate decreased by 2.40 % compared with that of 2019. The Department upholds the principle of talents first and fosters innovative talents, brings into full play the maintaining and fostering role of the Young Scientists Fund, and steadily enhances the funding following the idea of properly controlling the funding intensity and further expanding

the funding scope. The Young Scientists Fund stresses on the research projects with innovative ideas, discourages the research that simply continue the advisors' topics, and gives less weight to research accumulation and the constitution of the relevant research teams, so as to facilitate the growth of young scientists.

For the selection of Fund for Less Developed Regions projects, the Department received 1,554 proposals in 2020, an increase of 194 or 14.26 % compared with the year 2019. After review, 235 proposals were funded with the success rate of 15.12 % and the average direct cost of 399,400 yuan per project. In 2020, the success rate decreased by 2.16 % compared with that of 2019. On the basis of stabilizing the funding scale of the Fund for Less Developed Regions, the Department will make efforts to further promote the research quality and efficiency of the Fund, stabilize a batch of research talents for fundamental research, and continuously bridge the gap with the developed regions. Applicants are encouraged to carry out research by taking advantage of the local resources, in order to promote the economic development of the regions in a coordinated way.

Attention: Proposals that have the same or similar research contents cannot be applied by different applicants.

Division I of Chemistry

The Division supports research in the field of synthetic chemistry.

Synthetic Chemistry (B01)

Synthetic chemistry is the science dealing with the creation and transformation of matter, which involves the synthesis and assembly of inorganic, organic, polymeric substances, etc. Synthetic chemistry is to selectively control the process of creation and transformation of molecules and substances, so as to realize the precise preparation and application of new materials with specific properties and/or functions. As the basis of chemical science, Synthetic chemistry actively seeks interdisciplinary interactions and collaborations, searches for solutions to major scientific problems, and boosts the economic and social development.

Synthetic chemistry is to fulfill the demand for new substances, new materials and new devices in the fields of physical sciences, life sciences, and applied science including materials science, computer science and information technology, energy and environmental science. The relevant research activities mainly focus on: seeking rational design and structural control of substances with potential functions, their synthesis/assembly methodologies and reaction processes with high efficiency and selectivity; developing new synthetic strategies, inspired by biosynthesis of living systems, facilitated with the combination of the state-of-the-art research technologies in physics and computation science; exploring the mechanism and rules of reactions and conversion processes, and establishing the corresponding fundamentals and standardized protocols. Synthetic chemistry aims at a safer, greener and more efficient goal, making the synthesis of matter more precise and environment friendly. It will put more emphasis on human health, effective utilization of natural resources, and sustainable development. To this end, the following directions are preferentially encouraged: synthetic chemistry promoted by new reagents, new reactions, new concepts, new strategies and new theory; synthetic methodology of atom economy, precise control and sustainability; biological and biomimetic synthesis rationalized by chemical principles; synthesis under unconventional and extreme conditions; non-covalent synthesis based on intermolecular interactions; molecular design and synthesis of novel functional materials; controlled synthesis and high-performance functionalization of macromolecules; novel substances

and their emerging properties and function.

The Division appreciates the research activities focusing on creation and transformation of molecules and substances, which actively involve interdisciplinary interactions and collaborations, original and fundamental breakthroughs, and substantially supportive and beneficial to industrial applications.

Division II of Chemistry

The Division supports the research in the field of catalysis and surface/interface chemistry and chemical theory and mechanism.

Catalysis and Surface/Interface Chemistry (B02)

Catalysis and surface/Interface chemistry are intended to study catalytic processes and the structure and properties of the surface/interface and to reveal the physical and chemical basic rules of catalysis and the surface/interface.

The areas funded by Catalysis and surface/Interface chemistry include chemical catalysis, surface chemistry, colloid and interface chemistry and electrochemistry. These areas involve surfaces, gas-solid interfaces, gas-liquid interfaces, liquid-liquid interfaces, liquid-solid interfaces and solid-solid interfaces and gas-liquid-solid multi-phase interfaces.

Supports in the field of chemical catalysis are focused on developing new concepts and catalytic theory, discovering new catalytic reactions and creating new catalytic materials, promoting the cross-over and fusion between heterogeneous, homogeneous and biological catalysis, fostering the understanding of rational design and regulation of catalytic active site structures, developing new catalytic characterization methods and technologies with the features of in-situ, dynamic and high temporal-spatial resolution, strengthening the research on catalytic reaction mechanisms as well as structure-performance relationships and the coupling and integration during the catalytic reactions.

Surface chemistry mainly supports the research at atomic and molecular levels on chemical and physical processes related to solid surface interfaces, as well as their correlative characterization techniques and methods. Encouraged research orientations include: solid surface/interface structure, performance and control; dynamics and energy transfer theory in the assembly and reactions at surface/interface; the new methods for physical and chemical processes at surface/interface.

Colloid and interface chemistry supports the research on the usage of new methods and techniques to reveal the essences of colloids and interface chemistry; the design and synthesis of new surfactants and the construction of aggregation; the development of new dispersion systems; the understanding of assembly processes, interface adsorption and filtration behaviors; construction of a colloidal material with self-healing and outfield responsiveness; the enhancement of basic research for applications of colloid and interface chemistry in the fields of material, life science and environment science.

Electrochemistry mainly supports the research including the construction and characterization of electrochemical interface systems; the methods of in-situ electrochemical spectroscopy with high spatial and temporal resolution; the theory and simulation methods of electrochemical systems; surface/interface process in the high-end manufacturing of electronics; recognition and control of electric charge transfer, mass transport and conversion in electrochemical interface; design, synthesis and characterization methods for electrocatalysts;

reveal of problems in the fields of electrochemical energy conversion and storage, electrochemical synthesis, bioelectrochemistry, photoelectrocatalysis and electrochemical engineering and manufacturing.

Chemical Theory and Mechanism (B03)

Chemical theory and mechanism aims to establish and develop new chemical theories and experimental methods to reveal the mechanism and basic rules of chemical reaction and its related processes.

The areas supported by chemical theory and mechanism include theoretical chemistry, computational chemistry, chemical thermodynamics, chemical kinetics and reaction dynamics, structural chemistry, photochemistry and spectroscopy, chemical reaction mechanisms, moletronics and molecular magnetism, polymer physics and polymer physical chemistry, chemical informatics and artificial intelligent.

Chemical theory and mechanism focuses on the new methods of electronic structure theory, dynamics and statistical mechanics, conducting theoretical design and computational simulation of complex systems such as chemical system, material system, energy system and biological system, and the development of computational chemistry methods and software. For chemical thermodynamics, there is a need to develop theoretical and experimental methods suitable for complex systems, revealing the internal logic between microstructures and system thermodynamic properties, and to focus on the applications of chemical thermodynamics in biological systems/energy systems/material systems and other cross fields. Research in chemical kinetics and reaction dynamics focuses on the development and utilization of new experimental and theoretical methods to explore the substantive characteristics of the chemical reaction and the non-adiabatic process during the reaction as well as the chemical kinetics in extreme conditions. Applicants are encouraged to conduct research employing advanced coherent light source and focus on the work of ultrafast dynamics, microstructure and mechanisms of condensed phase. Structural chemistry focuses on the structural characterization and techniques of complex functional systems, controllable synthesis and assembly, dynamic bonding and transformation, and encourages the rational design, construction and application of mew multi-porous structures. Research of photochemistry and spectroscopy should focus on the development of spatial resolved, time-resolved and energy-resolved new technologies and their new assembly methods to the study of photochemical and photophysical mechanism of luminescent and light conversion material. The research of chemical reaction mechanisms will be focused on exploring microscopic mechanism and basic rules of chemical reaction by means of theoretical chemistry, computational chemistry and experimental strategies, clarifying molecular polarization, electronic coupling, and mechanism of spin conversion. Polymer physics and polymer physical chemistry mainly focus on the chain behavior and interaction of macromolecules, the evolution mechanism and control over different scales of the structure, the essence of the connection between microstructure and macroscopic properties. For chemical informatics, it is encouraged to develop algorithms for storage, retrieval, transformation and data mining of molecular structure information based on general system principles. Artificial intelligent in chemistry should base on big data and artificial intelligent technologies, and focus on its application in chemistry, chemical engineering, material, energy, and life science.

Division III of Chemistry

The Division supports research in the field of Materials chemistry and Energy chemistry.

Materials Chemistry (B05)

Materials chemistry is to study the design, preparation, structure, property and application of materials. It is a bridge between chemistry and materials, energy, environment, life, medicine and information science. Materials chemistry is the scientific basis of new material systems. Principles and methods of chemical sciences are used to design new materials at the atomic and molecular levels and to develop preparation techniques and study the structure-activity relationships of materials. It aims to realize the control over the materials' micro, meso, and macro-scopic properties by means of structure function transfer, integration and coordination at multi-scale and multi-level; to study the creation of new high-performance and multi-functional materials as well as their applications in the fields of energy, health, environment and information.

Materials chemistry focuses on the precise preparation of new materials with specific functions, accurate construction and control over the structure and properties of materials, the crossover and integration of multi-disciplinary, the correlation between structure and properties, and the investigation of the molecular basis of material systems using various characterization techniques. Materials chemistry aims to address the major national needs and focuses on the in-depth utilization of characteristic resources in our country.

Materials chemistry focuses on the development of functional materials, which have the characteristics of electronics, optics, magnetism, acoustics and thermology, and those related to biology, medicine and pharmacy. It needs to develop materials of wearable devices and microelectronic system devices. Attentions should be paid to the optimization of structure design of new advanced materials as well as their preparation process using artificial intelligence. There is also a need to develop materials chemistry methods and principles in the processing of advanced materials.

Energetic materials chemistry focuses on the basic issues in storage, release and application of high-density chemical energy, and developing methods in the design and preparation of novel energetic materials such as materials of all-nitrogen structure, ionic type and coordination type.

Energy Chemistry (B09)

Energy chemistry is a science focused on energy conversion, transmission, storage and utilization by applying chemical principles and methods. Its basic task is to investigate new energy conversion and storage mechanisms, design new materials, establish new theories and methods, develop new systems, and create new devices to achieve efficient and clean utilization of chemical energy.

Energy chemistry focuses on clean and efficient utilization of fossil resources, and strengthens the investigation on the preparation chemistry of clean energies such as non-fossil liquid fuels and hydrogen energy, storage materials and their efficient energy conversion. Electrochemical energy focuses on various batteries with power and energy storage which pays attention to the innovative research of electrolytes, battery separators and electrode materials, and to the design and preparation of highly efficient solar cell materials, device assembly and integration. Energy chemistry pays attention to developing materials of energy conversion and storage and optimizing phase-changed energy storage materials. Basic chemical issues in important energy conversion processes such as photochemical energy, thermoelectricity, photoelectricity and

optothermal as well as the conversion of biomass into energies and resources should also be worthy of attention. The utilization of biomass should be focused on catalytic pyrolysis and conversion to high quality liquid fuels.

Division IV of Chemistry

The Division supports research in the field of chemical measurement sciences, environmental chemistry and chemical biology.

Chemical Measurement Sciences (B04)

Chemical measurement sciences aims to develop chemistry-related measurement and analysis theories, principles, methods and techniques, and to develop related instruments, devices and software to obtain the variation rules of the matter's composition, distribution, structure, properties and interactions.

The studies of chemical measurement sciences emphasize interdisciplinarity, and focus on methodological research, instrumental creation based on new principles and development of key technologies. The funding scope of chemical measurement sciences ranges from detection and analysis from macroscopic to microscopic systems with high throughput, high sensitivity and high specificity, aiming at establishing new theories, principles, methods and technologies, and broadening the application of existing technologies in important scientific fields. The research includes theory innovation of chemical measurement, sample treatment and separation, qualitative and quantitative analysis, spectroscopic methodologies and applications, chemical and biological sensing, chemical imaging, material analysis, measured data process, creation of instruments and the development of key technologies, application of novel technology from other fields in chemical measurement sciences, etc.

The priority funding areas for chemical measurement sciences include: processing, separation and identification methods for complex sample; spatial and temporal resolved spectroscopy and chemical imaging; new spectroscopic principle and technology; precise measurement of single atom, single molecule, single cell and single particle; micro/nano analysis and devices; structural and functional analysis of biological macromolecules; in-vivo and real-time detection of living organisms; omics analysis; biomolecular recognition and probes; in-situ and on-line characterization techniques; analysis technology for diagnosis of major diseases; analysis technology under deep space, deep earth and deep sea environment; early warning, screening and traceability of public safety; creation of miniature instruments and devices; chemical measurements based on the big science facility, artificial intelligent in chemical measurement sciences.

Environmental Chemistry (B06)

Environmental chemistry is a science that studies the existence, characteristics, behaviors, effects of chemical substances in environment and the principles and methods for pollution control. It is an important branch of chemical science and the core discipline of environmental science.

Environmental chemistry faces the frontier of the discipline and the national strategic demands, adheres to the problem orientation, and highlights foresight, innovation, crossover and application. Major funding areas of environmental chemistry cover the following branches: environmental pollution and analysis, pollution process and mechanism, pollution control and remediation, environmental toxicology and health effects, environmental theory and computation, radiochemistry and radiation chemistry, chemistry safety and security.

Facing the major issues of ecological environment protection in our country and refining the key scientific issues, environmental chemistry encourages developing new detection technologies and methods, and studying the environmental chemical behavior, ecological and health effects and its prevention and control principles and methods through the combination of laboratory research, field experiment, theoretical simulation and environmental big data. The priority funding areas include: characterization and analysis of pollutants in complex environmental media; tracing and behaviors of emerging contaminants on multi-media interface; new principles and technologies in environmental catalysis; forming mechanism and control techniques of atmospheric combined pollution; pollution process of soil and water and their control and remediation; treatment and utilization of solid wastes; environmental exposure and health effects of new toxic pollutants; environmental behaviors and toxicology of micro- or nano-materials; formation and control of antibiotic resistance of microorganisms; environmental computational chemistry and big data; prevention and control of radioactive pollution and utilization of radioactive nuclides; key chemical issues in the prevention and control of hazardous chemicals and radiation, etc.

Chemical Biology (B07)

Chemical biology utilizes exogenous chemicals to modify or regulate the biosystem precisely at the molecular level by interventional chemical methods or pathways. It provides new ideas and new concepts for life science research via creating new reaction technology and new molecular tools, and promotes the realization of visual, controllable and creative research in life processes (or functions).

Chemical biology focuses on the processes and dynamic rules of important molecular events in life science, and gives full play to the characteristics and creativity of chemical science. The study mainly focuses on those areas: to achieve, explore and regulate the vital activities in real-time, in-situ and in quantitative analysis by constructing and discovering molecular probe; to develop new biocompatibility reactions, achieve modification and labelling of biological molecules by the orthogonal and coupling technology and study the biological functions of biological macromolecules such as protein, nucleic acid, polysaccharide, lipid compounds, as well as active molecular and key ions; to discover the functional or biogenic oriented active natural products with new structure and new skeleton, and reveal their mechanism of action and targets; to establish and optimize small molecule compounds library and screening technology to explore and interfere the biological process in cell, thereby to reveal unknown pathways and new vital activities of interaction of biological molecules, promote the study of signal transduction and gene transcription based on functional small molecules, and realize the identification of drug targets, discovery of biomarkers and development of leading compounds, reveal the bio-function of active molecular; to analyze the biosynthesis mechanism of substance in vital activities, and to synthesize specific target molecule or complete special chemical reaction by using biosystem and/or biological components; to carry out chemical assembly and simulation of complex living system, develop new theory for chemical biology, and reveal chemical essence of life activities, on the basis of creating and developing innovative chemical tools and techniques.

Chemical biology encourages original innovation. It preferentially supports the research in molecular function and functional regulation with molecular probes in major biological events and diseases; encourages the research oriented to solving biological and medical problems by chemical means and methods; strengthens the fundamental research of chemical reaction mechanism and chemical theory of biological system; explores the chemical origin of life and the chemical communication of life system; promotes the interdisciplinary, integration and cooperation of chemistry, biology and medicine.

Young scientists are encouraged to conduct independent and original research. Proposals

without interdisciplinary research will not be supported.

Division V of Chemistry

The Division supports research in the field of chemical engineering and industrial chemistry.

Chemical Engineering and Industrial Chemistry (B08)

Chemical engineering and industrial chemistry is to study the flow, transfer and reaction in the conversion processes of matter and the relationship between them. The tasks include to recognize the transport, reaction phenomena and laws in the conversion processes of matter, and its mechanism on the process efficiency and properties of products; to study the theories, methods and technologies for efficient conversion of matter; to develop new technologies, new processes and new equipment suitable for industrialization. Chemical engineering emphasizes the research on "engineering science" and the integration with other disciplines such as chemistry, material, biology and information, etc. Chemical engineering provides scientific basis for national major demands such as modern manufacturing industries, energy security, strategic emerging industries and life and health.

Chemical engineering and industrial chemistry emphasizes the research on process engineering, system engineering, products engineering and multiscale science. In recent years, facing the major application demands and scientific frontier, chemical engineering and industrial chemistry encourages researchers to study the key scientific issues of application and to develop scientific frontier theories, methods and technologies. The recent research is more focused on the regulation, measurement and simulation in micro-/meso-structure, interface and mesoscales, the processes intensification and scale-up rules, and the uncommon and extreme processes as well as the relevant information and intellectualization research. The research further expands from chemical engineering to the product engineering and integrates with new fields such as life and health, ocean, electronic information, new materials and new energy.

Innovative research work with chemical engineering feature is encouraged. Chemical engineering and industrial chemistry preferentially supports the research in spatial and temporal dynamic structure at mesoscale, chemical big data and intelligent processes, system security in chemical engineering, thermodynamics, transport and reaction under unconventional conditions, green chemical engineering, clean transformation and high-value utilization of resources, agriculture and marine chemical engineering, green biological manufacturing, product engineering as well as the fundamentals of chemical science related to material, energy, resources, environment and health, etc.

Department of Life Sciences

Life science is one of the most active frontier fields of modern science to explore life phenomena and their basic laws. As a guarantee of national population health, food security, food safety and ecological civilization, life science is an important support for technological progress and industrial development. Life science research is closely related to national economic and social development, and plays pivotal dual roles in promoting scientific exploration and supporting of national strategic needs.

The Department has been encouraging researchers to carry out original study with

innovative academic ideas, as well as novel technology and approaches, particularly for those playing a pivotal role of promoting the development of related disciplines with authentic ideas. Emphasis will be put on proposals with novel theories, firm hypotheses and the interdisciplinary importance based on previous research over a long period of time. The Department will pay attention to important frontiers and new emerging fields in life sciences in the future, while keeping a balanced and harmonious development among various disciplines. In line with the principles of "encouraging exploration, highlighting originality; focusing on the frontier, creating novelty; demand promoted, breaking through bottlenecks; common orientation, cross-disciplines", scientists are encouraged to aim at basic scientific issues both in the frontier of science and the major national needs. The Department implements the funding policy depending on the performance of previous funded project, and gives preferential consideration to applicants with good performance in their previous projects under equivalent conditions.

Due to the frequent occurrence of infectious diseases and zoonosis caused by various pathogenic microorganisms in recent years, which has caused great harm to social and economic development and people's health, it is particularly urgent to strengthen basic research in related fields. Although the Department has funded many fields closely related to the origin, evolution, transmission, genetic variation, infection and vaccine research and development of viruses and other pathogenic microorganisms, there is still a lack of knowledge about viruses and new pathogenic microorganisms. Therefore the related research needs to be emphasized and deepened. In the future, the Department will actively encourage scientific researchers to carry out systematic research in fields related to virology, pathogenic microbiology, immunology, and will also pay close attention and provide stable support to the above encouraged research fields in the funding process.

Since 2021, the application codes of all disciplines in the Department have been set as a two-level structure with only the first level application code and the second level application code. Numeral research directions have been set under the second level application code. Applicants should pay attention to the research direction under the second level application code.

Attention:

(1) In the explanation part of the *Guide* of the Department, as well as of all the disciplines, the funding scope is emphasized and the categories that will not be accepted have been clearly noted. Therefore applicants should read carefully according to their subject of application.

(2) Concerning applications related to operation with highly pathogenic microbe, applicants should abide by national regulations concerned, and perform under bio-safety qualified conditions.

(3) Projects involving animal experiments shall comply with relevant national regulations and requirements of animal ethics and welfare.

(4) The application code should be specified to the final level. Applications fail to provide the detailed code will be declined. Please refer to the discipline guides for specific requirements on application codes.

In addition, the Department has made the following requirements for ethics-related research applications in biomedical research:

(1) To carry out research in the field of biomedicine, researchers must abide by the relevant provisions of the state, respect internationally recognized bioethical norms, and abide by the relevant requirements of the state for ethical research.

(2) Biomedical research involving human beings must provide the review opinions of ethics committees of the supporting units or their superior departments in the application form.

(3) Applications involving multi-unit participation in ethical research should be supported by certification documents examined and approved by each participating unit or the ethics committee of the competent department at a higher level.

(4) When overseas institutions or individuals cooperate with domestic medical and health institutions to carry out research and declaration fund projects involving ethics, they shall issue certification documents for examination and approval by ethics committees provided by domestic relying units.

(5) For research projects that need to sign informed consent, the process and procedure of signing informed consent should be described in the application form.

(6) If the ethics-related fund project is approved and the research plan is changed during the implementation period, the review opinion certificate of the ethics committee after the change of the research plan shall be submitted to the fund committee again in accordance with the above requirements.

Applicants should follow the requirement of the *Guide* and the application syllabus when writing their proposals. Otherwise, the proposals will not be accepted.

Funding in Department of Life Sciences in 2020

Unit: 10,000 yuan

Divisions		General Program			Young Scientists Fund			Fund for Less Developed Regions		
		Projects	Direct cost	Funding rate (%)	Projects	Direct cost	Funding rate (%)	Projects	Direct cost	Funding rate (%)
Biology I	Microbiology	189	10,960	21.36	140	3,344	18.82	42	1,465	17.21
	Botany	211	12,238	24.62	146	3,504	18.81	67	2,347	17.14
	Zoology	143	8,294	25.54	75	1,800	17.08	25	876	17.12
Biology II	Genetics and bioinformatics	147	8,526	25.70	118	2,792	19.87	20	690	17.39
	Cell biology	109	6,322	26.85	79	1,856	18.24	14	492	17.07
	Developmental biology and reproductive biology	75	4,350	27.47	52	1,208	19.77	8	296	16.33
Biomedicine	Immunology	80	4,640	27.03	60	1,416	22.56	7	252	16.67
	Neurosciences and Psychology	146	8,468	20.28	124	2,960	15.90	16	570	16.84
	Physiology & integrative biology	86	4,988	25.44	48	1,128	18.60	9	330	16.36
Interdisci-plinary research	Biophysics/Biochemistry	116	6,720	27.29	80	1,864	21.16	11	396	16.67
	Biomaterials /Imaging/tissue engineering	106	6,148	20.11	99	2,336	16.92	10	336	17.86
	Molecular biology/Biotechnology	73	4,234	23.86	63	1,504	16.71	5	174	17.24
Environment and ecology	Ecology	190	11,020	20.77	161	3,856	19.83	84	2,942	17.14
	Forestry and grassland science	217	12,586	16.93	163	3,912	14.25	91	3,188	17.14
Agriculture and food science	Agriculture and crop sciences	243	14,094	15.49	205	4,888	13.70	103	3,602	17.17
	Food science	225	13,050	14.06	227	5,432	13.07	74	2,599	17.09
Agricultural environment and horticulture	Plant protection	153	8,874	17.75	138	3,296	17.23	58	2,023	17.21
	Horticulture and plant nutrition	174	10,092	17.33	161	3,840	14.74	84	2,954	17.07
Agriculture animal	Animal husbandry	117	6,786	15.85	100	2,400	14.73	51	1,801	17.00
	Veterinary medicine	144	8,352	17.54	119	2,840	18.71	43	1,489	17.34
	Aquaculture	85	4,930	15.54	88	2,104	15.25	13	438	17.81
Total or average		3,029	175,672	19.54	2,446	58,280	16.45	835	29,260	17.13
Direct cost per project		58.00			—			35.04		

Division I of Biology

The funding scope of the Division covers three disciplines, namely microbiology, botany and zoology.

Microbiology (C01)

The characteristics of basic research supported by the Discipline are focusing on the cutting edge fields as well as with national demand basis. There is an obvious lack of balanced development of different branches in microbiology, observed based on previous years of grant application and funding situation. The number of proposals aiming at study on mycoplasma, rickettsia, chlamydia, spiroplasma, phage, prion, etc., is relatively small, which indicates that the related research team needs to be augmented and intensified. The Discipline encourages researchers to carry out fundamental and authentic studies on resources, diversity as well as biological relevance in the fields listed above.

This discipline encourages microbiologists to carry out in-depth and systematic research around virology and pathogenic microbiology, and strive to promote the cutting-edge theory and technology of virology and virus immune system interaction research. The Division encourages the use of modern technologies such as microbiome and big data in combination with traditional methods to carry out microbial classification research, reveal the systematic evolution and evolution rules of microbial groups with important classification status or application potential, and further strengthen the cultivation of taxonomic talents. The Division encourages microbiologists to cooperate with researchers in the fields of mathematics, physics, chemistry and informatics. Moreover, the following research fields are especially encouraged: single cell, CO infection, microbiomics and epigenetics of microorganisms; enrichment and isolation of difficult to cultivate microorganisms; basic scientific research on pathogenic microorganisms and marine microorganisms; frontier research on the major environmental problems in China. Moreover, the usage of microorganisms as model materials to carry out systematic and in-depth research on the basic and frontier scientific issues of life science are encouraged.

In order to promote the development of novel theories, new technologies and methodology of microbiology, gather academic ideas, research methods and technical means in various fields, break through the barriers of traditional disciplines, as well as solve complex scientific problems, applicants are encouraged to carry on collaboration with ones with mathematics, physics, chemistry, electronics, information, engineering and other backgrounds to devote to the basic research of microbiology.

In 2021, the application code of this discipline has been updated and integrated. The 9 secondary application codes are remained with content adjustment, and each secondary application code has multiple research directions for applicants to choose.

Botany (C02)

With plants as the research object, the Discipline has always aimed to focus on the world's leading edge, based on the national needs, and subsidizes basic research projects. Research interests include plant taxonomy, plant phylogeny and evolution, plant photosynthesis and nitrogen fixation, transportation and metabolism of water and nutrients, interaction between plant and environment, plant hormones and growth regulators, plant reproduction and development, protection and utilization of plant resources, phytochemistry and secondary metabolism, new technologies and methods of botany research, etc.

It can be seen from the applications accepted and funded in recent years that the development of each branching field within the Discipline is unbalanced. There are relatively more applications in areas such as plant phylogeny, plant hormone, growth and development, and

resistance physiology, and therefore the research quality is relatively high. On the other hand, there are fewer applications in the fields such as paleobotany, biological nitrogen fixation, mineral elements and the metabolism, organic synthesize and transportation, hydrophytes and ocean plant and resources, etc. Applications that have research basis in the above-mentioned subjects will be encouraged. Systematic and creative research combined with structural biology, system biology and computational biology should be further strengthened henceforth.

The Discipline will pay close attention to natural variation and domestication mechanism of plants, environmental adaptation mechanism of plants, simulation of plant life processes and functions. Applicants are also encouraged to carry out their studies in the fields of phytosystematics, introduction and plant germplasm conservation, plant cell totipotency, molecular basis of plant important traits, interaction between plants and other organisms, and plant response to environmental changes.

The Discipline will continue to give preferential support to plant taxonomy in 2021, especially to strengthen the support to young taxonomists. The discipline encourages applicants to carry out research on species revision of certain families and genus on the world wide range and plant resources research in key areas and special environment. Application of novel technology to plant taxonomy is encouraged.

The interdisciplinary studies of botany with other related fields will be strongly encouraged, especially with mathematics, physics, chemistry, geosciences, information science and technology as well as social sciences. Development of new model plants with important evolutionary positions is encouraged in order to explore special biological phenomena. In order to achieve better use of local advantages, resources advantages, and talent training, the discipline will encourage collaborations among applicants with institutions or groups having unique special advantages.

Special notice for applicants:

(1) Projects accepted under the plant-enticement interaction code (C0205) do not include applications for research related to crops and other cash crops.

(2) Under the application code for Phytochemistry (C0209), it is encouraged to conduct in-depth exploration and functional research on important chemical components in plants, but applications with pharmacological research and structural modification or synthesis research will not be accepted.

(3) In 2021, the application code of this discipline has been updated and integrated. There are 10 secondary application codes instead of 7, and each secondary application code has multiple research directions for applicants to choose.

Zoology (C04)

Zoology studies the life phenomena and principles in animal morphology, taxonomy, physiology, behavior, ecology, evolution and genetics. The effective application of theory and techniques has greatly enriched the research contents of zoology. On this basis, the research of animal resources and protection, wild animal diseases and control, marine animal diversity, development and application of experimental animal models reflect the national needs. With the deepening and integration of various directions of zoology, the interdisciplinary and compatible development characteristics of zoology have been formed.

In the future, the identification and description of unknown species of animals, and revised study of known species of animals will remain the key funding areas by the branching field of taxonomy. Taxonomy of ocean animals should also be highly valued. Key research areas currently focus on the animal phylogeny and zoogeography, as well as the life history around the evolution. The discipline will encourage researches on animal physiology, animal behavior, and the establishment of model animals, etc. Support will be strengthened for researches on conservation

biology for endangered animals, the sustainable utilization of important resource animals, and related biological researches for important alien invasive species and bio-safety. Basic research of zoology for specific species in China and fragility of western and remote areas will be continually encouraged. The Division attaches great importance to the study of experimental animals and animal models, but do not accept the application of clinical medical diagnosis and treatment based on model animals. In addition, the discipline will pay more attention to basic research on zoology; encourage original studies and exploration based on animal resources and regional features in China and the application of new theory and technologies, encourage interdisciplinary research such as animal behavior and neurobiology.

Applications accepted by the discipline in recent years have demonstrated that researches in some subjects have already formed their own features and acquired significant international impact. It can be also observed that not only the formulation of scientific problems as well as rationality of designs, but also the creativeness of academic thoughts of the proposals are greatly improved. However some problems still exist, for example, the excessive pursuit of hotspots without solid research basis, and the lack of justification for proposed research and feasibility of technical routes; the inaccurate orientation of the four scientific classification properties; insufficient experimental accumulation was provided by some of applications, or the description of detailed research progress and contents; some proposals were lack of scientific problem or hypothesis with explicit definition, or overstating research objectives; the budget for research is impractical in some proposals and repetitive application still exist on a small scale.

In 2021, the application code of this discipline has been updated and integrated. There are 8 secondary application codes instead of 11, and each secondary application code has multiple research directions for applicants to choose.

Special notice for applicants: This discipline does not accept the application of medical research only using model animals as research materials, the application of applied research using livestock and poultry as research materials, and the application of agricultural pest related research.

Division II of Biology

The funding scope of the Division covers the following three disciplines: genetics and bioinformatics; cell biology; and developmental biology and reproductive biology.

Genetics and Bioinformatics (C06)

Genetics is to study the inheritance and variation of organisms on various levels of molecules, cells, individuals and populations. Bioinformatics is an interdisciplinary field of biology and computing science, aiming at the exploration and improvement of methods and means to obtain, store, manage and analyze biological data. The discipline of genetics and bioinformatics encourages the combination of bioinformatics analysis and experimental verification, and encourages trans-disciplinary applying new theories, methodologies and technologies. Moreover, research on the genetic basis of human phenotypes, behaviors and diseases will be specially favored.

The genetics discipline will give priority support on the following fields: the study of genomic variation and evolution law of complex biological characteristics; study on the genetic and epigenetic basis of human diseases; studies on basic genetic laws and the molecular mechanisms of gene expression and regulation by using model organisms; the establishment of genetic operating system, new methods and technologies of phenomics and genetic breeding; basic researches on the

genetic law of typical resources, major agriculture crops, microbe, etc.; and the molecular basis of genetics and variation of organisms under extreme or special environment; novel genetic fields such as genetic editing, chemical genetics, photo-genetics, phenotype-nomics, 3D/4D genomics, algorisms and methodology in biological big data, etc.

As for bioinfomatics, future funding directions and key areas will be focused on the following fields: developing new theories, algorithms and analytical techniques of bioinformatics and computational biology; genomics and epigenomics, transcriptome and epigenomics, phenomics; integrating genomics data and system biology analysis; research on methods of integration, standardization and visualization of large biological data; machine learning and in-depth learning of biological data; virtual reality display of biological data; design and synthesis of molecular modules and networks and research on biological networks, etc.

In 2020, the numbers of applications received in areas of population genetics, animal genetics, network model of biological system and simulation and construction of biological loop were relatively small. Whereas those fields are pivotal concepts in classical genetics or bioinfomation research, the discipline will prioritize proposals with solid previous studies and novel scientific questions in the above branches. In 2021, the discipline continues to encourage original studies on combination of bioinformatics analysis and bio-experimental verification. The Division will continue to support projects to further explore the basic mechanisms and laws of genetics and epigenetics, methodology research on multi-level data integration and analysis of the formation mechanism of complex traits, and research on efficient and high-performance computational genetics methods for genomic big data analysis.

In 2021, the application code of this discipline has been updated and integrated. There are 9 secondary application codes instead of 8, and each secondary application code has multiple research directions for applicants to choose.

Cell Biology (C07)

Cell biology is a fundamental and cutting-edge subject to study the principles and mechanisms of cell life activities, mainly aiming at revealing the structure, function, phenotypes and regulation mechanism at molecular, cellular and individual levels within organisms, as well as studies on cytological mechanisms of phenotype and functional abnormal occurrence of organisms.

Studies on the structure and function of cell and subcellular machinery have been the major aspects supported by the discipline. Applicants are encouraged to carry out integrated studies on the mechanisms of synthesis, modification, degradation, localization, and translocation of protein with the aggregation, dissociation, location of its components, and the activity diversification with time and space of protein complex during the process of cell signal transduction with dynamic change mechanisms of life activities of cells. Highlight will be given to endeavors on solving important problems in basic cell biology upon using cell models or model systems, in combination with techniques and methods of genetics, developmental biology, chemical biology, and cell imaging technologies, etc.

Among the applications accepted in 2020, there were fewer applications in areas of cell movement, intercellular interaction, and single cell study. Whereas the above areas are pivotal in cell biology and have foundations in related researches in China, the discipline will prioritize funding to applicants who present their proposals with scientific issues from their solid research background on these aspects. In 2021, the discipline will continue to emphasize on functional and mechanism issues, highlighting the utilization of various novel research technologies and methodologies in cell biology. The discipline will actively promote the development of techniques in cell in situ and real time, dynamic and high-resolution analysis, and highly value integrated researches from molecular to cellular and individual levels, so as to reveal different molecular

mechanisms closely linked with cell function and biological effect and regulation network.

In 2020, some applicants did not pay enough attention to medical ethics issues, and submitted projects without ethical review for the research involving human subjects, which should be paid special attention to.

In 2021, the application code of this discipline has been updated and integrated. There are 9 secondary application codes instead of 19, and each secondary application code has multiple research directions for applicants to choose.

Developmental Biology and Reproductive Biology (C12)

Developmental biology and reproductive biology is a science that studies the basic biological laws in the process of formation, development, growth and aging of multicellular individuals.

This Discipline focuses on the basic laws of gametogenesis, fertilization, embryonic development, organogenesis, homeostasis, aging, damage repair and regeneration, identification, establishment, reprogramming, pluripotent stem cell induction and other important biological processes of human, animal and plant.

Modern developmental biology and reproductive biology emphasize on the continuity of development and dynamic process of change, emphasize the collaborative function of multi-cells and multi-genes, value the relationship of development and diseases, and encourage the exploration of molecular regulating mechanisms of development and reproduction by using model organisms. Applications will be encouraged on the creative development of research methods and systems, as well as the establishment of model diseases concerning development and reproduction, so as to provide basis for clinical transformation.

In 2020, the number of project applications for this discipline increased steadily. The number of project applications in the fields of early embryonic development, tissue and organ development and regeneration, stem cells, early germ cells, and reproductive abnormalities and infertility has been keeping at relatively high level. Some projects were able to aim at the forefront of science with accurate topics and high starting point. The research in the field of reproductive biology was generally closely combined with the important scientific issues in the field of human reproduction, with scientific questions covering both basic and practical considerations.

In 2020, some applicants did not pay enough attention to medical ethics issues, and submitted projects without ethical review for the research involving human subjects, which should be paid special attention to.

In 2021, the application code of this discipline has been updated and integrated. There are 8 secondary application codes instead of 5, and each secondary application code has multiple research directions for applicants to choose.

Division of Biomedicine

The Division covers the following three disciplines: immunology, neurosciences &psychology, and physiology & integrative biology.

Immunology (C08)

Immunology studies the structure and function of immune system. It has been a frontier and leading discipline, bridging biology to clinical medicine.

This Discipline mainly supports the following fields: development and aging of innate

immunity and adaptive immune system; activation, differentiation, migration, tissue distribution and functional regulation of immune cells and their subsets; structure, function and effect mechanism of immune molecules; genetic basis and epigenetic regulation of immune response and related diseases; cellular and molecular mechanism of immune tolerance and autoimmunity; molecular and cellular mechanism of mucosal immunity and local immune characteristics and regulation mechanism of tissues and organs; neuroendocrine immune network, metabolism and immune regulation; mechanism of primary and acquired immunodeficiency; occurrence, development, regression and intervention of infectious and non-infectious inflammation; regulation and intervention of reproductive immunity; mechanism and tolerance of transplantation immune rejection strategy; vaccine, antibody and immune intervention.

It is clearly demonstrated from the applications in 2020 that the number of projects applied to this discipline has increased steadily, and the number of projects applied in vaccine, adjuvant and delivery system and neuroimmunology has increased significantly compared with that in 2019. The number of projects in the fields of immune system development and aging, immune genetics, epigenetic regulation, and reproductive immunity kept roughly the same as that in 2019, which was relatively small. On the other hand, the proportion of funding for virus immunization and vaccine related fields has been appropriately increased in 2020. It is worth noting that some of the projects applied in 2020 have inaccurate understanding of the classification of scientific problems, especially the "encouraging exploration and highlighting originality" category. In total the discipline accepted 294 general projects, of which 39 (13.3%) in the "encourage exploration, highlight originality" category, but most of the projects were not funded due to lacking of originality.

In 2021, the discipline will support applications with creative academic thoughts; encourage applicants to concentrate scientific problems from their former research and practice to carry out in-depth exploration of mechanisms targeting at specific scientific target; encourage the establishment of typical research system and techniques platform, and highlight the setting-up and application of various novel methods and techniques in immunological studies; encourage study in areas of systems immunology, immunomics and computational immunology; encourage basic research relating to the structure of immune system and abnormal function, and the close cooperation of scientists working in basic and clinic studies.

In 2021, the application code of this discipline has been updated and integrated. There are 8 secondary application codes instead of 14, and each secondary application code has multiple research directions for applicants to choose.

Neuroscience and Psychology (C09)

The funding scope of this discipline includes neuroscience, psychology and cognitive science. The key scientific question of neuroscience research is to analyze the essence of human nervous activity, from primary sensation and instinctive behavior to advanced language, learning, memory, attention, consciousness, thinking and decision-making, etc. Psychology is the science of studying human psychology and behavior, aiming at clarifying law and mechanism of occurrence, development, expression and function of psychological phenomena such as personality, cognition, emotion, motivation, thinking, consciousness, and decision-making. Cognitive science is a science that studies the nature and law of cognition and intelligence including cognitive and intellectual activities at all levels and aspects including perception, attention, memory, reasoning, choice, consciousness and even emotional motivation.

The number of applications in 2020 clearly indicated that the development of neuroscience and psychology was imbalanced. A large number of the proposals submitted and projects funded are focused on molecular and cellular neurobiology, behavior and emotional neurobiology,

structure and function of nervous system, cognitive psychology, developmental and educational psychology, whereas there are fewer applications in fields of novel technology and paradigm of cognitive simulation, computing and artificial intelligence, neuroscience and psychology.

In 2020, some applicants did not pay enough attention to medical ethics issues, and submitted projects without ethical review for the research involving human subjects, which should be paid special attention to. Besides, it is also worth noting that some of the projects applied in 2020 have inaccurate understanding of the classification of scientific problems, especially the "encouraging exploration and highlighting originality" category.

In 2021, the discipline will continue to encourage the exploration of the neurobiological basis of cognition and behavior, through analysis at different scales, such as micro, mesoscopic and macro scales. Interdisciplinary studies will be encouraged to clarify the occurrence, development and mechanism of nervous system diseases at the molecular, cellular and body levels. Cross-species neuroscience research is encouraged for perform research or develop novel technologies and methods to solve bottleneck problems. Psychology and cognitive sciences will continue to support the dominant areas, while encouraging interdisciplinary integration, using modern neuroimaging, genomics, deep brain stimulation, big data analysis, longitudinal tracking, computational models and other technologies and methods to promote in-depth research on psychological activities and cognitive processes and their material basis, and to encourage the development of new theories, technologies and models.

In 2021, the application code of this discipline has been updated and integrated. There are 14 secondary application codes instead of 3, and each secondary application code has multiple research directions for applicants to choose.

Physiology and Integrative Biology (C11)

Physiology and integrated biology are the basic disciplines of biomedicine, which study the phenomena, laws and regulation of organism's life activities. The scope of funding includes the functions of various systems in physiological state and mechanism of their homeostasis maintenance, the structural, metabolic and functional imbalance of cells, tissues and organs in pathophysiological state, and innovative research on the interaction and functional integration of cells, tissues, organs and systems. The discipline also encourages research on mechanisms of stress, adaptation and compensation for organisms in special environments or diseases.

The core funding areas include: the mechanisms of heart and blood vessel homeostasis maintenance and imbalance; hematopoietic regulation, coagulation and fibrinolysis, blood cell function and abnormality; respiratory system function and abnormality; digestive system function and its regulation mechanism; urinary system function and its regulation mechanism; classical and non-classical endocrine tissue and organ function and regulation; nutrient and energy metabolism regulation and imbalance mechanism, the role of trace elements homeostasis regulation, structure and function of ion channel/transporter; neuroendocrine immune regulation, interaction regulation between nervous system and other tissues and organs; maintenance and regulation mechanism of reproductive system function; mechanism of structure, function regulation and abnormality of movement related tissues and organs; mechanism of movement improving body function and promoting health; regulation and abnormality of sensory organ function; biological rhythm and physiological mechanism of aging; human tissue anatomy and embryology.

It is worth noting that the following common problems reflected from applications in 2020: (1) some of the projects applied had inaccurate understanding of the classification of scientific problems (especially the "encouraging exploration and highlighting originality" category); (2) the author's contributions were not correctly marked in some applicants' papers following publication common view; (3) some applicants did not pay enough attention

to medical ethics issues, and submitted projects without ethical review for the research involving human subjects.

In 2021, the discipline will continue to encourage the comprehensive research on traditional, cutting-edge and original technologies, and those carrying out in-depth multi-level integrated investigation; encourage interdisciplinary research, especially those armed with various novel technologies to further improve and expand the research frontier of human physiology and injury adaptability; and encourage the research in the field of pathophysiology.

In 2021, the application code of this discipline has been updated and integrated. There are 9 secondary application codes instead of 18, and each secondary application code has multiple research directions for applicants to choose.

Please note in particular that applications concerning researches about plants, traditional Chinese medicine, wild animals (except comparative physiology) and livestock are not accepted in this discipline.

Division of Interdisciplinary Research

The Division covers disciplines as follows: biophysics and biochemistry, molecular biology and biotechnology, and biomaterials, imaging and tissue engineering. The Division encourages applicants to challenge the existing research paradigm, propose new research directions through transdisciplinary and interdisciplinary convergence, and generate subversive academic ideas; besides, the applicants are also encouraged to make innovations and breakthroughs in technology and methods based on multi disciplines and multi perspectives, so as to solve the existing important scientific problems in the field of life science.

Biophysics and Biochemistry (C05)

Biophysics and biochemistry is a cross discipline, applying the theory and method of physics and chemistry to investigate mechanisms of biological problems and phenomena, to study chemical composition of living organisms as well as chemical changes during the process of life, and to investigate the life phenomena and activities of life process at the level of biological molecules. By exploring the characteristics of biomolecules and their interactions, this discipline has gradually expanded to grasp the whole process of important life activities, showing a distinct progressive characteristic.

The funding scope of this discipline mainly includes: structural biology, molecular biophysics, cell sensing and environmental biophysics, physical biology, protein, peptide and enzyme biochemistry, sugar and lipid biochemistry, nucleic acid biochemistry, inorganic biochemistry and environmental monitoring, biological process and metabolism, etc.

Considering the contents of applications received in recent years, fields with more applications as well as more approved grants are the following: structural biology, interaction of biomacromolecule, biochemistry of protein and polypeptide, biochemistry of enzyme, modification of biomacromolecule, etc., whereas the application and research of environmental biophysics, physical biology, systems biology were less funded.

The discipline encourages cross-disciplinary research on biophysics and biochemistry, especially the application of new theory, disruptive ideas as well as novel technology to consider life activity from a different angel. In order to further encourage the research work with original scientific significance and respond to the relevant needs of national economy, this discipline will give appropriate preference to the applications within the categories of “encouraging exploration, highlighting originality” and “demand traction, breaking through bottlenecks”.

In 2021, the application code of this discipline has been updated and integrated. There are 9 secondary application codes instead of 17, and each secondary application code has multiple research directions for applicants to choose.

Special reminder to applicants: For high-resolution imaging, biomolecular labeling and other instrument investigation projects, please select the corresponding application code of molecular biology and biotechnology. For projects related to molecular modification of biomaterials, please select the corresponding application code of biomaterials, imaging and tissue engineering.

Biomaterials, Imaging and Tissue Engineering (C10)

The Discipline is a branch intercrossing of life science with other research areas, with clear characteristics demand orientation and cross disciplinary interaction. The funding scope covers biomechanics and biorheology, biomaterials, tissue engineering, biomedical electronics, bionics and nano-biology.

The application and approval in 2020 is the following: the field of biomaterials is steadily increasing, currently focused on implantation, interventional biomaterials, genes, drug carrier biomaterials, material surface interface, biocompatibility, safety, etc.; in tissue engineering field, most projects focused on bone and cartilage tissue engineering, oral tissue engineering, stem cell transplantation and tissue regeneration, but there were lack of proposals on other important organ tissue engineering, as well as novel methodology; in the sub-discipline of biomechanics, projects were mostly in such fields as biomechanics of cellular and molecular biomechanics and biorheology, cellular-molecular biomechanics, bone and other tissues and organs of the movement, while biomechanics studies on other organs were rare; there was a generally lack of study in the biological image and bioelectronics devices sub-discipline; in the field of nano biology, nano carriers and delivery are dominant, while only a few studies were proposed on nano-bio safety evaluation or nano technology. In addition, there were few applications in the fields of bionics and artificial intelligence, new technologies and methods of biological and medical engineering.

This Discipline encourages applicants to carry out original, systematic and interdisciplinary research in the fields of biomechanics and biorheology, biomaterials, tissue engineering, bioimaging and bioelectronics, bionics and artificial intelligence, nanobiology, and new technologies and methods of biological and medical engineering. This Discipline will focus on: tissue and organ repair and regeneration, biological imaging and nano diagnosis and treatment, cross-scale tissue and organ biomechanics, biomaterial and body interaction, support the research of new biological and medical technologies and methods, and explore the pathogenesis and treatment of diseases by using the principles and technologies of tissue engineering.

In 2021, the application code of this discipline has been updated and integrated. There are 8 secondary application codes instead of 7, and each secondary application code has multiple research directions for applicants to choose.

Special notes for applicants: biomaterial and bionic research other than biology/biomedical applications is excluded in this discipline.

Molecular Biology and Biotechnology (C21)

Molecular biology is a discipline that studies the structure and function of bio-macro molecules at the molecular level to clarify the essence of life phenomena. Biotechnology is a subject of research, development and application of life science technology and methodologies, which provides powerful new technology and methods for the research and development of life sciences. The outstanding feature of molecular biology and biotechnology is the interdisciplinary fusion of biology, physics, chemistry and computer science, providing original exploration and

source innovation for technology breakthrough and method innovation, analyzes and processes the existing knowledge, intergradations of the life system, and finally providing potential solutions for breaking through the related technology bottleneck.

In 2019 and 2020, most projects are focused on synthetic biology, histology technology, gene editing and biomolecular manipulation and application of biotechnology, while there are still lack of research on molecular biology, biomolecular detection technology, protein and vaccine engineering, single molecule and single cell technology, stem cell and tissue engineering, biological imaging, artificial intelligence biology, cutting-edge biotechnology, reagent development and new instrument development.

Funding scope includes: basic theories of frontier technology including pilot theories and principles in the field of molecular biology and biotechnology; synthetic biology and biological transformation technology; biomics technology; generic biotechnology; cross fusion biotechnology; applied biotechnology; and disruptive biotechnology.

In 2021, the discipline will continue to support interdisciplinary and original study, encourage applicants to carry out new technology, new methods and new application research in the fields of synthetic biology, gene editing, *in situ* and *in vivo* analysis of biomolecules, single molecule and single cell analysis of complex systems, multi-scale multimodal imaging, artificial intelligence and computational biotechnology. It should be noted that the determination of sugar sequence and structure is the technical bottleneck of current sugar related research. This discipline will continue to encourage applicants to carry out principle exploration and technology research and development in this field, and will give appropriate preference to them. Meanwhile the subject focuses on the development of reagents and new instruments related to basic research of life science.

In 2021, the application code of this discipline has been updated and integrated. There are 7 secondary application codes instead of 21, and each secondary application code has multiple research directions for applicants to choose.

Division of Environment and Ecology

The Division supports researches in areas of ecology and forestry and grassland science.

Ecology (C03)

Ecology studies the interaction between organisms or between organisms and the environment. It plays a pivotal role in solving the national ecological problems that are getting increasingly important. The scope of funding includes basic and applied basic research in the fields of ecological theory and methods, behavioral ecology, physiological ecology, population ecology, community ecology, ecosystem ecology, landscape and regional ecology, global change ecology, environment and biological evolution, pollution ecology and restoration ecology, soil ecology, conservation biology, and sustainable ecology, etc.

In recent years, significant progress has been achieved in ecological study in China. Ecology in China has made important progress in the fields of system construction and monitoring of field observation stations and experimental platforms, ecosystem response to global change, evolution of important biological groups and conservation biology, whereas traceability research is still common and the overall quality of fundamental ecology needs to be improved. From the perspective of project applications accepted in 2020, the development of sub disciplines is unbalanced: there are more applications in the fields of physiological ecology, community ecology, ecosystem ecology,

soil ecology, global change ecology, conservation biology and restoration ecology etc., while lack of applications in the fields of ecological theories and methods, evolutionary biology etc. There are a small portion of applications, which failed to correctly mark the author's contributions following publication common view. Some of the projects had inaccurate understanding of the classification of scientific problems (especially the "encouraging exploration and highlighting originality" category).

In 2021, facing the forefront of ecological research, the discipline will further give priority to support long-term field observation and research, application of new technologies and interdisciplinary integration, integration and analysis of ecological big data. It will be encouraged to carry on research in biodiversity and ecosystem functions, biological disasters and ecological security, natural ecosystem protection and restoration, and support the development of ecological research on evolutionary ecology and adaptation, ecological model and ecological prediction, and regional sustainable development, etc.

In 2021, applications should accurately grasp the connotation of the four categories of scientific issues, provide accurate information of the academic contribution, highlight the research focus and moderate content, pay attention to the scientificity and feasibility of the technical route, research methods and data processing, and strengthen the combination with the national needs.

In 2021, the application code of this discipline has been updated and integrated. There are 13 secondary application codes instead of 14, and each secondary application code has multiple research directions for applicants to choose.

Forestry and Grassland Science (C16)

Forestry and Grassland science is to reveal the essence and mechanisms of the biological phenomena by taking forest and grassland as its research objects. The scope of funding includes: grass germplasm resources and genetic breeding, grass cultivation protection and utilization, wood physics, forest product chemistry, tree biology, forest soil science, forest cultivation, forest informatics and forest management, forest protection, forest genetic breeding, economic forestry, landscape architecture, desertification and soil and water conservation, and bamboo science.

In recent years, the fields of forest soil science, forest product chemistry, grass germplasm resources and genetic breeding have developed rapidly, whereas the study of forest cultivation, forest management and economic forestry has been shrinking. The project of homologous cloning and heterologous function verification in forest genetic breeding is mostly tracking research, lacking of novel theories and methodology for major breakthroughs. In 2020, the number of proposals submitted such as landscape architecture, forest genetics and breeding, forest product chemistry and wood physics is large, while there are much fewer applications to the sub-disciplines like forest resource science, forest information science and forest management science. As for grassland science, there are more applications for grass germplasm resources and genetic breeding, grass physiology and cultivation processing, and less applications for grassland protection and resource utilization and turfgrass science. There are a small portion of applications, which failed to correctly mark the author's contributions following publication common view. Some of the projects had inaccurate understanding of the classification of scientific problems (especially the "encouraging exploration and highlighting originality" category).

In 2021, the discipline will keep focusing on the national major needs, continue to vigorously promote the development of basic research on forest and grass cultivation, protection and resource utilization; give priority to continuous long-term field research; focus on supporting conventional genetic breeding, formation and maintenance mechanism of mixed forest, relationship between forest management measures and wood properties, grassland utilization and interference mechanism, restoration and function improvement of degraded grassland. The Division encourages

the research on the genetic transformation and gene function verification system of model tree species, the mining and innovation of germplasm resources, and vigorously support the economic resources and utilization under the forest, forage cultivation, storage, processing and utilization.

In 2021, applications should accurately grasp the connotation of the four categories of scientific issues, and provide accurate information of the academic contribution. This discipline doesn't accept the following fields: (1) proposals on pharmaceutical functional verification of effective components targeting at animals; (2) research and development projects for forestry machinery, wood cutting tools, road and bridge design, forest engineering machinery and equipment, forest engineering and civil construction in forest areas; (3) projects in the forest product chemistry field without forest biomass research will not accept.

In 2021, the application code of this discipline has been updated and integrated. There are 14 secondary application codes instead of 15, and each secondary application code has multiple research directions for applicants to choose.

Division of Agriculture and Food Sciences

The Division covers two disciplines: basic agriculture and crop science, and food sciences.

Basic Agriculture and Crop Science (C13)

The Discipline mainly supports basic and applied basic research on crops and their growing environment, aiming at the major needs of national agriculture to carry out basic research with prominent characteristics of "demand traction, breakthrough bottleneck". In recent years, the research fields of this discipline focus on: agricultural informatics and interdisciplinary agricultural production system research, crop yield potential mining, cultivation physiological mechanism of quality improvement and resource efficiency collaborative improvement, crop germplasm resources research and the exploration and utilization of important factors, genetic control network of important traits of main crops, crop molecular design The theory and method of breeding.

In 2021, the application code of this discipline has been updated and integrated. There are 12 secondary application codes instead of 6, and each secondary application code has multiple research directions for applicants to choose. The new application code reflects the interdisciplinary basis of agronomy, the theory and method of crop yield, quality and resistance formation and regulation, the national demand of crop germplasm resources utilization and genetic breeding, crop production process and its key technologies, etc.

It is reflected from the applications in 2020 that there was a climbing number of proposals with basic issues on topics meeting the national demand of agriculture, an obvious increase in interdisciplinary studies around basic agricultural issues. However, major problems remain as the following: (i) researches on crop genome are generally concerned, but more attention is yet to pay on further exploration of mechanisms of physiology and genetics; (ii) following-up work with the international frontier is increasing, but it should be performed in close combination with practical issues of national agricultural production, so that to provide potent support of basic research to applied research; (iii) some of the applications are lack of systematic and sustainable studies; (iv) there are more applications in agricultural information, utilizing physical methods (such as spectrum, infrared, remote sensing, 3D photography) to acquire agricultural information, but there is a lack of in-depth theoretical study, and difficulty exists on actual utilization; (v) some of the proposals are not standardized with inaccurate information, such as untrue or incorrect contents in the resume part, especially in the order of authors for publications, or the list failed to present the real contribution of the applicant and others.

The Discipline encourages applicants to condense scientific issues from the reality of agricultural production in China, aiming at the frontier of the Discipline and the major needs of national agriculture; encourages the development of basic research by combining modern biotechnology with crop agronomic traits improvement; encourages the development of germplasm resources mining and innovative research by using new technologies and methods; and encourages the development of high-yield, light cultivation and resources around crops; encourage crop cultivation regulation and tillage system based on efficient utilization; encourage research on characteristic small crops.

Applications to the Discipline should take crops and crop products as their research objects, and the interdisciplinary studies with other subjects should not depart from the principal object; proposals purely studying agricultural materials, agricultural machinery and facilities will not be accepted. The Discipline does not accept applications with research objects of agricultural animals, animal products, microbe, forest, vegetable, traditional Chinese medicine, algae, woods, and model plants of Arabidopsis thaliana.

Food Science (C20)

Food science studies basic research on food and food materials. In recent years, the Discipline focuses on the following research fields: the selection, regulation and fermentation of food microbial strains with independent intellectual property rights; the preparation of food enzyme expression system and food enzyme engineering; the changing and interaction mechanism of food nutrient components and their processing process; the biological basic research of organic food processing and comprehensive utilization; the regulation of food storage and transportation as well as post-harvest quality control mechanism; formation mechanism, detection methods and control mechanism of food harmful substances; and separation, analysis and formation mechanism of food flavor substances.

In 2020, the number of projects focusing on the actual scientific problems of agricultural production in China has increased, and the trend of carrying out interdisciplinary research around crop production is obvious. Major problems existing in proposals accepted in 2019 include: (i) there were lack of projects to put forward and refine scientific problems according to the bottleneck of food production in China; (ii) some projects focused on process and product development, should pay more attention to the scientific problems behind the industrial bottleneck; (iii) many of food inspection applications focused on detection methods, ignoring the impact of food matrix and practical application goals; (iv) some of the projects followed the international research hotspots one-sidedly, especially food nutrition and food detection, without consideration of the actual needs of food science in China; (v) there were a small portion of applications, which failed to correctly mark the author’s contributions following publication common view.

In 2021, the application code of this discipline has been updated and integrated. There are 12 secondary application codes instead of 9, and each secondary application code has multiple research directions for applicants to choose.

The Discipline continues to encourage projects facing the major strategic needs of the country, bases on the scope of funding, with condensed scientific issues from the actual food production, especially the key technical issues that restrict the food industry in China. It is encouraged to adhere to the guidance of scientific issues, closely focus on the actual food production, and attach importance to traditional Chinese food, special food and food quality and safety. Applicants are encouraged to focus on interdisciplinary research with food science as the main body, integrate new theories, methods and technologies of other related disciplines, and analyze key scientific issues of food science; encouraged to carry out original, continuous and systematic basic research and applied basic research on the basis of their previous work.

The Discipline will not accept the following applications: (i) research on treatment to human diseases; (ii) research on product development of health products and medicines; (iii) research on the growth, development and metabolic physiology of animal and plant cultivation and aquaculture; (iv) research on food machinery, packaging materials and food processing technology.

Division of Agricultural Environment and Horticulture

The funding scope of the Division covers two disciplines: plant protection, horticulture and plant nutrition.

Plant Protection (C14)

Plant protection is a subject that studies the biological characteristics, occurrence regularity and disaster mechanism of crop diseases, insects, grass and rats, and carries out technological innovation on this basis to establish green control strategies for pests. The Discipline covers plant pathology, agricultural entomology, agricultural weeds, agricultural rats and other pest, plant chemical protection, biological prevention and cure, quarantine of agricultural pests, invasion biology, and biological techniques of plant protection, etc. Recently, the theory and technologies of genomics, proteomics, metabolic and molecular genetics are widely applied in the innovation of theory and techniques of pest control. However, basic research of plant protection in China is relatively weak, and especially there is a large gap between China and developed countries in the basic research on functional genomics of the interaction of important pests and crops, mechanisms of pest's virulence and crop resistance (sensibility), law of pest disaster, production and safe utilization of new pesticides with high efficiency, low poison, and environment-friendly property, etc.

The following problems exist in the 2020 applications: (i) some of the projects had inaccurate understanding of the classification of scientific problems (especially the "encouraging exploration and highlighting originality" category);(ii) the topics of some applied projects failed to cut into the urgent problems in China's agricultural production; (iii) some applications simply traced or imitated researches related at home and abroad, or grafted one research method (or material) to another material (or method), with a lack of original ideas; (iv) in some of the applications, the research topics were over broadly laid out, with a lack of concrete of scientific problems, and the research contents were not precise, lack of in-depth studies and substantive subject intercrossing; (v) there are a small portion of applications, which failed to correctly mark the author's contributions following publication common view.

In 2021, the Discipline will continue to encourage the following fields: as for research contents, it is encouraged to carry out explorations of the reciprocity mechanisms of crop-pest-environment (biotic and abiotic) at either microscopic or macroscopic level; principles of disaster of hazardous organisms; monitoring, forecast, prevention and control of pests; and the basic and applied basic research of pesticide toxicology and its safe utilization. Special attention should be paid to new scientific issues, combining with the factors of the national crop of ecological features of different regions, to study the adjustment of industrial structure, improvement of cultivation measures, and the global climate change, etc. On the research approaches, emphasis should be put on the combination of new theory and new technologies with traditional methods, as well as integration of laboratory work with field experiment. For interdisciplinary studies, the specific aim of solving major scientific questions in the plant

protection field should be elaborated. Preferential support will be given to continuous and systematic research.

Application to the Discipline should focus on the research object of crop pests, and take the prevention and control of pest hazards as the scientific goal; otherwise it will not be accepted. Applications taking woods or model organisms such as Arabidopsis and Drosophila as main research objects will not be accepted.

In 2021, the application code of this discipline has been updated and integrated. There are 8 secondary application codes instead of 9, and each secondary application code has multiple research directions for applicants to choose.

Horticulture and Plant Nutrition (C15)

The funding scope of this discipline covers two research subjects, namely horticulture and plant nutrition.

Horticulture studies physiology and cultivation of horticultural crops under natural conditions, germplasm resources and genetic breeding, growth and development mechanism, as well as protected horticulture and post-harvest quality maintenance under artificial control. The funding scope of horticulture covers pomology, olericulture and fruit science, ornamental horticulture, horticultural facilities, post-harvest biology of garden crops and food mycology. In recent years, there has been a rapid development of basic research in horticulture in China. The quality and activity of research work have been much improved in the field of horticulture: the research objects have broadened and diversified, and research approach has been gradually transferred from traditional organism level and cell level to molecular level; studies based on omics have been actively carried out in horticulture. Great achievement has been made in the study on basis of trait formation of horticulture crops, regulating measures, gene mining and function identifying, germplasm excavations and innovation, mechanisms and control of quality formation, response mechanisms to adversity, mechanisms of rootstock-scion interaction, and the formation and regulation of unfavorable components of horticultural products.

Plant nutrition is the study of plant nutrition basis and fertilizer and nutrient technology management discipline. The funding scope of plant nutrition covers the heredity of plant nutrition, physiology of plant nutrition, manure and fertilizer science, nutrient resources and recycling, crop-soil interaction and regulation, etc. In recent years, based on the frontier of subject development and the demand of agricultural resources, environment and green development in China, plant nutrition has made significant progress in the genetic mechanism of plant nutrition, nitrogen and phosphorus recycling and efficient utilization of soil plant system, and the creation and application of new fertilizers.

In 2020, common problems in both horticulture and plant nutrition layed in the following three aspects: the research content in some of the applications was too broad and lack of the precise layout of basic technique requirement for research approach and method; research on characteristic horticultural crops is relatively weak; there were a large number of proposals pertaining to copying and tracing research. Major problems with the discipline of horticulture is that some projects relied too much on high-throughput technology and reverse genetics research methods, not closely related to horticultural biology problems, and lack of biological significance mining for genomic data. Major problems with the discipline of plant nutrition lay in the following aspects: there were many researches on nitrogen, phosphorus and potassium, while few on medium and trace elements; there was a lack of coordination and interaction of elements; insufficient research on green new fertilizer and cash crops; few research projects on water fertilizer coupling mechanism. In 2021, the Discipline will continue to encourage endeavors on scientific issues based on national agricultural practice and agricultural industry development, with a close combination of new approaches with

traditional methods. Priority funding will be given to original, continuous and systematic and distinctive research. The discipline of horticulture will support proposals which take horticultural crops as their research objects, and address scientific problems on the features of horticulture crops, and production yield, quality, fastness, and constancy. Studies on the genetic, physiologic and molecular mechanisms of nutrient utilization of high efficiency, interaction between crop, soil and microbe and its control, and the coupling mechanisms of soil water and fertilizer, and its effectiveness to crops will be prioritized in funding. It is especially encouraged to apply for the experimental testification of laboratory research in the field and excellent proposals in "manure and fertilizer science". Researches on the nutrient mechanisms of middle and trace elements will also be encouraged for an active promotion of healthy development of all branches in plant nutrition.

In 2021, the application code of this discipline has been updated and integrated. There are 13 secondary application codes instead of 10, and each secondary application code has multiple research directions for applicants to choose.

Applications using forest or model plant like Arabidopsis as its research objects will be not accepted by this Division. Application of medical health research projects will not be accepted by this Discipline.

Division of Agriculture Animal

The funding scope of the Division covers three disciplines: animal husbandry, veterinary science and aquatic science.

Animal Husbandry (C17)

Animal husbandry is a science that studies the germplasm resources, genetic breeding and reproduction, growth and development, nutrition and feed of livestock and poultry (including special economic animals).

Applications accepted and funded in 2019 covered all branches of this discipline, among which, there are more grants in fields as animal genetics and breeding, animal reproduction, animal nutrition and feed science, whereas fewer in animal husbandry foundation, animal germplasm resources, animal behavior and welfare, breeding environment and facilities, beekeeping and sericulture, etc. Peer review and evaluation of project indicated that the innovation of academic ideas has been improved on the whole, and the characteristics and advantages have been formed in animal genetics and breeding and animal nutrition. However there are still some obvious shortcomings, such as indicated in the following aspects: some projects blindly followed the research hotspots and new technologies, and the refinement of specific scientific problems remained to be improved; not enough attention paid to focus on major national needs and some project topics were out of touch with the actual problems of animal husbandry production, failing to aim at solving the basic problems behind the bottleneck of animal husbandry production technology.

In 2021, the application code of this discipline has been updated and integrated. There are 9 secondary application codes instead of 10, and each secondary application code has multiple research directions for applicants to choose.

In 2021, the applicants are expected to accurately understand the attributes of the four categories of scientific problems and continue to carry out original, systematic and continuous research guided by industrial demand. The Discipline will continue to encourage research on the discovery of excellent genes, regulation mechanism and important scientific issues related to

breeding of good breeds in livestock, poultry, silkworm and bee resources; encourage the basic research on Germplasm resources, genetic breeding, reproduction, nutrition and feed of livestock and poultry. Appropriate support should be given to the research on environment and pollution of livestock and poultry, facilities and equipment of livestock and poultry and bee and silkworm breeding, behavior and welfare, sericulture and apiculture. Applicants are encouraged to carry out original, systematic and continuous research on the basis of their previous work, and to give preference to the high quality of the completion of the pre-scientific fund projects.

Special notes for applicants are the following: study object of the research should be livestock, poultry, grass, silkworm, or bee; interdisciplinary studies with other subjects are not allowed to depart from the main research aspect above; otherwise the proposal will be not funded.

Veterinary Science (C18)

Veterinary science is to study the occurrence, development, diagnosis, prevention and cure of animal diseases. The Discipline covers the following branching: animal diseases, zoonoses, public hygiene, laboratory animals, veterinary medicinal industry, etc., as well as other related novel interdisciplinary research areas. The Discipline supports basic researches taking animal diseases as major objects on animal infectious diseases, zoonoses, most common diseases and comparative medicine.

Proposals accepted and funded in 2020 covered all subjects of this discipline. Among them, the majority of applications were focused on veterinary immunology, veterinary epidemiology, basic veterinary, clinical veterinary. Some of them were able to aim at the international frontiers, highlight the creativeness in the selection of their research themes, and actively prompt the international standard of research work. However, problems still exist as demonstrated here: some of the applications paid much attention on the international hotspots, but were lacking of enough concentration of scientific issues; there is not enough attention paid to the research on the major needs of the country.

The Discipline is based on the national strategic needs of animal health, food safety, public health, human health and environmental and ecological security. The Discipline will continue to encourage studies on the epidemiology, pathogenic biology, mechanisms of pathogenic infection and immunity about important animal epidemic diseases and zoonoses, meanwhile, strengthen researches on the basic veterinary immunology, the non-infectious disease of animal mass populations, food safety of animal source, and related research, and give moderate preferential support to studies on traditional Chinese veterinary, and animal (veterinary) pathology, etc.

In 2021, the application code of this discipline has been updated and integrated. There are 11 secondary application codes instead of 9, and each secondary application code has multiple research directions for applicants to choose.

In 2021, applicants are expected to accurately understand the attributes of the four categories of scientific problems. The Discipline requests applicants to take animal diseases as their main research objects and interdisciplinary studies should not deviate from the research objects. This Discipline encourages research for the development of national animal husbandry and veterinary science, aiming at defeating new and recurrent animal diseases.

Special notes to applicants: when involving highly pathogenic microbes, the operation of the project must strictly abide by the relevant animal ethics provisions of the state, with the biological safety of the appropriate conditions.

Aquatic Science (C19)

Aquatic science is to study basic rules of the development, growth, breeding, genetics,

physiology and immunology of aquatic organisms and their breeding ecology, breeding engineering, nutrition and foodstuff, control of diseases and pests, and the protection and utilization of aquatic resources, etc.

In 2020, most of proposals accepted and funded were in areas of immunology and disease control of aquatic organisms, basic biology of aquatic organisms, nutrition and feed science of aquatic animals, genetics and breeding of aquatic organisms, etc., whereas there were fewer applications in aquaculture and fishery engineering. Relatively in-depth studies were conducted on important economic traits of aquatic animals, molecular characters of important pathogens and their pathogenesis, etc., and some of studies have formed their own research features and superiority in some aspects. It can be seen from peer review and panel meetings that the creativeness of academic thoughts of proposals were obviously improved. However, only a small portion of applications were able to propose original research on the important scientific issues of aquiculture, whereas for most of the studies, concentration of specific scientific issues was yet to be improved.

In 2021, the application code of this discipline has been updated and integrated. There are 9 secondary application codes instead of 8, and each secondary application code has multiple research directions for applicants to choose.

In 2021, the applicants are expected to accurately understand the attributes of the four categories of scientific problems and continue to carry out original, systematic and continuous research guided by industrial demand. The Discipline will request applicants to focus their studies on research fields of aquatic science, and aim at the frontier and important demands of production. The interdisciplinary study on aquaculture subjectively with other disciplines will be encouraged. It will be strengthened to support proposals with original ideas. Applicants should choose topics based on new development of subjects concerned at home and abroad, and their research background, aim at scientific problems, focus on original innovation, and avoid over emphasizing on R&D for technology while lacking of key scientific issues. Research on model organisms should be based on aquaculture science. The Discipline will encourage cooperation of applicants with superior units and teams, so as to fully exert regional and resource priority, and enforce cultivation of talents. The Division will prioritize applications in the following areas: genetic rules and gene function of economic traits of important breeding organisms; epidemiology and pathogenesis of important aquatic organisms; host immunity and diseases prevention and treatment; molecular basis and regulation mechanisms of breeding and development of important aquatic organisms; regulation mechanisms of the utilization as well as metabolism of nutrient stuffs for aquatic animals. Moderate priority support will be provided in the following areas: basic research of aquatic breeding and interaction with eco-environment, conservation of aquatic resource, new model and new techniques of breeding, etc.

Department of Earth Sciences

Earth science studies the formation and evolution of the planetary earth system, including geography science, Geology, Geochemistry, Geophysics and Space Physics, Atmospheric Science, Marine Science, and Environmental Geosciences, and other related interdisciplinary subjects.

Through the support of General Programs, the Department encourages original innovations, expands scientific frontiers, matches national demands, pushes disciplinary crosses, and lays a comprehensive and solid foundation for the balanced, coordinated, and sustainable development of all earth sciences disciplines. In 2021, the selection of General Programs will follow the principles: (1) The innovation and academic value of the program; (2) The research ability of applicant; (3) The rationality of the idea and the clarity of the scientific issue in the application; (4) Research

basis and conditions. Program proposal selection attaches great importance to basic and traditional disciplines, and focuses on primary data accumulation; effectively enhances the research in weak and "endangered" disciplines, and promotes the fields development of relatively weak in China but predominant in the world; strengthens the research in frontier disciplines, and encourages disciplinary cross, integration and infiltration, especially the intersection of earth sciences and other disciplines; maintains the international status of dominant disciplines and fields in China; supports the development of sub-disciplines closely related to experiment, observation, data integration and simulation. Pay attention to the accumulation of research work while advocating innovative research. For the General Program proposal applying for continued support, which have had a good accumulation in previous studies and a high-quality completion of recent research, preferential support will be given under the same conditions. Applicants are required to address the relation between the proposed research work and their accomplished programs. Based on the exploratory, unpredictable, and long-term characteristics of basic research, general program encourages scientists to face the most challenging scientific issues and actively carry out exploratory research.

One of the most important goals of the NSFC is to nurture and support excellent young scientist continuously and steadily. The Young Scientists Fund mainly plays the role of "cultivation", shifts the funding focus forward, and provides timely funding for early-career young scholars who are about to independently carry out basic scientific research. The Young Scientist Fund supports them in the critical period of the individual development to help them grow up as quickly as possible.

In 2020, the Department received 8,678 General Program applications with 851 applicant institutions in total; of these, 2,000 were funded with a funding cost (direct cost, and hereinafter) of 1,162.76 million yuan in total and 581,400 yuan in average, and the average funding rate is 23.05%. Among the funded projects in 2020, 1,315 (65.75%) were from colleges and universities, and 664 (33.20%) were from scientific institutes. The PIs of 1,511 projects (75.55%) were under 45 years old. There were 131 inter-department and 268 interdisciplinary projects funded. The average funding cost for General Programs in 2021 is expected to keep the same as that in 2020.

In 2020, the Department received 8,321 Young Scientist Fund applications with 1,031 applicant institutions in total; of these, 5,431 (65.27%) were from colleges and universities, and 2,536 (30.48%) were from scientific institutes. 1,730 were funded with a funding cost of 411,12 million yuan in total and 237,600 yuan in average, and the average funding rate is 20.79%. Among the funded projects in 2020, 1,145 (66.18%) were from colleges and universities, and 553 were applied from scientific institutes.

In 2020, the Department received 1,301 Fund for Less Developed Regions applications with 168 applicant institutions in total; of these, 1,156 (88.85%) were from colleges and universities, and 107 (8.22%) were from scientific institutes. 204 were funded with a direct cost of 72,12 million yuan in total and 353,500 yuan in average, and the average funding rate is 15.68%. Among the funded projects in 2020, 187 (91.67%) were applied from colleges and universities, and 11 (5.39%) were applied from scientific institutes. The average funding cost for fund for Less Developed Regions in 2021 is expected to keep the same as that in 2020.

Notes:

(1) In 2021, the Department will carry out a new trial system of two-grade application code. Please carefully read the application code list and the instruction in this *Guide*, and select the application code well matched the content of the application. The filled-in application code should generally be refined to the secondary application code.

(2) Please carefully read and abide by the requirements of scientific integrity

in this *Guide*. Do not list academic papers at the submission stage in the application.

(3) The application to the Department of Earth Sciences involving ethics should refer to the related regulations of the Department of Life Sciences and the Department of Health Sciences in this *Guide*.

Funding in Department of Earth Sciences in 2020

Unit: 10,000 yuan

Division		General Program			Young Scientists Fund			Fund for Less Development Regions		
		Projects	Direct cost	Success rate (%)	Projects	Direct cost	Success rate (%)	Projects	Direct cost	Success rate (%)
I	Geography	455	25,156	21.98	417	9,992	20.81	77	2,695	15.75
II	Geology	345	21,131	24.50	311	7,392	20.79	21	735	15.22
	Geochemistry	82	5,000	24.19	67	1,520	20.94	9	315	15.52
III	Geophysics and Space Physics	226	13,379	25.68	158	3,728	20.82	9	315	15.25
	Environmental Geoscience	456	26,108	21.12	433	10,280	20.79	70	2,522	15.73
IV	Marine Science	243	14,250	23.55	200	4,760	20.75	7	245	15.91
V	Atmospheric Science	193	11,252	24.43	144	3,440	20.72	11	385	16.18
Total or average		2,000	116,276	23.05	1,730	41,112	20.79	204	7,212	15.68
Direct cost per project		58.14			—			35.35		

Division I of Earth Sciences

Geography (D01)

Funding of this Discipline is available for research on geography science. This mainly includes Physical Geography (i.e., D0101 Geomorphology, D0102 Hydrology and Climatology, D0103 Biogeography and Soil Geography, D0104 Environmental Geography and Disaster Geography, D0105 Landscape Geography and Integrated Physical Geography, D0106 Cryospheric Science, D0107 Geographical Environmental Change and Civilization Evolution), Human Geography (i.e., D0108 Economic Geography, D0109 Urban Geography and Rural Geography, D0110 Human Geography, D0111 Land Science and Natural Resource Management, D0112 Regional Sustainable Development), Geographic Information Science (i.e., D0113 Remote Sensing, D0114 Geographic Information Science, D0115 Cartography and Geodesy, D0116 Geographic Big Data and Spatial Intelligence), and approaches and tools for observations, simulation and analysis in Geographical Science (i.e., D0117 Geographical Observation and Simulation Technology).

The geography science focuses on the spatial distribution, temporal evolution and regional features of the physical and human elements, geographical information and geocomplexes.

The object of the geography science research is the earth surface system, which is formed from the interactions and interpenetrations of the lithosphere, hydrosphere, atmosphere, biosphere, cryosphere, and anthroposphere. The earth surface system (also known as the “water-soil-air-biology-human” complex) should be considered in its entirety in the geography

science research.

The core of the geography science is the interrelationships between human and nature, and their interaction mechanisms in the earth surface system. Owing to the comprehensive, intersectional, and regional characteristics, the geography science must be studied systematically and comprehensively from the spatio-temporal scale-dependent multi-dimensional and dynamic perspectives.

This Discipline encourages the applications of comprehensive, exploratory, and prospective projects, urges the earth surface process research using the theories, methods and technologies of mathematics, physics, chemistry, biology, and information science, and promotes interdisciplinary frontier research on national priorities such as "Ecological Civilization Construction", "The Belt and Road Initiative", and "Rural Revitalization".

In response to the changes in the scientific research paradigm caused by the big data and artificial intelligence, the Discipline encourages the research on the geographical intelligence theories, methods and technologies combining big data, artificial intelligence and geographical issues, aiming to enhance our understanding and prediction capabilities of geographical issues and to establish the scientific paradigm and technology system for the spatio-temporal big data analysis.

In front of the frontier sciences such as comprehensive research on terrestrial surface system, global change and sustainable development, the Discipline encourages to focus on the development, reuse and integration of the geographical observation technologies and simulation methods, and promotes the construction of the scientific research facilities such as the comprehensive geographical modeling and simulation systems, and the decision support system for sustainable development, realizing the integration of the geographical data, geographical mechanism, geographical pattern, and geographic decision-making.

Division II of Earth Sciences

Geology (D02)

Geology is the discipline studying the composition, structure, and evolution of the Earth (planets). Geology aims to disclose the structure and composition of the Earth, to explain the mechanism controlling the transition of Earth materials, to elucidate the Earth's environment and life evolution recorded in these materials, to reveal the agents and processes which modify the Earth's surface, to apply the knowledge of geology to explore the utilizable energy, mineral and water resources, to uncover the relationship between geological processes, life evolution and human activities, to protect the Earth environment, and to prevent (or give early warning) and mitigate geo-hazards.

The development of geology is based on the advancement of the fundamental theory and technology. The theory of plate tectonic has brought about revolutionary changes to the understanding of the Earth. The disclosure of the complexity of continental dynamics and the tectonic schemes predating the plate systems are raising new themes for the advancement of plate tectonic theory. Due to the emerging new framework of Earth system science, the correlation between deep processes and surface impacts of the Earth has become the frontier for geological sciences. The enhancement of abilities to obtain and to analyze data has become a major driving force for promoting the development of geological sciences. The implementation of high precision, in-situ and real-time analytical methods for the composition and structure of Earth materials has enhanced the capability to constrain the composition and evolution of the Earth. The developments of geophysical exploration, space-based observation, and geological drilling technology had

increased the integrity and accuracy of understanding of the Earth's structure. New high-tech approaches such as information systems, the internet of things and photoelectron technology have helped to realize real-time monitoring of crustal movements, earthquakes, and volcanic activities. The reproduction and prediction of important geological processes have been made possible through the development of computer simulation and high-temperature/high-pressure experiments.

This geological program encourages basic researches on fundamental theory based on field and site observations by using the abundant materials and data recently acquired and accumulated by geology-related agencies and institutions. Multidisciplinary approaches, such as the application of theory, technology and methodology of mathematics, physics, chemistry, bioscience, and computer science, are encouraged to study geological issues. International collaborations are also advocated for promoting geological researches and theory advancement with a global scientific view.

Geochemistry (D03)

Geochemistry is the science to investigate the chemical compositions, evolutionary processes, and interaction of different spheres of the Earth, and the distribution, state, migration, transformation, cycle, and fate of the substances of the Earth surface system affected by anthropogenic and natural forcing, both in modern times and in Earth's history. It is based on the principles of element geochemistry and isotope geochemistry, and makes use of the tools of modern analytical techniques, theoretical calculations, and experimental simulations.

Specifically, the research fields of geochemistry include the processes, mechanisms, impacts and regulations of the chemical compositions, chemical reaction and chemical evolution of celestial bodies (planets), rocks, sediments, soil, waters, atmosphere, ore bodies, oil and gas, living organisms, volatiles in Earth's interior and surface, etc.

The characteristics of modern geochemistry studies include: (1) In the field of research methods and techniques, dynamically quantitative simulation has gradually replaced statically qualitative descriptions. The advantages of in-situ micro-analytical techniques and high temperature and high-pressure experiments have been valued. The rule of four-dimensional time-space evolution has been emphasized. The development and application of new isotopic systems have been paid great attention. Combined with new methods of big data and artificial intelligence, the multi-dimensional information of geochemical data is deeply mined. (2) In the field of solid geochemistry, the research topics have expanded from the chemical composition, structures, and reactions of the materials in Earth's interior to the interactions of different Earth's layers and the corresponding effects of resources and environment. The relationship between these interactions and plate tectonics and global change has drawn much attention. The research objects have expanded from the Earth itself to celestial bodies and other cosmic materials. (3) In the field of Earth surface system geochemistry, it pays attention not only to the reconstruction of geologic events on long time scales, but also to the descriptions of physical, chemical, and biological processes on short time scales and the prediction and simulation of environment changes in the future.

Geochemistry is not only a basic discipline to cognize the Earth and the universe, but also an applied discipline to solve the problems faced by human to survive and develop, such as natural resources, ecological environment, and geologic hazards. A new application code scheme of geochemical discipline has been proposed in 2020, which has a framework comprising three layers: fundamental theories, analytical techniques, and applications. The objectives of optimizing the codes within the applications area are to develop a theoretical system, expand applications and enhance the use of geochemistry for national needs, in order to achieve "in line with the internal logic and structure of knowledge system, realize the unity of knowledge level and application

field".

Division III of Earth Sciences

Geophysics and Space Physics (D04)

Geophysics, space physics, and geodesy are disciplines which are based on the theories and methods of physics and related disciplines, and combine observation and experimental means, to understand the basic laws of the space structure and evolution of the Earth and planets, to explore the internal resources of the Earth and planets, and to reveal the characteristics of the Earth and space environment, and draw out the variation of human livable residential environment.

Geophysics, through direct observation and experimental and theoretical studies on the basic geophysical fields of the Earth and planets, is to reveal the internal structures of the Earth and planets and their components and dynamic processes, to effectively understand the mechanism of earthquake and geological disasters and mineralization and accumulation, to develop the foundation of new methods and technologies of geophysical data collection, processing, inversion and interpretation, to provide theoretical and scientific support for resource exploration, engineering exploration, disaster prevention and reduction.

Space physics is based on space borne or ground-based detection and experiment, theoretical research, and numerical simulation, to reveal physical phenomena and their variation laws of upper atmosphere, ionosphere, magnetosphere of the Earth and planets, and interactions of solar atmosphere, heliosphere, and interplanetary space, to provide scientific support for astronautic activities, communication, and navigation.

Geodesy, through the study of geodetic theory, with the help of space and ground geometry and physical quantity observation, is to determine the precise location of the surface of the earth and its outer space point, to accurately measure the geometry and deformation filed and gravity field, the motion state of mobile carrier and the shape and deformation of large buildings (structures), to provide space datum, elevation datum, gravity datum and time datum guarantee for the national economy and national defense.

Geophysics and space physics attach importance to basic theoretical research, experiment, and observation. According to the development trend of earth science and space science, encourage will be focused on core scientific issues of deep earth, deep sea, deep space, and the Earth system ("three deep and one system"), more efforts will be given to new growth and pioneering studies, as well as the deep cross integration with other disciplines. In order to provide technical support for the development of earth science and space science, attention will be given to develop new technologies and methods and detection instruments.

Environmental Geosciences (D07)

With the rapid development of the economy and society, environmental problems including shortage of water and land resources, aggravation of environmental pollution, degradation of ecosystems, and frequent occurrence of disasters are becoming more and more severe and threatening the ecosystem and sustainable development of human society. The goal of developing research in environmental geosciences is to solve various environmental problems in a scientific way.

Environmental geosciences is the subject that studies the Earth's surface system. Based on the principles of geological and environmental sciences, interdisciplinary approaches are often adopted to investigate the pedosphere, the hydrosphere, the surface lithosphere, the atmosphere,

and the biosphere; and to investigate their interactions including physical, chemical, and biological processes and the coupling mechanisms. The subject is also to reveal the changes of geological environment and the rules of the occurrence and development of geohazards, to establish the systematic methodology for risk assessment, control and management, to investigate the regional environmental quality, to predict and respond to environmental changes, to reveal the multiphase/interphase behaviors and effects of pollutants and the underlying mechanisms, to determine environmental baseline and elucidate fundamental scientific questions regarding environmental restoration and ecosystem rehabilitation.

According to the NSFC's guidance on the subject reformation and optimization to deal with the challenges from the developments of theories, technologies and subject paradigm, the codes for application are adjusted, and the subject structure is established, including four fundamental subjects, i.e., soil science, environmental water science, environmental atmosphere science and environmental biology; four interdisciplinary subjects, i.e., engineering geoenvironment and geohazard, environmental geology, environmental geochemistry, and ecotoxicology; four cutting-edge areas, i.e., environmental behaviors and effects of pollutants, environmental and health risks, quaternary environments, and environmental information and forecast. New technologies and methodologies are pivotal supports for the development of the Environmental Geosciences. Regional environmental quality/safety and environmental protection/sustainability are the primary national needs and interests. Due to the large number of applications under Soil Science and to advance the subject development, the second order of application codes are further divided into three categories, i.e., fundamental soil science, soil fertility and erosion, and environmental soil science. Based on the features and advantages that serve the national interests, the Discipline focuses on environmental studies relevant to pollution, ecology, hazards, and health.

For national strategic interests, the discipline encourages novel, interdisciplinary, and cutting-edge researches to answer fundamental scientific questions; encourages new theories, ideas, methodologies, and technologies for innovative application and to nurse the growth of the subject; encourages scientific researches focusing on sustainable and habitable Earth system, which lead to major breakthroughs and enable the flourish of the discipline.

Division IV of Earth Sciences

Marine Science (D06)

The scope of funding includes marine science and polar science.

Marine science is a knowledge system that studies the natural phenomena and changing rules of the ocean and its interaction with atmosphere, lithosphere, biosphere, pedosphere, and cryosphere, as well as the development, utilization, and protection of the ocean. It is a comprehensive discipline including both the study of the Earth's natural processes (e.g., physical, chemical, biological, and geological processes) and the study of marine social attributes (e.g., resources, environment, economy, national defense, culture, international relations, etc.). Meanwhile, marine science is increasingly integrated with marine engineering technology and marine space development and utilization. It has to be recognized that marine science has multiple attributes such as science, technology, and sociology, and there is an increasingly trend of large-span cross-discipline study guided by basic scientific issues. However, there is still insufficient attention to the comprehensive characteristics of marine science. It is urgent to strengthen the interdisciplinary research and to improve the cognitive level of marine science.

Marine science is a data-intensive discipline based on observations, and the promotion of its

academic thoughts and research abilities depends on long-term observation and data accumulation. To meet the demands of research projects in ocean observation, NSFC implemented the Ship-time Sharing Project (NSFC Open Research Cruise, NORC). For those applications that require field sampling and observations, they need elaborate the cruise plan and observation content during the project implementation and combined with the technical route in the proposal. The guidelines for the Ship-time Sharing Project will be announced separately, and please pay close attention to the relevant notice from the Department.

Polar science is a discipline studying various natural phenomena, including the processes and changing rules peculiarly in polar region, as well as its interaction with other components of the earth system. It includes polar space, polar weather and climate, polar ocean, polar ecosystem, polar biogeochemical process, polar resources, polar cryosphere, polar solid earth, polar observation and detection technology, polar engineering and environment, relationship of environment change among the three polars of the earth, and polar protection and utilization. The development of polar science would deepen the understanding of the interaction of the earth's sphere and enhance the ability of polar protection and utilization.

For the past few years, polar science in China has been facing important development opportunities; meanwhile significant progress has been achieved in international polar research. However, it is still the weakest area in earth science. Aiming at the key scientific issues of current global change and sustainable development, the main development trend of earth science is to focus on the integrated research for the characteristics and interactions of the different spheres of the earth system, as well as the interactions between the polar and other regions on the Earth.

In order to promote the research level of marine and polar sciences in China as well as to achieve continuous support and leadership of cutting-edge research in marine and polar science, it is necessary to improve the scientific funding structure, and expand cross-disciplinary integration, as well as promote the building of research talents. It is encouraged that carrying out marine and polar research with coupled nature and social scientific aspects. To deepen the understanding of the Earth system, we need integrate the researches of earth process and the resource and environmental effects. It is necessary to provide stable and reliable support for the major research subjects of marine and polar science and accelerate sharing the information and data of marine scientific investigation. The research aspects include physical, chemical, biological, ecological, and geological processes of the oceans and polar regions; interaction between marine systems and climate change; interaction between human activities and marine space utilization; environmental protection of marine and polar regions; processes of marine disaster and its prevention and mitigation; formation, evolution, development and utilization of marine energy resources; ecological security and sustainability of marine biological resources; environmental protection of marine and polar region, land and sea coordination and global sustainable development; remote sensing and information sciences; observation and detection technology; marine and polar engineering and its environmental effects.

Division V of Earth Sciences

Atmospheric Science (D05)

The scope of funding: meteorology, atmospheric physics, atmospheric chemistry and the atmospheric environment, and other branch disciplines, as well as their corresponding supporting technologies and development fields.

Atmospheric science is the study of various phenomena and their changes in Earth's

atmosphere and other planets' atmospheres so as to serve the mankind. The atmosphere is one of the most active spheres of the Earth system. Its changes are affected and controlled by other spheres of the system and celestial bodies such as the Sun. At the same time, changes in the atmosphere can directly or indirectly impact oceans, the terrestrial surface, the cryosphere, as well as the ecosystem of the Earth. The atmosphere plays an important role in the interactions among different spheres of the Earth system and regulates the functions of the Earth system and its interactions with the other spheres. Besides studying dynamical, physical, chemical, and biological processes within the atmosphere, atmospheric science currently involves comprehensive investigations into the mechanisms underlying atmospheric variations and their interactions with the hydrosphere, lithosphere, cryosphere, biosphere, human activities, and global climate; the regularity of weather, the climate system and theories of climate change and its prediction and projection methods; technologies and measures affecting weather and climate; the impact of human activities on weather, climate, and environmental systems; and the impact of weather, climate, and environmental system changes on human society. Attention should also be paid to studying the occurrence, variation, mechanisms, and predictions of various disastrous events of weather, climate, and the environment; studying the issues of global climate and environmental changes and their impacts, adaptation, and mitigation; comprehensive understanding, integration, systematic observation and modeling of various processes; and interdisciplinary studies which could lay the scientific foundation for improving the quality of life and the sustainable development of society.

In 2021, the Atmospheric Division will continue to solicit proposals for exploratory, original and frontier studies in the following areas: the various phenomena, processes, and mechanisms of the atmosphere, and physical, chemical, and biological processes taking place in the atmosphere, and exchanges and interactions of energy and momentum between the atmosphere and other spheres by applying novel ideas, methods, and advanced observation technologies to study synoptic meteorology, climatology, atmospheric dynamics, hydrometeorology, atmospheric physics, atmospheric chemistry, the atmospheric environment, atmospheric in situ observations and remote sensing, the boundary layer, stratosphere, and mesosphere; climate change, extreme weather and major climatic events; new theories and methods for weather forecasting, climate prediction, assessment of various complex disasters; new theories and methods for numerical modeling and data assimilation; basic research on satellite and radar meteorology; analysis and applied studies on the data acquired from major scientific experiments and scientific initiatives that have been conducted and ongoing ones, as well as from large observation networks established in China and around the world; the principles and methods of meteorological observation, development of meteorological instruments, data analysis, and applications; interdisciplinary studies of such key national interests as defense, agriculture, energy, transportation, forestry, hydrology, health, economy, ecology, among others, as well as national strategic needs such as the Belt and Road Initiatives and support of major engineering projects, serving the livelihood and sustainable development of society.

"D0509 Atmospheric Observation Techniques", "D0510 Atmospheric Data and Information Techniques", "D0511 Atmospheric Numerical Model Development", and "D0512 Earth System Model Development" are suitable for the research of new technologies and methods in the field of atmospheric science. The project application based on the existing technology for theory and application research is not suitable for selecting such application codes.

Department of Engineering and Materials Sciences

Engineering and materials sciences deliver scientific and technical supports to national security, the sustainable development of the society and economy, and the improvement of people's living standard. Aiming at cutting-edge areas and meeting the national strategic demands of social and economic development, and starting from the organic combination of national goal orientation and frontier exploration, the Department promotes the combination of basic research and its engineering application, strengthens original innovation, commits to discoveries, inventions and innovations, enhances the sustainable development of interdisciplinary integration, in order to achieve a higher level of sustainable development and broad international impact in the field of engineering and materials.

In 2020, under the work guideline of "feature first, appropriate size, dynamic optimization, serving the management", the Department adjusted its discipline layout and optimized the application codes, wherein the third-level application codes were cancelled. The application codes were then optimized, in the hope that through the integration of funding fields, the features and developing patterns of engineering and materials sciences can be fully appreciated, so as to promote the cross-integration of disciplines, to realize the organic integration of the discipline frontiers and the major national needs, to elevate the scientific funding management level and the funding productivity, to promote the high-quality development of basic research in engineering science and materials science.

In 2020, the Department received 20,740 General Program proposals, increased by 15.91%, and among them 3,309 were supported with a total direct cost of 1,923,980,000 yuan. The average direct cost is 581,400 yuan per project and the success rate is 15.95% (18.23% in 2019).

In 2020, the Department received 18,771 Young Scientists Fund proposals, increased by 14.04%, and among them 3,127 were supported with a total direct cost of 745,600,000 yuan. The average direct cost is 238,400 yuan per project and the success rate is 16.66% (18.96% in 2019).

In 2020, the Department received 2,703 proposals for the Fund for Less Developed Regions, increased by 2.43%, and among them 393 were supported with a total direct cost of 137,500,000 yuan. The average direct cost is 349,900 yuan per project and the success rate is 14.54% (13.04% in 2019).

In 2021, the Department will continue to optimize the discipline layout on the basis of summarization and optimization of the pilot work of application code adjusting. The applications will be regulated according to the adjusted architecture of "application code", "research direction" and "key words", therefore the applicants should carefully check the corresponding application code and select the appropriate secondary application code. The Department encourages interdisciplinary and cutting-edge researches, especially the original innovation researches which focus on extracting critic scientific issues and condense basic research content from the practice of engineering applications, with such great significance and relevance of our country's conditions that industrial development could be promoted and international competitiveness could be raised. Priority is given to researches with important scientific research value and potential application prospects, and potentials of being new knowledge growth points, and to researches that can lead the development of disciplines, and have the potential to obtain independent intellectual properties suitable for national conditions. The Department will further strengthen the construction of academic discipline and create a good academic ecological environment.

Attention:

(1) In accordance with the NSFC requirements for the application code adjustment, the application code published by the Department contains only the first- and second-level application

code, wherein the third-level application code was cancelled (i.e., the original six-digit application code). Applicants should carefully read the relevant instructions and be aware of the scope of funding, accurately select an appropriate secondary application code and the corresponding research direction and keywords.

(2) The applicants have the obligation to ensure the accuracy and completeness of all information in the application. Attention should be paid to correctly fill in the personal information of the applicants and other main participants, history of received project funding and academic paper publications. In particular, when filling in the representative works, the applicants must comply with the instruction and writing outline of the application form, and refer to the scientific integrity requirements in the application rules of this *guide*. The department will strictly review the representative works provided in the proposals by the applicants, and any items with falsely marked information will be dealt according to the severity of the problem.

(3) Interdisciplinary researches will be encouraged so as to promote the progress of the cross disciplines involved. Applicants should put forward new conceptions and ideas as creative as possible with specific scientific issues.

Funding in Department of Engineering and Materials Sciences in 2020

Unit: 10,000 yuan

Divisions	General Program			Young Scientists Fund			Fund for Less Developed Regions		
	Projects	Direct Cost	Success rate (%)	Projects	Direct Cost	Success rate (%)	Projects	Direct Cost	Success rate (%)
Metallic materials	240	13,935	16.43	246	5,864	16.27	40	1,388	14.08
Inorganic nonmetallic materials	316	18,407	16.67	333	7,936	17.26	38	1,337	14.67
Organic polymer materials	222	12,957	16.91	241	5,720	17.17	21	746	15.33
Mining and metallurgy engineering	366	21,296	15.60	343	8,176	16.66	49	1,720	14.85
Mechanic design and manufacture	561	32,550	16.23	523	12,512	16.99	66	2,297	14.32
Engineering thermophysics and energy utilization	219	12,739	16.29	250	5,968	16.73	17	597	17.17
Electrical science and engineering	223	13,000	15.65	200	4,712	16.22	21	743	14.79
Architecture and civil engineering	509	29,537	15.47	414	9,888	16.56	68	2,371	13.71
Hydraulic engineering	151	8,780	15.73	149	3,552	17.17	29	1,025	14.65
Environmental engineering	196	11,390	16.18	187	4,472	15.73	23	790	15.03
Ocean engineering	110	6,415	13.65	94	2,256	15.14	2	71	13.33
Traffic and transportation engineering	102	5,916	15.96	81	1,944	16.60	10	350	15.15
New concept and general science of materials	94	5,476	15.88	66	1,560	16.71	9	315	14.29
Total or average	3,309	192,398	15.95	3 127	74,560	16.66	393	13,750	14.54
Direct cost per project	58.14			—			34.99		

(4) The fundamentality and innovation should be fully discussed in proposals. Applicants should pay attention to proposing key scientific issues, concentrating research contents and highlighting research focus. For different types of projects, please refer to the relevant project administrative policies, and put forward proposals according to the requirements.

(5) Applicants are required to provide the research achievements of the previous completed project(s), and list the scientific papers published in domestic or foreign academic journals. The provided information must be objective and accurate; otherwise it will be treated as a research integrity issue.

(6) Please refer to the funding amount of different projects, and put forward proposals with a reasonable budget plan according to actual demands of various expenses.

Metallic Materials (E01)

The Discipline supports fundamental researches on metallic materials. Research proposals should present the merits of the proposed fundamental research clearly, including clear objectives and scientific significance of the project, and the suitability of the methods to be employed. Proposals should target either to advance the materials science in cutting-edge areas or to promote development in the relevant areas that meet the national demands.

The funding scope of the Discipline covers compositions, microstructures, phases, surfaces and interfaces, scales effect, impurities and defects in metals, alloys, metal matrix composites, inter metallic compounds, metal-like materials and metamaterials, and their influence on mechanical, physical and chemical properties and performance; theories, calculation methods, modern analysis and testing techniques, big data and artificial intelligence analysis methods of material research; basic issues in the preparation and processing of metallic materials, including melt composition control, solidification and crystal growth, casting, heat treatment, forging, welding, forming, additive manufacturing and powder metallurgy; service behaviors such as corrosion and protection, friction and wear, fatigue and fracture, creep; the interaction between materials and service environment, functional degradation and failure, recycling mechanism and related basis; the behavior of metals under extreme conditions such as irradiation, high temperature, high pressure, high strain rate, strong electric field and magnetic field; the microstructure, structure and properties of metal surface; surface modification and coating; strengthening and toughening, deformation and fracture of metals; mechanical and functional properties and structural design of metal matrix composites; mechanical and functional characteristics, interaction mechanism of material and structure, matching optimization design, preparation and processing of structural-functional integrated materials; metallic amorphous, quasicrystal and metastable materials; low dimensional metallic materials; optical, electrical, magnetic, acoustic and thermal functional metallic materials; energy, environmental and catalytic materials; metallic materials used in information generation, transmission and storage, conversion and processing; biological, intelligent and bionic materials.

It is encouraged to concentrate on common key scientific issues beyond materials systems. Researchers should pay attention not only to the frontiers and the hot areas, but also new understandings of the basic scientific problems in traditional materials. Applications with a cross-disciplinary background should focus on issues within the funding spectrum of the Discipline.

Inorganic non-metallic materials (E02)

The Discipline supports fundamental researches with various inorganic non-metallic materials as the main research subject. Along with the development of the basic theory of materials and the innovation in preparation technologies, new inorganic non-metallic materials continue to emerge, including two-dimensional materials, smart materials, biomaterials, and new energy

materials, etc. The researches on inorganic non-metallic materials are becoming more and more active. At present, in the researches of inorganic non-metallic materials, functional materials are developing in the direction of high performance, high reliability, high sensitivity, smartness, and functional integration; and structural materials are improving in respect of strength and toughness, functionalization, extreme environment endurance, eco-friendly preparation, and high reliability. While developing new materials, conventional inorganic non-metallic materials are constantly being remolded, upgraded, and developed as well. More and more attentions have been given to the applications of inorganic non-metallic materials in various engineering sciences and technologies including information technology, life science, energy and environmental science, aerospace technology, and so on.

According to the proposals submitted in the past 3 years, the researches on inorganic non-metallic materials involve various areas with a broad interdisciplinary range. Among the proposals, the researches on functional materials accounted for 67.8%, which was the most active field, forming many subject hotspots including energy conversion and storage materials, semiconductor and information functional materials, low-dimensional carbon and two-dimensional materials, multiferroic and lead-free piezoelectric materials, biomedical materials, and so on. Among them, the proposals on energy conversion and storage materials (about 26.3% of the total in the year 2020) ranked above all the others. The proposals in the field of structural materials were relatively concentrated among some institutions, and the corresponding proposals accounted for 32.2% of the total. There were also a large number of proposals for composite materials based on inorganic non-metallic materials, among which the number of the proposals on functional composite materials has increased compared with the past. However, in terms of the quality, quite a number of them were of follow-up, low-level repetition, lack of innovation ideas and features.

This Discipline supports the research projects with innovative ideas, as well as substantive interdisciplinary researches of inorganic non-metallic materials cross-cutting with other related disciplines. The Discipline encourages and supports the following areas: exploration of new inorganic non-metallic material systems based on domestic resource status; researches on preparation sciences and new technologies, new theories, new effects, new characterization technologies and methods for inorganic non-metallic materials; applied basic researches on novel inorganic functional materials and smartness materials, advanced structural materials, photoelectric information functional materials, low-dimensional carbon and two-dimensional materials, biomedical materials, new energy materials, ecological and sustainable environment materials, etc.; researches on the surface, interface, and composite design of materials; basic researches on "structure-function" integrated composite materials; and applied basic researches on the improvement and remolding of conventional inorganic non-metallic materials using new theories, new techniques, and new processes.

Organic Polymer Materials (E03)

The Discipline mainly supports the following areas in the field of organic and polymeric materials science: synthesis and preparation of organic and polymeric materials; physics of polymeric materials; processing of polymeric materials; general polymer materials (plastics, rubbers, fibers, coatings, adhesives, etc.); polymer-based composite/hybrid materials; polymeric materials related to ecological environment; intelligent and biomimetic polymer materials; biomedical organic and polymeric materials; organic and polymeric materials with photo, electro or magnetic functions; other organic and polymeric functional materials (such as separation and adsorption materials, flexible electronic materials and devices, low-dimensional functional materials, battery related organic and polymeric materials, information polymer materials, porous materials, COFs and MOFs, catalytic materials, self-assembly functional materials, photonic

crystals, organic-inorganic functional composite materials); special polymer materials.

The Discipline encourages interdisciplinary basic and applied basic researches involved with mathematics, chemistry, physics, life science, medical science, information science, energy, environment, mechanical and manufacturing science, transport and aerospace science, and oceanography, etc., which lead to creativity and innovation. To be specific, the researches in the following areas are encouraged: scientific issues in the preparation of polymeric materials, including high efficient and controllable synthetic methods of polymeric materials, synthetic chemistry of polymer materials with high performance, including new monomers, new routes and new technologies, the preparation of functional polymer materials, new method and theory in polymer processing, the relationship between the aggregation structures and the properties of polymeric materials and their composite materials; the method and theory in the implementation of the high performance and functional properties of general polymer materials; low-cost and green method in the preparation of functional organic and polymeric materials, the structure-property relationship and the implementation of their stability; performance-directed biomedical polymer materials and the evaluation method of their application; design and preparation of function-directed organic and polymeric materials with photo, electro, magnetic or information functions, and study on the implementation of high performance and the stability of their devices; new concept in the design theory and preparation method of smart and biomimetic polymer materials; the controllable preparation and assembly methods of supramolecules and polymer materials with multilevel structures and their functionalization, eco-environmental polymer materials, including the structures, properties and efficient utilization of natural polymers, as well as the design theory and preparation method of environment-friendly polymer materials, the recycling and utilization of polymeric materials; polymeric materials for environmental control and improvement in water, soil and air pollution, and the stability and aging of polymeric materials.

The Discipline also encourages enhancing the design of polymer materials with the guidance of theories; basic research aiming at the difficult problems existing in the preparation, modification and processing of the main assortments of domestic polymer materials; basic research aiming at new organic and polymeric materials and new technologies in polymer processing for the national strategical objective; research on the basic issues of the “Key & Core Technology” related organic and polymeric materials.

Mining and Metallurgical Engineering (E04)

The Discipline supports the fundamental researches on mining and metallurgical engineering, involving mainly natural resources exploitation (petroleum, natural gas, and mineral ores), safety science and engineering, mineral engineering and separation science of substances, ferrous and nonferrous metallurgy, materials preparation and processing, resource recycling and utilization, ecological environment, etc.

In recent years, benefited by continuous financial supports, and driven by major national needs, mining and metallurgy engineering science in China has obtained great progresses through continuous innovations. The research capability has improved, and some researches have reached international frontiers. Many significant research results have been achieved. The main developmental trends of the Discipline include: (1) Discipline deepening and extension. The theory of the Discipline is much deepened and improved by continuously assimilating novel methods and techniques with the changes and expands of demands for resources, environment, and mineral and metallic materials. (2) Interdisciplinary and integration. Basic disciplines such as mathematics, physics, chemistry, mechanics and electromagnetism are involved in this discipline more deeply, and the integration within this discipline is closer. New research areas have emerged one after another due to further development of interdisciplinary. (3) Combination of fundamental research

and application. The applications, such as in the fields of mining and metallurgical equipment, system monitoring and control, metallurgical reaction engineering and systems engineering, ecological technology of mining and metallurgy, engineering and safety, pay more attention to the depth of basic research and the update of basic knowledge. The obvious characteristics include "process integration, technology integration and disciplinary integration". Therefore, it is getting faster and faster in integration, interaction and transformation of science and technology. At present, the Discipline is in the focal point of resource, energy, environment and safety. Due to gap between demand and development, upgrading of traditional industries and improvement of ecological environment, the developmental concepts including "innovation, coordination, green, open, and sharing" should be put into practice in upgrading traditional industries and improving ecosystem to fulfill new meaning of industrial upgrading promoted by the fundamental research.

Hot research topics of the Discipline include complex oil and natural gas exploitation, intelligent green mines, environmental management and ecological restoration of mining and metallurgy, basic science of engineering safety, accurate control of mineral separation process, preparation of high value-added mineral materials, intellectualization, greenization, refinement of material metallurgical process engineering, high-clean and high-homogeneous metal materials metallurgy, precision hot forging for light alloy, resource circulation and utilization, integration of mining, metallurgy and materials, etc.

Focusing on engineering science, the Discipline will continuously enhance interdisciplinary research, explore new methods, pay close attention to new theory, concepts and methods, and their creative applications. The Discipline will attach importance to ensuring the development of the national economy and improving the quality of people's lives. The aim is to enhance the levels of basic research on promoting the core competitiveness in China's petroleum, mining industry, metallurgy, and materials preparation and processing, and engineering safety by providing problem-oriented solutions to meet the major national needs. In the aspect of natural resources exploitation, research will focus on the intellectualization, greenization, refinement of engineering and scientific issues, encourage reengineering technology to improve mining efficiency and safety, emphasize source controlling, cyclic utilization and environmental protection, and finally achieve both economic and environmental benefits. In the aspect of techniques, process, and equipment, emphases will be placed on structure optimization and adjustment, process intensification, the scientific law of engineering and basic research of big data and artificial intelligence application. In terms of selecting research topics, priority should be given to the funding of the basic researches that have great theoretical significance, have potential applications and foresights, are likely to become the growth point of new knowledge, and are involved in many research fields. Priority should be especially given to the funding of youth scientific research projects with original ideas, and with cooperation at home and abroad. Researchers are encouraged to conduct long-term research and boldly put forward their own hypotheses to form their own research features. Research teams and innovation groups are encouraged, and continuous support are provided to integrate talents in certain fields to solve technical bottlenecks and promote industrial upgrading in the main industrial chain, which can truly reflect the role of basic engineering science research.

The following research fields are encouraged: (1) new theory and method to enhance recovery of oil and natural gas; (2) theory of safe and efficient development in drilling and production for complex oil and gas resources in deeper formation and deeper sea; (3) theory of safe and efficient operation of oil and gas pipeline network; (4) theory of high-efficient mining of geothermal resources in deeper formation, and safe, green and intelligent mining of deep mineral resources; (5) theory of rock mechanics and strata control under multiple fields; (6) theory of prevention and emergency of major disasters and accidents in the production process; (7) theory of mine ecological environment and occupational hazards; (8) theory of green separation for mining

and metallurgy; (9) clean and efficient extraction of mineral resources; (10) thermodynamic basis and metallurgical theory for the production of high quality metal materials; (11) theory of formation, transportation and control of pollutants produced in the metallurgical process; (12) theory of efficient fabrication, processing and fine forming of metal materials and special materials; (13) theory of information acquisition and data processing of mining and metallurgy, intellectualization of mining and metallurgy process and materials preparation; (14) theory of green metallurgy, new theory, new method and new technology for metallurgical process efficiency; (15) theory of efficient cycle and utilization of secondary resources.

Mechanical Design and Manufacturing (E05)

The Discipline supports fundamental research in the fields of mechanical and manufacturing science.

Mechanical science is a fundamental discipline that involves the study of functional synthesis, quantitative representation, performance control for various mechanical products, and the development of novel design theories and methodologies by applying related knowledge and technologies regarding mechanical systems. It mainly includes robotics and mechanism, transmission and drive, mechanical system dynamics, strength theory for mechanical structures, mechanical tribology and surface technology, mechanical design, and mechanical bionics. Manufacturing science primarily involves studying theories, methods, technologies, processes, equipment, and systems concerned with production manufacturing of high-efficiency, low-cost, intelligent, and high-performance. It mainly includes biomanufacturing, forming, machining, manufacturing systems and intelligence, mechanical measurement and test theory, and micro/nanomechanical systems.

The particular focuses of the support in this Discipline are: fundamental researches concerning national strategic priorities, the cutting-edge sciences of mechanics, and significant application potential for industrial applications; researches aimed at the eco-friendly, resource-saving, and energy-efficient integration of sustainable design and manufacturing; researches concerning innovative design, new manufacturing principles and process optimization, and measurement theories and equipment prototype for ultrahigh-precision, extreme loading, and in particular, large or heavy equipment and instruments; methodologies for designing, manufacturing and testing under extreme working conditions, for instance, parameters ranging from conventional to extraordinary or extreme conditions, and scale ranging from macroscale to mesoscale, microscale, nanoscale, and multiscale. In 2021, priority funding will be provided under equal conditions by the General Program to groups in two areas, mechanical design under extreme working conditions (E0506), and integrated theoretical method and technology of measurement and machining (E0509, E0511). For the two types of proposals mentioned above, applicants should indicate the project group in the Explanatory Notes of application cover.

Based on the basic tasks of mechanical design and manufacturing, the Discipline encourages continual in-depth research in specific fields and high-risk exploratory research for original breakthroughs and disruptive innovation. The research that has yielded innovative achievements and is expected to achieve significant breakthroughs will be preferentially supported; moreover, substantial and profound interdisciplinary research with natural science and other engineering science is also welcome. However, it should be noted that applications should not deviate from the funding scope of the Discipline.

The Discipline insists on project performance evaluation. New applications from high-quality executed project leaders will be given priority funding under equal conditions; new applications submitted by the person in charge of a poorly executed project will be strictly controlled.

Engineering Thermophysics and Energy Utilization (E06)

The Discipline of engineering thermophysics and energy utilization supports the fundamental researches on basic principles and the application technology theory in the processes of energy conversion, transfer and utilization. The traditional research mainly focuses on the basic laws of conventional energy conversion and utilization in the form of heat and work. At present, it has been extended to the researches on the conversion, storage and utilization of a variety of energy including renewable energy and new energy by using the basic principles of engineering thermophysics. The supports involve in engineering thermodynamics, refrigeration and cryogenics and dynamic characteristics of thermodynamic systems, aerothermodynamics, heat and mass transfer, multi-phase flow, combustion, thermo-physical properties and measurement, and renewable energy utilization, as well as other fundamental and innovative researches related to engineering thermo-physics and energy utilization.

The main development trends of the Discipline are as follows: (1) research on the basic issues has been deepen from macro-level to meso-level and micro/nano-level, from isolated studies to coupled studies, from common parameters to parameters under ultra- or extreme conditions, from routine thermo-physical problems to random, unsteady, multi-dimension, multi-phase and complicated thermo-physical problems and intercrossing research in the Discipline; moreover, research becomes more quantitative and precise; (2) research themes have been crossed over traditional disciplinary borders and integrated with related disciplines, for example, physics, chemistry, life science, information science, materials science, environment and safety. Researches in the following areas are active: the mechanism of new type thermodynamic cycles and non-equilibrium thermal dynamics, refrigeration and low temperature engineering, dynamics, optimization and control of complicated systems, turbulence properties of internal flows and properties and control of unsteady flows, porous media and micro-scale heat and mass transfer, radiation and heat exchange by phase transformation, clean, supersonic and micro-scale combustion, thermo-physical problems in the prevention of disasters, mechanism of interaction between phases and thermo-physical model in multi-phase flow, new principles and methods in thermo-physical measurement, and new thermo-physical principles in energy conservation, renewable energy transformation and utilization, energy and environment.

The Discipline will give priority to fundamental researches with theoretical significance, potential application and prior prospect, which might be the new fields for knowledge production, continuously promote interdisciplinary studies and the exploration of novel methods, and encourage original ideas and creations. The Discipline will continue supporting the researches with interdisciplinary nature, or international cooperation background or excellent achievements in the completed projects. It is expected to produce original research results with independent intellectual property rights in China, and to promote the continuous development of fundamental researches in the field of engineering thermo-physics and energy utilization.

Electrical Science and Engineering (E07)

The Discipline includes two main fields: electric (magnetic) energy science and the interaction between electromagnetic field and matter. The key areas of funding include the basic research and applied basic research with objects or means of electric (magnetic) phenomenon and principle, the related scientific problems in electric (magnetic) energy generation, transformation, conversion, transmission and utilization, as well as the mechanism and laws of the interaction between electromagnetic field and matter. This Discipline is based on electromagnetic field, circuit (electric network), electrical materials, and other fields of electrical science. It focuses on electric machine and its system, power and integrated energy system, high voltage and insulation, electrical apparatus, pulse power, discharge plasma, power electronics, electric energy storage and

application, superconducting electrotechnics, bio-electromagnetics, and other electrical engineering fields. Researches on new phenomena, new theories, new models, new methods, new devices and new equipment are encouraged.

The areas of electromagnetic field and circuit mainly include: electromagnetic field, circuit (electric network), static electricity, electromagnetic measurement and sensing, new energy conversion and power transmission technology, electromagnetic environment, and electromagnetic compatibility. The areas of superconducting and electrical materials mainly include: superconducting conductor and magnet, superconducting power technology, engineering dielectrics, conductor/semiconductor/insulation/magnetic/energy storage/sensing materials and other new electrical materials. The areas of electric machine and its system mainly include: analysis and design of electric machine, conversion and control of electric machine system, integration of electric machine system, and electric drive. The areas of power and integrated energy system mainly include: power system analysis, power system control, power system protection, electricity market, electricity information, integrated energy system and energy internet. The areas of high voltage and discharge mainly include: high voltage and large current, electrical equipment insulation, overvoltage and its protection, arc and electric contact, electrical apparatus, pulse power technology, discharge plasma technology. The areas of power electronics include: power electronic device and its application, and power electronic system and its control. The areas of electric energy storage and application mainly include: principles of electric energy storage and conversion, as well as device, equipment and system of electric energy storage. The areas of bio-electromagnetic technology mainly include: bio-electromagnetic phenomenon and mechanism, biological effect of electromagnetic field, electromagnetic diagnosis and treatment of disease.

In recent years, electrical science and engineering presents a new trend of development: (1) The scope of researches is constantly enriched. For example, the integrated energy system, independent power system, the electrical materials, devices and equipment under extraordinary environment and extreme condition and so on. (2) The application fields are expanding continuously. For instance, the electric machines used in robots and servo systems, electrified traffic, new energy transport equipment, more electric ships and aircrafts, the power supply, storage, conversion, power transmission and drive (propulsion) in aeronautics and astronautics, electromagnetic launch, electromagnetic metallurgy, electromagnetic environmental protection technology, and etc. (3) The interdisciplinary becomes more noticeable. For instance, smart grid, energy and electricity market, electrical safety, intellisense, electric energy storage, pulse power, plasma and bio-electromagnetic technology have been intercrossed deeply with the fields like physics, chemistry, materials, information, management and biomedicine.

For electrical science and engineering discipline, free exploration and interdisciplinary, tracking and leading the frontiers of the Discipline, and solving the scientific problems existing in the technical bottlenecks are encouraged, the researches about interdisciplinary basic theory and key technology, in aspects of interaction between electromagnetic energy and materials, electrical equipment, power electronic devices, bio-electromagnetic technology and medical electromagnetic equipment, are particularly encouraged.

In 2020, the application codes of electrical science and engineering discipline were optimized. The applicants should fully understand the funding scope of this discipline, and correctly choose or fill in the application codes, as well as the corresponding research areas and keywords.

Architecture and Civil Engineering (E08)

The Discipline covers the fundamentals of both architectural and civil engineering. The development trend of architectural area relates to both human and environment simultaneously.

Based on the development of urban and rural areas and the concepts of sustainability and green engineering, the fundamental theory, design, and construction of architecture can be advanced. The civil engineering should focus on the needs of quality construction, operation, and maintenance of major national projects and infrastructures; study the basic theory; develop the key technology; and solve the cross-discipline issues. The architecture and civil engineering features advanced testing, AI applications, and the combination of innovative material, structural system, and construction.

The related disciplines to the area of architecture include three secondary application codes: architecture, urban and rural planning, and building physics. The related disciplines to the area of civil engineering include seven secondary application codes: engineering structures, engineering materials, engineering construction and service, geotechnical and foundation engineering, underground and tunneling engineering, transportation and railway engineering, and civil engineering disaster prevention. In 2020, the architecture and civil engineering made partial revision and adjustment to the application codes. Please carefully select the application codes and the corresponding research areas and keywords to avoid incorrect submission. If the key scientific issues and main research contents are not within the scope of funding for the Discipline, another discipline area may be recommended.

The area of architecture should emphasize on the new scientific issues, including the scientific methods for architectural design and urban and rural planning, and the innovation in building physics, building environment control, and energy conservation theory, with the encouragement given to the innovative research on the relevant scientific issues in the priority field of "design principles and technologies in architecture and urban-human habitat environment". In the area of civil engineering, more attention should be paid to the innovative research on the combined design of high-performance material with high-performance structure, maintenance and functionality improvement of existing structures, and stability and control of geotechnical and foundation engineering in complex environments. The following four key topics are encouraged: basic theory on the integration of material and structure, failure mechanism and performance control of structures under severe loading or environment, advanced experimental and numerical simulation methods, and AI applications in civil engineering.

Hydraulic Engineering (E09)

This Discipline includes two research fields: hydro-science and hydraulic engineering, and geo-mechanics and geo-engineering as well as hydro-power engineering. The funding scope covers engineering hydrology and water resources utilization, agricultural water conservancy and rural water conservancy, hydraulics and river dynamics, hydro-machinery and systems, geo-mechanics and geo-engineering, and hydraulic structures. The research content in the above funding scope includes not only the mechanics and physics process at different scales in the Discipline, but also their extension towards and combination with chemical and biological processes.

Engineering hydrology and water resources utilization include: monitoring and modeling of hydrological processes and interactions with associated processes, basin water systems, flood and drought disasters, water resources, and integrated basin management. Hydraulics and fluvial dynamics include: fluid mechanics and applications, mixed transport of contaminants, organic matters, and aquatic organisms, erosion, transport, and deposition of sediment, processes and laws of river systems, regulation and protection, and integrated management of water, sediment, and ecosystems in river basins. Hydraulic geotechnical engineering includes: rock and soil mechanics, common basic characteristics of geotechnical engineering, geotechnical engineering oriented toward hydraulic engineering and ocean engineering.

Major development trends of the discipline include the following six aspects. On engineering hydrology and water resources utilization: hydrological processes under a changing

environment and mechanisms of generation and evolution of basin water resources; water disaster prevention, rational allocation of water resources, and sustainable development and utilization of water resources. On agricultural and rural water conservancy: agricultural and rural water resources, water and soil environment and agroecosystem, zoning of agricultural water conservancy, planning of irrigation and drainage systems, and water supply and drainage systems in towns and villages, degradation of irrigated land and losses of water and soil; smart irrigation districts and modernization of rural water conservancy. On hydraulics and fluvial dynamics: hydrodynamics and engineering applications, transport of sediment and environmental substances in open waters and management, interactions between aquatic biology and environmental conditions, integrated management of rivers, lakes and watersheds. On hydraulic machinery and systems: flow inside hydraulic machinery, cavitation and erosion, wear and abrasion, multiphase flow, vibration and noise, flow control, energy dissipation, thermoelastic flow, fluid-solid-magneto-thermo-acoustic multi-fields coupling, anti-wear material, composite material, failure diagnosis, intelligent control, and system of power station and pump station. On hydraulic geotechnical engineering: constitutive relationship of geomaterial, numerical simulation, laboratory and in situ testing, investigation, and observation, geotechnical structure deformation and stability; geotechnical problems in dam foundation, foundation, slope, embankment, tunnel, underground space and underground structure. On hydraulic structure: Hydropower complex, water diversion project, embankment project, design, construction and operation of hydropower stations, navigation and fish passing structures, as well as river channel protection and treatment measures.

Environmental Engineering (E10)

The Discipline is an emerging interdiscipline developed on the basis of natural science, engineering science, humanities and social science, aiming at better understanding and solving environmental problems. Its main research targets cover the fundamental theories, technologies and management methods for environmental pollution control, remediation of contaminated environment, restoration of damaged ecosystem and recycling of wastes. With distinct problem-orientation and cross-discipline, the Discipline is of key importance for sustainable development of human society.

The research areas of the Discipline have been expanded to nine 2nd-level application codes, including drinking water supply and treatment, urban wastewater treatment and resource recovery, industrial wastewater treatment and reuse, urban and rural water system and ecological recycling, air pollution control, solid waste recycling and safe disposal, environmental pollution control and remediation, regional and urban eco-environment system engineering, and ecological and environmental risk control. To avoid errors in application, the applicants should carefully understand the scope of discipline funding, and correctly select or fill in the application code and the corresponding research direction as well as keywords. For key scientific issues and main research content outside the funding scope of this discipline, please apply for other relevant disciplines. It encourages the use of new theories, technologies and methodologies from other disciplines to address environmental engineering-related problems.

The Discipline emphasizes the identification, analysis and resolution of key scientific problems encountered in the environmental pollution control process; encourages the development of innovative fundamental theories and technologies for high-efficiency, low-cost pollution control processes, especially for the research fields of “urban wastewater reclamation and resource recovery”, “environmental quality improvement and ecological remediation” and “ecological and environmental risk control and health and safety”.

Ocean Engineering (E11)

The Discipline includes four research fields, which are coastal and ocean engineering, ship engineering, marine technology, navigation and maritime technology. The funding scope covers (1) fundamental theories of coastal and ocean engineering, port and waterway engineering, debouche sand coasts (estuarine coast) and delta engineering, subsea engineering, offshore and deep-sea engineering, polar engineering, offshore equipment and system, exploitation and utilization of ocean resources; (2) surface ships, underwater vehicles, unmanned vehicles, ship equipment and systems, new energy for ships and energy-saving-and-emission-reducing technology; (3) environment perception and target detection technology, positioning and navigation technology, information assurance for offshore operations, special marine materials and surface technology; (4) fundamental theories of navigation and maritime technology, risk control and safety of navigation, intelligent shipping and polar transportation.

The statistics of the approved grants and the applications in 2020 show increasingly wider coverage of disciplines and stronger interdisciplines. The fields of coastal and ocean engineering, and ship engineering have received more grants as well as applications. The fields of marine technology, navigation and maritime engineering have received less applications and grants. In 2021, the following two research fields are emphatically encouraged: (1) intelligent ships and navigations; (2) exploitation and utilization of deep sea resources. The applications falling in the above two categories are to be labeled in the first line of the proposal "the present application falls in the encouraged research fields listed in the General Program Guidelines".

The main development trends in the Discipline are: The trend in the field of coastal and ocean engineering refers to port and waterway engineering and underwater engineering, protection and utilization of coastal zone resources, disaster prevention and mitigation in extreme cases, safety and smart operations in port, waterway and coastal engineering, marine rock and soil engineering and exploration of subsea minerals; polar engineering equipment and technology, research and development of island engineering equipment, deep-sea fishery equipment and technology, exploitation and utilization of new ocean energy, development and design technology of deep sea engineering equipment, and key technologies of deep-sea space station. The trend in the field of ship engineering refers to the design and manufacture of green and intelligent ships, extreme environments and ship safety, intelligentization and informatization of ship equipment, unmanned marine vehicles, new marine power systems, special auxiliary devices and systems. The trend in the field of marine technology includes marine environmental characteristics, marine special sensors, acoustic and non-acoustic environment perception and target recognition, underwater communication, positioning and navigation, offshore operations and information assurance, marine special materials. The trend in the field of navigation and maritime technology refers to navigation and maritime management, maritime warning and rescue salvage, maritime safety and environmental protection, and ship intelligent navigation, autonomous surface transportation systems.

Transportation and Vehicle Engineering (E12)

The discipline deals with the operational characteristics, principles, and the interconnections between different modes of transportation (highway, rail, aeronautical and aerospace, waterway, etc.) as well as various types of vehicles, and supports fundamental research in the field of traffic engineering and vehicle engineering. Specifically, this discipline studies transportation planning and design, control, and operation, and focuses on the fundamental theories of design, performance optimization, and safe operation of vehicles. With the help of theoretical research and breakthroughs in core technologies, this discipline aims to achieve safety, intelligence, efficiency, energy saving, and environmental protection in all modes of transportation and for the integrated

transportation system.

Transportation engineering deals with the integrated transportation system composed of transportation participants, vehicles, facilities, environment, and other elements within different transportation modes, as well as the principles and interactions between these elements of the system. Its study areas include the operational characteristics and principles of vehicles and pedestrians as individuals or groups in different transportation facilities and transportation environments to improve the transportation system analysis theory, the planning and design methods and operation safety of the integrated transportation system, facilities and spaces, hubs and stations to achieve intelligent transportation planning and design; the core technologies of operation control of different transportation modes with the help of modern computational and statistical analysis methods, and network technology to achieve safe and reliable control; the preventative mechanisms of traffic accidents, safety evaluation, pollution causes, and other theories. There are four second-level codes in this field, including traffic system analysis theory, traffic planning and design, traffic information and control, and traffic safety and environment.

Vehicle engineering deals with the fundamental design theory, performance optimization, safe operation, and intelligent technologies of road vehicles, non-road vehicles, rail transportation systems, shipping systems, aeronautical aerospace vehicles. By improving the fundament theories of innovative design and manufacture of the vehicle systems, this discipline is dedicated to: explore the dynamic control theory of complex vehicle systems; make breakthroughs in core intelligent vehicle technologies related to perception, decision making, planning, and collaboration; master the coupling mechanisms of the human-machine-environment and inclusiveness design methods of vehicles; develop safety and reliability technologies of comprehensive applications, collaborative management, operation and maintenance and other supportive technologies for the vehicle systems. There are four second-level codes in this field, including fundamentals of vehicle design, the dynamics of the vehicle system, intelligentization of the vehicle system, and operation engineering of the vehicle system.

This discipline is newly established to accommodate the needs from the advancements of transportation systems and vehicle technologies and the interdisciplinary developments. The discipline will focus on supporting theoretically significant, forward-looking, and exploratory fundamental research, and encourage interdisciplinary research of transportation and vehicle engineering. This discipline does not support applications of product development or management-type projects.

New Conceptual Materials and Common Science of Materials (E13)

The Discipline mainly supports research in the areas of new methods of material design and characterization, new material preparation technology and digital manufacturing, multi-functional integration of materials and devices, new composite and hybrid materials, new conceptual materials, key materials of advanced manufacturing, key engineering materials, etc.

With the rapid development of materials science and constant evolution of new theories and technologies, the research and application of materials are no longer rigidly adhered to the current material system. It has now become a general trend to develop new conceptual materials and cross-fused material systems to meet higher requirements put forwarded to the properties and functions of materials. In the paradigm of fundamental research of materials science, it is highly desired to resolve some pending common scientific problems facing new materials, such as the design, preparation, characterization, performance regulation and fracture characteristics. At the same time, many key bottleneck issues encountered in national major engineering are expected to be solved by developing new conceptual materials and coordination of multi-material systems. Therefore, to meet the strong demand of national major industrial technology for pure, superior,

unique and new materials, this Discipline will focus on the key common science issues of materials science, as well as the new conceptual and revolutionary materials leading future technology, to advance the integrated development of materials and engineering technology.

This Discipline focuses on supporting fundamental research and applied fundamental research in three aspects: leading cross materials, key commonalities and technical support. Specifically, (1) it focuses on leading materials and interdisciplinary research, such as new conceptual materials, new composite and hybrid materials, multi-functional integration of materials and devices. It encourages initiating projects to develop new materials with unique property and more superior performance to traditional materials; design multi-functional integrated materials and devices facing intelligence and information, and reveal the principles of collective response and cooperative function of materials, structures and systems; develop composite and hybrid materials with multi-scale, multi-dimensional, and multi-degree-of-freedom interaction. (2) It focuses on supporting the research on key commonality of materials, including new methods of material design and characterization, new material preparation technology and digital manufacturing, etc. It encourages initiating projects to establish theories and models for the materials design and performance prediction, explore new paradigm for material preparation and digital manufacturing, and develop advanced in-situ and ex-situ material characterization techniques to probe the electronic structure, surface and interface, defects, etc. (3) It focuses on supportive materials research, including key materials for advanced manufacturing and engineering. It encourages initiating projects to develop new materials facing high-end manufacturing and national major engineering, seek breakthrough of key materials and technologies, and improve the whole chain connection, cross integration and practical application of new materials in key fields of national advanced manufacturing and engineering.

Department of Information Sciences

The Department funds researches in areas of the generation of signals, acquisition, storage, transmission, processing and utilization of information. Information science is based on informatics, control theory and system theory, and its main method is information methodology, and its main platform and means of research are computer, integrated circuity and photo electric devices.

Based on the trends of disciplinary development and social progress, the Department gives priorities on funding research on electronics, communication and network, electric devices and integrated circuit, computer science, automation, AI, photo electronics and microelectronics, network security, quantum information. Preferential support will be given to basic researches that meet national demands and have far-reaching importance in promoting the national economic and disciplinary development.

Scientific and technical issues in information sciences are increasingly interdisciplinary in nature. Therefore, the Department pays great attention to proposals for interdisciplinary researches between information science and mathematics, physics, chemistry, life sciences, medical sciences, materials sciences, engineering, geo-sciences and management sciences, and so on. The Department encourages cooperative research among scientists with different backgrounds and knowledge to put forward cross-disciplinary research proposals in smart city, smart agriculture, health, service and education information technology sciences. It also encourages scientists to combine theory with practice and explore basic theory and key technical issues that have important application potentials for national economy and security. Encourage research on basic theory and key technology driven by national need, and promote deep integration of industry and research. The Department will continue to encourage scientists to conduct substantial international

cooperative research with scientists abroad in frontier areas of information sciences.

In 2021, the Department encourages creative basic research that is different from traditional research ideas, and welcomes researchers to conduct discussions and studies on new concepts, new theories, new methods and new technologies.

In 2020, the Department received 12,348 applications for General Program, and funded 2,064 projects with a total direct cost funding of 1.19680 billion yuan, and a funding rate of 16.72%. Among them, 270 applications were received for education information sciences, and 45 projects were funded, with average direct cost funding 480,000 yuan per project, and a funding rate of 16.67%. In 2020, the Department received 9,559 applications for Young Scientists Program, and funded 2,152 projects with direct cost of 513.12 million yuan. The success rate was 22.51%. In 2020, the Department received 1,577 applications for Fund for Less Developed Regions, and funded 248 projects with direct cost of 87.69 million yuan. The success rate was 15.73%.

Funding in Department of Information Sciences in 2020

Unit: 10,000 yuan

Divisions		General Program			Young Scientists Fund			Fund for Less Developed Regions		
		Projects	Direct cost	Success rate (%)	Projects	Direct cost	Success rate (%)	Projects	Direct cost	Success rate (%)
I	Electronics and technology	170	9,942	16.43	189	4,512	22.61	18	648	15.79
	Information and communication system	175	10,234	17.11	170	4,024	22.67	14	517	15.05
	Information acquisition and processing	159	9,123	16.67	169	4,016	22.44	19	676	15.83
II	Theoretical computer science, computer software and hardware	94	5,287	17.18	77	1,848	22.32	10	359	15.15
	Computer applications	189	10,746	17.03	152	3,624	22.52	29	1,043	15.68
	Network and information security	207	11,769	16.97	170	4,064	22.55	32	1,115	16.33
III	Control theory and control engineering	346	20,191	16.74	382	9,136	22.43	36	1,296	15.52
	Systems science and system engineering	263	15,379	16.72	257	6,136	22.43	49	1,764	15.71
	Artificial intelligence and intelligent systems	45	2,160	16.67	30	720	22.39	9	324	15.79
IV	Semiconductor science and information devices	168	10,029	16.33	231	5,480	22.71	13	463	16.05
	Information optics and photoelectric devices	105	6,240	16.67	122	2,888	22.89	8	285	15.38
	Laser and technical optics	143	8,580	16.07	203	4,864	22.23	11	390	15.94
Total or average		2,064	119,680	16.72	2,152	51,312	22.51	248	8,880	15.73
Direct cost per project		57.98			—			35.81		

Division I of Information Sciences

Electronic Science and Information System (F01)

The Division mainly funds basic research in areas of electronic science and technology, information and information system, information acquisition and processing and related

interdisciplinary areas.

Researches funded in areas of electronic science and technology include circuit and system, electronic science and technology, magnetic field and wave, as well as electronics and applications. Researches funded in information and information system include the theory and key technologies for information transmission, exchange and application in fields information of and communication. Researches funded in information acquisition and processing include the theory, methods and applied technology of information sensing, acquisition and processing.

In 2021, the Division will continue to support researches in areas of basic theory and key technologies that are significant to the national security in areas of new method of circuit and system design, wave transmission and antenna, microwave and millimeter wave integrated circuit, acquisition of electromagnetic energy, tetra hertz device and system, magnetic electronics, micro wave photon radar, new sensor mechanism and design method, bio data analysis, medical image processing, space, sea and land information network, mobile internet, vehicle internet, smart communication, communication system security and wireless connection security, optical communication, underwater communication and sensor network, new principle and method of radar, detection and imaging, remote sensing image processing, multimedia information processing, space information acquisition and processing, underwater information acquisition and processing. The innovative and cross-disciplinary research and exploratory studies with good prospects will be supported; preferential funding will be given to the projects which have scored outstanding achievements in previous research. Preferential support will be given and encouraged to the combination of theory and practice to focus on innovation and to study and solve basic problems in important application areas, so as to improve China's research capabilities in this discipline.

Division II of Information Sciences

Computer Science (F02)

The Division mainly funds researches in areas of basic theories, basic methods and key techniques related to computer science and technology and relevant interdisciplinary areas. Computer science and technology is one of the most active, fast-growing and widely influential areas in information sciences. The important trend of computer science and technology development is to obtain super speed, large storage, high performance, high reliability, easy interaction, intelligent, networking, universal and mobile applicability. Applicants are recommended to pay attention to these new features in this Division.

In 2021, the Division welcomes research proposals with creative ideas and reasonable plans in basic and farsighted areas and interdisciplinary subjects. The Division continues to support collaborations with researchers in areas of life sciences, medical sciences, mathematics, earth sciences, management and economics and social sciences to make joint explorations on new theories, new method and technology in interdisciplinary areas so as to promote the mutual development of computer science and other sciences. The Division especially encourages and support scientists to focus on strategic national goals and address those basic issues that are well known internationally for their complexity and significance and of strong exploratory nature, so as to increase the level and international impact of computer science research in China.

Division III of Information Sciences

The Division mainly funds basic research and far-sighted research for the national economy and national security in areas of automation, artificial intelligence, and information science in interdisciplinary areas.

Automation (F03)

The Discipline focuses on automation includes control theory and technology, control system, system modeling and emulation, bio medical information analysis and technology, navigation, guidance and control, smart manufacturing and automation system theory and technology, robotics and intelligent system.

Artificial Intelligence (F06)

The Discipline focuses on key scientific issues and technology in AI research. The Division supports close cooperation between AI researchers and those in other disciplines and humanities and social sciences to explore new concepts, theory, method and technology. The Division especially encourages researches to explore basic issues of great difficulties and great impacts.

Education Information Science and Technology (F0701)

The Discipline focuses on knowledge generation, cognition laws and learning mechanism, and original, fundamental, far-sighted and interdisciplinary research, encourage research on basic theory and method of AI driven education, education assessment method and models supported by big-data, online and mobile learning environment and key technology. The Division encourages collaborations with other disciplines including social science disciplines to explore new concept, theory, method and technology to solve education problems in China.

In 2021, the Division gives priorities on funding research in biomedical information system, intelligent manufacturing automation theory, industrial internet, autopilot, complex science and AI theory, natural language processing, and cognitive and neural science inspired AI.

Division IV of Information Sciences

The funding scope of the Division covers two disciplines, namely, semiconductor science and information devices, and optics and photo-electronics.

Semiconductor Science and Information Devices (F04)

The Discipline mainly supports semiconductor electronic and photo electric material and devices, IC design, fabrication, packaging and EDA tools, and micro and nano mechanical and electrical devices and control system.

Optics and Photo Electronics (F05)

The Discipline mainly supports optical information acquisition, display and processing, photoelectric devices and integration, inferred and tetra-hertz physics, nonlinear optics, laser, spectrum technology, applied optics, micro nano mechanical electronic devices and control

systems.

Since application codes under the category of F04 and F075 in the Division are revised, please check before making applications.

The Discipline will give priority to researches on high performance light source, low power consumption integrated circuit and radio frequency chips, new types of sensor materials and devices and technology, tetra hertz devices, micro and nano device and technology, new types of optical field control technology and devices, quantum optics and quantum devices, quantum communication and quantum computation, optical information processing and display technology, photon electronic devices and photonic integration, wide gap semiconductor materials and devices, semiconductor integrated circuit system, energy photonics, new types of laser technology and devices, new optical imaging method and technology, biomedical optics, new spectrum technology, and space and astronomical optics, environment and marine optics, etc. The Discipline will encourage studies to improve device performance (both yield and reliability) including scientific issues in device physics, structure and technology development. The Division also encourages interdisciplinary studies with physics, chemistry, materials, life and medical sciences, and promote creative research on new information devices such as brain-like chips.

Department of Management Sciences

The Department mainly supports research on improving the understanding of objective law in management and economic activities. The research findings can provide theory and method to optimize the utilization of limited resources. The Department consists of three divisions, handling and reviewing proposals of four disciplines, which are Management Science and Engineering, Business Administration, Economic Sciences, and Macro-Management and Policy.

During the 14th Five-Year Plan, the Department will be more active to encourage original studies, give preference to proposals discovering and exploring universal scientific issues based on Chinese management practices, and promote research on issues of management science to meet major national needs, so as to broaden the knowledge of management science and improve the ability of service management practice.

The Department emphasizes applying “scientific methods” to explore the objective laws of management and economic activities, and therefore ordinary management research will not be supported. The Department supports experimental research that observes and discovers the new management phenomena based on data obtained from experiments, observations and measurements. The Department also supports theoretical research that aims at addressing management issues by analyzing and explaining management phenomena through modeling, computation, induction and deduction. The Department will offer higher funding support than the average funding level for experimental research projects that do need long-term and large-scale data collection, data processing and field investigation, and high performance computing and experiments.

The Department encourages and supports scientists from diverse academic background to take an active part in management science research and explore the laws, theories and approaches of management science. However, applications focusing on humanities and social science, as well as those within the funding scope of other scientific departments of NSFC, will not be accepted by the Department.

In 2021, the Department adjusted the application codes of the four disciplines in accordance with the arrangement of NSFC, so that each discipline has clearer research focus and orientation. Applicants are required to select appropriate application code before submitting proposals.

General requirements for applications in 2021 are as follows:

1. No repetitive funding with the National Social Science Fund

To optimize the allocation of the National Natural Science Fund and to ensure that the project leaders invest adequate time and energy in their on-going national projects, the Department will decline proposals by the following applicants in 2021 (except for the applications of National Science Fund for Distinguished Young Scholars):

Applicants who were supported by the National Social Science Fund as a project leader within the past 5 years (from January 1, 2016), and have not yet obtained the project completion certificate awarded by the National Planning Office of Philosophy and Social Science until the deadline of this year's fund application.

Note: if an applicant has gained the project completion certificate from the National Planning Office of Philosophy and Social Science, and is applying for an NSFC project with the application code starting with G in 2021, the applicant needs to submit a scanned electronic version of the certificate with an official signature and seal of his/her home institution online.

If the applicant has submitted the project completion certificate for the NSFC in the previous year, he/she will be not requested to submit again in this year.

(2) Applicants who apply for National Social Science Fund as a project leader in the year of 2021.

2. Accuracy and integrality information

Applicants are responsible for the accuracy, integrality, and reliability of the contents of their applications, and their home institutions are obligated to undertake serious check on the relevant information. The following requirements should be complied with when applicants prepare and submit the project proposals:

(1) Applicants are required to give a detailed description on their previous research work related to the project proposals, as well as the publications in previous work. The five representative works should be journal articles or monographs that have already been published (including published online). When filling out the information of the representative works, the applicant should carefully read the requirements for filling in the representative works of application template, and must comply with it with honesty.

(2) The Department treats it unacceptable that applicants submit the same proposals to more than one science funding agency (or department). Applicants who propose new research topics based on their previous NSFC projects are required to describe the progress of the previous NSFC project and clarify the relations and differences between the newly submitted proposals and the previous ones. For applicants who are undertaking projects funded by other agencies, such as Ministry of Science and Technology, Ministry of Education, National Social Science Fund or local science funding organizations, they are required to clarify the similarities and differences between their on-going projects and the new proposals submitted to NSFC.

3. Special requirements for project leaders starting NSFC projects in recent years

To ensure that project leaders invest adequate time and energy in their on-going projects, the applicants in 2021 who has been approved any kind of NSFC projects as a project leader in recent two years, 2019 or 2020, will be reviewed and assessed through stricter procedures. The project leader approved in 2020 will be more attentions.

4. Consideration of the performance of accomplished projects

The Department conducts performance evaluation for all General Program projects, Young Scientists Fund projects, and Fund for Less Developed Regions projects one year after completion of these projects. The evaluation results will be released to the public on the NSFC website. Researchers with excellent performance evaluation results will be given priority for funding when they apply for new projects. However, researchers with poor performance evaluation results will undergo stricter review procedures when they apply for new projects.

The above requirements apply to all projects in the Department.

Funding in Department of Management Sciences in 2020

Unit: 10,000 yuan

Divisions		General Program			Young Scientists Fund			Fund for Less Developed Regions		
		Projects	Direct cost	Success rate (%)	Projects	Direct cost	Success rate (%)	Projects	Direct cost	Success rate (%)
I	Management science and engineering	221	10,620	17.78	225	5,392	17.46	31	868	15.50
II	Business administration	194	9,324	16.33	235	5,632	15.64	33	924	14.86
III	Economic sciences	151	7,259	13.84	216	5,176	13.73	37	1,036	13.36
	Macro-management and policy	240	11,581	13.99	245	5,824	13.52	44	1,232	13.37
Total or average		806	38,784	15.39	921	22,024	14.91	145	4,060	14.11
Direct cost per project		48.12			—			28.00		

Division I of Management Sciences

Management Science and Engineering (G01)

The Division mainly supports research on management theories and methods in the field of management sciences, which includes complex system management, operations management, decision-making and game, forecast and evaluation, management statistics theory and method, management psychology and behaviors, management system engineering, industrial engineering and quality management, logistics and supply chain management, service science and engineering, data science and management, information system and management, risk management, financial engineering, engineering management and project management, transportation management, digital platform management theory, smart management and artificial intelligence, and management theories and methods driven by new technology, etc.

The orientation of this Division is more focused on basic theories, emphasizing innovative research on management theory and method integrated with China's management practices. The Division encourages interdisciplinary research and international frontier research.

For the past few years, the Discipline has experienced rapid development in China. Its performance and reputation in the international scientific society has been unceasingly raised up in many research areas. However, the number of application and funded applications varied significantly across different research areas. The application amount of operations management, logistics and supply chain management, information system and management, transportation management, and financial engineering was relatively large, while the number of applications in

the field of basic theory and method on management sciences was relatively small, including the management statistics theory and method, etc.

In 2021, the Division will continue to encourage and support original research on basic theories on management sciences, frontier approach and innovative studies that are based on China's management practices, pioneering research to explore the frontiers of management sciences and innovative research findings with international influence. Meanwhile, the Division will give priority to the proposals that combine theoretical research and practical issues to solve the scientific issues generated from management practices in China and derive management theory and methods with universality. In this division, researchers are strongly encouraged to do frontier research and solve the problems related with important national demand, especially for the issues of management sciences behind the technical problems of "neck-lock". The Division also encourages integrations of management sciences with mathematics, economic sciences, behavior sciences, information sciences, as well as other disciplines, and supports studies of seeking breakthroughs of theories, methods, and practices through multi-interdisciplinary.

Division II of Management Sciences

Business Administration (G02)

The Division mainly supports basic research on management theories and new management techniques and methodologies, taking micro-level organizations (all types of industries, enterprises, institutions and nonprofit organizations) as the research objects. The funding areas of the Division include strategic management, theory of the firm, enterprise technology and innovation management, human resource management, financial management, accounting and auditing, marketing, organizational behavior, business intelligence and digital commerce, corporate finance, enterprise operations management, corporate governance, entrepreneurship, international business management, tourism management.

For the past few years, the Discipline has experienced development in various fields. The number of applications in the fields of financial management, marketing, operations management, accounting and auditing, enterprise technology and innovation management, organization theory and organizational behavior was relatively large, and correspondingly, the number of funded projects in these fields was also larger than the one in other fields. On the other hand, the number of applications in the fields of project management, international business management, and e-commerce was much smaller, and the number of funded projects in these fields was relatively small. In general, the proposals of basic research on expanding the frontier theories of business administration, and exploring new methods and new technologies has shown certain innovativeness, and the number of applied basic research focusing on national strategic demands and industry's practical issues was steadily increasing.

In 2021, the Division will continue to support research on innovative and cutting-edge scientific issues, highlight theory innovation and new knowledge discovery and creation. The Division will give priority to frontier exploratory proposals that integrate scientific methods and mutually verified data from various sources, and value researches with substantial international cooperation. The Division advocates scientific spirits, encourage exploration, and give priority to support innovative research on management theory innovation and research paradigm changes that are based on the practices of Chinese enterprises.

In order to promote the balance within the discipline, the Division will continue to support basic research focusing on frontiers in areas of strategic management, theory of the firm,

organizational behavior, enterprise technology and innovation management, human resource management, financial management, accounting and auditing, marketing, business intelligence and digital commerce, and enterprise operations management. Preference will be given to three newly added areas of corporate finance, corporate governance, and tourism management, as well as areas with fewer applications, including international business management and entrepreneurial management.

Division III of Management Sciences

The Division supports two basic research areas: economic sciences and macro-management and policy.

Economic Sciences (G03)

The Discipline mainly supports the basic research on unveiling the laws of economic activities, explaining economic phenomena, and deriving economic theories through scientific research methods. The funding areas covers econometrics and economic statistics, behavior economics and experimental economics, mathematical economics and computational economics, microeconomics, macroeconomic management, international economics and trade, financial economics, finance and public economics, industrial economics, economic development and economic systems, agricultural and forestry economics and management, regional economics, population labor and health economics, resources and environmental economics, etc.

In recent years, in the disciplines of economic sciences, there have been a large number of applications and funded projects in the fields of agriculture and forestry economics and management, economic development and trade, financial management, population, resources, environment economics and labor economics, regional economics and industrial economics. On the contrary, applications and supports in some fields are much less, including behavioral economics and experimental economics, econometrics and economic computation, etc. It implies the significant differences in research teams and scales for different fields.

In 2021, the Discipline will pay more attention to those research proposals on the topics of macroeconomic theories that are based on China’s national conditions, theories and methods of econometrics and experimental economics, modern fiscal and financial systems, income distribution mechanisms, industrial transformation and upgrading, collaborative development of regions, and so on. In addition, it will encourage and give priority to the proposals focusing on the high-quality development of China, which includes dual circulation economy system and economic structural adjustment under the background of global change, the construction of a global economic governance system, productivity and innovative technology development, population and labor force, resource and environment, income distribution, etc.

Macro-Management and Policy (G04)

The Discipline is a group of disciplines that study the behaviors of governments and related public sectors in formulating macro policies and implementing comprehensive governance policies, in order to achieve social and economic development goals. It covers research on public administration and public policy, policy science theory and methods, science and technology management and policy, innovation management and policy, public health management and policy, pharmaceutical management and policy, public security and emergency management, social governance and social security, environment and ecology management, resource management and

policy, regional development and urban governance, digital governance and information resource management, global governance, and sustainable development, etc.

In recent years, there are much more applications and supports for the areas of health management and policy, medical management and policy, resource management and policy, environment and ecology management, regional development and urban governance, public security and emergency management, innovation management and policy, etc. Among them, the number of applications on health management and policy, medical management and policy has grown so rapid that they account for 36.44% of all applications in the discipline in 2020. In addition, applications on innovation management and policy, public security and emergency management also grow fast. On the contrary, there are much less applications and supports in the fields of public administration and public policy, policy science theories and methods, cultural management, and social security.

In 2021, the Discipline will pay more attention to research proposals that focus on topics of socialism with Chinese characteristics for a new era, including China's governance, public policy, social governance, public security and emergency management, health management and policy, innovation management, education management, and environment and ecology management.

The Discipline aims to facilitate discipline development, promote academic innovation, and support talented scientists and research teams. In particular, the Division encourages researchers to provide scientific support and evidences for macro policy makers while developing theories and methods. The applications should take China's practical management issues as the main research objects, and bring up scientific issues from the research objects accurately. The scientificity and normativeness of research methods should be paid special attention. Applicants are advised to differentiate management science research and practical management work. In addition, the applicants should also pay attention to the difference between an NSFC project and a humanity and social science project in terms of research methods. Several other requirements are listed as follows: the scope of the research topic should be appropriate; the research goal should be concentrated and clear; the research content should be specific and concrete; the research methods and technology roadmap, as well as how to address the key scientific issues, need to be clearly clarified in the application.

Department of Health Sciences

The Department adheres to target the global science frontiers, serve the main economic battlefield, strive to fulfill the significant needs of the country, and benefit people's lives and health. It mainly supports the basic research that aims at scientific issues in disease prevention, control and treatment, and focuses on the structural, functional, developmental, genetic and immune abnormalities of human body, as well as the occurrence, development, outcome, diagnosis, treatment and prevention of disease. It also supports researchers to conduct innovative research in basic medicine, clinical medicine, preventive medicine, materia medica, pharmacology, traditional Chinese medicine, Chinese materia medica and interdisciplinary fields of medicine and engineering, so as to improve the level of medical scientific research in China.

Basic research is the activity to realize natural phenomena, reveal natural laws, put forward and resolve scientific issues. The Department encourages research areas as follows: innovative academic thinking and methodological research on the scientific issues emerging from clinical practices; systematic and indigenous research on key scientific issues; translational medical research combining basic medicine with clinical medicine; integrative medical research on the occurrence, development and regression of diseases at various levels from molecular, cellular,

tissue level to organ, individual and population level by using new multidisciplinary and comprehensive techniques or methods; in-depth research on the basis of existing findings and previous research evidence; interdisciplinary research integrated in other fields; substantive international joint research. The Department will give priority to funding basic research on major diseases that are important to the national economy and people's livelihood, sudden/emerging public health problems, and common and frequently occurring diseases that severely endanger people's health. The Department will also highlight research in distinctive fields, support relatively weak research fields, and ensure balanced, coordinated and sustainable development of all fields.

Instructions:

1. Specific instructions for applicants

(1) Applicants are encouraged to carry out in-depth basic research toward scientific issues, especially the original research. Applications with solid previously accumulated research work are encouraged to carry out further systematic research. Those tracking others' without innovative scientific ideas, or applications merely pursuing new high-technology rather than scientific novelty will not be in consideration for grant.

(2) Applicants are expected to elaborate the scientific and potential clinical values of the anticipated research results in detail. Applicants are suggested to propose a defined scientific issue or a specific hypothesis based on analysis of the relevant latest literatures and research progress in the field. Furthermore, elucidation of theoretical and applicable value of the research is needed.

(3) Applicants are expected to elaborate whether the proposed research will possibly solve the specific scientific problems or verify the hypothesis, and the proposed research is supposed to be specific, feasible and logical. Furthermore, applicants are expected to propose adequate research content, detailed research design, clear research method and reasonable budget.

(4) Applicants are expected to provide detailed information about relevant previous research. In case of extension of previously funded project, the innovative ideas and further scientific problems of research are expected to be elaborated in detail. Besides, all the relevant published papers are expected to be listed, and relevant unpublished results including experimental data, tables or graphics, etc., are suggested to be provided.

(5) Applicants are expected to provide true and accurate information in their applications, including the resume of applicant and major participants, previous grant information and relevant publications. Please fill in the published academic papers according to the instructions and outlines of application form. Patents and awards should also be listed according to the format and requirements of the application form.

(6) Applicants are expected to provide a signed institutional certification or approval (the scanning copy should be attached to the electronic proposal) to meet the related ethical or informed consent requirement if applications are involved in special medical research objects such as human tissues. Applications that do not provide certification or approval as required above will not be funded.

(7) Applicants are expected to follow all appropriate guidelines for the use and handling of pathogenic microorganisms, including the guideline "Bio-safety Administrative Rules of Pathogenic Microorganism in Lab" released by the State Council of China and the ethical and bio-safety regulations by other governmental agencies. If applications were involved in human genetic resources, applicants should strictly follow "Regulations on Management of Human Genetic Resources". Additionally, a commitment letter to guarantee bio-safety should be provided by the research institutions when applications were involved in the study of highly pathogenic microorganisms. Applications that do not provide certification or approval as required above will not be funded.

(8) Applicants with good performance records in their previous grants will be given priority on equal conditions.

(9) Applicants are expected to notice that: in 2021, the Department will generally not give further funding for General Program to applicants who either have got intensive funding in 2020 from NSFC (such as Key Program, Key International (Regional) Joint Research Program, Major Program, Key Program of Major Research Plan or Programs of Joint Funds, Special Fund for Research on National Major Research Instruments), or are applying for repetitive or similar research to their ongoing national scientific projects funded by other governmental agencies.

(10) Applicants are expected to provide PDF copies of no more than 5 representative papers in their electronic applications (Applicant's papers only).

2. General overview of applications in the Department in recent years and instructions to host institutions

The number of applications has been increasing in the Department ever since its establishment. In 2020, the number of applications was 85,029 from 1094 research institutions, accounting for 30.24% of the total applications (281,170) in NSFC, including 33,691 applications for General Program which account for 29.85% of the total applications (112,885), 38,363 applications for Young Scientists Fund which account for 34.06% of the total applications (112,642), and 8,170 applications for Fund for Less Developed Regions which account for 36.77% of the total applications (22,222). To enable the healthy, stable and sustainable development of both science foundation and medical research in China, the research institutions are required to further strengthen their management in the process of NSFC grant applications, and make efforts to further improve the scientific quality of applications (rather than increasing the number of applications) under the guidance of "Requirements of NSFC for Host Institutions to Improve Management of Scientific Projects".

3. Specific explanations on application codes

The application codes of Department of Health Sciences are composed of 35 primary application codes (H01 to H35) and many relevant secondary codes. The basic characteristics of the application codes are as following: (1) the primary application codes, which are mainly arranged in the order of organs or systems, include research areas relevant to both basic and clinical research, in an effort to ensure that applications on similar scientific issues from different disciplines are reviewed in the same reviewing system; (2) the secondary application codes, which are arranged in the order from basic to clinical research and from structural, functional and developmental abnormalities to diseases, cover both basic and clinical research relevant to the given organ or system.

The applicants are expected to carefully choose the primary application code and the relevant secondary one. For more details, please refer to the following contents in the *Guide* of each division of the Department.

Special instructions for applicants are as follows:

The Department sets up the oncology discipline separately. Please select the corresponding secondary application code under Oncology (H18) for all kinds of tumor-related medical scientific researches except for hematological tumor, epidemiology of tumor, oncological pharmacology, medical imaging of tumor and tumor traditional Chinese medicine. The proposals on hematological tumor should be submitted to the corresponding secondary application code under Hematological System (H08); the proposals on tumor epidemiology should be submitted to the Epidemiology of Noncommunicable Diseases (H3010); the proposals on oncological pharmacology should be submitted to Anti-tumor Pharmacology (H3505); the proposals on medical imaging and biomedical engineering of tumor should be submitted to the corresponding secondary application code under Medical Imaging/Nuclear

Medicine (H27) and Biomedical Engineering/Regeneration Medicine (H28); the proposals on traditional Chinese medicine tumor research should be submitted to Traditional Chinese Medicine (H31), Chinese Materia Medica (H32), or Integrated Chinese and Western Medicine (H33).

The field of Radiation Medicine (H29) mainly covers the research of radiology toxicology and pathology, radiological hygiene and protection, and non-oncology radiotherapy, and does not fund applications of radiodiagnostics and oncology radiotherapy. For the applications of radiodiagnostics, please select the appropriate secondary application code under Medical Imaging/Nuclear Medicine (H27). For the applications of tumor radiotherapy, please select the application code (H1816).

The field of Gerontology (H19) only funds research on the pathogenesis and intervention of diseases related to the mechanisms of aging. Applications that focus on age-associated diseases that do not involve pathophysiological mechanisms of aging should be submitted to other proper divisions.

Applications that focus on neonatal diseases should be submitted to Reproductive System/Perinatology/Neonatology (H04). For other scientific issues in pediatrics, please select the application code of the corresponding system.

Applications that focus on sexually transmitted diseases should be submitted to the application code (H2208) under Human Pathogens and Infections (H22).

4. Funding plan and budget

The average funding intensity of direct cost for various projects in 2021 is expected to be basically the same as that in 2020. Please apply for funds reasonably according to the actual needs of the work and fill in the fund budget table.

5. Special projects of General Programs: guidelines for "Exploration of Scientific Problems Derived from Clinical Practice"

The exploration of scientific problems derived from clinical practice is not only an important way to realize and improve the transformation from basic research to clinical practice, but also the source of putting forward major medical scientific issues. Based on clinical practice, it is of great value to innovate research methods, carry out research on the occurrence, development, diagnosis, prevention and treatment of diseases, discover and explain new mechanisms, improve the level of medical innovation, and promote the transfer of basic research achievements to clinical practice.

The Department encourages the combination of clinical practice and basic research, the interdisciplinary research and the innovation of clinical research methods, promotes the development of clinical research and medical science in China, and improves the funding pattern of medical research. In 2021, it is planned to set up the special project of "Exploration of Scientific Problems Derived from Clinical Practice" in General Programs, with about 50 projects funded and average funding of direct cost about 800,000 yuan per project. The following research is supported: (1) Important scientific problems are summarized based on clinical phenomena and problems discovered in clinical practice, rather than purely scientific research from the literature. (2) With the help of clinical tissue samples collected under strict conditions in clinical trials, the relevant mechanisms can be deeply discussed and discovered, so as to achieve the research of important guiding significance for the diagnosis, treatment, prevention and treatment of diseases. (3) Exploratory clinical research based on the transformation of original basic research achievements.

According to the research field, applicants shall independently choose the secondary application code under the primary application codes of H01–H35, and indicate "Exploration of Scientific Problems Derived from Clinical Practice" in the annotated column of the application form. The research should be in line with the above three directions. It should be clearly introduced in applications that the new phenomenon of clinical discovery or the new discovery that can be

transformed into clinical practice from the previous basic research, the originality and innovation of the research, and the protection of independent intellectual property rights. This special project does not fund clinical research already carried out by hospitals and enterprises. For projects involving clinical research, the host institution should be qualified as a drug clinical trial institution. The applications for the special projects are limited to General Program.

Funding in Department of Health Sciences in 2020

Unit: 10,000 yuan

Divisions		General Program			Young Scientists Fund			Fund for Less Developed Regions		
		Projects	Direct cost	Success rate (%)	Projects	Direct cost	Success rate (%)	Projects	Direct cost	Success rate (%)
I	Respiratory system, circulatory system, hematological system	526	28,946	15.15	477	11,400	12.27	99	3,347	12.22
II	Digestive system, urinary system, endocrine system, metabolism, and nutrition support, ophthalmology, otorhinolaryngology head and neck science, oral and craniomaxillo-facial science	646	35,588	13.24	634	15,176	11.22	109	3,708	11.28
III	Nervous system, mental health and psychological health, gerontology	423	23,338	15.43	382	9,136	12.24	60	2,026	9.65
IV	Reproductive system/perinatal medicine/neonatology, medical immunology, medical genetics	273	15,057	15.82	267	6,384	12.42	40	1,362	10.87
V	Special medicine, forensic medicine, medical imaging/nuclear medicine, biomedical engineering/regenerative medicine	257	14,189	12.83	247	5,856	10.33	33	1,109	10.15
VI	Locomotor System, emergency and intensive care medicine, trauma/burns/plastic surgery, rehabilitation medicine, medical virology and virus infection, Human Pathogens and Infections, laboratory medicine	431	23,732	12.16	399	9,544	10.57	81	2,755	10.53
VII	Oncology (hematological system not included)	859	47,386	12.84	914	21,776	11.59	145	4,950	8.86
VIII	Dermatology, radiation medicine, preventive medicine	262	14,504	17.15	243	5,768	15.74	55	1,912	14.25
IX	Materia medica, pharmacology	274	15,152	16.39	320	7,600	15.94	60	2,029	13.16
X	Traditional Chinese medicine, Chinese materia medica, integrated Chinese and western medicine	633	34,828	11.64	622	14,880	10.46	235	8,002	12.83
Total or average		4,584	252,720	13.61	4,505	107,520	11.74	917	31,200	11.22
Direct cost per project		55.13			—			34.02		

Division I of Health Sciences

The Division mainly supports basic research on the diseases of respiratory, circulatory, and hematological systems.

Respiratory System (H01)

The Discipline mainly supports the basic research focusing on the diseases of lung, airway, pulmonary circulation, mediastinum, pleura, thorax, diaphragm and other related diseases. The

funding areas includes: respiratory system structure, function and developmental abnormalities; respiratory system infections, inflammations and immunity; environmental factors and airway diseases; bronchial asthma; chronic obstructive pulmonary disease; bronchiectasis; pulmonary circulation and pulmonary vascular disease; interstitial lung diseases; acute lung injury and acute respiratory distress syndrome; sleep disordered breathing and breathing regulation; respiratory failure and respiratory support; pleura, mediastinum, thoracic and diaphragm related diseases; respiratory intervention, tracheal reconstruction and lung transplantation. Researches on new methods and strategies related to respiratory diseases also belong to its funding areas.

In present, proposals received in the respiratory system mainly focus on the areas of respiratory infections, inflammations and immunity, bronchial asthma, chronic obstructive pulmonary diseases, pulmonary circulation and pulmonary vascular diseases, interstitial lung disease, acute lung injury and acute respiratory distress syndrome. The number of application in other areas is relatively small.

Accumulating attention has been drawn to the impact of emerging, sudden out-breaking respiratory infectious diseases and environmental factors on human health. This discipline encourages studies of pathogenic mechanism, immune function imbalance and related pathological research, including research on scientific topics such as inflammation microenvironment, tissue damage and repair, pulmonary fibrosis; encourages studies of environmental and occupational factors (e.g. airborne fine particles, harmful gases, smoke and allergens, etc.) on the physiological functions of airway and lungs, and related pathological changes and underlying mechanisms; encourage studies of alveolar and blood barrier, pulmonary fluid transport and pulmonary edema, pulmonary epithelial atypical hyperplasia and nodular lesions; encourage studies on lung stem cells and lung regeneration.

This discipline will continue to support the studies of extra pulmonary organ damage related to sleep disordered breathing; support the studies of biological treatment of respiratory diseases; support the studies on new strategies for precise diagnosis and treatment of diseases, as well as studies on potential molecular markers and intervention targets. Break-through research methods and strategies play an important role in promoting clinical and basic research in the respiratory field. Therefore, this discipline encourages applicants to combine modern biological technologies, such as multi-omics technology, big data technology and humanized animal models, to promote related research in this research field.

Most of applicants in the respiratory field are from the frontline of the clinic. Therefore, this discipline encourages applicants to capture research topics from the clinic, extract scientific questions, and translate into research proposals after preliminary experimental validation. The advancement of basic research in the respiratory field is inseparable from the participation of scientific researchers focusing on basic science research, so basic science researchers are welcomed to engage in studies focusing on the respiratory field, and the cooperation between clinical experts and basic researchers are also encouraged and welcomed.

Circulatory System (H02)

The Discipline mainly supports basic researches in the growth and development, physiology, pathophysiology, and diseases of cardiovascular and lymphatic system. In recent years, the number of applications in the field of cardiac/vascular injury and protection was the largest, followed by atherosclerosis, coronary heart diseases, arrhythmia and heart failure. In addition, there were numerous applications related to non-coding RNA, but the innovation and unique characteristics of those projects were insufficient. Applicants are encouraged to carry out original basic research, cooperate with clinicians, developmental and genetic biologists, regenerative medicine specialists and other related disciplines to study on the mechanisms in the development and therapeutic

strategy of cardiovascular diseases. In the cutting-edge fields of cardiovascular diseases, researchers are encouraged to establish international collaborations, to propose innovational hypothesis based on their own research data, and eventually gain achievements with independent intellectual properties. Researches on the regulatory and damage mechanisms of the biological active substances on the heart and vessels are encouraged to find the potential biomarkers for diagnosis, therapeutic targets and innovative treatment technologies. Studies on the molecular etiology, regulatory network and intervention targets of the metabolic disorder related cardiovascular diseases are encouraged, and the effects of other systemic diseases on the cardiovascular system are also encouraged. Infectious cardiovascular diseases, immune-related circulatory system diseases, microcirculatory diseases, lymphatic circulatory diseases, and tumor-related cardiovascular diseases are still the comparatively weak fields, and relevant researches are encouraged. Studies on cardiovascular diseases in children and sex-related cardiovascular diseases are required to be strengthened. Researches and applications of new techniques, new methods and new materials in the cardiovascular field are supported. The basic researches for important clinical issues in the circulatory device implantation and perioperative period of cardiovascular surgery are encouraged.

Hematological System (H08)

The Discipline mainly supports original basic research of hematopoietic tissue/organs, blood system and its related diseases including hematopoiesis, hematopoiesis regulation and hematopoietic microenvironment; erythrocyte and its related diseases; leukocyte and its related diseases; megakaryocyte, platelet and their related diseases; bleeding, coagulation, fibrinolysis and thrombosis; aplastic anemia and bone marrow failure; myelodysplastic syndromes; myeloproliferative diseases; leukemia; lymphoma and lymphatic diseases; myeloma and plasma cell diseases; blood system disease associated infection and the treatment; hematopoietic stem cell transplantation and its complications; immunotherapy for hematologic diseases; blood transfusion, blood regeneration and blood products; new technologies and methods for hematological disease research.

In recent years, most applications are concentrated in the areas of hematopoiesis, hematopoiesis regulation and hematopoietic microenvironment, leukemia, lymphoma and lymphatic diseases, myeloma and plasma cell diseases, stem cell transplantation and its complications. Applications in other areas are relatively low in number. Immune and cell therapies have been shown to play critical roles in the treatment of blood diseases. This year, a new application code: Immunotherapy for blood diseases is added under H08. Any basic or clinical based basic researches in this area may apply under this code.

Diseases in hematological system are a type of diseases that severely affect the health of human beings. The etiology, pathogenesis, precision diagnosis and treatment have always been the support focus in hematologic area. The Division thus encourages applications in the fields of: hematopoietic microenvironment and the clonal evolution of hematologic malignancies; metabolism of hematological malignancies and its clinical correlation such as drug resistance; precision diagnosis and treatment for hematologic diseases; biotherapy in hematology field, including HSC transplantation, immunotherapy, gene therapy; basic and applied basic research using gene editing and new immuno-technologies.

The Discipline also supports applications in the following fields such as: disease related basic researches in areas of hematopoiesis, hematopoiesis regulation and hematopoietic microenvironment, hematopoietic development, differentiation and its lineage mapping; hematological disease-omics, hematologic biomarkers and their clinical application validation; in vitro regeneration and expansion of functional blood cells; studies of normal or abnormal blood

cells using new biotechnologies such as single cell technology or multi-omics.

There is an excellent and closely related solid research foundation in both basic and clinical basic research in the field of hematology in China. Applicants are thus encouraged to make full use of rich clinical resources in the field, to propose basic applications that arise from clinical problems, to carry out relevant research, and to strengthen translational medical research.

For projects involving research contents of pulmonary circulation and pulmonary vascular diseases, the applicant shall choose the appropriate application code from the respiratory system (H01) and the circulatory system (H02) according to their specific scientific topics. Division I does not support the applications of non-hematological malignancy projects. For details, please refer to the general introduction of the Department.

Division II of Health Sciences

The Division mainly supports basic researches on digestive system, urinary system, endocrine system/metabolism and nutrition support, ophthalmology, otorhinolaryngology, head and neck science, as well as oral and craniomaxillo-facial science.

Digestive System (H03)

The Discipline mainly supports studies on the related to various non-communicable and non-neoplastic diseases of the digestive system. The number of applications for projects in the field of digestive system research in 2020 increased by 20.72% over 2019. The applications on liver diseases, such as liver fibrosis, cirrhosis and portal hypertension, are still the most dominant research areas in this division. Other research topics in hepatology include metabolic liver disease, liver regeneration, hepato-protection, liver failure and artificial extracorporeal liver support. In the field of GI diseases, applications on internal environment disturbance of GI tract, intestinal mucosal barrier impairment and related diseases, mechanisms of immune-related diseases of gastrointestinal tract, abnormal GI motility and GI functional disorders are among the primary focuses. There are fewer applications in areas such as vascular and circulatory disorders of digestive system, abnormal endocrine and neurohumoral regulation of digestive system, abnormal structure and function of abdominal wall/peritoneum structure, abnormal gastric acid secretion and acid related diseases and hereditary diseases of the digestive system. The total number of items mentioned above was 91, accounting for only 2.49% of the total number of items. The young researchers are mainly focused on liver and intestinal diseases, liver fibrosis, liver cirrhosis, metabolic liver disease, inflammatory bowel disease, intestinal mucosal barrier, and so on. The number of applications for the Youth Science Fund significantly exceeded the number of regular projects. The important area of concern of intestine in recent years is the relationship between homeostasis and digestive system diseases and its role in the occurrence, development and treatment of diseases. The NSFC encourage the basic and clinical research on the key frontier issues in the above-mentioned fields. The Division also encourages the research of the role of the interaction among the various organs of the digestive system in the pathogenesis of digestive diseases.

Urinary System (H05)

The Discipline is to focus on the structural and functional disorders of the kidney, ureter, bladder, prostate and urethra, not including tumor research. The number of applications received in 2020 increased by 14.53% compared with that in 2019. Popular research topics are still in areas of the prevention and treatment of acute kidney injury and chronic kidney diseases, under the code of

the injury and repair of the urinary system, followed by the secondary renal diseases, the primary kidney disease and the renal failure. The number of urolithiasis proposals in 2020 decreased compared with that in 2019. The number of proposals related to kidney transplantation, urinary tract infection, benign prostatic and bladder diseases, urinary continence and micturition disturbance diseases in 2020 were similar to that in 2019. Fewer proposals were received in the area of urinary tract infection, abnormal structure, function and development of urinary system; attention is necessary to be paid to these areas. The NSFC will continue to support the continuous and innovative researches in urinary system.

Endocrine System, Metabolism, and Nutrition Support (H07)

The Discipline mainly supports studies on abnormity of endocrine organ structure and/or function and relative non-neoplastic chronic diseases. Supported areas include various diseases of the endocrine system, classical or non-classical endocrine tissue function and dysfunction, metabolic disorders, clinical malnutrition, and relevant therapeutic treatment. The number of total applications increases by 17.25% in 2020 relative to 2019, and the distributions of major research areas remain unchanged. The majority of the proposals are still centered on diabetes and diabetes-related diseases, followed by the projects investigating energy metabolism/obesity. Compared with 2019, bone disease decreased slightly, while thyroid disease increased slightly. In contrast, there are few applications on water/electrolyte metabolic disorders, acid-base imbalance, amino acid metabolic abnormality, aberrant adrenal gland development and/or structures in 2020. The important clinical researches will continue to be emphasized and considered preferentially or funding in the future. Similarly, researches around the discovery of new phenomena and new questions in the clinic and innovative approaches/designs will be encouraged. These areas with minor applications but significant clinical research value will continue to be emphasized and supported in the future. Similarly, researches around the discovery of new phenomena and new questions in the clinic and innovative approaches/designs will be encouraged.

Ophthalmology (H13), Otorhinolaryngology Head and Neck Science (H14), Oral and Craniomaxillo-Facial Science (H15)

The Discipline mainly supports non-neoplasm diseases of related fields. The field of ophthalmology mainly supports the research in the related fields of non-neoplasm diseases. They are focused on the inflammatory, immune related, genetic, degenerative, and neovascular eye diseases. The number of applications in ophthalmic research increased by 13.31% in 2020 compared with that in 2019. The research on fundus diseases remains to be the most concentrated area, followed by corneal diseases, glaucoma, optic nerve and visual pathway related diseases and optometry diseases. Diabetic retinopathy, retinal/choroidal neovascular diseases, refractive error and age-related macular degeneration remain to be the hot fields of ophthalmic research. The Division encourages extracting the scientific issues around clinical bottlenecks such as prediction, diagnosis and treatment of diseases, clarifying the mechanisms of occurrence and development in diseases, obtaining original scientific research achievements and promoting basic research to guide clinical diagnosis and treatment.

The field of otorhinolaryngology head and neck science mainly funds research on new techniques and methods for non-neoplastic diseases and functional reconstruction caused by structural and functional abnormalities in related regions. The number of applications in 2020 increased by 17.07% over that in 2019, and mainly focused on hearing abnormality and balance disorders, diseases of the olfactory system, the nose and the anterior skull base, and disease of throat and neck. The mechanism of hearing impairment as well as the strategies for hearing restoration is the key issues of auditory science, including the genetics and molecular mechanisms

underlying the pathogenesis for various types of deafness, and the signal pathways related to hearing impairments as well as the antagonistic therapies, etc. In the field of rhinology, research mainly focuses on the pathogenesis and development of rhinosinusitis and the pathogenesis and immunotherapy of allergic rhinitis. Research on laryngopharyngeal diseases focuses on respiratory disorders, phonetic disorders, and functional reconstruction. The research on the mechanism and intervention of auditory development and degeneration, tinnitus, hyperacusis, vertigo and olfactory disorder is an important research direction, and the interdisciplinary studies with artificial intelligence, new imaging technology, biomaterials, biomechanics, 3D printing technology, mathematical algorithms and other fields has begun to receive much attention, and will be funded continuously. Further attention should be paid to the reconstruction techniques of the otolaryngology-related dysfunctions, including nerve injury, olfactory disorder, breathing disorder, phonation disorder and swallowing disorder, etc.

The field of oral and craniofacial sciences (OCS) mainly supports research on craniomaxillo-facial tissues, organs and non-neoplastic diseases. The number of project applications in 2020 increased by 18.6% compared to 2019. In 2020, the OCS project applications were still focused on periodontal and oral mucosal diseases, followed by the prosthodontic and orthodontic fields of tooth defects, missing and dentognathic deformities, and oral and maxillofacial tissue biomechanics and biomaterials. The studies of tooth/bone development and regeneration, the application and mechanism of stem cells and exosomes, the biomechanics of oral and maxillofacial tissues and the research of biomaterials were still hot topics of concern. In addition, the number of applications for cross-research in fields such as artificial intelligence and additive manufacturing has increased year by year. This discipline encourages the integration of different directions of oral craniofacial science and the interdisciplinary research with other disciplines.

Division II does not support oncology research. All applications on oncology research in those areas please refer to the general introduction of the Department. Division II does not support researches on drug design and pharmacology as well. Please submit the related proposals to Division IX (H34, H35). Proposals on the male reproductive system and male sexual dysfunction are not included in code H05, so please submit related proposals to Division IV (H04).

Division III of Health Sciences

The Division mainly supports basic research in the fields of nervous system, mental health, and geriatrics.

Nervous System (H09)

The Discipline provides funding support for researches on the etiology, pathogenesis, diagnosis, treatment, and prevention of various non-neoplastic neurological diseases, including common neurological diseases (e.g., cerebrovascular diseases, cognitive dysfunction, neurodevelopmental disabilities, injury and rehabilitation of nervous system, neurodegenerative disorders, epilepsy, pain and analgesia), and rare neurological diseases. Division III also supports diagnosis, pathogenesis and therapy studies on inherited metabolic, autoimmune and infectious diseases of the nervous system, as well as studies on neurobiological mechanisms underlying anesthesia and sedation, and comorbidity of neurological diseases and psychiatric disorders.

In recent years, funded projects in the field of nervous system predominantly focused on

cerebrovascular diseases, cognitive dysfunction, injury and rehabilitation of nervous system, pain and analgesia, in which there is a significant increase in applied projects from the perspectives of glia, non-coding RNA, pyroptosis, autophagy, and exosomes to study neurological diseases. However, most of the applied projects were follow-up studies and/or lack of originality. Division III prioritizes the original studies regarding key scientific issues originated from clinical problems and clinical cohort studies using advanced method, as well as interdisciplinary studies using non-human primates, drosophila, and zebrafish model. Additionally, studies on the key technologies and mechanisms for strengthening neural modulation to promote the function recovery after nervous system injury are also the funding priority. Standard protocols of clinical research is required in cerebrovascular diseases studies for promoting basic research around clinical concerns, especially early intervention for neurovascular injury, revascularization, function recovery, and application and effects of precise diagnosis and treatment in acute stroke and neurotraumatic patients. Mechanisms underlying pain, especially chronic pain, and intervention studies need to be strengthened by the collaboration of basic and clinical study. Research on neurological diseases of the nervous system in children has been an ongoing concern of the Division. In addition, it is encouraged to perform substantial cooperative research in clinical and basic medicine, materials, bioinformatics and artificial intelligence.

Mental Health and Psychological Health (H10)

The Discipline provides funding support for researches on the etiology, pathogenesis, diagnosis, treatment, and prevention of psychobehavioral disorder, including common psychiatric diseases (e.g., anxiety disorder, depressive disorder, schizophrenia), as well as sleep disorders, drug dependence and other addictive disorders, stress-related disorders, neurodevelopmental disorders, psychological evaluation and intervention of psychiatric disorders, and new technology/method used for psychiatric diseases and psychological health research.

One of the hallmarks in the spectrum of modern human disease is the rapidly increased prevalence of psychological and psychiatric diseases. Elucidation of the etiology, pathogenesis and biological basis is the key issue in psychological and psychiatric disease studies, which is beneficial for early detection, objective diagnosis, and etiological treatment. In recent years, funded projects in the field of mental health predominantly focused on depressive disorder, anxiety disorder, and schizophrenia rather than biological rhythm disorders related diseases and psychological evaluation and intervention of psychobehavioral disorders. Due to the weak foundation in the field of child and adolescent mental health studies in China, researchers in this field are encouraged to carry out relevant research. Studies on the role of genetic, environmental and other factors in the occurrence and development of psychobehavioral disorders are encouraged to discover potential etiological and intervention targets, and to establish biological markers monitor system representing the occurrence, development and prognosis of psychological and psychobehavior disorders. Psychological and behavioral examination technology should be optimized to realize the early detection and diagnosis of psychological and psychobehavior disorders. The interdisciplinary cooperation between psychiatry and other disciplines is encouraged, which improves the diagnosis and treatment of psychological disorders and mental diseases in China by implementing early intervention and treatment using pharmacological or non-pharmacological methods.

Gerontology (H25)

The Discipline mainly covers the studies on pathophysiological mechanisms of aging and aging-related diseases. To fulfill the major national requirements of aging population in China, investigation should be performed to elucidate the pathophysiological changes and its mechanism of aging at organ, tissue, cell, subcellular and molecular levels. Focused studies on the

physiological mechanisms underlying aging of organ, tissue or cell should be performed to elucidate the relationship between genetic, metabolic, injury, stress and inflammation factors and organ/tissue aging as well as aging related diseases. It is encouraged to perform new technologies, methods and interdisciplinary research regarding to aging and related diseases, as well as to study on the mechanisms underlying caloric restriction, exercise and small molecule chemicals that delays aging of tissues and organs, to provide a theoretical basis for the prevention, early warning, diagnosis, treatment and prognosis of aging related diseases.

Division III does not provide funding support for tumor related studies, for which please refer to the general introduction of the Department. The field of gerontology does not support the project application of senile diseases in organs or systems unrelated to aging mechanism, for which please select other corresponding application codes.

Division IV of Health Sciences

The Division mainly supports basic and translational research in the areas of reproductive system/perinatal medicine/neonatology, medical immunology and medical genetics.

Reproductive System/Perinatal Medicine/Neonatology (H04)

The Discipline mainly supports basic and translational research on structure/function/ development abnormalities, injury and repair, inflammation and infection, endocrine abnormalities and related disease of the reproductive system, the mammary structure/function/development abnormalities, sexual dysfunction, gametogenesis and fertilization, embryo implantation, maternal-fetus interaction, reproductive immunity and related diseases, assisted reproduction, placental structure/function and development abnormalities, pregnancy related diseases, fetal development and fetal diseases, neonatal diseases, and development of novel techniques on diagnosis and treatment for diseases of reproductive system and neonatus.

Research projects focus on establishing novel multidisciplinary technology platform to study the molecular and cellular mechanisms of human reproductive and developmental diseases, damage, remodeling and fertility protection of human reproductive organs, gametogenesis and regulation of meiosis, the principle and abnormalities of human sperm-ovum recognition, fertilization and early embryonic development, regulation of pregnancy establishment and maintenance and the pathogenesis of related diseases; the effect of intrauterine and extrauterine environment on the pregnancy outcome and descendant health; the novel mechanisms of neonatal diseases; assisted reproduction and related safety evaluations based on the advances in regenerative medicine, organoid and artificial intelligence. It is encouraged to condense the scientific questions from clinical practice and to carry out original and translational research by means of the abundant clinical and genetic resources in China. The novel research paradigm is needed to be established in the study of reproductive medicine, perinatal medicine and neonatology by interdisciplinary cooperation.

In 2020, there are more proposals for General Program, Young Scientist Fund, and Program for Less Developed Region of this discipline, and which research areas are concentrated as following: pregnancy related complications, neonatal diseases, female reproductive endocrine abnormalities and related diseases, sperm development abnormalities and male infertility, endometriosis and adenomyosis, abnormalities of embryo implantation and early embryonic development, etc. The following research areas are suggested to be concerned: pubertal endocrine regulation, pathogenesis of perimenopause related diseases, genetic disorders of reproductive

system, sexual dysfunction, inflammation and infection of reproductive system, mammary development abnormalities and perinatal breast disorders; the effect of maternal nutrition, environmental and genetic factors on pregnancy outcomes and descendant health; physiology of parturition and abnormal labor, early diagnosis and treatment of congenital defects; the neonatal acute diseases, critical care, chronic organ damages and neonatal nutrition, etc. The deficiencies in proposal application are as follows: the proposals' preliminary experimental basis is weak and difficult to support the scientific hypothesis which is only derived from references and some simple data; the research content of some projects lacks mechanism research in-depth; a few of projects are descriptive, presupposition, transplantation and programmatically designed without innovation.

The field of reproductive system/perinatal medicine/neonatology (H04) does not support the research related to tumor. For the project related to tumor, please refer to the general introduction of the Department.

Medical Immunology (H11)

The Discipline mainly supports basic and translational research on the structure, function, development, and/or residence of organs, cells and molecules of the immune system, as well as the research on immune regulation and tolerance, immune homeostasis and injury, and immune diagnosis and intervention.

Key research directions and areas include: the development and differentiation of immune cells, the identification and function of novel immune cell subtypes, the structural basis and activation of immune recognition, the formation and maintenance of immune memory, the reconstruction and senescence of immune system, the immune response and its injury on hosts, the epigenetic regulation on immune system and immune functions, the interaction between metabolism and immunity, the interaction among neural system, endocrine system, and immune system, the interaction between microbiota and immune system, the new targets of immunotherapy, the new vaccines and adjuvants, the investigations of immune mechanism, specific diagnosis and intervention strategies of infection, organ transplantation, cancer, autoimmune diseases, and various chronic diseases using immunology theory and technology as well as multi-disciplinary new technology methods, and the focus on discovery of new molecular pathways and effective mechanisms for immunotherapy. It is encouraged to carry out interdisciplinary research between immunology and bioinformatics, synthetic biology, biomechanics, nanoscience, etc. It is also encouraged to condense the scientific hypothesis of immunology from preliminary research discovery and clinical practice, to explore the immunological spectrum of important human diseases, and to carry out innovative research based on clinical practice.

In 2020, there are more applications in autoimmune diseases, inflammation, infection and immunity, organ transplantation and transplantation immunity, immune recognition, immune tolerance and immune dysregulation, immune related factors and diseases, etc. The deficiencies in proposal application are as follows: the experimental basis of some clinical disease-related research projects is weak, which is difficult to support the scientific hypothesis; the design of some research projects are presupposition, routine and transplantation, and lacks mechanism exploration in depth.

Medical Genetics (H23)

The Discipline mainly supports basic and translational research on the pathogenesis, prevention and treatment of human genetic diseases and rare diseases, as well as development of new technologies and methods in medical genetics.

The key research directions and areas include studying the genetic principles of genetic diseases, discovering new pathogenicity genes, clarifying the pathogenesis and epigenetic mechanisms caused by pathogenicity genes and their mutations during the onset and development

of diseases by use of the advantages of human genetic and clinical resources in China; and exploring novel diagnosis methods and strategies of prevention and treatment. It is advised to excavate and make full use of the resources of rare diseases in China, and to carry out basic research in depth in the fields of resource protection, pathogenesis, prevention and diagnosis and drug discovery for rare diseases. It is encouraged to employ multidisciplinary techniques to perform cross-research on the genetic structure and regulatory mechanisms, and to develop new strategies for diagnosis and intervention of human genetic and rare diseases.

Division V of Health Sciences

The Division mainly supports basic research and basic clinical research in the fields of special medicine, forensic medicine, medical imaging/nuclear medicine and biomedical engineering/regenerative medicine.

Special Medicine (H24)

The Discipline is aimed at the unique medical support needs under special circumstances (aeronautics, aerospace, navigation, deep diving, plateaus, polar regions, etc.), researching and solving various special medical problems, and providing theoretical and technical support for major national strategic needs. These studies will aim at understanding the physiological and pathological changes and related mechanisms, on the level of molecules, cells, tissues, organs and the entire human body, and revealing the regulatory mechanism of the body's adaptive changes and pathological damage in the special environment, as well as the key factors of the body's tolerance to extreme environments. On this basis, risk prediction and assessment techniques, as well as novel protection techniques, are carried out for body damage under special environmental conditions. Special medicine mainly supports research on pathophysiological changes and prevention methods of related disease in special or extreme environments such as weightlessness, overweight, radiation, hypoxia, high pressure, high temperature, high humidity, high cold, and small confined space. It is encouraged to apply physics, chemistry, biology and biomedical engineering in the above-mentioned fields, to carry out in-depth and systematic research on specific medical issues in extreme environments, and to explore new theories and techniques for maintaining and enhancing body functions and physical fitness under special environmental conditions. Integration of different directions within special medicine and interdisciplinary research are also encouraged.

Forensic Medicine (H25)

The Discipline mainly funds research on resolving problems of biological, chemical and medical evidence in the judicial practice, with human body and other related forensic samples/materials as the research objects. The funding fields mainly include: identification of cause of death, estimation of postmortem interval, injury and death mechanism and screening of forensic markers, novel methods for evaluation of head injury, mechanism and assessment of personal injury caused by environmental pollution; toxicant (drug) abuse and dependence, toxicant metabolism and analysis; injury mechanism, AI identification of injured area, wound age inference by multi-omics combined with AI; objective evaluation of mentally disabled people's capacity and responsibility; individual identification of difficult samples, identification of complex relationship, tissue origin and family origin inference, multi-omics identification of identical twins, single-cell sequencing and identification of mixed stain, and basic theory and application research on forensic epigenomics. Applications of theories and technologies in other disciplines such as medicine,

biology, genetics, physics, chemistry, law, psychology, and information science are encouraged in the aforementioned fields to conduct in-depth and systematic research on forensic science issues. Interdisciplinary studies between forensic medicine and other disciplines such as medical imaging and biomedical engineering are strongly supported, too.

Medical Imaging/Nuclear Medicine (H27)

The Discipline mainly funds research on imaging and applying imaging methods to solve medical-related scientific problems. The scope includes diagnostic radiology (magnetic resonance imaging (MRI), conventional X-ray imaging and computed tomography), ultrasound medicine, nuclear medicine, electromagnetic imaging, optical imaging, and interventional medicine. Multidisciplinary exploratory research is encouraged in cutting-edge scientific fields such as new imaging principles and imaging methods, new contrast agents, multimodal cross-scale imaging, molecular imaging and molecular probes, functional imaging, imaging big data and artificial intelligence, precision intervention, theranostics, and translational medicine. Application of new imaging technologies is supported in research on the pathogenesis, early diagnosis and treatment, prognosis and efficacy evaluation, and drug screening of various diseases.

Biomedical Engineering/Regenerative Medicine (H28)

Biomedical engineering is characterized by using the principles and methods of engineering science to study and solve problems in biomedicine and improve the level of disease diagnosis and treatment. It mainly includes related research involving the intersection of electronic information, instrument science, material science and biomedicine.

The Discipline mainly funds such basic research as medical electronic engineering, regenerative medicine, and nanomedicine with relation to disease prevention and early warning, detection and diagnosis, treatment and rehabilitation. Main funding directions include: biomedical signals and images, biomedical sensing, biomedical photonics, chips and micro-nano systems, biomedical system modeling and simulation, medical information systems, rehabilitation engineering, neural engineering and brain-computer interaction, treatment planning and navigation, medical robots, biomedical instruments and medical devices, gene and drug carriers and delivery systems, medical biological materials, tissue engineering and regenerative medicine, artificial organs, etc. Such research is also supported as neural interface and control technology, biological micro-electromechanical systems, biomedical smart materials, diagnostic and therapeutic functional materials, 3D printing and tissue and organ construction, medical virtual reality and augmented reality, cell and immunotherapy, tissue-like organ construction and application, and health big data mining and medical artificial intelligence, etc.

In 2020, among the applications for funding in special medicine, forensic medicine, medical imaging/nuclear medicine, and biomedical engineering/regenerative medicine, those in medical imaging/nuclear medicine had the largest increment, with those on secondary codes evenly distributed. The application volume and distribution in biomedical engineering/regenerative medicine and special medicine did not change significantly, whereas the applications in forensic medicine decreased slightly. In order to promote the further rapid development of special medicine, forensic medicine, medical imaging/nuclear medicine, and biomedical engineering/regenerative medicine, the Division encourages researchers with different academic backgrounds to cooperate in multidisciplinary research work, supports original work, emphasize clinical application and the transformation of clinical outcomes, and gives appropriate special support to young scholars who conduct research in the above-mentioned fields.

Regarding medical imaging/nuclear medicine and biomedical engineering/regenerative medicine, Division V does not accept applications on radiation oncology or radiation

prevention, which could be submitted to related codes in Division VII (H18) or Division VIII (H29). Division V does not support applications in pharmacology and drug administration, either, which should go to related codes in Division IX (H34, H35).

Division VI of Health Sciences

The Division mainly supports the basic research and clinical basic research in the fields of locomotor system, emergency and critical care medicine, trauma, burns, plastic surgery, rehabilitation medicine, medical virology and virus infection, human pathogens and infections, and laboratory medicine.

Locomotor System (H06)

The Discipline mainly supports the research on the abnormalities in structure, function and development of the bone, joint, muscle, ligament, and related nerve, blood vessel and other tissues, and the research in the etiology, pathogenesis, diagnosis, prevention and cure of the musculoskeletal diseases including the immune-related diseases, inflammation and infection, injury and repair, grafting and reconstruction, fatigue and recuperation, degenerative disorders, sports injury, deformity and correction. Meanwhile, the researches on the emerging scientific issues such as medical biomaterials and artificial intelligence in musculoskeletal fields are highly encouraged. In 2020, applications were mainly focused on the research fields in the musculoskeletal damage and repair, and the degenerative diseases of bone, joint and soft tissue. In contrast, applications in musculoskeletal fatigue and recuperation filed were still at quite low volume. This field encourages the innovative and translational research based on clinical needs, the systematic and original research on major scientific issues in locomotor system, the interdisciplinary research using new techniques and methods, the cross-talk research between locomotor system and other organs and tissues, and the research of aging and pain in locomotor system.

Emergency and Critical Care Medicine (H16)

The Discipline mainly supports the researches on sepsis, organ function failure and support, cardiac-pulmonary resuscitation, poisoning, heat stroke, new technologies and methods in the field of emergency and critical care medicine. The pathogenesis, accurate diagnosis and treatment and scientific prevention in the field of emergency and critical care medicine should be paid more attention to. Meanwhile, researches on pathophysiological changes and immune dysfunction in this field are highly encouraged.

Trauma/Burns/Plastic Surgery (H17)

The Discipline mainly supports the researches on trauma, burns, chimatlon, wound healing and scar management, repair, transplantation and reconstruction of surface tissues and organs, craniomaxillo-facial deformity and its correction, new technologies and methods in the field of trauma/burns/plastic surgery. The pathogenesis, accurate diagnosis and treatment and scientific prevention in the field of trauma/burns/plastic surgery and malformation should be paid more attention to. Meanwhile, researches on the following aspects are highly encouraged, which include injury mechanisms, prevention and treatment of complications, tissue repair and function reconstruction, wound healing, scar prevention and treatment, repair, reconstruction and reengineering of body surface tissue and organ deformity and defect.

Rehabilitation Medicine (H20)

The Discipline mainly supports the research on the rehabilitation mechanism of structural abnormalities, disability, activity and participation limitations and the researches on the basic scientific issues related to the evaluation and treatment of rehabilitation. At the same time, the effects and mechanisms of kinesiotherapy, physical factors, occupational therapy and speech therapy are highly encouraged. This field also encourages interdisciplinary and original research to meet rehabilitation needs and the exploration of new techniques and methods in the treatment and evaluation of rehabilitation.

Medical Virology and Virus Infection (H21)

The Discipline mainly supports the researches on diseases caused by medical viruses and their infections, including respiratory viruses and infections, digestive tract viruses, picorna viruses and infections, hepatitis viruses and infections, retroviruses and infections, herpes viruses and infections, arboviruses and infections, hemorrhagic fever viruses and infections, human papilloma virus, rabies virus, parvovirus, prion and other viruses and infection, focusing on etiology, biological characteristics of viruses, host interaction, pathogenic mechanisms, epidemic characteristics of infections, and new technologies, new methods, new strategies, and new paradigms of medical virology for the diagnosis, treatment, and prevention and control of virus-related diseases. With the guarantee of ethics and biosafety, the program encourages associated research on emerging and highly pathogenic and highly transmissible viruses and infections.

Human Pathogens and Infections (H22)

The Discipline mainly supports the researches on the pathogenic bacteria, fungi, parasites, and vectors of infectious diseases including the biology of bacteria, fungi, parasites, and medical vectors and associated infections. The Discipline also supports research on the biology of mycoplasma, chlamydia, rickettsia, spirochetes and associated infections, the mechanisms of drug resistance and hospital-acquired infections, sexually transmitted disease, and the development of new technologies and methods for the study of infectious diseases. The Discipline focuses on genetic variation and evolution of pathogens, and molecular mechanisms of drug resistance and pathogen-host interactions. With the guarantee of ethics and biosafety, the Discipline encourages associated research on new and reemerging diseases and tropical diseases.

Laboratory Medicine (H26)

The Discipline mainly supports researches on biochemical test, microbiological analysis, cytological examination, hematological examination, immunological test, molecular biology test, and new technologies and methods in the field of laboratory medicine. Discoveries and identification of new biomarkers of diseases, new technology of rapid and accurate detection, and researches on new theories should be paid more attention to. The laboratory medicine researches on interdisciplinary researches coupled with chemistry, physics, biosensing and artificial intelligence are highly encouraged.

The fields of Locomotor System (H06), Emergency and Critical Care Medicine (H16), and Trauma/Burns/Plastic Surgery (H17) do not support the oncology-related research, please select the appropriate secondary application code under Oncology (H18). The field of Rehabilitation Medicine (H20) neither supports research that is not directly related to rehabilitation mechanism, evaluation and treatment, nor funds the projects of rehabilitation engineering and rehabilitation of traditional Chinese medicine. For research only involved in

the occurrence and development of diseases, please select application codes of the corresponding systems. For applications related to rehabilitation engineering and rehabilitation of traditional Chinese medicine, please select the corresponding secondary application codes under Biomedical Engineering/Regenerative Medicine (H28) and Traditional Chinese Medicine (H31). The field of Laboratory Medicine (H26) does not support research on clinical laboratory reference system and standardization, nor pathogenesis and regulation pathways of diseases. In addition, for the applications related to genetic resources, ethics, and highly pathogenic microorganisms, please see the general introduction of the Department.

Division VII of Health Sciences

The Division mainly funds oncology research.

Oncology (H18)

Oncology research seeks to understand the nature of tumor biology and foster the progress in tumor prevention, diagnosis and therapeutic strategies. On the one hand, it emphasizes to decipher cancer etiology and molecular mechanisms governing cancer development, progression and interaction of tumor with the human body. On the other hand, it aims to facilitate the transfer of new knowledge from basic research into clinical application in tumor prevention, diagnosis and treatment.

Oncology research encompasses basic research, translational and clinical research. Proposals related to basic scientific questions, including tumor biological behaviors and the intrinsic mechanisms of cancer, should select corresponding application codes for tumor etiology, tumor occurrence, tumor cell fate, tumor genetics/evolution, tumor epigenetics, tumor immunology, tumor metabolism, tumor microenvironment, tumor reoccurrence/metastasis, cancer stem cells, and interdisciplinary research of cancer (application codes H1801–H1811). Proposals related to translational research and clinical applications, including tumor prevention, diagnosis, and treatment, should choose corresponding application codes for tumor prevention, tumor diagnosis, chemotherapy, targeted therapy, radiotherapy, tumor physical therapy, tumor immune therapy, tumor biological therapy, tumor comprehensive treatment, tumor treatment resistance, tumor rehabilitation, oncology study focusing on distinct clinical characteristics, big data and artificial intelligence, translational study of cancer, and new technology and methods in oncology research (H1812–H1826).

Oncology research is one of the most active fields in medical sciences. With the rapid development and understanding of cancer, there are some emerging trends in this field. (1) The paradigm of cancer research switches from a micro, local view to a macro, systemic view. Thus, instead of focusing on tumor cell alone, oncology research is extending to tumor microenvironment, macroenvironment and emphasizes studying the interactions of tumors with the human body by comprehensive investigation from molecular, cellular to tissues, organs and system levels. (2) Due to the complexity of the nature of cancer, interdisciplinary integration becomes increasingly important in cancer research. Advanced techniques from other frontiers fields have been employed in tumor diagnosis and treatment. Thus, paradigm of oncology research switches from a model mainly based on medicine and life sciences toward a new one which is featured by cross-integration and coordinated development of multi-disciplines. The new paradigm emphasizes the employment of interdisciplinary methods, including molecular structure, signal pathways,

animal models, bioinformatics, clinical medicine, preventive medicine, imageology, as well as materials science, big data and artificial intelligence technology, mathematics, physics, chemistry, etc., to promote the systematic advances in oncology research. (3) Advance in oncology research increasingly depends on close cooperation of basic research and clinical practice. On the one hand, due to insufficient understanding of the nature of cancer, there is a lack of effective prevention, diagnosis and treatment methods in clinic. Therefore, breakthrough in basic research is prerequisite for advance in translational and clinical research. On the other hand, the diversity and complexity of tumor clinical features, as well as treatment responses, continue to raise new scientific questions for basic research. To this end, a high degree of integration of clinical and basic research activities should be strengthened to foster innovation in basic research and clinical application. (4) Additionally, the exploration of cancer research continues to integrate the concepts, models, and practical experiences of traditional medicine in the world to evoke a comprehensive and complementary model of modern medicine and traditional medicine. Thus, it highlights the importance to clarify the mechanisms of action, effectiveness, and safety of various treatments used by traditional medicine in tumor management.

The initiation and progression of cancer is a complex multi-level, trans-scale and intertwined process. It requires close cooperation of multidisciplinary investigators, as well as integration of basic research and clinical practice, to unveil the so-called mesoscopic structure of cancer, law of evolution and regulatory mechanisms of cancer that between the unit scale and the system scale from different points and multiple layers, and to define the interactions and boundary conditions inside and outside the system, as well as the connections between multiple layers. A new paradigm of oncology research helps to deepen the understanding of mechanisms governing cancer initiation and progression, prompting the development of more effective approaches of cancer prevention, diagnosis and treatment.

Applicants are encouraged to discover and refine scientific questions from preliminary research and clinical practice, and to systemically investigate the mechanisms of malignant tumors for translational research and clinical improvement of cancer diagnosis and treatment, as well as to develop multidisciplinary techniques and new methods for cancer research. Integrated research proposals taking advantage of the clinical resources in China and studies focusing on common and frequently-occurring tumors or rare cancers in Chinese population are also encouraged. In order to develop comprehensive strategies for cancer managements, applicants are also encouraged to conduct integrative studies by combining approaches of traditional medicine with modern medical science.

Applicants should note that the proposals on tumor epidemiology should be submitted to Division VIII (H30), and proposals on hematologic and lymphatic system tumors should be submitted to Division I (H08).

Division VIII of Health Sciences

The Division mainly supports the basic researches in fields of dermatology, radiation medicine and preventive medicine.

Dermatology (H12)

The funding scope of dermatology covers the basic research on the abnormality of structure, function and development of skin and its appendages, as well as immune-mediated, infectious, hereditary, metabolic, traumatic and physicochemical skin diseases. In recent years, the results of

project application and funding show that the level of basic research on skin-related diseases has improved rapidly, and research on skin and its appendages has shown a good trend. The basic research on epidemiological, diagnostic and therapeutic techniques and methods of skin diseases should be strengthened. Interdisciplinary and integrated researches with life science, physics, chemistry, computer science and other disciplines should be encouraged.

Radiation Medicine (H29)

The funding scope of radiation medicine covers basic research on radiation injury and intervention, radiation toxicology and radiopathology, radiological hygiene and protection. In recent years, the number of project applications and the quality of the funding projects indicate that great progress has been made in the scientific research and some studies have reached the international advanced levels, although the volume of the researcher team engaged in Radiation Medicine is small. While the funded projects mainly focus on radiological injury and intervention, basic research on the early diagnosis and prevention of radiation damage should be further strengthened. The Discipline attaches importance to the biological effects of low dose radiation and radiation-induced bystander effects, encourages the fundamental researches of medical radiobiology, promotes the establishment and development of a completed discipline system.

Preventive Medicine (H30)

The funding scope of preventive medicine covers the basic research on environmental hygiene, occupational health and diseases, food hygiene, human nutrition, children and adolescent health, maternal and child health care, hygienic toxicology, hygienic analytical chemistry, infectious disease epidemiology, epidemiology of non-communicable disease, epidemiological methods and medical statistics, behavior/psychological factors and health, endemiology. Based on this new code system, occupational medicine and endemiology are integrated into the scope of preventive medicine. The research of behavioral/psychological factors and health is added to strengthen the prevention beforehand strategic layout of the disease control and prevention. It is encouraged to carry out interdisciplinary and integrated researches and expand discipline areas and research directions to constantly adapt to new health needs. Population-based data accumulation and analysis of biological samples are encouraged.

In the field of Dermatology (H12), oncology-related researches are not funded, which should be applied to Division VII (H18). In the field of Radiation Medicine (H29), applications involved in cancer radiotherapy are not funded, and may refer to categories under Division VII (H18), while applications for medical imaging and radiological diagnosis are also not accepted, which should refer to categories under Division V (H27). Food Hygiene (H3004) does not support the study only on food processing and relevant divisions of Life Science are recommended. Applications for studying gynecologic diseases and pediatric diseases are not accepted in the field of Maternal and Child Health Care (H3005), or Children and Adolescent Health (H3006). The former may refer to categories under Division IV (H04), and the latter depends on the classification of diseases. Applications on drug toxicology are not supported by Hygienic Toxicology (H3007), which may refer to categories under Division IX (H35). Researches on clinical test are not included in the category of Hygienic Analytical Chemistry (H3008), which may refer to categories under Division VI (H26). Pharmaceutical analyses which are excluded from H3008 may refer to Division IX (H34). The category of Epidemiology (H3009, H3010) does not fund purely laboratory research projects that are non-population-based. Applications for health economics and policy, hospital administration, and other health management-related projects are not accepted in Epidemiology of non-communicable disease (H3010), which may refer to related categories under Department

of Management Science. Applications for non-population-based studies of pure etiology, treatment and prognosis will not be accepted in Epidemiology of Infectious Diseases (H3009), which should refer to other relevant codes of the Department. Non-population based studies of clinical and experimental research on psychosocial diseases will not be accepted in Behavioral/Psychological Factors and Health (H3012), which should refer to relevant application code of other divisions. Applications of disease projects without geographical features are not accepted under the category of Endemiology (H3013). For related applications, please select the application code of the relevant disease system.

Division IX of Health Sciences

The Division mainly supports basic researches in the discipline of materia medica and pharmacology for diseases therapy.

Materia Medica (H34)

The field of materia medica covers research areas or sub-disciplines including synthetic medicinal chemistry, medicinal chemistry of natural products, microbial drugs, biotechnological drugs, marine drugs, special drugs and orphan drugs, drug design and drug informatics, pharmaceutics, pharmaceutical materials, pharmaceutical analysis, drug resources, etc.

The discipline of materia medica provides emphasis on interdisciplinary researches, basic researches of innovative drugs and druggability. Funding in synthetic medicinal chemistry focuses on the research of active molecules based on new targets, new mechanisms or new structures, and generally does not support the simple optimization research of active compounds for known targets. Funding in medicinal chemistry of natural products and microbial drugs mainly provides to innovative theories, technologies and approaches for drug discovery from plants, animals and microorganisms. Funding in biotechnological drugs mainly supports researches on innovative biotechnologies or approaches to obtain biotechnological drugs including therapeutic antibodies, vaccines, proteins, nucleic acid and cells, etc.; meanwhile, exploratory researches on new types of expression systems and large scale cultural techniques will also be supported rationally. Funding in marine drugs mainly supports chemical, pharmaceutical and ecological researches of rare marine creature and marine microorganism from deep sea. Funding in special drugs and rare disease drugs supports drug researches involved in aeronautics, astronautics, deep sea, radiations, militaries, special environments, rare diseases etc. Funding in drug design and drug informatics mainly supports researches on innovative theories, approaches, software or computational program for drug design and druggability prediction, and meanwhile, on the discovery and structural optimization of completely new chemical structures of hit molecules. Funding in pharmaceutics mainly supports researches on innovative theories, technologies and methods, which are associated with physical pharmacy, biopharmaceutics, molecular pharmaceutics, industrial pharmaceutics, novel drug delivery systems and pharmaceutical dosage forms, and which are investigated for various disease or administration route. Funding in pharmaceutical materials mainly supports basic researches on establishment and safety evaluation of new pharmaceutical excipients and carriers, which should have owned prominent features in pharmaceutical functions and structures and can be distinguished from researches in the area of pharmaceutics. Funding in pharmaceutical analysis mainly supports basic researches on the establishment and development of innovative approaches and techniques for analysis of the pharmaceutical molecules, drug targets or biofunctional molecules, especially, the in vivo effector molecules and the interaction between drug molecules

and target molecules or effector molecules to solve key scientific problems in the fields of materia medica and pharmacology, and supports integrated investigations on the novel techniques for multi-omics with the important scientific problems of drug targets and biomarkers. As for drug resources, the Division mainly supports researches on key scientific problems associated with discovery, exploration, sustainable utilization and protection of new pharmaceutical resources.

Pharmacology (H35)

The field of pharmacology mainly supports researches on target discovery and validation, drug action mechanism or drug resistance mechanism, target validation, drug metabolism and pharmacokinetics, clinical pharmacology and drug toxicology, etc. The involved drugs should be therapeutic drugs or drug candidates or bioactive substances with some advantages in treatment of diseases.

The discipline of pharmacology puts emphasis on in-depth study of action mechanism of drugs or bioactive products and their target, including exploring the basic rule of life and the pathologic mechanism of disease by using drug molecules as probes. In-depth and systematic studies should be strengthened in proposals related with research fields as below: discovery and validation of new target, disease-specific and sensitive biomarker, discovery of new pharmacological actions of drugs or bioactive compounds and elucidation of their action mechanism, strategies and methods to effectively overcome multi-drug resistance, new targets, novel drugs and new strategies of drug combination based on pharmacogenomics, epigenetics, systematic biology, etc. Basic research should be strengthened in proposals as below: molecular regulatory network of complex disease and mechanism of drug intervention, individualized drug therapy and new treatment approaches, translational medicine, innovative pharmacological models, techniques and approaches. In the sub-discipline of drug metabolism and pharmacokinetics, new approaches and new models should be constructed and developed to strengthen the integrated researches on the drug target, pharmacodynamics, toxicology, clinical medication and drug intervention, and the regulation mechanism researches on the drug-metabolizing enzymes and transporters. In the sub-discipline of clinical pharmacology, the researches should focus on the exploratory research of individualized medication and the interaction between drugs and human body, and lay more emphasis on rational administration of special community such as children, pregnant women and the highest-risk population, etc. In the sub-discipline of drug toxicology, researches should be strengthened in the research fields as below: molecular mechanism, intervention strategy to drug toxicity, mechanism on metabolite toxicity, novel models and approaches for drug safety evaluation.

Innovative fundamental research and continuous in-depth projects will be granted in priority. Because translational medicine is of far reaching significance in improving clinical application value of basic research, laboratory basic research on discoveries of new drug, clinical therapeutics and diagnostics will be strengthened to reveal new targets for drug therapy, new biomarkers for disease diagnostic in the course of exploring the mechanisms on occurrence and development of disease, furthermore, to lay theoretical and experimental foundation for developing innovative drugs and diagnostic reagents with independent intellectual property.

Division IX does not fund conventional researches for drug development for new drug approval such as pharmaceutical process and general pharmacology. To the innovative basic research with a great prospect for new drug development, the entire chemical structures or backbone of compounds should usually be provided in application, but the applicants should pay special attention to the protection of intellectual property and carefully handle the relationships between application and secrecy. Confidentially core contents or techniques, which are not suitable to illustrate or describe in proposals such as chemical structures,

should be sent directly to Division IX by confidential letters and explained in proposals. Applicant of young scholar should get the consent of applicant's supervisor and Letter of Authorization signed by applicant's supervisor should be attached with proposal, if research proposal is similar with or closely related to applicant's supervisor research work.

Division X of Health Sciences

The Division identifies its role as advancing the theories of Traditional Chinese Medicine (TCM) including traditional medicine of various ethnic groups (the same below) while highlighting advantages of TCM. It provides funds to basic science research and clinic research programs in TCM, Chinese material medica (CMM) and integrated Chinese and western medicine.

Traditional Chinese Medicine (H31)

Funding areas: (1) Fundamental theories of TCM: Zang-Fu organs, Qi-Blood-Body Fluid, body constitutions, etiology and pathogenesis, basis of TCM syndromes, therapeutic principles and methods, prescriptions and diagnostics in TCM; (2) basic research in clinical Chinese medicine: internal medicine, surgery, orthopedics and traumatology, gynecology, pediatrics, ophthalmology, otorhinolaryngology, stomatology, oncology, geriatrics, and health preservation and rehabilitation in TCM; (3) acupuncture and moxibustion, Tuina and massage: acupoints and meridians, acupuncture and moxibustion, Tuina and massage; (4) ethnomedicine of minority; (5) novel techniques and methods in TCM research.

Chinese Materia Medica (H32)

Funding areas: (1) Chinese material medica: resources, identification, substances in pharmacodynamics, quality evaluation, processing, pharmaceutics and theories in the properties of Chinese herbs; (2) pharmacology of TCM: neuropsychopharmacology, cardiovascular and cerebrovascular pharmacology, anti-tumor pharmacology, endocrinological and metabolic pharmacology, anti-inflammatory pharmacology, immunopharmacology, antiviral and anti-infective pharmacology, respiratory pharmacology, digestive pharmacology, urinary and reproductive pharmacology, metabolism of CMM, pharmacokinetics and toxicology in CMM; (3) ethnopharmacy of minority; (4) novel techniques and methods in CMM research.

Integrated Chinese and Western Medicine (H33)

Funding areas: (1) fundamental theories of integrative medicine; (2) basic clinical research of integrative medicine; (3) novel techniques and methods in integrative medicine research.

In recent years, the funded projects in the fields of TCM, CMM, and integrative medicine have exhibited the following features: (1) based on TCM theories and clinical effects of TCM, and conducted from both macroscopic and microcosmic levels, the projects explored the holistic rules of human life and the integrating regulatory effects of TCM; (2) through introducing cutting-edge theories, methods and techniques exerted in the modern medical science and other fields, incessant innovation of research thoughts and methods, dynamic integration of TCM and new emerging disciplines, the projects have particularly been promoting the development of TCM; (3) these projects also highlighted the priority of clinic-based research of functional disorders, age-associated diseases, metabolic diseases, immunological disorders, and viral infectious diseases treated by TCM and the underlying mechanisms.

The Discipline's top priority is to support the best projects on in-depth exploration of the

modern scientific connotation of TCM on the key scientific issues of TCM and under the guidance of TCM fundamental theories, while emphasizing normative and rational applications of modern science and technology as well as methods, and thus to promote the inheritance, consistence, development, and innovation of TCM fundamental theories.

In light of the current TCM research, the Division's funding priority will continue to support the following areas in 2021: biological basis of Zang-Fu organ theories (visceral function), animal models of combining disease and syndrome, regularity in herbal combination of classical formulas, pharmacodynamic material basis, combination of macrocosmic and microcosmic syndrome differentiation, mechanisms for therapeutic effects of TCM on preponderant diseases, methodology in clinical therapeutic evaluation of TCM, specificity of acupoint, regularity in acupoint formulae and acupuncture manipulation, mechanisms underlying the therapeutic and preventive effects of acupuncture, Tuina and rehabilitation on diseases, methodology of big data mining based on ancient documents and modern clinical practices, basic theory, diagnostic and therapeutic regularity, mechanisms for the effects of integrative medicine in the prevention and treatment of major, refractory, rare diseases, emerging and infectious diseases, herb-drug interactions, ecological planting, natural farming, bionic cultivation of CMM, substitute of rare or endangered CMM, CMM identification principles and methods, methods and mechanisms for quality evaluation of CMM, regularity and mechanisms of CMM processing and preparation, technical principles of CMM preparation and novel drug delivery system with overall efficacy, CMM properties, material basis for effects, physiological disposition and the related regulation, pharmacological effects and mechanism of CMM, CMM toxicity, toxicology, and the correlation between toxicity and efficacy, ethnomedicine such as Mongolian medicine, Tibetan medicine, Uyghur Medicine, Dai medicine, Korean medicine, Zhuang medicine and so on, innovative techniques and methods in TCM and CMM research.

Division X does not support any proposal which is not associated with TCM. Any proposal focusing on pure modern medical research should be submitted to other divisions (H01─H30). Any proposal focusing on natural medicine should be submitted to the pharmaceutics division (H34) or pharmacology division (H35).

Research on CMM resources should reflect the unique properties of CMM, such as the related characteristics of the yield and quality in the production process of CMM, protection of CMM resources, development and production of new CMM resources. The Division will not support research which focus on non-medicinal plants, non-medicinal animals and non-medicinal minerals. The studies of active substances and pharmacology of CMM should explain the correlation with its clinical efficacy or the values to the development of CMM. Pharmaceutics research of minority should explain the relevance of ethnomedicine theory or traditional medicine administration principles. Any proposal without natural science feature will not be supported. TCM or acupoint formulas should list the components in the proposal. For those which cannot be shown openly should be sent to the Division directly by confidential mails and specifically explained in the proposal. All proposals which do not meet the above requirements will not be funded.

Department of Interdisciplinary Sciences

The Department was established in November 2020 by the NSFC. Its primary mission is to coordinate the funding work in the interdisciplinary field, initiate development strategies and funding policies, provide primary funding directions and project guidelines, accept, evaluate, and manage scientific projects including international cooperation and research, construct a

merit-review system, and provide consultations on cross-disciplinary issues.

Guided by major questions in basic research, the Department supports scientific activities in the interdisciplinary field and establishes an integrated funding mechanism to promote multidisciplinary research on complex science and technology issues that meet national needs. The goal is to advance the formation of new disciplines, accelerate technological breakthroughs, establish an interdisciplinary research method, cultivate world-class, multidisciplinary talents, and creates an interdisciplinary scientific culture.

The Department is divided into four divisions that fund and support interdisciplinary scientific research in the following fields: Physical Science, Intelligence Sciences, Life & Health Sciences, and Convergence Sciences.

Division I of Interdisciplinary Sciences

The Division supports research in the field of material sciences. It was established based on the interdisciplinary study across mathematics, physics, chemistry, life science, and other basic science. The Division funds projects aiming to solve the fundamental problems in materials, energy, environment, and information, make significant scientific breakthroughs, or form new interdisciplinary disciplines.

Division II of Interdisciplinary Sciences

The Division supports research in the field of intelligence and intelligent manufacturing. To facilitate the transformation of the national economy in China, the Division was established based on the interdisciplinary study across big data, artificial intelligence, cyberspace, information technology, etc. It aims to tackle the critical science and technology issues in control engineering and precision/advanced intelligent manufacturing relating to complex systems and solve bottleneck problems in engineering and manufacturing.

Division III of Interdisciplinary Sciences

The Division supports research in the field of life science and health. To advance the national health and welfare, the Division was established based on interdisciplinary research in science, engineering, medicine, etc. It aims to reveal the scientific principles behind life phenomena, clarify the multi-level interaction mechanism of complex systems related to life and health, and respond to the major challenges in human health and disease control and prevention.

Division IV of Interdisciplinary Sciences

The Division supports the research in the field of integrated sciences. It is orientated to explore issues in the macro-complex systems and economic development such as exploration and utilization of resources, construction of the ecological civilization, and improvement of human

settlement. The Division was established based on interdisciplinary scientific research across natural science, humanities, society, management, etc. It studies the natural laws and scientific causes behind the evolution of human civilization, the feedback mechanism between nature and society, the dynamic structure of the man-land system, and other major scientific issues in connection with matters relating to the sustainable development of humankind.

General Program

General Program supports scientists engaged in basic research on self-selected topics within the funding scope of NSFC to conduct innovative research and promote a balanced, coordinated and sustained development of all disciplines.

An applicant must meet the following qualifications:

(1) Have the experience of undertaking basic research projects or conducting other basic research;

(2) Hold a senior professional position (title) or doctoral degree, or be recommended by two professionals with senior academic positions (titles) in the same research field.

Full time post graduate students are not eligible to apply for the General Program, but on-the-job graduate students may apply through their employer institutions with the consent of their supervisors.

Applicants should be familiar with the current situation of relevant research in China and the world, capable of leading a group to conduct research. Applicants should prepare proposals in accordance with the guideline. The proposed research should be of scientific significance and research merits, and have sufficient thematic basis, novel academic ideas, clear-cut objectives, reasonable and detailed research contents and feasible research schemes. The number of collaborative institutions for General Program projects should not exceed 2, and the duration is 4 years (except for PIs as in-site post-doctoral researchers, whose duration of the project should be determined based on the written commitment from their host institutions, and start time should be January 1, 2022 and finish time should be December 31, 20XX, they cannot change the host institution after the project is awarded).

In 2020, NSFC funded 19,357 General Program projects, with direct cost of 11 billion yuan. The average funding was 575,000 yuan per project. The success rate was 17.15%. The funding of the General Program projects in 2020 is shown in the table below.

In 2021, the pilot review based on four natures of science topics will be implemented for the General Program. When preparing the application for General Program, the applicant should select the nature of science topic based on the key scientific issues to be solved and the research content, and clarify the reasons for choosing the science feature concerned. In the case of multiple science features, the applicant should choose the science feature that best matches, and is most focused and characteristic. NSFC shall organize respective review by

experts based on the science feature the applicant chooses.

Funding of the General Program Projects in 2020

Unit: 10,000 yuan

Departments	No. of applications	Awards				Success rate (%)
		No. of awards	Funding for direct cost	Average funding for direct cost	Share of NSFC total funding for direct cost (%)	
Mathematical and physical sciences	7,779	1,750	103,090	58.91	9.26	22.44
Chemical sciences	8,889	1,815	114,374	63.02	10.28	20.42
Life sciences	15,503	3,029	175,672	58.00	15.78	19.54
Earth sciences	8,678	2,000	116,276	58.14	10.45	23.05
Engineering and materials sciences	20,740	3,309	192,398	58.14	17.29	15.95
Information sciences	12,348	2,064	119,680	57.98	10.75	16.72
Management sciences	5,237	806	38,784	48.12	3.48	15.39
Health sciences	33,691	4,584	252,720	55.13	22.71	13.61
Total or average	112,885	19,357	1,112,994	57.50	100.00	17.15

The average funding intensity for direct cost in 2021 for General Program is basically the same as that in 2020. Please refer to the funding areas and announcements of departments for detailed funding scope and situation in recent years and other relevant requirements about General Program. Applicants are advised to prepare their research proposals in line with the funding intensity and the instructions by respective science departments.

Young Scientists Fund

The Young Scientists Fund supports young scientists to freely select their research topics within the funding scope of NSFC to conduct basic research, particularly focus on fostering the ability of young scientists to independently undertake research projects and conduct creative research, stimulates their creative thinking and trains backup talents for basic research.

An applicant must meet the following qualifications:

(1) Have the experience of conducting basic research;

(2) Hold a senior professional position (title) or doctoral degree, or be recommended by two professionals with senior academic positions (titles) in the same research field.

(3) By January 1 of the year of application, male applicants must be younger than 35 (born on or after January 1, 1986) and female applicants must be younger than 40 (born on or after January 1, 1981).

On-the-job doctoral students who satisfy the above criteria may apply through their employer institutions with the consent of their supervisors. Those who are the PIs of ongoing project of Young Scientists Fund or have undertaken it, including one-year Small Fund for Exploratory Studies, and terminated or withdrawn projects, cannot apply again.

For Young Scientists Fund, the creative potential of the applicant is mainly evaluated. Applicants should compose proposals in accordance with the outlines of application for Young Scientists Fund. The project duration is 3 years. (except for PIs as in-site post-doctoral researchers, whose duration of the project should be determined based on the letter of commitment from their host institutions, and start time should be January 1, 2022 and finish time should be December 31, 20XX, and they cannot change the host institution after the project is awarded).

Special reminders to the applicants:

(1) Participants are no longer listed in Young Scientists Fund.

(2) In 2021, the Young Scientists Fund projects are still funded in fixed amounts, the direct cost is 80,000 yuan and the indirect cost is 20,000 yuan per project for each year.

(3) In 2021, the pilot review based on four natures of science topics will be implemented for the Young Scientists Fund. When preparing the application for Young Scientists Fund, the applicant should select the nature of science topic based on the key scientific issues to be solved and the research content, and clarify

the reasons for choosing the science feature concerned. In the case of multiple science features, the applicant should choose the science feature that best matches, and is most focused and characteristic. NSFC shall organize respective review by experts based on the science feature the applicant chooses.

In 2020, a total of 18,276 Young Scientist Fund projects were funded. The direct cost was 4.4 billion yuan. The success rate was 16.22% (please refer to the table below for the funding situation).

Funding of the Young Scientists Fund Projects in 2020

Unit: 10,000 yuan

Departments	No. of applications	Awards			Success rate (%)
		No. of awards	Funding for direct cost	Share of NSFC total funding for direct cost (%)	
Mathematical and physical sciences	7,355	1,813	43,264	9.93	24.65
Chemical sciences	9,229	1,582	37,536	8.62	17.14
Life sciences	14,867	2,446	58,280	13.38	16.45
Earth sciences	8,321	1,730	41,112	9.44	20.79
Engineering and materials sciences	18,771	3,127	74,560	17.12	16.66
Information sciences	9,559	2,152	51,312	11.78	22.51
Management sciences	6,177	921	22,024	5.06	14.91
Health sciences	38,363	4,505	107,520	24.68	11.74
Total or average	112,642	18,276	435,608	100.00	16.22

Fund for Less Developed Regions

The Fund for Less Developed Regions supports scientists of some host institutions in specified regions of China to conduct innovative research within the funding scope of NSFC, so as to foster and support researchers in the regions, to stabilize and gather outstanding talents to facilitate the construction of the regional innovation system as well as the social and economic development of the regions.

An applicant must meet the following qualifications:

(1) Have the experience of undertaking basic research projects or conducting other basic research;

(2) Hold a senior academic position (title) or doctoral degree, or be recommended by two professionals with senior academic positions (titles) in the same research field.

Full-time researchers meeting the above qualifications and working in Inner Mongolia Autonomous Region, Ningxia Hui Autonomous Region, Qinghai Province, Xinjiang Uyghur Autonomous Region, Xinjiang Production and Construction Corps, Tibet Autonomous Region, Guangxi Zhuang Autonomous Region, Hainan Province, Guizhou Province, Jiangxi Province, Yunnan Province, Gansu Province, Yanbian Korean Prefecture of Jilin Province, Enshi Tujia and Miao Prefecture in Hubei Province, Xiangxi Tujia and Miao Prefecture in Hunan Province, Liangshan Yi Prefecture in Sichuan Province, Ganzi Tibetan Prefecture in Sichuan Province, Aba Tibetan and Qiang Prefecture in Sichuan Province, Yan'an City and Yulin City in Shaanxi Province, may apply for the Fund. Researchers seconded by the Organization Department of the Central Committee of the CPC to Xinjiang Uyghur Autonomous Region and Tibet Autonomous Region for 3 or more years are also eligible to apply for this fund during their tenure, on the condition that they provide the scanning copy of certificate documents issued by the organization departments or personnel department of their host institutions to prove their identity of aid scientists when applying for this Fund. If the host institution that an aid scientist is working in Xinjiang or Tibet is not a registered host institution at NSFC, they are allowed to apply for the Fund for Less Developed Regions through the eligible host institutions in the aided autonomous regions.

Researchers from the affiliated institutions to the central government or the PLA, and part-time researchers working in the eligible host institutions in the above regions and provinces cannot apply, but may join the application as main participants. Graduate students cannot apply, but on-job students may apply through their employer institutions with the consent of their supervisors. Researchers without an institution or

whose host institutions have not been registered at NSFC cannot apply for the Fund for Less Developed Regions.

In order to provide balanced support for qualified applicants for the Fund for Less Developed Regions and encourage them to apply for projects of General Program and other competitive programs of NSFC, so as to improve basic research in less developed regions, researchers who have been granted 3 or more projects under the Fund for Less Developed Regions are not allowed to apply for this fund again since the year 2016, but the Fund for Less Developed Regions grants approved in 2015 and earlier will not be counted in.

Applicants should prepare proposals in accordance with the outline of application. The number of collaborative institutions for Fund for Less Developed Regions projects should not exceed 2, and the duration is 4 years (except for PIs as in-site post-doctoral researchers, whose duration of the project should be determined based on the written commitment from their host institutions, and they cannot change the host institution after the project is awarded).

In 2020, the Fund supported 3,177 projects with a total funding for direct cost of 1.1 billion yuan. The average funding was 348,600 yuan per project, and the success rate was 14.88% (please refer to the table below for the funding situation).

Funding for Projects of the Fund for Less Developed Regions in 2020

Unit: 10,000 yuan

Departments	No. of applications	Awards				Success rate (%)
		No. of awards	Funding for direct cost	Average funding for direct cost	Share of NSFC total funding for direct cost (%)	
Mathematical and physical sciences	1,015	200	6,990	34.95	6.31	19.70
Chemical sciences	1,554	235	9,386	39.94	8.48	15.12
Life sciences	4,874	835	29,260	35.04	26.42	17.13
Earth sciences	1,301	204	7,212	35.35	6.51	15.68
Engineering and materials sciences	2,703	393	13,750	34.99	12.42	14.54
Information sciences	1,577	248	8,880	35.81	8.02	15.73
Management sciences	1,028	145	4,060	28.00	3.67	14.11
Health sciences	8,170	917	31,200	34.02	28.17	11.22
Total or average	22,222	3,177	110,738	34.86	100.00	14.30

In 2021, the average funding for direct costs is expected to be consistent with that of 2020. Please refer to the funding intensity of direct cost of relevant departments and make budget request in a realistic manner.

Key Program

The Key Program supports researchers engaged in basic research to conduct in-depth, systematic and innovative research in orientations with sound research basis or where new growth points of scientific disciplines might emerge, so as to promote disciplinary development and breakthroughs in important areas or scientific frontiers.

Key Program projects should follow the principle of limited objectives, limited research scope and focused goals, pay attention to inter-crossing disciplines, make effective use of existing major scientific research bases at national and ministerial levels, and conduct substantive international cooperation and exchange.

An applicant must meet the following qualifications:

(1) With the experience of undertaking basic research projects;

(2) Hold a senior professional position (title).

In-site post-doctors, full-time postgraduate students and people without host institution or whose institutions are not registered at NSFC are not qualified for application as PI.

The research areas or directions of Key Program are listed in the *Guide*. Applicants should prepare proposals in accordance with the *Guide* and the outline of application, identify scientific issues within the research fields and directions, define project title according to research content, and avoid using research area as project title.

In general, one Key Program project is conducted by only one research institution. If necessary, two institutions at maximum are allowed to work as collaborators. The funding duration of a Key Program project is 5 years.

Special reminder to the applicants:

In 2021, for the Key Program, NSFC still implements the category-specific review based on 4 natures of science topics. When preparing the application for Key Program, the applicant should select the nature of science topic based on the key scientific issues to be solved and the research content, and clarify the reasons for choosing the science feature concerned. In the case of multiple science features, the applicant should choose the science feature that best matches, and is the most focused and characteristic. NSFC shall organize respective review by experts based on the science nature the applicant chooses.

In 2020, NSFC funded 737 projects under the Key Program, with a total funding of 2.17 billion yuan, and the average funding for direct costs is 2.94 million yuan per project. The funding of the Key Program in 2020 is shown in the table below.

Funding of the Key Program Projects in 2020

Unit: 10,000 yuan

Departments	No. of applications	Awards				Success rate (%)
		No. of awards	Funding for direct costs	Average funding for direct costs	Share of NSFC total funding for direct costs (%)	
Mathematical and physical sciences	371	90	26,530	294.78	12.25	24.26
Chemical sciences	307	70	21,100	300.00	9.70	22.80
Life sciences	607	115	33,335	295.00	15.40	18.62
Earth sciences	588	92	27,500	298.91	12.70	15.65
Engineering and materials sciences	634	108	32,400	300.00	14.96	17.03
Information sciences	450	105	31,500	300.00	14.55	23.33
Management sciences	173	34	7,140	210.00	3.30	19.65
Health sciences	759	125	37,122	296.98	17.14	16.47
Total or average	3,889	737	216,527	293.80	100.00	18.95

Please refer to the respective sections in each department for research areas and orientations of the Key Program projects.

Department of Mathematical and Physical Sciences

In 2020, the Department announced 122 areas for Key Programs, and received 371 applications. 90 projects were funded with direct cost funding of 265.30 million yuan and about 2.9478 million yuan per project.

In 2021, the Department plans to fund about 90 Key Program projects. The average direct cost funding will be about 2.6 million yuan per project for mathematics, and 3.4 million yuan for mechanics, astronomy, physics I and physics II. The funding will be 5 years. Please provide with the proper application code when applying.

To ensure the high quality of projects, applicants are required to have held national projects, with relatively large research teams.

Please give the proposed research directions in the note section of the application form, otherwise the application will be not accepted.

In 2021, the main research directions are as follows:

1. Key problems in arithmetic algebraic geometry
2. Analytical method in modern number theory
3. Basic mathematics in modern cryptography
4. Algebraic structure and representation
5. Geometry and homology method in algebra
6. Algebraic and transcendental method for algebraic clusters
7. Geometry analysis and applications
8. Riemann geometry and related theory
9. Low dimension manifold and geometric group theory
10. Complex analysis and complex geometry
11. Real variable theory and application in harmonic analysis
12. Modern variation method and applications
13. Non exchange analysis, geometry and related theory
14. Geometric structure and complexity of dynamical systems
15. Invariant and asymptotic properties of differential equation
16. Mixed and degraded partial differential equation theory
17. Modeling and analysis of applied partial differential equations
18. Geometric method in topological quantum field theory
19. Modern theory and method of integrable system
20. Theory and application of random equations
21. Statistical analysis in disordered systems
22. Statistical basis and method of big data
23. Statistical analysis of complex structured data
24. Mathematical theory and method of AI
25. Optimization theory and method
26. Problem driven optimization modeling and efficient algorithm
27. Mathematical method in modern control theory
28. Mathematical theory and algorithm in new generation of information technology
29. Mathematical theory and application in biology and medicine
30. fractal geometry theory and analysis
31. Theoretical computer science and uncertainty mathematical theory
32. Key mathematical problems in economy and finance

33. Theory and application of combination mathematics
34. Key problem, algorithm and application in graph theory
35. Basic computational methods and theoretical analysis
36. Computable modeling and simulation
37. problem driven science and engineering computation
38. Mathematical model and computation method for industrial software
39. Geometric theory for infinite dimensional systems
40. Modeling, analysis and control of complex system dynamics
41. Nonlinear dynamic theory and experiment for high dimensional system
42. Nonlinear dynamics of rotor system
43. Vibration characteristics and control of complex structures and system
44. Solid deformation and constitutive relations
45. Strength, failure and damage of materials and structure
46. Mechanical behavior of new materials and structures in multi-field environment
47. Soft matter mechanics and flexible structure design method
48. Structural optimization theory and design method
49. Integrated design theory and method for multi-functional materials and structures design
50. Unsteady complex flow mechanism and control
51. Aerodynamics and thermodynamics of aircraft
52. Hypersonic and reaction gas dynamics
53. Hydro dynamics of marine vessels and structures
54. Theory and method of complex fluid and multi-phase and interface flow
55 Theory and method of bionic mechanics
56. Mechanics and biological problems of cells and tissues
57. Bio mechanical problems in human health and medicine
58. Theory and method of physical mechanics
59. Mechanism of energy release and damage in energy containing material explosion
60. Mechanical behavior of material and structure in dynamics loading
61. Rock mechanics in high temperature and high pressure conditions
62. Key mechanical problems in environmental evolution and catastrophe
63. New methods and technology in experimental mechanics
64. New method of computation mechanics and high performance software
65. Theory and method of fluid solid coupled mechanics
66. Mechanical behavior of media and structure in extreme conditions
67. Key mechanical problems in high end equipment and advanced manufacturing
68. Key mechanical problems in energy and environment areas
69. Key mechanical problems in aerospace
70. Nature of dark matter and dark energy and physical process in evolution of cosmos
71. Galaxy formation, evolution and impact of surrounding environment
72. Structure, formation and evolution of large mass black holes and active galaxies
73. History, structure, and evolution of the Galaxy
74. Formation of stars, structure and evolution of stars and stellar media
75. Star eruption, dense celestial body formation and evolution
76. Origin of high energy particle, transient source physics and multi messenger
77. Solar atmosphere, magnetic field and activities
78. Formation, detection and dynamics of the solar system and extra-solar planetary system

79. High precision astronomical measurement and time frequency

80. Measurement, determination of precise orbit and dynamics of fast moving celestial bodies

81. Optical and inferred key technology

82. Key technology of radio astronomy

83. Key technology for space astronomy

84. Basic physical problems for solid quantum computation

85. Physics of functional materials and devices

86. Surface and interface and membrane physics

87. Physics of confined quantum systems

88. Strong correlated system and superconductivity

89. Physical problems and method of soft matter and bio systems

90. Computational solid state physics and method and software

91. Topological matter state and quantum self-spin liquid

92. Solid magnetism and multi field regulation

93. Physics of semiconductor defects and impurity

94. New physics in energy transformation process

95. Quantum optics and quantum information physics

96. Fine structure and dynamics of atoms and molecules

97. Atomic and molecular physics of external field

98. Quantum effect of cold atoms and molecules

99. Precision spectroscopy and precision measurement physics

100. Super-fast and super strong optical physics

101. Optical field regulation and interaction with matter

102. Optical physics in man-made micro-structures and complex systems

103. Sound propagation and regulation in artificial sound structures

104. Acoustic filed and information processing in complex media

105. Acoustic sensing and application of multi physical field in extreme conditions

106. Frontier problems in basic theory of quantum physics

107. Frontier problems in basic theory of statistical physics and physical systems

108. Frontier problems in theory of gravitation and cosmology

109. Higgs physics and new physics beyond standard models

110. New method in quantum field and high precision measurement of standard models

111. Strong interaction and hadron structure

112. Dark matter, particle celestial physics and nuclear celestial physics

113. Quark gluon plasma and quantum chromo dynamics

114. Novel structure and reaction mechanism of unstable nuclei

115. Heavy ion nuclear physics and laser nuclear physics

116. Accelerator physics and its advanced technology

117. Material, mechanism, method and technology of radiation detection

118. Particle detection mechanism and method based on large facilities

118. Technology and method of nuclear electronics

119. New techniques of neutron physics, reactors and scattering

120. Reactor physics, neutron physics and technology

121. Inertia confined fusion and plasma physics, experiments and diagnosis

122. Magnetic confined fusion plasma theory, simulation, experimental and diagnosis technology

123. Low temperature plasma physics, diagnosis and applications

124. Basic research on nuclear technology applications in new materials and energy areas

125. Basic research on nuclear technology applications in biomedical and agriculture and environmental areas

126. Key problems related to radiation physics and radiation protection

127. Studies on advanced technologies and experimental methods of synchrotron radiation and free electron laser

Department of Chemical Sciences

In 2020, the Department funded 70 Key Program projects with 210 million yuan and 3 million yuan of average funding intensity per project (direct cost). The duration of each project is 5 years.

In 2021, the Department releases the guidelines for Key Program projects and accepts proposals in 105 research areas, and the average direct funding intensity will vary from 2.5 to 3.5 million yuan for each project. In principle, no more than 2 projects will be funded in each research area expect for the Key Program projects group. In order to further improve the horizon and quality of projects, proposals from those groups and teams with excellent research basis and a certain scale are preferred, and proposals for interdisciplinary cooperative research carried out by teams which have strong background are encouraged.

The applicants must indicate the selected research area in "the column of note" in the application form; otherwise, the application will be declined.

In 2021, the main research directions are as follows:

1. New methodologies and/or mechanisms of inorganic synthesis (B01)

2. Synthesis, structure and properties of organometallic/organo-elementary compounds (B01)

3. Novel synthetic strategies for natural products and complex drug molecules (B01)

4. Novel building blocks, strategies and systems for supramolecular functions (B01)

5. Precise synthesis of functional solid materials (B01)

6. New reagents for organic synthesis (B01)

7. New methodologies and/or reactions of organic synthesis (B01)

8. Organometallic catalysis (B01)

9. New synthetic methodologies for functional polymers (B01)

10. Synthesis of polymers with controlled topological structures (B01)

11. Green synthesis (B01)

12. Synthesis of molecules with special/emerging structure and/or function (B01)

13. Synthesis and reaction mechanism under extreme conditions or external fields (B01)

14. Characterization of reactive intermediates in synthetic chemistry (B01)

15. Biological and biomimetic synthesis (B01)

16. Characterization and theoretical simulation of dynamic surface/interface structure in catalytic process (B02)

17. Fundamental for efficient catalytic reaction (B02)

18. Design and construction of efficient catalyst (B02)

19. Scientific issues of electrochemical surface and interface (B02)
20. New method for study on surface and interface chemical reactions (B02)
21. Scientific fundamental of solid electrolyte and its interface (B02)
22. Scientific fundamental of colloid and interface chemistry (B02)
23. Activation and regulation of chemical bonds at surface and interface (B02)
24. Life-related colloid and interface chemistry (B02)
25. Accurate function regulation of electrochemical system (B02)
26. Ordered structure and regulation of functionalized surface molecules (B02)
27. Application-oriented chemistry of colloid and Interface (B02)
28. Surface/interface chemistry of photoelectric functional materials and devices (B02)
29. New method for interfusion of homogeneous and heterogeneous catalysis (B02)
30. Quantum theory and method in chemistry (B03)
31. Ultrafast chemical kinetics of complex molecular systems (B03)
32. Structure and evolution mechanism of polymer aggregation states (B03)
33. Design and mechanism study of optical function materials (B03)
34. Structural chemistry in confined space (B03)
35. Theory and simulation of multiscale systems (B03)
36. New luminescent and light-conversion materials and mechanisms
37. Thermodynamics of complex systems (B03)
38. Solvation electron-related chemical processes (B03)
39. Molecular-scale transport properties and devices (B03)
40. Big data analysis method of chemical measurement (B03)
41. Ultrafast, multidimensional and high-resolution analysis method (B04)
42. New method and technology of in-situ and operando analysis (B04)
43. Chemical measurement based on modern analytical methods and technologies (B04)
44. Measurement and analysis for single molecule, particle and cell (B04)
45. New analytic techniques for diagnosis of major diseases (B04)
46. Micro-nano analysis method and devices (B04)
47. Intelligent sensing and measurement (B04)
48. Chemical measurement for national security (B04)
49. Separation and analysis of complex systems (B04)
50. In-vivo chemical measurement (B04)
51. New chemical imaging methods (B04)
52. New theory and mechanism of chemical measurement (B04)
53. Chemistry of low-dimensional semiconductor functional materials (B05)
54. Chemistry of intelligent materials (B05)
55. Organic luminous materials and devices (B05)
56. Chemistry of protein-polymer conjugates (B05)
57. Polymer membrane materials and membrane reactors (B05)
58. Chemistry of recyclable polymer materials (B05)
59. Chemistry of flexible electronic materials (B05)
60. Molecular creation for energetic materials with high safety and ultra-high energy (B05)
61. Environmental interface behavior and chemical transformation mechanism of typical pollutants (B06)
62. Environmental exposure and toxicity research of pollutants (B06)
63. Intermediates of environmental pollutant molecule transformation and their

reaction mechanisms (B06)

64. New technologies and methods for pollutant detection in complex environmental media (B06)

65. Fundamental chemistry of new functional materials in polluted environment remediation (B06)

66. Process mechanism and remediation of soil/groundwater pollution (B06)

67. Fundamental study of environmental catalysis in pollution control (B06)

68. Environmental chemistry in the treatment and utilization of waste pollutants (B06)

69. Fundamental study of microorganisms in environmental pollution control and remediation (B06)

70. Environmental computational chemistry and big data (B06)

71. Environmental health effects of ultrafine particles and its molecular mechanism (B06)

72. Biosynthetic pathway Analysis of active natural products (B07)

73. Artificial design and directed evolution of proteins (B07)

74. Design and biological application of biomimetic catalysis system based on nano-enzyme (B07)

75. Assembly mechanism and regulation of biological system (B07)

76. Small molecular recognition and regulation of membrane proteins (B07)

77. Tracing and molecular intervention of pathogen (B07)

78. Discovery and biological function study of natural products with new skeletons (B07)

79. A new method for discovery of bioactive small molecular biological targets (B07)

80. New method and application of in-vivo quantitative detection (B07)

81. Small molecule intervention and regulation of protein degradation (B07)

82. Precise measurement and simulation of essential data for chemical engineering (B08)

83. Fundamental of catalyst engineering for typical chemical reactions (B08)

84. New separation methods for chemical engineering (B08)

85. New principles of chemical process intensification (B08)

86. Fundamental of intelligent chemical engineering and chemical engineering safety (B08)

87. Greening and multiscale regulation of industrial biological processes (B08)

88. Synthetic biology and industrial biocatalysis process (B08)

89. Chemical engineering fundamental of high-end specific chemicals (B08)

90. Engineering fundamentals of new chemical engineering materials (B08)

91. High-value conversion and utilization of fossil energy (B08)

92. Chemical engineering fundamental and key technologies of new energy system (B08)

93. Chemical Engineering Fundamental of biomass conversion and utilization

94. Chemical Engineering Fundamental for efficient utilization of special strategic resources (B08)

95. Utilization of chemical waste (B08)

96. Green and clean approach of chemical engineering process and environmental chemical engineering (B08)

97. Chemical regulation of energy storage carbon materials (B09)

98. Activation and transformation of light alkanes (B09)

99. Interface chemistry of solid electrolyte materials (B09)

100. Safety mechanism and chemical regulation of secondary high energy batteries (B09)

101. Non-noble metal catalysts and membrane electrodes in fuel cells (B09)

102. Photoelectrochemistry of clean fuel preparation and conversion (B09)

103. In-situ study of reaction mechanism in energy chemistry (B09)

104. Biorthogonal reaction of living animals (B0X)

105. Chemistry and chemical engineering in semiconductor industry (B0X)

(1) Chemistry of key materials for electronic packaging

It mainly includes: Chemistry of high performance and low-temperature solidification photosensitive polyimide materials; chemistry of functional polymer materials such as latent curing agents/catalysts with special structure.

(2) Chemistry of high-density organic substrates raw material

It mainly includes: Chemistry of low-loss, low-expansion and high-adhesion epoxy coating composite materials; Chemistry of high-performance, solder-resisting, and photo induction modified epoxy based materials.

(3) Chemistry of wafer manufacturing key materials for logic integrated circuits

It mainly includes: Design and preparation of Hf/Zr/La metal-based functional precursors for atomic layer deposition and chemical vapor deposition.

(4) Electrochemical surface and interface processes in high-end electronic manufacturing

The research guides from 104th to 105th listed above are the Key Program project group driven by the disciplinary frontier. The applicants may organize the collaborative research teams to apply for one of them according to the international development trend of this field and their research basis and interests. The General Office of the Department will accept and handle the proposals. When filling in the application form, the applicants should select the corresponding code based on the research contents (for code B0X, please select code from B01 to B08).

Department of Life Sciences

The research fields funded by the Department cover biology, basic medicine and agricultural sciences. According to the orientation of key projects, funding of key projects is carried out in line with the principle of “limited objectives, limited scale and prominent focus”. The Department will carry out projects peer-review and funding focusing on the following development layout: the forefront of scientific development, major national needs, promoting revolution innovation, and solving the core scientific problems behind key technologies. In 2020, the Department received 607 applications, among which 606 projects were accepted and 113 projects were approved.

In 2021, the Department will continue to encourage scientists to aim at the scientific frontier, select scientific problems related to the fundamental and overall situation to carry out systematic innovation work, and form a key project group in important research directions of the discipline in accordance with the funding principle of **"encouraging exploration, highlighting originality, focusing on the frontier, exploring new ways, demand traction, breaking through bottlenecks, commonality orientation and cross accommodation"** to promote the development of the field. At the same time, more attention will be paid to the funding of projects with "pioneering" characteristics and scientists are encouraged to carry out substantive cross research. The direct cost of key projects is planned to be about 270 million yuan, and the number of funded projects is about 90. The average funding intensity of direct costs is the same as that in 2020. The applicants are

requested to put forward a reasonable capital budget according to their own research needs.

In order to apply for the Key Program, applicants should read the application requirements, special notes, and the funding plan of the Department in this chapter carefully. Moreover, since the research areas in the Department cover a broad spectrum from fundamental biological sciences and basic medicine to agricultural science, the designated areas of Key Program in each discipline is closely correlated with the funding areas of the discipline. **Please note that applicants should correctly apply for the Key Program according to the funding areas. Those as described in "attention" as described in "Scientific departments" parts are equally applicable to Key Program.**

The requirements for application to the Key Program projects of the Department are as follows:

(1) Applicants should propose research topics and compose every parts of the proposal following the guidelines of designated areas issued by the Department in 2021. In the column of Annotations on the basic information table of the application form, applicant should fill in the applied research area; with the corresponding application code lined out in each discipline's designated areas correctly.

(2) Applicants for the Key Program of the Department are required to attach the first pages of five representative research articles (published in the recent five years) closely related to the proposal (uploaded as attachment with application).

The designated areas of the Department in 2021 are as follows:

1. Characteristics and transmission infection mechanism of pathogenic micro-organisms (C01)

2. Special microbial groups and their interaction with environment (C01)

3. Regulation mechanism of organ/tissue genesis and plastic growth (C0207)

4. Mechanism of plant\environment and other biological interactions (C02)

5. Evolution and adaptation of important animal traits (C0401)

6. Mechanisms of animal phylogeny and diversity formation (C0402)

7. Inheritance or epigenetic mechanism of phenotype and important function (C06)

8. Bioinformatics methods and big data analysis (C06)

9. Cell signal transduction and cell adaptation (C07)

10. Intracellular structure and regulation (C07)

11. Gametogenesis, embryo and organ development (C12)

12. Construction and regeneration of stem cells and organs (C12)

13. Mechanisms of immune cell development, differentiation and response (C08)

14. Mechanism, abnormality and intervention of Immune regulation (C08)

15. Neural circuit basis of instinctive behavior (C0901)

16. Synaptic development and plasticity (C0901)

17. Psychological representation and calculation of emotional cognition (C0902)

18. Regulation of tissue and organ homeostasis and correlation with the occurrence and development of diseases (C11)

19. Metabolic regulation and diseases (C11)

20. Dynamic regulation mechanism of biological macromolecules (C0502)

21. Production, transmission and regulation of metabolic signals of important substances (C0509)

22. Tissue engineering and organoid architecture (C10)

23. Effects of biomaterials and drug delivery (C10)

24. Principle Exploration and technology development of important biological process

reconstruction (C2101)

25. Development and application of high spatiotemporal editing, manipulation and imaging technology for biomolecules (C2105)

26. Formation and maintenance mechanism of ecosystem multifunctionality (C03)

27. Ecological mechanism of pest transmission (C03)

28. Directional Cultivation and efficient utilization of forest and grass biomass (C16)

29. Biological basis and regulation mechanism of excellent characters of forest and grass (C16)

30. Molecular basis and genetic regulatory network of crop complex traits (C13)

31. Biological mechanism of the coordination between crop quality formation and yield and quality (C13)

32. Biological basis and regulatory mechanism of food processing, manufacturing and storage (C20)

33. Mechanisms of food nutrition, flavor formation and safety control (C20)

34. Mechanism and control basis of crop pest disaster and evolution (C14)

35. Identification and regulation of pest resistance genes in crops (C14)

36. Biological basis of efficient cultivation and quality formation of horticultural crops (C15)

37. Mechanism and genetic improvement of crop nutrient efficient utilization (C15)

38. Biological basis for the formation of important traits of livestock, poultry, bee or silkworm (C17)

39. Precise nutrition of livestock and poultry and efficient utilization of feed (C17)

40. Pathogenic biology, pathogenic mechanism and drug resistance mechanism of zoonoses (C18)

41. Pathogenesis and host response mechanism of important diseases in livestock and poultry (C18)

42. Basic research on prevention and control of endemic livestock diseases in plateau (C18)

43. Occurrence and control mechanism of important diseases in aquaculture (C19)

44. Breeding and formation mechanism of economic characters of aquaculture organisms (C19)

Moreover, considering common problems in the past years, the Department particularly reminds applicants of avoiding the following listed mistakes. Otherwise, proposals may be rejected during the preliminary checking procedure:

(1) Applications do not specify the title of designated research areas in the column of "Annotations" on the basic information table in main body of the application text;

(2) Applications do not fill in the corresponding application code specified by this guide;

(3) Applications to key projects, without submitting the 5 representative publications within 5 years (since 2016) as first author or corresponding author.

(4) Applications indicate the designated areas in the "Annotation" column, but the actual research contents do not match the scope of funding;

(5) Applications submitted by applicants who are still holding a full time position abroad, or who cannot ensure necessary time and efforts for implementing the proposed research in China.

For other issues to be noted for proposal preparation, please refer to the G*uide* to the "matters needing attention" as described in "Scientific departments" parts.

Department of Earth Sciences

Earth science is a basic science to understand the planetary earth system, including geography science, geology, geochemistry, geophysics and space physics, atmospheric science, marine science, environmental geoscience, and other related interdisciplinary subjects. It mainly explores all kinds of phenomena, processes, and interaction, change and causality among these processes occurred in the planetary earth system, and provides scientific and technical support for solving key issues such as resource supply, environmental protection, and disaster prevention and mitigation. Innovation study of earth sciences will continuously improve the new understanding of the planetary earth system, updating the knowledge hierarchy about the origin and evolution of the Earth and planet. Scientists, not only from different disciplines of earth sciences, but also from mathematics, physics, chemistry, biology, medicine, material sciences and engineering, informatics and management sciences, should be encouraged to apply Key Program of the Department jointly, and note the application codes for interdisciplinary studies in the application form.

The relevance and academic contribution to the specific priority themes must be stated in the proposals. To avoid repetitive funding, applicants shall state clearly the relations and differences between the application and related projects funded by other national agencies.

Each priority field of the Department emphasizes the cross and integration to different traditional disciplines. The topic of Key Program is not restricted by traditional disciplines. The application codes for Key Program proposal should be filled upon the applicant's selection.

In 2020, the Department received 588 Key Program proposals, and 92 were funded with direct cost of 275 million yuan in total and 2.9891 million yuan in average. In 2021, 95 projects will be funded with an expectation of 3.00 million yuan per project and the research period of 5 years.

The 8 designated areas of the Department in 2021 are as follows:

(1) New techniques and methods of the Earth and planet research;
(2) Habitability and Evolution of the Earth and Planets;
(3) Deep Earth processes and dynamics;
(4) Ocean processes and polar environment;
(5) Earth system processes and global change;
(6) Weather, climate, and associated sustainable development;
(7) Human activities and environment;
(8) Formation mechanism and supply potential of resources and energy.

In the "Annotations" item of the proposal, applicant must select one appropriate field from the above eight fields in the pull-down menu. Proposals with incorrect "Annotations" or without "Annotations" will not be accepted.

The applicants may determine the title, content, and research plan for their own proposals according to the key themes listed in the 8 fields based on the previous research work and new scientific problems, as well as new research approaches. The application text should explain the relationship between the project and the research direction of the selected field.

1. New techniques and methods of the Earth and planet research

Scientific objectives: Oriented to scientific frontiers of technological breakthroughs in the observation of key processes or key components of the earth and planetary exploration, the novel techniques, which related with the basic theory, experimental simulation, observation and information extraction, should be developed; and the innovation of remote sensing, in-situ detection, simulation and prediction of physical and chemical properties on the earth or other

planets should be promoted, as well as the integrated application of new technologies from microscopic to macroscopic features. Stimulate the establishment of a scientific research system driven by data-model, and lead the comprehensive innovation of multi-layer, multi-scale, quantitative, and integrated research methods in the earth system.

Preferred research themes:

(1) New theory, technique and method of earth observation, lunar and planetary exploration;

(2) Integrated observation methods and detection techniques oriented by deep space, deep earth, deep time, deep ocean, and habitable Earth strategy;

(3) New techniques and methods for the analysis of the composition and structure of earth and planet materials;

(4) Techniques of assimilation, fusion, analysis, and integration for spatio-temporal big data;

(5) Establishment and techniques of earth observation system and multi-sources data fusion platform.

2. Habitability and evolution of the Earth and planets

Scientific objectives: The processes of transportation, conversion, and coupling evolution about the matter and energy need to be studied in the Earth and Planets multi-layer systems, to explore the origin and early evolution of life, to understand the formation and evolutionary processes of planetary habitable environments. The evolution of life on Earth and the terrestrial health are truly going to rise or fall together. Besides, the habitation of the Earth is closely related to the interaction of multi-layer of planets and human activities. The field of this research is dedicated to understand the mutual feedback processes between the terrestrial habitability and the evolution of life and environment from the perspective of multidisciplinary integration, which is also an effective way to promote the development and innovation of planetary science.

Preferred research themes:

(1) Origin and evolution of cosmos and the sun and solar system;

(2) Solar-terrestrial space physics;

(3) Space environment and its changes of the planets and interplanetary space;

(4) The evolution of magnetic field and atmosphere of the Earth and Planets and its influence on habitability;

(5) Key geological process constraints and the habitability evolution of the Earth and Planets;

(6) Environment of the Earth and Planets and the evolution of life;

(7) Influence of human activities on the Earth’s habitability.

3. Deep Earth processes and dynamics

Scientific objectives: Adhering to the views of Earth and planetary sciences, using multi-disciplinary methods of geology, geophysics, and geochemistry to obtain information about the deep materials, architectures and kinematics of the Earth. This field is aimed to decipher how the solid Earth operates, to characterize the interactions among multiple spheres of the Earth, to disclose the coupling relationship between deep Earth and surficial processes and to promote development and innovation in Solid Earth science.

Preferred research themes:

(1) Deep materials, architectures and kinematics of typical regions and global scale;

(2) Coupling of deep and surficial Earth processes and its environmental and disaster effects;

(3) Early Earth evolution and the formation, growth, and reconstruction of continents;

(4) Processes and dynamics of continent assembly and break up;

(5) Earth’s deep materials and the distribution, migration and effects of volatiles;

(6) Plate subduction, mantle plume and the interactions among its multiple spheres;

(7) Multiple-scale geodynamics experiment and simulation.

4. Ocean processes and polar environment

Scientific objectives: To construct a theoretical framework for multi-scale motion in the ocean, revealing the mechanisms of material-energy cycle in the multi-spheres of the ocean, to clarify the interaction mechanism of marine dynamic processes with biological and chemical processes, and the dynamic ocean floor evolution, and to explore the regulation mechanism relating to the variation of the earth system in the deep sea, polar regions, and land-sea interaction zone, to reveal the formation and evolution mechanism of the oceanic lithosphere from nascent to extinction, and to provide scientific and technological support for national coordination of land and marine development, blue economy, marine sustainable development, and deep sea and polar national strategies.

Preferred research themes:

(1) Ocean dynamics and its coupling with biogeochemical and ecological processes including the study of observation, mechanism, and simulation prediction;

(2) Rapid changes in polar environment and multi-spheric interactions;

(3) Deep sea fluid-solid coupling, material energy cycle and environmental resource effects;

(4) Driving and response of the processes in high and low latitude oceans responding to global change;

(5) Multi-interface coupling process and sustainable development in offshore and coastal zones;

(6) Formation and maintenance mechanism of marine biodiversity;

(7) Linkage effect of high-latitude and alpine ecosystem changes.

5. Earth system processes and global change

The scientific objectives: The evolution and operation laws of the different spheres need to be explored associated with the Earth surface system at diverse spatio-temporal scales, to understand the co-evolution and coupling relationship among the biosphere, hydrosphere, atmosphere and lithosphere of the Earth surface, thereby to reveal the impacts of the Earth system evolution on the resources and environment; and to comprehend the interactions of the Earth surface processes and climate change with the development of the Earth's life and human society, thus providing key scientific evidence and theoretical support for the future predictions of the Earth surface processes, biodiversity, resources and environment, and environmental change trends.

Preferred research themes:

(1) Earth surface processes and mechanisms based on interactions among diverse spheres;

(2) Carbon and nitrogen cycles, key processes in water cycle and environmental changes;

(3) Coupling and regulation of human-nature system during the process of global change;

(4) Mechanism and strategy of sustainable development in the context of global change.

6. Weather, climate, and associated sustainable development

Scientific objectives: To investigate physical and chemical processes in the atmosphere and their interactions with other spheres; to reveal the principles and mechanisms of the evolution of and variations in weather, climate, and the atmospheric environment; to develop high-resolution numerical models; to improve the theories and technologies for forecasting and predicting weather, climate, and the atmospheric environment; and to provide scientific support for the sustainable development of the economy and society by focusing on national needs, thus enhancing our capabilities in disaster prevention and adaptation to global climate changes.

Preferred research themes:

(1) Mechanisms, forecasting, and prediction theories and technologies for weather, climate, and atmospheric environmental variations;

(2) Physical and chemical processes in the atmosphere and the mechanisms underlying their

interactions;

(3) Biogeochemical processes and weather/climate;

(4) Multi-spheres coupling and evolution mechanism of the earth's climate system;

(5) Research and development of atmospheric models and Earth system models;

(6) Atmospheric environment and its health effects;

(7) Impacts, mitigation and adaptation of extreme weather and climate change.

7. Human activities and the environment

Scientific objectives: Regarding the complex human-Earth system, researches are needed to reveal the evolution and succession of the Earth environment and the affecting factors, to elucidate the disturbance and transformation of the Earth environmental components, such as water, soil, air, organisms and the stratum, induced by human activities, to provide a fundamental scientific understanding of the formation mechanisms of the livable Earth surface layer that couples different environmental components.

Preferred research themes:

(1) Regional environmental pollution process, health effects, and pollution control and management;

(2) Soil degradation mechanisms and soil restoration;

(3) Mechanisms of catastrophic engineering and geological hazards, early detection and warning, prevention, and management;

(4) Interaction mechanisms, coupling process and environmental effects of the human-Earth system.

8. Formation mechanism and supply potential of resources and energy

Scientific objectives: To aim at realizing the secure supplies of resources and energy and supporting the high-quality development of China. Centering around the basic and cutting-edge scientific issues on the full chain of the utilization of resources and energy, theoretical and experimental studies will be conducted on the efficient exploration of conventional oil and gas, the finding of "sweet spots" of unconventional oil and gas, and the enrichment of strategic and scarce mineral resources, through which to consolidate the foundation for independent scientific and technological innovation in the resource and energy fields in China.

Preferred research themes:

(1) Interaction among different spheres and its effects on resources and energy;

(2) Formation mechanism and exploration technology of solid mineral resources;

(3) Accumulation mechanism of oil, gas and natural gas hydrate and their exploration theories and techniques;

(4) Metallogenic mechanism and exploration and development technology of submarine polymetallic resources;

(5) Organic-inorganic interactions in Earth's interior and their resource effects;

(6) Formation and distribution of new energy and its exploration and development technologies;

(7) Polar and space resources.

Department of Engineering and Materials Sciences

In 2021, the Department plans to give priority to 14 key project funding areas in engineering, materials and the integration of engineering and materials.

The application for Key Program should be oriented to facing the world's leading edge of science and technology, the main sectors of the economy, the major needs of the country and

people's live and health, strengthen the ability to extract the core scientific issues from behind the major needs of the country and bottleneck technologies, focus on the research direction, carry out original basic research in the frontier field, embody the combination of the frontier discipline and the major needs of the country, and promote the interdisciplinary integration and the application of the basic research findings.

In 2020, the Department received 634 proposals for the Key Program, among them 108 were supported with a total direct cost of 324 million yuan, with a direct cost of 3 million yuan per project. In 2021, about 110 projects in the following 14 fields will be supported, with an average direct cost of 3 million yuan per project and time duration of five years.

The 14 designated areas of the Department in 2021 are as follows:

(1) Common software support platform in engineering and materials field;
(2) Design, preparation, processing and application of metallic materials;
(3) Design, preparation and application of inorganic nonmetallic materials;
(4) Design, preparation and application of organic polymer materials;
(5) Efficient exploitation and utilization of resources;
(6) Scientific problems in mechanical design, manufacturing and service;
(7) Engineering Thermophysics and energy utilization;
(8) Scientific basis and key technology of electrical engineering;
(9) High performance civil engineering structure and green building design;
(10) Water safety and engineering support;
(11) Regional environmental compound pollution control and ecological restoration;
(12) New green intelligent marine structure;
(13) Intelligent transportation and transportation engineering;
(14) New concept materials, material commonness and interdisciplinary with engineering.

Application should label the corresponding field name of the Key Program in the Annotation area of the front cover. Applications without an Annotation or with a wrongly selected Annotation will be rejected.

The applicants have the option to determine the project name, research content and research scheme independently according to the research direction of the key program funding fields, and select an appropriate application code of the Department in the column of "application code 1", with the supplement information by selection of "application code 2".

1. Common software support platform in engineering and materials fields

The platform aims at the bottleneck technologies of software in the field of engineering and materials, solves the basic scientific problems and common basic theories in the field of general purpose software and industrial software in engineering and materials sciences, and provides basic support for the development of independent and controllable key tool software.

Applications failed to meet the requirements of this *Guide*, or failed to reflect the features of engineering and materials sciences will be rejected. Applications of mere information science are not supported.

2. Basics in the design, preparation, processing and application of metal materials

(1) Key issues in the design, manufacture, processing and application of ferrous and nonferrous metals;
(2) High temperature alloys, intermetallic compounds and metal matrix composite materials;
(3) Metastable and nano metallic materials;
(4) Optical, electric, magnetic, acoustic and thermal materials;
(5) Energy, environmental and catalytic metallic materials;
(6) Biomedical, intelligent and biomimetic metallic materials;

(7) Characterization of structure, surface and interface of metallic materials.

3. Design, preparation and application fundamentals of Inorganic non-metallic materials

(1) Research on frontier scientific issues of inorganic non-metallic materials;

(2) Research on basic issues in bottleneck technologies of inorganic non-metal materials;

(3) Research on multi-scale structure effects of high-performance inorganic non-metallic materials;

(4) Preparation science of large-size and high-performance ceramic components;

(5) Exploration of new theories, new technologies and new systems of inorganic non-metallic materials.

4. Design, preparation and application of organic polymer materials

(1) New synthetic methods and principles of polymeric materials;

(2) Manipulation of the aggregation structure of polymeric materials and its influence on properties;

(3) New theories and methods for the processing (including micro-nano processing and additive manufacturing) of polymeric materials;

(4) Basic issues on biomedical polymeric materials;

(5) Basic issues on optoelectronic organic polymeric materials and devices with high performance;

(6) Basic issues on flexible and wearable polymeric materials;

(7) Basic research on the major problems & challenges existing in the fields of polymeric materials those fulfill the requirements for the national strategical objective.

5. Efficient exploitation and utilization of resources

(1) Basic research on new theory, new method and new technology of drilling and exploitation of difficult-to-exploit oil and gas reservoirs;

(2) Key scientific issues on safety and reliability of oil and gas storage and transportation;

(3) Theory and key technology of safe, efficient and intelligent mining of deep mineral resources;

(4) Theory and key technology of disposal and utilization of mine solid wastes;

(5) Safety control mechanism and prevention and control methods of industrial production process;

(6) Fine regulation mechanism of mineral separation process enhanced by combination of mineral and metallurgical processing;

(7) Research on basic issues of new techniques, new technology and environmental protection in iron and steel metallurgy;

(8) New technology and theory on metallurgy, preparation and recycling of complex metal resources

(9) New technology and principle of metal controlled solidification and controlled forming;

(10) Basic research on short-flow and intelligent forming and processing technology of high-performance metal materials.

6. Scientific problems in mechanical design, manufacturing and service

(1) New design theories, methods and technologies for mechanical system driven by synthetic performance;

(2) New principles and configurations for energy-efficient high-reliable transmission and drive;

(3) Dynamic characteristic design and intelligent operation of high-end equipment;

(4) Strength design for mechanical structures under extreme working conditions;

(5) Test, mechanism and control of complex mechanical surface/interface mechanics and

tribological behavior;

(6) Mechanical bionic design and biomanufacturing;

(7) Foundation and equipment of precision forming manufacturing for complex components of high-performance materials;

(8) Theory, method and technology of ultra-precision, ultra-high speed and super-strong energy field machining;

(9) New principles, modes, systems and equipment for intelligent manufacturing;

(10) New method of multi-dimension and multi-parameter measurement and micro-nano manufacturing.

7. Engineering thermophysics and energy utilization

(1) Thermodynamic system analysis, control and optimization for energy conservation and environmental protection;

(2) Turbulent flow mechanism and flow control in fluid machinery;

(3) Fundamentals on mass and heat transfer in energy conversion and utilization;

(4) Fuel combustion theory, mechanism of pollution and emission reduction and combustion new technique;

(5) Fundamentals on multi-phase flow in power systems;

(6) Principles and methods of measurement for complex thermo-physical quantity and field;

(7) Key thermo-physical issues on the utilization of new energy and renewable energy.

8. Scientific fundamentals and key technologies of electrical engineering

(1) Common fundamentals and new technologies of electrical engineering, such as electromagnetism and plasma (including sensing and testing, multi-field coupling, digital twinning, new type of power generation, power transmission, discharge plasma and its applications);

(2) Electrical materials, devices and equipment;

(3) Smart grid and integrated energy system;

(4) Electromechanical energy conversion and electric drive;

(5) Electric energy conversion and control;

(6) Electric energy storage and its application;

(7) Bioelectromagnetic technology.

9. High-performance civil structures and green building design

(1) High-performance civil materials and structures;

(2) Civil engineering design and construction in complex and severe environments;

(3) Theories and innovative technologies of the intelligent and industrialized construction in civil engineering;

(4) Enhancement of serviceability and functionality of civil engineering infrastructures;

(5) Key scientific issues in geotechnical engineering under extreme environment;

(6) Full lifecycle design and disaster mitigation for underground and tunnel engineering;

(7) Theory and method of multi-hazard effect and resilience analysis of civil structures and infrastructures;

(8) New design theory and method of high energy-efficient and intelligent building;

(9) Theory and method of urban space development;

(10) Theory and method of ecological landscape planning in livable urban and rural areas.

10. Water security and its engineering support

(1) Evolution and regulation of basin water systems;

(2) Green and high-efficient agricultural water use;

(3) Water and sediment processes and eco-environmental effects;

(4) Design theories of new hydraulic machinery;

(5) Rock and soil mechanics and geotechnical engineering for deep seas and plateaus;

(6) Intelligent construction and operation of hydraulic structures;

(7) Flood and drought disasters and prevention.

11. Regional environment compound pollution control and ecological restoration

(1) Urban wastewater reclamation and water sanitation and safety;

(2) New theories and technologies for industrial wastewater pollutant control;

(3) Air purification, disinfection, health and safety in indoor public places;

(4) Mechanism of high-efficiency urban organic waste recycling;

(5) Sustainable urban water system construction and water safety assurance;

(6) Theories and technologies for collaborative treatment of compound contaminated sites;

(7) Urban and rural/regional material and energy cycle process simulation and pollution risk control.

12. New green and intelligent marine structures

(1) Pumpless marine mining and carrier systems;

(2) Intelligent sensing of ship hull attitudes and digital twins;

(3) Mixture flows of water and bubbles around green ships;

(4) Intelligent collective operations of underwater vehicles;

(5) Human robot confluence of intelligent shipping.

13. Intelligent transportation system and intelligentization of vehicles

(1) Intrinsic characteristics acquisition, control optimization and modelling, simulation of urban transportation systems;

(2) Theories and key technologies for synergetic development of resilient comprehensive transportation system;

(3) Decision-making for intelligent vehicles based on drivers' cognitive mechanism;

(4) Development of vehicle-infrastructure communication involving automated driving promoted by digital transportation infrastructure;

(5) Key scientific issues of integration for propulsion, levitation and guidance of high-speed maglev systems.

14. New conceptual materials, commonality of materials and their cross with engineering

(1) Research on key common scientific issues in such as the design, preparation and characterization of new conceptual materials;

(2) New conceptual materials and new properties;

(3) New composite, fusion and hybrid materials;

(4) Multi-functional integrated materials and devices facing intelligence and information;

(5) Key new materials for high-end manufacturing and national major projects.

Department of Information Sciences

In 2020, the Department announced 89 areas and several non-specified areas meeting the major national demands for the application of Key Programs, and received 450 applications (290 in the specified areas and 160 not in the specified areas), of which, 105 projects (83 announced areas and 22 non-specified areas) were funded with direct cost funding total of 315 million yuan, and average direct cost funding intensity of 3 million yuan per project.

In 2021, the Department will announce 8 groups of Key Program projects in 40 priority directions, and 72 areas for Key Program projects. The Department plans to fund 100 Key Program projects with average direct cost funding of about 3 million yuan per project for 5 years. Applicant should follow the guidelines for research directions in relevant areas, in accordance to the trend of

development in the research area and basis of their research team and the actual research object or process, propose key scientific problems and conduct systematic and in-depth theoretical studies or experimental verification. Apart from high level papers, research results should be verified in experimental system or in practical applications.

The deadline for proposing areas of Key Program for 2022 is April 30, 2021; please see the department website (http://www.nsfc.gov.cn/cen/oo/kxb/xx/tztg.htm).

In 2021, the main research directions are as follows:

1. New mechanism and method for target detection in complex electromagnetic environment

Projects funded will include studies on the interactions of microwave and other electromagnetic signals with complex targets and environment, precise acquisition of information, modeling and processing of multi-dimensional signals, spatial temporal spectrum information processing, wide range cognition and smart detection of group, weak, stealth, high speed and high maneuverability targets in complex electromagnetic environment, and key technology research and verification so as to solve difficult problems in precise target identification, and provide basic theories and technology support for space target detection, off shore marine targets and monitoring of major urban infrastructure safety. It will have 6 research directions, and plan to fund 6 projects.

(1) Efficient and coordinated processing of multi signals and reduction of interference;

(2) Autonomous sensing and smart resistant process in regional complex environment;

(3) Mechanism and characterization of complex electromagnetic space signals;

(4) Detection and identification of far sea surface targets with active and passive electromagnetic waves;

(5) Imaging and cognition of space targets;

(6) Dynamic monitoring of urban infrastructure by near imaging radar.

2. Theory and technology for electronic devices, circuits and radio frequency for future information system

Projects funded will include studies on electronic device, circuit and system, radio frequency theory and technology, so as to provide strong support for future information system. It will have 5 research directions, and plan to fund 5 projects.

(1) Design method and key technology of EDA for millimeter tetra hertz IC;

(2) Millimeter tetra hertz devices and chips;

(3) Millimeter tetra hertz integrated receiver and transmitter front end and wide band efficient antenna;

(4) Millimeter tetra hertz source, amplifier and power synthesis;

(5) In situ multi parameter micro nano physical sensor in extreme conditions such as high temperature and high pressure.

3. New generation of network architecture and safety

Computer network is one of the most important technologies supporting our information society, and network architecture is the key of computer network. Now network architecture is facing challenges of having more expansion, real time security and openness. Projects funded will include studies on unknown threat, secure connection across regions, definite time delayed transmission and IT/OT integration, so as to provide theory and technology for next generation of network. It will have 5 research directions, and plan to fund 5 projects.

(1) Core mechanism and key technology for new generation internet architecture supporting

multi target forms;

(2) Theory and mechanism to ensure definite time delayed end to end transmission;

(3) Unknown threat and bugs and smart defense of network architecture in incomplete conditions;

(4) Mechanism of secured cross region connection based on path markers;

(5) Integrated IT/OT network architecture and key technologies.

4. Sensing and interactive computing of 3 dimensional space for man machine and object

Deep merging of cyberspace, physical world and human society becomes important part of our daily life. Therefore the following projects will be funded in this category, which will include 5 research directions, and 5 projects.

(1) Scenario cognition and interactive optimization of man machine object space;

(2) Digitizing real world based on digital twins;

(3) Physical and behavior emulation combining with virtual reality;

(4) Information representation and interactive analysis of 3 dimensional space;

(5) Geometric design and emulation optimization for additive manufacturing.

5. Basic theory and key technology for physical system of industrial information

Traditional industry system based on automation is now changing to integrated system of sensing, communication, computing and control, thus developing into new manufacturing model characterized by personalized design and network coordination. Therefore this group of Key Program project will fund studies on total information sensing, interactions between cyberspace and physical space and real-time reliable transmission of knowledge integration and distributed control and coordinated decision making, and the method of constructing cyberspace and physical world system supporting manufacturing process. It will have 5 research directions, and plan to fund 5 projects.

(1) Smart connection and security of industrial cyberspace and physical systems;

(2) Smart design and verification of applications of industrial cyberspace and physical systems;

(3) Interactive learning and coordinated decision making integrating all factors in industrial production system;

(4) Modeling and regulation of complex manufacturing system based on digital twins;

(5) Smart sensing and scenario cognition of industrial cyberspace and physical systems.

6. Theory, model and system of credible artificial intelligence

Credibility is an important issue in the development of artificial intelligence. The problems now include difficulties in formalized description and verification in the learning process, the stability in machine learning, and the verification of correct results, and difficulties in constructing and reasoning of large knowledge base, common sense base and knowledge across difference mode, separation of symbolic model and statistical learning model, and lack of autonomous learning and evolution abilities. Therefore this category will have 5 research directions, and the Department plans to fund 5 projects.

(1) Model and method for multi granularity uncertain reasoning for integrated knowledge and common sense;

(2) Interpretative machine learning framework and model for complex problems;

(3) Machine learning of integrating human cognitive mechanism and meso scale knowledge characterization

(4) Theory and method of self-adaptive to environment, two way understanding man machine group intelligent coordination;

(5) Model and test platform for credible artificial intelligence based on block chain technology.

7. Next generation semiconductor materials and devices

This group of key program project will fund studies on new generation of semiconductor materials and devices characterized by wide band gap semiconductor and 2D material systems. It will have 5 research directions, and the Department plans to fund 5 projects.

(1) Epitaxial growth of new types of narrow band gap sulfur group semiconductor and its photoelectric devices;

(2) Wide band gap semiconductor radiation detector;

(3) Single particle effect of SiC power devices and method of strengthening;

(4) Flexible X-ray detector of lead free perovskite base;

(5) Local field photoelectric regulation in2-D material Van der Waals hetero-junction.

8. Photoelectric integrated technology

New scenarios such as autopilot and smart city demand super wide band, high rate and large scale integrated photo electric devices. Therefor this group of Key Program project will fund studies on difficult issues such as heterogeneous, matching of model field and scale, material compatibility. It will have 5 research directions, and the Department plans to fund 5 projects.

(1) Silicon based mixed integrated photo emission and amplifier devices;

(2) Multi-dimensional information detection photoelectric integrated circuits;

(3) High capacity smart photo exchange integrated devices;

(4) Photo electric brain like smart chips;

(5) High speed medium inferred dispatcher integrated devices.

Key Program project areas funded by the Department in 2021

1. Mechanism and basic theory of information transfer in brain like systems

2. Coarse sampling theory and technology for space electromagnetic frequency monitor

3. Smart reflecting surface added mobile communication

4. Large scale random multi address insertion

5. Capability development of open source wireless network

6. Communication network for large scale satellite castellations telemetry

7. Impact of atmospheric turbulence on laser communication systems and reduction techniques

8. Microwave quantum information processing based on optical mechanical system

9. Distributive machine learning method for large scale communication signal processing

10. Optical field vision radar technology for autopilot

11. Key technology and method for micro high flux optical field microscopy

12. Computing video theory and method for code couple and decoding reconstruction optimization

13. Port circuitry and energy management chips for multi-source coordinated energy capture

14. Micro nano magnetic field sensing based on magnetic electro membrane coupled resonance

15. Analytical method and functional modeling of single cell data

16. Evaluation model for smart integration of medical imaging based on multi model of CT/MRI/PET

17. New operation system architecture and autonomous secured core

18. Credible translation and program analysis for formalized verification

19. Translation technology for AI chips

20. Security theory and technology for ubiquitous wireless sensing

21. Data security theory and technology in sharing and transaction of big data

22. Post quantum key security for internet of things

23. Basic theory and technology of group smart group computation for integration of man machine and object

24. Basic theory and technology for marginal big data computation

25. Basic theory and technology for the unification of CAD/CAE

26. Basic theory and technology for knowledge driven visual content generations

27. Visual flow sensing and comprehension in extreme environment

28. Panorama visual data processing and analysis

29. Bio-molecule image processing and 3-D reconstruction

30. Sequential data analysis algorithm and system

31. Bio data analysis theory and algorithm

32. Big data integration technology for real time security evaluation for key infrastructures

33. Theory and method for distributive optimal control in multi energy systems

34. Data merging and smart decision making of ubiquitous power internet of things

35. Theory and method and integrated evaluation of fast charging of vehicle power battery

36. Coordinated control of vehicle road merged cloud sensing and multiple autopilot

37. Ground/air extreme test control and analysis of aircraft flutter characteristics

38. Diagnosis of digestive diseases based on medical image

39. Single cell informatics of drug resistance of cancer

40. Total flexible sensor system for complex sensing environment based on new principles

41. Fine 3-D sensing and autonomous operation of robot in complex restricted environment

42. Sensing and control of operation robot in narrow channels in dynamic environment

43. Theory and key technology for group gaming in 5G communication environment

44. Theory and application of smart optimization for integrated ecosystem operations of mines driven by learning and knowledge

45. Distributive machine learning and online decision making for big data

46. Smart interpretation of weakly marked high resolution remote sensing image

47. 3-D sensing and syntax expression method for city scenarios

48. Physiological data driven and man machine interactive technology for chronic disease recovery

49. Strengthened learning theory and application for multiple tasks

50. Analysis of brain image genome based on deep learning

51. Data driven learning behavior modeling and interpretation analysis for education

52. 2D and 3-Dcompatib long distance micro optical detectors

53. Post quantum key technology and IP

54. Smart image sensors integrating sensing and computing

55. Single chip integrate super surface vertical emitting laser

56. Embedded photoelectric neural interface devices

57. Micro-LED/TFT display driving technology

58. Multi-dimensional modem high density holographic storage technology

59. Basic research on high efficiency AlGaN deep ultraviolet fluorescence devices

60. Femto second laser controllable high repetition frequency mechanism and devices

61. Mechanism and key technology for total optical fiber multi point active ultrasonic monitoring

62. Long distance high speed high resolution laser 3-D imaging technique

63. Measurement of no floating vessel heated melting spectrum emission rate

64. Large diameter high precision space optical free surface fabrication

65. High precision optical detection and control of bio molecules

66. Dynamic super resolution quantitative FRET microscopy

67. Basic research on sub wave length membrane nonlinear light sources

68. High temperature inferred focal plane devices

69. Multi-mode cross-scale super resolution coronary artery imaging techniques

70. Large scale strong interference programmable photoelectric mixed Ising machine

71. Theory and key technology for ground based single photon detection system imaging for space attitude sensing

72. Long translation high precision displacement monitor for large area grating manufacturing

Department of Management Sciences

In 2020, the Department received a total of 173 Key Program applications, and funded 34 projects. The average funding for direct expenses was 2.10 million yuan per project.

During the 14th Five-Year Plan period, the Department will release funding fields of Key Program annually. The Key Programs should be focused on (1) scientific frontier issues that can promote discipline development, obtain great innovative achievement, and generate international impacts; (2) important theoretical and application issues regarding economy development, society development, reform and opening-up, and the improvement of China's comprehensive competitiveness, which need to be addressed immediately, and are possible to be addressed; (3) systematic and in-depth innovative research, which explores management theories and laws with Chinese characteristics and has sound research background or good potential for discipline development.

The funding priority areas described in this guideline outline the main contents and scopes. Please note that the title of application is not required to be exactly the same as the area titles of the following listed Key Programs. Applicants are required to possess solid research experiences and abilities in the areas that they are applying for. Applicants are encouraged to exploit their full advantages, make the research goals clear and concrete, emphasize the key points of their application, focus on one or several key scientific issues of the research and actually address them, and have theoretical breakthroughs. In addition, applications are required to integrate theories with practice, discover key scientific issues that address the major national needs from the perspective of China's actual conditions, conduct in-depth research, and provide new approaches to address practical management issues. Applicants should focus on the guidance of scientific methodology, emphasize the application of scientific approaches, and take actual data and cases as the fundamental information of their research.

In 2021, the main research directions are as follows:

Applicants who apply for Key Program of the Department should choose the codes noted after the areas of the Key Program in this guideline as the first application code, and choose the name of the corresponding areas in the Appendix of the application. Applications that fail to do so will not be accepted.

In 2021, the Department proposes priority areas for Key Programs as follows and plans to support 35 Key Program projects. The funding for direct expenses will be 2.10 million yuan per project, and the implementation period of the Key Program projects will be 5 years.

1. Analyzing, modeling and computing method for complex management system

(1) Macro-economy and the dynamics and systemic risk of financial complex system (G0101);

(2) Intelligent planning method for complex management tasks (G0102);

(3) Modeling, simulation and operation management of stochastic system in complex scale environment (G0102);

(4) Computational modeling of complex economic system (G0107).

2. Data-driven online learning and optimization algorithm theory in management (G0102)

3. Data-driven cooperation and competition (G0103)

4. Behavior and algorithm of online trading platforms (G0106)

5. Supply-chain risk prevention and intelligent management for key core-products (G0109)

6. Intelligent management information system (G0112)

7. Mode and service management of "Internet plus" construction platforms (G0116)

8. Digital platform model and mechanism design (G0117)

9. Fundamental theory of state-owned enterprise reform

(1) Mechanism for the reform of introducing mixed ownership to state-owned enterprise (G0202);

(2) Incentive mechanism for state-owned enterprise management (G0204);

(3) Merger and reorganization theory of state-owned capital (G0205);

(4) Corporate governance theory of state-owned enterprise (G0212);

(5) Globalization of state-owned enterprises and risk prevention (G0214).

10. Digitization and management of enterprises

(1) Strategic management and digitization of enterprises in the post-pandemic era (G0201);

(2) Organizational behavior and human resources of platform-based enterprises (GO204);

(3) Corporate financial decision-making and resource allocation efficiency in the digital economy (G0205);

(4) New paradigm of technology-enabled business information management and decision-making (G0209);

(5) Governance mechanism and value co-creation of platform economy (G0209).

11. Machine learning method of high-dimensional measurement model and its application in economic and management (G0301)

12. Theory of data as a factor of production in the digital economy (G0302)

13. Theory and evaluation of "structural" monetary policy (G0305)

14. Changes and reconstruction of global value chains under the changing world (G0306/G0309)

15. Central and local fiscal relations and fiscal system optimization (G0308)

16. Identification, monitoring and governance of relative poverty (G0310)

17. The impact of artificial intelligence on labor market (G0313)

18. Energy industry upgrading, environmental pollution control and high-quality economic development (G0314)

19. Cross-organizational and cross-sectoral coordination mechanism for complex public affairs (G0401)

20. Comprehensive social impact of artificial intelligence based on social experiments (G0403/0410)

21. Science and technology support system and capacity for public health security (G0403/0405)

22. Graduate education governance system for major national interests (G0407)

23. Emergency response and collaborative decision-making mechanism for major emergencies (G0409)

24. Health benefit assessment and collaborative policy-design of greenhouse gas emission reduction and air pollution control (G0411)

25. Key factors and policies of regional development driven by new infrastructure projects (G0413)

26. Mode and policy for the governance of international commons (G0415)

Department of Health Sciences

A total of 759 applications for the Key Program in 38 thematic areas and macroscopic areas were received in 2020, 125 of which were funded with a total funding of 371.22 million yuan (direct cost) and an average funding of 2.9698 million yuan (direct cost as well) per project. **In 2021, the funding plan for the Key Program will still be divided into two categories. It will be funded with about 100 projects in the listed thematic areas and about 20 projects in macroscopic areas. The average funding intensity of direct cost is expected to be about 3 million yuan per project, and the duration is 5 years.**

According to the significant national needs, combining the discipline development strategy and the priority funding direction in the field of medical science, 44 thematic areas for solicited Key Program were determined by the Department in this *Guide* which are also applicable to the Key Program, including: the Department will generally not give further funding to the applicants who either have been intensively funded in 2020 from NSFC (such as Key Program, Key International (Regional) Joint Research Program, Major Program, Key Program of Major Research Plan or Programs of Joint Funds, Special Fund for Research on National Major Research Instruments), or are applying for repetitive or similar research to their ongoing national scientific projects funded by other governmental agencies.

(2) Applicants are required to attach the first page of their representative paper in PDF format to the electronic version of the application, and provide the full text of the representative paper in PDF format in attachment.

Applications for Key Program fail to write and provide relevant materials as required above will not be accepted.

In 2021, the main research directions are as follows:

1. The mechanisms of action of lung inflammation and repair (H01)

2. The studies on therapies for hematologic diseases based on genetic manipulation (H08)

3. Metabolic anomaly and its regulation in malignant blood diseases (H08)

4. Cellular and sub-cellular organelles interaction and cardiac remodeling (H02)

5. The mechanism and intervention of vascular injury induced by hypertension (H02)

6. Mechanism of immune and metabolic remodeling in digestive system diseases (H03)

7. Immune regulatory mechanism of endocrine and metabolic diseases (H07)

8. Molecular pathogenic mechanisms and intervention of ocular degenerative diseases (H13)

9. Craniomaxillo-facial tissue repair and regeneration mechanisms (H15)

10. Pathogenesis and intervention strategies of olfactory disorders and chronic inflammatory diseases of the nose (H14)

11. Brain mechanism and intervention of chronic pain (H09)

12. Pathogenesis and intervention of cerebral small vessel disease (H09)

13. Biomarkers related to diagnosis and treatment of common mental disorders and their biological mechanisms (H10)

14. Mechanism and intervention of aging related immune inflammation (H19)

15. Maternal-fetus metabolic interaction and pregnancy related diseases (H04)

16. Pathogenesis, early diagnosis and intervention of major neonatal diseases (H04)

17. Immune aging and disease development (H11)

18. Immune memory formation and maintenance (H11)

19. Stress, injury and adaptation mechanisms in special environments and operations (H24)

20. Accurate identification of forensic evidence of complex forensic damage (H25)

21. Research on vascular diseases based on cross-scale imaging by artificial intelligence (H27)

22. Research on imaging materials that can be safely used in clinics (H28)23. Mechanisms and intervention strategies of acute and severe multiple organ and system dysfunction (H16)

24. Pathogen infection and microbiota (H21/H22)

25. The disease transmission mechanisms of vector organisms and its crosstalk with pathogens (H22)

26. New technologies of laboratory diagnosis for major diseases (H26)

27. Mechanism and intervention of sports injury (H06)

28. Dyshomeostasis of cellular organelles in cancer development and progression (H18)

29. Immune responses against tumor neoantigens and its application strategy (H18)

30. Mechanisms of hereditary cancers and intervention strategy (H18)

31. Stress and tumor microenvironment (H18)

32. Research on the metabolic network of important skin diseases and the underlying molecular mechanisms (H12)

33. Research on occurrence, prevalence and early warning of emerging infectious diseases (H30)

34. Research on mechanisms of epigenetic regulation on environmental exposure-caused health damage (H30)

35. Research on mechanisms of environmental and biogeographic factors on the occurrence of endemic diseases (H30)

36. Study on the lead compounds discovery for fighting SARS-CoV-2 (H34)

37. Time-spatial modulation of drug action by advanced drug delivery systems and the biological effects (H34)

38. Identification of novel drug target and leading compounds for the prevention and treatment of inflammatory disorders (H35)

39. Target validation, leading compound discovery and pharmacological intervention based on novel function of the intracellular organelles (H35)

40. Research on quality evaluation methods and key technologies of Chinese herbal compound (H32)

41. Processing methods and mechanisms responsible for toxicity reducing and efficacy enhancing of poisonous herbs commonly used by minorities (H32)

42. Preventive and therapeutic strategies in neurodegenerative diseases and the underlying mechanisms: based on the principles, methods, herbal formulae in Traditional Chinese Medicine (H33)

43. Biological basis of progress rules of febrile diseases and the corresponding therapeutic principles and methods (H31)

44. The integration mechanism of acupuncture analgesia (H31)

Major Research Plan

Major Research Plan is designed to be a program cluster which contains a number of projects with relatively unified objectives and orientations by focusing on critical scientific issues in accordance with major national strategic demands and key scientific frontiers, strengthening the top-level design, encapsulating scientific goals and gathering advantageous research resources, so as to facilitate crossing and convergence of multiple-disciplines, foster innovative talents and groups, promote the original innovation ability of the basic research in China and provide scientific support for the national economy, social development and national security.

The Major Research Plan follows the principle of "definite objective, stable support, integration and promotion, and leap-forward development". The funding period for Major Research Plan projects is 8 years in general.

An applicant must meet the following qualifications:

(1) Have the experience of undertaking basic research projects.

(2) Have a senior professional position (title).

In-site post-doctors, or full-time graduate students, or researchers without a research institution or whose host institutions have not been registered at NSFC cannot apply as the Principle Investigator.

An applicant may submit no more than one proposal in the same year, and grantees of the Major Research Plan program are not allowed to apply for this kind of programs in the following year, excluding Integrated Program and Strategic Research Program.

The Major Research Plan consists of several subcategories, namely, the Fostering Program, Key Support Program and Integrated Program etc. The applicants should prepare the proposals in accordance with the requirement for the Major Research Plan and outlines of application, highlighting definite objective and key breakthrough, featuring interdisciplinary research, emphasizing on the contributions to solving critical scientific issues and fulfilling the overall goals of the Major Research Plan. In the course of application, Applicants should select "Major Research Plan" for the column of the funding type, and Fostering Program, Key Program, or Integrated Program for the column of sub-type, and input the title of the Major Research Plan in the annotation.

In general, the duration for Fostering Program project is 3 years, for Key Support Program project is 4 years, and that for Integrated Program project is determined by the Steering Committee of each Major Research Plan based on the

actual need. For Fostering Program project and Key Support Program project, the collaborative institutions involved may not exceed 2 in number. The number of collaborative institutions involved in one Integrated Program project may not exceed 4. The main participants must be the actual contributors to the Integrated Program project, and total number of main participants may not exceed 9.

Regulations on managing and sharing of data and information should be observed by the grantees in order to implement the overall scientific objectives and multi-disciplinary integration of the Major Research Plan. During the progress of project, attention should be paid to the supporting relationship among various programs.

Annual academic seminar on funding projects of the Major Research Plan and aperiodic academic symposium(s) on relevant research area should be held, so as to strengthen academic exchange, achieve research on the overall scientific objectives and cross and integration of multi-disciplines. The PIs of the granted projects are obliged to participate in these activities.

For details of each Major Research Plan, please refer to the relevant sections of introductions on Major Research Plan in the Guide.

Program Guidance for other Major Research Plans will be released successively on the NSFC website. Program Guidance for other Major Research Plans will be released successively on the NSFC website.

Generation and Evolution of Turbulent Structures and Mechanism of Its Effect

This Major Research Plan, the Generation and Evolution of Turbulent Structures and Mechanism of Its Effect, is needed in research in aeronautics, space, navigation and atmospheric science, and related disciplines in turbulent research. Based on turbulence structural dynamic theories, using numerical method, experimental measurement and data processing and analysis, this research plan studies the generation and evolution of turbulent structures and mechanism of its effect under various conditions. We encourage combining physical mechanism and applied research, encourage new ideas, new theories, new method and new technologies, developing high precision numerical method and fine measurement technology, revealing the generation, evolution and interaction mechanism, developing turbulent model theory of high spatial temporal accuracy based on turbulent structures, and verify theory and model, and make accurate prediction and control of turbulent drag, heat flux rate and turbulent noise in major engineering project. We hope the original research results can provide scientific theory and method in major engineering areas such as development of large carrier equipment in aeronautical, space navigation industries, and control of atmospheric pollution.

I. Scientific Target

Main target of this major research plan is to obtain original results in developing new ideas, new theories, new methods and new technologies, solve several key difficulties in major engineering applications, so as to promote innovation capabilities, and provide scientific theories for technology development. We also aim at fostering outstanding talents in turbulent research, developing several interdisciplinary research platforms in turbulent research, developing basic and applied basic research in complex problems in turbulence, and a school of turbulent research with Chinese characteristics. It is planned to make breakthroughs in the following 4 aspects.

1. New ideas based on turbulent structures, exploring disruptive ideas;

2. New theories based on structural unit, new models based on spatial temporal coupling and physical constraints;

3. New method of characterizing turbulent structures based on Lagrange views, and computational and experimental method for near boundary 3D turbulent structures with spatial temporal analysis of high precision efficiency;

4. New technology of flow control, and drag reduction, thermal protection and noise reduction, new design based turbulent structure, and improvement on turbulent software.

II. Key Scientific Problem

1. Dynamics of turbulent structure generation in different conditions: study transitions from the view of turbulent structure generation, and propose transition theory based on dynamics of turbulent structure generation by breaking the current framework stability theory.

2. Dynamics of multi-spatial temporal scales: study the evolution of turbulent structures from spatial temporal coupling, break theoretical framework of turbulent energy level process develop turbulent theory, computation method and experimental techniques based on multi-spatial temporal scale dynamics.

3. Mechanism and principles of controlling the impact on mechanical, thermal and acoustic transport by turbulent structures: by fine description of turbulent structures, to break the traditional

framework of viscous vortex model, and make accurate prediction and control of drag, heat flow and flow noises.

III. Funding Plan for 2021

It is planned to fund about 6 fostering projects with an average funding of about 1 million yuan per project for 3 years, and about 4 key projects with an average funding of about 4 million yuan per project for 4 years.

IV. Key Funding Areas for 2021

In 2021, it is planned to fund projects in the form of Fostering Projects and Key Projects, and start to fund Integrated Projects. The Fostering Projects will be of the exploring and novel type, and Key Projects will be of the type having originality, solid research accumulation, and hopes of making breakthrough. The Integrated Projects are for very important and very hopefully making breakthrough projects. We encourage participation of different disciplines such as mechanics, mathematics, physics, atmospheric science, engineering thermal physics and information sciences.

i. Fostering Projects and Key Projects

The following research directions will be funded.

1. Generation and evolution of complex turbulent structures

Study the mechanism of flow transition in transverse flow, adverse gradient boundary layer and shear flow conditions, study flow transition, separation and laminar mechanisms and models of prediction in rotating conditions; and study the effect of Mach number, boundary temperature, boundary vibration, and roughness on hypersonic instability and transition; study impact of different disturbance (such as roughness and wakes) on transition process and position on hypersonic boundary layers; explore transition mechanism of complex media flow; study instability, transition and aerothermodynamic mechanisms during spacecraft re-entry; study flow interface growth and turbulent mixing in extreme conditions; conduct studies on multiple physical interface instability and turbulent mixing structures and lower dimensional simplified models; and study mechanism of mixing flow transition with density variation.

2. Multi-time space scale interactions of turbulent structure evolution

Develop models combining dynamics and kinematics of two phase turbulent flow, study the interaction between bubbles and particles with turbulent structure; study mechanism and evolution of the interaction between typical shock turbulence and shock wave boundary layer; develop model theory for temporal and spatial evolution based on turbulent structures, Reynolds number averaged simulation model and large eddy model; develop transition prediction model for wall flow and turbulent near wall model, and self-adaptive turbulent prediction model based on transition mechanism and turbulent structure characteristics; develop laws and mechanism of temporal and spatial multi scale interactions of the turbulent structure in dynamic and static disturbance of rotor blade machines; reveal turbulent flow field characteristics of complex marine structures and related computation models; study laws of evolution of turbulent structure for complex boundary and moving boundaries, and reveal mechanism of interaction of the turbulent structures of the near wall turbulent flows for inner and outer regions.

3. Mechanism of the impact of turbulent structure on mechanical, thermal and acoustic properties

Study turbulent sound generation mechanism of high subsonic to transonic flight in typical roughness, reveal the relations between turbulence and sound boom; develop large eddy simulation and super large computation techniques for turbulent structure evolution and turbulent noise; explore aerodynamic noise generation mechanism and control method for rotor machinery; develop active and passive control method for wall flow transition and turbulent drag reduction; study

optimal control strategy, develop flow separation control method based on turbulent structure and artificial intelligence; study mechanism of impact of multi scale turbulent structure in heat transfer and mass transfer process; study mechanism of impact of hypersonic turbulent structure and aerothermodynamics, and heat protection principles and strategies for key parts of hypersonic aircraft; study the mechanism and modeling of cavity induced noise and erosion caused by cavity, the interactions between cavity and turbulence; and study coupled mechanism of interactions between turbulent flows and heat transfer, noise, chemical reaction, multi-phase or media, and electromagnetic and optical field.

4. High precision computation of turbulent flows and high resolution experimental techniques

Develop high precision robust numerical method for multi-phase flows; develop high precision and high efficiency finite volume method; develop high precision simulation and turbulent computation model for aircraft in large angle of attack turbulent flows; develop high precision experiment method for turbulence boundary layer structure and hypersonic boundary layer aerothermodynamics; develop time resolution measurement technology for highly unsteady, extreme velocity, temperature and pressure conditions; study synchronized test and experimental method for turbulent structure and multiple physical parameter fields; study high precision experimental measurement method and technology for flow field in rotating, magnetic field and buoyancy conditions.

ii. Integrated Projects

We plan to fund in the following areas:

1. Studies on turbulent structure based on data

Research objectives: Addressing problems in aircraft drag reduction, noise reduction and heat reduction, using typical turbulent structure generation and evolution, to develop numerical simulation and experimental data base, and to obtain significant research results and typical applications by demonstrations.

Research contents: flow data base of civil large airplane aerofoil in typical flight conditions; data base for flows around typical hypersonic aircraft shapes; internal flow data base of typical parts in airplane engines; data base for flows around submarine craft and key components in typical conditions; efficient storage and online sharing techniques for turbulent database; studies on turbulent flows based on turbulent database and machine learning.

2. New theory, new method and new technology of turbulent flow

Research objectives: using innovative ideas in theory, numerical computation, experimental technique and methods of data processing and analysis, to explore the generation, evolution and functions of turbulent structure, and achieve important original results in developing new theory, new method and new techniques.

Research contents: turbulent theory based on structure elements in different flow and different flow forms; turbulent models based on temporal and spatial relationship and physical constraints; precise and efficient computation and experimental measurement methods with temporal and spatial analysis of the 3D near boundary turbulent structure; flow control, drag reduction, heat protection and noise reduction techniques, and design ideas based on turbulent flow structure, and improvement on the accuracy and practicability of turbulent application software.

V. Basic Principles of Selection

This Major Research Plan requires that

1. Research should meet the requirement outlined in this *Guide*;

2. Exploratory research is encouraged; priority is given to new concept, new theory, new systems and new method of turbulent structure evolution and models;

3. Interdisciplinary research is encouraged;

4. International cooperation is encouraged;

5. Please pay attention to the difference with the Major Research Plan of "Turbulent Combustion for Engines".

Excellent Young Scientists Fund

The Excellent Young Scientists Fund supports young scholars with good achievements in basic research to conduct innovative research in areas on their own choice, so as to promote fast growth of young talents and foster a number of outstanding talents on the international science frontiers.

The applicant for Excellent Young Scientist Fund should be based in the host institution and meet the following qualifications:

(1) Abide by the laws of the People's Republic of China and the relevant management regulations of NSFC. Have good scientific integrity, and consciously practice the spirit of scientists in the new era;

(2) Under the age of 38 (for male, born on or after January 1, 1983) or 40 (for female, born on or after January 1, 1979) by January 1 of the year of application;

(3) Have a senior professional position (title) or doctoral degree;

(4) Have the experience of undertaking basic research projects or conducting other basic research;

(5) No employment with foreign institutions;

(6) Guarantee to work in the host institution for more than 9 months per year within the funding period.

The following people may not apply:

(1) Grantees of the National Science Fund for Distinguished Young Scholars or the Excellent Young Scientists Fund;

(2) Applicants for the National Science Fund for Distinguished Young Scholars in the same year;

(3) In-site post-doctors and full-time graduate students;

Special reminder to the applicants:

In 2020, the creation of ceilings and enabling retention of unused funds will be piloted in The Excellent Young Scientists Fund. Division between direct and indirect funding will be removed. The funding for each project is 2 million yuan.

According to the policy of connecting the Excellent Young Scientists Fund project with other national science and technology talent programs, only one project can be applied for or undertaken at the same level, and no application can be made to the lower level.

In 2020, NSFC received 6,333 applications for the Excellent Young Scientists Fund and granted 600 awards with a total funding of 72 million yuan for direct cost.

In 2021, the Excellent Young Scientists Fund plans to grant 600 projects for 3

years.

Funding for Projects of Excellent Young Scientists Fund in 2020

Departments	No. of applications	No. of awards	Success rate (%)
Mathematical and physical sciences	743	71	9.56
Chemical sciences	855	86	10.06
Life sciences	911	86	9.44
Earth sciences	656	59	8.99
Engineering and materials sciences	1,239	110	8.88
Information sciences	995	90	9.05
Management sciences	217	22	10.14
Health sciences	717	76	10.60
Total or average	6,333	600	9.47

Excellent Young Scientists Fund (Hong Kong and Macao)

In order to support the scientific and technological innovation and development of the Hong Kong and Macao Special Administrative Regions (hereinafter referred to as the Hong Kong and Macao), encourage patriotic scientific researchers who love Hong Kong and Macao to participate in the central science and technology funding plan, and contribute to the construction of a strong country in science and technology, NSFC continues to launch the Excellent Young Scientists Fund (Hong Kong and Macao) to the scientific researchers of the host institutions in the Hong Kong and Macao Special Administrative Regions in 2021.

1. The applicant for Excellent Young Scientist Fund (Hong Kong and Macao) should be based in the host institutions and meet the following qualifications:

(1) Abide by the Basic Law of the Hong Kong Special Administrative Region of the People's Republic of China, the Basic Law of the Macao Special Administrative Region of the People's Republic of China and the management regulations of NSFC, have good scientific integrity and consciously practice the spirit of scientists in the new era;

(2) Officially employed in the host institutions of Hong Kong or Macao;

(3) Guarantee to work in host institution for more than 9 months per year within the funding period.

(4) Under the age of 38 (for male, born on or after January 1, 1983) or 40 (for female, born on or after January 1, 1981) by January 1 of the year of application;

(5) Have a senior professional position (title) or doctoral degree;

(6) Have the experience of undertaking basic research projects or conducting other basic research;

2. The following people may not apply:

(1) Grantees of the National Science Fund for Distinguished Young Scholars or the Excellent Young Scientists Fund;

(2) In-site Post-doctors and full-time graduate students.

3. Host institutions in Hong Kong and Macao

The University of Hong Kong, the Chinese University of Hong Kong, the Hong Kong University of Science and Technology, the Hong Kong Polytechnic University, City University of Hong Kong, Hong Kong Baptist University, University of Macao, Macao University of Science and Technology have registered as NSFC host

institutions. NSFC only accepts application from the above mentioned institutions.

In 2020, NSFC received 169 applications for the National Science Fund for Distinguished Young Scholars (Hong Kong and Macao) and granted 25 awards with a total funding of 30 million yuan for direct cost.

In 2021, the National Science Fund for Distinguished Young Scholars (Hong Kong and Macao) plans to fund 25 projects for 3 years with 1.6 million yuan as direct cost per project and 400,000 yuan as indirect cost per project.

Funding for Projects of Excellent Young Scientists Fund (Hong Kong and Macao) in 2020

Department	No. of applications	No. of awards	Success rate (%)
Mathematical and physical sciences	21	4	19.05
Chemical sciences	24	3	12.50
Life sciences	19	4	21.05
Earth sciences	12	2	16.67
Engineering and materials sciences	26	4	15.38
Information sciences	29	4	13.79
Management sciences	11	1	9.09
Health sciences	27	3	11.11
Total	169	25	14.79

National Science Fund for Distinguished Young Scholars

The National Science Fund for Distinguished Young Scholars supports young scholars who have made outstanding achievements in basic research to select their own research directions and conduct creative research, so as to speed up the growth of young scientific talents, attract overseas talents and foster a group of prominent academic pacemakers in the frontier of international science and technology.

The applicant for National Science Fund for Distinguished Young Scholars should be based in the host institution and meet the following qualifications:

(1) Abide by the laws of the People's Republic of China and the management regulations of NSFC, have good scientific integrity, and consciously practice the spirit of scientists in the new era.

(2) Under the age of 45 by January 1 of the year of application (born on or after January 1, 1976);

(3) Hold a senior professional position (title) or doctoral degree;

(4) Have the experience of undertaking basic research projects or conducting other basic research;

(5) Have no employment by foreign institutions;

(6) Guarantee to work in host institution for more than 9 months per year within the funding period.

The following people may not apply:

(1) Grantees of the National Science Fund for Distinguished Young Scholars;

(2) Grantees of ongoing project of the Excellent Young Scientists Fund (application is allowable on the year of completion of the funding of the Excellent Young Scientists Fund);

(3) Applicants for the Excellent Young Scientists Fund in the same year;

(4) In-site post-doctors or full-time graduate students.

Special reminder to the applicants:

In 2021, the creation of ceilings and enabling retention of unused funds will continue to be piloted in National Science Fund for Distinguished Young Scholars. Division between direct and indirect funding will be removed. The funding for each project is 4 million yuan (for the Department of Mathematical and Physical Sciences and Department of Management Sciences, the intensity is 2.8 million yuan).

According to the policy of connecting the Excellent Young Scientists Fund project with other national science and technology talent programs, only one project can be applied for or undertaken at the same level, and no application can be made to the lower level.

In 2020, NSFC received 3,749 applications for the National Science Fund for Distinguished Young Scholars and granted 298 awards with a total funding of 11,692 million yuan.

In 2021, the National Science Fund for Distinguished Young Scholars plans to fund 300 projects for 5 years.

Funding for Projects of the National Science Fund for Distinguished Young Scholars in 2020

Departments	No. of applications	No. of awards	Success rate (%)
Mathematical and physical sciences	498	37	7.43
Chemical sciences	528	45	8.52
Life sciences	478	38	7.95
Earth sciences	394	32	8.12
Engineering and materials sciences	658	57	8.66
Information sciences	583	43	7.38
Management sciences	138	10	7.25
Health sciences	472	36	7.63
Total	3,749	298	7.95

Science Fund for Creative Research Groups

The Science Fund for Creative Research Groups supports prominent academic leaders in China and abroad to conduct innovative basic research on orientation self-selected with the self-assemble group as PI, and foster a research group in the frontier of international science and technology.

Applicants and participants should meet the following qualifications:

(1) Have the experience of undertaking basic research projects or conducting other basic research;

(2) Guarantee to work in host institutions for more than 6 months per year within the funding period;

(3) Have a self-assemble group based on long-term collaboration, including 1 academic leader and no more than 5 backbone researchers;

(4) As the applicant, the academic leader should hold a senior professional position (title), with outstanding academic achievements and international influence, and be less than 55 years old by January 1 of the year of application (born on or after January 1, 1966);

(5) Backbone researchers or group members should hold senior professional position (title) or doctoral degrees;

(6) Applicants and participants should be in the same host institution.

The following people may not apply:

(1) Grantees of Science Fund for Creative Research Groups as PI;

(2) PI and participants with senior academic position (title) of an ongoing project supported by the Science Fund for Creative Research Groups;

(3) Participants quit from a project supported by the Science Fund for Creative Research Groups or Basic Science Center Program within 2 years.

Applicants with senior academic titles may only apply for one project of the Science Fund for Creative Research Groups each year. **The total number of Science Fund for Creative Research Groups and Basic Science Center Program shall not exceed 1.**

In 2020, a total of 281 applications for the Science Fund for Creative Research Groups and 37 awards were made with a total funding of 360 million yuan for direct costs.

In 2021, the duration of each project is 5 years with a funding amount of 10

million yuan for direct cost and 2 million yuan for indirect cost per award (8 million yuan for direct cost and 2 million yuan for indirect cost per award by mathematics and management sciences).

Awards Granted by the Science Fund for Creative Research Groups in 2020

Unit: 10,000 yuan

Departments	No. of applications	Awards		Success rate (%)
		No. of awards	Direct cost	
Mathematical and physical sciences	32	4	3,670	12.50
Chemical sciences	32	5	5,000	15.63
Life sciences	36	5	5,000	13.89
Earth sciences	34	5	5,000	14.71
Engineering and materials sciences	51	6	6,000	11.76
Information sciences	48	5	5,000	10.42
Management sciences	12	2	1,340	16.67
Health sciences	36	5	5,000	13.89
Total	281	37	36,010	13.17

Basic Science Center Program

The Basic Science Center Program aims to gather and integrate domestic advantageous scientific research resources, deploy in advance targeting at international science frontiers, give full play to the advantages and characteristics of the science funding system, rely on outstanding academic pacemakers, attract and assemble outstanding S&T talents with all research areas, and promote in-depth cross-disciplinary integration, so as to support scientific personnel to conduct research and exploration in a relatively long-term and stable way, breakthrough scientific frontier, produce a number of original achievements at international leading level, seize the dominant position in international scientific development and establish a number of academic highlands with significant international influence.

Applicants and key participants for the Basic Science Center Program should meet the following qualifications:

(1) Have the experience of undertaking basic research project or conducting other basic research;

(2) The team should be an excellent research group with multi-disciplinary crossings at the scientific frontiers, including 1 academic leader and no more than 4 backbone participants.

(3) As the applicant, the academic leader should be an internationally well-known scientist in the field, with senior academic position (title), outstanding academic achievements and macro-control ability, strong coordination and cohesion, and able to assemble excellent researchers from various scientific backgrounds, under the age of 60 by January 1 of the year of application (born on or after January 1, 1961);

(4) Backbone participants should be mainly young or middle-aged, with senior academic position (title) and outstanding research achievements in related scientific fields and potential for continuous growth.

Note to applicants:

The total number of host institution and collaborative institution cannot exceed 3.

At the stage of application, the Basic Science Center Program is not counted in the total number of application and on-going projects, but counted after being accepted or approved by NSFC. Grantee, as PI or backbone participant, of the Basic Science Center Program cannot apply for or participate in other types of program except for the National Science Fund for Distinguished Young Scholars and the Excellent Young Scientist Fund during the funding period.

The total number of applications for National Major Instrument Equipment R&D Program (department recommendation) and Basic Science Center Program for one

applicant within the same year cannot exceed 1.

The total number of the Creative Research Group and the Basic Science Center Program that one researcher applies for either as the applicant or the main participants (including backbone participants and key research personnel) cannot exceed 1.

The grantee and the participant with senior academic positions (titles) of the on-going Science Fund for Creative Research Groups cannot apply for the Basic Science Center Program either as the applicant or participant, unless it is in the last year of the funding. Participants who quit from a project supported by the Science Fund for Creative Research Groups or the Basic Science Center Program are not permitted to apply again in 2 years after the quit.

In the course of application, the applicant should select “Science Center Program” in the funding category, “Basic Science Center Program” in the sub-category and the subject area code according to the actual research content of the application.

The funding duration of the Basic Science Center Program is 5 years. The direct cost shall not exceed 60 million yuan (for mathematical and physical sciences and Management sciences, the direct cost shall not exceed 50 million yuan).

Tianyuan Fund for Mathematics

Tianyuan Fund for Mathematics is a special fund to integrate collective wisdom of mathematicians, explore funding approach that suits the unique features and development laws of mathematics, and make China a strong country in mathematics. The fund supports researchers to conduct research according to the features and need of mathematics, so as to foster young talents, promote academic exchange, optimize research environment, spread mathematical culture and thus strengthen creativity of China in mathematics. The fund mainly provides the following 5 types of funding in 2021.

1. Tianyuan Center of Mathematics

The main objective of the Tianyuan Center of Mathematics is to set up a platform for cooperative research and academic exchange. Focusing on several topics and relevant interdisciplinary areas through various types of academic activities to gather research groups, center on scientific issues, deepen communications among multidisciplinary scientists in China and abroad, foster research talents, and promote research in various branches of mathematics and interdisciplinary studies in China.

This project supports various academic exchange activities based in large regions all over China at frontier areas and important directions in mathematical research, including summer schools and training of young teachers of mathematics. The proposal should include the scientific significance, contents, plan, foundation, and conditions of the proposed activity, and possible partners and related collaborative institution.

NSFC plans to fund 2 projects in 2021, including 1 project of 12 million yuan for 4 years, and 1 project of 3 million yuan for 1 year.

2. Tianyuan Exchange Program

The exchange program supports high-level academic exchange activities. It aims at promoting in-depth level exchange and cooperation on hot spot of mathematical problems. Each program should invite world renowned mathematicians, in the form of lectures and workshop and discussion sessions.

The program should be organized by 3 to 5 organizers, who should be world famous mathematicians in the area. Applicant should be a full time working mathematician with Chinese nationality at the host institution in China, and have written consent of the organizers. Each program may only invite up to 50 participants

and the duration is limited to 1 week.

The applicant may decide the topic of the application, and provide detailed information such as scientific significance, contents and objectives of exchange, agenda and name list of the participants. The funding will be no more than 300,000 yuan per project.

3. Tianyuan Visiting Mathematicians Program

This program aims at promoting a balanced development of mathematical research in China by supporting talented young mathematicians in less developed institutions in China to work with leading mathematicians in China. The hosting institution should have good mathematical background.

Requirements on application:

(1) Joint application. Application should be submitted respectively in pair by the visiting mathematician and the host supervisor, and their host institutions are partners as well. The visiting young mathematician should be from less developed regions or institutes and born after January 1, 1982, and the host supervisor should be national leading mathematician with international influence. They are no teacher-student relationship before in the different city. The applicant should provide detailed information such as scientific significance, contents, plan and foundation. Titles and subject area codes should be the same in the applications in pair. The visiting time should not be less than 9 months.

(2) Please include a letter of promise as an attachment to the application. The letter of promise should include the terms of visiting, including salaries, working conditions and evaluations etc.

(3) Please include an agreement as an attachment to the application. The visitor and host supervisor should sign the agreement on contents, funding and sharing of the right of intellectual properties etc.

(4) The supervisor only applies for no more than 1 project of the Tianyuan Visiting Mathematicians Program in the same year.

The funding will be 200,000 yuan per project for the host and 100,000 yuan per project for the visitor.

4. Special lectures on mathematics, high-level workshops

Special lectures are organized for postgraduate students focusing on one theme so as to introduce frontier topics in mathematical research. Lectures could include basic courses and special courses with large audience lasting for 3 weeks. Application should provide teaching outline, contents and name list of the lecturers.

High-level workshops mainly support research groups of high-level and excellent mid-aged young mathematicians to held workshops on clear topics and important international mathematical issues. At least one review paper should be published after

the workshop, and proceedings or papers are highly recommended.

Each project will be funded with 200,000 yuan approximately.

5. Mathematical culture and knowledge dissemination

This funding provides support to publications of popular mathematical books, including domestic and translated foreign books, so as to raise the interest of primary and middle school students on learning mathematics and understanding of mathematics by the public; the publication of national influential journal related to mathematical culture, dissemination of mathematics, mathematical education and mathematical modeling, so as to improve journal quality and impact on the public; the important national activities of mathematical dissemination by universities, research institutes, science associations and mathematical society above provincial level.

In 2021, for the Tianyuan Fund for Mathematics, online and paperless applications are carried out. There are two application windows: From March 1, 2021 to March 20, 2021 (due by 16:00 Beijing time) and from July 1, 2021 to July 20, 2021 (due by 16:00 Beijing time). The applicant should submit the application online, and provide the scanning copy of credential materials, approval documents and other special attachments required as attachments, without having to submit a paper form application version. Once approved, the signature and stamp page of the application form should be submitted at the time of submitting the project plan. The signature and stamp information should be consistent with that of the electronic application version.

In the course of application, Applicants should select "Tianyuan Fund for Mathematics Program" for the column of the funding type, and "Tianyuan Fund for Mathematics" for the column of sub-type, and input one of the above types in the annotation. The funding is for less than one year, and will be direct cost funding only.

Special Fund for Research on National Major Research Instruments

The Fund aims to encourage and develop the exploratory research and development of instruments with creative ideas, and major research instruments and equipment with original creative ideas, which should be based on frontier of science and national needs and guided by scientific targets, so as to enhance original innovation in China.

Projects funded by the Special Fund for Research on National Major Research Instruments comprise of departmental recommendation projects and free application projects.

Funding for Projects of Special Fund for Research on National Major Research Instruments in 2020

Unit: 10,000 yuan

	No. of applications	No. of awards	Direct cost	Average funding for direct costs
Departmental recommendation	49	4	34,862.20	8,715.55
Free application	611	84	59,632.58	709.91

The funding duration for projects of the Special Fund for Research on National Major Research Instruments is 5 years, and in general the number of collaborative institutions in one project should not exceed 5.

1. Eligibility for applicants

Applicants for the Special Fund for Research on National Major Research Instruments should:

(1) Have the experience of presiding basic research;

(2) Hold a senior professional position (title).

In-site post-doctors, full-time postgraduate students, researchers without host institutions, and researchers whose host institutions have not been registered at NSFC are not eligible for application.

2. Requirements for application

(1) For free application projects, applicants may submit research proposals via their host institutions. The budget for direct costs is less than 10 million yuan per

project.

(2) For departmental recommendation projects, the following 14 departments are entitled to recommending projects of the Special Fund for Research on National Major Research Instruments: Ministry of Education, Chinese Academy of Sciences, Ministry of Natural Resources, Ministry of Industry and Information Technology, Ministry of Ecology and Environment, Ministry of Agriculture and Rural Affairs, National Health Commission, China Earthquake Administration, State Administration for Market Regulation, China Meteorological Administration, China Academy of Engineering Physics, Equipment Development Department and Logistic Support Department of Central Military Commission. The budget for direct costs of the departmental recommendation projects of the Special Fund for Research on National Major Research Instruments should be 10 million yuan or above per project.

3. Notes on application

(1) Applicants are advised to read this *Guide* carefully and prepare research proposals in accordance with the preparation outline of applications of the Special Fund for Research on National Major Research Instruments. Please select the "Special Fund for Research on National Major Research Instruments" from the funding categories, and select "free application" or "departmental recommendation" under the subcategory of funding. Please choose subject area code in all departments except that of the Department of Management Sciences. Applicants are advised to clarify the details if they are carrying out other national projects which have some links with the current application. Explanation of the similarities and differences in research contents between the ongoing project and the current application should be presented.

(2) For applicants and participants with senior academic positions (titles), the number of applications plus ongoing projects of the Special Fund for Research on National Major Research Instruments as well as the Special Fund for Research on National Major Research Instruments administered by the Ministry of Science and Technology should not exceed one in total.

(3) Projects of the Special Fund for Research on National Major Research Instruments are funded by the way of cost reimbursement, so applicants are advised to make their budget requests in an objective and practical manner according to the real costs of the development of instruments. NSFC will invite experts to assess the budget requests.

International (Regional) Cooperation and Exchange Programs

In order to improve the quality of China's scientific research and its international competitiveness, the International (Regional) Cooperation and Exchange Programs aim at creating and deepening cooperation opportunities, funding Chinese scientists to conduct substantial cooperation with their international collaborators in science frontier and take full advantage of international scientific and technological resources on the basis of "equal cooperation, mutual benefits, and equal sharing of results".

The funding system of the International (Regional) Cooperation and Exchange Programs is currently comprised of Key International (Regional) Joint Research Program, International (Regional) Joint Research and Exchange Programs funded under the Agreements/MoUs between NSFC and its foreign partners.

Key International (Regional) Joint Research Program

The Key International (Regional) Joint Research Program (hereafter referred to as Key Joint Research Program) gives priority to research in the following areas: the priority funding areas of NSFC, areas that China urgently needs to develop, international mega projects and programs with Chinese participation, and utilizing large-scale scientific facilities abroad.

Researchers applying for this program shall, in accordance with the priority funding areas announced by relevant scientific departments in the *Guide*, choose innovative joint research subjects centering on major scientific issues, and clarify the necessity and complementarities of the cooperation. Chinese applicants in the mainland and their partners shall have long-term steady collaboration (e.g., coauthored publications and continued personnel exchanges and interactions) and the partners shall have matching resources for this research. In the process of cooperation, attention shall be given to the sharing of outcomes and the protection of intellectual property rights.

In 2020, altogether 102 out of the total 476 applications under the Key Joint Research Program were funded with a total funding of 250 million yuan for direct costs.

In 2021, the Key Joint Research Program plans to fund 100 projects with the same average funding for direct costs per project as in 2020, and the duration of each project is 5 years.

An applicant must meet the following eligibilities:

(1) With the position (title) of professor or associate professor;

(2) As the PIs of on-going or completed NSFC research project with the duration of no less than 3 years.

(3) Having a good foundation for cooperation with foreign (regional) partners.

Partners should meet the following eligibilities:

(1) Engage in scientific research abroad and be in charge of research laboratories or hold key research projects independently;

(2) With the position (title) of professor or associate professor in the host countries/regions.

Appendix Documents

Apart from the Chinese application form, the applicant must also submit the following documents as required:

(1) English Application Form: The English Application Form can be downloaded in NSFC's Internet-based Science Information System (ISIS) and should be submitted online at the time of submission.

(2) Letter of Agreement: A copy of the Letter of Agreement signed between/among the collaborating PIs must be provided. Unilaterally signed letters are not valid. The Letter of Agreement mainly covers:

(i) Research contents and objectives;

(ii) List of collaborating PIs and participants;

(iii) Duration, mechanism and plan of joint research;

(iv) Ownership, use and transfer of IP rights;

(v) Relevant budgetary arrangements.

Please refer to the sample Letter of Agreement which can be downloaded at http://www.nsfc.gov.cn/Portals/0/fj/fj20161230_02.doc.

(3) Documents verifying the partners' holding or participation in research projects related to the application, or a list of publications related to the submitted application by the foreign partners in the past 3 years.

(4) Letter of confirmation by the partner.

If the partner cannot sign the English Application Form, a letter of confirmation by him/her

should be provided. The letter of confirmation must be written in official forms including the title, logo and contact information of the foreign collaborator's employer. The letter of confirmation should contain contact information about the partner. In addition, it should contain detailed information such as the title of the research, the content and period of cooperation, the way to share IPR, etc. as well as the confirmation that the partner has read and agrees with the English Application Form.

Funding Priorities for the Key Joint Research Program in 2021

1. Department of Mathematical and Physical Sciences

(1) Modern theories of algebra and geometry;

(2) Modern analysis theory and its application;

(3) New theories and new methods of computing in the era of big data and artificial intelligence;

(4) Cognition, design and control of complex system dynamics mechanism;

(5) Mechanics of new materials and new structures;

(6) Theories, methods and control of high-speed flow;

(7) Dark matter, dark energy and galaxy survey research;

(8) Multi-messenger detection and research of the Milky Way, stars, the sun and planetary systems;

(9) Research on key technologies for next-generation telescopes;

(10) Quantum materials and devices;

(11) Quantum information and quantum precision measurement;

(12) The mechanism and regulation of electromagnetic and sound fields in complex structures and media;

(13) The nature and interaction of basic fermions;

(14) The essence of strong interaction force;

(15) Key scientific issues in thermonuclear fusion;

(16) Joint research based on large-scale scientific facilities at home and abroad.

2. Department of Chemical Sciences

Applicants should focus on topics featuring basic, interdisciplinary, frontier and complementary research.

(1) Catalysis and chemical precision synthesis;

(2) Green chemistry and the reaction and process of sustainable chemistry;

(3) Process and mechanism of surface and interface chemistry;

(4) Theoretical and computational chemistry of complex systems;

(5) Precise chemical measurement and imaging;

(6) Molecular assembly, structure and function;

(7) Molecular basis for advanced functional materials;

(8) Natural products chemistry and drug discovery;

(9) Chemical biology;

(10) Environmental pollution chemistry and control;

(11) Scientific issues on the medium scale in chemical process;

(12) Artificial intelligence chemistry.

3. Department of Life Sciences

(1) The evolutionary mechanism of biologically important traits and environmental adaptation;

(2) Visualization of single molecule and cell fine structure;

(3) Infection and immune response regulation mechanism;

(4) Cell fate plasticity and organogenesis, metabolic regulation, aging and regeneration;

(5) Establishment and inheritance of genetic and epigenetic information;

(6) Neural mechanisms of cognition and behavior;

(7) The structure, function and dynamic interaction of biological macromolecules;

(8) Precise design, transformation and simulation of living bodies;

(9) The theoretical basis for the evolution of important genetic resources of agricultural plants and molecular design breeding;

(10) The mechanism of high-quality and high-yield cultivation of agricultural plants and efficient use of nutrients;

(11) The response and regulation mechanism of agricultural plants to adversity and the improvement of traits;

(12) Formation and regulation of yield and quality traits of agricultural animal products;

(13) The theoretical basis for the occurrence, spread and control of agricultural animal diseases;

(14) The formation mechanism of food safety and nutritional quality;

(15) The structure, function and formation mechanism of the multi-level ecological unit.

China's international cooperation and exchanges in the field of biology should be guided by national demands and national interests, and be closely combined with China's medium and long-term scientific and technological development plans and major scientific and technological special program. Due attention will be paid to joint research between strong partnering research teams and joint research between Chinese researchers and foreign partners with superior research capacities or facilities. Chinese applicants are encouraged to take the lead in joint research activities.

4. Department of Earth Sciences

(1) Land surface critical processes and their multiple effects;

(2) Environmental pollution processes and prevention;

(3) Human activities and consequent eco-environmental effects;

(4) System and mechanism of metallogenic accumulation;

(5) Dynamic processes of continental plates interiors and boundaries;

(6) Coupling relation between deep and surface earth processes;

(7) Mechanism, monitoring, early warning and risk control of geological disasters;

(8) Solar-Earth energy transfer processes and the impacts on human activities;

(9) Water cycle and ecohydrological process;

(10) Key processes and extreme climate events in weather and climate system;

(11) Monsoon, drought and global change;

(12) Origins and major evolutionary events of key biological taxa and the environmental backgrounds;

(13) Life processes in the extreme environment;

(14) Dynamic processes and mechanisms of marine multi-scale interactions;

(15) Marine ecological system and deep-sea biological resources;

(16) Advanced science and technology platforms to promote the development of Earth and planetary sciences;

(17) Human activities and environment along the Belt and Road regions;

(18) Nano-geoscience research platform;

(19) Global comparison of major geo-environment-biological events;

(20) Polar science research;

(21) Planetary Earth science;

(22) Interfacial structure and properties of global subduction zones;

(23) Integrated observation and research on "Two oceans, One sea" (Pacific Ocean, Indian Ocean, South China Sea);

(24) Earth system model development and application;

(25) Formation of mineral and oil and gas resources and global environment;

(26) Health geoscience.

5. Department of Engineering and Materials Sciences

(1) Energy materials;

(2) Nano material and devices;

(3) Biomedical materials;

(4) High-performance structural materials and sustainable materials;

(5) Efficient exploitation of resources and green processing and smelting;

(6) Intelligent manufacturing and biological manufacturing;

(7) Renewable energy, new energy and energy efficient and clean utilization;

(8) High-efficiency electric energy conversion and conversion system;

(9) Multi-media environmental pollution control and ecological restoration;

(10) Water resources, water environment and water disasters;

(11) Integrated disaster prevention and mitigation and life-span design for smart buildings and civil engineering in smart cities;

(12) Deep-sea engineering;

(13) Intelligent transportation and transportation engineering;

(14) Key supporting materials for high-end manufacturing and major national projects.

6. Department of Information Sciences

(1) The basic theory and key technology in new generation mobile communications;

(2) Multimedia information processing;

(3) Remote sensing information processing;

(4) Medical information detection and processing;

(5) New calculation theory and software method;

(6) The architecture and system of large-scale and complex computing scenarios;

(7) Big data calculation theory and application;

(8) New control theory and methods;

(9) Brain-like model and brain-like information processing;

(10) Semiconductor electronic devices and integration;

(11) Micro-nano electromechanical devices and control systems;

(12) Biological, medical optics and photonics;

(13) Photonic integration technology and devices.

7. Department of Management Sciences

(1) Behavioral law in the management systems;

(2) Analysis, experiment and modeling of complex management systems;

(3) Complex engineering and complex operation management;

(4) Data-driven financial innovation and risk laws;

(5) The law of entrepreneurial activities and its ecosystem;

(6) The reform and innovation laws of Chinese enterprises;

(7) Enterprise innovation behavior and national innovation system management;

(8) Management science issues in the service economy;

(9) Research on China's economic structure transformation and mechanism reconstruction;

(10) The basic management laws of national security;

(11) The basic laws of state and social governance;

(12) Management rules and mechanisms of new urbanization;

(13) Mobile internet medical and health management;

(14) International macroeconomic policy coordination mechanism and international economic governance structure;

(15) Climate change and public health;

(16) Scientific ethics and scientific research integrity.

8. Department of Health Sciences

(1) New mechanisms of the common pathology of development, inflammation, metabolism, probiotics, microenvironment, etc.

(2) Pathogenesis and precise diagnosis and treatment of major chronic diseases;

(3) Epidemiology of chronic diseases and injuries and related prevention and intervention strategies;

(4) Rapid identification, pathogenesis, prevention, early warning new treatment of emerging and emergency infectious diseases;

(5) Infectious diseases and antibiotic resistance;

(6) Frontier research on first aid, trauma, rehabilitation and regenerative medicine;

(7) Women and children's health;

(8) Research on the frontier of reproduction, development, aging related diseases;

(9) Nutrition, environmental, genetic and health;

(10) Stem cells and diseases;

(11) Organ fibrosis and prevention mechanism;

(12) Tissue and organ damage, dysfunction and intervention;

(13) Protection of organs and replacement therapy;

(14) Pathogenesis and intervention of neuropsychiatric disorders;

(15) Mechanisms of immune-related diseases and new immunotherapy strategies;

(16) Interdisciplinary scientific research on diseases;

(17) Medical imaging and biomedical engineering;

(18) Innovative medical technologies and personalized medicine;

(19) Biomarkers and personalized medicine;

(20) Discovery of new drug targets and pharmacological validation;

(21) Modern scientific connotation of traditional Chinese medicine theories;

(22) Material basis and mechanism of traditional Chinese medicine;

(23) Basic research on special and forensic medicine.

In principle, PIs in programs with large funding amounts such as Key International (Regional) Joint Research Program, Major Program, Key Projects of Major Research Plan Program granted in 2020, will not be considered for funding under the Key International (Regional) Joint Research Program in 2021.

International (Regional) Cooperation and Exchange Programs under Agreements/MoUs

Jointly organized and funded by NSFC and foreign science funding agencies (or research institutions and international organizations), the International (Regional) Cooperation and Exchange Programs under Agreements/MoUs support bilateral and multilateral joint research and academic exchanges between Chinese scientists and their foreign partners. In recent years, greater efforts by NSFC have been focused on policy research on international collaboration, and both the

cooperation network and funding areas have been expanded with the U.S., Canada, and Australia. More extensive exchanges have been conducted between NSFC and partners in South America. The partnership between NSFC and European partners has been promoted comprehensively by further enhanced diverse collaborative activities with respective European partner countries and the EU as a whole. The collaboration mechanisms with Japan and South Korea have been further deepened, with expanded funding scale for the Asian 3 Foresight Program. The scientific cooperation with Israel and Singapore has also been promoted to more expanded research areas. Greater efforts have been put in furthering the bilateral cooperation with partners of key potentials and impacts in such developing countries as India, South Africa, Brazil, Thailand, Egypt, etc. Multi-lateral international cooperation between Chinese applicants and their international partners has been encouraged to take advantage of the coordinative role played by international scientific organizations in promoting cross-border scientific research programs, and participate in and conduct cross-border regional research programs. Besides, NSFC plays an active role in promoting the cooperation between Chinese scientists and their partners along the Belt and Road route. Adhering to the "one country, two systems" policy of the central government, NSFC has always been attaching significance to the collaboration between researchers in mainland China with partners in Hong Kong, Macao and Taiwan regions. NSFC has by far concluded 98 cooperation agreements/MoUs with science funding agencies and research institutions in 51 countries/regions. By negotiation, NSFC reaches agreements with its foreign partners on cooperation and exchange pattern, funding area, volume of awards, funding amount and review mechanism. Based on mutual agreement, NSFC launches joint call for proposals with its foreign partners on their websites and then organize scientists to submit and review applications.

The International (Regional) Cooperation and Exchange Programs under Agreements/MoUs include Joint Research Program and Personnel Exchange Program.

The Joint Research Program under Agreements/MoUs includes bilateral or multilateral joint research projects funded by NSFC and its international partners under the framework of cooperation agreements/MoUs signed between them to support Chinese researchers and their collaborators abroad to carry out research in basic sciences.

The Personnel Exchange Program under Agreements/MoUs aims to encourage NSFC grantees to participate in extensive international cooperation and exchange activities, and to enhance the innovativeness, talent training, disciplinary development and research quality of the on-going NSFC projects. The Personnel Exchange Program under Agreements/MoUs include personnel exchange program and academic conference program featuring the mobility of scientists. Meanwhile, it encourages scientists to maintain sound bi/multilateral relations with overseas partners through wide cooperation and exchange, laying a solid foundation for future in-depth and substantial collaboration. Academic Conference Program under Agreements/MoUs is aimed at supporting scientists to hold bilateral or multi-lateral international conferences in China or outside the mainland with a view to enabling Chinese scientists to keep pace with the latest research frontiers and hotspots in the international academic arena, to enhancing the partnership between Chinese scientists and their foreign peers, and to promoting the visibility of the results achieved by NSFC funded projects and raising the profile of China's academic community.

Applicants could refer to the following introductions and the calls for proposals irregularly launched on NSFC website for application eligibility, priority funding areas, funding duration, and application requirements.

Applicants could also refer to the column for International Cooperation on NSFC's website for relevant information about these programs in 2021. An introduction of the funding opportunities under this category in 2021 is listed as follows.

Asia and Africa

Japan

Japan Society for the Promotion of Science (JSPS)

The call for proposals of exchange project and bilateral workshop is issued jointly by both NSFC and JSPS on their respective websites in June to July every year. The submission deadline is Friday of the first complete week in September.

(1) Exchange Project

NSFC and JSPS jointly support 10 exchange projects each year, the duration of which is 3 years. The exchange volume shall not exceed 60 person-days per year for each side.

(2) Bilateral Workshop

NSFC and JSPS support 4 bilateral workshops per year organized jointly by Chinese and Japanese scientists, of which two are held in China and two in Japan. Participants of a bilateral workshop from each side must come from at least three institutions.

In 2021, NSFC and JSPS will also release a call for join research projects. For more information regarding application, please refer to the call for proposals to be launched by NSFC in the column of "Notice and Announcements" on its website in due time.

South Korea

National Research Foundation (NRF)

NSFC and NRF will jointly support joint research projects, exchange projects and bilateral workshops in 2021.

Two calls for proposals will be released in 2021 by both foundations on their respective websites, one for joint research project, and the other for exchange project & bilateral workshop. The joint funding decision for exchange project and bilateral workshop will be made at the Sino-Korean Joint Committee on Basic Science after deliberation and discussion of participating experts.

(1) Joint Research Project

Two to four three-year joint research projects are planned to be funded by NSFC and NRF in 2021 with NSFC investing 2 million yuan (direct cost) for each project.

(2) Exchange Project

Around 20 two-year exchange projects are planned to be funded by NSFC and NRF in 2021.

(3) Bilateral Workshop

Around 10 bilateral workshops are planned to be funded by NSFC and NRF in 2021. Participants of bilateral workshops from each side must come from at least three institutions.

Israel

Israel Science Foundation (ISF)

NSFC and ISF together fund joint research projects and bilateral workshops.

(1) Joint Research Project

The priority collaborative areas in 2021 are precision sciences. Around 35 three-year projects are planned for joint funding with NSFC investing 2 million yuan (direct cost) for each project.

(2) Bilateral Workshop

Each year, no more than 2 bilateral workshops are planned to be funded by NSFC and ISF. The workshop themes are decided by both sides through negotiation.

Three Asian Countries (China, Japan and South Korea)

A3 Foresight Program

The A3 Foresight Program is a funding program for joint research which was set up and sponsored by NSFC, Japan Society for the Promotion of Science (JSPS) and National Research Foundation of Korea (NRF) together. China, Japan and South Korea support the cooperation of scientists from the three countries to conduct world-class cutting-edge research in selected strategic areas, so as to foster excellent young researchers and make contributions to the solution of common regional issues.

The priority area of A3 Foresight Program for each year is in accord with the theme of the Northeastern Asian Symposium jointly organized by NSFC, JSPS and NRF in the previous year.

The call for proposals is simultaneously announced on the websites in November by the three parties and 2 five-year projects will be jointly funded annually, with NSFC investing 4 million yuan (direct cost) in each approved project.

Thailand

National Research Council of Thailand (NRCT)

NSFC and NRCT jointly support joint research projects, exchange projects and bilateral workshops. In 2021, NSFC and NRCT will also release a call for join research projects. For more information regarding application, please refer to the call for proposals to be launched by NSFC in the column of "Notice and Announcements" on its website in due time.

(1) Joint Research Project

In 2021, the joint call for proposals with specific collaborative topics will be launched by NSFC and NRCT on their websites respectively, and around 5 projects with duration of three years will be funded, with an investment of 2 million yuan (direct cost) by NSFC for each project.

(2) Exchange Project

Chinese and Thai scientists are required to submit proposals to NSFC and NRCT respectively. The two agencies will make a funding decision after consultation.

(3) Bilateral Workshop

NSFC and NRCT support bilateral workshops every year. The themes and number of workshops to be funded will be decided by both sides through negotiation.

Singapore

National Research Foundation of Singapore (NRF)

NSFC and NRF together fund joint research projects and bilateral workshops.

In 2021, NSFC and NRF will also release a call for join research projects. For more information regarding application, please refer to the call for proposals to be launched by NSFC in the column of "Notice and Announcements" on its website in due time.

Pakistan

Pakistan Science Foundation (PSF)

NSFC and PSF together fund joint research projects and bilateral workshops.

(1) Joint Research Project

In 2021, the joint call for proposals with specific collaborative topics will be launched by NSFC and PSF on their websites respectively, and around 10 projects with duration of three years will be funded, with an investment of 2 million yuan (direct cost) by NSFC for each project.

(2) Bilateral Workshop

NSFC and PSF support bilateral workshops every year. The themes and number of

workshops to be funded will be decided by both sides through negotiation.

Egypt

Academy of Scientific Research and Technology (ASRT)

In 2021, NSFC and ASRT will release a call for join research projects. For more information regarding application, please refer to the call for proposals to be launched by NSFC in the column of "Notice and Announcements" on its website in due time.

Other Cooperation Channels

NSFC has signed bilateral collaborative agreements for funding personnel exchange projects and bilateral workshops with the Mongolian Foundation for Science and Technology (MFST), Department of Science and Technology of India (DST), Council of Scientific & Industrial Research of India (CSIR), Iran National Science Foundation (INSF), etc. The specific projects as proposed by scientists will be jointly decided on a case-by-case basis through mutual agreement.

International Scientific Organizations

International Center for Theoretical Physics (ICTP)

About 50 Chinese young scholars are funded by NSFC every year in the areas of mathematics, physics and earth sciences to participate in various research activities at ICTP, such as summer seminars and short-term joint research.

An open call for candidates of short-term specific activities at ICTP is announced on NSFC's website in November every year. A name list of candidates is recommended by NSFC to ICTP after being selected by relevant experts. The recommended candidates should apply to ICTP according to requirements of each ICTP activity.

International Institute of Applied Systems Analysis (IIASA)

NSFC encourages Chinese scientists to conduct multilateral cooperation with various IIASA Programs in the areas of energy, environment, land use, water, population, etc., and to jointly apply for research funding from various governmental organizations, private and national science foundations, World Bank and EU Framework Program.

NSFC provides full support for 5 to 7 Chinese young scholars to participate in the annual 3-month Young Scientists Summer Program (YSSP) from June to August at IIASA in Vienna every year. For detailed information and application forms, please refer to the IIASA website (www.iiasa.ac.at). Besides, NSFC also supports workshops, exchange and joint research projects jointly applied by Chinese and IIASA scientists.

For more information regarding application in 2021, please refer to the call for proposals to be launched by NSFC in the column of "Notice and Announcements" on its website in due time.

Consultative Group on International Agricultural Research (CGIAR)

NSFC has reached agreements with 11 CGIAR affiliated institutes/centers (i.e., Bioversity International, CIAT, CIFOR, CIMMYT, CIP, ICARDA, ICRAF, ICRISAT, IFPRI, ILRI, and IRRI) to fund joint research projects conducted by scientists from both sides.

The call for proposals is released by NSFC on its website in February every year, and the deadline for application in 2021 is April. Around 12 projects are planned for funding in 2021 with

an average funding amount of 2 million yuan (direct cost) per project with duration of 5 years.

United Nations Environment Program (UNEP)

According to the cooperation agreement between NSFC and UNEP, both sides support scientists to conduct scientific collaborative research in the fields of eco-system, climate change, resource efficiency and environment governance. Special importance is placed on cooperation with developing countries in Africa and Asian-Pacific regions.

The call for proposals is released by NSFC on its website in February every year, and the deadline for application in 2021 is April. Around 4 projects are planned for funding in 2021, with a funding amount of 3 million yuan (direct cost) per project for 5 years.

Multilateral Collaboration under Belmont Forum (BF/IGFA)

According to the agreement between NSFC and Belmont Forum, since 2014 NSFC has supported Chinese scientists to participate in the multilateral cooperation under the framework of Belmont Forum. For more information regarding application in 2021, please refer to the call for proposals to be launched by NSFC in the column of "Notice and Announcements" on its website in due time.

International Centre for Integrated Mountain Development (ICIMOD)

According to the agreement between NSFC and ICIMOD, starting from 2016, both sides have supported Chinese scientists, ICIMOD scientists and scientists from ICIMOD member countries to carry out cooperation and advance research in China and the surrounding countries in the region of Hindu Kush-Himalayas. For more information regarding application in 2021, please refer to the call for proposals to be launched by NSFC in the column of "Notice and Announcements" on its website in due time.

BRICS STI Framework Program

According to the agreement to fund joint research projects under the framework of BRICS STI Framework Program among research funding agencies such as NSFC, Chinese Ministry of Science and Technology (MOST), Brazil National Council for Scientific and Technological Development (CNPq), Foundation for Assistance to Small Innovative Enterprises of Russia (FASIE), Russia Ministry of Education and Science (MON), Russian Foundation for Basic Research (RFBR), Department of Science and Technology of India (DST), Department of Science and Technology of South Africa (DST), and National Research Foundation of South Africa (NRF), the aforementioned parties have jointly supported scientists from the countries to carry out cooperation starting from 2016. For more information regarding the fourth round of application, please refer to the call for proposals to be launched by NSFC in the column of "Notice and Announcements" on its website in due time.

America and Australasia

USA

The National Science Foundation (NSF)

According to the cooperation agreement between NSFC and NSF, both sides jointly support research projects and bilateral workshops in areas of common interests.

(1) Joint research project

NSFC and NSF accept joint research applications in the areas of Dimensions of Biodiversity and the Evolution and Ecology of Infectious Diseases in the year of 2021.

NSFC and NSF will together publish guide to programs. Chinese and US researchers submit to NSFC and NSF respectively. NSFC and NSF jointly make final funding decisions based on the agreed evaluation methods and procedures. For detailed requirements about application in 2021, please refer to the call for proposals to be launched on NSFC's website.

(2) Bilateral workshop

NSFC and NSF will fund bilateral workshops in areas and numbers mutually identified and agreed by both parties.

Bill & Melinda Gates Foundation (BMGF)

According to the cooperation agreement between NSFC and BMGF, both sides jointly support research projects and bilateral workshops in areas of common interests.

(1) Joint research project

NSFC and BMGF will accept joint research applications in the areas of response to COVID-19 and malaria in the year of 2021.

NSFC and BMGF will together publish guide to programs. NSFC and BMGF jointly make final funding decisions based on the agreed evaluation methods and procedures. For detailed requirements about application in 2021, please refer to the call for proposals to be launched on NSFC's website.

(2) Bilateral workshop

NSFC and BMGF will fund bilateral workshops in areas and numbers mutually identified and agreed by both parties.

Canada

Canadian Institutes of Health Research (CIHR)

According to the cooperation agreement between NSFC and CIHR, both sides jointly support research projects and bilateral workshops in areas of common interests.

(1) Joint research project

NSFC and CIHR will together publish guide to programs. Chinese and Canadian researchers submit to NSFC and CIHR respectively. NSFC and CIHR jointly make final funding decisions based on the agreed evaluation methods and procedures. For detailed requirements about application in 2021, please refer to the call for proposals to be launched on NSFC's website.

(2) Bilateral workshop

NSFC and CIHR will fund bilateral workshops in areas and numbers mutually identified and agreed by both parties.

Fonds de Recherche du Québec (FRQ)

According to the cooperation agreement between NSFC and FRQ, both sides jointly support research projects and bilateral workshops in areas of common interests.

(1) Joint research project

NSF and FRQ will accept joint research applications in the areas of green chemistry and big data management in the year of 2021. NSFC and FRQ will together publish guide to programs. Chinese and Quebec researchers submit to NSFC and FRQ respectively. NSFC and FRQ jointly make final funding decisions based on the agreed evaluation methods and procedures. For detailed requirements about application in 2021, please refer to the call for proposals to be launched on NSFC's website.

(2) Exchange program

NSFC and the FRQ provide support for exchange visits between Chinese and Quebec

researchers with duration of 1-3 months. For detailed requirements about application in 2021, please refer to the call for proposals to be launched on NSFC's website.

(3) Bilateral workshop

NSFC and FRQ will fund bilateral workshops in areas and numbers mutually identified and agreed by both parties.

New Zealand

Health Research Council (HRC)

According to the cooperation agreement between NSFC and HRC, both sides jointly support research projects and bilateral workshops in areas of common interests.

(1) Joint research project

NSFC and HRC will accept joint research applications in the area of biomedicine in the year of 2021.

NSFC and HRC will together publish guide to programs. Chinese and New Zealand researchers submit to NSFC and HRC respectively. NSFC and HRC jointly make final funding decisions based on the agreed evaluation methods and procedures. For detailed requirements about application in 2021, please refer to the call for proposals to be launched on NSFC's website.

(2) Bilateral workshop

NSFC and HRC will fund bilateral workshops in areas and numbers mutually identified and agreed by both parties.

Chile

National Commission for Scientific and Technological Research of Chile (CONICYT)

According to the cooperation agreement between NSFC and CONICYT, both sides jointly support research projects and bilateral workshops in areas of common interests.

(1) Joint research project

NSFC and CONICYT will together publish guide to programs. Chinese and Chilean researchers submit to NSFC and CONICYT respectively. NSFC and CONICYT jointly make final funding decisions based on the agreed evaluation methods and procedures. For detailed requirements about application in 2021, please refer to the call for proposals to be launched on NSFC's website.

(2) Bilateral workshop

NSFC and CONICYT will fund bilateral workshops in areas and numbers mutually identified and agreed by both parties.

Argentina

National Scientific and Technical Research Council of Argentina (CONICET)

According to the cooperation agreement between NSFC and CONICET, both sides jointly support research projects and bilateral workshops in areas of common interests.

(1) Joint research project

NSFC and CONICET will together publish guide to programs. Chinese and Argentine researchers submit to NSFC and CONICET respectively. NSFC and CONICET jointly make final funding decisions based on the agreed evaluation methods and procedures. For detailed requirements about application in 2021, please refer to the call for proposals to be launched on NSFC's website.

(2) Bilateral workshop

NSFC and CONICET will fund bilateral workshops in areas and numbers mutually identified and agreed by both parties.

Other Cooperation Channels

NSFC has signed bilateral collaborative agreements for funding joint research projects, personnel exchange projects and bilateral workshops with the National Institutes of Health(NIH), the Gordon and Betty Moore Foundation (GBMF), the São Paulo Research Foundation (FAPESP), the Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES), Consejo Nacional de Ciencia y Tecnología of Mexico (CONACTY), and the Ministerio de Ciencia, Tecnología y Medio Ambiente-República de Cuba (CITMA) etc. The specific projects are jointly decided on a case-by-case basis through mutual agreement.

Europe

European Union

European Research Council (ERC)

Talent Program

NSFC and ERC jointly fund the Chinese researchers to visit European countries for a single long-term or multiple short-term research stay (3 to 12 months in total). The Chinese researchers should join the ERC-funded project teams to carry out collaborative research based on the common interest. The international traveling cost will be covered by NSFC. The local and research costs in Europe will be covered by the ERC-granted projects. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Joint Programming Initiative (JPI) Urban Europe

Joint Research Program

NSFC and JPI Urban Europe jointly fund the collaborative research between the Chinese and European researchers on the previous collaborations and the research fields of common interests. NSFC and JPI Urban Europe will jointly launch call for proposals. The Chinese and the European researchers should submit the proposals to the respective funding agencies. The submitted proposals will be evaluated according to the agreed approach and procedures. The final decision for funding will be mutually made. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

UK

Royal Society (RS)

Exchange Program

NSFC and RS jointly fund the exchange visits between the Chinese and UK researchers. The funding period is 2 years. The maximum funding amount for each project is 100,000 yuan for Chinese researchers from NSFC and 12,000 pounds for UK researchers from RS. The cost for the international traveling, accommodation, meals and intercity transportation will be covered by the granted projects. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Royal Society of Edinburgh (RSE)

Workshop Program

NSFC and RSE jointly fund the bi-lateral workshops between researchers in China and UK. The maximum funding amount for each project is 150,000 yuan from NSFC and 17,000 pounds from RSE. For bi-lateral workshops held in China, the local cost of the attendees and the expense of the workshop will be covered by NSFC, while the cost of the international traveling of British

attendees will be covered by RSE. For bi-lateral workshops held in UK, the local cost of the attendees and the expense of the workshop will be covered by RSE, while the cost of the international traveling of Chinese attendees will be covered by NSFC. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

UK Research and Innovation (UKRI)

Joint Research Program

NSFC and UKRI (EPSRC, BBSRC, NERC, MRC, ESRC and STFC) jointly fund the collaborative research between the Chinese and UK researchers based on the previous collaborations and the research fields of common interests. NSFC and UKRI will jointly launch the call for proposals. The Chinese and UK researchers should submit the proposals to the respective funding agencies. The submitted proposals will be evaluated according to the agreed approach and procedures. The final decision for funding will be mutually made. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Germany

German Research Foundation (DFG)

Joint Research Program

NSFC and DFG jointly fund the research projects in areas of common interests between Chinese and German researchers. NSFC and DFG will jointly launch call for proposals. The Chinese and German researchers should submit the proposals to NSFC and DFG, respectively. The submitted proposals will be evaluated according to the agreed approach and procedures. The final decision for funding will be mutually made. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

France

French National Research Agency (ANR)

Joint Research Program

NSFC and ANR jointly fund the research projects in areas of common interests between Chinese and French researchers. NSFC and ANR will jointly launch call for proposals. The Chinese and French researchers should submit the proposals to NSFC and ANR, respectively. The submitted proposals will be evaluated according to the agreed approach and procedures. The final decision for funding will be mutually made. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Russia

Russian Foundation for Basic Research (RFBR)

Exchange Program

NSFC and RFBR jointly fund the exchange visits and bi-lateral workshops between the Chinese and Russian researchers. The funding period is 2 years. The maximum funding amount for each project is 150,000 yuan from NSFC, supporting the traveling cost and local expenses for the Chinese researchers in Russia, as well as the expenses for the workshop held in China. While the traveling cost and local expenses for the Russian researchers in China, as well as the expenses for the workshop held in Russia will be covered by RFBR. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Finland

Academy of Finland (AF)

(1) Exchange Program

NSFC and AF jointly fund the exchange visits between the Chinese and Finnish researchers. The funding period is 2 years. The maximum funding amount for each project is 100,000 yuan from NSFC, supporting the traveling cost and local expenses for the Chinese researchers in Finland. While the traveling cost and the related expenses for the Finnish researchers in China will be covered by AF. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

(2) Workshop Program

NSFC and AF jointly fund the bi-lateral workshops between Chinese and Finnish researchers. The funding period is 1 year. For the bi-lateral workshops held in China, the expenses for the workshop, the traveling cost and local expenses for Chinese attendees will be covered by NSFC. While the cost for the international traveling and local costs of Finnish attendees will be covered by AF. To the bi-lateral workshops held in Finland, the cost for the international traveling and the local costs for Chinese attendees will be covered by NSFC. While the expense for the workshops, the traveling cost and local expenses of Finnish attendees will be covered by AF. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Netherlands

Dutch Research Council (NWO)

(1) Joint Research Program

NSFC and NWO jointly fund the research projects in areas of common interests between Chinese and Dutch researchers. NSFC and NWO will jointly launch call for proposals. The Chinese and Dutch researchers should submit the proposals to NSFC and NWO, respectively. The submitted proposals will be evaluated according to the agreed approach and procedures. The final decision for funding will be mutually made. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

(2) Exchange Program

NSFC and NWO jointly fund the exchange visits between the Chinese and Dutch researchers. The funding period is 2 years. The cost for the international traveling and the local expenses of the attendees will be covered by NSFC and NWO. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

(3) Workshop Program

NSFC and NWO jointly fund the bi-lateral workshops between Chinese and Dutch researchers. For the bi-lateral workshops held in China, the expenses for the workshops and the local costs for the attendees will be covered by NSFC. While the cost for the international traveling of Dutch attendees will be covered by NWO. For the bi-lateral workshops held in Netherlands, the cost for the international traveling of Chinese attendees will be covered by NSFC. While the expenses for the workshops and the local costs of the attendees will be covered by NWO. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Sweden

Swedish Research Council (VR)

Joint Research Program

NSFC and VR jointly fund the research projects in areas of common interest between Chinese and Swedish researchers. NSFC and VR will jointly launch call for proposals. The Chinese and Swedish researchers should submit the proposals to NSFC and VR, respectively. The submitted proposals will be evaluated according to the agreed approach and procedures. The final decision for

funding will be mutually made. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Swedish Foundation for International Cooperation in Research and Higher Education (STINT)

Exchange Program

NSFC and STINT jointly fund the exchange visits and bi-lateral workshops between the Chinese and Swedish researchers. The funding period is 3 years. The maximum funding amount for each project is 400,000 yuan from NSFC, supporting the traveling cost and local expenses in Sweden of the Chinese researchers as well as the expenses of the workshops held in China. The maximum funding amount for each project is 600,000 Swedish Kroner from STINT, supporting the traveling costs and local expenses in China of the Swedish researchers as well as the expenses for the workshops held in Sweden. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Switzerland

Swiss National Science Foundation (SNSF)

Joint Research Program

NSFC and SNSF jointly fund the research projects in areas of common interests between Chinese and Swiss researchers. NSFC and SNSF will jointly launch call for proposals. The Chinese and Swiss researchers should submit the proposals to NSFC and SNSF, respectively. The submitted proposals will be evaluated according to the agreed approach and procedures. The final decision for funding will be mutually made. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Belgium

The Research Foundation-Flanders (FWO)

Joint Research Program

NSFC and FWO jointly fund the research projects in areas of common interests between Chinese researchers and Flemish researchers from Belgium. NSFC and FWO will jointly launch call for proposals. The Chinese and Flemish researchers should submit the proposals to NSFC and FWO, respectively. The submitted proposals will be evaluated according to the agreed approach and procedures. The final decision for funding will be mutually made. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

The Fund for Scientific Research (FNRS)

Exchange Program

NSFC and FNRS jointly fund the exchange visits between researchers from China and Wallonia-Brussels Federation (BWF) of Belgium. The funding period is 2 years. The maximum funding amount for each project is 100,000 yuan from NSFC, supporting the traveling cost of the Chinese researchers to Belgium and local expenses of the Belgian researchers in China. The traveling cost of the Belgian researchers to China and local expense of the Chinese researchers in Belgium will be covered by FNRS. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Belarus

Belarusian Republican Foundation for Fundamental Research (BRFFR)

Exchange Program

NSFC and BRFFR jointly fund the exchange visits between Chinese and Belarusian researchers. The funding period is 2 years. The maximum funding amount for each project is

200,000 yuan from NSFC, supporting the traveling cost and local expenses of Chinese and Belarusian researchers as well as the expenses for the bi-lateral workshops. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Bulgaria

National Science Fund of Bulgaria (BNSF)

Exchange Program

NSFC and BNSF jointly fund the exchange visits between Chinese and Bulgarian researchers. The funding period is 2 years. The international travelling cost, local expenses and expenses for the bi-lateral workshops will be covered by NSFC and BNSF jointly. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Poland

The National Science Centre (NCN)

Joint Research Program

NSFC and NCN jointly fund the research projects in areas of common interests between Chinese and Polish researchers. NSFC and NCN will jointly launch call for proposals. The Chinese and Polish researchers should submit the proposals to NSFC and NCN, respectively. The submitted proposals will be evaluated according to the agreed approach and procedures. The final decision for funding will be mutually made. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Turkey

The Scientific and Technological Research Council of Turkey (TUBITAK)

Joint Research Program

NSFC and TUBITAK jointly fund the research projects in areas of common interests between Chinese and Turkish researchers. NSFC and TUBITAK will jointly launch call for proposals. The Chinese and Turkish researchers should submit the proposals to NSFC and TUBITAK, respectively. The submitted proposals will be evaluated according to the agreed approach and procedures. The final decision for funding will be mutually made. The details for the application in 2021 can be found in the call for proposals to be launched on NSFC official website.

Hong Kong and Macao SARs and Taiwan Region of China

NSFC has established cooperations with the Research Grant Council of Hong Kong (RGC), Beijing-Hong Kong Academic Exchange Centre, Macao Foundation for the Development of Science and Technology, and K.T. Li Foundation for the Development of Science and Technology in Taiwan Region, jointly funding cooperation and exchange between researchers from the inland of China and Hong Kong and Macao SARs, and between researchers from two sides of the Taiwan Straits in areas of common interest. Types of activities that can be funded are joint research projects and exchange projects (including exchanged visits and academic workshops).

Hong Kong

NSFC and the Research Grant Council of Hong Kong(RGC) will continue to fund join research in areas of natural sciences in 2021. The priority funding areas include information

sciences, biological sciences, new materials, marine and environmental sciences, medical sciences, and management sciences. Meanwhile, to further encourage academic exchanges between young researchers from Hong Kong SAR and the inland of China, academic forums are organized and funded in areas of common interest. For detailed requirements, please refer to the call for proposals launched in the column of "Notice and Announcements" on NSFC's website.

Macao

In 2021, NSFC and Macao Foundation for Science and Technology Development (FDCT) will, under the framework of the signed cooperative agreement, together fund joint basic research projects between scientists from the inland of China and Macao. The priority areas include information science, TCM research, marine science, environmental science, biological science, as well as new materials. Meanwhile, NSFC and FDCT will organize and fund academic workshops in areas of mutual interest for academic communities from the inland of China and Macao region. For detailed requirements, please refer to the call for proposals launched in the column of "Notice and Announcements" on NSFC's website.

Taiwan

NSFC has been dedicated to encouraging and promoting scientific cooperation and exchange between scientists on both sides of the Taiwan Straits. In 2021, NSFC will continue to support cross-Straits academic workshops held by scientists from the mainland of China and the Taiwan region. NSFC will also fund substantial joint research projects according to the consensus reached with K.T. Li Foundation for the Development of Science and Technology. For detailed requirements, please refer to the call for proposals launched in the column of "Notice and Announcements" on NSFC's website.

Sino-German Center for Research Promotion

The Sino-German Center for Research Promotion (abbreviated as SGC) is a research funding agency, jointly set up by NSFC and German Research Foundation (DFG). SGC's legal status is NSFC's affiliated institution. It aims at promoting scientific cooperation and exchange between Chinese and German researchers and providing all-around services with its diverse funding instruments for researchers at various stages of their career, and thus is able to push forward in-depth cooperation and development in fundamental science between China and Germany.

1. Subjects Covered

The Sino-German Center for Research Promotion mainly supports the cooperation activities between Chinese and German scientists in fundamental research in all fields of natural sciences.

2. Eligibility of Applicants

An applicant from China must be a PI or participant in an NSFC granted project (either ongoing or already completed) with a duration of at least 3 years; or an excellent young researcher who is less than 35 years old and holding a doctorate (applicable only to certain programs). Applicants from Germany must be eligible to apply for funding from DFG. Eligible Chinese and German scientists might submit a proposal jointly to the Sino-German Center for Research Promotion.

3. Application Limit

The projects funded by the Sino-German Center for Research Promotion will not be subject to NSFC's regulation on the limit of the number of projects that an individual researcher could undertake or apply for.

4. Programs

(1) Preparatory Visit

Chinese and German scientists might apply to the Sino-German Center for funds to pay a short visit to their partners' institutions in order to make preparations and plans for proposing a Bilateral Workshop, Summer School, Young Scientist Forum, Mobility Program or NSFC-DFG Joint Research Project. Through the short visit, the two sides could work out a plan for a joint project efficiently, complete the preparation and submit their joint proposal as soon as possible.

(2) Bilateral Workshop

The most fundamental program supported by the Sino-German Center is Bilateral Academic Workshops which aim at promoting setting up new partnerships, deepening existing partnerships, and stimulating new joint research projects between Chinese and German scientists. The workshops must have specific scientific themes, and be coordinated and co-hosted by senior scientists from both sides. To ensure the authoritativeness and representativeness, participants of the workshops must be representative scientists in related fields in both countries, and should come from different institutions and regions. The workshop could be held either in China or Germany. The Sino-German Center could provide funding for up to 40 participants for each workshop, i.e., not more than 15 participants from the travelling party and at most 25 participants from the hosting party. The number of participants from the same institution should not exceed a third of all the participants from that party. In addition, scientists from a third party can be invited to the workshop and the total number of such scientists should be no more than three. Formal representatives from Germany must have doctorates. The Center provides funding for domestic and international travel expenses, local subsistence of all formal participants, venue fees and other necessary costs of the workshop according to its current funding rates standard.

(3) Post-Workshops Young Scientist Academic Visit

The Sino-German Center encourages early career researchers participating in a Sino-German workshop to spend an immediately following additional research stay in a cooperation partner's group. Applicants for Post-Workshops Young Scientist Academic Visit should be formal representatives of Bilateral Workshops funded by SGC, who have received an invitation letter for scientific visit from cooperation partner. Up to 2 participants from each Bilateral Workshop can apply for this visit. The funding duration is up to 14 days, and the funding rates cover travel expenses inside China or Germany, catering and hotel accommodation costs.

(4) Mobility Program

The Program aims at supporting in-depth cooperation and exchanges between Chinese and German scientists in a specific field over a period of 3 years. It mainly supports scientists' short-term visits and small-scale workshops. The Sino-German Center covers domestic and international travel expenses, accommodation costs, meal cost and venue fees according to its current funding rates standard. A maximum of 1.5 million yuan (or equivalent sum of euros) per project would be provided to both Chinese and German teams.

(5) Summer School

The Program aims to introduce advanced scientific methods, techniques and their applications to young scientists and provide them with training and discussion on specific issues in a certain area. The Sino-German Center attaches great importance to the screening/selection of the young scientists to attend the Summer School and requires that the participants of the seminars

must be selected according to an open and competitive selection procedure.

The Sino-German Center may fund 4 to 6 senior experienced scientists from both countries as lecturers. The applicants on both sides must be among the funded lecturers. Participants are mainly university undergraduates, graduates or young researchers from both countries. The number of participants is decided according to specific conditions, such as equipment and infrastructure of the laboratory, but it shall not exceed 40 persons in total. The number of participants shall not exceed 15 from travelling party, and 25 from the hosting party. The Summer School can be held either in Germany or in China and usually lasts at most 14 days, including one day for arrival and one for departure. The Center provides funding for all formal participants and lecturers for domestic and international travel expenses, local accommodation & meal costs and venue fees according to its current funding rates standard.

(6) Young Scientists Forum

The Program aims at providing a venue for Chinese and German young scientists active in their own fields to meet and discuss with each other, providing them with an opportunity to introduce their own work to the outstanding scientists and learn new research methods. The forum could be held either in China or Germany. The Sino-German Center in principle provides 5 to 7 days' funding including one day's academic visit and arrival & departure. The total number of participants shall not exceed 42 persons. The travelling party shall not be more than 16 persons (15 young scientists and one senior scientist). The receiving party shall not exceed 26 persons (25 young scientists and one senior scientist). In addition, scientists from a third party can be invited to the workshop and the total number of such scientists should be no more than three, that is, 20% of the number of participants from the travelling party. Apart from the basic eligibility required, the participants shall be less than 40 years old (as of the holding date of forum). The German participants must have doctorates. The Chinese assistant professors (lecturer) are also eligible to attend. The organization of the forum shall be coordinated by a young scientist from each side. The Center provides funding for international travel expenses, inter-city travel expenses, local subsistence costs and venue fees according to its current funding rates standard.

(7) Excellent Early-career German Scholar Program

The Program is established in order to further promote scientific cooperation between China and Germany, strengthen scientific and technological exchanges between young scholars of these two countries. The program will fund excellent early-career German scholars to carry out researches for a period of time in China, so as to familiarize them with Chinese research system, and establish and strengthen the interaction and long-term cooperation with Chinese scientists. This program can be funded in the following two terms: the short term and the long term. The Short-term funding covers domestic and international travel expenses, catering and hotel accommodation costs for up to two months; the Long-term funding period is three years, supporting up to 3 research stays in China with a whole duration of 6 months completed within three years. Funding rates cover domestic and up to three round trips of international travel expenses, catering and hotel accommodation costs, and an add-on for research expenses of up to 300,000 yuan.

(8) Lindau Program

Lindau Nobel Laureate Meeting is held in late June each year in Lindau, Germany. Excellent young scientists from around the globe are also invited to attend the event. The Sino-German Center, together with Lindau Nobel Laureates Foundation, invites and funds 30 excellent Chinese PhD students to participate in the Nobel Laureate meeting in Lindau, Germany, followed by a week-long academic visit to the German research institutions famously in relevant disciplines solely organized by the Center.

Candidates are selected throughout China and must be recommended by their home

institutions. The final approval list is decided by correspondence review and interviews by a panel of Chinese and German experts. The Center provides funding for formally selected students for international travel expenses, inter-city travel expenses and accommodation costs according to its current funding rates. The Center will handle the visa affairs for the selected students and pay for the related fees.

(9) Post-Lindau Program

Grantees of Lindau Program who has got the PhD degree and a fixed position in a Chinese research institution may apply for the funding from the Sino-German Center for an academic stay of less than 12 months in Germany if they could get invitations from German research institutions or universities, and approval from their host institutions. The Center provides funding for international travel expenses, inter-city travel expenses, accommodation costs and insurance expenses according to its current funding rates standard.

The Mobility Program will be accepted according to a solicited call, while other types of programs will be accepted in a continuous mode at any time. The detailed requirements, application forms and processes of each type of program in 2021 can be found at the website of the Center: https://sinogermanscience.dfg.nsfc.cn.

Programs of Joint Funds

The joint funds set up by NSFC and relevant government departments, provincial governments and industrial sectors are committed to supporting basic research in agreed scientific areas.

The joint funds are designed to give full play to the leading role of the National Natural Science Fund, integrate social resources for basic research, promote the synergy of relevant departments, industries and regions with universities and research institutions, foster scientific and technological talents, and enhance China's indigenous innovation capabilities in related research areas, industries and regions.

In 2018, the Joint Fund for Regional Innovation and Development and the Joint Fund for Industrial Innovation and Development were set up by NSFC and relevant provincial departments or enterprises. These Funds are designed in a way that ensures integrated management regarding grant expenses, call solicitation, review process, etc. In the meantime, by focusing on key scientific issues in relevant industrial sectors with joint support from NSFC and major administrative departments, the Joint Funds will contribute to the establishment of an upgraded system characterized by higher funding efficiency in the new era.

The joint funds are part of the Natural Science Funds. The application, evaluation and management of the joint funds will comply with management methods such as the Regulations, NSFC's Rule on Funding Management and NSFC's Rule on Joint Fund Management.

In 2021, the joint funds in the *Guide* include the Joint Fund for Regional Innovation and Development, Joint Fund for Industrial Innovation and Development, NSAF Joint Fund, Civil Aviation Joint Research Fund, Joint Fund for Water Science Research of Yangtze River, "Ye Qisun" Science Fund, Joint Fund for Meteorological Science, Joint Fund for Seismological Science, Joint Fund for Smart Grid, Joint Fund for Nuclear Technology Innovation, NSFC-Yunnan Joint Fund, and NSFC-Shandong Joint Fund. **Guidance for other Joint Funds will be published on NSFC website.**

Applicants for the Joint Funds should:

(1) Have the experience of conducting basic research;

(2) Hold senior professional position (title) or PhD degree;

(3) Meet other requirements in the Guide.

For any research achievements funded by the Joint Fund, NSFC's contribution and support to the project should be acknowledged in a prominent place and in an appropriate form according to the *Guide* with the title of the joint fund and the project number.

Applications for the joint funds should be prepared according to the requirements and outlines specified for each Joint Fund. Please select “Joint Fund” for funding category, “Fostering Project” or “Key Project” or “Integration Project” for subcategories, and select the name of the joint fund in the notes section.

The number of collaborative institutions for “Fostering Project” and “Key Project” shall not exceed two. The number of collaborative institutions for Integrated Project shall not exceed four.

The funding duration for “Fostering Project” is three years and the funding period shall be “from January 1, 2022 to December 31, 2024” in the application form. The funding duration for “Key Project” and “Integration Project” is four years and the funding period shall be “from January 1, 2022 to December 31, 2025” in the application form.

Joint Fund for Regional Innovation and Development

The Joint Fund for Regional Innovation and Development co-established by NSFC and provincial governments aims to give play to the guiding role of the National Natural Science Fund, and attract and gather excellent scientific research teams across the country. Focusing on the major needs in regional economic and social development, it carries out basic research and applied basic research on key scientific issues, promote cross-regional and cross-sector collaborative innovation, and promote the improvement of the country's regional independent innovation capabilities.

In 2021, the Joint Fund for Regional Innovation and Development calls for proposals of "Key Project" and "Integration Project" with a funding duration of four years. The average direct funding for Key Project is 2.6 million yuan per project. The average direct funding for Integrated Project is specified in this *Guide*.

I. Biology and Agriculture

i. Proposal should carry out relevant basic research on key scientific and technological issues such as hybrid wheat fertility, millet quality, and gopher models for human disease, so as to meet the needs of Shanxi province in the development of life science and agriculture.

Key Project:

1. The establishment of human disease hamster model and the study of its pathogenesis

Taking Chinese hamsters as the research object, proposals should establish hamster models of human diabetes and other metabolic diseases and form resource groups through artificial induction, genetic screening, genetic modification and other methods, as well as the identifying the phenotypic characteristics and basic biological data. Proposals should carry out analysis of the genetic mechanism of the hamster model and the study of important functional genes.

2. Analysis of genetic mechanism of hybrid wheat fertility, study of the breeding of strong hybrid varieties and key technologies

In response to the unclear genetic mechanism of three-line hybrid wheat fertility and the lack of strong hybrid varieties, proposals should make parental materials such as wheat male sterile lines, maintainer lines and restorer lines, analyze the genetic mechanism of three-line hybrid wheat fertility, and select hybrid wheat varieties with strong superiority. Proposals should focus on the research and development of high-yield hybrid wheat seed production technology, and provide germplasm and technical support for the selection and promotion of three-line hybrid wheat.

3. The influence of ecological environment on millet quality and its mechanism

In view of the problem that the quality of millet is easily impacted by the ecological environment system of the production area, proposals should explore the influence of different ecological environments in Shanxi province on the quality of millet and its physiological, biochemical and molecular mechanisms to provide a theoretical basis for the integration of millet quality breeding and cultivation technology.

The above research directions encourage applicants to conduct cooperative research with colleges and universities or research institutions with certain research strength and research conditions in Shanxi Province.

Applicants are encouraged to conduct cooperative research with colleges and universities or research institutions with substantial research strength and research conditions in Shanxi Province.

ii. Proposals should meet the needs of the development of special agricultural fields, and conduct basic research or applied basic research on key scientific issues, such as the traceability mechanism of famous and high-quality aquatic products, the mutually beneficial symbiosis mechanism of rice and crab integrated cultivation, the prevention and control

mechanism of soil erosion in the Liao River Basin, the compound planting model of grain and oil crops, and the genetic mechanism of tussah silkworm traits.

Key Project:

1. The formation mechanism of "geographic fingerprint" of Liaoning famous and high-quality aquatic products and the construction of traceability identification model

In order to establish a common traceability technology for Liaoning's famous and high-quality aquatic products, proposals should focus on the living environment of sea cucumbers and other aquatic products, the relationship between natural foods and geographic fingerprints, study the flux changes and distribution rules of fatty acids, amino acids and other synthetic pathways, and establish origin traceability index system and identification model through multi-dimensional stable isotope.

2. Study on the mechanism of mutual benefit and ecological regulation of comprehensive cultivation of rice and crab in Northeast China

Taking the northeastern rice crab comprehensive planting and breeding ecosystem as the research object, proposals should carry out research on the interaction mechanism of rice, river crab, pests, natural enemies and other major species and the mechanism of biodiversity control, reveal the mechanism of improving the effect of chemical fertilizers and pesticides in the integrated cultivation rice and crabs, explore the mutually beneficial symbiosis mechanism and ecological regulation methods of the rice and crab integrated cultivation system, and provide a theoretical basis for realizing the efficient integration of rice production and aquaculture.

3. Research on the ecological environment diagnosis and function improvement mechanism of the main stream of the Liao River and the estuary

Taking the main stream of the Liao River and the coastal estuary as the study area, proposals should study the movement law of water, sand, and nutrients in the "watershed-river-estuary" under wind, hydraulic, and freeze-thaw forces, as well as the interaction mechanism of forests, farmland, wasteland, and wetland, so as to make eco-environment diagnosis based on the sea-land synergy; study the coupling mechanism of ecological hydrology and nutrient transport in the river basin, and propose techniques for improving the quality and function of the ecological environment based on hydrological regulation.

4. Study on the composition and interaction mechanism of anthocyanin stability in berry products

In view of the problems of poor stability, easy degradation, and serious nutritional loss during the processing of anthocyanins, a special berry in Liaoning province, proposals should carry out research on the interaction mechanism and stability of anthocyanin polysaccharide, protein, and lipid coexisting molecules, and provide theoretical basis for the innovation of berry anthocyanin homeostasis, the development of new high-quality berry products and the regulation of stability.

5. The anti-wind erosion ecological synergistic cultivation mechanism of compound planting model of grain and oil crops

Taking grain and oil crop planting patterns as the research object, proposals should aim at problems of wind erosion and desertification, decline in soil fertility, and continuous cropping obstacles that occur in large-scale peanut planting in Liaoning province, carry out different crop compound planting models to optimize the effects of anti-wind erosion and soil improvement and their physiological and ecological mechanisms, and provide a theoretical basis for the establishment of an ecologically efficient compound planting model for grain and oil crops.

6. The genetic mechanism and the mechanism of immune prevention in the control of superior traits of tussah silkworm

Taking Liaoning characteristic tussah silkworm as the research object, proposals should carry out research on resistance, development mechanism and molecular regulation mechanism, as

well as the interaction mechanism of tussah silkworm, tussah tree, disease and insect pests, and provide a theoretical basis for improving the quality and efficiency of the tussah silkworm industry.

Applicants are encouraged to conduct cooperative research with colleges and universities or research institutions with substantial research strength and research conditions in Liaoning Province.

iii. In view of the cold environment of Jilin province, proposals should focus on the development needs of livestock and poultry, bees, red pine cones and other industries, carry out basic and applied basic research in the field of intestinal micro-ecology of livestock and poultry, energy supply structure of livestock and poultry, efficient breeding of red bumblebee in Changbai Mountain, and biological control of major pests in red pine cones area.

Key projects:

1. Research on the interaction mechanism between important pathogenic infections of livestock and poultry and intestinal microecology

In response to the current serious infectious diseases of livestock and poultry in Jilin and the unknown anti-disease mechanism of new antibiotic substitutes such as intestinal microecological preparations, proposals should study the structural characteristics of the intestinal microecological flora of livestock and poultry under pathogen infection, the immune regulation of the microecological flora against pathogenic infections of the host, the molecular mechanism of probiotics-regulated intestinal resistance to pathogenic infections, strategies for the development of antibiotic substitutes for new functional microecological preparations and their anti-infective molecular mechanisms, and provide support for the prevention and control of infectious diseases of livestock and poultry and ecological healthy breeding in Jilin province.

2. Research on the optimization of the energy structure of feed for growing-finishing pigs under the cold weather in northern China

In view of issues of low resource utilization and heavy environmental load caused by the misalignment of the structural demand and supply of feed materials for growing-finishing pigs in cold northern regions, proposals should conduct a systematic study of the utilization of energy carrier materials by growing-finishing pigs in the cold northern environment. Proposals should, from the dimensions of the nutritional requirements of the body under the different environmental temperatures and energy metabolism during growth and development, reveal the conversion and balance mechanism of energy content of each carrier material, and establish a dynamic and accurate energy nutrition model.

3. Physiological regulation mechanism of red bumblebee breeding in Changbai Mountain

In view of issues such as low queen storage survival rate, low spawning rate, slow colonization, weak colony, and serious degradation of subsequent generations in the breeding of bumblebees in Changbai Mountain, proposals should carry out study of the physiological regulation mechanism of diapause, recovery and oviposition of Bumblebees and high-efficiency swarming technology provides, thus providing a theoretical support for breakthroughs into the technical bottleneck of efficient breeding as well as improvement the utilization of genetic resources of local bumblebees in Jilin province.

4. Research on biological prevention and control technology of major pests in the red pine cone forest in Changbai Mountain

In response to the lack of biocontrol technologies for major pests such as pine caterpillars and fruit moths that seriously threaten the red pine cones in the Changbai Mountains of Jilin Province, and the low level of development of biocontrol products, proposals should focus on the collection and identification of natural enemy insects and biocontrol bacteria resources, establish the insects library of live natural enemies of major pests in red pine cones, reveal the interaction

mechanism among pine caterpillars (fructus sylvestris), natural enemy insects and biocontrol bacteria, elaborate the biocontrol potential and control mechanism of natural enemies, select dominant natural enemies suitable for use in the region species, clarify the key technical parameters for efficient production and breeding, and formulate new technologies and new theories for biological control of major pests in the red pine cone forest in Changbai Mountain.

5. The genetic basis of high-yield and high-quality soybeans in Northeast China and its application in germplasm creation

In view of issues such as low yield of soybeans, poor comparative benefits, and shrinking planting area year by year in Northeast China, proposals should focus on researches into the interaction mechanism among components of the soybean population yield components, the molecular mechanism of heterosis, the innovation and utilization of high-yield germplasm resources, and the physiological and ecological mechanisms of high-yield cultivation. Proposals should reveal the regulation mechanism of the traits of soybean population production capacity and the mechanism of high-yield advantage, and provide a theoretical support for improving the yield of spring soybeans.

Applicants are encouraged to conduct cooperative research with colleges, universities or research institutions with substantial research strength and research conditions in Jilin Province.

iv. Based on the major needs of food security in Heilongjiang, proposals should focus on the key scientific issues in the transformation and upgrading of agriculture, animal husbandry and forestry taking into account of special agriculture, livestock and forest models of cold regions, and carry out relevant basic and applied basic research.

Key projects:

1. Research on the development and application of a new gene editing technology system

In response to the major technical needs of the national development of biology, agriculture, and medicine, proposals should research and develop a new gene editing technology system with independent intellectual property rights, and conduct the editing function research of the system. Proposals should reveal the mechanism and rules of the new gene editing technology system, and realize its application in the field of biology, medicine and agriculture.

2. Basic research on the mining and application of biocontrol microbial resources and active substances in cold regions

In response to major technical requirements for green prevention and control of crop pests in cold regions, proposals should explore new active microorganisms and metabolites, study biosynthetic metabolism regulation mechanisms, and increase the yield of active products, thus providing a theoretical and application basis for the efficient utilization of agricultural microbial resources and product development.

3. Research on gene discovery and mechanism of fungal disease resistance in gourd vegetables of cold regions

In response to the major technical requirements for disease resistance and breeding of guard vegetables such as watermelon and muskmelon in Heilongjiang province, proposals should study the genetic law and mechanism analysis of the resistance to powdery mildew and other fungal diseases, explore important resistance genes and functional research, and provide a theoretical and application basis for the genetic improvement and molecular breeding research of the disease resistance of gourd vegetables in cold regions.

4. Research on the synergistic regulation mechanism of new biological fertilizers and black soil health

Taking the black soil of Heilongjiang farmland as the research object, proposals should focus on issues such as excessive soil organic and inorganic pollutants caused by pesticide

application, agricultural film residues and livestock manure returning to the field, carry out research on in-situ pollutant reduction laws and methods based on the coupling of physics, chemistry and biology, reveal the synergistic mechanism of fertilization and restoration, create multifunctional biological fertilizers for restoration, optimize and construct new ways of black soil ecological function restoration and plant nutrition regulation, and provide a theoretical and technical support for ensuring the green and sustainable use of black soil.

5. Research on the structure-activity relationship of feed antimicrobial peptides and key technological innovations in its application

In view of major scientific and industrial issues such as bacterial resistance and animal product safety caused by the abuse of feed antibiotics, proposals should, by taking the antimicrobial peptides are as the research object, analyze the structure-activity relationship and mechanism of feed antimicrobial peptides using bioinformatics technology, and establish the theoretical system; create high-efficiency, safe, targeted, and anti-enzymatically anti-enzymatic feed antimicrobial peptides, and realize their recombinant and quantitative preparation through genetic engineering expression; reveal the metabolic pathways and molecular mechanisms of feed antimicrobial peptides in the intestines, and provide a theoretical and technical support for feed antimicrobial peptides to replace feed antibiotics in animal production.

6. Research on the molecular types and tolerance mechanism as well as traceability of harmful microorganisms in the processing environment of infant formula milk powder

In response to the major needs for the prevention and control of harmful microorganisms in infant formula milk powder, proposals should focus on issues including pathogenic bacteria such as Cronobacterium and heat-resistant bacillus that are easy to be polluted, cause great harm, and are difficult to be prevented and controlled in the processing environment of infant formula milk powder in Heilongjiang. A basic database of major harmful microorganisms should be established to analyze the molecular types and distribution characteristics of strains, reveal environmental tolerance mechanisms and discover the source of pollution, and provide a theoretical foundation and technical support for effective prevention and control.

7. The growth adaptability of important materials and characteristic economic tree species and the multi-objective management and control mechanism

In view of the growth adaptability of Heilongjiang red pine, Larix gmelinii, Fraxinus mandshurica, uglansmandshurica and other tree species and the unclear multi-objective management and control mechanism, proposals should carry out quantitative study of site conditions, climate change, and the dynamic effects of management measures on growth and carbon storage. Proposals should reveal the regulation mechanism of forest growth and multi-objective management under climate change, establish an optimized management model that takes into account timber, carbon storage, and fruit, and provide scientific support for the precise improvement of forest quality in the northeast forest area.

8. Research on the in vitro reproduction of northeastern characteristic forest medicine plants and the efficient synthesis and transformation mechanism of active substances

Proposals should take forest medicine plants with Heilongjiang characteristic as the research object, meet the need of high-efficiency production technology of the high-value-added active substances, research on the synthesis and accumulation of active substances and regulation mechanisms during the in vitro reproduction of characteristic forest medicine plants, analyze the functions and specific catalysis of key enzymes, and provide a theoretical and technical support for the high-efficiency large-scale production of rare active substances of special forest medicines.

9. Research on bioinformatics methods for excellent gene mining of agricultural and forestry species in cold regions

Proposals should take the important agricultural and forestry species in Heilongjiang as the

research object, integrate multiple omics data such as genome, episet, transcriptome, proteome, metabolome, and phenotype, and systematically analyze genotype and phenotype through methods such as bioinformatics and artificial intelligence. The key genes for growth and development, yield, quality, and stress resistance of cold-land farming and forestry species should be analyzed. A genetic network for each species to regulate target traits should be established to provide methods and scientific basis for genetic improvement of farming and forestry species.

10. Study on coupling mechanism and restoration of black soil and agricultural waste in Sanjiang Plain

Proposals should take the black soil of the Sanjiang Plain as the research object, solve the problem that unclear impact mechanism of agricultural waste returning to the field on black soil, study the coupling mechanism of agricultural waste returning to the field and black soil restoration in different time and space scales, reveal the evolution of key physical, chemical and biological characteristics of black soil after agricultural waste is returned to the field under the effects of freezing and thawing, and provide a theoretical basis and technical support for agricultural waste utilization and cold black soil restoration.

11. Analysis of the pathogenic law of main potato diseases and gene mining of important disease resistance

Proposals should take the late blight, scab, Rhizoctonia of Heilongjiang potato as the research objects, study the molecular mechanism of pathogen-host interaction, and identify several key pathogenic factors and their functional characteristics. New technology will be applied to quickly explore and identify important disease resistance genes, comprehensively evaluate the characteristics of disease resistance and differentiation of main plant varieties, and provide genetic resources and theoretical basis for genetic improvement of potato disease resistance and disease prevention and control.

12. Research on pathogen ecology and disease resistance gene mining as well as new prevention and control technology of major livestock and poultry diseases

In response to avian influenza, African swine fever and other important animal diseases and zoonotic diseases that seriously endanger the development of the breeding industry and public health safety, proposals should carry out researches on epidemic law, prediction and early warning, pathogenicity and transmission mechanisms, explore the antiviral drug resources, elaborate on its mechanism of action, and create new and efficient vaccines and other epidemic prevention technologies and products.

Applicants are encouraged to conduct cooperative research with colleges, universities or research institutions with substantial research strength and research conditions in Heilongjiang Province.

v. In view of the development of modern agriculture in Zhejiang province and changes in the society's demand for high-quality agricultural products, proposals should carry out relevant basic research on key scientific issues such as excellent animal traits and their regulation, occurrence and prevention and control of important crop diseases and insect pests, high yield and quality formation of protected horticultural crops, formation mechanism of rice quality and information acquisition in crop phenotype groups.

Key projects:

1. Research on the molecular mechanism and nutrition regulation of the formation of advantageous traits of Zhejiang local pig resources

Proposals should take the Jinhua pigs and other local pig breeds with Zhejiang characteristics as the research object, analyze the dominant trait genes, signal pathways, regulatory network and intestinal microbial characteristics such as good meat quality and high reproductive rate, reveal the genetic and epigenetic mechanisms of the formation of their dominant traits, and

establish the molecular nutrition regulation strategies, and provide a theoretical basis and technical support for the scientific conservation and innovative utilization of local pigs.

2. Research on the molecular mechanism of microbial synergy in the process of crop pests and diseases and biological control

In view of the needs of green agriculture development in the Zhejiang region, proposals should focus on the multi-interaction relationship of major crops-pests-natural enemies-microorganisms, clarify the molecular basis of microorganisms' cooperative pests and diseases and the molecular mechanism of biological control, explore new targets for green prevention and control, and build a new system for green prevention and control.

3. Collaborative regulation mechanism for stress resistance, high yield and quality improvement of facility fruits and vegetables

Proposals should take the Zhejiang tomato and Hangzhou pepper the research objects, explore the key physiological processes and restraint factors that affect yield and quality under facility conditions, study the key genes and their regulatory networks for synergistic yield and quality should be studied, investigate the synergistic improvement of yield and quality, explore the physiological and environmental regulation methods for synergistic improvement of yield and quality, thus laying a theoretical foundation for the creation of high-yield and high-quality germplasm, molecular breeding and production technology innovation.

4. Research on the molecular mechanism of the formation of rice quality traits and its environmental impact

Proposals should take the rice quality traits in Zhejiang area as the research object, proposals should study the genetic basis that determines the formation of rice quality and the environmental impacts such as high temperature and heavy metal pollution on rice; discover the key genes with breeding value, analyze their genetic mechanism and gene regulation network; establish technical ways to aggregate good genes to improve rice quality, and create high-quality, safe, and nutritious new rice germplasm.

5. Research on crop phenotype acquisition and intelligent crop disease resistance breeding

Proposals should focus on the high-throughput phenotype acquisition and analysis technology of crops as the research object, and study the main rice diseases in Zhejiang provinces. From cell-organ-plant-population multi-scale phenotypic changes, proposals should efficiently explore excellent disease resistance genes of wild rice, analyze the functions of new disease resistance genes, and realize disease resistance breeding.

Applicants are encouraged to conduct cooperative research with colleges, universities, research institutions or enterprises with substantial research strength and research conditions in Zhejiang Province.

vi. The basic and applied basic research in the fields of green tea aroma in Anhui province, corn-AM fungal symbiosis, rice breeding improvement, dairy pathogens and rice nematode disease prevention and control.

Key projects:

1. The material basis of the characteristic aroma of Anhui green tea and its transformation mechanism

Taking the Anhui's unique green tea (Huangshan Maofeng, Taiping Kowkui, and Lu'an Guapian) as the research object, proposals should use the molecular sensory methods to study the composition, chemical structure and aroma attributes of its unique aroma substances, discover the laws of synthesis, metabolism and transformation of aroma components in unique varieties and its processing, and reveal regulation mechanisms, and provide a theoretical basis for high-quality green tea processing and product development.

2. The molecular mechanism of corn-AM fungus symbiosis to improve nutrient absorption and utilization

In view of the biological characteristics of maize-AM fungal symbiosis to improve nutrient absorption and utilization in the low-yield fields and fields returned from straw of Jianghuai region, proposals should focus on discovering the key genes of maize nitrogen and phosphorus absorption mediated by AM fungal symbiosis, analyzing their biological functions, reveal related molecular regulation mechanism, develop the excellent genetic molecular markers, and provide the theoretical basis and technical support for efficient maize nutrient absorption and utilization of molecular breeding and green production.

3. Research on genetic basis and design breeding of complex traits of rice in Jianghuai area

Proposal should focus on the core scientific issue of using design breeding theory and technology for precise improvement of the complex traits of food crops in the Jianghuai region. Proposals should analyze the genetic and epigenetic mechanisms of rice yield, quality, stress resistance, etc., explore its application in breeding, and solve the problems of genetic interaction and interaction between genes and environment in the process of designing and breeding complex traits, and provide scientific support for the large-scale mining and design breeding of excellent genes for crop germplasm resources in the Jianghuai region.

4. Study on molecular regulation mechanism of biofilm formation and adversity response of milk-derived high-risk pathogenic bacteria

In view of the key technical problem that it's difficult control the high-risk pathogenic bacteria in dairy products, proposals should focus on the core scientific issues of bacterial biofilm formation and adversity response, build static and dynamic biofilm models and simulating adversity conditions in dairy production, use omics technology and analysis strategies to deeply explore the key to pathogenic bacteria biofilm formation and adversity response factors, analyze the function of key genes, clarify the molecular regulation mechanism of pathogenic bacteria's biofilm formation and adversity response, and provide a theoretical support for Anhui's creation of key technologies for efficient control of pathogenic bacteria in dairy products.

5. Study on the mechanism of fungi controlling rice stem nematode disease

In view of the problem of unclear mechanism of biocontrol fungi on the rice stem nematode, proposals should focus on the research and identification of the main active substances in the metabolites of Aphelenchoides besseyi, clarify the effect of the active substances on the growth and development of nematodes and rice defense pathways, analyze its targets and mechanisms in organisms from the molecular and histological level, and provide the scientific basis for the development of new biological pesticides for preventing and controlling rice nematode diseases in Anhui province.

Applicants are encouraged to conduct cooperative research with higher education institutions or research institutions with substantial research strength and research conditions in Anhui Province.

vii. Based on the characteristic agricultural resources in Fujian province, the research should carry out basic and applied basic researches on the excavation of excellent germplasm resources and functional genes of important animals and plants in Fujian and Taiwan region, the biological basis and molecular regulation mechanism of post-harvest quality of agricultural products, the environmental adaptability mechanism of important crops, the catastrophic mechanism of major diseases and insect pests and ecological control, as well as the pathogenic mechanism and immune regulation mechanism of the main pathogens of important farmed animals in Fujian and Taiwan regions.

Key projects:

1. The basis of molecular biology for the formation of excellent traits of important crops in Fujian and Taiwan regions

Proposals should take the important crops including rice, vegetables and subtropical fruits in Fujian and Taiwan regions as research objects. Proposals should study the molecular biological basis of yield, quality, and environmental adaptability, reveal the key genes, signal pathways and genetic regulation mechanisms of trait formation, design efficient molecular improvement breeding strategies, create excellent strains with high yield, high quality, wide adaptability or strong regenerative ability, and provide scientific basis for effective genetic improvement.

2. The pathogenesis and host resistance mechanism of major agricultural animal diseases in Fujian and Taiwan regions

Proposal should focus on research objects of important agricultural animals in Fujian and Taiwan regions such as Muscovy ducks, white feather broilers, pigs, eels, and large yellow croakers. Proposals should study the genetic evolution, epidemic transmission and pathogenic mechanisms of important animal pathogens, explore the molecular basis of the interaction between pathogens and hosts, and reveal the host immune system and disease resistance mechanisms of key host factors, and provide a theoretical support for vaccine research and development, disease prevention and control, and bio-safety.

3. The catastrophic mechanism and ecological control mechanism of major plant diseases and insect pests in Fujian and Taiwan regions

Proposals should focus on the major pests and diseases of rice, vegetables and subtropical fruits in Fujian and Taiwan regions, clarify the regional occurrence characteristics of pests and diseases, study the biological mechanism of pest transmission and disasters, explore the host, media, endogenous microorganisms and multiple pests interaction, explore green pesticides against harmful organisms or study ecological prevention and control strategies, and provide scientific basis for the green and safe production of important crops on both sides of the Taiwan Strait.

4. The biological basis and molecular regulation mechanism of postharvest quality of subtropical fruits in Fujian and Taiwan regions

Proposal should focus on the subtropical fruits longan, lychee, and olives in Fujian and Taiwan regions, analyze the biological basis and molecular regulation mechanism of post-harvest quality changes from multiple perspectives such as gene transcription, protein translation, and epigenetic modification, provide new ideas and scientific basis for the research and development of the preservation, storage and transportation technology of postharvest quality of subtropical fruit.

5. Genetic analysis of economic traits of Fujian-Taiwan regional characteristic aquatic products and molecular basis for improvement

Proposals should focus on the characteristic aquatic products such as eel and large yellow croaker in Fujian and Taiwan regions, carry out genetics and multi-omics research on economic-related traits such as quality, growth, disease resistance, gender, feed nutrition requirements and utilization efficiency, clarify the molecular basis and regulation mechanism of trait formation and difference, explore the important functional genes and regulatory elements and breeding molecular markers, and provide a theoretical basis for efficient molecular breeding.

Applicants are encouraged to carry out cooperative research with higher education institutions or research institutions with substantial research strength and research conditions in Fujian Province. Researchers from Taiwan region are encouraged to participate in projects to promote scientific and technological cooperation and exchanges across the Straits.

viii. proposals should take Henan's main crops as the research object, analyze the genetic mechanism of important traits such as corn drought resistance and heterosis, soybean nitrogen fixation and cotton disease resistance, and research on the molecular mechanism of

carbon nanosol materials in regulating crop growth and development; focus on the healthy breeding of livestock and poultry, and study the pathogenicity and immune mechanism of livestock and poultry; carry out animal evolution research in the transition zone of the middle and lower reaches of the Yellow River; conduct relevant basic research on key scientific issues such as the efficient separation of peanut oil and protein.

Key projects:

1. Research on the mechanism of carbon nanosol materials regulating crop growth and development

In view of the unclear mechanism of carbon nanosol materials on crop growth, proposals should will be applied to clarify the regulation of the carbon nanosol materials on crop growth and development mechanism using the gene editing, omics and in-situ observation techniques, and provide a theoretical basis and technical support for the agricultural application of Henan's dominant crops such as wheat and peanuts.

2. The regulation mechanism of efficient utilization of water in corn in Huanghuaihai area

In view of the serious shortage of water resources in China, proposal should take maize as the research object, analyze the regulation mechanisms of stomatal development, transpiration rate and water efficient utilization, and provide important genetic resources and theoretical basis for molecular breeding for drought tolerance of maize in Huanghuaihai area.

3. Cloning and molecular mechanism analysis of key genes of maize heterosis

Proposal should focus on the key scientific problem of the formation of heterosis, explore key genes that regulate corn heterosis, clarify the metabolic regulation network of heterosis formation, analyze the molecular mechanism of heterosis formation, establish a technical system for high-efficiency prediction of excellent hybrid combinations, and provide a theoretical basis for the strong hybrid selection and breeding.

4. Excellent gene mining and molecular mechanism of soybean high-efficiency symbiotic nitrogen fixation under abiotic stress

Proposal should focus on the soybean germplasm resources in Huanghuaihai area as the research object, study the genetic and molecular mechanisms of non-biological adversity regulating soybean symbiotic nitrogen fixation in line with the characteristics of regional agricultural ecology and green sustainable development, reveal the molecular mechanisms of key genes, discover excellent allelic variations of key genes, and provide theoretical basis and genetic resources for improving the efficiency of symbiotic nitrogen fixation and stress resistance of soybeans.

5. Epidemiology and genetic variation as well as vaccine research of important immunosuppressive diseases and tumor diseases in poultry

Proposals should focus on the important immunosuppressive diseases and tumor diseases that seriously harm the poultry industry in Henan Province as the research object. In view of problems including the increased pathogenicity of pathogens and poor immune effects of vaccines, proposal should carry out study of the epidemiological characteristics, genetic evolution rules and new vaccines of related pathogens, and provide the theoretical basis and technical support for poultry disease prevention and control.

6. The mechanism and regulation of efficient and simultaneous separation of peanut oil and protein

Proposal should focus on peanut which is the dominant oil crop in Henan Province as the research object. In view of the common key problems in the current oil and protein process, such as solvent residue, protein nutrition and function, and unclear structure-activity relationship, proposal should carry out biological enzymatic method to prepare the molecular mechanism and regulation mechanism of peanut oil and protein, and provide a theoretical basis for peanut processing and

efficient use of resources.

7. Research on the interaction mechanism between wheat and main pathogenic fungi in Huanghuai wheat area

Proposals should focus on the wheat and main pathogenic fungi in Huanghuai wheat area as the research object. Researches on interaction between wheat and pathogenic fungi should be carried out to clarify the pathogenic mechanism of pathogenic bacteria and the disease resistance mechanism of wheat, and provide the basis for wheat germplasm innovation and disease resistance breeding.

8. The adaptation and evolution mechanism of terrestrial animals in the transition area of the middle and lower reaches of the Yellow River

Proposals should focus on the terrestrial animals in the transitional area of the middle and lower reaches of the Yellow River as the research object. Researches on the coupling effect of regional climate, land use change and habitat fragmentation on biodiversity as well as the response strategies of terrestrial animals to environmental changes in the middle and lower reaches of the Yellow River should be conducted, thus providing the theoretical basis for ecological protection and high-quality development.

9. Molecular mechanism of resistance to verticillium wilt of natural edible (forage) cotton seeds

To solve the problem that it is difficult to balance the edible (feeding) use of seeds and disease resistance in the cotton industry, researches on the molecular mechanism of resistance to verticillium wilt in natural seed edible (feeding) cotton should be carried out to provide the theoretical basis and technical support for a new type of disease-resistant green edible (feeding) cotton.

Applicants are encouraged to conduct cooperative research with higher education institutions or research institutions with substantial research strength and research conditions in Henan Province.

ix. Based on the development needs of life sciences and agricultural industry in Hubei province, proposals should carry out basic and applied basic research on key technological issues including freshwater aquaculture, colored rice breeding, rhizosphere microorganisms affecting fruit and tea quality, rice heat-resistant genes, animal tuberculosis, specific nutritional effects of oil resources, crop disease prevention, variation of corn silage traits and plastic pollution degradation.

Key projects:

1. The molecular basis of Hubei representative freshwater fish quality improvement and nutritional metabolism regulation

In view of the degradation of quality traits of aquatic products in the green development of aquaculture in Hubei province, researches should be carried out on the formation of quality traits of representative freshwater fish in Hubei, the production of abnormal quality traits and their metabolic regulation mechanism, and the precise nutritional regulation of quality improvement to provide scientific theories and technologies for improving the quality of aquatic products.

2. Basic research on genetics and metabolomics of health-related nutrient elements in colored rice

Proposals should focus on the nutritional quality of colored rice as the research object, evaluate the nutritional value of colored rice, analyze the genetic basis and regulatory molecular network of its important nutritional value control, and provide theoretical support for colored rice breeding and industrial development.

3. Research on the effect of rhizosphere microorganisms on the quality of fruit and tea and its mechanism

Proposals should focus on the citrus and tea as the main research objects, combine the modern omics technology with traditional physiological and biochemical technology, study the differences in the rhizosphere microbial composition of orchards or tea gardens with obvious differences in quality under different climate and soil conditions in the main producing areas, and discover the core flora that affects quality; study the mechanism of these microorganisms on the improvement of fruit and tea quality, identify the environmental factors of high-efficiency microorganisms that are conducive to the improvement of quality; provide a basis for the development of microbial fertilizer products and the formulation of supporting cultivation measures.

4. Heat-resistant gene mining and molecular basis analysis as well as breeding utilization research of rice

In view of the pressing problem of decreased rice yield and quality caused by frequent high temperature heat damage in rice production in Hubei province, the identification and evaluation of heat tolerance of rice germplasm resources and gene mining and utilization should be carried out to analyze the molecular basis of rice heat tolerance and create heat-resistant rice germplasm, and provide support for the sustainable and healthy development of rice production in Hubei province.

5. Research on the pathogenic variation of animal tuberculosis in Hubei province and its interaction with the host

Proposals should focus on the animal tuberculosis as the research object, carry out research on its transmission rules between animals or animals and humans to find out the mutation rules of key genes of tuberculosis pathogens; systematically study the interaction of virulence genes, secreted protein genes and host cell biological effector molecules and performance regulation networks, analyze important pathogen-host interaction nodes and pathogen escape host immune mechanism, and clarify the evolution of the pathogenicity and immune escape ability of tuberculosis pathogens and their potential cross-species transmission mechanism; provide a theoretical basis for the molecular epidemic of animal tuberculosis, pathogenic mechanisms and new drug gene targets.

6. Nutritional health effects and regulation mechanism of specific components of high-quality rapeseed

Proposal should focus on polyphenols, glucosinolates, sterols and other specific active components contained in high-quality rapeseed the object, study the structure-activity, dose-effect and composition-effect relationship and regulation mechanism, analyze the composition transformation law and nutrient content maintenance during rapeseed processing, and provide a scientific basis for the high-quality and high-efficiency industrialization of nutritive rapeseed in Hubei and China.

7. The molecular mechanism of the improvement of corn silage traits

Based on the key scientific issues such as the genetics and molecular mechanisms of corn silage-related traits, proposals should use biological big data and artificial intelligence algorithms to develop high-throughput functional genomics research strategies, carry out relevant basic applied researches, and explore suitable genetic resources for improving the yield and quality of silage maize in Hubei province.

8. The molecular basis of rice resistance to brown planthopper

Proposals should focus on the issue of the virulence variation of the brown planthopper, efficiently discover and clone the new rice brown planthopper resistance gene, create excellent allelic variation of the brown planthopper resistance gene, screen and verify the corresponding brown planthopper effectors, reveal the molecular mechanism of rice resistance to brown planthopper, analyze the co-evolution of rice and brown planthopper, establish the basic theory and technical system of molecular design breeding for brown planthopper resistance, and provide new

strategies, new technologies and genetic resources with independent intellectual property rights for brown planthopper resistance rice breeding.

9. Research on the structure analysis and modification of PET plastic degrading enzyme

Proposal should use X-ray crystallography and single-particle cryo-electron microscopy technology comprehensively to analyze the structure of a variety of PET plastic degrading enzymes (PETase) and substrate analog complexes, clarify its catalytic reaction mechanism; carry out the rational design and transformation of PETase, construct a mutant enzyme with high vitality, heat stability, and strong pH tolerance; establish a high-efficiency expression process of PETase, in order to achieve efficient biodegradation and product recycling of PET plastic in the future.

10. Accurate extraction and intelligent identification of deep traits of crops

In view of important issues of obtaining important biological characteristics of the deep layer, dense occlusion and underground root system of crops, proposals should, based on X-ray, CT, multispectral and other imaging methods, carry out research on related technologies and methods for automatic and accurate collection, identification and feature value acquisition of crop phenotypes, achieve real-time non-destructive intelligent identification and accurate extraction of phenotypes of tissues and organs such as leaves, stems, ears and roots;, and based on specific traits Extraction, establish the correlation analysis system of crop phenotype and genotype, provide important theoretical scientific basis for precision design and breeding of future crops.

Applicants are encouraged to conduct cooperative research with higher education institutions or research institutions with substantial research strength and research conditions in Hubei Province.

x. Focusing on the major scientific and key technical issues in the sustainable development of Hunan's agricultural industry, basic researches should be carried out on the genetic basis of important traits of Hunan's superior grain crops, superior cash crops, and characteristic livestock and aquatic products, germplasm innovation, and utilization of heterosis will be performed.

Key projects:

1. Rice heterosis mechanism and application

Proposals should focus on the molecular mechanism of the formation of rice heterosis, explore the important genes that control heterosis, and research and create new materials, new technologies and new ways for the utilization of heterosis.

2. Ideal plant type control and high-yield mechanism of super hybrid rice

To solve the key scientific problem of the high-yield mechanism of super hybrid rice, proposals should carry out researches on the genetic basis of yield traits of super hybrid rice with different yield potentials, clarify the nutritional and photosynthetic molecular mechanism of super-high yield, and establish morphological and physiological index systems required for super-high yield in different ecological regions.

3. The biological basis of hybrid rice resistance breeding

To overcome the hazards of biotic and abiotic stresses in rice production, proposals should focus on the response mechanism of hybrid rice to biotic and abiotic stress, as well as the molecular basis research on the synergistic balance of yield, quality and resistance traits to improve the stress resistance traits of hybrid rice varieties.

4. Research on gene mining of important traits of characteristic cash crops and its mechanism of action in Hunan province

In view of the major needs for the agricultural industry development in Hunan and the construction of the Yuelu Mountain Seed Industry Center, proposals should focus on core fundamental issues restricting the efficiency of creating new varieties of Hunan's characteristic

vegetables, tea trees, camellia, Xianglotus, bast fiber, fruits, Chinese medicinal materials, and underforest dominant superior cash crops; collect, identify, and explore specific germplasm resources of Hunan's superior cash crops; study the genetic basis and molecular mechanism of the formation of key traits of germplasm resources, discover a number of functional genes with important application value, and clarify their biological functions and mechanisms of action.

5. Molecular mechanism of crop gender differentiation and its utilization in heterosis

Crop gender differentiation is closely related to floral organ development, yield formation, and utilization of heterosis. Proposals should focus on the important crops with gender differentiation, study the molecular biological basis of crop gender differentiation, discover key genes that regulate gender differentiation, analyze its genetic regulatory network, reveal the mechanism of floral development and fertility, and explore the new use of crop heterosis.

6. The genetic regulation mechanism and its utilization of important traits of characteristic livestock, aquatic animals and bee silkworms

In view of the needs for quality improvement of livestock, aquatic animals, and bee silkworm germplasm in Hunan province, proposals should screen and analyze the major genes related to their growth, reproduction, product quality, disease resistance and stress resistance; systematically study the genetic basis of their excellent traits, and clarify the regulation mechanism of their reproduction and growth; establish core technology system of whole genome selection, and provide theoretical basis for the creation and improvement of local characteristic livestock and poultry, aquatic animals and bee silkworm breeding technology.

7. The molecular mechanism of the nutritional metabolism and immune regulation of characteristic livestock, aquatic animals and bee silkworms

In view of the key scientific issues in the healthy breeding of characteristic livestock, aquatic animals and bee silkworms in Hunan province, proposals should study the utilization of local forage plant resources, reveal the mechanism of interaction between the host and the gastrointestinal microbes; study the key markers of nutrition metabolism and their harmful effects, as well as the safety evaluation, quality inspection and improvement of aquaculture products; analyze the interaction between the host and pathogenic microorganisms, and clarify the host's immune principle against pathogens; systematically explain the mechanism of metabolism-immune-endocrine network in regulating the body health of livestock, aquatic animals, bees and silkworm.

Applicants are encouraged to conduct cooperative research with higher education institutions or research institutions with substantial research strength and research conditions in Hunan Province.

xi. Proposals should focus on key scientific issues in the prevention and control of zoonotic diseases and plant cultivation in South China.

Key projects:

1. Basic research on the prevention and control of zoonotic diseases of animal origin in South China

Considering the difficulties faced in the prevention and control of zoonotic diseases in South China, proposals should carry out researches on the biological characteristics, pathogenic mechanisms and transmission characteristics of important zoonotic pathogens carried by farmed and wild animals in South China; clarify the source of the pathogen, storage host and transmission characteristics, as well as the molecular mechanism and evolutionary mechanism of high transmission, high virulence, and cross-species infection of the pathogen; and on this basis, develop pathogen diagnosis/traceability tools and new targets for drugs and vaccines; provide a theoretical basis for the prevention and control of zoonotic diseases of animal origin in South China.

2. Research on molecular mechanism of characteristic fruit diseases in Lingnan area

In view of important diseases such as lychee, banana, citrus, and other characteristic fruits in Lingnan, proposals should identify key disease-causing genes, combine whole-genome association analysis and multi-omics analysis, and analyze the molecular basis of disease and its molecular regulatory network.

3. The epigenetic mechanism of dynamic changes in the high-level structure of chromatin regulates the fate determination of pluripotent stem cells

Proposals should focus on in vitro establishment of different animal pluripotent stem cell induction systems combined with early embryo development, systematically analyze the epigenetic mechanism of animal somatic cell reprogramming to different levels of pluripotent stem cells using epigenetics, three-dimensional genomics, cell biology, combined with bioinformatics analysis and other multidisciplinary research methods, and reveal the mechanism by which the dynamic changes of chromatin high-level structure regulate cell fate transition.

4. Research on the mechanism of root microorganisms and soil nutrients to improve the quality of Chinese medicinal materials

Proposals should focus on the tangerine peel and other characteristic Chinese medicinal materials in South China as the research object, study the effects of root microbial composition and soil nutrient differences on the quality of Chinese medicinal materials using metagenomics, transcriptome, metabonomics and other multi-omics technologies, find the best combination of key microbial composition and soil nutrition that affect the quality of Chinese medicinal materials, establish interaction mode of Chinese medicinal materials-soil nutrient-microbe, and provide a scientific basis for formula fertilization and quality improvement of Chinese medicinal materials.

5. Research on the molecular mechanism of the formation of all-female traits of characteristic melons and vegetables in South China

Proposals should focus on the characteristic melon vegetables in South China as the research object, analyze the molecular mechanism of the formation of all-female traits, establish a gender-regulating molecular model and a full-female trait molecular design breeding system, and provide a theoretical basis for breeding high-yield characteristic melon vegetable varieties suitable for cultivation in South China and improving the purity of hybrid seeds

6. Research on the quality formation mechanism and nutrition regulation of yellow feather broiler

In view of the problem of unclear formation mechanism of yellow feather broiler and further improvement path, proposals should study the formation mechanism of important traits and flavor of meat quality; study the influence of dietary nutrition on the key gene network of meat quality and flavor characteristics; as well as the nutritional metabolism regulation mechanism of meat quality and flavor; explore the main genes, signal pathways and regulatory networks of meat quality and flavor traits in response to nutritional regulation and establish a scientific basis for improving chicken quality.

Applicants are encouraged to conduct cooperative research with higher education institutions or research institutions with substantial research strength and research conditions in Guangdong Province.

xii. The relevant basic and applied basic researches on key scientific issues in characteristic agriculture, forestry, animal husbandry and fishery, healthy and sustainable development of the livestock and poultry industry, and innovative utilization of characteristic biological medicinal resources in Guangxi province.

Key projects:

1. The molecular basis and regulation mechanism of quality changes during the processing of characteristic aquatic products in the Beibu Gulf of Guangxi province

Proposals should focus on tilapia, golden pomfret and oysters and other characteristic

aquatic products of the Beibu Gulf in Guangxi as the research object, carry out research on the molecular basis and regulation mechanism of quality changes during processing, build a characterization and evaluation model for processing quality of Beibu Gulf characteristic aquatic products, explore functional genes and key regulatory enzymes for quality changes during processing, reveal the regulatory pathways and mechanism for quality changes during processing, and provide a theoretical basis for the deep processing of special aquatic products in the Beibu Gulf.

2. Fundamental research on the discovery of excellent trait genes of Guangxi characteristic vegetable germplasm resources and molecular breeding

Proposals should focus on the characteristic vegetables of Guangxi province such as Chiehqua and Snake Gourd as the research objects, carry out researches on the location, cloning, functional verification and molecular marker development of genes related to excellent agronomic traits; based on the mining of genes related to excellent traits, study the molecular breeding, create a batch of germplasm material with important application value, and provide new germplasm and theoretical basis for genetic improvement of Guangxi characteristic vegetables.

3. Research on the molecular mechanisms of stress resistance of germplasm resources of characteristic fruit tree in Guangxi

Proposals should focus on the characteristic fruit trees in Guangxi province as the research object, carry out researches on the cloning and functional identification of important stress resistance genes, explore important stress resistance genes, create high-quality fruit tree breeding materials with high resistance, clarify the molecular mechanism of its adversity response, analyze its gene regulatory network, and provide a theoretical basis for resistance breeding.

4. Collection and evaluation as well as mechanism research of citrus germplasm materials resistant to Huanglong disease

Proposals should collect, identify and evaluate germplasm resources of wild citrus and field resistant citrus., establish a systematic disease resistance evaluation system; study the proliferation and distribution of pathogens in disease-resistant materials; screen candidate genes for disease resistance, study disease resistance mechanisms and lay a theoretical and practical foundation for disease resistance breeding.

5. Research on the efficient transformation of agricultural non-food biomass by microorganisms and its regulation mechanisms

Proposals should focus on the fungi that transform bagasse and tapioca starch and other characteristic agricultural non-grain biomass in Guangxi as the research object, screen and identify the fungi with high efficiency transformation, carry out the study on the mechanism of fungal cellulase, xylanase and raw amylase gene expression regulation, and reveal the molecular mechanism of fungi regulating its biomass conversion efficiency.

6. Research on the key theory and technology of early screening and rapid detection of zoonotic diseases based on smart terminals

Proposals should focus on problems of lack of effective early screening and diagnosis methods for high-incidence zoonotic diseases such as Streptococcus suis (type 2) and avian influenza in Guangxi, carry out research on new color tone recognition materials, and explore the principles and key technologies of a visualized quantitative immunochromatographic platform based on smart terminals, develop a precise and high-sensitivity rapid detection platform for zoonotic diseases, and meet the needs of de-instrumented on-site screening and home self-inspection.

7. Study on genetic analysis and regulation mechanism of important economic traits of local pig breeds

In view of the germplasm characteristics of Guangxi native pig breeds, proposals should

analyze the genetic mechanism of its quality traits, discover and identify key genes and pathways involved in the formation of traits, design and screen regulators of key genes and pathways, and provide a theoretical support for trait regulation.

8. Research on the distribution pattern and renewal as well as maintenance mechanism of soil carbon pool in karst areas

In view of the wide distribution of karst area and strong heterogeneity of karst habitats, proposals should study the distribution pattern, renewal and maintenance mechanism of soil carbon pool in karst area ecosystems, clarify the source of soil organic carbon and its accumulation and stability rules, reveal the dynamic changes of karst soil carbon pool and its effect on karst carbon sinks under the conditions of vegetation and ecological restoration influences, and provide a theoretical basis for the protection of ecosystems in karst areas in Guangxi.

9. Genetic and molecular research on key agronomic and economic traits of Camellia oleifera

Proposals should focus on the characteristic Camellia oleifera of the Guangxi province as the research object, study the diversity of germplasm resources and their genetic structure, analyze the formation mechanism of important economic traits, solve the problems of trait difference and yield instability caused by complex genetic background and disorder of germplasm relationship, carry out association analysis of candidate genes for important economic traits such as high oil yield, solve the scientific problems related to early screening of excellent lines of Camellia oleifera, carry out research on the adaptability of excellent strains of different ecological types and molecular breeding, and provide a scientific basis for the selection and breeding of Guangxi characteristic Camellia oleifera varieties.

10. Research on the influencing factors and molecular mechanism of quality formation of characteristic traditional Chinese medicine resource in Guangxi

Proposals should focus on characteristic medicinal materials as research object, carry out mechanism research on its reproduction, genetic diversity, active ingredient detection and pharmacodynamic evaluation, as well as the development of medicinal parts and the analysis of active ingredient biosynthesis pathways, evaluate the effects of varieties, habitats, harvesting time, and processing methods on active ingredients, explore the regularity of the composition of medicinal materials and the performance of medicinal effects, solve related scientific issues such as the factors affecting the quality formation of the characteristic medicinal plants in Guangxi and the molecular mechanism, and provides a theoretical basis for the standardized cultivation of characteristic medicinal materials and medicinal plants in Guangxi, the formulation of quality standards, the protection and innovation of germplasm resources, the development of medicinal materials and the biosynthesis and regulation of active ingredients.

Applicants are encouraged to conduct cooperative research with colleges and universities or research institutions with substantial research strength and research conditions in the Guangxi Zhuang Autonomous Region.

xiii. Based on the characteristic agricultural and animal and plant resources of the Chongqing municipality, proposals should carry out basic and applied basic research on the prevention and control of diseases of characteristic crops such as fruit trees and vegetables, as well as key scientific issues such as the genetic improvement and quality improvement of animals such as silkworms and pigs.

Key projects:

1. Research on the molecular mechanism of ecological adaptation of fruit and vegetable fruit flies

Proposals should study the behavioral and molecular mechanisms of ecological adaptation (interaction with environment, host, and microorganisms) of fruit fly pests such as Bactrocera

dorsalis, which seriously harms citrus and vegetables in Chongqing, clarify the behavior of fruit fly outbreaks and molecular physiological mechanisms, discover new targets for sustainable control of fruit fly pests, and provide a theoretical basis for establishing its behavior regulation technology.

2. Excellent gene mining based on the silkworm genetic resource database

In response to the urgent needs of modern sericulture for high-quality, high-efficiency, disease-resistant, adversity-resistant, suitable artificial feed breeding and diversification of new breeds, proposals should focus on the silkworm genetic resource bank as the research object, carry out in-depth sequencing and genome variation analysis of diverse strains, establish a high-resolution genetic variation map, explore and identify high-yield, high-quality, disease resistance, stress resistance, and food tolerance related excellent genes, and provide genetic foundation support for silkworm molecular improvement and genome-assisted selection breeding.

3. Research on the mechanism of intestinal microbes regulating the appetite of pigs

Proposals should carry out the gut microbe-host interaction animal model of sterile pigs, gnotobiotic pigs, colony transplanted pigs, etc., to analyze the influence of colonization and changes of gut microbes on the regulation of pig appetite, screen and identify the main functional bacteria that affect pigs' appetite and functional metabolites, clarify the mechanism of action, and provide new theories and new methods for microbial regulation of the healthy growth and efficient production of pigs.

Applicants are encouraged to conduct cooperative research with higher education institutions or research institutions with substantial research strength and research conditions in Chongqing municipality.

xiv. Based on the characteristic agricultural resources in Sichuan province, study should be carried out on the transformation and upgrading of traditional agriculture, the cultivation of green and high-quality agriculture, and the development of ecological agriculture.

Key projects:

1. The regulation of nutrient substances on the spermatogenesis and immune function of boars

In view of the special environmental and climatic conditions in Sichuan, proposals should carry out research on the problem of fertility and immunity decline in breeding boars, study the effects of nutrients on the sperm production and immune function of breeding boars, and analyze its regulatory mechanism.

2. The genetic basis and regulation mechanism of corn in Sichuan province in response to seasonal drought stress

Proposals should focus on the Sichuan maize as the research object, carry out research on the discovery, creation and molecular regulation mechanism of maize-specific genetic resources under drought adversity, clarify the genetic basis and regulation mechanism of stress-resistant traits, and provide a theoretical basis for molecular design and breeding of high-yield and stress-resistant maize in southwestern China.

3. The genome traceability of important pathogenic bacteria in the Sichuan pig and chicken industry chain and the transmission mechanism of new drug resistance genes

Proposals should focus on problems such as the over-large scale of pig and chicken breeding, the unclear spread of important pathogenic bacteria in the industrial chain, serious drug resistance of pathogenic bacteria and drug product residues caused by over reliance on antibacterial drugs against common bacterial diseases. Based on modern biological technologies such as genomes and metabolomes, proposals should carry out the tracing of the genomes of important pathogenic bacteria such as Streptococcus, Campylobacter, and Salmonella in pigs and chickens, discover new resistance genes and clarify the mechanism of transmission, and provide a scientific basis for

effective prevention and control of pathogens, reduction of antibacterial drugs, and protection of the safety of pig and chicken products.

4. Inheritance and regulation mechanism of important quality traits of major food crops

Considering the major needs of food production in Sichuan province, proposals should focus on the rice, wheat, and corn as the research objects, use comprehensive multi-disciplinary methods to analyze the main genetic regulation mechanisms that regulate quality traits such as protein and starch in genetic resources, analyze the common regulatory factors and regulatory network of the three major crop's quality traits, reveal the genetic mechanism of crop quality traits, and provide genetic material and theoretical basis for cultivating superior varieties.

5. Research on the reintroduction of captive giant pandas and the rejuvenation of isolated small populations in the wild

Proposals should focus on the isolated small populations of giant pandas with a high risk of extinction, study the feasibility of reintroduction of artificial captive giant pandas and their adaptability to the environment, population exchanges and spatial pattern formation; research on the evaluation criteria for the effectiveness of reintroduction, and the reasons and influencing factors, maintenance mechanism and extinction risk of isolated small populations in the wild. A sustainable population restoration and protection model should be built to provide theoretical guidance and technical support for the scientific rescue and protection of isolated small populations of wild animals around the world.

Applicants are encouraged to conduct cooperative research with higher education institutions or research institutions with substantial research strength and research conditions in Sichuan Province.

xv. Relevant basic research on important scientific issues and key technical issues concerning the genetic basis and germplasm innovation of important traits of advantageous forage grass, livestock, fruit trees, and cash crops in the Tibetan area.

Key projects:

1. Research on the cold and drought tolerance mechanism of dominant pasture under high-cold, high-altitude and low-oxygen environment

Proposals should collect wild and cultivated forage varieties (lines) suitable for the plateau environment, study the physiological and ecological mechanisms of forage resistance formation under low temperature, drought and their interactions, explain the molecular mechanisms and signal pathways for the formation of resistance to low temperature, drought and other adversity, and analyze the relationship between yield and stress tolerance under low temperature and drought stress.

2. High-efficiency utilization of germplasm resources of Tibetan pigs and ecological and healthy breeding technology

Proposals should focus on key technical issues in the industrialized production of Tibetan pigs, carry out research and development, optimization and integration of germplasm resource improvement systems; study the regulation mechanism of Tibetan pigs' stress resistance and meat quality traits, explore Tibetan pigs' characteristic and excellent genes, select excellent breeds, and build an ecologically healthy breeding system for Tibetan pigs.

3. Protection and exploration of genetic resources of peculiar fruit trees in plateau areas

Proposals should conduct genomic analysis of peculiar fruit tree resources with high economic value on the Qinghai-Tibet Plateau, build a DNA fingerprint database, reveal the plateau adaptability mechanism of characteristic fruit trees, analyze the origin of characteristic fruit trees in Tibet, clarify core germplasm resources, explore specific genes, and carry out research on the

domestication of characteristic fruit trees.

4. Gene mining of unique fungal resource diversity and functional components in high-cold and high-altitude areas

Proposals should establish Tibet's unique fungal resource library, study the diversity of fungal resources, identify the characteristic active components of strains, isolate new structural active molecules, evaluate the efficacy of target molecules, study targets and mechanisms of action, and discover innovative drug leaders.

5. Research on the formation of important economic traits of tea trees and green planting technology in high altitude environment

Proposals should analyze the effects of environmental factors such as soil and climate in high altitude areas on the growth of tea trees and the formation of tea quality, reveal the network regulation and molecular mechanisms of important economic traits such as high quality and stress resistance of Tibetan tea trees, select high-quality tea varieties suitable for planting in Tibet, and establish a green tea planting technology system in high altitude environment.

Applicants are encouraged to conduct cooperative research with higher education institutions or research institutions with substantial research strength and research conditions in the Tibet Autonomous Region.

xvi. Considering the development needs of typical agriculture and animal husbandry in Gansu province, relevant basic research should be conducted on key scientific issues such as the supplementary feeding effect of livestock in alpine pastures, the water and fertilizer use efficiency of crop rotation in dry farming areas, the quality evaluation of olive oil, the breeding of characteristic livestock and the occurrence of livestock insect-borne diseases.

Key projects:

1. Ecosystem effect and mechanism of supplementary feeding of yak in cold season in Gansu pastoral area

Proposal should focus on the study of the Gansu yak pasture. In view of key issues such as the degradation of grassland ecological production function and the difficulty of supplementary feeding caused by the imbalance between the supply and demand of forage and livestock in pastoral areas, study should be carried out on the ecological effects and mechanism of yak grazing in cold season on grassland, and provide a theoretical basis for grassland ecological assessment and ecological restoration of degraded grassland.

2. Research on the mechanism of diversified allocation to improve water and fertilizer use efficiency of crops

Proposals should focus on the study of rotation and intercropping modes of the main crops in dry farming areas of Gansu province, explore the water and fertilizer thresholds in the diversified allocation of crops, reveal the temporal and spatial ecological mechanism of water and fertilizer use efficiency and physiological response, and provide diversified allocation models and theoretical guidance for the efficient use of crop water and fertilizer in arid habitats.

3. Research on the quality and characteristic substances of olive oil

Proposals should focus on the study of olive oil of the Gansu province. They should establish the analysis method and database of trace characteristic substances in olive oil, reveal the change rule of characteristic substance groups during olive oil storage, identify the differences of characteristic substance groups in olive oil from different producing areas; on this basis, build intelligent grading methods and models for different grades of olive oil to provide a theoretical basis and scientific basis for olive oil quality identification and precise grading.

4. Research on the molecular regulation mechanism of yak oocyte development

Proposals should focus on the study of the yak, identify genes that regulate meiosis in yak oocytes, analyze their biological functions, and clarify the regulatory mechanism of yak oocyte

development. They should solve the key scientific problems in the development of yak oocytes and provide a theoretical basis for improving the reproduction rate of yak.

5. Research on the transmission and pathogenic mechanism of important vectors and vector pathogens of livestock

Proposals should focus on the study of the livestock vectors and vector pathogens. Study should be carried out on the temporal and spatial distribution characteristics of insect vectors and vector pathogens in Gansu province, to analyze the developmental regulation, transmission and pathogenic mechanisms of vectors and vector pathogens, and develop new diagnostic and new prevention strategies.

Applicants are encouraged to conduct cooperative research with colleges and universities or research institutions with substantial research strength and research conditions in Gansu Province.

xvii. Based on the advantageous and characteristic agricultural industry of Ningxia Hui Autonomous Region, basic research on key scientific issues such as resource mining, efficient planting and breeding, and post-harvest treatment should be conducted.

Key projects:

1. Research on the mechanism of prevention and treatment of recessive mastitis of dairy cows with traditional Chinese medicine and development of alternative products

In view of the high incidence of latent mastitis in dairy cows, proposals should use characteristic traditional Chinese medicine and natural medicine resources of Ningxia as raw materials, and carry out the compatibility formula and dose-effect optimization research for the prevention and treatment of latent mastitis in dairy cows during the full growth period of dairy cows. Proposals should clarify the material basis of efficacy, and reveal its regulatory network and biological mechanism based on multi-omics technology, and provide a basis for the development of alternative anti-products for the prevention and treatment of dairy cow mastitis.

2. The mechanism of action of microorganisms at the eastern foot of Helan Mountain in wine quality style shaping and quality safety

Proposals should study the composition, evolution and interaction of local microbial flora in the wine fermentation process of the eastern foot of Helan Mountain, reveal the relationship between microbes and wine quality and quality, establish high-throughput molecular screening techniques for excellent microbes, clarify the aroma production mechanism of specific wine-making microorganism strains and the regulation mechanism of undesirable microbial metabolites, and build a wine quality and health assurance control system.

3. Research on the germplasm characteristics of Yanchi Tan sheep and the formation mechanism of excellent traits

Proposals should focus on the study of Yanchi Tan sheep, study the genetic diversity, the genetic mechanism of excellent economic traits, the regulation mechanism and the evaluation of the breeding value of important functional genes, explore the nutritional and environmental requirements of different growth and development (physiological) stages in the house and the control of meat quality, and provide a theoretical basis for the protection of local fine breed sheep germplasm resources, the utilization of excellent genetic resources, genetic improvement and quality improvement.

4. Research on multi-scale heat and mass transfer law and cell response mechanism in the cold chain preservation process of characteristic agricultural products

Considering the technical bottlenecks in the preservation and control of characteristic agricultural products during the cold chain transportation process, proposals should carry out multi-scale research on the coupling law of cooling heat transfer and water and mass transfer loss, calculate the basic thermal physical parameters corresponding to the biological heat and mass transfer process, clarify the biological heat and mass transfer as well as the boundary conditions of

deterioration and microbial contamination, and provide theoretical support for the regulation and control of special agricultural products.

5. Research on early warning and green prevention and control mechanism of continuous cropping obstacles in melon and vegetable soil

Proposals should solve the problems in production such as continuous cropping and serious diseases, build a soil health early warning system, analyze the formation mechanism of continuous cropping obstacles, and establish a technology system for the prevention and control of continuous cropping obstacles based on micro-ecological balance to lay a foundation for the sustainable production of melons and vegetables.

Applicants are encouraged to conduct cooperative research with higher education institutions or research institutions with substantial research strength and research conditions in Ningxia Hui Autonomous Region.

II. Environment and Ecology

i. Based on the major needs of typical ecosystems and environmental regions in Hebei Province, surrounding the key scientific issues such as efficient utilization of resources, ecosystem restoration, pollution control, groundwater regulation and sustainable development in overdraft areas.

Key directions for research:

1. Study on the impact mechanism of soil microbial community on soil health (D07)

In order to meet the major needs of food security and ecological civilization construction, the expected directions would be to coordinate the protection and sustainable utilization of biological resources, develop efficient utilization of resources and ecological protection and restoration technologies, reconstruct reasonable microbial communities by using soil microbiome methods, and focus on the study of soil micro ecological change law, plant-microorganism-soil environment interaction and regulation, soil pollutant degradation and resource recycling, microbial interaction and crop health production, and development the theory of regulation and control of healthy soil system and innovation of the key technologies.

2. Study on the influence law and control method of environmental change on the growth process of jellyfish (C19)

Aiming at the problem that jellyfish disasters occur frequently and cannot be monitored, the expected projects should take typical ecological disaster jellyfish in Hebei sea area as the object to study the impact of environmental changes on the growth process of jellyfish; analyze the environmental factors and optical methods to control the growth rate of jellyfish; and investigate the optical monitoring technology and system of jellyfish quantity and density in typical marine functional areas (power plants, baths and farms) in Hebei Province. The research should provide theoretical and technical support for the healthy development of marine ecology and related industries.

3. Research on production of environmental functional materials based on microstructure reconstruction of iron tailings and non-metallic minerals (E02, E04 or E10)

In view of the resource characteristics of Hebei iron tailings, sepiolite, tourmaline and other non-metallic minerals and their low level of high value-added resource utilization, the projects should focus on the methods of microstructure reconstruction of iron tailings and non-metallic functional minerals and the synthesis of environmental functional materials, as well as focusing on new methods and technologies for adsorption, degradation and transformation of antibiotics and mycotoxins by new materials and easy cleaning and environmental protection of ceramics.

4. Study on evolution mechanism of groundwater circulation and comprehensive control in over exploitation area (D01)

Aiming at the problem of comprehensive treatment of groundwater in the over exploited area of Hebei Province, the grants should study the evolution law of water cycle in the over exploited area after comprehensive treatment of groundwater, reveal the interaction relationship between groundwater and different surface water sources such as external water transfer and local water, study the double control indicators and thresholds of water quantity and water level in different types of groundwater over exploited areas, establish the dynamic evaluation and prediction technology of groundwater over exploitation, and construct the model for groundwater conservation The grants should also build the large-scale and multi-source joint operation technology in Hebei Province and provide theoretical basis for the comprehensive treatment of groundwater.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Hebei Province.

ii. Based on the monitoring of groundwater pollution in Songnen Plain, the risk of non-point source pollution in large-scale agricultural development, the risk assessment of agrometeorological disasters and the maintenance of the stability of plant diversity in peatland communities of Changbai Mountain.

Key directions for research:

1. In situ monitoring theory and key technology of petroleum hydrocarbon pollutants in groundwater in seasonal freeze-thaw zone (D04)

In view of the lack of in-situ rapid monitoring instruments for petroleum hydrocarbon organic pollutants in groundwater in Songnen Plain of Jilin Province, which makes it difficult to support the major practical needs of effective supervision of regional groundwater pollution, the in-situ monitoring technology for hydrocarbon pollution is developed to reveal the temporal and spatial evolution characteristics and laws of magnetic resonance signals in complex underground media in seasonal freeze-thaw area of northern China, and to study the risk of petroleum hydrocarbon pollutants in groundwater, the weak disturbance real-time monitoring method of leakage source can improve the support ability of accurate prevention and control of groundwater pollution and the independent innovation ability of environmental monitoring instrument development in Jilin Province.

2. Study on the early warning and adaptive countermeasures system of meteorological disaster risk of multi disaster species in Songliao Corn Belt (D05 or D07)

In view of the problems of agricultural production fluctuation, instability of food supply and increase of food security risk caused by meteorological disasters in Songliao Corn Belt of Jilin Province under the background of global warming, the application should focus on research into the coupling stress effect and mechanism of disaster formation under the background of climate change, the establishment of a new theory and technology for risk prediction of whole process disaster scenario prediction for crop under the background of climate change, the construction of comprehensive disaster risk adaptation countermeasures and optimization plan to deal with climate change, and put forward the climate security method system of high quality and high yield of crops and industrial improvement and efficiency, which provides theoretical and technical support for disaster prevention and mitigation, crop variety and planting structure adjustment, climate change, food security and agricultural sustainable development in Songliao corn belt, Jilin Province.

3. Risk prediction and control mechanism of non-point source pollution in large-scale paddy field development in Western Songnen Plain (D07)

After the implementation of “river lake connection” project in the west of Songnen Plain, the output load of non-point source pollution caused by large-scale dry land to water and saline alkali land paddy field development increased, which seriously threatened the water environment

safety of receiving lakes and salt marshes, so the application should focus on the output mechanism and load of characteristic ions in soda saline alkali soil and environmental pollutants discharged from rice cultivation, and predict the impact of non-point source pollutants on lake wet environment. Also, in order to provide theoretical and technical support for water environment security and sustainable development of agriculture in Western Jilin Province, the application should build regional environmental pollution monitoring and control technology system, and develop online monitoring system of typical pollutants.

4. Plant diversity pattern and carbon accumulation effect of peatland communities in Changbai Mountain Area (D01 or D03)

In order to solve the problems of unclear distribution pattern of Sphagnum diversity and underestimation of ecosystem carbon pool function in Changbai Mountain area, the altitude gradient distribution pattern of Sphagnum diversity and its carbon accumulation effect were studied to form the basic theory and new technology of formation mechanism, carbon pool effect and stable maintenance of Sphagnum diversity distribution pattern, the application should provide theoretical and technical support for the regional ecological security and ecological construction of Changbai Mountain.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Jilin Province.

iii. Based on the major needs of ecological security in Heilongjiang Province, based on the characteristics of natural geographical environment and ecological resources in alpine regions, the related basic research is carried out around the key scientific issues in the fields of water and soil pollution prevention and ecological environment security.

Key directions for research:

1. System construction and directional regulation mechanism of efficient straw biotransformation combined with hydrogen alcohol methane production (E10)

Aiming at the problems of environmental pollution and resource waste caused by straw waste and combustion, based on the material flow of straw biotransformation, the efficient fermentation system for hydrogen production, butanol biotransformation and methane fermentation, the application should work to optimize the microbiome and metabolic network, study the coupling mechanism and directional control method of hydrogen, butanol and methane fermentation module realize the efficient biotransformation of straw and hydrogen butanol methyl fermentation CO production of alkane to provide scientific support for the comprehensive utilization of straw resources and energy.

2. New method for efficient treatment and resource utilization of livestock and poultry wastewater in cold region (E10)

According to the major technical requirements of livestock and poultry wastewater treatment in Heilongjiang Province, the application should focus on the main characteristics and existing problems of wastewater from typical livestock and poultry farms in cold regions, the efficient transformation and utilization of carbon source organic matter, efficient removal and recovery of nitrogen and phosphorus, analysis of migration and transformation law of typical antibiotic pollutants and development of new removal methods under medium and low temperature conditions. The application should also focus on improving the level of aquaculture wastewater treatment and resource utilization, reducing the cost of treatment, and achieving the goal of energy conservation and emission reduction in cold regions

3. Study on the molecular ecological mechanism of Alfalfa stress resistance in cold region (C03)

Taking alfalfa in cold region as the research object, the application should focus on the

applied basic research on the mining of stress resistant functional genes, the molecular ecological mechanism of microbial plant stress interaction, etc., laying a theoretical foundation for the genetic improvement and cultivation of alfalfa, and providing scientific basis for the vegetation restoration and ecological reconstruction of saline alkali soil in cold region.

4. Research on new nitrogen removal technology and control mechanism of cold region sewage (E10)

Aiming at the problem of deep nitrogen removal of wastewater with low C/N ratio in alpine region, application should focus on a new nitrogen removal technology based on extracellular electron transfer, analyze the molecular mechanism of microbial community interaction and metabolic regulation; construct an enhanced low-temperature nitrogen removal process to achieve efficient autotrophic nitrogen removal dependent on non-nitrite electron acceptor, providing theoretical and technical support for wastewater treatment in Heilongjiang cold region.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Heilongjiang Province.

iv. Based on the demand of improving the atmospheric and water environment in Anhui Province, the application should focus on the basic and applied basic research on the atmospheric micro particles, the Jianghuai Meiyu front cloud system, the discharge of agricultural active nitrogen from the Jianghuai area and the treatment of urban sewage.

Key directions for research:

1. Multi scale calculation of heterogeneous phase transition and flow of atmospheric fine particles (D05)

In order to solve the problem of haze and other air pollution and its control, the geometric structure, chemical composition and other characteristics of atmospheric fine particles in Jianghuai region are extracted, and the efficient parallel algorithm based on molecular motion theory should be developed to simulate the heterogeneous phase transition micro process of water vapor on the surface of particles, and the heterogeneous nucleation and droplet growth models under typical atmospheric flow conditions are established by using deep learning technology Considering the local transport of phase change and atmospheric macro flow, the multi-scale algorithm should be used to study the interaction characteristics between phase change and atmospheric flow, understand the influence mechanism of water vapor phase change of ultrafine particles on heavy haze outbreak and other pollution weather, and explore the prediction technology and control means of haze weather.

2. Research on macro and micro parameters of Meiyu front cloud system in Jianghuai area (D05)

Aiming at the fine characterization of macro and micro parameters of Meiyu front cloud system with high spatial and temporal resolution, the application should focus on the vertical distribution of macro and micro physical parameters of cloud and aerosol, and the three-dimensional structure of precipitation and latent heat. The typical aerosol cloud precipitation data set of Jianghuai Meiyu front should be established to quantitatively study the relative sensitivity of Jianghuai Meiyu front cloud system to aerosol, and distinguish natural variability and latent heat, and the influence of anthropogenic factors on Meiyu front cloud system in Jianghuai area.

3. Study on the key role of agricultural emission of atmospheric active nitrogen in the formation of atmospheric oxidation and atmospheric compound pollution in the Yangtze Huaihe River Basin (D03, D05 or D07)

According to the characteristics of active nitrogen emission from agricultural sources in Jianghuai region, a new method for quantitative measurement of atmospheric active nitrogen

emission intensity should be developed, and a comprehensive characterization system of atmospheric oxidation should be established to clarify the emission intensity of active nitrogen from agricultural sources and its contribution to atmospheric oxidation, so as to provide a scientific basis for the cause analysis, reduction and control of atmospheric complex pollution in Jianghuai basin.

4. New technology and method of urban sewage treatment (E10)

The application should be focusing on the characteristics of low concentration of organic matter and high content of nitrogen in urban sewage of Chaohu Lake Basin, explore the transformation mechanism of carbon, nitrogen and phosphorus in the sewage treatment process. The structural change characteristics of microbial community and the microbiological mechanism of pollutant enhanced removal should be analyzed, so as to provide scientific basis for the sewage treatment of Chaohu Lake Basin.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Anhui Province.

v. Based on the major regional eco-environmental needs of Henan Province in the Yellow River Basin, the relevant basic research is called for around the key scientific issues of ecosystem succession, environmental evolution, biological invasion, water and soil resources synergy, mining subsidence affecting regional food security and high-quality development.

Key directions for research:

1. Ecosystem process and simulation in Henan section of the Yellow River region (D01)

In view of the complexity of ecosystem process law and action mechanism in Henan section of the Yellow River region, the application should use ecological spatiotemporal big data to establish technical methods for monitoring ecosystem and environmental changes, ecological security and ecological risk early warning; carrying out multi-scale intelligent ecosystem process comprehensive model research; and establishing ecosystem succession and service flow evaluation method supported by spatiotemporal big data, providing scientific and technological support for ecological protection and sustainable development of the Yellow River Basin.

2. Study on ecological and environmental change and prediction in Central Plains (D01 and D07)

The application should aim to develop a new technology of monitoring and simulation based on the natural characteristics of ecological and environmental changes, reveal the changes of ecology and environment in Central Plains in the past 2000 years, and construct the optimization path of “human nature coupling system” under different scenarios. The application should also provide a scientific basis for the plan of “comprehensive ecological environment quality improvement” in Central Plains.

3. Plant invasion mechanism and regulation in Henan section of the Yellow River

The application should aim to reveal the mechanism of the outbreak of invasive plants in Henan section of the Yellow River; to clarify the interaction between invasive plants, aboveground insects, underground mycorrhizal fungi and rhizosphere microorganisms; to study the regulation mechanism of invasive plants and provide theoretical basis for controlling invasive plants and protecting ecological security.

4. Coordination and regulation of water and soil resources in Henan water supply area of the Yellow River (E09)

The application should aim at the problem of the incoordination of water and soil resources allocation in the water supply area of the middle and lower reaches of the Yellow River, reveal the interaction mechanism between land use and eco hydrological process, put forward the quantitative method of ecosystem service effect in the process of water and soil co evolution, and establish the

regulation model of coupling and mutual feedback of water and soil resources. It should provide a scientific basis for the efficient utilization of water and soil resources in the water supply area of the middle and lower reaches of the Yellow River.

5. Mining subsidence law and land damage mechanism of main grain producing areas in Central Plains (E04)

The application should be based on the typical geological and mining conditions in Central Plains, aiming at the problem of land damage induced by coal mining, the temporal and spatial evolution law and driving mechanism of mining induced overburden aquifer damage, land subsidence and damage, and the surface subsidence control damage and land collaborative restoration technology, providing theoretical support for green coal mining and food security.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Henan Province.

vi. Based on the needs of ecological development in Hubei Province, this topic focuses on the major water resources, water environment and water ecology research in the middle reaches of the Yangtze River Basin, intelligent interpretation of geological environment information, stability of rock mass engineering in the new channel of Three Gorges water transportation, impact of high-dose disinfection on the operation of urban sewage treatment plants, domestic waste treatment, energy storage power station, geological environment problems and ecological prevention and control scientific issues, carry out relevant basic and applied basic research.

Key directions for research:

1. Study on the migration and transformation of nitrogen and phosphorus in the groundwater system of the middle reaches of the Yangtze River and its impact on wetland water environment (D01, D03 and D07)

The application should take Jianghan Plain in the middle reaches of the Yangtze River as the key area, reveal the ecological and environmental effects of nitrogen and phosphorus excretion from groundwater system to wetland under the dual influence of natural processes and strong human activities, find out the temporal and spatial variation characteristics of nitrogen and phosphorus in wetland and groundwater system, identify the main sources and contribution proportion of nitrogen and phosphorus in groundwater system, and quantify the distribution of nitrogen and phosphorus to wetland in groundwater system, reveal the nitrogen and phosphorus cycling mechanism under the interaction of groundwater and wetland, providing scientific support and decision-making basis for ecological culture construction and wetland ecological protection in the middle reaches of the Yangtze River.

2. Study on ecological flow and adaptive management of river and lake system in plain area (For application code 1 select subordinate code of D01 or D07)

The application should be based on the investigation and analysis of water environment and water ecological status of typical river and lake systems in the middle and lower reaches of Hanjiang River, the relationship between hydrology, ecology, economy and society of river and lake systems in plain area is explored, and the calculation method of ecological flow of river and lake systems in plain area is studied to scientifically determine the suitable ecological flow of one river and three rivers in the middle and lower reaches of Hanjiang River, and put forward the adaptive management mechanism of ecological flow.

3. Bioremediation mechanism of heavy metal contaminated farmland soil in Hubei Province (C15)

The application should be aiming to solve the key scientific problems of heavy metal migration and microbial resistance and control, and conduct the basic research on the

transformation of heavy metal valence/speciation in the complex ecosystem of soil plant microorganism.

4. Prevention and control mechanism and analysis method of TBM tunneling large deformation jammer disaster in deep soft stratum (E08 or E09)

The application should be aiming at the key scientific problem of "mechanism and control method of squeezing deformation jammer in soft stratum of deep buried long tunnel driven by TBM", revealing the application of high geostress soft rock stratum in TBM formation and effective control mechanism of extrusion deformation jammer disaster under the action of excavation strong unloading, establishing the three-dimensional numerical simulation method and software platform for the formation and control process of extrusion deformation jammer disaster, and developing the new materials, new technologies and effective methods for deep soft stratum extrusion deformation jammer disaster control.

5. The change process, mechanism and restoration countermeasures of aquatic habitat quality in the Yangtze River under the interference of multiple human activities (D07)

The application should be aiming at the aquatic ecosystem crisis of the Yangtze River, discuss the mechanism of the decline of aquatic biodiversity caused by the change of habitat quality driven by the change of hydrological situation and human activities such as sand mining from the three dimensions of water habitat species, and the response of different aquatic organisms to human activities. The application should take Hubei section of the middle reaches of the Yangtze River as an example, carry out the monitoring of typical aquatic habitat and biological status, the change trend of aquatic habitat and the evolution pattern of aquatic biodiversity in the main stream of the Yangtze River were modeled and predicted, and develop the natural and artificial restoration technology system of aquatic habitat in the Yangtze River.

6. Quantitative analysis of non-point source pollution load into the middle reaches of the Yangtze River and study on lag effect (D07)

The application should focus on the process of nitrogen and phosphorus non-point source pollution flowing into the Yangtze River with runoff in the middle reaches of the Yangtze River, taking Hubei section of the middle reaches of the Yangtze River as the research object. The application should analyze the runoff loss path and the way of entering the river of non-point source pollution, and quantitatively analyze the contribution of non-point source pollution load in different ways; study the migration and transformation characteristics of nitrogen and phosphorus non-point source pollution in the process of farmland, ditch, river network, and coastal zone, and reveals the characteristics of non-point source pollution entering the Yangtze River, analyze the response mechanism of river time lag effect to the process of pollutant interception and re-transportation, and discuss the targeted non-point source pollution prevention and control strategies.

7. Research on the theory and key technology of intelligent interpretation of remote sensing big data of geological environment information (D01 or D02)

The application should aim at the geological environment problems induced by the economic development and urbanization of Hubei Province, taking Wuhan "1 + 8" urban circle as the key area, considering the unique physical and geological meaning of quantitative remote sensing products. The application should also reveal the correlation mechanism between geological environment scene and remote sensing information representation model, establishes remote sensing sensitive feature combination optimization model of geological environment information, and develops geological environment information based on deep learning Intelligent interpretation model, carry out the interpretability research of deep learning model characteristics, improve the precision and automation ability of geological environment information interpretation, identify the spatial-temporal change process of geological environment in Wuhan metropolitan area, and

provide spatial-temporal big data system platform and auxiliary decision-making basis for Hubei geological environment monitoring and protection.

8. Study on the stability of rock mass engineering in the new waterway of the Three Gorges Project (E09)

The application should aim at the stability of rock mass engineering in the new channel of Three Gorges water transportation, carry out the experimental study on mechanical properties of complex rock mass and simulation analysis on excavation of rock mass engineering to study the mechanical deformation characteristics and engineering disturbance effect of surrounding rock of super large span underground cavern, reveal the formation and evolution mechanism of excavation disturbance area of complex rock mass on high and steep slope, and construct the evaluation criteria for the stability analysis of complex rock mass in the new channel of Three Gorges water transportation, providing scientific basis and technical support for the design and construction safety of the Three Gorges new waterway project.

9. Impact mechanism of high-dose disinfection on the operation of urban sewage treatment plants in major epidemic areas (E10)

The application should focus on the high dosage of disinfection measures to deal with the major epidemic situation of novel coronavirus infected pneumonia in Hubei area and study the problem of high residual chlorine in municipal sewage treatment plant. The application should take the biochemical treatment core unit of the sewage treatment plant as the research object, study the effect of high residual chlorine on the biochemical process treatment efficiency and operation stability, and study the microbial community structure and generation of biochemical process. The application should aim to provide important information and theoretical guidance for improving the ability of sewage treatment plants to cope with major epidemics, elucidate the molecular mechanism of the impact of high-dose disinfection on the operation of urban sewage treatment plants, and explore the diffusion mechanism of disinfectant resistance genes in sewage treatment plants.

10. Research on basic theory and key technology in the process of collaborative combustion of medical waste by domestic waste incineration facilities (B06)

The application should focus on the characteristics of municipal solid waste in Hubei Province, considering the adverse effects of high water, high chlorine and high infectious medical waste CO combustion on the safe operation stability and pollutant emission of municipal solid waste incineration facility furnace, exploring the methods and technologies of toxicity reduction and quality improvement of medical waste pretreatment, and the effects of medical waste CO combustion on combustion stability, studying the heating surface corrosion coking and dioxin generation/retardation of municipal solid waste incineration furnace. The application should provide theoretical basis and technical options for the construction of emergency reserve capacity of medical waste centralized disposal facilities in Hubei Province and even in the whole country, exploring the influence mechanism of heavy metal migration and transformation, and collaborative incineration technologies such as combustion optimization adjustment, heating surface corrosion prevention and control, reduction of fly ash source, stable regulation of heavy metal form in bottom slag and new ways of ash resource recovery.

11. Disaster mechanism and ecological prevention and control of the front edge erosion of large reservoir reactivated landslide in Western Hubei mountain area (D02 or D07)

The application should focus on the large reservoir reactivated landslide in Western Hubei mountain area as the research object, aiming at the disaster problem caused by long-term compound hydrodynamic erosion at the front edge of the landslide, the research on the erosion mechanism of the front edge of the landslide, the evolution and prediction of bank collapse, the monitoring and early warning of the whole process of erosion bank collapse landslide and

ecological prevention and control are carried out, so as to provide theoretical guidance for the geological environment protection and disaster prevention and reduction of the reservoir slope.

12. Key theory and application of salt cavern pressurized air storage for large scale energy storage (E07)

The application should take the salt cavern compressed air storage power station as the research object, aiming at the problems of underground salt cavern stability and volume shrinkage, study the key theoretical basis of large-scale energy storage of salt cavern compressed air storage. It should consider the characteristics of high-frequency gas injection and production, studying the long-term deformation and failure mechanism of salt cavern under high-frequency periodic load, revealing the high-frequency periodic gas. The destructive mechanism of the load on the near-field surrounding rock of the salt cavern can solve the key scientific problems of the influence of high-frequency gas injection on the near-field surrounding rock of the salt cavern, and provide a theoretical basis for the key design, construction and safe operation of the salt cavern compressed air storage power station.

13. Water conversion and agricultural water saving and emission reduction in Jianghan Plain under changing environment (E09)

The application should be based on the change of water transformation relationship and its impact on irrigation and drainage in Jianghan Plain after the Three Gorges Project and the middle route of the South to North Water Diversion Project, studying the variation characteristics of water transformation, the adaptive regulation mechanism of agricultural water saving and emission reduction, and the efficient utilization mode of irrigation and drainage in the changing environment, so as to provide scientific basis and support for the great protection of the Yangtze River, rural revitalization and high-quality development.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Hubei Province.

vii. Focusing on the major needs of ecological environment security and sustainable management of ecosystem in Hunan Province, the basic research on typical regional ecological processes, effects and regulation.

Key directions for research:

1. The environmental and ecological effects and regulation mechanism of urban-rural integration development in Hunan Province (D01 or D07)

The application should focus on the collaborative interaction between urbanization and rural revitalization, construct a process based carbon budget model of urban agglomeration green space ecosystem, carry out quantitative assessment of resources and environment carrying capacity, discuss the coupling mechanism between urban-rural integration development and resources and environment in Changsha Zhuzhou Xiangtan area, analyze the effects of urbanization and rural revitalization on water and soil resources and ecological environment, and reveal the ecological space control mechanism of urban-rural integration development The application should study the mechanism of sustainable utilization and green development of water resources in the national sustainable development agenda innovation demonstration area, and provide a scientific basis for promoting the integration of urban and rural development and ecological security.

2. Improvement of ecological effect and service function of wetland environment in Dongting Lake Basin (D01, D03, D05 or D07)

The application should analyze the evolution and driving factors of wetland ecological pattern under human activities and climate change, study the ecological process and its coupling mechanism, reveal the formation mechanism of wetland biodiversity, carbon sink and other ecological services, explore the lack of internal stability mechanism of wetland ecosystem, put

forward the ways to improve the wetland service function of Dongting Lake, and analyze the generation of wetland pollutants and its relationship with production and life. The application should aim to provide a scientific basis for the comprehensive management of Dongting Lake Basin, the migration and transformation behavior, clarify the compound pollution effect and ecotoxicity of typical pollutants in water environment, and reveal the interaction between water and solid interface and the driving mechanism of degradation and transformation of pollutants.

3. Multimedia environmental behavior and prevention and control mechanism of typical pollutants and wastes in Hunan grain producing areas (B06)

The application should focus on the transformation of typical pollutants (nitrogen and phosphorus, pesticides, antibiotics, heavy metals, etc.) and agricultural wastes (agricultural film, livestock manure, straw, etc.) in the water soil crop multi-media environment and their spatial and temporal distribution, and study distribution behavior and coupling mechanism. The application should also establish the multi-media environmental migration and transformation process model to clarify the environmental behavior and ecological effects of pollutants and reveal the collaborative control mechanism and the principle of restoration technology, providing a theoretical basis for promoting the safety of agricultural ecological environment.

4. Formation mechanism of rice field complex ecosystem regulation and ecological service function (C03)

The application should focus on the response characteristics of material cycle, nutrient utilization and water and soil quality of typical rice field compound planting and breeding system, discussing the evolution trend of rice field biodiversity and the ways to improve the productivity and utilization rate of natural resources, clarifying the biological interaction process and product quality regulation law of compound planting and breeding system, and revealing the formation mechanism of ecological services of compound planting and breeding system, providing a theoretical basis for improving the quality and efficiency of the compound planting and breeding system.

5. Formation mechanism of biodiversity conservation and ecosystem services in typical ecologically vulnerable areas (C03)

The application should focus on the ecological restoration needs of karst rocky desertification and purple soil areas, carrying out researches on biodiversity conservation, population adaptation mechanism and ecological spatial change characteristics under the change of human activities, clarifying the long-term effects of ecosystem service function change, revealing the impact mechanism of large-scale ecological engineering construction on regional ecosystem services, putting forward suggestions on biodiversity conservation, and providing a scientific basis for the improvement of ecosystem service function in ecologically fragile areas, the optimal regulation and control approaches of ecosystem maintenance and overall ecosystem restoration.

6. Environmental geochemical behavior and resistance control mechanism of potential hazardous elements in typical characteristic metal mining areas (D03 or D07)

The application should aim at the environmental and ecological problems in the development of characteristic metal resources, study the migration process and spatial differentiation of potential hazardous elements in the geological environment and their coupling pollution to water, soil and air under the influence of geological background and human activities in the mining area, determine the bioavailability, control factors and pollution threshold of hazardous elements, explores the “control resistance reduction” pollution prevention and control mechanism, and put forward the countermeasures of heavy metals. In order to put forward a scientific basis for the environmental safety of metal mining area, the application should provide solution to harness and reuse the tailings of urban mines.

For the above research directions applicants are encouraged to carry out cooperative

research with universities or research institutions with research strength and research conditions in Hunan Province.

viii. The topic focuses on the problems of environmental pollution and ecological function closely related to the current social and economic development of Guangdong, Hong Kong and Macao Bay area

The average direct cost of integration projects is about 15 million yuan per project. The directions include:

1. Paracel Islands' air sea interaction process and its environmental regulation mechanism (D05 or D06)

The application should aim at the strategic demand of national marine power and ecological civilization construction, conduct the basic and applied research on the air sea interaction process of the Paracel Islands in the South China Sea, build a comprehensive observation and research platform for the Paracel Islands sea land (Island) gas interaction process, and launch the regional ocean-land (reef)-atmosphere ecosystem interaction mechanism and its extreme weather and climate. The main research contents are as follows:

(1) Land air interaction mechanism on heterogeneous underlying surface of Xisha Island

The application should develop a new method of flux observation on heterogeneous underlying surface, to study the momentum/energy/mass exchange law between Nansha Island atmosphere and underlying surface, the development characteristics of heterogeneous atmospheric boundary layer, the multi-scale characteristics of land air interaction on heterogeneous surface, and the coupling mechanism of ocean atmosphere microorganism; to establish the theoretical model and parameters of the influence of heterogeneous surface on land air interaction on Xisha island, and verify the applicability of the traditional near formation similarity theory.

(2) Air sea interaction process in Xisha and its surrounding waters and its impact on extreme events and disasters

The application should observe and study the characteristics and mechanism of air sea interaction process in Xisha and its surrounding waters, study the effects of multi-scale changes of ocean circulation and its precursor signals on the onset of South China Sea Monsoon and the occurrence and development of extreme marine meteorological disasters, reveal the processes and mechanisms of air sea exchange, atmospheric convection and ocean adjustment in key regions. The application should put forward the atmospheric and ocean precursor signals serving for monitoring and prediction, and establish the model based on the theoretical model of air sea interaction, exploring a new method of disastrous weather forecast based on the coupling model of air sea, observation data assimilation and artificial intelligence.

(3) Ecosystem change of Xisha Island and its interaction with regional climate system

The application should focus on observing and analyzing the effects of Xisha island ocean interaction process on vegetation, soil and key elements of atmosphere to clarify the role of tropical island ecosystem in mitigating climate change, element enrichment and land sea material exchange; the multi-source remote sensing identification method of oligotrophic high productivity sea area around islands and reefs to identify its spatial-temporal distribution characteristics and land sea impact mechanism; the spatial-temporal distribution of Xisha Islands and reefs, revealing the mechanism of land sea interaction between sand and surrounding areas and the impact of land-based materials on island ecosystem.

(4) Refined multi-layer targeted typhoon and storm surge prediction model based on air-sea coupling in Xisha and its surrounding area

The application should focus on the research and development of the Paracel Islands super high resolution ocean prediction model, coupled air sea coupled with the fine typhoon and storm surge prediction models with special regional functions, construct a fine multi-layer typhoon and

storm surge forecasting model with seamless connection with hydrology, meteorology, engineering and aviation applications, and develop the ultra-high resolution coverage of typhoons and storm surges affecting coastal areas, ports and airports (horizontal resolution 10 m) forecast model.

(5) Development and application demonstration of integrated marine, terrestrial and air born prediction system in Paracel Islands area

The application should focus on carrying out the comprehensive research on the interaction process and mechanism of Xisha and its surrounding area sea land air production system, developing the comprehensive integrated forecasting system of the key elements of Xisha and its surrounding area ocean atmosphere-land (Island)-ecology, integrate the developed numerical model system, data assimilation system, application demonstration platform and so on, and building a comprehensive model from the basic research of comprehensive observation and comprehensive theory to the regional sea. It should be a decision-making service support platform for marine security, marine economy, disaster prevention and mitigation, and ecological civilization construction, which carries out application verification and trains the backbone of relevant business departments, so as to realize the application transformation and popularization of scientific research achievements.

The application of this integrated project should include the above 5 research contents, focusing on the project theme "Research on the interaction between marine and terrestrial air and its environmental regulation mechanism" in Paracel Islands. The expected results include observation, theory, methodology, technology, integration platform and transformation to industry sector.

Key research directions include:

1. Environmental geochemical process and control mechanism of typical toxic pollutants in Guangdong, Hong Kong and Macao Bay Area (D03 or D07)

The application should focus on the major scientific issues of water safety in Guangdong, Hong Kong and Macao Bay area, study the spatiotemporal variation characteristics of typical toxic pollutants in the basin of Guangdong, Hong Kong and Macao Bay area, clarify the occurrence forms, distribution characteristics, migration and transformation mechanism and key control factors of typical pollutants, analyze the source and fate of characteristic pollutants, focus on the exchange law and interaction mechanism of land sea interface, and break through the principles and methods of purification of high efficiency and low consumption pollutants, construct the green water treatment and disinfection system to realize the green catalytic removal of typical pollutants, focusing on the reaction mechanism of transition metal oxides and non-metal catalytic activation of persulfate; base on the biological ecological regulation, improve the biological enhanced purification efficiency and control mechanism of typical toxic pollutants, so as to ensure the safety of Guangdong and Hong Kong and provide scientific and technological support for water safety in the bay area.

2. Sources and control technologies of air pollutants in Guangdong, Hong Kong and Macao Bay Area (B06)

The application should be oriented towards the characteristics of air pollution control in Guangdong, Hong Kong and Macao Bay Area in the new period. A new method for on-line analysis of chemical components in water phase and gas phase should be developed to study the emission law of air pollutants (H2S, VOCs and NOx) in typical areas, focusing on the impact of water phase or gas phase chemical components on air key pollutants (H2S, VOCs and NOx), and clarifying the chemical reaction process and mechanism of their formation, so as to provide scientific and technical support for further improving the level of joint prevention and control of air pollution in Guangdong, Hong Kong and Macao Bay area.

3. Key ecological environment process and regulation mechanism in Guangdong, Hong

Kong and Macao Bay Area (D01, D03, D05, D06 or D07)

The project should aim at the key ecological and environmental problems in Guangdong, Hong Kong and Macao Bay Area. A new method of in-situ observation and simulation experiment should be established, focusing on the regulation of multi-scale evapotranspiration on the thermal environment of urban agglomerations, the source and sink process and ecological effect of environmental black carbon, the pollution process of new hormones in farmland and the reduction and resistance control of original organisms, the monitoring and comprehensive prevention and control of nitrogen and phosphorus loss process of agricultural non-point source pollution, and the industrial and mining industry in order to provide scientific and technological support for the ecological environment management of Guangdong, Hong Kong and Macao Bay Area. The application should study the impacts of restoration and reconstruction of damaged ecosystem, water conservancy projects and biological invasion on the aquatic ecosystem, and explains the key ecological environment processes and their regulation mechanism.

4. Collaborative disposal and resource utilization of typical solid wastes in Guangdong, Hong Kong and Macao Bay Area (B06 or B08)

The application should accord to the characteristics of solid waste of typical industries in Guangdong, Hong Kong and Macao Bay Area, focusing on the comprehensive and efficient utilization of industrial, agricultural, domestic and other solid waste, exploring the microbial animal plant efficient collaborative transformation and in-situ safe absorption technology system of aquaculture waste, and establishing a three-dimensional green circular economy model of aquaculture waste. The application should analyzes the high-temperature reconstruction and activation mechanism of low-level components of industrial solid waste, reveal the migration, transformation and interaction rules of various pollution elements, explore the directional regulation mechanism of high value-added resource products, construct the resource system of echelon utilization, study the efficient transformation and comprehensive utilization of various solid wastes, and study the stability of harmful components for hazardous wastes such as incineration fly ash to explore the mechanism of detoxification and mineralization stabilization of toxic and refractory pollutants such as heavy metals, dioxins and PCBs in the process of harmless treatment, so as to provide scientific support for high-level resource utilization and harmless treatment of typical solid wastes in Guangdong, Hong Kong and Macao Bay Area.

5. Geological basis and ecological effects of three-dimensional geological space development in medium and long distance islands and reefs of the South China Sea (D02 or D06)

The application should aim to meet the needs of space development of islands and reefs in the South China Sea, comprehensively studying the basic geology, three-dimensional geological space modeling and ecological effects of in medium and long distance islands and reefs and their adjacent areas, studying the basement and quaternary geology of islands and reefs. The structure, composition and formation mechanism of quaternary sediments should be analyzed with emphasis. The three-dimensional geological space model of islands and reefs should be constructed, and the methods for evaluating the geological environment suitability of island and reef development should be explored, so as to provide scientific and technological support for the efficient and comprehensive utilization of land and resources of in medium and long distance islands and reefs, explaining the ecological and environmental effects of different development modes of islands and reefs.

6. Study on membrane microstructure and separation process mechanism (B08)

The application should focus on the implementation needs of new chemical industry, analyze the micro structure analysis of separation membrane based on large-scale scientific device to reveal the separation process and mechanism from the micro scale, solve the core problem of

precise and directional control of chemical products, develop new water treatment methods of MOF polymer mixed membrane, solve the macro preparation of efficient multi-functional mixed matrix membrane, and realize the new method of efficient removal of water pollutants law and new theory.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Guangdong Province.

ix. The basic and applied basic research should be carried out in the key scientific problems in the ecological protection, disaster warning, pollution restoration in karst area and Beibu Gulf region of Guangxi.

Key directions for research:

1. Research on environmental risk and prevention and control mechanism of pathogenic microorganisms (C01)

The application should study the efficient and high-throughput monitoring and screening technology of pathogenic factors such as pathogenic bacteria, antibiotic resistance genes, mobile genetic elements, viruses, etc.; reveal the occurrence, migration and transformation mechanism of pathogenic microorganisms in environmental media such as farms and aquaculture waters, sewage treatment plants and waste disposal plants, gas, water and soil; carry out the hazard, exposure, health risk assessment and risk assessment of pathogenic microorganisms basic and applied basic research on risk prevention and control.

2. Study on Mechanism of collaborative remediation process of contaminated soil/groundwater in Karst mining area (D01, D03 or D07)

The applications should analyze the migration and transformation process of typical heavy metals and organic pollutants in soil and groundwater of mining area and surrounding area in karst area, identify the main control factors, construct the migration and transformation model of pollutants in soil and groundwater, clarify the source sink relationship and regulation mechanism of pollutants in soil and groundwater, and clarify the chemical and microbial characteristics of pollutants in soil groundwater environment in karst area. The application should also study the transformation process and influencing factors of pollutants at the water soil interface in different oxidation-reduction environments, reveal the attenuation law of soil and groundwater pollution characteristics, and form the key technology of soil/groundwater composite pollution collaborative remediation, which can provide reference for Karst mine and theoretical basis and technical support for the collaborative remediation of contaminated soil and groundwater.

3. Monitoring and risk assessment of radionuclides and heavy metal pollutants (B04 or B06)

The application should focus on the rapid sample preparation and injection technology of gaseous and liquid nuclide samples, the ultra-high sensitivity measurement technology of accelerator mass spectrometry (AMS), and the measurement technology of X-ray spectrum and gamma ray spectrum, to reveal the isotopic composition of CD, Se and other metals in the typical high cadmium geological background area of Guangxi, and to study their occurrence, migration and transformation behavior, internal exposure and risk of human body in the multi-media environment.

4. Research on human economic activities and urban scale related development in coastal cities around the Beibu Gulf (D01 or D06)

The application should combine the unique geospatial strategic position of the Beibu Gulf of Guangxi and the special geospatial characteristics of sea-land union, research a set of night light remote sensing image data processing method system with strong target, high universality and excellent image quality; synthesize multi-source data such as ground observation, night light

remote sensing image, social media and cell phone location, add vertical dimensional change information and construct a night light-socio-economic model with spatio-temporal continuity; estimate the urbanization rate and provide theoretical support for analyzing and studying the spatial structure and spatio-temporal evolution trend of the Beibu Gulf urban cluster system.

5. Research on ecological and environmental changes in the near-shore waters of the Beibu Gulf (D05, D06 or D07)

The application should focus on the pollution of the near-shore water environment in the Beibu Gulf and the ecological damage and response mechanism of the coastal zone, the research on the process and mechanism of hydrological and environmental changes in the rivers and near-shore waters of the Beibu Gulf with the special characteristics of the subtropical high temperature and high humidity environment; the research should carry out the acquisition of environmental elements and pollution traceability modeling methods such as active and passive remote sensing and ground monitoring to realize the fine monitoring of the ecology and environment of the multi-dimensional coastal zone; the morphology and structural types of mangrove wetland tidal ditches and the evolution of the ecological pattern of mangrove wetland landscape; the mechanism of disaster change of farms under the action of strong storm surge to provide scientific basis for the ecological protection of the near-shore waters of the Beibu Gulf.

6. Research on scientific issues related to the mechanism of marine pest outbreak and prediction and early warning (D06 or D07)

The application should focus on the key marine functional area near the coast of Guangxi as the research object, the key scientific issues such as the mechanism of marine pest outbreak and disaster-causing mechanism under the multiple pressures of human activities and global changes, carry out the research on the key technology of pest population outbreak mechanism, risk assessment and prediction and early warning, and provide theoretical support to enhance the ecological function of the marine ecological functional area.

7. Research on carbon sinks processes and regulatory mechanisms of typical karst in Guangxi subtropical area (D01, D03, D05 or D07)

The application should take the typical karst features of subtropical landscapes in Guangxi as the research object, focusing on the water-heat combination in the process of climate change in typical watersheds; the research on the characteristics and processes of carbonate weathering carbon sinks and their physical, chemical and biological control mechanisms; assessing the efficiency of endogenous organic carbon production by terrestrial aquatic photosynthetic organisms and the potential of rock desertification management and land use configuration to regulate rock weathering carbon sinks, providing a theoretical basis for the sustainable development of the Beibu Gulf region. The application should provide a theoretical basis for the sustainable development of the Beibu Gulf region and scientific management of the watershed.

8. Research on the mechanism of the evolution of ecosystem service function and ecological security in Li River basin (D01 or D07)

The application should aim at the key scientific issues such as the evolution of ecosystem service function and ecological security pattern in Li River basin, research on the formation mechanism, influence scope and transfer mechanism of ecological service flow in the basin and the formation, evolution and influence mechanism of ecological security pattern in the basin; carry out research on establishing high-precision digital elevation model based on the multi-source observation data in the Li River basin, construct the disaster risk level assessment method for different geographical units, and provide scientific basis for the reconstruction and risk assessment of ecological security pattern and geological disaster early warning in Guangxi. The study will provide scientific basis for reconstructing ecological security pattern and risk assessment of typical watershed and early warning of geological disasters.

9. Research on connectivity characteristics and regulatory mechanisms of typical marine ecosystems (C03)

The application should focus on the specific biological species and typical marine ecosystems in Beibu Gulf as the research objects, the research on life history, genetics and risk-causing factors of biological species, as well as the research on marine ecosystem connectivity, landscape ecological patterns and evolutionary mechanisms to provide scientific basis for improving the ecological functions and overall conservation capacity of typical marine ecosystems in Beibu Gulf, in response to key scientific issues such as changes in life history strategies of specific biological species and reconstruction of typical marine ecosystems under multiple pressures.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Guangxi Zhuang Autonomous Region.

x. Surrounding the natural and engineering disaster protection needs of Sichuan, for the unique natural geographic environment and ecological resources in Sichuan and its surrounding areas, difficulties in the development of special resources, disaster prevention and mitigation and ecological protection of the relevant basic research should be carried out.

Key directions for support:

1. Basic research on efficient exploitation of deep carbonate gas reservoirs in Sichuan Basin (E04)

Deep carbonate rocks are the main battlefield for increasing gas storage and production in Sichuan Basin, and improving acid pressure reformation volume and sulfur prevention and water control are the keys to efficient gas reservoir extraction. The application should focus on the complex mechanism of acid formation and etching in deep high-temperature and high-pressure hole-hole-slit reservoirs, and the complex mechanism of seepage by the joint action of side and bottom water intrusion and sulfur deposition, conduct basic research on the competitive fracture initiation and expansion of acid fractures, dynamic evolution of acid-etching and flow-conducting capacity, and multi-scale coupled seepage mechanism to support the construction of 100 billion cubic meters production capacity in Sichuan Basin.

2. Intelligent inspection and theoretical methods and technologies of safety evaluation for high dam hub flood discharge and energy dissipation buildings (E09)

Safe flood discharge and efficient energy dissipation of high dam hubs are the keys to safe operation of hydropower projects. The application should focus on the structural safety problems faced by flood discharge and energy dissipation buildings in Sichuan high dam hubs during operation, carry out research on the coupling mechanism between flood discharge and high-speed water flow and damage to the overflow surface, break through the theoretical method of intelligent inspection with strong adaptability to complex environments and efficient identification technology of damage characteristics, and establish a structural safety analysis and evaluation method with multiple information fusion to effectively support the safe operation and intelligent control of high dam hubs.

3. Stability of peatland carbon pools and evolutionary mechanisms of carbon sink function in southwest China (D01 or D03)

The application should assess the stability of peatland carbon pools, clarify the evolution mechanism of peatland carbon sink function, quantify the ecological threshold of peatland carbon sink transformation, reveal the key biogeochemical processes of peatland carbon sink transformation, and provide scientific basis and theoretical support for peatland restoration and conservation, targeting the key scientific issue of the evolution mechanism and biogeochemical processes of peatland ecosystem.

4. New mechanism of directional degradation and high value utilization of polyolefin plastic waste (B01 or B05)

The application should aim at the increasingly serious problem of environmental pollution caused by plastic waste, the research targets polyolefin plastic waste, which accounts for the largest proportion, and carries out research on new methods and mechanisms for mild and targeted degradation of waste oriented to the application of functional/high-performance materials, develop new methods for controlled, in-situ modification and high-value utilization of degradation products, study the relationship between structure and performance of recycled materials, and provide theoretical basis for the development of economical and feasible plastic recycling technologies to reduce plastic waste pollution and resource waste.

5. Microfabrication reinforcement mechanism of muddied interlayer on red-layered slopes in central Sichuan (E08)

The application should focus on the demand of infrastructure construction in Chengdu-Chongqing Economic Circle, aiming at the problem of massive sliding and instability of Sichuan Central red formation slopes containing muddied interlayer, and carry out research on the basic scientific issues such as quantitative characterization and similar clustering of microstructure features of muddied interlayer, the evolution law of microstructure and crystal phase of typical muddied interlayer under microwave environment and its correlation mechanism with shear characteristics and water stability, reveal the microscopic reinforcement mechanism of muddied interlayer under microwave environment, and provide theoretical support for green and efficient reinforcement of muddied interlayer slopes.

6. Evolutionary mechanism and dynamic monitoring and early warning of flash flood mudflow formation in earthquake-prone areas (D01 or D07)

The application should respond to the major demand for high discovery and refined monitoring and early warning of flash floods and debris flow disasters in Sichuan under the superimposed influence of strong earthquakes and extreme climate, the research on the critical activation conditions of seismic loose material sources in small watersheds in earthquake areas, the mechanism of violent siltation of gully beds, the evolution model and disaster formation characteristics of flash floods and debris flows, the construction of refined monitoring and dynamic classification and early warning system of flash floods and debris flows, and the demonstration in a typical small watershed in Dujiangyan to solve the problems of flash floods and debris flows forecasting and early warning and disaster prevention and mitigation.

7. Spatial functional units and environmental effects of villages and towns in the Sichuan Basin (D01)

The rational and orderly spatial structure and function of villages and towns is an important foundation for rural environment and ecological protection and regional coordinated and sustainable development. The application should focus on the scientific classification and precise positioning of the spatial functions of villages and towns at multiple scales, quantitative analysis of the metabolic processes and environmental effects and mechanisms of village systems, the calibration from “functional units” to “functional units” of village space, and the integration of multidisciplinary knowledge and methods, providing a systematic and comprehensive solution to the key issues of rural environment and development. The application should also integrate multidisciplinary knowledge and methods, and innovate the theories and methods for systematically and comprehensively solving key problems of rural environment and development.

8. Study on the characteristics and degraded ecological conservation of the calcium wars in Xuebaoding watershed (D02 or D03)

The application should take the natural heritage of Calcarea in Xuebaoding watershed as the object, in view of the recent tourism pressure and natural disasters, study the characteristics of

cross-scale pore unit and co-deposition coupling law of calcarea natural sponge geological body in Xuebaoding watershed, study the characteristics of Ca-C-H2O cycle system, the process and mechanism of calcarea-microbial co-evolution, clarify the degradation characteristics and evolution law of calcarea in Xuebaoding watershed, study the ecological restoration and conservation technology of calcarea, and provide scientific support for the conservation of calcarea natural heritage.

9. Multi-phase interaction mechanism and environmental response of in-situ mining of typical solid potassium ore in Sichuan Basin (D03)

The application should focus on the resource characteristics of typical solid potassium ore in Sichuan Basin, conducting the research on multi-scale damage mechanism and ecological response of typical insoluble solid potassium ore under the introduction of external field, revealing the dissolution mechanism of major elements such as potassium and sulfur, and forming a physical phase regulation scheme for leach mining; conducting research on water-salt-rock interaction under temperature-pressure coupled field, analyzing the migration and enrichment law of mineralizing elements such as potassium and sulfur, and multi-media mass transfer mechanism, and providing theoretical support for green in-situ efficient mining of typical insoluble solid potassium ore.

10. Research on 3D geological structure model and earthquake risk of Longquanshan Fault Zone in Sichuan Basin (D02 or D04)

The application should carry out research on fracture structure detection, deep and shallow tectonic relationship, tectonic deformation mechanism and its related seismic activity using seismic geological and geophysical methods, establish a fine 3D geological structure and tectonic model, reveal the seismic recurrence pattern of fold-fault combination and its seismic risk, and provide scientific basis for urban planning and seismic disaster prevention and mitigation in Chengdu.

11. Basic research on chemical method to monitor environmental disasters and post-disaster pollution in Sichuan (B04 or B06)

The application should focus on major environmental disasters in Sichuan and addressing the problems such as short warning time of physical method, research on chemical method to monitor natural and engineering environmental disasters and post-disaster pollution. The application should screen molecular/atomic level markers for disaster warning and post-disaster pollution prediction, study their mechanisms of action, and achieve the goal of significantly earlier and more accurate disaster warning and post-disaster pollution prediction through on-site, real-time monitoring, and provide technical support for new monitoring methods, devices and applications for disaster prevention and emergency management.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Sichuan Province.

xi. Basic research for the ecological environment of Tibet, on ecological restoration, ecological protection and ecological construction

Key directions for research:

1. Impact of Sichuan-Tibet railway construction on typical ecosystem and its restoration technology (D01 or D07)

The application should identify the types of ecosystems and dominant ecosystem service functions along the Sichuan-Tibet railway, assess the possible impacts of the construction of the Sichuan-Tibet railway on the structure, functions and carrying capacity of different typical ecosystems along the route, propose effective countermeasures and ecological restoration techniques to safeguard the diversity and scarcity of ecosystems along the Sichuan-Tibet railway, maintain or improve the ecosystem service functions, explore the path to realize the ecological values along the Sichuan-Tibet railway, and build a green Sichuan-Tibet railway.

2. Glacial microbial communities and their driven biogeochemical cycles on the Qinghai-Tibet Plateau (C01)

To study the structure and diversity of glacier microbial communities, analyze the construction of molecular ecological networks and their characteristics, and reveal the composition of glacier microbial communities and their key factors affecting the biogeochemical processes of carbon and nitrogen transformation and the molecular mechanisms of their microbial actions.

3. Resource excavation and protection technology for ethnic communication, exchange and blending along Sichuan-Tibet railway (G04)

Excavate the cultural forms, excellent cases, typical relics and important cultural relics of ethnic communication, exchange and blending along the Sichuan-Tibet railway, clarify the context and origin of ethnic communication, exchange and blending along the railway, explore the carriers and inheritance channels of ethnic communication, exchange and blending, and explore the effective ways of rational utilization, inheritance and development of ethnic communication, exchange and blending resources along the Sichuan Tibet railway, such as the reconstruction of relics, restoration of cultural relics, architectural restoration and demonstration of folk scenes, and build the Sichuan-Tibet railway into a demonstration line of ethnic unity.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Tibet.

xii. Based on ecological environmental protection and restoration in Gansu, focusing on the evolution of forest, wetland, and grassland ecosystems in alpine regions, optimal allocation and ecological restoration of water resources in the upper reaches of the Yellow River, prevention and control of desertification in the Hexi Corridor and ecological barrier effects, major water diversion projects and prevention of key disasters, carry out related basic research on key technical and scientific issues such as seismic reinforcement of the cave temple.

Key directions for research:

1. The impact mechanism of global changes on the forest structure and function of the upper reaches of the Yellow River (D01 or D05)

The application should take forests in the upper reaches of the Yellow River as the research object, carry out research on the response process and mechanism of forest ecosystems in alpine regions to global changes; clarify the impact mechanism of regional climate change on the distribution, composition and succession of forests in alpine regions in the past 100 years; and reveal forest ecosystems in alpine regions, and the coupling mechanism of water, carbon and nitrogen, providing scientific support for ecological protection and restoration in the upper reaches of the Yellow River.

2. Biological coupling mechanism of the evolution of alpine wetland and grassland ecosystems (D01 or D07)

The application should focus on the degradation status of the alpine ecosystem in the source area of the Yellow River, study the carbon and nitrogen cycle, the coupling mechanism of aboveground/underground organisms, the mechanism of community change and degradation during the succession of alpine wetlands and grasslands; reveal the key driving factors affecting the multifunctionality of the ecosystem, providing a theoretical basis for the restoration and protection of the degraded alpine ecosystem in the upper reaches of the Yellow River.

3. Optimal allocation of water resources and ecological restoration of the Yellow River Basin in Gansu (D01 or D07)

The application should take the Yellow River Basin in Gansu Province as the research object and based on methods such as positioning monitoring, isotope tracing, and model simulation,

describe the regulation mechanism of glacial frozen soil, forest, grassland, wetland and other ecosystems on the ecological hydrological process and water cycle; and reveal the influence of the ecological environment evolution process on the water source. The application should reveal the influence mechanism of conservation capacity and soil water carrying capacity; build a model for ecological restoration, water conservation function enhancement, and water resource optimal allocation under changing environments, providing a theoretical basis for the sustainable use of water resources in the Yellow River Basin (Gansu Section).

4. The mechanism and regulation of sand fixation in the barrier zone of the Hexi Corridor (D01 or D07)

The application should take the large-scale sand-resisting sand-fixing belt in the Hexi Corridor area as the research object, clarify the coupling relationship of key factors such as water, soil, gas, generation, wind-sand/dust; analyze the edge effect and mechanism of sand-resisting and sand-fixing; determine the key to the stability of the sand-resisting sand-fixing belt factors and their thresholds; and reveal the stability mechanism of sand-fixing communities and the mechanism of water regulation, providing a theoretical basis for the establishment and ecological restoration of sand-blocking sand-fixing belts at the edge of oasis.

5. The damage mechanism and key prevention technology of major water diversion projects in cold and arid areas (D01)

The application should focus on the complex geological conditions, harsh environment, and salt-alkali hazards of freezing and thawing in cold and arid areas, research on the impact of freezing and thawing, salt-alkali erosion, and dry-wet cycles on the water diversion project; and reveal the harmfulness and damage caused by multiple factors, disaster-causing mechanism; research and development of key prevention and control technologies for project operation risks caused by complex environments, providing technical and theoretical support for the safe and stable operation of water diversion projects in cold and arid areas.

6. Study on the ecological barrier effect of the ecological system changes in Qilian Mountains (D01 or D07)

The application should construct a new eco-hydrological model based on stable isotope tracing in cold regions; analyze the hydrological effects of changes in ecosystems such as glaciers, frozen soils, forests, and meadows; and simulate soil water vegetation carrying capacity and ecosystem water conservation functions under different climate change scenarios, proposing an optimization plan for the ecological barrier function to provide scientific and technological support for the sustainable development of the Qilian Mountain ecosystem.

7. Earthquake disaster risk and prevention of the Maijishan Grottoes (D04 or D07)

The application should comprehensively carry out the seismic environmental evaluation of the Maijishan Grottoes, the seismic response mechanism of the cliff, the stability evaluation of the rock mass and plank road structure, the identification of earthquake disaster risks and the seismic safety defense countermeasures, reveal the earthquake damage mechanism of the cave temple, and construct the earthquake hazard assessment and analysis of the cave temple. The monitoring and early warning system provides theoretical support for seismic reinforcement and safety protection of cave temple cultural relics with special terrain in areas with high seismic intensity.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Gansu Province.

viii. In view of the insufficient research on the adaptation mechanism of alpine vegetation in Qinghai, the fragile ecosystem, easy degradation, sensitivity to climate change, and the need to improve the adaptive management level of the ecosystem, the application should develop the ecological adaptation mechanism of vegetation in typical regions of

Qinghai Province and provide good grass animal germplasm resistance, global change impact, ecosystem stability maintenance function enhancement, ecological function impact and regulation analysis, degraded ecosystem restoration and management and other related basic research.

Key directions for research:

1. Vegetation adaptation mechanism and ecological restoration of saline-alkali land in the alpine region of Qinghai (C03)

The application should take the alpine salinized desert vegetation in the Qaidam Basin as the research object, carry out the analysis of the characteristics and adaptation mechanisms of the alpine-tolerant, saline-alkali ecosystem-soil-plant community, and study the degradation and desertification of the saline-alkali ecosystem under extreme conditions, revealing the salinized soil damaged characteristics, and proposed ecosystem restoration and regulation mechanisms.

2. Research on the resistance molecular adaptation mechanism of perennial and annual native forage species in Qinghai (C16)

The application should be based on the existing Poa, Fescue, Elymus, Roegneria, Phyllostachys, Oats, Puccinellia, Leymus, etc. in Qinghai pastoral area, Kobresia of Cyperaceae, Moss Grass genus, leguminous forages and other native grass species are the research objects, to carry out researches on the physiological ecology, high-yield cultivation and environmental adaptability of forages in the process of domestication and breeding, discover genes or genome segments that regulate important traits of forages, and innovate and cultivate suitable high-yield, multi-resistant, high-quality forage grass strains or varieties in different ecological regions of Qinghai (such as the source of the three rivers, the surrounding lakes and the Hehuang valley).

3. Research on the spatial distribution pattern and energy utilization mechanism of animal intestinal microbes on the Qinghai-Tibet Plateau (C17)

The application should be aimed at the characteristics of important ecological and economic value of large herbivores such as wild animals and domestic animals in the alpine area of Qinghai, study the synergistic mechanism of forage-animal intestinal microbes, reveal the changing laws of forage-herbivore intestinal microbes, and analyze the potential functions and metabolic characteristics of the special animal intestinal flora, clarify the important role of intestinal microbes in the adaptation, evolution, and physiological functions of herbivores, clarify the mechanism and control factors of animal methane emission and energy efficient utilization, and provide a theoretical basis for the protection of wild animals and the development of ecological animal husbandry.

4. The relationship between biodiversity and ecosystem functions in Qinghai's alpine region under climate change and human disturbance (C03)

The application should be based on the greater impact of climate change and human disturbance on the relationship between species diversity and ecosystem functions in Qinghai Plateau ecosystems, Qinghai alpine ecosystems (including alpine grasslands, alpine deserts, and alpine wetlands) of different succession degrees (including alpine grasslands, alpine deserts, and alpine wetlands) were selected for natural gradient observation and control experimental research, carry out the analysis of the relationship between biodiversity and ecosystem functions in the ecological function areas of the Sanjiangyuan, Qilian Mountains and the Qinghai Lake, and clarify the impact mechanism of climate change and man-made disturbances on the relationship between alpine biodiversity and ecosystem functions, providing a theoretical basis for Qinghai's ecological protection, ecosystem management, ecological compensation strategy formulation and response to climate change.

5. Study on the interaction between plateau frozen soil-vegetation-climate (D01 or D05)

The application should be in response to the ecological consequences of greenhouse gas

emissions, vegetation degradation, and decline in water conservation functions brought about by the freezing and thawing of frozen soil on the Qinghai Plateau, the feedback relationship between frozen soil-vegetation-climate has been developed in typical areas such as the source area of the Three Rivers and the Qinghai area of the Qilian Mountains. The mechanism of the spatiotemporal changes of soil layers on the properties of plants, soil and microorganisms, the study of the response of key ecological processes to freezing and thawing effects and extreme plateau conditions, revealing the feedback mechanism between permafrost-vegetation-climate, and clarifying the changes and the process and mechanism of ecosystem degradation under the action of freezing-thawing of plateau frozen soil.

6. Research on the cooperative mechanism between livestock and rodents in Qinghai grassland and the sustainability of "rewilding" (C04)

The application should be based on the symbiotic relationship between livestock and rodents in the alpine region of Qinghai, analyze the relationship between grassland biodiversity, rodent populations and livestock population changes, and clarify the "re-wildization" of livestock and rodents and the biodiversity and ecological multi-functionality of alpine grasslands, the interaction relationship among livestock, pasture and rodents, reveal the multi-directional feedback regulation mechanism among domestic animals, pastures and rodents, and explain the internal connection and occurrence mechanism among producers, consumers, and decomposers, as well as provide theoretical basis for grazing management and rodent control in Qinghai alpine grasslands.

7. Water-holding function of the Yellow River source ecosystem and its regulation mechanism (D01, D05 or D07)

The application should aim at the key issues of functional degradation, species diversity and reduction of water content capacity of typical ecosystems in the Yellow River headwaters. The application will investigate the interactions between the water cycle, the driving force of hydraulic erosion and factors, the relationship between solid-liquid imbalance in the cryosphere and water content function, the coupling mechanism and influence among water content function and climate environment, ground and air action, soil characteristics, vegetation cover, plant and animal population dynamics. The application should carry out the study which should reveal the water content function of the main ecosystems of the Yellow River headwaters and its regulation mechanism, and maintain and improve the water content function of the wetland and grassland ecosystems of the Yellow River headwaters.

8. Research on recovery and evolution of degraded alpine grasslands (C03)

The application should be based on the degradation and evolution of alpine grasslands in Sanjiangyuan and other typical ecological function areas in Qinghai (e.g., small tarragon meadow, purple fescue grassland, etc.), study key plant traits such as seed set rate, seed bank and germination rate of dominant plants in the process of grassland degradation, elucidate the degradation mechanism and recovery mechanism of alpine grasslands in Sanjiangyuan, clarify the key limiting factors for the recovery of degraded alpine grasslands in Sanjiangyuan and other regions, study the ecological integrated effects and recovery of species allocation, plateau sage-grouse, and the ecological effects of species allocation, biological control, exogenous nutrient addition such as biogenic carbon, black soil beach/black soil mountain management and restoration model to improve the ecological and productive functions of degraded grasslands, and build alpine grassland community with Song grass and grass as the dominant species.

9. Research on adaptive management of national park ecosystems (D01, D05 or D07)

The application should conduct research on the mechanism of biodiversity formation and maintenance in Qinghai Sanjiangyuan and Qilianshan National Parks, the mechanism of near-natural restoration and function enhancement of typical ecosystems such as grasslands and wetlands, analyze the mechanism of grazing production, snowpack, multi-year permafrost, seasonal

permafrost and atmospheric interaction, study the process of wildlife habitat restoration and maintenance and the regional coupling model of grassland-herbivore balance, integrate the function restoration and enhancement model of typical degraded ecosystems such as wetlands, grasslands, woodlands and deserts in the parks, conduct research on adaptive management of national park ecosystems at different scales, and build an ecological-economic-humanistic coupled adaptive management model.

10. Research on the mechanism and model of sustainable restoration of degraded alpine ecosystems (C03)

The application should aim at the short-term effects, unsustainability and uncontrollability of the recovery of degraded ecosystems in alpine regions of Qinghai. The study focuses on the degradation process, mechanism and its recovery effect tracking and evaluation of alpine grasslands and wetlands, reveals the ecological mechanism and recovery potential of sustainable recovery of degraded ecosystems in alpine regions of Qinghai such as Sanjiangyuan, proposes the theoretical system of degraded ecosystem adaptability and recovery technology, and provides theoretical basis for realizing the virtuous cycle of ecological and productive functions of alpine ecosystems.

11. Early warning thresholds for alpine ecosystem multistability maintenance mechanisms and leapfrogging (C03)

The application should reveal the maintenance and driving mechanisms of biotic and abiotic factors on alpine ecosystem multi-stability during the critical period of alpine ecosystem degradation and restoration succession sequence in Qinghai Plateau, detect the early warning signals of leap changes in the state of alpine meadows, grasslands, deserts, wetlands and other ecosystems, determine the multi-threshold values of leap changes in ecosystem structure and function, and provide early warning and response measures for the critical period of alpine ecosystem degradation and restoration process.

12. Research on ecological conservation of cordyceps and other special biological resources (C03)

The application should investigate and evaluate the distribution and ecological reserves of characteristic plant germplasm resources in different regions of Qinghai, assess the ecological benefits, and conduct research on ecological conservation and protective development and utilization of Cordyceps and other characteristic resource populations in their native habitats.

13. Alpine Plateau ecosystem service functions and ecological security (D01)

The application should conduct research on the spatial and temporal differences of ecosystem service functions in key ecological function areas of Qinghai and the driving forces of their changes, the trade-offs of ecosystem service values and spillover effects outside the region, the assessment of ecological functions and ecological values of typical ecosystems, accounting for the ecological values of alpine ecosystem services in the Qinghai Plateau and outside the region, and analyzing the ecological carrying capacity and ecological security pattern construction of ecologically critical areas such as the Yellow River source area, Qilian Mountains, Qinghai Lake and Cocosili.

For the above research directions applicants are encouraged to carry out cooperative research with universities or research institutions with research strength and research conditions in Qinghai Province.

III. Energy and Chemical Industry

i. Basic research responding to the major needs of the renewable energy, chemical and pharmaceutical industries in Hebei Province and focusing on key scientific problems in the fields of basic materials, hydrogen energy, green chemical process, nanomedicine, natural gas

storage and flexible DC transmission.

Priority research areas:

1. Mechanism and control of large-scale renewable energy-source multi-energy complementary hydrogen production and sunlight-driven hydrogen production from coal (E06 or E07)

Proposals are expected to respond to the demand for green energy supply of the Zhangjiakou Renewable Energy Demonstration Zone in Hebei Province and the national strategy of coal production capacity cutting, promote the green upgrading of coal industry with low energy-consumption and low-pollution coal-based hydrogen production technology, and provide scientific support to the comprehensive utilization of new energy. Priorities will be given to basic problems related to wind and photovoltaic power storage, off-grid and grid-connected systems, hydrogen production and storage of high-efficiency hydrogen production based on DC interconnection under wide power fluctuation, including the DC interconnection mechanism and coupling mechanism of multiple energy sources such as wind power, photovoltaic power, electricity, hydrogen and heat; the modeling, control and optimization of integrated energy system. Key areas include the development of new routes, new technologies and new equipment for high-performance sunlight-driven hydrogen production from coal, new sunlight-driven catalytic system for large-scale application, and the influences of photon capture mode, photochemical energy conversion principle and coal hydrogen catalytic mechanism on the sunlight-driven hydrogen production from coal.

2. The intrinsic safety reaction process and reinforcement mechanism for the synthesis of alicyclic isocyanates (B08)

Toluene diisocyanate (TDI) is an important raw material for polyurethane production. Hebei's production of TDI ranks first in China. However, the phosgene method of TDI production currently used by enterprises at home and abroad is highly toxic. Proposals are expected to solve the bottleneck problems that limit the green development of TDI industrial production, such as the use of highly toxic phosgene and environmental pollution, respond to the demand for high-performance polyurethane materials, and conduct research on the green reaction, intrinsic safety method and process enhancement technology for the synthesis of methylcyclohexane diisocyanate, so as to provide scientific basis for the green and safe production of methylcyclohexane diisocyanate.

3. Controllable preparation and properties of carbon based composite anode materials (B05)

Proposals are expected to address the urgent needs of the development of new energy vehicles and energy storage industry in Hebei, focus on the existing problems of battery system in terms of energy density, power characteristics, safety and other problems, conduct research on carbon based composite anode materials and provide scientific basis for the design and application of high-performance carbon matrix composite anode materials. Priority areas include green preparation method of carbon-based materials; the structure-activity relationship and control mechanism of carbon based composite anode materials; the exsolution mechanism of carbon/phosphorus composite anode materials; the stabilization mechanism of electrode/electrolyte interface; the in-situ testing method of the reaction process of carbon matrix composite anode materials; the growth and inhibition mechanism of lithium dendrite and the interface stability mechanism.

4. Green controllable preparation and film formation mechanism of waterborne composite coatings (B08)

Proposals are expected to address the urgent demand for waterborne industrial coatings in Hebei Province, solve the problems of existing waterborne coatings, such as poor weather

resistance, low adhesion, poor corrosion resistance, poor flame retardance and antibacterial properties, etc., and provide theoretical support for the green transformation and technological progress of waterborne industrial coatings in China. Priority areas include the molecular design and green controllable preparation of composite emulsion for waterborne coatings; the film formation mechanism of waterborne coatings, especially the interaction between resin molecules, pigments, fillers and auxiliaries in the emulsion and the interaction mechanism between coatings and the substrate; and the molecular-level mechanism of underlying the functioning of corrosion resistant and flame retardant components.

5. Basic research on enhanced intratumoral delivery of antitumor drugs (B08)

Proposals are expected to focus on basic research of intratumoral delivery of anti-tumor drugs and design nano-drugs with high intratumoral-delivery efficiency to reduce tumor interstitial fluid pressure, improve efficacy, kill deep-level cancer stem cells, and effectively inhibit tumor recurrence and metastasis. It is also expected to reveal the reaction process and regulatory mechanism of reducing tumor interstitial fluid pressure to achieve efficient delivery of drugs.

6. Efficient joint exploitation and utilization of offshore wind and photovoltaic power in Bohai Bay (E07 or E11)

Proposals are expected to improve the utilization efficiency of wind and solar power in Hebei offshore area, and provide scientific basis for efficient exploitation and utilization of renewable energy in Hebei. Priority areas include: the new offshore wind and photovoltaic power generation infrastructure system under the combined action of wind, wave, current and ice, and he safety assessment theory; high-efficiency construction methods and safety control principles of offshore wind and photovoltaic power generation structures; and the complementary allocation and regulation theory of offshore wind and photovoltaic power.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Hebei province.

ii. Applied basic research addressing the major needs of comprehensive energy reform of Shanxi Province, including conversion and high value-added utilization of coals, comprehensive utilization of low-grade coal-based resources and high-efficiency energy systems

The average funding (direct costs) for each Integrated Program project is 10 million yuan. Priority areas include:

1. Basic theories and methods of energy management for large-scale integrated energy systems (E07)

This program aims at multidisciplinary problems related to large-scale integrated energy systems such as electrical technique, thermokinetics, architecture, environment and information technology, focus on energy conversion, storage, scheduling, control and other key links of multi-energy cooperation, explore the deep integration mechanism of heterogeneous multiple energy flow and information flow, develop theory, methods and models for energy management of large-scale integrated energy system, produce the prototype systems featured by multi-agent distribution and cooperation for energy management of large-scale integrated energy system and conduct a pilot application so as to support the intelligent transformation and upgrading of energy industry in Shanxi. The program includes the following topics:

(1) The theoretical model and methods for efficient conversion and multi-spatial-temporal scale collaboration of energy for energy terminals

Proposals are expected to solve the problems faced by energy terminals such as lack of collaborative energy transfer mode, energy grade differences, and unclear mass-energy conversion effect, study the modeling methods for spatiotemporally multi-scale high-efficiency energy conversion, reveal the rules of dynamic matching of multi-energy flow, development dynamic

coupling and collaboration methods for mass-energy transfer and conversion process, produce prototype devices for spatial-temporal collaborative operation of energy terminals, and provide flexibility for the regulation of energy systems.

(2) Methods for self-organized and coordinated control and operation optimization of large-scale multi-energy storage carriers and energy storage clusters

Proposals are expected to solve the problems of multi-energy storage carriers, such as property differences, energy conversion complexity, and cluster property differences, conduct research on the properties of multi-energy storage carriers and high-efficiency energy conversion methods, reveal the mechanism of dynamic coupling and coordination of spatiotemporally multi-distributed multi-energy storage clusters, propose the self-organized coordination control method and multi-level coordination control architecture of clustered multi-energy storage, and develop prototype devices for energy storage coordination with high energy conversion efficiency and experimental platform for self-organized coordination of energy storage clusters.

(3) The unified analysis model and collaborative optimization method for heterogeneous multi-energy flow networks

Proposals are expected to solve the problems of electricity-heat-cold-gas heterogeneous multi-energy flow, such as strong coupling complementarity, high risk of cascading failure in operation, difficulty in integrating multiple disciplines, low problem-solving efficiency for large-scale systems. It is expected to study the unified analysis modeling methods, establish the theoretical model of unified time-varying energy circuit, find solutions for the dynamic state estimation, safety analysis, optimal scheduling and network reconfiguration of multi-energy flow for quantity regulation of heat supply network, explore the regulation flexibility of different energy resources, and improve the safety and economic efficiency of the operation of multi-energy flow systems.

(4) The analysis methods and collaborative optimization of the deep integration of the information flow and energy flow

Proposals are expected to address the security risk of energy flow in large-scale integrated energy systems induced by the coupling of information flow and energy flow and the vulnerability of information flow in open cyberspace, establish modeling theory and quantitative analysis methods for information-energy space integration, study the disturbance propagation mechanism under the deep integration of information, energy and society, establish the comprehensive security assessment and attach-defensing methods for large-scale integrated energy systems under the scenario of an integrated public-private sector communication, develop the prototype system for the distributed and collaborative multi-agent energy management of large-scale integrated energy systems, and carry out pilot trial in large cities of Shanxi Province, so as to build a safe, efficient, clean and low-carbon urban energy system.

Applications for the Integrated Program grants should cover all the four topics mentioned above and conduct in depth and systematic studies around the theme of “basic theories and methods of energy management for large-scale integrated energy systems”. The expected results should include theory, methods, technologies, software systems and patents.

Areas for Key Program grants:

1. Preparation and property regulation of coal-based surfactants (B08)

Proposals are expected to address the demand for technologies that can increase the added value of coal chemical products, focus on the preparation and property regulation of coal-based surfactants, achieve breakthroughs on key scientific issues such as the effective separation of long-chain olefins/alkanes, the design and construction of hydrophilic and lipophilic linker groups of surfactants, and the selective control of surfactant properties, and provide scientific support for the industrial chain of new coal-based fine chemicals.

2. Basic research on heterogeneous catalytic system for cycloaddition of CO2 with ethylene oxide (B08)

Proposals are expected to focus on the inorganic metal oxide-based halogen-free bifunctional heterogeneous catalysts, construct a catalytic system with cation-deficient acidic and basic centers with coordinatively unsaturated oxygen atoms simultaneously, reveal the mechanism of the synergistic activation of CO2 with ethylene oxide, clarify the matching of activation performance and steric hindrance effect of the centers of metal oxide catalysts at the at the electronic and molecular level, and realize the high-efficiency and green cycloaddition of CO2 with ethylene oxide.

3. The distributed micro energy network and intelligent control of low concentration coal-bed methane coupled renewable energy (E05, E06 or E07)

Proposals are expected to address the key scientific problems of distributed energy network of low concentration coal-bed methane coupled renewable energy, such as high-efficiency conversion of coal-bed methane, energy coupling and collaborative regulation of micro energy network, the framework and basic design of multi-energy complementary micro energy network, the control mechanism of the quality and stability of multi-grade waste heat of distributed micro energy network, establish the distributed micro energy network for low concentration coal-bed methane coupled renewable energy, and achieve the intelligent control and optimization of energy flow of the distributed energy network of low concentration coal-bed methane coupled renewable energy.

4. Preparation and process of catalyst for ethylene production from low concentration coal-bed gas (B02 or B08)

Proposals are expected to focus on the characteristics of coal-bed methane of Shanxi Province, develop high-efficiency adsorption materials for low concentration coal-bed methane, design and construct catalysts for highly selective conversion of methane into ethylene and high-selectivity olefin adsorption separation materials, reveal the catalytic mechanism of metal oxides, and realize the selective catalytic conversion of methane to ethylene based on in-depth thermodynamic and kinetic studies.

5. Basic research on the engineering of separation-based quality improvement and cascade collaborative separation of low-grade coal (B08)

Proposals are expected to address the difficulties in separating and upgrading of low-grade coal, and in separating and recycling resources from complex chemical components of fly ash after combustion, study the high-efficiency separation and upgrading methods of minerals from emulsion, the micro-mechanism of the interactions of gas-liquid-solid phase interface in separation process, and the cascade collaborative separation of metals from complex systems, and develop technologies for separation-based quality improvement and cascade collaborative separation of low-grade coal.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Shanxi province.

iii. Basic research addressing key scientific and technological issues that will contribute to the development of the energy and chemical industries of Liaoning province, such as energy conservation and emission reduction of mines, construction of energy storage project, methane catalytic cracking for hydrogen production, and high-performance ethylene separation membrane

Areas for Key Program grants:

1. Optimization of the mining technologies for intelligent and ecological mining (E04)

Proposals are expected to focus on large mines in Liaoning province and address urban ecological and environmental problems emerged in the interaction between mining and

urbanization, study key technologies of energy conservation in mine blasting, ore blending and crushing, reconstruct the energy dissipation system of intelligent mining, and achieve a dynamic balance between mine production and environmental effects.

2. The coupling mechanism of directional and high-efficiency accumulation of phosphorus and high-temperature adsorption of heavy metals in two-step heat treatment process for sludge (E06 or E10)

Proposals are expected to address the major technical requirements and key scientific problems of sludge treatment and resource recycling in the field of sewage treatment in Liaoning Province, focus on the recycling of resources in sludge, study the directional and high-efficiency accumulation methods for phosphorus resources in sludge, and explore the mechanism of coprecipitation decoupling of heavy metals and phosphorus and the mechanism of high-temperature resistant adsorbents.

3. Technologies for the high-safety and efficiency construction and operation of gas reservoirs-converted underground gas storage group (E04 or E08)

Proposals are expected to focus on the gas storage group of Liaohe oilfield and address the problems in the efficient construction and operation of gas reservoirs-converted underground gas storage group, such as the three-dimensional seepage–true stress coupling theory for underground gas storage stratum, the theory and techniques of airtightness assessment, and the storage performance evaluation and parameter optimization method, so as to establish a technology system for the safe and efficient operation of gas reservoirs-converted underground gas storage group with a capacity of tens of billions cubic meters.

4. Technology of methane catalytic cracking for hydrogen production (B08)

Proposals are expected to address the demand of Liaoning chemical industry, focus on the safe and value-added utilization of methane, especially the abundant resources of dispersed methane from coalbed methane and biogas fermented by biomass such as straw, study the key scientific problems such as the mechanism of methane catalytic cracking and the deactivation kinetics of iron-based catalysts, so as to achieve major breakthroughs of technologies and equipment of methane catalytic cracking for hydrogen production and solve the problem of value-added utilization of methane.

5. Nano materials for viscosity reduction and flooding in heavy oil recovery (E02 or E04)

Proposals are expected to meet the specific requirements of heavy oil recovery in Liaohe Oilfield, study the new nano materials for viscosity reduction and oil displacement, and explore the underlying mechanism so as to improve heavy oil recovery efficiency.

6. High performance ethylene separation membrane (B08)

Proposals are expected to address the problem of high energy consumption of ethylene separation in Liaoning chemical industry, conduct research on the materials and structure of high-performance ethylene separation membrane, establish the precise control mechanism of membrane microstructure, improve the selectivity, permeability and stability of membrane, and reduce the energy consumption of ethylene and ethane separation systems.

7. Green synthesis technology of high-performance zeolite catalysts (B08)

Proposals are expected to address the sustainable development needs of Liaoning new catalytic material industry, focus on the green production of zeolite catalysts in the process of new coal chemical industry, and study the regulation of reaction activity of liquid and solid wastes, the crystal phase reconstruction mechanism and scale-up preparation process in the catalyst production.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Liaoning province.

iv. Basic research addressing key scientific and technological issues related to the

exploitation and utilization of petroleum, coal and other mineral resources that affect the energy security of Heilongjiang province

Areas for Key Program grants:

1. Theological basis of high-efficiency injection-production technology and integrated down-hole and surface separation technology of produced fluid in high watercut oilfield of the Daqing Oilfield (E04)

Proposals are expected to address the technical requirements of reducing costs and increasing efficiency under high watercut conditions of the tail period of Daqing Oilfield. Topics include the injection-production process, the fluid rheological characteristics in multi-phase flow, the influences of the characteristics and structure of interphase transfer on downhole oil-water separation and injection-production performance, the mechanism underlying the migration and accumulation of multiphase fluid medium in the injection-production wellbore of tail-period wells, the mechanism underlying the influence of the oil-solid-water interface action on emulsion stability of the produced liquid of ASP flooding, the mechanism of high wax oil-water separation, and theoretical basis of high-efficiency oil-water separator and low-temperature transportation of crude oil.

2. Theoretical study on microseismic source inversion and sweet spot prediction of distributed state estimation method for tight oil and shale oil in Daqing Oilfield (D04)

Proposals are expected to address the major technical needs of Daqing Oilfield for the exploitation of tight oil, shale oil and other resources, focus on the absorption and attenuation effect and sweet spot distribution of microseismic signals in the process of propagation, study the nonlinear inversion problems in parameter inversion and sweet spot identification of microseismic source inversion in anisotropic media, solve the problems related to the low signal-to-noise ratio of microseismic signals, low source inversion accuracy, and multi-information integrated sweet spot identification, and achieve the high-efficiency exploitation of unconventional oil and gas.

3. Basic research on the conversion of middle maturate coals into high-value materials and functional resources (E06 or E10)

Proposals are expected to address the need of turning middle maturate coals in Heilongjiang province into high value materials and functional resources, study the formation mechanism of the skeleton structure of coal-based carbon materials, develop the multi-scale regulation method for the functions and structure of coal-based carbon materials, reveal the mechanism enhancing the storage and transportation of electron/molecule/ion in coal-based carbon skeleton and confined pore structure, and provide theoretical and technical support for the development and application of high-value coal-based functional materials.

4. Key basic scientific problems and efficient energy utilization of unconventional natural gas engine (E04 or E06)

Proposals are expected to address the urgent demand of efficient and environmental-friendly utilization of biogas, coalbed methane, synthetic natural gas and oilfield-associated gas resources in Heilongjiang province, focus on the cogeneration type high-power natural gas engine, study the combustion mechanism, high-energy reliable ignition and adaptive control of combustion process of complex-composition unconventional natural gas engine, reveal the combustion mechanism and real-time control mechanism of engines using natural gas with variable composition and concentration, and provide theoretical and technical support for the effective utilization of unconventional natural gas resources.

5. Basic research on gas hydrate curing for outburst prevention in deep coal mine (E04)

Proposals are expected to address the demand of coal and gas outburst prevention and control in Heilongjiang province, select fast hydration additives for coal gas, reveal the

thermodynamic and dynamic mechanisms of the hydration process, carry out the experiments on the mechanical properties of coal gas hydrate system under deep mining conditions, explore the mechanical reinforcement mechanism of gas hydrate-bearing coal, establish the monitoring technology of gas hydrate curing under deep mining conditions, and provide theoretical evidences for the engineering practices of gas outburst prevention.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Heilongjiang province.

v. Basic research addressing key scientific issues in intelligent chemical production, green synthesis technology, green separation technology that meet the demand of developing green chemical industry in Zhejiang Province

Areas for Key Program grants:

1. Controllable catalytic reactions in intelligent manufacturing of fine chemicals (B08)

Proposals are expected to address the problems of high material and energy consumption in the manufacturing process of high-end fine chemicals in Zhejiang Province, and study the reaction process, separation and equipment enhancement for the intelligent production of chemicals. Topics include: the influences of catalyst structure on the bonding of high-end fine chemicals, the key structural properties to improve the reaction selectivity, the development of new catalysts with high reaction selectivity, the coupling mechanism of reaction and separation, and the intensification system for the intelligent production process.

2. New green synthesis technology of bio-based furandimethanol (B08)

Proposals are expected to address the demand of upgrading the polymer and fine chemical industry in Zhejiang Province, study the catalytic synthesis method, process intensification, solvent effect and efficient separation technology of bio-based reduction products of 5-hydroxymethyl furfural series, reveal the principles of non-noble metals as catalytic reaction center, explore the kinetic characteristics of alkali metals and alkaline earth metal promoters, pay key attention to the study of fixed bed hydrogenation catalytic activity and selective regulation mechanism, establish the technical route of novel chemical synthesis such as the synthesis of tetrahydrofuran dimethyl, and promote the application of bio based furandimethanol in the synthesis of high-value chemicals of the Zhejiang Province, such as chemical intermediates, polymer materials, green oil additives and etc.

3. Basic research on green separation in the of manufacturing high-end pharmaceutical chemicals (B08)

Proposals are expected to address the urgent needs of the transformation and upgrading of Zhejiang pharmaceutical and chemical industry, focus on the high-efficiency green separation of important pharmaceutical raw materials, key intermediates, and high-end products, design novel separation mediums with excellent molecular identification ability, high synergistic effect and mass transfer efficiency, reveal the host guest interactions at the nano and micro scale, the relationship between surface/interface structure and molecular transfer mechanism, the multi-field synergy and confinement effect, develop technologies for the molecular identification and separation platform, and achieve highly selective removal of homologues, chiral isomers and trace harmful impurities.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Zhejiang province.

vi. Frontier science and applied basic research addressing key scientific issues in safe and precise mining of coal resources, green conversion of metallurgical gas, reduction of carbon dioxide to liquid fuel, large-scale and efficient consumption of renewable energy, heat load capacity and avoidance of melting of tungsten and copper parts that meet the demand of developing the new energy industry in Anhui province

Areas for Key Program grants:

1. Risk identification and prevention and control technology of typical dynamic disasters in coal mines (E04)

Proposals are expected to address the problems hindering the safe and accurate mining of deep coal resources in Anhui province, study the disaster-forming mechanism of typical dynamic disasters in coal mines under the evolution and coupling effect of multi-physical fields, establish the precursor information database of typical dynamic disasters, improve the disaster risk identification methods, develop the data analysis model and algorithm for intelligent and accurate mining and disaster early warning and monitoring, support the development of disaster monitoring and early warning platform for typical dynamic disasters in coal mines, integrate key technologies of disaster prevention and control, and achieve the safe and accurate mining of deep coal resources.

2. Green conversion of metallurgical gas in iron and steel industry (E04)

Proposals are expected to address the major demand of low carbon emission and by-product recycling in the iron and steel industry of Anhui province, focus on the metallurgical gas (such as blast furnace gas and converter gas), study the green conversion of metallurgical gas under mild conditions, reveal the mechanism of the electro-catalytic regulation of the C-C bond coupling, explore a new electro-catalytic system for the conversion of multi-component metallurgical gas to high value-added chemicals such as olefins, and develop the bench-scale test equipment.

3. High-efficiency conversion of carbon dioxide to multi carbon liquid fuels under mild conditions (E04)

Proposals are expected to focus on two-dimensional ultra-thin semiconductor-assisted photocatalytic activation and directional hydroconversion of carbon dioxide, analyze the fine structure of two-dimensional ultra-thin semiconductor catalysts using large scientific equipment platforms such as synchrotron radiation, monitor the dynamic evolution process of reactant molecules on the catalyst surface in real time by high-resolution in-situ characterization technology, clarify the micro mechanism of chemical bond fracture/formation based on theoretical simulation, and provide scientific support to the design and development of a high performance photocatalytic system for hydroconversion of carbon dioxide to liquid fuels.

4. Theory of power generation, grid connection and collaborative control of large-scale distributed renewable energy (E07)

Proposals are expected to contribute to the large-scale and sustainable development of renewable energy power generation in Anhui province, promote the safe grid connection of large-scale distributed renewable energy, study the distributed stability analysis method of large-scale renewable energy power generation under multiple uncertain conditions, such as the uncertainty of renewable energy generation output, the uncertainty of the temporal and spatial distribution of electric vehicle charging load and the uncertainty of power flow, study the operation plan for power generation and storage integrated power stations of distributed renewable energy, develop the active clustering strategy, autonomous cluster control and active support control scheme of large-scale distributed renewable energy power stations, provide theoretical guidance for the effective regulation of renewable energy power generation capacity and the safe, clean and economic operation of power grid, and provide technical support to the high-efficiency and large scale consumption of renewable energy in Anhui province.

5. The melting mechanism and control of W-Cu components in Tokamak divertor (A29)

Proposals are expected to solve the bottleneck problem of the melting of divertor W-Cu components under the condition of complex high heat flux from Tokamak which limits the long-pulse high-parameter plasma operation, explore the real-time monitoring methods for in-situ melting of W-Cu components and advanced diagnosis methods for the spatial and temporal distribution of divertor heal flow based on the internationally advanced actively water-cooled W/Cu

divertor in the EAST, simulate the heat flow distribution by the particle method, carry out thermotechnical simulation, reveal the melting mechanism of W-Cu components in the operation of EAST, and find effective methods to improve the heat load capacity of W-Cu components and avoid melting of W-Cu components.

6. Key technology of ultra-high-pressure hydrogen compressor in hydrogenation station (E06)

Proposals are expected to address the major demands of Anhui province in hydrogen utilization and the development of fuel cell vehicles, carry out theoretical and applied research on the efficient and safe utilization and conversion of hydrogen and key components of fuel cell vehicles, and provide theoretical and application support for the technological development and industrialization of hydrogen utilization and fuel cell vehicles.

7. Catalytic conversion of agricultural and forestry wastes to liquid fuels and chemical co-products (B05)

Proposals are expected to focus on the abundant agricultural and forestry waste resources in Anhui province, study the co-production of chemicals from biomass based oxygenated fuels, especially the key reactions of biomass catalytic conversion and the basis and technical problems of catalysts and conversion processes, reveal the mechanism of directional conversion of chemicals by typical catalytic reactions, and provide theoretical basis and technical support for the recycling and utilization of agricultural and forestry wastes in Anhui province.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Anhui province.

vii. Frontier science and applied basic research on key scientific issues in battery safety improvement, high-efficiency conversion and utilization of renewable energy, energy chemical process intensification, and design and preparation of electronic chemicals that meet the strategic demand of developing the energy and chemical industry in Fujian province

Areas for Key Program grants:

1. Synthesis and application of high performance ionic liquids (B08)

Proposals are expected to focus on the comprehensive utilization of forest resources in Fujian province, design new high-performance ionic liquids for ester synthesis reaction and separation process, develop the preparation methods of new ionic liquids, study the mechanism of the ionic liquid-assisted intensification of ester synthesis reaction and separation process, and provide a scientific basis for the green and high-efficiency synthesis process of ester reaction.

2. Safety mechanism and performance control of lithium ion battery (B09)

Proposals are expected to focus on the improvement of lithium-ion battery safety, study the safety mechanism and thermal runaway behavior of single battery under different working conditions, explore battery materials with high safety and high performance, develop the in-situ characterization technology of single battery, find new methods of comprehensively improving the safety performance of battery, and provide technical support for lithium battery enterprises of Fujian province.

3. Basic research on catalysis of oxide porous single crystal materials (B09)

Proposals are expected to focus on the growth and porosity of oxide single crystals, explore the evolution of the surface/interface structure and local electronic structure of oxide single crystals and the interaction mechanism of oxide single crystals with CO and other small molecules, and develop high-performance catalytic materials for the treatment of nuclear graphite wastes.

4. Basic research on pyrolysis and catalytic conversion of waste woody oil resources to liquid fuels and chemicals (B08)

Proposals are expected to make use of the abundant forest resources of Fujian province, focus on the key scientific problems of the comprehensive utilization of waste woody oil resources

and carbon dioxide, study the mechanism of catalytic conversion of woody oil by pyrolysis deoxidation and the coupled catalytic pyrolysis of multi-source biomass and carbon dioxide, design and construct high-performance catalytic materials, and realize the coupled conversion of waste woody oil and carbon dioxide to liquid fuels and chemicals.

5. Design and preparation of functional photoresist (B05 or B08)

Proposals are expected to address the major demand of developing electronic industry in Fujian Province, make breakthroughs in bottleneck areas of the preparation of photoresist, study the molecular design and preparation of amphiphilic/amphiphobic photoresist with both development and stripping functions, reveal the functioning mechanism of functional phtoresist, and provide a scientific basis for the industrial production and application of high-performance amphiphilic/amphiphobic photoresist.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Fujian province. Researchers from Taiwan region are encouraged to join the application to promote the scientific and technological cooperation of both sides of the Taiwan Straits.

viii. Basic research on key scientific issues in material fundamentals and green reactions that meet the strategic demand of the energy and chemical material industries in Henan province

Areas for Key Program grants:

1. Basic research on key technologies of coal based natural gas production by short process (B08)

Proposals are expected to focus on the catalytic synthesis of coal based natural gas, especially the key problems of the activity and service life of low-temperature methanation catalysts and rapid heat transfer of reactors, study the interaction mechanism between catalysts and environment and external field, and provide a theoretical basis for catalyst preparation and equipment manufacturing for short-process coal-based natural gas production.

2. The design, synthesis and combustion mechanism of high-energy ion fuels (B08)

Proposals are expected to address the key problems of high viscosity, poor atomization performance and long ignition delay time of high-energy ion fuels, focus on the molecular design, directional synthesis and controllable combustion of high-energy ion fuels, and provide scientific support for the development and application of high-efficiency fuels for a new generation of power energy system.

3. Electrocatalytic nitrogen fixation of molecular based porous composites (B02 or B05)

Proposals are expected to focus on molecular based porous composites, address the problem of improving the activity of electrocatalytic nitrogen fixation, study the mechanism of catalysts/electrolytes, new mediators and the construction of electrochemical oxidation-reduction system for electrocatalytic nitrogen fixation, and provide theoretical support for electrocatalytic nitrogen fixation.

4. The design and synthesis of photosensitive dye molecules for diagnosis and treatment of regional high-incidence tumors (B08)

Proposals are expected to focus on the intersystem crossing ability and hypoxia tolerance of photosensitive dyes for integrated diagnosis and treatment, conduct applied basic research on the design and synthesis, excited state energy regulation and stability of dye molecules based on the regional characteristics in the causes of high incidence tumors (such as esophageal cancer) in Henan province, and provide theoretical support for the construction of photosensitive dyes with high added value.

5. Catalysts for the high-efficiency conversion of bio oil resources and their mechanism

(B02 or B08)

Proposals are expected to focus on the catalysts for the high-efficiency conversion of bio oil resources, address the problems of the composition complexity of bio oil and the catalyst deactivation caused by impurities such as free fatty acid and water in the catalytic conversion process, study the surface/interface characteristics, bulk characteristics, active center and mechanism of carrier action of catalysts, improve the catalytic stability and efficiency, and provide theoretical support for the clean and efficient conversion of bio oils.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Henan province.

ix. Basic and applied basic research on key technologies issues in the development of biomass energy, the safe exploitation of shale gas, and the IOT sending industries in Chongqing municipality

Areas for Key Program grants:

1. Component transfer and directional transformation in biogas fermentative liquid treatment and resource utilization by microalgae (B02 or B08)

Proposals are expected to meet the urgent needs of efficient treatment and resource utilization of biogas slurry in the biogas production from anaerobic fermentation of livestock and poultry manure in Chongqing, study the biochemical transformation of multi-component pollutants in biogas slurry by microalgae biofilm reactors and the utilization system of microalgae hydrothermal carbonization chemical co-products, explore the component transfer mechanism and control methods in the process of biochemical/thermochemical transformation, reveal the collaboration mechanism of component transfer regulation and recycling of the nitrogen and phosphorus pollutants in biogas slurry, clarify the mechanism and integrated methods for the directional conversion of biogas slurry into functional carbon materials and high-value chemicals by microalgae hydrothermal carbonization, and realize the advanced treatment and resource utilization of biogas slurry and microalgae.

2. Mechanism and intelligent monitoring/early warning of geological hazards induced by shale gas exploitation in mountainous regions (D07)

Proposals are expected to focus on the potential geological and environment problems caused by large-scale fracturing in mountainous regions in the shale gas exploitation process, clarify the temporal and spatial evolution rules of multi physical fields of strata before and after shale gas exploitation, reveal the dynamic mechanism of geological disasters induced by large-scale hydraulic fracturing, establish the quantitative evaluation method for geological stability, develop the monitoring and early warning technology of geological disasters based on the complex geological and engineering big data and intelligent algorithm, and provide scientific support for the building of geological environment safety monitoring system for shale gas exploitation in mountainous regions.

3. New mechanism for collection and conversion of environmental mechanical energy for energy supply of IOT nodes (E07)

Proposals are expected to address the problem of power supply and maintenance of IOT sensors, develop new technologies of power generation by friction based on collection and conversion of low-frequency mechanical energy, explore the physical mechanism of ultra-high power output of devices and the key technology of IOT nodes matching, establish a comprehensive theoretical framework of high-efficiency output, material properties and device structure, achieve the goal of the surface charge density of device output greater than 3.0mc/m2 and the energy utilization rate of sensor node higher than 90%, and provide theoretical and technical support for the realization of self-powered sensor network.

Applicants are encouraged to conduct research on the above topics in collaboration with

universities and research institutes in Chongqing municipality.

x. Basic research on energy exploitation, utilization and transmission for the green and sustainable development of Tibet

Areas for Key Program grants:

1. Distribution characteristics and formation mechanism of high temperature geothermal resources in the Tibet plateau (D02 or D04)

Proposals are expected to analyze the distribution characteristics of geothermal-controlling structures and geothermal fields, construct the geothermal geological models, reveal the distribution characteristics and dynamics of high temperature geothermal resources in the plateau region, make comprehensive comparative studies of high temperature geothermal resources in Yangbajing and the eastern margin of the Qinghai-Tibet Plateau, and improve the continental dynamics theory of the Qinghai-Tibet Plateau.

2. Key Technologies of source-network coordination for UHV trans-regional transmission system of clean energy in high altitude and alpine regions (E07)

Proposals are expected to focus the UHV power transmission for clean energy, put forward the optimized allocation scheme of photovoltaic/photo thermal power generation, hydropower and other clean energy and cross-provincial/regional mutual assistant technology for the sending-end grid to improve the utilization of UHV grid, study the voltage and frequency control technology of clean energy sending-end grid that can resist UHV blocking fault, so as to ensure the economy and security of UHV clean energy transmission in Tibet.

3. Green development and ecological protection technology of mines in high altitude and alpine regions (E04)

Proposals are expected to select typical mines in high altitude and alpine areas, clarify the key elements of ecosystem, establish the technical standard system of ecological and environmental investigation, evaluation, protection, governance and restoration for mining areas, evaluate the environmental and resources carrying capacity and the land spatial development suitability of the mining areas, evaluate the bottom line for the ecological environment and ecological risk of mining activities, explore the green development and ecological protection approaches for high altitude and alpine mining areas.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Tibet Autonomous Region.

xi. Basic research on key scientific issues of mural material detection technology and mural discoloration mechanism to meet the need of Dunhuang cultural relics protection in Gansu province

Areas for Key Program grants:

1. Basic research on in-situ rapid detection technology of pigments and cementing materials in Dunhuang Grottoes murals (F05)

Proposals are expected to address the need of in-situ nondestructive testing and the difficulties of multi-layer mural analysis in pigment and disease analysis for Dunhuang Grottoes murals, study the influence of complex matrix on spectral signals, set up the combined analysis method of laser-induced breakdown spectroscopy and Raman spectroscopy, carry out in-situ analysis of the complex composition of mural pigments and cementing materials in Dunhuang Grottoes, so as to provide technical support for the development of professional multi-component detection instruments.

2. Mechanism of pigment discoloration and color restoration of Dunhuang Grottoes murals (B03)

Proposals are expected to focus on the problem of pigment discoloration in Dunhuang Grottoes murals, study the characteristics and rules of the discoloration of mineral pigments

containing lead, arsenic, mercury and copper, reveal the chemical mechanism of pigment discoloration, develop methods of mural restoration based on material analysis, so as to provide scientific support for the color restoration and preventive protection of Dunhuang Grottoes murals.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Gansu province.

xii. Basic research on the enrichment and separation of potassium, lithium, boron and other resources in the effective exploitation of salt lake resources in Qinghai province and the production and application of functional materials.

Areas for Key Program grants:

1. Evolution of salt forming elements in typical salt lakes of Qaidam Basin and fractionation of potassium, lithium, abd boron resources in salt lake brine and the sedimentary evaluation of ore deposits (D03)

Proposals are expected to address the demand for common technologies of sustainable exploitation, utilization and effective extraction of potassium, lithium and boron resources in Qaidam Basin, focus on the key factors of enrichment and mineralization of potassium, lithium and boron resources in typical salt lakes of the Qaidam Basin, study the migration, fractionation and enrichment rules of salt forming elements in water resources of salt lake basins, reveal the doping and exchange mode and path of salt lake brine and salt forming elements, evaluation the trend of hydrogeochemical change and the effect of salt resource change in the salt lake basin, and provide scientific support to for the sustainable exploitation of salt lake resources.

2. Electrochemical properties of molten salt hydrate and new preparation technology of Magnesium rare earth master alloy (B08)

Proposals are expected to focus on the physicochemical and electrochemical properties of magnesium chloride-rare earth chloride molten salt hydrate system, reveal the water-bearing state in molten salt hydrate and hydrate deep dehydration mechanism, study the process mechanism and develop new technologies of electrolytic preparation of magnesium rare earth master alloy from hydrous chlorides, clarify the production mechanism and elimination process of electrolytic slags, design and develop electrolyzers of magnesium rare earth master alloy applied for 6000A or stronger current, eliminate influence of water on the electrolysis process, improve the service life of the electrolyzers, optimize process and equipment parameters, and provide theoretical and technical support for the value-added utilization of magnesium resources in Qinghai salt lakes.

3. Green separation and high-efficiency utilization of lithium in high sodium and low lithium solution (B08)

Proposals are expected to focus on the key common basic scientific issues high-efficiency green lithium recovery from mother liquor of Qinghai salt lakes, study the methods of lithium separation and extraction from high sodium and low lithium solution, clarify the mechanism of new separation technology for different coexisted ions, reveal the interface interaction and transfer of molecules and ions in the separation of different ions, establish new separation and extraction technologies to improve the separation coefficient of lithium and sodium and the recovery rate of lithium, and provide scientific support for the green separation and high-efficiency utilization of lithium from high sodium and low lithium solution.

4. Design and physicochemical properties of new wide temperature-range heat transfer/storage materials based on salt lake resources (B08)

Proposals are expected to develop composite heat transfer/storage materials suitable for different temperature ranges based on Qinghai salt lake resources and establish impurity content control standards, create the correlation model of heat transfer/storage performance parameters with composite composition and impurity contents, explore the influence of impurity content on the physicochemical properties of heat storage materials, and reveal the thermal stability and corrosion

mechanism of composite materials, achieve breakthroughs in the common problems of heat transfer enhancement of heat storage system, lay the theoretical basis of the multi-energy complementary and comprehensive utilization technology of solar energy system based on heat transfer/storage materials, improve the efficiency of comprehensive utilization of solar energy, build a small-scale platform for enhanced solar energy verification, and provide important support for the promotion and application of solar energy.

5. Key materials for high voltage and wide temperature range lithium ion batteries based on salt lake resources (B08 or B09)

Priority areas include: the influence mechanism of associated elements of Qinghai salt lake on the performance of cathode materials with high voltage (> 4.5V) and wide temperature range; the design and preparation of high voltage and wide temperature-range (-40—60 ℃) electrolytes; the preparation mechanism of carbon anode for high performance lithium-ion battery and the structure-activity relationship of materials, interface and performance; large-scale energy storage battery with the advantages of large capacity, environmental friendly and high stability on the basis of using natural salt lake brine resources as the electrolyte solution, and the design of the overall structure of large-scale salt cavern battery electrode; the research method of the influence of salt lake associated elements on the performance of lithium-ion battery, multi-scale analysis of the action mechanism of lithium ion batteries and the methods for stable interface, solution of the low energy density and poor weather ability of batteries, and the setting up of a research platform of cell charge and discharge performance of full batteries.

6. New design method and performance strengthening mechanism of magnesium-based functional materials (E01, E02 or E04)

Proposals are expected to address the problems in the utilization of Qinghai salt lake magnesium resources, such as lack of utilization approaches and lack of production variety, especially high value-added products, study the key technology of the preparation of high value-added magnesium-based materials, develop new design methods of magnesium-based functional materials, explore new technology to strengthen the performance of magnesium-based materials, reveal the structure-activity relationship between the precise control of material structure and performance enhancement, and provide scientific support for the high-efficiency utilization of magnesium resources.

7. Refining and dehydration process enhancement of bischofite (B08)

Proposals are expected to build the kinetic model of the natural evaporation process of $MgCl_2\ 6H_2O$, study the migration rule of impurities in the evaporation process, establish the mathematical model of natural evaporation rate related to meteorological factors and components, study the enhanced dehydration process from $MgCl_2\ 6H_2O$ to $MgCl_2\ 2H_2O$, establish the kinetic model of $MgCl_2\ 2H_2O$ dehydration process in HCl atmosphere, develop devices of high-efficiency treatment of dehydration tail gas, and provide scientific support for the refining of Qinghai salt lake bischofite and the preparation of anhydrous magnesium chloride for low-cost electrolytic magnesium using dehydration of bischofite.

8. Design and preparation of high-performance membrane materials and the separation mechanism of magnesium and lithium from salt lake resources (B08)

Proposals are expected to focus on the separation of resources from high magnesium and low lithium brine of Qinghai salt lakes, design new membrane materials with high selectivity, high throughput and high stability, regulate the microstructure and charge of the membrane separation layers; control the membrane forming process and solve the problem of matching the separation layer and the support layer, realize the low-cost green preparation of membrane materials; study the lithium-magnesium separation characteristics of high-performance membrane materials, clarify the mechanism of selective separation of monovalent and divalent ions, improve the tolerance of

membrane materials to high salt, acid-base and other complex application environment, and provide scientific and theoretical support for the efficient extraction of salt lake lithium resources by membrane.

9. Key basic research on the preparation of anhydrous lithium chloride and electrolytic preparation of metallic lithium and lithium hydroxide from Qinghai salt lake lithium resources (B08)

Proposals are expected to study the deep removal of impurities, lithium loss mechanism and yield enhancement technology in the process of preparing anhydrous lithium chloride from Qinghai salt lake brine, and controlled crystallization molding process of anhydrous lithium chloride; reveal the influences and mechanism of anhydrous lithium chloride impurities on the process of electrolytic preparation of metallic lithium and battery grade lithium hydroxide, and develop new processes of high-performance electrolytic preparation of metallic lithium.

10. Monitoring and integrated analysis of salt lake resources and ecology (B08)

Proposals are expected to focus on the two themes of resources and ecology of Qinghai salt lakes, carry out technological demand analysis, priority area research, grant tracking analysis, implementation evaluation and output transformation analysis, and built a domain knowledge service platform integrating the monitoring of domestic and foreign research frontiers, knowledge mapping, and visual integrated analysis and evaluation; set up machine learning-based knowledge sensing and tracking model for resources and ecology of Qinghai salt lakes, achieve the dynamic tracking of frontier research, technical demands and scientific problems in the field; integrate the semantic ontology method and the know metric method to make semantic integration and visual analysis of the target domain, and meet the demand of knowledge sharing and integrated analysis service for the research and innovation of salt lake resources and ecology.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Qinghai province.

xiii. Basic research on key scientific issues of entrained flow coal gasification, thermochemical conversion of medium and low rank coal, solid waste resources of coal chemistry to meet the major demand of modern coal chemical industry of Ningxia

Areas for Key Program grants:

1. Basic research on the multiphase process of typical entrained flow coal gasification under high temperature and high pressure conditions (B08)

Proposals are expected to focus on the typical entrained flow gasification devices in Ningdong energy and chemical industry base, study the flame characteristics and combustion state of the multiphase turbulent jets in entrained flow gasification under high temperature and high pressure conditions, develop the prediction method of typical mineral crystallization, solve the common scientific problems under hot conditions, such as the multiphase gasification and combustion reaction mechanism in the gasification furnace, and the mechanism of controlling the viscosity and temperature of typical mineral slags, and provide theoretical support for expanding the applicability of raw materials, improving the efficiency of coal utilization and achieving the safe, stable and optimal operation of gasification devices at full capacity for a long run.

2. The migration and transformation mechanism of pollutants from the thermochemical conversion process of middle and low rank coal in Western China (B08)

Proposals are expected to focus on the typical middle and low rank coal in Ningdong energy and chemical industry base, study the mechanism of migration and transformation of sulfur, nitrogen and heavy metal pollutants such as mercury from the thermochemical conversion process of pyrolysis/gasification, clarify the mechanism underlying the influences of coal quality and technical conditions on the migration and transformation of pollutants, build the pollutant emission reduction and control model the under the coupling condition of heat and mass transfer and

chemical reactions, realize effective control and simultaneous removal of pollution elements and their thermal conversion products, and provide theoretical support for the clean and efficient conversion of coal resources in Ningxia Autonomous Region.

3. Recycling of industrial solid wastes and solidification mechanism of heavy metals (B06 or B08)

Proposals are expected to focus on the extraction of lithium, germanium, gallium and other high-value elements from solid wastes of coal chemical industry base, study the enrichment and separation mechanism of high-value elements, the preparation of functional materials and process strengthening methods, explore the mechanism of solidification, migration and transformation of heavy metals, develop the technology of producing soil conditioners from industrial wastes, study the new methods of producing non-toxic and high-value diopside glass ceramics based on value-added utilization of electrolytic manganese slags, and explore the mechanism of heavy metal detoxification and the coupling of multiple reactions.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Ningxia Autonomous Region.

IV. New materials and advanced manufacturing

i. Basic research on key scientific issues on new materials and advanced manufacturing of Beijing

The average funding (direct costs) for each Integrated Program project is 10 million yuan. Priority areas include:

1. Key technologies and dynamic process of functional systems of high spatiotemporal resolution electron microscopy system (E01, E02 or E13)

This program aims to achieve breakthroughs in the research on new quantum system and low dimensional nano material system, focus on the key technologies and dynamic process of functional systems of high spatiotemporal resolution electron microscope, solve the key scientific and technological problems such as pulsed electron beam generation, pulse width compression and microscopic imaging, and develop the multi time domain and multi-dimensional femtosecond sub-nano electron microscopic imaging methods and analytical theories.

The program includes the following topics:

(1) Key technologies of high spatiotemporal resolution electron microscopy system

Proposals are expected to develop high performance electron source for ultrafast electron microscopy, improve the emission performance of pulsed electron beam, and develop new electron microscopy characterization methods with ultrafast time resolution and high spatial resolution.

(2) Dynamic process of quantum system

Proposals are expected to study the dynamic changes of charge order, orbit order and spin magnetic vortex structure in the new quantum systems; the evolution of multiple order femtosecond time domain; and the ultrafast electron response and relaxation process of electronic states of low dimensional quantum materials.

(3) Ultrafast dynamics of plasmonic nano system

Proposals are expected to study the structure and plasmonic properties of sub nanocavity to realize high spatial-temporal resolution imaging of photon localized states; the physical mechanisms of enhanced ultrafast process, in-situ photocatalysis and interface charge transfer of plasmonic localized field; the electro-optical spectrum and excited state spectrum of ultrafast electron beam-excited nano system.

Applications for the Integrated Program grants should cover all the three topics mentioned above and conduct in depth and systematic research on the theme of “key technologies and dynamic process of functional systems of high spatiotemporal resolution electron microscopy

system". The expected outputs include theory, methods, technologies, devices and patents.

2. Standardized design and verification of complex microsystems (E05)

The design and manufacture of microsystems involves knowledge from many disciplines such as mechanics, optics and electricity. The growing complexity and intelligence of Microsystems further increase the challenge to the design of microsystems. This program aims to achieve breakthroughs in the technical bottleneck of standardized design and manufacturing of functional units, establish the technical process of typical heterogeneous integration, and provide theoretical basis and technical support for the design software of microsystems.

The program includes the following topics:

(1) Modeling and simulation of cross scale multi field coupling

Proposals are expected to study the modeling and simulation methods of multi-scale coupling of force field, electric field, light field and thermal field of microsystems, solve the basic problems of multi-level system grid partition, boundary condition transfer, convergence and optimization effect, and provide theoretical support for the establishment, classification and standardization of microsystem functional units.

(2) Single chip standardized design and verification of functional units

Proposals are expected to establish standardized feature parameter extraction and transfer methods for functional units, study the multi-domain analytical modeling and the parametric digital modeling of typical architecture microsystems and functional components based on system-level modeling and simulation method of standard functional units on a chip.

(3) The technical process of heterogeneous integration of standard functional units

Proposals are expected to study the three-dimensional integration method of compatibility of multiple standard functional units and the electromagnetic interference and thermodynamic interference in the interconnection of functional units, and establish the standard technical process library of microsystems and the parametric rule checking methods and yield evaluation methods for the technical process.

(4) Software/hardware prototype verification in typical scenarios

Proposals are expected to establish the complex microsystem component database and the standard functional unit software database, set up the sample database of multiple physical-field simulation-driven design of typical materials, structures, devices and microsystems, apply the database to relevant technical platform, and realize the whole process verification in the development of microsystems.

Applications for the Integrated Program grants should cover all the four topics mentioned above and conduct in depth and systematic research on the theme of "standardized design and verification of complex microsystems". The expected outputs include theory, methods, technologies, devices and patents.

Areas for Key Program grants:

1. Integrated design of joint motor reducer for bionic mobile robots (E05)

Proposals are expected to address the need for the integration of joint motor reducers of bionic mobile robots, construct the models for loaded contact analysis of the internal parts of joint motor reducers, study the influences of parameters of joint motor integrated structure on the vibration responses of the transmission system, explore the parametric optimization design methods for whole machine mechanism aiming at the qualities of light weight, small structure, long service life and shock resistance, and establish the theory of integrated design of joint motor reducer for bionic mobile robots.

2. Key materials and application of all-solid-state lithium batteries (E02, E03 or E13)

Proposals are expected to focus on key materials of all-solid-state lithium batteries, design and develop high-energy, high-safety and long cycling all-solid-state lithium batteries,. Topics

include the preparation, processing and characterization of high-stability cathode materials, high-performance ion conductive film materials and high-capacity composite lithium metal anode materials; the application of new materials in all-solid-state lithium batteries; new approach of the solid-solid interface compatibility of all-solid-state lithium batteries; and the design of matching positive and negative electrode materials and interface ion transport mechanism in all-solid-state lithium batteries.

3. Mass production of high purity semiconductor carbon nanotubes (E02, E03 or E13)

The key problem of carbon nanotube electronics is the difficulty in mass production of high-purity semiconductor carbon nanotubes. In the commonly used method of purification of nanotubes from conjugated polymers, it is very difficult to control the molecular weight and distribution of conjugated polymers, which leads to large differences between batches of nanotubes. Proposals are expected to focus on basic scientific questions of the structural design and synthesis technology of conjugated polymer systems, achieve the mass production of conjugated polymers with controllable differences between batches, and lay a theoretical foundation for the mass production of high-purity semiconductor carbon nanotubes.

4. Design and manufacturing of optical devices based on metasurface structure (E05)

Proposals are expected to study the metasurface structure optical devices to support the development of enhanced/virtual reality display technology, design and produce integrated metasurface structure optical devices with wide spectrum and high efficiency. Topics include the phase modulation mechanism, single unit structure design, processing and manufacture technology of large-aperture wide-spectrum metasurface optical devices, application of metasurface optical devices in AR display systems, new AR display method of metasurface structure lens, solution to the shortcomings of traditional optical components, such as heavy weight and structural redundancy, and the structure-activity relationship between metasurface structure and phase, amplitude and other characteristics of light.

5. The low temperature 4K in-situ vibration detection and active vibration control using new ferroelectric materials and devices (A20)

Proposals are expected to address common demand for low temperature, low vibration and convenient materials and devices in the fields of scanning microscopy, optics and quantum information, study the response characteristics of new ferroelectric materials and devices under low temperature and strong magnetic field environment, establish the low temperature in-situ high sensitivity vibration detection and control method, explore new sensing and actuation scheme based on new ferroelectric materials and devices, and develop accurate in-situ vibration detection tech

6. Atomic scale quasi in situ characterization and mechanism of automotive fuel cell catalysts (B09)

Proposals are expected to meet the technical demand for high-activity and high-durability catalysts of automotive fuel cells, study new catalysts with low dimension, high activity and voltage stability for noble metal oxygen reduction reactions, explore the surface structure and atomic migration process of the catalysts using quasi in situ characterization method at atomic scale, clarify the structure-activity relationship between the surface atomic structure and catalytic activity, and the mechanism of catalyst stability, produce oxygen reduction catalysts with high activity and long cycling life for fuel cells.

7. Novel silicon-based heterojunction solar cells (E02)

Aiming at developing a new generation of efficient and cheap photovoltaic technology, proposals are expected to focus on new silicon-based heterojunction solar cells, carry out studies on the solar cell materials, device structure, preparation process and theoretical innovation, realize the photoelectric conversion efficiency greater than 25%, and establish a testing system of photoelectric conversion efficiency for new silicon-based solar cells.

8. Mechanism of microstructure control of thermoelectric transmission in high power devices (E13)

Proposals are expected to focus on high-end heat dissipation modules and precision packaged conductors, study the regulation mechanism of multi-scale interface and two-phase heat transfer on the time-space characteristics of variable heat flux and the size effect of micro mesoscopic scale conductors, establish the theoretical model of solid-solid coupling of three-dimensional integrated module, phase change heat transfer of micro fluid and evolution of material microstructure and properties at micro mesoscopic scale, and realize the microstructure adjustment of heat dissipation of high-power devices.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Beijing.

ii. Basic research and applied basic research on new material design and preparation, high-end equipment manufacturing, intelligent cooperative robot, digital design and manufacturing, aerospace, etc., to support the development of the new material and manufacturing industry of Hebei province

Areas for Key Program grants:

1. Controllable preparation of novel metastable layered crystals and application of devices (E02)

Proposals are expected to focus on the key technologies of controllable preparation of layered crystal materials, study the band structure evolution of layered crystals, especially the structure, performance and function evolution of layered crystals, explore new types of metastable layered crystal materials and their potential novel optical, electrical and magnetic properties, and produce new optical (magnetic) electronic, biosensor and other devices.

2. Transformative design and interface strengthening and toughening mechanism of layered composite metal materials with multi-level structure (E01)

Proposals are expected to focus on the transformative design of dissimilar metal interface and multi-scale toughening effect of component materials, develop the wide range vacuum hot rolling technology and accumulative roll bonding technology, produce maraging steel and high entropy alloy-based high strength and toughness layered composite metal materials with layer/net coupling interface structure and multi-scale structure, study the interface strengthening and toughening mechanism of high strength and toughness layered composite metal materials under the coupling effect of temperature, stress and other fields, establish the theoretical model of strengthening and toughening of layered composite metal materials with layer/net coupling interface and multi-scale structure, and develop the design technology and large-scale manufacturing technology of high strength and toughness layered composite metal materials.

3. Basic theoretical study of key technologies of remanufacturing robot for aeroengine components (E05)

Proposals are expected to address the demand for dimension recovery and performance improvement of damaged aero-engine components, seek breakthroughs in the theoretical and technical problems of remanufacturing robot such as precise identification, precise repair, precise grinding and polishing, etc., study the mechanism of defect generation and suppression of mechanical and thermal coupling effect in the remanufacturing process of damaged components, and the shape-position and force-position control of robot system under multi-dimensional constraints, establish the basic theory of robotic plasma pulse welding, grinding and polishing.

4. Ultra high stress wear and fatigue behavior and failure mechanism of high speed and heavy haul railway track (E01, E04 or E12)

Proposals are expected to focus on the service behavior and failure mechanism of high-speed and heavy haul railway track, study the microstructure evolution, wear and fatigue

behavior and the main failure mechanism of track steel under extreme service conditions, establish the track service behavior database under extreme service conditions, and lay the theoretical basis for chemical composition design and manufacturing technology development of track fork steel with ultra-long service life.

5. Multi field coupling mechanics and performance control of piezoelectric semiconductor materials and devices (A08)

Proposals are expected to focus on piezoelectric semiconductor materials with potential applications, study basic scientific problems of piezoelectric semiconductor materials such as indentation response, fluctuation and vibration, pursue accurate explanation of the physical essence of the nonlinear interaction between piezoelectricity and semiconductor properties, explore the mechanism of external electromechanical load regulation of mechanical and electrical properties of piezoelectric semiconductors and the technical approach to improve the mechanical and electrical conversion efficiency, and provide scientific support for the application of piezoelectric semiconductor materials.

6. New high efficiency photovoltaic cell materials and devices (E02, E03 or E13)

Proposals are expected to address the need of the photovoltaic industry in Hebei province and provide important theoretical basis for the production of new solar cells with high conversion efficiency, low cost and high stability. The key scientific and technical problems include: interface control and device stability of new solar cells, low-temperature vacuum-free organic passivation technology, and high-efficiency solar cell tunneling passivation with light-induced degradation-resistant characteristics.

7. Metallurgical behavior and mechanism of ultra-high speed thin slab continuous casting (E04)

Proposals are expected to support the development of continuous casting technology in Hebei province, focus on the metallurgical behaviors of molten steel such as flow, heat transfer, solidification, deformation and lubrication in the mold of ultra-high speed thin slab continuous casting, reveal the complexity and impact of multi-field coupling and multi-phase coexistence in the mold of thin slab continuous casting through the analysis and description of multiple physical fields such as temperature, flow rate, stress and electromagnetic field in different media and between different media in the mold, and provide a theoretical basis and solution for optimizing the design and metallurgical behavior of funnel mold for ultra-high speed thin slab continuous casting.

8. Mooring and docking heavy load robot system (E05)

Proposals are expected to solve the problems of high risk and low efficiency of mooring and docking, loading/unloading and ocean replenishment operations of ships in harbor, study the common technology and theory of the modeling, analysis, design and intelligent control of fluid structure coupling large-scale heavy-load equipment system composed of floating body, wharf (floating or fixed) and multiple robots under the action of wind and waves, innovate the series-parallel robot manipulators, develop the prototype of multi-robot heavy-load intelligent system for mooring and docking, and provide theoretical basis and key technologies for a new generation of smart wharf in Hebei and Tianjin, as well as intelligent equipment for offshore construction and replenishment operations.

9. Femtosecond laser-based production of high biocompatibility surface for implantable medical devices (E01, E05 or E13)

The metal surface of implantable medical devices is the interface that directly contacts with the organism. Its microstructure, material properties and functional groups directly act on the organism and affect the behaviors of tissues, cells and microorganisms. Proposals are expected to focus on the basic scientific problems of biological functions and safety of implantable medical devices, study the mechanism of biocompatibility between the device surface and organism,

modify the device surface by femtosecond laser to realize the functions of reversible and rapid regulation of super wettability, promotion of cell adhesion and growth, broad-spectrum antibacterial activity and sustained drug delivery and release, establish femtosecond laser-based composite processing technology system for the production of customized biocompatible surface, and improve the biocompatibility of the surface of medical devices.

10. Key mechanical problems of the application of thermoplastic carbon fiber reinforced composites in aerospace engineering (A08)

Proposals are expected to study the nonlinear mechanical behaviors of thermoplastic carbon fiber reinforced composites in extreme aerothermal environment of spacecraft, in particular to solve the problems of large thermal elastic-plastic deformation, thermal aeroelastic nonlinear divergence and flutter stability, thermal elastic-plastic fracture of typical thermoplastic carbon fiber reinforced composite structural parts of spacecraft, reveal the working and failure mechanism of thermoplastic carbon fiber reinforced composite in extreme aerodynamic thermal environment, and provide theoretical and technical support for the application of advanced thermoplastic composites in reusable spacecraft in China.

11. Special solid state bonding technology and its application (E05)

Proposals are expected to address the need for long service-life, high reliability and low cost integrated key structural parts of aircraft, study the mechanism of electromagnetic pulse assisted backfill friction stir welding and the design of welding actuator, explore the new mechanism of microstructure and performance control of typical composite welding joints, establish the new theory of electromagnetic pulse assisted backfill friction stir welding manufacturing. It is also expected to solve the problem of online connection of intermediate billets in endless rolling, develop the new technology of fast connection (less than 1 second) of solid metal based on high-temperature shear deformation, reveal the formation mechanism of interface during shear deformation connection process, and establish the physical model of interface bonding and solid-state bonding assessment criteria.

12. Lightweight high-temperature flame-retardant composites based on tubular nano mineral resources (E03)

Proposals are expected to meet the major needs of upgrading the inorganic/general resin composite industry in Hebei province, study the modification of tubular nano mineral resources and the dispersion of tublar nano-mineral resources in the organic resin matrix, realize the functions of cross-linking, flame retardancy and reinforcement, and provide theoretical and technical support for the construction of lightweight high-temperature flame-retardant composite materials for high-speed aircraft.

13. The theoretical basis of microalloying based on oxide metallurgy (E04)

Proposals are expected to focus on the thermodynamics and kinetics mechanism of oxide metallurgy, in particular the scientific problems such as inclusions in metallurgical process, intragranular ferrite induced by second phase particles, grain refinement, improvement of strength and toughness, and weldability, construct the Nb-Mo-Ti-Mg-V multi-element micro alloy system and the solidification and hot working control models of oxide metallurgy, and provide theoretical and technical support for the development of high strength and toughness shipbuilding plate and marine steel.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Hebei province.

iii. Basic theories and key technologies of new materials, new processes, new technologies and new devices of semiconductor and carbon-based new materials to meet the demand for industrial upgrading and cultivation of new industries of Shanxi province

The average funding (direct costs) for each Integrated Program project is 10 million yuan.

Priority areas include:

1. Electronic technology of carbon nanotubes for intelligent terminal (F01 or F04)

Future intelligent terminals require the integration of display, sensing, signal processing and other functions on substrates such as glass. The key of intelligent terminal technology is to develop compatible and large-scale molding technologies of carbon nanotube thin film transistors (TFTs), sensor arrays and CMOS circuits on glass substrates. This program aims to support research on relevant basic scientific issues and develop the intelligent manufacturing technology system based on carbon nanotube TFT technology.

The program includes the following topics:

(1) Preparation of semiconductor carbon nanotube films

Proposals are expected to develop the preparation method of high-purity semiconductor carbon nanotube solution and the high-efficiency preparation methods of carbon nanotube films, and establish the quantitative characterization method of the quality of carbon nanotube solution and films.

(2) Production technology of carbon nanotube TFTs

Proposals are expected to develop technologies of large scale production of carbon nanotube TFT, and promote the application of carbon based TFT devices in high-definition display and flexible electronics.

(3) Technology of CMOS integrated circuit based on carbon nanotubes on glass substrate

Proposals are expected to develop the fabrication technology of CMOS integrated circuit based on carbon nanotube on glass substrate, and achieve the capability of driving carbon based TFT arrays.

(4) Integration technology of carbon based materials for intelligent terminal

Proposals are expected to develop carbon based MOS sensing technology based on glass substrate and its compatible integration with display driver TFT and CMOS devices on glass substrate.

Applications for the Integrated Program grants should cover all the four topics mentioned above and conduct in-depth and systematic research on the theme of "electronic technology of carbon nanotubes for intelligent terminal". The expected outputs include theory, methods, technologies, devices, demonstration samples and patents.

Areas for Key Program grants:

1. Collaborative design and intelligent operation of large mining electrical shovel for complex environment (E05)

Proposals are expected to study the cognitive mechanism of information fusion and multidisciplinary integrated collaborative design theory under the rock-machine-control coupling effect, the multiple failure mechanism and predictable maintenance method of electric shovel under extreme service conditions, and the real-time online optimal decision-making mechanism for multi tasks.

2. Ordered carbon/silicon-based composite aerogels and their electromagnetic protection (E02 or E13)

Proposals are expected to study the impedance matching and thermal resistance performance, structure and composition, interface control of ordered carbon/silicon composite aerogels and the mechanism of the electromagnetic response and thermal insulation properties of ordered carbon/silicon composite aerogels in complex environment (high temperature, damp heat, salt spray, oscillation, etc.), explore the wide-band electromagnetic wave absorbing and efficient heat insulation mechanism of the multi-scale structure and multi-component interface of aerogels, and establish effective models of broadband electromagnetic protection.

3. Basic research on preparation of coal-based pitch carbon fiber (E02)

Proposals are expected to study the evolution of colloidal structure and carbon matrix phase diagram in the production process of coal tar pitch carbon fiber and the regulation theory, clarify the characteristics of carbon matrix evolution in the process of liquid and solid phase carbonization, and provide scientific basis for designing and controlling the structure and performance of coal pitch carbon fiber.

4. The design, preparation and structure-activity relationship of natural polymer ecological materials made from straw biomass (E03 or E13)

Proposals are expected to study lignocellulose dissolution processing and new material construction techniques and methods, investigate the chemical structure, material properties and molecular mechanisms of functional regulation of lignocellulose, elucidate the relationship between the structure and properties of derivatized materials, and lay the theoretical foundation for improving the comprehensive utilization of crop straws.

5. The structural design and performance regulation of polymer functional composites based on carbon nanomaterials (E03 or E13)

Proposals are expected to study the kinetic and thermodynamic behavior of carbon nanomaterial functional structure during the molding process, elucidate the regulation of electromagnetic response characteristics, high load interface failure forms, and multi-interface phonon and electron transport and energy conversion mechanisms of carbon nanofunctional composites, and provide technical support and theoretical basis for promoting the high-performance, intelligent and functionally integrated applications of polymer-based carbon nanofunctional composites.

6. Theory and key technology of gob-side entry retaining in the mining of thick coal seam (E04)

Proposals are expected to establish the mechanic model of the gob-side entry retaining, reveal the mechanism of gob-side entry retaining in the comprehensive mining of thick coal seam, and study the basic theory and key technology of safe and efficient mining of gob-side entry retaining of the comprehensive release working face of thick coal seam.

7. Basic research on magnesium oxide series materials for high-grade thin strip silicon steel (E01 or E02)

Proposals are expected to explore the evolution of grain growth and interconnection interface at the atomic scale of magnesium oxide series materials for high-grade thin strip silicon steel, reveal the physical nature of the interaction between the underlying attachment microstructure of magnesium oxide and silicon steel loss and magnetic energy; establish the macro-microscopic integrated design guidelines of magnesium oxide coating with excellent surface-guided magnetic and insulating properties, and enrich the theoretical system for the preparation of magnesium oxide materials for high-grade thin strip silicon steel.

8. The preparation of ultra-large size electronic grade diamond and its surface interface sealing technology (E02 or E13)

Proposals are expected to address the demand for high power capacity and low transmission loss transmission window of high-power microwave vacuum devices, study the basic scientific problems of diamond microstructure regulation, surface interface wetting and connection mechanism, and realize the preparation of oversized electronic grade diamond and high strength and high gas-tight sealing technology.

9. Key scientific issues in the preparation of biomass-based energy storage carbon materials (E02 or E13)

Proposals are expected to investigate the evolution of chemical composition, crystal structure, pore structure, functional groups and other microstructures during the transformation of organic biomass into inorganic carbon materials, explore the mechanism of removing

oxygen-containing functional groups from the surface and the mechanism of removing impurity ions in the purification process, realize the controlled preparation of high-performance biomass-based energy storage carbon materials, and clarify the structure-activity relationship between the microstructure and energy storage performance of the materials.

10. The mechanism of forming fine metal masks for OLED vacuum evaporation plating (E04)

Proposals are expected to carry out basic theoretical research on the key properties of precision strips such as strain, creep, magnetostriction, and linear expansion under micron-level thickness conditions, explore the influence of residual stress on fine etching, and establish methods for regulating high-precision molding processes.

11. Basic research on corrosion-resistant and functional protective coatings for magnesium alloys (E01)

Proposals are expected to address the bottleneck problem of corrosion in the development and application of magnesium alloy deep processing products, carry out the basic research of high corrosion resistance-self-repair-thermal control/conductive/magnetic integrated protective coating.

12. The cross-scale manufacturing method of complex curved optical micro-resonant cavities (E05)

Proposals are expected to study the key basic science issues of the manufacturing of ultra-high precision micro-cavity optical quantum core functional units and devices, realize the design and manufacturing of ultra-high quality factor micro-resonant cavities, achieve breakthroughs in the key technology of spatial optical coupling cross-scale heterogeneous integration of optical quantum devices, and establish the manufacturing methods of micro-compact, integrated ultra-high precision optical quantum devices.

13. "Hand-tear steel" surface microstructure optimization and fatigue resistance theory and key technology (E04 or E05)

Proposals are expected to study the evolution of the surface microstructure and metal rheological behaviors of stainless steel foil, investigate the influence mechanism of rolling process on the surface microstructure, microstructure characteristics and fatigue resistance performance of the materials, reveal the mechanism of microscopic non-uniform deformation on the surface quality and performance of the foil, and establish an integrated control strategy of "microstructure control-performance evaluation-process optimization" for stainless steel foil.

14. Basic theory and key technology of THz photonic filtering for ferroelectric-acoustic-optical coupling (F05)

Proposals are expected to focus on the micro and nano scale ferroelectric wave conducting-acoustic-optical coupling dynamic mechanism, scalar fluctuation equation and THz photonic filtering mechanism, achieve breakthroughs in key technologies of ferroelectric-optical wave conducting domain structure regulation and cascade acousto-optical phase locking, and solve the problems in the design and manufacturing of high-frequency high-Q photonic filtering devices.

15. Key technologies of large-area flexible chalcogenide solar cells (E03 or E13)

Proposals are expected to develop efficient and stable large-area flexible chalcogenide solar cells, and lay an important theoretical/experimental foundation for the industrialization of chalcogenide solar cells. Topics include: the controllable and low-cost preparation methods, surface interface passivation and modification techniques, cavity transport materials, flexible electrodes of large-area 2D-3D hybrid chalcogenide films.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Shanxi Province.

iv. Basic research on the quality and efficiency improvement of traditional materials, intelligent manufacturing, new technology and new technical process of advanced materials,

to meet the major demand of Liaoning in the aerospace, transportation, equipment manufacturing, metallurgy, building materials and resource utilization.

Areas for Key Program grants:

1. High-quality transparent ceramics for high-energy ray detection (E02)

Proposals are expected to meet the demand of Liaoning for core components of medical diagnostic and safety detection equipment, focus on the high-performance transparent ceramics, optimize the particle size, morphology, dispersion and optical conversion efficiency of rare earth sulfur oxide powder, study the controllable preparation, processing mechanism and optical properties of high energy soft X-ray transparent ceramics, and provide theoretical basis and key technologies for the preparation of high quality transparent ceramics for high energy ray detection

2. The energy state and property regulation of bulk amorphous alloys (E01)

Proposals are expected to meet the demand for high-performance amorphous materials in Liaoning's aerospace and electronics industries, study the organization, energy state and performance evolution of bulk amorphous alloys under force/thermal conditions, explore the nature of amorphous alloy rejuvenation, and lay the foundation for the development of high toughness bulk amorphous alloys.

3. Design of high entropy environmental barrier coating and the mechanism of its wide temperature domain-corrosion self-adaptive resistance (E01, E02 or E13)

Proposals are expected to meet the demand for environmental barrier coating technology for aerospace engines and industrial combustion engines of Liaoning, study the design theory and stabilization mechanism of high-entropy environmental barrier coatings, reveal the damage pattern of coatings in coupled corrosive environments and explore the adaptive principle and regulation guidelines of coatings against wide temperature domain corrosion.

4. The efficient preparation and mechanism of tissue regulation of large/thick gauge steel (E01 or E04)

Proposals are expected to meet the major common needs of Liaoning steel industry to improve quality and increase efficiency, focus on hot-rolled structural steel, study the microstructure evolution, tissue regulation and toughness mechanism of the second phase and matrix under the whole process of smelting, casting and rolling, collaboratively improve the quality of each process, solve the key problems of low temperature deformation of steel materials and poor tissue uniformity of large/thick gauge products, and provide theoretical support for the high quality and efficient preparation of hot-rolled steel materials such as plates and shapes.

5. The dynamic digital twin-based and intelligent coordinated optimization information-physical system for the whole process of steel production (E04)

Proposals are expected to meet the major needs of Liaoning in the digital transformation of steel enterprises, focus on the whole process of steel production, study the deep perception methods of steel surface quality, organization structure and processing performance, establish a dynamic digital twin-based model with high fidelity for the whole process of steelmaking-rolling through big data, mathematical models and AI, and build an information-physical system for the whole process of steel production with global dynamic digital twin as the core and featured by multi-objective collaborative optimization.

6. Basic research on key technologies for additive manufacturing of metal-based aerospace complex components (E01, E04, E05 or E13)

Proposals are expected to meet the demand for lightweight manufacturing of high-performance components in Liaoning's aviation industry, focus on complex components of high-temperature alloys and aluminum-based materials, carry out research on powder preparation, tissue structure design, laser forming mechanism and defect control, performance characterization and failure modes, innovate manufacturing methods for complex components of aviation, and

provide theoretical support for laser additive manufacturing of difficult-to-process materials.

7. Research on the lightweight and complex thermal-mechanical load-bearing performance of thin-walled aerospace vehicle structures (A08)

Proposals are expected to address the contradiction between lightweight quality and complex thermal-mechanical load-bearing performance of aerospace structures in Liaoning aerospace industry, focus on the complex thin-walled structure of aerospace vehicles, study the thermal buckling failure mechanism of complex wall plates, innovative configuration lightweight theory and defect tolerance design method, and effectively improve the load-bearing performance and design of thermal structure of aerospace equipment.

8. The lightweight design of the load-carrying structure of composite material vehicle body (E05 or E12)

Proposals are expected to meet the demand for lightweight vehicle body of the auto industry in Liaoning, study the load-bearing structure of vehicle body, carry out research on mechanical properties, dynamic and static failure mechanism, low stress connection technology and key manufacturing technology of thin-walled load-bearing components of carbon fiber composites, and innovate the optimal design and manufacturing method of composite vehicle body structure under complex working conditions.

9. Design of key structures of coal tunnel TBM with damage resistance features (E04)

Proposals are expected to focus on tunnel boring machine (TBM), an important industrial product in Liaoning, meet the urgent demand of long-distance and stable coal tunneling of TBM in the field of comprehensive coal mining, study the vibration damage mechanism of coal tunnel TBM systems, achieve breakthroughs in the design and in-situ monitoring of coal tunnel TBMs, and improve the operational stability and damage resistance of coal tunnel TBMs

10. Key technology to improve the efficiency, safety and stability of high end turbocompressor (E05, E06 or E09)

Proposals are expected to focus on high-end turbocompressor, an important industrial product in Liaoning, meet the demand for safety, high efficiency and low noise of turbocompressor, study the coupling mechanism of compressor flow, solid and thermal multi-physical fields, the method of expanding stability and efficiency, the optimization of structural reliability and vibration/noise reduction technology to improve the overall service performance of turbocompressor.

11. Theory and key technologies of intelligent operation and maintenance of large turbocompressor units (E05 or E06)

Proposals are expected to meet the demand for safe and reliable operation of large turbocompressor units in Liaoning, focus on large turbocompressor units, study the coupling mechanism of equipment structure, failure mode, operation parameters and operation and maintenance performance, achieve breakthroughs in key technologies such as intelligent equipment perception, state identification and life prediction and multi-objective maintenance decision, and improve the intelligent operation, maintenance and management of large turbocompressor units.

12. Automotive powertrain flexible assembly research (E05)

Proposals are expected to meet the demand of intelligent precision assembly in the non-structural environment of Liaoning automotive industry, carry out theoretical and technological research on intelligent perception of the assembly process, learning and optimization of assembly process parameters and human-machine collaboration to improve the intelligence and adaptability of the flexible assembly process of automotive powertrain.

13. Key theory and technology for the design and manufacturing of new high-efficiency vacuum dry pumps (E05)

Proposals are expected to focus on the design and manufacturing theory and technology of

the new screw type vacuum dry pumps for the integrated circuit industry, carry out research on the key theoretical technology of accurate design and high efficiency operation of the space rotor three-dimensional surface under the conditions of cross-flow state, full basin and full pressure for thin gas transportation, and solve the problem of accurate testing and optimization of performance parameters under the conditions of given differential pressure and flow rate at the suction and discharge ports of the vacuum dry pumps.

14. Key technology of minimally invasive transgastrointestinal endoscopic surgical robotics (F03)

Proposals are expected to meet the major demand for surgical robotics in Liaoning, study key technologies such as high-precision force feedback perception, endoscopic and endoscopic ultrasound and other multimodal image mixing reality and tracking of the gastrointestinal endoscopic surgical robot, explore the optimal selection of transgastrointestinal surgical lesion positioning and path and robot arm motion control principles, and propose feasible design methods and technologies for a gastrointestinal endoscopic robotic surgical platform.

15. Laser additive manufacturing methods for ceramic-reinforced composites with complex structures (E02 or E05)

Proposals are expected to meet the demand of high-precision integrated manufacturing of large-size complex structural ceramic-reinforced composite parts, carry out research on the theory of in-situ preparation of ceramic composites, material compatibility and strengthening mechanism, innovate the optimal design method of ceramic composite structures, and provide theoretical support for laser additive manufacturing of complex ceramic-reinforced composites.

16. Key technology for preparation of high performance films (E01 or E02)

Proposals are expected to meet the demand for high-performance film layers with heat-resistant protection and catalytic activity in Liaoning aviation and energy industries, carry out research on the design, preparation and service behavior of film layers, and significantly improve the temperature-bearing capacity, service life and functional characteristics of film products.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Liaoning province.

v. Applied basic research aiming at the technical bottlenecks of the development of automobile, high-speed trains, precision manufacturing and other new materials and advanced manufacturing industries in Jilin province

Areas for Key Program grants:

1. Precision processing of free-form extreme ultraviolet lithography objective (E05)

Free-form extreme ultraviolet lithography objective is considered to be the most promising technology to further improve the resolution and image quality in the next generation of lithography. Proposals are expected to meet the urgent need of Jilin high-end optical manufacturing industry to solve the problems of long manufacturing cycle, high cost and low efficiency of free-form ultraviolet lithography objectives, study the key scientific issues involved in the creation of free-form ultraviolet lithography objectives with multi-field synergy of laser/mechanical dynamic loads and multiple servo cutting of geometric/physical quantities, and develop new principles and methods for the creation of free-form ultraviolet lithography objectives with high surface integrity, high efficiency, low cost and ultra-precision cutting.

2. Design and preparation of copper matrix composites for rail transportation and their dynamic thermal-mechanical coupling performance (E01, E04, E05 or E07)

Proposals are expected to address the bottleneck problems of poor stability of friction coefficient and abnormal wear of the new generation of high-speed train friction plate, study the multi-scale design and interaction of multi-component copper-based friction plate composites; study the formation pattern and wetting and bonding behavior of the interface during the composite

process of matrix and lubrication and friction elements; study the evolution pattern of the surface and interface structure of copper-based composites under the dynamic thermal-mechanical multi-fields, and clarify the collaborative reinforcement and regulation mechanism of friction reduction and friction resistance.

3. Structural design and efficient preparation of highly toughened core-shell elastomeric particles (E03)

Proposals are expected to design and construct the molecular and aggregate structures of nucleation-shell elastomeric particles, clarify the relationship between the effectiveness of toughened polymer resins and the particle structure, explore the new mechanism of nucleation and growth of latex particles in emulsion polymerization, establish an efficient method for the preparation of submicron elastomeric latex particles with narrow distribution, and provide a new strategy and pathway for the design and preparation of nucleation-shell elastomeric particles with high toughening effectiveness.

4. The principle and technology of in-situ testing of mechanical-electrochemical response of lithium-ion batteries in cold regions (E07 or E12)

Proposals are expected to address the performance weakening and failure of lithium-ion batteries in winter of Northeast China caused by low temperature and mechanical abuse, reconstruct the complex working conditions of low temperature-mechanical-electrochemical coupling, study the principle and technology of in-situ characterization of battery performance evolution under multi-factor coupling environment, carry out multi-scale in-situ testing of single cell and internal material performance evolution and failure, reveal the performance decline mechanism and thermal runaway mode of batteries, and provide theoretical and technical support for the failure diagnosis, reliability and safety of automotive batteries and other low-temperature batteries in Jilin and Northeast China.

5. The structural design and performance of high toughness polyaryl ether ketone resins and their composites (B05)

Topics include: the molecular chain structure, molecular weight and distribution of polyaryl ether ketone resin, the structure-activity relationship between the phase morphology and toughness of polyaryl ether ketone resin and its regulation; the design strategy and synergistic mechanism of polyaryl ether ketone resin-based composites with multiphase structure; the formation mechanism of the interface between reinforcing fiber, toughening filler and resin matrix and the method of improving the interface strength; the influence of microscopic phase morphology of polyaryl ether ketone on its macroscopic performance, the reinforcement and toughening mechanism of polyaryl ether ketone and its composites.

6. Applied basic research on alpine-resistant porous organic skeleton-based solid electrolytes (B09)

Proposals are expected to solve the challenging problem of sudden performance degradation of new energy vehicles in alpine regions, design and synthesize highly stable covalent organic skeleton/porous aromatic skeleton materials, study the structure-activity relationship between ionic conductivity and mechanical properties and microstructure of ordered organic skeleton-based solid electrolyte materials and their enhancement mechanism; explore the electrochemical performance, interface matching and multi-dimensional evolution mechanism of organic skeleton-based solid electrolytes for lithium batteries in alpine environments, realize the micro and nano precision construction and enhance the battery performance at low temperature.

7. High efficiency synthesis and application of polyamino acid antibacterial materials (E03)

Proposals are expected to solve the problems of lacking high value-added polyamino acid materials and promote the development of related industry in Jilin, conduct research on the efficient

synthesis of antimicrobial polyamino acids, construct a new seven-membered cyclic monomer and a highly active organocatalytic system, and realize the regulation of polymer molecular weight and side chain structure, develop new polyamino acid materials with broad-spectrum antibacterial properties and large-scale synthesis technology; study the influence of polyamino acid topology on antimicrobial properties and toxicity and the antimicrobial mechanism, so as to provide theoretical and technical support to the development of new polyamino acid material industry in Jilin.

8. Key issues of thermal and hydraulic characteristics of petal-shaped fuel assembly rod bundle channel (E06)

Proposals are expected to develop the design method and manufacturing process for petal-shaped fuel assemblies in integrated small reactors, study the behavior and mechanism of bubble dynamics, the flow and heat transfer characteristics of the rod bundle channel, establish a high-precision flow and heat transfer model and numerical method for the rod bundle channel, clarify the flow mechanism of the natural circulation system under steady-state and transient conditions, and provide important theoretical support for the manufacturing of key components of small reactors in Jilin.

9. Low temperature resistant "plastic-rubber" hybrid materials and "selective switching" polymerization mechanism (B01)

Proposals are expected to address the key issues in the preparation of functionalized rubber materials such as low temperature resistance, study the regulation of the electronic properties of active centers on the coordination polymerization barriers of olefins and diolefins using new catalysts, explore the influence of coordination environment on the selective switching of diolefins and olefin binding rate, reveal the action pattern of synergy between catalysts on chain transfer reactions, clarify the relationship between chain composition, sequence distribution and structure regularity and performance, and realize the high performance of general purpose polymers.

10. Basic research on reliability design and accelerated testing of grating sensing components for CNC machine tools (E05)

Proposals are expected to address the problem of poor reliability and high failure rate of domestic components. Topics include the theoretical framework and design methods for the reliability innovation design of high speed and high precision grating sensing components for CNC machine tools; the multi-physics dynamic coupling mechanism and acceleration test methods for the environmental simulation of grating sensing components under complex working conditions of CNC machine tools; the main failure modes and their failure mechanisms affecting the reliability of grating sensing components for CNC machine tools.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Jilin province.

vi. Basic research on advanced new materials and manufacturing technology to promote the development of aerospace, robotics, equipment manufacturing and other industries in Heilongjiang

Areas for Key Program grants:

1. Basic research on the synergistic enhancement of modulus and strong plasticity of magnesium-lithium alloy based on quasi-crystalline phase and cumulative stacking (E01)

Proposals are expected to meet the urgent demand for lightweight structural materials in the aerospace industry, study the synergistic enhancement of modulus and strong plasticity of ultra-lightweight magnesium-lithium alloy, form high modulus phase and reinforced phase of magnesium-lithium alloy based on the quasi-crystalline phase design and cumulative stack rolling process, regulate the microstructure at multiple scales, achieve breakthroughs in the composition design theory and regulation technology of the synergistic enhancement of modulus and strong plasticity of magnesium-lithium alloy, and clarify the mechanism of synergistic enhancement of

modulus and strong plasticity and the principle of multi-scale construction of microstructure.

2. The heterogeneous structure and function integrated manufacturing method and in-situ regulation mechanism of microwave ferrite devices (E02 or E05)

Proposals are expected to meet the demand for the integration of heterogeneous structure and functions of microwave ferrite devices in aerospace, 5G communication, electronic information industries, develop new microcrystalline glass system with similar thermomagnetic properties and chemical compatibility with ferrite, study the three-dimensional network construction mode, precrystallization kinetics, wetting kinetics, heterogeneous interface metallurgical mechanism, and the in-situ strengthening magnetization mechanism of microcrystalline glass, realize the in situ joint regulation of transition zone force and magnetic property, so as to provide theoretical support for the production of new generation microwave ferrite devices.

3. Key technologies of mobile robots in complex field environments (E05)

Proposals are expected to meet the needs for reliable wheeled/footed mobile robots in complex field environments such as planets, study theory and key technologies of the modeling of mechanical interaction of robot and complex environment, the construction of comprehensive physical and geometric maps based on multimodal information, and the dynamic interaction of human-machine-data coupling, develop digital twin systems supporting hardware-in-the-loop high-fidelity real-time simulation, complete system fidelity verification, and virtual testing and remote control for planet vehicle, and provide theoretical and technical support for the future development of mobile robots in harsh environments.

4. Fracture toughness and strength-toughness matching mechanism of ultra-high-strength deformed rare-earth magnesium alloys (E01 or E04)

Proposals are expected to meet the demand for ultra-high strength and toughness magnesium alloy of Heilongjiang aerospace and light alloy industry, solve the bottleneck problem of low fracture toughness of high strength magnesium alloy, study the mechanism of multi-scale and multiphase microstructure on the fracture toughness and fracture behavior of ultra-high strength and deformation rare earth magnesium alloy, develop the rapid test and evaluation method of fracture toughness, establish the mechanical model of fracture toughness, reveal the strength and toughness matching mechanism of ultra-high strength magnesium alloy, and provide theoretical support for the development of ultra-high strength magnesium alloys.

5. The low-cost manufacturing of carbon/ceramic composites (E02)

Proposals are expected to meet the significant demand for ultra-high temperature thermal protection systems and materials for advanced high-speed aerospace vehicles, study multi-scale optimization design and low-cost manufacturing technology of carbon/ceramic composite materials, solve the bottleneck problem of thermal protection of internal and external thermal structures in ultra-high temperature oxidation environment, realize on-demand design and low-cost manufacturing of typical thermal structure components under different service environments, and lay the theoretical foundation for the industrialization of thermal protection systems for advanced vehicles.

6. The topology of high-capacity high-speed permanent magnet motor and the application mechanism of new materials (E07)

Proposals are expected to meet the demand of Heilongjiang for renewable energy and the upgrading of electrical power generation equipment due to the reduction of coal electricity, achieve breakthroughs in high-capacity high-speed rare earth permanent magnet motor technology and the application of key materials, study the multi-physics space design theory, new material application limits and of the digital twin monitoring technology of reversible frequency conversion, highly difficult high-speed megawatt-class large motor.

7. Basic research on fibrillation dissociation and functional materialization of rice

straw in cold regions (E03 or E10)

Based on the biological structure and physicochemical properties of rice straw resources in Heilongjiang, proposals are expected to study the scientific methods to transform rice straws into functional materials such as smart membrane materials, environmental remediation materials and electrochemical materials through green fibrillation dissociation, in situ assembly and doping, surface modification and bonding, platform customization and modularization, etc., reveal their functionalization principles and regulatory mechanisms, so as to provide new paths and theoretical support for value-added utilization of rice straws in cold regions.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Heilongjiang province.

vii. Basic research on intelligent materials, energy materials, advanced polymer materials and fibers, digital manufacturing and extreme manufacturing, robotics, and high-end equipment to meet the demand of new material and advanced manufacturing industries of Zhejiang

Areas for Key Program grants:

1. The mechanical-thermal-electric damage theory and life extension of highly reliable protective materials for extreme environments (E01, E02, E03, E05, E07 or E13)

Proposals are expected to address the common needs of aerospace, nuclear power equipment, hydrogen energy and marine engineering for highly reliable protective materials in extreme environments, and develop the mechanical-electrochemical-thermal interactive damage theory and life extension strategy of materials under extreme service environments. Topics include: the multi-scale interface control methods for long-life functional protective materials in extreme environments (ultra-high vacuum, special atmosphere, high/low temperature media corrosion, etc.), the accelerated damage evolution mechanism of protective materials in service under mechanical-electrochemical-temperature multi-field coupling, the atomic-molecular-scale simulation of strong surface coupling damage behavior, the mechanisms of extreme service environment-induced friction reaction film, high temperature oxide and corrosion passivation film kinetics, defect effects and interface electronic behavior.

2. Mass transfer mechanisms and functional integration of asymmetric separation membrane materials (B08)

Proposals are expected to focus on the major scientific problems and needs of Zhejiang in water treatment and medical care, study the structural design and functional integration of asymmetric separation membrane materials, clarify the intrinsic relationship between their properties and the performance of targeted mass transfer and separation, reveal the structural regulation mechanism of functional integration, realize the macro-preparation of asymmetric membrane materials from flat plate to hollow fiber separation, and provide the scientific basis for the application of such membrane materials in seawater desalination, oil-water separation, artificial lung oxygenators, ion switches, etc.

3. Mechanisms for regulating the transport properties and property correlation of rare earth elements in magnetically ordered systems (E01)

Proposals are expected to meet the needs of Zhejiang rare-earth magnetic material industry to improve the performance of rare-earth product and efficiency of rare-earth utilization, study the kinetic behavior and migration pattern of rare-earth elements in the main phase and grain boundary phase of the materials, reveal the mechanism of interaction between the magnetic endowment and the orbital-spin angular momentum of 3d-4f electron layer of rare-earth elements and other elements; elucidate the f-electron properties and exchange interaction evolution and control mechanism of 3d-4f strongly coupled systems; establish the correlation between the microscopic properties of rare-earth elements and the macroscopic properties of rare-earth magnetic materials in

different states; realize the regulation and characterization of rare-earth elements in magnetic materials; and provide theoretical support for the improvement of magnetic material performance and the efficiency of rare-earth resource utilization.

4. The design, performance control and processing of highly filled thermoplastic functional composites (E03)

Proposals are expected to focus on the demand for key materials with thermal/electrical conductivity, dielectricity and electromagnetic shielding in the field of digital communication and energy recovery in Zhejiang and the key scientific problems in the design and preparation of filled functional composites, study the structural design, performance regulation and molding processing of highly filled thermoplastic functional composites, clarify the interfacial structure and formation principles of highly filled composites, reveal the bonding mechanism and regulation methods of polymer matrix and functional filler, study the relationship between structure and performance of composites under multiple hybrid filling states, conduct research on the rheological characteristics of highly filled thermoplastic composites, realize the processing and molding of highly filled functional composites such as film, sheet and tube, etc., and provide scientific basis and technical support for the large-scale application of highly filled thermoplastic materials with thermal/electrical conductivity, dielectricity and electromagnetic shielding.

5. The controllable preparation and performance regulation of key materials for high efficiency flexible organic solar cells (B09)

Proposals are expected to focus on the priorities and strategic needs for new solar cells of Zhejiang, carry out research on key materials and flexible preparation methods for low-cost, high-efficiency, long-life organic solar cells, and provide scientific support for the development of highly efficient flexible organic solar cells. Topics include: the design and preparation of new feeder materials with strong absorption and high carrier mobility; the design of new small molecule interface materials with simple structure and water/alcohol solubility; key technologies for high-performance, bending-resistant flexible transparent electrodes and solar cells; the kinetic mechanisms of charge separation, transport and compounding processes; the relationship between material, interface and cell performance.

6. The hardness enhancement mechanism and molding of powder hot pressed infrared gradient refractive index (GRIN) glass lens (E02)

Proposals are expected to focus on the demand for infrared optical systems in Zhejiang in the fields of temperature measurement and civil monitoring, conduct research on new methods of hot pressing glass powder preparation and material properties, establish the process model of plastic deformation and creep diffusion of glass powder under the coupling effect of temperature and pressure, reveal the pattern of glass densification and the new mechanism of hardness enhancement of infrared glass materials, explore the mechanism of hot pressing of gradual refractive index (GRIN) lenses and the relationship between surface accuracy, surface finish and mold design parameters during the molding process, so as to provide a scientific and technical basis for the efficient and low cost preparation of infrared lenses.

7. Key materials of high energy density, long service life sodium/potassium ion battery (E02)

Proposals are expected to support the development of large-scale energy storage and distributed power generation industry in Zhejiang, focus on the basic scientific problems and key technologies of new sodium/potassium ion battery with low cost, high safety, high energy density and long service life. Topics include: the mechanism of electrode reaction, the decay of battery capacity and the factors affecting battery failure of sodium/potassium ion batteries, the intrinsic correlation between material-interface-battery performance, the preparation technology of new high energy density, long-life sodium/potassium ion battery materials, and the new energy storage

mechanism of sodium/potassium ion battery.

8. Cross-scale structural characterization and performance modulation of advanced nickel-based single-crystal high-temperature alloys (E01 or E13)

Proposals are expected to focus on the key scientific issues in the design and preparation of high generation nickel-based single crystal high temperature alloys and the development priorities of Zhejiang in key aerospace materials, and carry out cross-scale structural characterization and performance regulation of advanced nickel-based single crystal high temperature alloys. Topics include: the dynamic structural evolution and failure mechanism of high generation nickel-based single crystal high temperature alloys under the action of extreme multi-field coupling; characterization of the organization characteristics, defect characteristics, solute migration and performance failure of single crystal high temperature alloys from the micro and nano scale, atomic structure and in situ dynamics across scales; the principles of structure and performance regulation of high generation single crystal high temperature alloys.

9. Low energy consumption and ultra-high density information storage materials based on ferroelectric topology (E02)

Proposals are expected to focus on Zhejiang's industrial advantages and major strategic needs in the field of digital economy and information materials, target at improving the sensitivity and information storage density and lowing the energy consumption of data storage devices, carry out basic research of multiferroic oxide and ferroelectric topological materials with low energy consumption, high sensitivity and ultra-high information storage density, characterize the crystal structure of these materials in situ by transmission electron microscopy, analyze the kinetic properties of their domain structure during the storage process, elucidate their structure-activity relationship, and clarify the main factors affecting the storage sensitivity and storage density. Proposals are also expected to achieve effective regulation of the microstructure, domain structure and storage performance of multiferroic oxides and ferroelectric topologies, and provide scientific basis and technical support for the development of information storage materials with high sensitivity, low energy consumption and high storage density and their applications in next-generation ultra-high density information memory devices.

10. The design theory and key technologies of miniature cryogenic refrigeration system for semiconductor chips (F04)

Proposals are expected to focus on the development needs of Zhejiang's high-performance semiconductor chip industry, study the design theory of miniature cryogenic refrigeration systems highly integrated with semiconductor chips and optimize the system structure parameters, investigate the performance regulation mechanism of chip-level cryogenic refrigeration systems and the mechanism of temperature fluctuations, improve the comprehensive performance of integrated miniature cryogenic refrigeration systems, and provide key technologies for semiconductor micro and nano manufacturing and cryogenic refrigeration of optoelectronic devices.

11. Intelligent control of large flexible hydraulic robot arms (E05)

Proposals are expected to focus on the demand for intelligent operation and precision control of large flexible hydraulic robotic arms. Topics include: the robust control of time-varying parameter interference in hydraulic medium, damping and flexibility control of large inertia arm and adaptive compensation and stability control of structural deformation; the integration method of intelligent control and diagnosis based on model and data learning; key technologies of the autonomous sensing, intelligent trajectory planning, autonomous obstacle avoidance of large flexible hydraulic robotic arm position, and the functional safety design and risk assessment strategy of electro-hydraulic control system.

12. The design theory and micro-nano integration of thermoelectric conversion devices

(E02, E05, E06 or E07)

Proposals are expected to meet the development needs of the internet of things and information technology in Zhejiang, carry out research on thermoelectric conversion devices for self-powered sensors and rapid cooling of chip, and provide theoretical and technical support for the micro-nano fabrication of efficient thermoelectric devices. Topics include: the design theory and structural parameter optimization methods of micro-devices, the multilayer interface construction theory and interface thermal/electric resistance control methods, new technologies for high-density patterned device integration; the service behavior and damage resistance mechanism of materials/devices under the conditions of "thermal-electrical-mechanical" multi-field coupling, the new technology of micro-nano integration and array fabrication of thermoelectric materials/devices in the middle and low temperature region.

13. Integration of ultra-precision machining and measurement of cross-scale micro and nano structures (E05)

Proposals are expected to meet the urgent demand for large-area functional surfaces of micro and nano structures in the fields of optoelectronic information and aerospace in Zhejiang, carry out research on the basic theory and key technologies of cross-scale and ultra-precision machining/measurement integration of functional surfaces of large-area micro and nano structures, explore the accuracy transfer pattern and quality control methods of ultra-precision cutting and machining of large micro and nano structures, establish the mechanism of machining/measurement integration, and form the key technologies to support the efficient and high precision manufacturing of cross-scale micro and nano components.

14. Basic theory and key technologies of intelligent robot cloud computing system (F03)

Proposals are expected to meet the development needs of Zhejiang's intelligent robot industry, explore the working mechanism of integrating both cloud computing and end computing of the intelligent computing engine, achieve breakthroughs in the theory of deep learning model compression and refinement of knowledge, focus on the basic scientific problems of robotic autonomous intelligence such as universal knowledge expression, reasoning and continuous learning, study the method of seamless collaboration of large-scale heterogeneous robot clusters, and provide basic theoretical and technical support for the construction of a new intelligent robot cloud computing platform.

15. Basic theory and key technologies for the design and control of lightweight bidirectional actuated exoskeleton robots (E05)

Proposals are expected to focus on the development needs of the elderly-assisted robotic industry, study the design theory and methods of lightweight bi-directional drive system based on high-torque density joint motors and high-efficiency reducers, reveal the biological information decoding and transmission mechanism of human movement intention under various movement modes, explore the coordinated movement control strategy of human body and exoskeleton, and provide basic theory and key technical support for the development of lightweight and interactive exoskeleton robots

16. Basic theory and key technologies of the design of new configuration UAV (F03)

Proposals are expected to meet the demand for efficient and reliable UAV technology in Zhejiang, carry out research on the basic theory and key technologies of innovative UAV configuration and drive control, study the multidisciplinary integration design methods of innovative UAV configurations such as multimodal aerodynamic layout and takeoff/landing mechanism, distributed electric propulsion, etc., explore the lightweight design methods of high power density motor drive system and intelligent drive interactive compensation control strategies, achieve breakthroughs in disaster and fault tolerance and automatic control technologies of new

UAV configurations based on stability theory, and provide theoretical and key technical support for UAV development.

17. Key technologies of high-throughput manufacturing of flexible chips (F04)

Proposals are expected to meet the development needs of Zhejiang flexible electronics industry, study the theory and key technologies of flexible chip high throughput manufacturing, solve the interface reliability problem of flexible chips under the multi-physical-chemical field coupling in the high throughput manufacturing process, study the theory of micro-damage and crack expansion and chip failure mechanism in the process of thinning and transferring, establish a multi-parameter chip performance prediction model, establish flexible chip reliability analysis guidelines and in-situ performance testing methods, and provide technical support for the high-throughput manufacturing of flexible chips.

18. Liquid-assisted transfer printing technology for multiscale flexible thin film devices (F04)

Proposals are expected to meet the development needs of Zhejiang flexible electronics industry, and focus on the liquid-assisted transfer printing technology of flexible thin film devices. Topics include: the principles of thin film mechanics and mechanical-electric coupling mechanism in the liquid-assisted transfer printing, the liquid surface regulation method under the action of liquid surface tension and three-phase interface pegging force, the mechanism of adsorption force regulation between thin film devices and liquid droplets, and the key technology of transfer printing based on the morphology and volume regulation of liquid droplets; the mechanism of liquid surface spreading of thin film devices and the mechanism of conformal coverage of shaped surfaces, the influence of interface force, device morphology, liquid properties and other parameters on the transfer printing yield, and the key technologies of liquid-assisted transfer printing on multi-scale thin film devices and multiple materials.

19. Computable modeling and inverse problem algorithm research for the design and characterization of advanced materials (A05)

Proposals are expected to meet the development needs of Zhejiang's new materials industry, and carry out research on intelligent design and precise characterization of new materials. Topics include: systematic study of the computable modeling, optimal design, and inverse algorithms of new materials; the inverse problem-oriented mathematical models and stabilization algorithms of new materials; inverse algorithms that can overcome difficulties such as strong discomfort characterization, nonlinearity, model uncertainty, and multi scales by various measurement means including acoustic waves, electromagnetic waves, or elastic waves, spectral information, as well as scanning electron microscopy and scanning probe technology (atomic force microscopy) to effectively determine and design the properties and characteristics of materials.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Zhejiang province.

xiii. Basic research and applied basic research on the new theories, new methods, new technologies of high-performance basic materials and new functional materials to meet the development needs of Anhui's new material industry and promote Anhui's advantages in research and large scientific facilities

Areas for Key Program grants:

1. Polyester synthesis of new rare-earth heterometallic catalysts based on carbon dioxide monomer (B01)

The proposed research is expected to address the core technological problem of catalysts for polyester production in Anhui province and the efficient utilization of CO2 resources of greenhouse gas, carry out research on the synthesis and catalytic performance of new rare-earth heterometallic complexes based on China's abundant rare-earth resources. It is expected to design and synthesize

new multi-dentate ligands containing nitrogen, oxygen and phosphine and their rare-earth heterometallic complexes, study the catalytic performance of rare-earth heterometallic complexes in the ring-opening polymerization reaction of epoxy compounds with carbon dioxide as monomer, reveal the influences of electron, steric effect, coordination effect, metal center effect, synergistic effect of rare-earth and heterometals on the catalytic activity and embeddedness of carbonate fragments and underlying mechanisms, study the catalytic reaction mechanism, develop new high-efficiency catalysts, realize the efficient utilization of greenhouse gas CO_2 and high-efficiency and concise synthesis of green degradable polyester, and provide theoretical and technical support for the utilization of rare earth resources and CO_2.

2. High efficiency three-dimensional preparation of metal micro-nano robots and their biological applications (E05)

The proposed research is expected to address the problems in the processing and application of micro-nano robots, study a new light field modulation method suitable for three-dimensional efficient processing of metal precursor, clarify the two-photon polymerization mechanism of femtosecond laser structured light field in metal precursor hybrid materials, develop the relationship model between CGH and forming structure, decouple and analyze the complex force field in metal polymer post-processing, clarify the influences of different forces on the post-processing process, establish an efficient preparation process for magnetically driven metal micro-nano-robots, build a platform for efficient preparation, performance evaluation and application testing of magnetically driven metal micro-nano-robots, explore the application of micro nano robot in cell transportation and targeted drug therapy, and provide theoretical support for the wide application of micro nano robot.

3. High-performance information storage materials and memory resistive devices based on high dielectric and ferroelectric properties (E02)

The proposed research is expected to focus on the preparation process and performance regulation of new high dielectric and ferroelectric oxide thin film heterojunctions to support the development of strategic emerging industry clusters such as integrated circuits and artificial intelligence in Anhui, construct DRAM dielectric layers with high dielectric property, low leakage, and low equivalent dielectric thickness, produce nonvolatile information storage materials and devices with sub-nanosecond, low write current, multi-resistance, high temperature resistance, irradiation resistance and memory resistive qualities, and construct artificial neural network with high image recognition rate based on optimized resistive memory simulation.

4. Hot stamping and forming of high performance metal plate (E04 or E05)

The proposed research is expected to address the key technical demands of Anhui automotive industry for hot stamping and forming of typical high-performance metal plates such as high-strength steel and aluminum alloy, reveal the coupling mechanism between hot stamping temperature field-material phase change-stamping characteristics-forming quality-process energy efficiency, establish forming quality evaluation methods based on multi-source detection information, study the basic theory and key technologies of the synergistic optimization of hot stamping forming quality and energy efficiency, and develop new processes and equipment for hot stamping of typical materials, and provide theoretical and technical support for the high quality and high efficiency hot stamping of high performance metals.

5. Theory and key technologies of dexterous operation robot (E05)

The proposed research is expected to meet the needs of robot operation in non-structural environments such as power inspection and disaster rescue, achieve breakthroughs in key theories and technologies such as reducer configuration, non-stationary coordination control, and refined teleoperation of dexterous robots. Topics include: new reducer configuration and design method different from RV harmonic reducer, and the design of integrated joint module with high weight

ratio; the dynamics control theory and method based on visual servo considering ground mechanics and environmental compliance; coordination optimization and autonomous planning of robot in dynamic environment for super redundant tasks and complex processes; the motion mapping technology of master-slave multi-information fusion, and the teleoperation in the obstacle space under the master-slave heterogeneous conditions based on 5G communication; the establishment of a robot platform and experimental verification for typical applications.

6. Topological optimization and heat transfer mechanism of low-interface thermal resistance thermal conductivity network (E03)

The proposed research is expected to promote the development of integrated circuits industry in Anhui, and carry out basic and applied research on the heat transfer capability of packaging materials, which is a key technology affecting the performance of integrated circuits. It is expected to construct polymer composite system, explore the influences of interface thermal resistance and preparation process on heat transfer capability; reduce the interfacial thermal resistance of composite material using non-covalent bonds based on theoretical study and experiments to optimize polymer composite systems and form efficient heat transfer pathways; conduct simulation calculations to explain the heat flow transfer mechanism of the composite system and establish the structure-activity relationship; prepare polymer-based thermally conductive composites with excellent overall performance, apply them to integrated circuits, and conduct device verification analysis.

7. Multi-stage assembly of atomically accurate metal cluster-based composite structures (B01 or B05)

The proposed research is expected to develop new assembly methods and theories of atomically precise metal nanoclusters through structural modification or modulation to achieve multi-level assembly of metal nanocluster-based structures (which can be compounded with other materials), achieve in-depth understanding of the structure-activity relationships of the structures, and lay the foundation for precise macroscopic fabrication and application of new metal cluster-based functional materials.

8. The composition and performance control mechanism of new high hardness silicon based materials (E02)

The proposed research is expected to focus on the utilization of high-quality silicon resources, study the composition-structure-property relationship of new display glasses, analyze the influence of raw materials on the thermodynamic and kinetic behavior of glass liquid melting process, establish a quantitative evaluation method of the clarification quality, elucidate the factors influencing the viscoelastic rheological characteristics of high-temperature glass liquid, and construct a multi-field and multi-phase coupling model for glass liquid forming to provide theoretical support and design basis for the efficient utilization of silica resources in information display and other fields.

9. Non-linear ultrasonic theory and evaluation methods for micro-defects of pressure-bearing equipment (E05)

The proposed research is expected to meet the major demand for micro-defect detection of key energy equipment such as pressure-bearing equipment, focus on the ultrasonic non-linear response mechanism of micro-defects, develop composite ultrasonic phased array detection equipment, establish non-linear high-end imaging and evaluation methods, and achieve breakthroughs in the effective detection of micro-defects in energy equipment and quantitative monitoring of early damages.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Anhui province.

ix. Basic research on new materials and advanced manufacturing to promote the

development of industries such as optoelectronic materials, new energy materials, equipment manufacturing, marine engineering and meet the demand for ecological protection in Fujian

Areas for Key Program grants:

1. Large-size mid- and far-infrared nonlinear optical crystals and devices (F05)

The proposed research is expected to focus on the atmospheric transmission window of 3-5 micron and 8-12 micron wavelength, and study the growth, optical-optical conversion and prototype devices of high quality and large size infrared nonlinear optical crystals.

2. Applied basic research on the preparation of advanced inorganic light-emitting materials and the efficient precision processing of semiconductor wafers (E02 or E05)

The proposed research is expected to conduct applied basic research on the zero-dimensional, one-dimensional and two-dimensional light-emitting and display materials and their deviceization, and basic research on the processing of wide forbidden band brittle semiconductor wafers such as silicon carbide, gallium nitride and diamond to provide theoretical basis for high precision intelligent manufacturing.

3. Applied basic research on the design, preparation and application of clean energy and environmental purification materials (B09)

The proposed research is expected to study the scientific issues related to the hydrogen production of fuel cells and the anti-toxicity of membrane electrode catalysts, develop a portable methanol hydrogen production-fuel cell integrated system, and carry out research on the structure design, preparation and pollutant purification mechanism of new molecular sieves for the purification and treatment of industrial waste water and volatile organic pollutant.

4. Applied basic research on the preparation and application of bamboo fiber-based functional materials (E03 or E13)

The proposed research is expected to study the key scientific issues in efficient separation of bamboo fiber and the preparation of bamboo fiber-based film materials, flame retardant materials, thermal insulation materials, energy materials and structural materials, especially the influence of the basic physical properties of bamboo materials on the transformation and performance of bamboo fiber-based functional materials and their regulatory mechanism, so as to provide new approaches and theoretical basis for the value-added utilization of bamboo resources.

5. Basic research on the drive, sensing and fault diagnosis of high-end intelligent equipment (E05)

The proposed research is expected to study the new core functional devices with high dynamic quality and high power density drive and transmission mechanism, develop intelligent sensing core functional components and integration technology, and fault diagnosis technology based on big data.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Fujian province. Researchers from Taiwan region are encouraged to participate in the projects to promote cross-strait scientific and technological cooperation and exchange.

x. Basic research on advanced new materials and manufacturing technology to promote the development of Henan's industries such as special materials, petrochemical engineering, new energy, high-end equipment manufacturing

Areas for Key Program grants:

1. Design, preparation and bio-application of nanodiamond (E02)

The proposed research is expected to study the preparation of nanodiamond materials and carry out biocompatible research on functionalized modification, nano-drug assembly, and construction of disease diagnosis and treatment platforms, and promote potential application of nanodiamond materials in bio-imaging, drug delivery, and disease diagnosis and treatment.

2. The green design, preparation and application of refractory materials for coal gasification (E02 or E04)

The proposed research is expected to carry out basic research on the design, performance regulation and service behavior of high-performance chromium-free high-temperature refractories, and provide refractory technology for the green development of coal chemical industry and solid waste utilization industries.

3. Coin metal cluster-based luminescent materials (B01)

The proposed research is expected to carry out basic research on the regulation of singlet or triplet emission from the shell layer of coin metal clusters, explore the kinetic processes of excited states of atomic state coin metal clusters, and provide theoretical basis for the design and preparation of efficient fluorescent materials based on coin metal clusters.

4. Fundamental scientific issues of non-precious metal catalytic materials for hydrogen fuel cells based on carbon limited domains (B09)

The proposed research is expected to focus on the non-precious metal catalysts for hydrogen fuel cells, solve the problems of poor activity and stability of carbon composite non-precious metal catalysts under acidic conditions, carry out basic research on new carbon composite limited domain structure non-precious metal catalysts, and provide a theoretical basis for the preparation of low-cost and high-performance hydrogen fuel cell catalysts.

5. Molecular design and direct solid-phase polymerization of high-temperature resistant polyamides (E03 or E13)

The proposed research is expected to focus on the mechanism and kinetic control mechanism of direct solid-phase polymerization of high-temperature resistant polyamides, carry out basic research on the molecular design and direct solid-phase polymerization of high-temperature resistant polyamides, and provide theoretical support and application basis for its efficient synthesis and preparation technology.

6. The processing of copper-based microfine bonding wire and its bonding properties (E01)

The proposed research is expected to meet the demand for the processing of copper-based bonding wire for 5G, conduct basic research on the regulation mechanism of solidification structure and the pattern of ultra-fine and ultra-fine deformation, and clarify the connections between nano-plating and bonding performance.

7. Key scientific issues in large-scale microwave preparation of high-performance ceramics (E02)

The proposed research is expected to improve the unity, consistency and stability of microwave heating, study common scientific problems such as the design of the thermal field and synchronous uniform regulation mechanism of microwave heating, and provide theoretical support for the industrialization and promotion of microwave heating technology.

8. Large scale magnesium energy storage system and devices (E01, E02 or E13)

The proposed research is expected to address the problems of low capacity and poor reversibility of existing magnesium metal batteries, study the design, synthesis and device working mechanism of high performance electrolyte system, and provide theoretical basis for the application of large-scale high-capacity magnesium energy storage system.

9. The surface/interface regulation and in situ action mechanism of 2D titanium-based energy storage materials (E02 or E13)

The proposed research is expected to focus on two-dimensional titanium-based energy storage materials and conduct research on the surface/interface regulation and the mechanism of its in-situ action in the energy storage process.

10. The supramolecularly assembled nanomaterials for near-infrared diagnosis and

treatment (E02 or E13)

The proposed research is expected to conduct research on supramolecular controlled self-assembly structure and near-infrared absorption regulation, reveal the structure-activity relationship between molecular assembly structure and anti-tumor performance based on patient-derived tumor models, and provide experimental basis for the development of new material system for tumor diagnosis and treatment.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Henan province.

xi. Basic and applied basic research promoting the development of engineer manufacturing industry of Hubei province, including the construction of digital site, laser light source, high-performance integrated sensor devices manufacturing, the structure design of synchrotron radiation facility, high-quality field anti-plasma preparation, marine super-thick components welding, the preparation of high-performance bulk titanium alloy parts, ceramic-based refractory materials, new energy storage and transformation materials, lightweight high-reinforced thin plate parts for transport equipment, high-performance fiber fabrics, and steel of high steel grade thick-walled acid-resistant pipeline

Areas for Key Program grants:

1. Theory and key technologies of construction quality and safety monitoring based on digital twin system (E08 or E09)

The proposed research is expected to carry out research on the deployment and ubiquitous sensing technology of internet of things in engineering safety of digital sites, realize the deep integration of physical space and digital space of construction sites, study and establish the digital twin model of digital site and man-equipment-environment coupling, explore blockchain-based engineering quality and safety management and dynamic monitoring methods under digital twin environment, realize online sensing, real-time analysis and intelligent control of the construction process for construction quality and safety monitoring.

2. All-solid-state deep-ultraviolet optical frequency comb (A22)

The proposed research is expected to carry out basic and applied research on innovative laser light sources based on the advanced manufacturing resources in the field of photoelectricity in Hubei, solve the problem of low comb power of narrow linewidth deep ultraviolet light source, explore new methods, technologies and approaches for improvement, and provide impetus for the incubation of new growth points in the optoelectronic industry.

3. Flexible integrated sensors (E05)

The proposed research is expected to draw on the excellent characteristics of biological micro-nano structures in nature, conduct research on the design, preparation and application of bionano structures for flexible integrated sensing, reveal the mechanism of composite sensing of biological and bionano micro-nano structures, design and optimize the functional interface of bionano micro-nano structures, realize the preparation and performance regulation of bionano micro-nano structures, establish the principles of packaging process and reliability evaluation models of flexible integrated sensor devices, and lay the foundation for their extensive application in the fields of intelligent manufacturing state monitoring, artificial intelligence perception and flexible wearable devices.

4. Key technologies of Wuhan synchrotron radiation facility (A28)

The proposed research is expected to focus on the accelerator physics of Wuhan synchrotron radiation facility and innovate its structural design to meet the requirement for extremely low emittance. The accelerator physics of Wuhan synchrotron radiation facility also requires unprecedented beam instability, which requires an in-depth study of the causes of beam instability and possible solutions. Meanwhile, the accelerator of the low energy ring of Wuhan synchrotron

radiation facility requires a permanent magnet diode with a magnetic field strength of 3.5T to provide hard synchrotron X-rays. It further requires extensive experimentation and breakthroughs in the physical design and mechanical processing of the magnet. Moreover, all existing room temperature high-frequency accelerating cavities cannot meet the requirements of the Wuhan synchrotron radiation facility (especially in terms of higher order modes). A high-frequency accelerating cavity with a completely new composition and spatial structure is needed to meet the full suppression of higher order modes required by the Wuhan synchrotron radiation facility.

5. The formation mechanism and methods of high quality field inverse plasma (A29)

The proposed research is expected to meet the demand for high quality field inverse plasma of magnetic compression fusion neutron sources and plasma space propulsion, study the formation mechanism of high density, high temperature, high flux, and high injection velocity field inverse plasma, establish the action models of factors affecting plasma quality such as the ionization process airflow and the spatial and temporal evolution of electromagnetic field, develop pulsed airflow control, dynamic electromagnetic field regulation technology and field inverse plasma formation methods, significantly improve plasma quality and perform experimental validation.

6. The stability and process control of ultra-thick marine components welding (E05)

The proposed research is expected to reveal the synergistic energy distribution of ultra-high-power laser-arc composite welding and the mechanism of its influence on stability, study the method of regulating the shape of ultra-high-power laser-arc composite welding joints of typical materials in the field of marine engineering, propose real-time working condition perception and adaptive control strategies of process parameters of laser-arc composite welding process, and provide theoretical and technical support for the welding of ultra-thick marine components.

7. Basic research on the preparation of high performance large volume titanium alloy parts by powder metallurgy (E04)

The proposed research is expected to address the demand of Hubei's deep-sea engineering equipment industry for the preparation of high-performance large-size titanium alloys and components, carry out applied basic research on powder metallurgy preparation of such alloys and components, solve a series of key scientific problems in the preparation of powder metallurgy method such as densification, homogenization and purification, etc., and produce typical sample parts of high-performance titanium alloy for 400 kg class for deep-sea engineering by powder metallurgy.

8. The preparation mechanism and structural-functional integration of erosion-resistant ceramic-based composite refractory materials (E02)

The proposed research is expected to carry out research on structural mechanics, erosion resistance and the integration of ultra-high temperature functions of ceramic-based refractories based on the outstanding high temperature performance and excellent functional characteristics of ceramic-based refractories, so as to provide technical support for the high temperature industry.

9. The forming mechanism and technology of lightweight thin plates of transport equipment (E05)

The proposed research is expected to meet the major demand for lightweight aviation, aerospace, naval vessels, automobiles and other transportation equipment, carry out research on axial envelope forming mechanism and key technologies for the high performance, high efficiency and low cost manufacturing of lightweight high-reinforced thin plate parts, explore new principles and new processes for axial envelope forming of high-reinforced thin plate parts, study key scientific problems such as the axial envelope forming motion mapping model and axial envelope forming mechanism and conditions, establish axial envelope forming technologies and quality control methods, so as to provide a scientific basis for near-net plastic shape forming of high performance and lightweight high reinforcement thin plates.

10. The structure and properties of high-performance aromatic poly(aryl)amine fibers and their fabrics against extreme environments (E03)

The proposed research is expected to focus on the application of high-performance aromatic poly (arylidene) amine fibers and their fabrics in extreme space environment, study the mechanism of resistance to extreme space environment based on surface structure, aggregated state structure, yarn structure and fabric structure, establish the fabric construction technology and method, and develop high-performance fiber fabrics for extreme space environment applications.

11. The hydrogen metallurgical mechanism and application of high steel grade thick-walled acid-resistant pipeline steel based on oxide metallurgy (E04)

Steel materials based on oxide metallurgy technology have high toughness, excellent welding performance and acid resistance. The proposed research is expected to meet the demand for high toughness and high acid corrosion resistant pipeline steels urgently needed for offshore oil and gas exploration, carry out the integrated research on the mechanism of steel microstructure and hydrogen interaction, low temperature fracture mechanism, welding performance and service safety, so as to provide technical support for the metallurgical industry.

12. Preparation and application of flexible organic porous materials for natural gas storage (B05)

The proposed research is expected to address the technological requirements of new energy vehicles in Hubei, and realize flexible efficient natural gas storage with organic porous materials, develop the construction strategy of flexible organic porous materials with high specific surface area, investigate the structure-activity relationship between the structure of flexible organic porous materials and methane storage performance, and realize the large-scale preparation and system integration of low-cost flexible organic porous materials.

13. The surface/interface science in the novel solar steam conversion and utilization (E02 or E06)

The proposed research is expected to make use of the excellent photothermal properties of carbon-based nanocomposites such as graphene produced in Hubei, build a highly efficient, stable and self-cleaning integrated photothermal conversion structure system, design a multi-functional support substrate with flexibility, high strength, heat insulation and water supply ability, innovate the construction strategy of organic combination of photothermal conversion materials and support substrates, carry out research on the photothermal conversion mechanism and performance regulation mechanism of graphene-based composites, and explore the patterns and mechanisms of the physicochemical processes of light-to-heat and water-to-vapor conversion at the surface/interface of photothermal conversion materials, and provide a scientific basis for the application of photothermal conversion in clean water preparation and environmental pollution treatment in Hubei.

14. New mechanisms, key materials and devices for human multi-modal energy harvesting and conversion (E02 or E03)

The proposed research is expected to explore new mechanisms for efficient conversion of multimodal dissipated energy to electrical energy such as low-frequency mechanical motion of the human body and ultra-low-grade skin thermal energy based on the development and design of wearable flexible materials and devices, build a prototype of complementary integrated human power generation system based on this mechanism, achieve an average output power larger than 1 W/m^2, and provide theoretical and technical support for the energy supply of wearable sensors.

15. The microstructure and macroscopic properties of ultra-high performance concrete materials under dynamic effects of bridges (E08)

The proposed research is expected to focus on the microstructure and macroscopic performance of ultra-high performance concrete, conduct basic research on the key technical issues

of the influence of bridge dynamic effects (traffic load, wave force, etc.) on the performance of ultra-high performance concrete during the curing stage of ultra-high performance concrete, so as to provide scientific support for the application of ultra-high performance concrete in the complex bridge construction.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Hubei province.

xii. Basic and applied basic research on non-ferrous metal resources and new alloys, chemical and catalytic materials, complex devices and components manufacturing to support the development of aerospace, national defense, transportation, energy, advanced manufacturing industries in Hunan

Areas for Key Program grants:

1. Basic theory of the value-added utilization of non-ferrous metal resources (E01 or E04)

Topics include: rare precious metal materials for energy conversion and value-added utilization of high-performance hard alloy materials, the green catalytic synthesis methods of organic antimony and bismuth compounds; the physiochemical and special functional properties of organic antimony and bismuth compounds and complexes; new theories and methods of the precise preparation of sub-stable rare precious metal catalytic materials; the design and preparation technology of new hard alloy materials and tools to improve the cutting performance and technical level of the industry.

2. Scientific issues in the design and preparation of high-entropy structural materials (E01, E02 or E13)

The proposed research is expected to meet the urgent needs of advanced manufacturing and major equipment, conduct basic theoretical research on the composition design, structure evolution, advanced preparation technology and service performance of high entropy or complex composition alloys and ceramics; develop computational methods integrating the first principle, phase diagram thermodynamics, phase field and machine learning, etc. to realize the rapid theoretical design and prediction of "composition-structure-performance" of high entropy structural materials; develop new theories of densification of high entropy alloys or ceramic powders, establish prototypes of rapid densification technologies, elucidate the service behavior of materials in special environments, and produce engineering materials with excellent performance.

3. Development and application of a new generation of photodynamic therapy (PDT) photosensitizer with near-infrared light modulation (B05 or B07)

The proposed research is expected to focus on the needs of photodynamic therapy, innovate the molecular structure of NIR materials to ensure their excitation wavelengths in the NIR region (wavelength >750nm); explore the regulation of energy release in the excited states of NIR materials molecules, reveal the relations between the molecular structure of materials and the ability to generate highly reactive oxygen species; modify NIR photosensitizers by molecular engineering means to improve their biocompatibility and renal metabolic ability, and realize the efficient enrichment and selective activation of photosensitizers in tumor sites, and photodynamic therapy guided by photoacoustic and NIR II fluorescence image.

4. Chemical transformation of unsaturated hydrocarbons (B01 or B08)

The proposed research is expected to focus on the strategic demand for raw materials in petrochemical and new energy industries, carry out basic research on chemical transformation of unsaturated hydrocarbons (alkenes, alkynes, conjugated dienes, etc.) and synthesis of high-value chemicals; explore new models and principles of the chemical transformation of unsaturated hydrocarbons; study the new chemical reagents, catalysts and ligand synthesis technologies based on chemical transformation of unsaturated hydrocarbons; carry out applied basic research on

chemical transformation of unsaturated hydrocarbons in pharmaceuticals, pesticides, and functional materials, and achieve breakthroughs in theoretical study.

5. The performance evolution and regulation mechanism of high-precision micro and nano sensors (F04)

The proposed research is expected to address the demand for high-precision attitude measurement and autonomous navigation of unmanned vehicles, robots, engineering machinery, aircraft and other equipment, study the performance evolution pattern of micro-nano sensors from the linear zone to the nonlinear zone, clarify the mechanism and impact of the nonlinear dynamics coupling, nonlinear energy dissipation and other effects in micro-nano sensors, explore the precise matching of nonlinear modes, sensitivity enhancement based on non-Hermitian physical effects, and high quality non-silicon structured micro and nano manufacturing, achieve effective regulation of the performance of micro and nano sensors, and support the development of micro and nano sensors such as high-precision motion measurement sensors and flexible deformable sensors.

6. The overall formability synergy of large lightweight and high-strength components (E04 or E05)

The proposed research is expected to meet the demand for structure-performance synergic manufacturing of large aluminum-based hybrid laminates for aerospace vehicles, high-speed trains and other equipment, study the correlation between multifaceted heterogeneous interface characteristics and bond strength under complex forming energy fields, reveal the mechanism of uniform deformation and collaborative rheology in the integral forming process of aluminum-based hybrid components, propose a unified intrinsic model and rebound/shrinkage compensation strategy for the prediction and control of hybrid component formability, and form the overall formability process and structure-performance synergy technology for aluminum-based hybrid components.

7. The design method and dynamics control of hybrid magnetic-gas bearing (E05)

The proposed research is expected to address the demand for high-speed, high-efficiency, precision and long-life bearing technology for energy power equipment and aerospace servo equipment, carry out research on structural fusion design, dynamic behavior analysis and performance regulation of hybrid magnetic-gas bearings, clarify the mechanism of bearing levitation and magnetic-gas coupling mechanism, study the bearing load distribution strategy and magnetic-gas levitation synergistic vibration reduction method, and provide theoretical support for the breakthrough of high-performance levitation bearing technology.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Hunan province.

xiii. Basic research on key scientific issues of new materials, new batteries, and artificial intelligence in Guangdong

The average funding (direct costs) for each Integrated Program project is 15 million yuan. Priority areas include:

1. Key materials of organic short-wave infrared detection (E03)

The proposed research is expected to study key materials and devices for high-performance organic short-wave infrared (1─1.4μm) detection, design and prepare low-cost, flexible and printable organic short-wave infrared photosensitive materials and thin film transistor driving materials, establish the structure-activity relationship between organic molecular structure and its excited state electronic structure and the precise regulation method of electronic structure for organic short-wave infrared detection materials, achieve large scale synthesis and preparation of flexible devices, and conduct short-wave infrared detection verification.

The program includes the following topics:

(1) The organic semiconductor photosensitive materials for short-wave infrared detection

The proposed research is expected to design short-wave infrared-sensitive organic semiconductor materials based on theoretical calculations, study the mobility, extinction coefficient excited state electronic structure and the structure-activity relationship between the working band and the molecular structure of organic semiconductor materials, achieve regulation of the short-wave infrared detection organic materials; explore the exciton generation and charge splitting mechanism of ultra-narrow bandgap organic photosensitive materials, solve the key technological problems of macro preparation and purification of ultra-high purity organic semiconductor materials, and realize the production of high performance, low cost and stable organic photosensitive materials for short-wave infrared detection.

(2) The thin-film transistor of short-wave infrared detector

The proposed research is expected to develop thin-film transistors with high optical stability, high mobility and high detection based on short-wave infrared organic semiconductor photosensitive materials, study and optimize the design of thin-film transistor arrays, investigate the mechanism of dark current generation in organic semiconductor thin-film transistor devices, study the physical basis and methods of dark current suppression, improve the signal-to-noise ratio of thin-film transistors in short-wave infrared detector, and produce thin film transistors with excellent comprehensive performance for organic infrared photodetectors by systematically optimizing the semiconductor active layer, bonded dielectric layer, metal layer materials and supporting integration methods.

(3) Validation and application of organic short-wave infrared detection materials

The proposed research is expected to assemble organic short-wave infrared detectors using the material system developed by the research based on organic semiconductor film morphology, optical design, device structure design, organic thin-film transistor tuning and integrated circuit design, verify and optimize short-wave infrared organic semiconductor photosensitive materials and organic thin-film transistors, and produce high pixel density organic short-wave infrared detection image arrays.

Applications for the Integrated Program grants should cover all the three topics mentioned above and conduct in depth and systematic research on the theme of "Key materials of organic short-wave infrared detection". The expected outputs include articles, patents and array module devices.

Areas for Key Program grants:

1. Basic research and key technologies of magnetic wave-absorbing fiber materials (E03)

Topics include: the coating method and mechanical properties of microscale magnetic absorbers on the surface of organic polymer skeleton; the absorption rate of various composites at the low frequency end of the microwave and the influence of the interface between magnetic materials and organic polymers on the absorption performance; the influence of the fractal topology design of magnetic absorbing fibers material on the low frequency microwave absorption characteristics.

2. The construction of nanomedicine and underlying mechanism (B08)

The proposed research is expected to meet the therapeutic needs of major diseases such as malignant tumors, cardiovascular diseases, rheumatoid arthritis, infectious diseases, etc., take advantage of nanomaterials, trace the in vivo process of nanomedicines with the help of imaging research methods, reveal the interaction of nanomaterial structure factor and biological interface and the underlying physicochemical mechanism, effectively regulate the nanomedicine-biological interface interaction; realize the large-scale manufacturing and precise delivery of nanomedicines, develop personalized and precise nanomedicines, and realize the efficient immunotherapy of major diseases.

3. Digital twin lithium-ion power cells (E07 or E12)

Topics include: analysis of test data of the whole life cycle performance of lithium-ion power battery through cloud computing, construction of the digital twin model of lithium-ion power battery based on deep learning technology, and comparison and error analysis of the battery model with the actual battery usage performance, and the performance improvement mechanism of power battery.

4. The basic theory and methods of motor rehabilitation robotics (F03)

The proposed research is expected to enhance the motor function rehabilitation effect for bedridden patients with hemiplegia by comprehensive physical intervention based on the brain-cardio-pulmonary synergistic mechanism; study the method of simultaneous acquisition of neuromuscular and cardiopulmonary function information, reveal the coupling mechanism between neuromuscular and blood circulation, explore the motor function rehabilitation method under brain-cardio-pulmonary synergy, and establish the active intelligent motor function rehabilitation system based on the patient's motor intention.

5. Theory and method of distributed decision optimization for intelligent manufacturing driven by group intelligence (F03)

The proposed research is expected to address the problems of multidimensional human-machine collaboration in complex manufacturing environment, focus on the mechanism of group intelligence individual behavior and system knowledge emergence; study the method of distributed collaborative control across layers and domains in manufacturing space such as equipment, cell, manufacturing system/plant; explore the multidimensional fusion model and industrial mechanism of massive historical data and industrial field data; and develop the bio-intelligence driven autonomous decision making and optimization based on human-computer-object collaboration for the whole process of production.

6. Robotic-assisted precision diagnosis of early-stage lung cancer (F03)

The proposed research is expected to address the problem that it is difficult to perform precise localization and biopsy of small peri-pulmonary nodules, study the precise surgical planning, surgical navigation and precise control methods for robot-assisted small nodule puncture biopsy under physiological dynamic environment to improve the detection rate of early lung cancer.

7. The low-temperature performance enhancement of metal ion batteries (B09)

The proposed research is expected to study the charging and discharging reaction mechanism of metal cathode materials at low temperature and the response relationship between voltage and temperature, optimize the material system and regulate the reaction voltage, clarify the effect of low temperature on the diffusion rate of metal ions in the cathode, reveal the key influencing factors of electrolyte decomposition on the surface of the cathode and the impedance characteristics of the interfacial film, and enhance the low temperature ion conduction and reaction kinetics of the electrode.

8. Basic research on neutron diffraction characterization, the giant electrocaloric effect and high energy storage density of multilayered ceramics (A30)

The proposed research is expected to conduct real-time, three-dimensional accurate characterization of ceramics using neutron diffraction (scattering) technology, establish the structure-property relationships under the real-time action of multiple fields in service, optimize various performance parameters, and propose new ways to improve the performance of multilayer ceramic capacitors.

9. Biomaterials for tissue regeneration and repair and their functionalization (E02, E03 or E13)

The proposed research is expected to study biomaterials which can promote tissue

regeneration and repair, establish the design theories, preparation methods and technologies for such biomaterials, study the mechanism of biomaterials in promoting tissue regeneration and repair at multiple levels such as the gene, protein and cell level, achieve in-depth understanding of the relationship between the structure and physicochemical properties of biomaterials and their biological properties, establish functionalization strategies for biomaterials, and develop biomaterials that promote tissue regeneration and repair.

10. Preparation and the structure-activity relationship of highly transparent and heat resistant polymers for flexible display (E03 or E13)

The proposed research is expected to study new high-performance polymer monomers and establish a structure-property database of polymer monomers; establish an efficient and controllable polymerization reaction system and systematically study the kinetics of the polymerization process; explore the evolution of polymer molecules in the new film-forming process and its impact on the structural properties of the membrane.

11. Basic theory and methods of additive manufacturing of multifunctional metal gradient composites (E01, E04, E05 or E13)

The proposed research is expected to develop new principles and processes for the preparation of gradient composites, including the toughening mechanism and design methods of multifunctional gradient composite system, the forming process of alloy powder and laser interaction excitation, the microstructure and mechanical properties, the component size deformation behavior, the composite melt/powder preparation technology, the composite forming process. It is also expected to carry out research on multimodal information fusion and intelligent control for additive manufacturing self-detection and self-diagnosis.

12. The robot-assisted nondestructive testing method for large-load bridge cables (E05 or E08)

The proposed research is expected to address the corrosion and wire breakage problem of internal wire bundles of cables and ropes of large-load bridge caused by long-term exposure, hardening and breakage, study the localization, identification and nondestructive detection methods of cable and rope surface defects, explore the multi-module magnetization and damage signal presentation principles of multi-layer wires, establish the mechanism design and control methods of high-speed and high-load split climbing robots, so as to realize the intelligent detection and health maintenance of cable-type bridges.

13. Key technologies of the parametric state monitoring system during laser processing (E05)

Topics include: the melt pool characterization and technologies of keyhole shape and stability monitoring, the small hole feature image capture and environment perception and accurate measurement under multiparameter interference; light, sound and other streaming media signal extraction and decomposition technologies; visual sensing-based highly robust image feature acquisition and analysis methods for laser processing plume and splash; the machine learning and parameter optimization algorithms for state parameter monitoring in laser processing.

14. Properties and mechanisms of energy conversion materials and devices (B08 or B09)

The proposed research is expected to address the development needs of new energy industry, carry out research related to new solar cells, key materials and devices of energy storage batteries, establish new theories, new mechanisms, new methods and new processes, and achieve an overall improvement in battery performance. It is also expected to carry out research on chalcogenide solar cell transmission layer materials and new near-infrared quantum dot solar cells, and reveal the mechanism of ionic conductivity regulation of solid electrolyte.

15. Novel catalytic materials for chemical engineering and their catalytic processes and

mechanisms (B08)

The proposed research is expected to address the development needs of energy and chemical industries in Southern China, conduct research on new catalytic materials and their catalytic processes and mechanisms, develop new concepts and theories of catalysis, discover new catalytic reactions, create new catalytic materials, and establish new catalytic processes. Topics include: the theory and technology of hydrogen energy, including the precise construction and regulation of catalytic materials in typical industrial reaction processes such as hydrogen production by water electrolytisis, biological desulfurization and pollutant degradation; new high-efficiency single-crystal electrocatalysis for industrial processes such as hydrogen peroxide and hydrogen preparation; photocatalytic process in photocatalytic reduction of CO2, hydrogen production by water photolysis, and photocatalytic degradation of pollutants.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Guangdong province.

xiv. Basic research and applied basic research on new nanomaterials, ceramic materials, thermoelectric materials, energy materials and equipment based on the advantages of metal resources of Guangxi

Areas for Key Program grants:

1. New methods and materials for tumor diagnosis and treatment (E01, E02, E03, E06 or E13)

The proposed research is expected to promote the development of advanced tumor diagnosis and treatment technologies, study new materials that efficiently induce the immunogenic death (ICD) of tumor cells; develop new theories and methods of treating tumors in combination with photothermal and photodynamic therapeutic agents; explore new materials for drug carriers and nanomaterials for diagnosis and treatment integration, and provide theoretical support for the development of tumor treatment technologies.

2. Basic research and applied basic research on new high-performance ceramic materials and their application (E02 or E13)

The proposed research is expected to support the development of automotive, electromechanical and electronic communication industries in Guangxi, carry out research on the design and preparation, performance control and application of new high-performance ceramic materials. It is expected to solve the problems of large hysteresis, poor temperature stability and actuator cracking and breakdown failure of sodium bismuth titanate (NBT) ceramics, and study the local structure of rare earth modified NBT-based ceramics, multi-dimensional sequence structure of piezoelectric actuators, temperature stability of dielectric point, strain performance regulation and fatigue failure mechanism under mechanical-electric-thermal multi-field coupling; study the design, controllable preparation and structural performance control of high-frequency dielectric ceramics in spinel system, and achieve breakthroughs in the ultra-low loss and ultra-low dielectric constant of dielectric ceramics in high-frequency and its high-frequency resonator/filter application, and solve the key scientific problems of high-frequency performance evaluation.

3. New thermoelectric materials and devices (E01, E02 or E13)

The proposed research is expected to make use of the abundant non-ferrous metal resources in Guangxi, design and prepare thermoelectric thin film materials and devices with average thermoelectric merit value of no less than 1 in low and medium temperature regions, explore new thermoelectric thin film preparation processes, study new mechanisms and theories of thermoelectric transport, optimize the device performance of thermoelectric materials, study the physical mechanisms to enhance the thermoelectric performance of thermoelectric materials and devices, and solve the key problems of device power supply and cooling materials.

4. The common fundamental problems of new high-efficiency solar cells (E02 or E13)

The proposed research is expected to carry out research on common basic problems of new copper/indium/gallium/selenide thin film solar cells with high-efficiency conversion characteristics based on Guangxi's advantages in mineral resources such as indium, gallium, and tin, establish a research model of multi-junction high-efficiency cells, and achieve the multi-interface energy level matching of new multi-junction thin film solar cells. It is also expected to provide a scientific basis for the design of new high-efficiency thin film solar cells with high conversion efficiency, stable performance, novel device structure and promising application prospects through the coupling and regulation of multi-associated parameters.

5. The mechanism of differential enrichment of shale gas in the lower carboniferous of Guizhong Depression (E04)

The proposed research is expected to address the problem of the enrichment and depletion of shale gas in the organic-rich shales of the lower carboniferous of the Guizhong depression, carry out research on the deposition of organic-rich shales, microscopic pores and their controlling factors, shale gas enrichment and preservation conditions, and carbonate top and bottom plate conditions of shales to reveal the enrichment difference mechanism of shale gas and provide a scientific basis for shale gas exploration in Guizhong.

6. Key technologies of the preparation of high performance ITO rotating target (E02 or E13)

The proposed research is expected to carry out the applied basic research on the key technology of ITO rotating target preparation based on the advantageous indium-tin resources of Guangxi. It is expected to study the powder forming and stacking theory, sintering densification mechanism and microstructure control for advanced lines, long pitch ITO rotating target, solve the problems of molding difficulty, sintering densification process complexity and microstructure control difficulty, and provide scientific support for the manufacturing and application of high quality ITO rotary targets.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Guangxi Zhuang Autonomous Region.

xv. Basic research and applied basic research on technical bottlenecks in new materials, advanced manufacturing and other industries of Chongqing

Areas for Key Program grants:

1. The design of high-performance cast magnesium wheel materials and theory and methods of the low-pressure non-uniform forming of wheel materials (E01, E04 or E05)

The proposed research is expected to address the demand for lightweight materials of the Chongqing automotive industry, focus on the strengthening/toughening and preparation of low-pressure cast magnesium wheels, and provide theoretical basis and technical support for the development and application of high strength and high corrosion resistance magnesium alloy wheels. Topics include: the design of new materials of low-pressure cast magnesium wheels, the new principles of high clean preparation, new method of non-uniform liquid forming, new mechanism of solidification organization homogenization and defect regulation, and service behavior evaluation.

2. The mechanism of strengthening and toughening of sub-stable β-titanium alloys for aerospace (E01)

The proposed research is expected to address the difficulty in obtaining both the strength and toughness and the difficulty in fully using the advantages of high strength of sub-stable β-titanium alloys for aerospace, carry out research on the mechanism of precipitation strengthening based on incoherent precipitates and its influence mechanism, reveal the correlation mechanism of matrix toughening, realize the simultaneous effect of precipitation strengthening and matrix toughening, and provide a theoretical basis for the development of high strength and toughness

sub-stable β-titanium alloys.

3. The principle and methods of formability-modification integration in the asynchronous loading and precision forging of high performance crankshaft (E05)

The proposed research is expected to meet the demand for transformation and upgrading of Chongqing's manufacturing industry, carry out research on macro and micro multi-scale modeling and prediction methods of the whole asynchronous loading forging process, the mechanism of shape evolution in the asynchronous thermal loading process, the formation and control principles of metal flow and error in the whole process of forming, and the control method of formability-modification integration in the asynchronous loading forging, so as to provide systematic theoretical and technical support for the industrial application of high-performance crankshafts for special vehicles.

4. The mechanism of high surface integrity formability of high-strength gears (E05)

The proposed research is expected to meet the demand for transformation and upgrading of Chongqing's gear manufacturing industry, and provide systematic theoretical and technical support for the industrial application of high-strength gear. Topics include: the mechanism of precision formability of high-strength complex curved gear, the correlations between high surface integrity parameters and gear precision formability parameters, and service performance evaluation, etc.,

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Chongqing.

xiv. Basic research addressing the development needs of functional materials of Sichuan

Areas for Key Program grants:

1. Large scale preparation of polyvinyl alcohol-based environmentally friendly packaging materials and products and the underlying mechanism (E03)

The proposed research is expected to address the major national demand for environment-friendly plastic packaging material and products, establish and develop advanced processing technology, produce the blended composites of degradable plastics and biomass materials with environment-friendly polyvinyl alcohol which has been massively produced in China, realize large scale production of cost-effective, environment-friendly new packaging materials and packaging products such as films, containers, and foam, carry out in-depth study of the environmental friendliness and performance improvement of materials and products, so as to promote the development of environment-friendly plastic packaging industry in Sichuan.

2. Collagen fiber-based nucleophile separation materials and related process (B06 or B08)

The proposed research is expected to prepare advanced adsorption and separation materials for nuclide wastewater treatment which are radiation resistant, suitable for uranium and various nuclides fixed bed adsorption, highly selective, capable of in situ repair and capacity reduction by making use of collagen fibers. It is expected to systematically develop the technology and scientific mechanism of the treatment of various nuclide wastewater by new materials, and provide new materials, new principles and new methods to break through the key technical bottleneck of nuclide wastewater treatment and ensure the healthy and sustainable development of China's nuclear industry.

3. Failure mechanisms and adaptation criteria for key materials of nanocrystalline NdFeB magnets (E01)

The proposed research is expected to meet the demand of developing the nano-crystalline NdFeB magnet manufacturing industry in Sichuan, aim to solve the technical bottleneck of easy to fail and short service life of key materials, focus on the multiple failure mechanisms of the key materials in the manufacturing process of nano-crystalline NdFeB magnets, establish the adaptation

criteria of the key materials to meet the requirements of long service life, in order to support the efficient and continuous manufacturing of nano-crystalline NdFeB magnets.

4. Ultra-precise low damage manufacturing of complex curved metal parts (E05)

High-performance rolling bearings and high-precision metal mirrors are key components that determine the safety and reliability of high-end equipment in service in rail transportation and aerospace, and in particular the performance and reliability of the products is determined by the precision and surface integrity In order to improve the performance of high-end equipment in service, it is urgent to carry out basic research on tribology for ultra-precision and low-damage manufacturing of complex curved metal parts, to achieve controlled removal of nanometer-level precision materials, and to obtain high-performance mechanical surfaces/interfaces.

5. Fundamental problems in the processing of lithium battery diaphragms for advanced light source (E03)

The proposed research is expected to address the problems of low battery capacity, short cycle life, and poor safety due to the difficulty of precise control of microstructure in the processing of lithium battery diaphragms, focus on the generation and regulation of crystal structure and the mechanism of microporosity generation under the external field of processing, and clarify the "processing process-structure-performance" relations of diaphragms by taking advantage of Sichuan's research strength on the ultramicrofine structure of polymer materials using the large scientific facilities (Mianyang Neutron Source), so as to provide theoretical and technical support for the development of high-performance lithium battery diaphragms.

6. The design, preparation and nuclear protection mechanism of comprehensive shielding optical window system (A30)

The proposed research is expected to address the existing problems in the service of nuclear optical windows, develop a new high neutron cross section and high Z-element composition of pure-phase complex oxide window system, explore the structural design and shielding mechanism for the comprehensive realization of high optical transmission, strong radiation comprehensive shielding performance and excellent service environment adaptability, establish a reliable system of comprehensive shielding optical windows, and obtain the new knowledge of integrated shielding optical material system to support the development and "Going-out strategy" of the nuclear energy industry of Sichuan.

7. Key technologies of the preparation of spherical powders and dispersion-reinforced vanadium alloys (E01 or E04)

The proposed research is expected to carry out basic research on the industrial preparation of spherical alloy powders and dispersion-enhanced vanadium-based alloys, improve the application level and basic support capability of new materials in Sichuan, and promote the integration of new materials into the high-end manufacturing supply chain.

8. Research on the physics of neutralization in high-energy ion beam plasmas (A29)

The proposed research is expected to meet the development needs of nuclear energy in Sichuan, study the physics of the neutralization of high-energy ion beams, in particular the neutralization of negative ion beam plasma, and explore the mechanisms of laser neutralization and electron neutralization.

9. Fundamental research in materials science for GaO semiconductor devices (E02)

The proposed research is expected to study the control of conductivity and band clipping of homoepitaxial gallium oxide thin films, develop innovative solutions for p-type doping and heterostructure construction, solve the material science problems for the development of bipolar electronic devices and deep-ultraviolet optoelectronic devices, and conduct device verification using standard compound semiconductor production lines.

10. Hollow fiber membrane for extracorporeal membrane oxygenation (ECMO) (E03)

The proposed research is expected to focus on hollow fiber membrane components for extracorporeal membrane lung oxygenation (ECMO), address the key scientific problems in the development of membrane artificial lung at home and abroad, construct new artificial lung membrane materials (such as lung membrane with good blood compatibility based on polyethersulfone), systematically study the relations between membrane material composition and blood compatibility, and gas exchange capacity, and provide new strategies for the development of extracorporeal membrane lung oxygenation products with intellectual property rights.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Sichuan province.

xvii. Basic research on key scientific and technical issues of nuclear technology application and equipment, ecological protection, new materials and manufacturing based on Gansu's special advantages in resources and industries

Areas for Key Program grants:

1. Treatment of key radionuclides in spent fuel reprocessing (A30)

Topics include: the efficient pretreatment of process solution, solid wastes, gas and liquid effluents in spent fuel reprocessing; rapid separation and purification of radioactive elements such as plutonium, neptunium and technetium, accurate measurement of low-level radionuclides; and the methods for the rapid and accurate analysis of plutonium isotopes, neptunium-237 and technetium-99 in reprocessing process.

2. The disaster mechanism and disaster prevention and mitigation theory of nuclear fuel production system (E08)

The proposed research is expected to carry out studies on the disaster elements, damage patterns, causal mechanisms and correlation of disaster-causing factors triggered by the production process and external causes, reveal the disaster mechanism of the nuclear fuel production system, evaluate the impact of nuclear fuel leakage caused by the disasters, and provide a scientific basis for disaster prevention and mitigation of the nuclear fuel production system.

3. Key issues of long-term operational stability of high-powered superconducting linear accelerator (A28)

The proposed research is expected to solve the bottleneck problem of long-term operational stability of high-power superconducting linear accelerator, conduct research on the existing superconducting linear accelerator, investigate the mechanism of nonlinear beam loss, the unstable coupling effect of superconducting cavity operation, explore the underlying physical mechanism behind the instability phenomenon, and solve the key technical problems of second-scale failure compensation, so as to provide theoretical and technical support for the long-term stable operation at the monthly scale and the industrial application of superconducting linear accelerators.

4. Key technologies of the multi-scale and multi-modal intelligent sensing network for ecological and hydrological data of Qilian Mountains (F02)

The proposed research is expected to solve the bottleneck problem of ecological-hydrological data acquisition in the extreme environment of Qilian Mountains, carry out research on wireless self-assembling network and IOT cloud-edge-end orchestrated computing technology to optimize the traditional monitoring network; adopt technologies such as group wise computing at different scales to explore the fusion method of multi-modal data, build a multi-scale multi-modal intelligent sensing network of ecological-hydrological elements in Qilian Mountains, effectively analyze multi-scale data from each unit to the whole area, and lay the foundation for the development of new ecological-hydrological observation tools in alpine mountains.

5. The preparation and electric transport properties of high-purity cobalt for chips (E13)

The proposed research is expected to carry out research on the mechanism of cobalt

purification and the principle and method of surface/interface regulation of the electric transport characteristics of high-purity cobalt at the nanometer scale, and provide theoretical and technical support for the manufacturing of key electrode materials for high-end chips.

6. The highly selective targeted flotation reagents for copper-nickel sulphide ores (B01)

The proposed research is expected to carry out research on scientific issues such as the selectivity of reagent-mineral interaction and the structure-activity relationship of reagent molecules, reveal the selective action mechanism and structural characteristics of targeted flotation reagents, and provide theoretical support for the efficient enrichment of nickel, copper and other valuable metal minerals in Jinchuan copper-nickel sulfide ore, as well as the separation of useful minerals from vein minerals.

7. Basic theory of the efficient extraction and high value utilization of valuable metal elements in nickel slag (E04)

The proposed research is expected to study the mechanism of mineral phase reformation and control of target elements in nickel slag, the enrichment mechanism of main valuable metal elements and the effective extraction mechanism of coal-based hydrogen reduction, the electromagnetic characteristics of magnetic mineral phase and microwave absorption mechanism, etc., establish the theoretical basis of the efficient extraction and high-value utilization of Fe, Ni and Co in nickel slag, and provide theoretical support for the comprehensive utilization of non-ferrous metallurgical slag.

8. Basic theory and key technologies of robot system for extreme environment operation in non-ferrous metallurgy (E05)

The proposed research is expected to address the problems of accurate positioning, cooperation and control of large inertia systems in extreme environments such as high temperature, high dust and strong radiation, carry out research on monitoring, identification and intelligent decision-making of robot cooperative operation status, and provide theoretical and technical support for the efficient application of operating robots in the non-ferrous metallurgical industry.

9. Mechanisms for the evolution of the whole-life performance of machine-made aggregates and their concretes in dry and cold environment (E08)

The proposed research is expected to address the key technical problems of environmental protection and durability in the development and application of machine-made aggregates, establish the classification index system and evaluation scales of machine-made aggregates, study the mechanism of concrete performance evolution of machine-made aggregates in early age under the coupling effect of large temperature difference and low negative temperature, reveal the correlation mechanism between property evolution and the service life performance, build the whole-life design method system, and provide scientific support for the development and application of machine-made aggregates.

10. Research on supramolecular assembly lubricating materials and their tribophysical chemical properties (B02)

The proposed research is expected to carry out research on the precise design and controllable preparation technology of supramolecular assembly lubricating materials, reveal the physicochemical mechanism of their adaptive friction, develop new supramolecular assembly lubricating material system, and provide scientific support for the application of space lubricants.

11. The behavior and key technologies of drag reduction of the inner wall of gluid transport pipe (E01, E02 or E03)

The proposed research is expected to address the demand for key technologies for pipeline corrosion resistance and drag reduction in the process of oil and gas extraction and transportation, carry out research on the design, preparation and drag reduction behavior of the internal interface of pipelines, achieve breakthroughs in key technologies such as integrated coating materials for

anti-corrosion and drag reduction functions, robotic coating equipment and monitoring, and provide a scientific basis for the protection of long-distance transmission pipelines.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Gansu province.

xviii. Basic research on graphene, rare metal materials, advanced ceramic materials, coal chemical equipment core components, to meet the strategic demand for the development of new materials and equipment manufacturing industries in Ningxia

Areas for Key Program grants:

1. The precision casting of high-performance beryllium aluminum alloy and metal beryllium distillation purification mechanism (E01 or E04)

The proposed research is expected to meet the demand for high performance beryllium-aluminum alloy for aerospace, `carry out basic research on the construction of multi-field coupling simulation system for the precision casting of beryllium-aluminum alloy and the intelligent casting and structural integration molding, solve the problems of defects and poor consistency of beryllium-aluminum alloy precision casting products; carry out studies on the thermodynamic and kinetic mechanism of vacuum distillation method to purify beryllium metal and the crystallization process/pattern of high purity beryllium, provide the theoretical basis for the preparation of high purity beryllium with uniform and fine grains, and meet the demand for high purity beryllium materials in application,

2. The preparation mechanism of high homogeneous niobium-titanium alloy and ultra-high strength titanium alloy materials (E01)

The proposed research is expected to meet the demand for high homogeneity Nb47Ti alloy for superconductivity, conduct basic research on the formation of titanium-rich spots, grain growth and element redistribution and homogenization mechanism, as well as the key process of solidification and thermo-mechanical treatment to solve the problem of titanium-rich spots in large-size rods. It is also expected to conduct basic research on the key technologies of ultra-high toughness design of titanium alloy, reveal the interaction of alloying elements and toughening matching mechanism by high-throughput test and multivariate multi-scale simulation, and provide a theoretical basis for the preparation of ultra-high toughness titanium alloys.

3. Microfluidics study of the microdrop injection array piezoelectric print head in 3D printing (A09)

The proposed research is expected to focus on the microdrop injection array piezoelectric print head for 3D printing, carry out basic research on the 3D printing material fluid transport characteristics, microdrop formation and injection process, factors affecting the print head service life, and droplet quality control methods to provide a theoretical basis for 3D printing technology.

4. Basic research on the application of graphene in aerospace tires (E02 or E03)

The proposed research is expected to address the aging and wear problems of aviation tires, conduct research on the graphene powder screening and quality control methods, the dispersion mechanism of graphene in natural rubber, and the mechanism of graphene modification, carry out performance characterization of natural rubber/graphene composites, and provide a theoretical basis for the manufacturing of high-performance aviation tires.

5. Research on the reliability of core components for key equipment of coal chemical industry (E05)

The proposed research is expected to focus on the core components of Ningxia coal chemical fluid machinery, carry out research on the deterioration mechanism of core components such as valves, blades and worm shells under high and low temperature, high pressure difference, solid-liquid-gas multi-phase medium, acid and alkali corrosion, process instability and other complex special working conditions; study the mechanism of complex fluid phase change control

and energy dissipation; optimize the design and manufacturing of flow channels under the complex flow fields, reveal the failure mechanism of core components of coal chemical industry under high service conditions, and solve the bottleneck problem that restricts the continuous operation of key coal chemical equipment.

6. The mechanism of functionalization and high-value preparation of coal-based carbon materials (E02)

The proposed research is expected to focus on the theoretical basis of graphite microcrystal/microdomain evolution and regulation in the preparation of high-end carbon materials such as Ningdong non-bonded coal, weakly-bonded coal and active carbon made of Taixi coal, explore the "defect-pore-morphology" multi-scale functionalization construction method and stabilization mechanism, and form the theoretical basis of large scale conversion of coal to high-value carbon materials.

7. Basic research on the mechanism of intrinsic microscopic defects of Czochralski monocrystalline silicon rods for photovoltaic and the efficiency enhancement of crystalline silicon cells (E02)

The proposed research is expected to study the formation mechanism of intrinsic defects in the production of CZ monocrystalline silicon rods for photovoltaics, improve the monitoring means, clarify the influences of different types of defects on cell efficiency, further study the new technology of surface passivation and new printing process of crystalline silicon cells, provide theoretical support and design basis for the production of high quality monocrystalline silicon rods, effectively reduce the solar thermal attenuation of cells and improve cell conversion efficiency.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Ningxia Hui Autonomous Region.

V. Modern transportation and aerospace

i. Basic research in line with the development needs of Sichuan aerospace industry and modern transportation development strategy, including research on aero engines, avionics networks, aerospace materials and structures, as well as the difficulties caused by the special terrain in the development of modern transportation

Priority areas of the Key Program:

1. Impact of multiple hazards of the Hengduan Mountains on bridges and their prevention and control (E08)

Bridges in the Hengduan Mountains are susceptible to multiple disasters such as high winds, strong earthquakes, floods, snow and ice, and falling rocks. The proposed research is expected to reveal the characteristics of typical disasters in the Hengduan Mountains and the mechanism of their effects on bridges, clarify the mechanism and effects of the joint action of multiple disasters, solve the fundamental problems of bridge disaster prevention and control, and support the improvement of disaster prevention capacity of bridges in the Hengduan Mountains.

2. High performance plasma sustainment and core-side coupling physics for fusion reactors (A29)

The proposed research is expected to study the high confinement operation mode of the Mega-Amp plasma, impurity agglomeration avoidance, core-edge coupling physics, and confinement control techniques for high performance plasma in low annular ratio (～3) tokamaks.

3. The basic theory and key technologies of intelligent train control of Sichuan-Tibet railway under the extreme and dangerous operating environment (E12)

The complex operating environment of Sichuan-Tibet railway, such as the extreme geographical environment and climate characteristics, brings unprecedented challenges to the potential operation. The proposed research is expected to focus on the core objectives of intelligent

train operation control of the Sichuan-Tibet railway, carry out studies from three aspects: modeling and online optimization of energy-saving train operation under complex conditions of long cross railway lines; the multi-source cooperative control of distributed train traction power systems; and optimization of emergency self-propelled train operation based on double constraints in space and time. The research is expected to provide strong support and technical guarantee for the efficient and safe operation of Sichuan-Tibet railway in the future.

4. The damage mechanism of wheels and rails and traffic safety control of Sichuan-Tibet railway (E12)

The proposed research is expected to focus on the wheel-rail damage caused by the complex operating conditions such as the undulating terrain and climate change along the Sichuan-Tibet railway, study the low/high-frequency dynamic action and the mechanism of wheel-rail damages such as the wear and rolling contact fatigue of Sichuan-Tibet railway EMUs and freight trains, establish a safety assessment method for wheel-rail damage under complex operating conditions, o propose wheel-rail damage control measures for the safe operation of trains, so as to provide theoretical support for the construction and safe operation of Sichuan-Tibet railway.

5. The design and preparation of polymer vibration and noise reduction materials for high-speed railroads in complex environments in Western China (E03)

The proposed research is expected to address the bottleneck problem of vibration and noise management of Sichuan-Tibet railway in the complex environment of western China. Topics include: the forward design methods of vibration and noise reduction, analysis of the vibration and noise characteristics of long tunnel-vehicle-track interaction; the vibration and noise reduction characteristics and mechanism of polymer materials in extreme composite environment, and the whole-life-cycle reliability evaluation method; the acoustic forward design solutions and vibration-noise reduction measures in complex environments; and high-performance lightweight polymer vibration and noise reduction acoustic materials.

6. The performance degradation mechanism of high-temperature dynamic sensors of aero-engine and in-situ fast response test method (E05 or E06)

The proposed research is expected to meet the demand of developing the aero-engine industry of Sichuan, study the in-situ surface acoustic wave testing technology of high-temperature dynamic press of aero-engine, explore the degradation mechanism of Q value and frequency characteristics of SAW sensors under high temperature, and the failure mechanism and solution of thin film electrode of devices under extreme high temperature above 1,000℃, design and develop dynamic pressure testing technology with sub-millisecond response time, and support the development of aero-engine testing technology and industrial development needs.

7. Integrated energy management of hybrid electric and oil power systems for UAVs (E06, E07 or E12)

The proposed research is expected to meet the demand for aero-power with multi-condition applicability and long-endurance for complex missions in mountainous and plateau areas of southwest China, clarify the key scientific problems of integrate energy conversion of oil-electric hybrid power system, study the common physical mechanism of the thermoelectric combined cycle of aviation hybrid power, establish the optimal mathematical and physical model of multi-objective, multi-variable and multi-constrained integrated energy conversion of thermoelectricity, explore the optimal energy conversion design strategy, carry out the ground integration experimental verification, so as to lay the foundation for the realization of long-endurance, high power-to-weight ratio hybrid power for UAVs.

8. Service performance assessment of highly redundant complex systems under incomplete information conditions (F03)

The proposed research is expected to study the service performance evaluation of highly

redundant complex systems under incomplete information conditions, and address the problems of high structural redundancy, incomplete information and strong coupling of parameters in the operation and service of UAVs.

9. The structural matching and dynamic characteristics of permanent magnet direct-drive built-in bogie (E12)

The proposed research is expected to study the new structure of permanent magnet direct drive built-in bogie, propose the design method of optimal matching of permanent magnet direct drive motor and built-in bogie, study the effective measures to reduce the under spring mass, establish the electromagnetic-mechanical coupling transmission model of permanent magnet direct drive traction system, reveal the dynamic operation characteristics under complex line conditions and conduct dynamics tests.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Sichuan province.

ii. Basic research addressing the needs of Tibet in the fields of bridges, tunnels and dams under the plateau environment.

Priority areas of the Key Program:

1. Damage mechanism, health monitoring and early warning technology for mega bridges in the alpine and high altitude areas (E08)

The proposed research is expected to study the damage mechanism of steel and steel-composite mega bridges in alpine and high-altitude areas, and develop the multi-parameter monitoring and transmission system and the danger warning technology with independent intellectual property rights for bridges in alpine and high-altitude areas.

2. Damage and deterioration mechanism and whole-life-cycle control technology for tunnel structure in plateau environment (E08)

The proposed research is expected to study the whole-life-cycle evolution pattern of tunnel structure and damage under freeze-thaw cycles in the plateau, and propose methods for safety evaluation, structural selection optimization and damage prevention.

3. Characteristics and control of hydrostatic response of ultra-deep overburden and dam foundation in the alpine and high altitude areas (E04, E08 or E09)

Topics include: the model related to the physical and mechanical properties of deep overburden and key technologies of in-situ experiments, the amplification effect, the reasonable value of equivalent modulus and damping parameters matched with strain, the observation technology of deep downhole strong vibration; the analysis model of site effect of ultra-deep overburden and the physical model of seismic source-ultra-deep overburden-dam site ground vibration in the test area, the influence mechanism of site dynamic effect and the mechanism of resonance excitation response, and the study of overall reinforcement of dam foundation and dam body.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in the Tibet Autonomous Region.

VI. Electronic information

i. Basic research on information devices, intelligent chips, core algorithms, underlying architecture, and intelligent transportation, etc., to meet the development needs of artificial intelligence in Beijing.

Key priority research areas:

1. Research on programming languages and libraries for intelligent computing systems (F02)

Proposals should focus on programming languages and programming library models for

intelligent computing systems to improve the efficiency of application development and energy efficiency of intelligent processing of intelligent computing systems. The proposed research is expected to focus on the technologies of hardware abstraction for intelligent computing, model definition and compilation optimization of programming languages for intelligent computing, and hybrid programming of programming languages and libraries, for the development of programming methods of intelligent computing systems that possess both high development efficiency and high energy efficiency.

2. Research on spiking neuron network training method and hybrid fusion brain-inspired architecture (F06)

Proposals should focus on spiking neuron network training methods and computational architectures to improve the training efficiency and application of spiking neuron networks. The proposed research is expected to focus on batch normalization methods for ultra large scale, ultra-deep and multi-scale spiking neuron networks, online direct training algorithms and hybrid fusion brain-inspired computing models and architectures, solving the training problem of fusion models of ultra-large-scale deep neural network and spiking neuron networks and validation on brain-inspired chips.

3. Research on programmable energy-efficient neural computing architecture (F06)

Proposals should focus on programmable and energy-efficient neural computing architectures to meet the demand of programmability and energy efficiency of processing of chips for edge intelligent computing scenarios. The proposed research is expected to focus on programmable/reconfigurable storage and computation integrated architecture incorporating non-volatile storage, agile architecture design and development methods, and compilation optimization techniques to improve the programmability, iteration efficiency, and processing energy efficiency of edge computing architecture.

4. Basic research on automated design and technical methods for system integration of hybrid chips (F04)

Proposals should focus on system integration of hybrid chips to address the key problems of micron-scale interconnection and high-speed communication between hybrid chips of different materials and technologies, making breakthroughs in the key technologies of digital-analog fusion, integration of storage, and calculation functions, and multi-chip packages and integration. The proposed research is also expected to explore the methods of system integration of chips of different materials and technologies and develop the basic technology of automated design tools for hybrid integrated chips.

5. Research on the automated co-design of algorithms and hardware architectures for heterogeneous intelligent chips (F04)

Proposals should focus on the automation co-design of algorithm and architecture for heterogeneous intelligent chips to improve the automation design of heterogeneous intelligent chips, The proposed research is expected to focus on space joint modeling of multi-domain fusion algorithms and design of heterogeneous computing architectures, design space search based on reinforcement learning and other methods, and design of network architectures of the heterogeneous chips, etc., proposing integrated software and hardware co-design methods for different optimization objectives.

6. Research on the key technology of low-power consumption 3D multifunctional integrated chip using low-temperature process (F04)

The proposed research is expected to address the key problems of on-chip 3D multi-functional heterogeneous integration, explore the research of low-power consumption transistors, new memories and sensors applicable to low-temperature process, study the basic methods and key common technologies for wafer-level 3D integration of heterogeneous devices,

such as sense-storage calculation devices. The proposed research is also expected to tackle the bottleneck problems of compatibility of on-chip device technology, and complete the prototype verification of low-power consumption 3D multifunctional heterogeneous integrated chips.

7. Research on learning theory and methodology of interpretable similarity measurement for visual information (F06)

To address the similarity calculation problem of large-scale visual data, the proposed research is expected to focus on the learning theory and methodology of interpretable similarity measurement for visual information to improve the accuracy, robustness and interpretation of the similarity measurement of visual information, laying the foundation for validation and application in the fields of intelligent security, smart phones, and intelligent robots.

8. Research on the key technology and intelligent wireless networking mechanism for industrial applications (F01)

Aiming at 5G and mobile communication networks empowering vertical industry applications and for the deep integration of mobile networks, industrial control networks, and artificial intelligence technologies, the proposed research is expected to focus on smart wireless network architectures with on-demand connectivity for industrial applications, including deterministic wireless access networks, adaptive routing, software-defined fully decoupled backbone networks and other bottleneck problems. The proposed research is also expected to focus on the slicing mechanisms of the wireless network integrated with industrial internet with on-demand connectivity and dynamic resource regulation method based on network endogenous intelligence. The proposed research is expected to explore the networking methods for typical scenarios, such as industrial applications, with high reliability, very low latency, ultra-large connectivity, and low power consumption, and carry out performance simulation, evaluation, and verification of typical scenarios of vertical industries empowered by the mobile network.

9. Research on the intelligent surgical planning for robotic joint replacement surgery (F03)

Due to the low accuracy, large noise, and manual marker discrepancy in automatic medical image segmentation, the proposed research is expected to focus on multi-task deep learning of image segmentation technology, optimization of automatic surgery planning, and evaluation method in the intelligent surgical planning for robotic joint replacement surgery, breaking through the bottleneck of mismatch between intelligent robotic joint replacement surgery and clinical medicine and providing basic theory and general method for intelligent surgery planning and clinical evidence.

10. Research on the key technology of intelligent planning of reduction path of complex fracture (F03)

The proposed research is expected to focus on the technology for the identification of fracture features, the method for defining fracture types, the technology of fracture reduction path planning, and human-machine cooperative control for precise reduction surgery of complex fractures. The proposed research is also expected to solve the problems of intelligent fracture diagnosis, optimal reduction path design, and precise reduction operation, exploring theory and method for robotic fracture reduction design.

11. 3D environmental perception and verification of targets status for road traffic scenes (F06)

With the environmental targets in complex road traffic scenes as targets, based on cost-effective monocular camera and domestic intelligent chips, the proposed research is expected to solve the problem of 3D analysis and modeling of forwarding road environment of intelligent vehicles, explore methods of 3D status detection and highly accurate distance measurement of road dynamic targets, and conduct performance verification by building prototype systems, so as to lay

the foundation for monocular vision 3D perception of L4 level autonomous vehicles.

12. Key technology research on the high real-time operating system for controlling intelligent connected vehicles (F02)

The vehicle operating system is the core of the intelligent connected vehicle, and its real-time performance is the bottleneck that restrains the system performance. Aiming at vehicle operating systems that support the performance of autonomous driving, the proposed research is expected to focus on real-time scheduling mechanisms of multi-application tasks, develop the privileged code for spatiotemporal isolation, worst-case execution time analysis, and interrupt latency time guarantee technology. The proposed research is also expected to establish formal characterization methods for the integration of software and hardware of intelligent connected vehicles, laying the foundation for solving the difficulties of localization of automotive operating systems.

13. Research on trusted fusion positioning method for rail transit trains based on Beidou navigation satellite system and 5G networks (F01 or F03)

For the development of positioning of new rail transit train control system and building a spatio-temporal reference model for seamless positioning under complex observation conditions for positioning, the proposed research is expected to focus on the reliable train positioning method with Beidou navigation satellite system as the core and complemented by PNT (positioning, navigation and timing) mechanisms with multiple sensing sources, developing 5G and Beidou combined cross-system fusion positioning interoperability technology for train control system, and a prototype train positioning system, and conducting experimental validation for typical rail transit operation scenarios.

14. Multi-mode fusion positioning with high accuracy of smart vehicles in connected vehicle environment (F01)

The interconnected intelligent vehicles inspired a brand new way for positioning with high accuracy. Aiming at the demands for putting the self-driving vehicles on the urban road, the proposed research is expected to focus on the theory and key technology of cooperative positioning of large-scale vehicle groups, explore the distributed sharing mechanism of status information between vehicles, and establish multi-mode information fusion methods of satellite positioning, SLAM positioning and wireless network positioning. The proposed research is also expected to address the problem of insufficient satellites or static targets due to the obstruction of tall buildings, bridges and tunnels in the urban road environment, so as to further improve the continuous and accurate positioning capability of autonomous vehicles and promote the application of 5G in the field of intelligent vehicle positioning.

15. Research on the vehicle-cloud integrated cloud management and control of the power battery of new energy vehicle (E12)

To address the applicational problems of decayed performance and declining security and stability of power battery of new energy vehicle during its operation, the proposed research is expected to focus on key technology and the intelligent control of the whole life cycle of power battery based on vehicle-cloud integration. Based on the key information in the cloud during the working status of power battery, the proposed research is expected to focus on "Terminal-Edge-Cloud" distributed computing architecture and cooperative information processing technology, building multi-level fine cloud model and develop assessment method of dynamic safety and health boundary for power battery, so as to realize the safety warning, life assessment and optimization management of power battery based on vehicle-cloud fusion, providing theoretical and technical support for the safe and stable operation of new energy vehicles.

16. Research on the computing method of distributed data sharing for rail transit (F06)

To address the problems of inefficient data sharing computation and lack of effective data access control means of rail transit system in large urban represented by Beijing, the proposed research is expected to focus on distributed data storage and control methods of shared access in rail transit system, the data distributed machine learning algorithms, distributed data sharing incentive methods, and related information security defensive strategies, so as to provide theoretical basis and technical support for the data sharing computation in urban rail transit system. The research will provide theoretical basis and technical support for data sharing computing in urban rail transit systems.

Applicants are encouraged to conduct research on the above topics in collaboration with enterprises in Beijing.

ii. Applied basic research on electronic information, artificial intelligence, and other key scientific issues in Hebei province.

Key priority research areas:

1. Research on the mechanism and key technology of multi-dimensional modulated high-repetition high-energy laser and laser shock forming (E05)

The proposed research is aimed at the demand of quick and precise manufacturing of laser shock forming, making breakthroughs in key technologies of laser shock forming equipment, such as high-energy laser forming, temporal shaping, optical field control, forming the multi-dimensional control capabilities of energy at 100 J level. The proposed research is expected to focus on the mechanism of laser shock forming of the high-energy laser by multi-dimensional parameter control for the development of high-end laser impact forming equipment in China.

2. Decoupling and dynamic intelligent control methods for plate shape detection signals of cold rolling mill strip; modeling, intelligent cooperative control, and application of the mechanism of vibration electro-machinery-hydraulic coupling in high speed and high precision rolling process (E04 or E05)

The cold-rolled strip steel production is developing features of complicated and extremely thin formation and high-speed production, which possess critical demands for plate shape control technology and high product quality. Based on the self-made strip shape measurement and control technology, the proposed research is expected to focus on the physical mechanism and intelligent control method of the signal decoupling of the strip shape on-line detection channel and the dynamic intelligent decoupling of the closed-loop control of strip shapes, providing a theoretical basis for the high-quality upgrading of the cold-rolled strip and the intelligent control of cold-rolled strip mills and generating global leading Chinese strip shape measurement and control technology. The vibration of the rolling process is the bottleneck restricting the speed and precision of the operation of the rolling mill. The proposed research is also expected to focus on establishing the non-linear time-lag dynamics model of the rolling process, revealing the influence of the structure and parameters of the mechanical, electrical, and hydraulic systems on the dynamic behavior of the vibration and depicting the evolutionary relationship between the system parameters changes and the vibration intensity. The proposed research is expected to propose effective vibration control methods to ensure the temporary steady-state performance index of the rolling mill from the machine-electric-hydraulic correlation system perspectives and conduct verification experiments.

3. Basic research on ultra-wide bandgap semiconductor materials and electronic devices (F04)

The proposed basic research is expected to focus on the epitaxy of Ga2O3 thin film and power devices of ultra-wide bandgap semiconductor, exploring the growth kinetics of the epitaxial growth of Ga2O3 and the mechanism of evolution of dislocation defects. The proposed research is expected to focus on the effects of different element doping on the electrical properties of devices and their manifestations, laws, and physical mechanisms, making breakthroughs in the new

terminal structure and interface regulation, and other key technologies. The proposed research is expected to develop MOSFET power devices with breakdown voltage ≥ 3,000V and specific on-state resistance ≤50mΩ, laying the foundation for the application of Ga2O3 power devices.

4. Research on the intent identification of fine movement and plasticity recovery of the neural pathway in stroke patients (F03 or F06)

Aiming at effectively induce brain function of plasticity in stroke rehabilitation, the proposed research is expected to focus on high-density EEG signal acquisition and recognition, developing a method for extracting motor evoked features and migration learning methods for ECG of motor intention for rapid and fine recognition of motor intention. The proposed research is also expected to study neuronal-astroglial cell microcircuits and establish a neuroplasticity induction model that combines active modulation and physical stimulation, developing new methods and technologies for highly robust intelligent human-computer interaction rehabilitation of stroke patients.

5. Research on the quality inspection theory and key technology of humanoid vision with autonomous learning ability (F03)

Aiming at the upgrading needs of the photovoltaic industry in Hebei province, the proposed research is expected to focus on the problems of clear imaging, humanoid perception and understanding, data collection and labeling in the process of manufacturing and operation, and maintenance of photovoltaic cells under complex lighting conditions. The proposed research is also expected to study the "hand-eye-brain" humanoid imaging system and mechanism, knowledge expression and migration of identifying skills, small sample and anomaly detection, and other key technologies, so as to make breakthroughs in autonomous evolution and knowledge driving bottleneck problems of defect recognition under different conditions and provide theoretical methods and key technical support for building a quality inspection system with high adaptability and autonomous learning capability.

6. Information perception, efficient operation and maintenance mechanisms for intelligent port energy systems (F03)

Due to the lack of application of information technologies and low energy utilization efficiency at ports in Hebei province, the proposed research is expected to focus on the mechanism and methods of intelligent information perception and interaction, and energy scheduling of intelligent port energy systems by adopting 5G communication technology, so as to explore the mechanism of efficient operation and maintenance of intelligent port energy systems, providing theoretical and technical support to improve the energy utilization efficiency at ports.

7. Mechanisms of intelligent sensing and safe operation of robots for high-risk industries (F03)

In order to meet the special demands of high-risk industries with labor shortages and limited human access, such as oil, chemical industry, wind/fired power operation and maintenance industry, the proposed research is expected to focus on the mechanisms and method of multi-dimensional intelligent sensing, information interaction and human-robot collaboration in the human-machine-environment-targets system adopting 5G communication technology. The proposed research is expected to reveal the mechanism of safe and efficient operation of robots in high-risk environments and provide theoretical and technical support for developing high-risk industry robots.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Hebei province.

iii. Basic research on quantum technology, big data, artificial intelligence, etc., to meet the demand of the new generation of information technology in Shanxi province.

The average funding (direct costs) for Integration Projects is about 10 million yuan per

project. The main research areas include:

1. Research on the development and application of high-performance optical resonator (F05)

To conduct cutting-edge basic and applied fundamental research to meet the urgent demands of precise optical sensing, high-performance laser, and quantum technology in innovative industries such as optoelectronic information, precise measurement and control in Shanxi province and China.

Aiming at developing optical resonator systems with high stability, quality, and controllability, the proposed research is expected to study the fundamental mechanisms of the interaction between optical resonators, atomic media, and single-quantum systems, so as to generate large-scale quantum resources and measurements of single particles with high-precision and high-sensitivity and realize efficient purification, quality enhancement, and precise characterization of laser light sources. The main research contents should include:

(1) Development of optical resonators interacting with specific atomic systems and research on generation of large scale quantum resources

The proposed research is expected to construct high-performance optical resonators that interact with atoms to develop stable and controllable light-atom interaction systems; study the generation of quantum resources such as large-scale photon at fock states and atomic at squeezed spin states by manipulating the atomic medium in optical microresonators, and to explore their applications in quantum-enhanced precise measurements. The proposed research is also expected to study high-performance resonators that interact with nonlinear media to generate compressed light sources with high stability and explore its application in precise measurement of magnetic field.

(2) Development and application of high-performance optical resonators for precise measurement of single-particle systems such as single atoms, molecules and solid defects

The proposed research is expected to design and develop high-performance optical micro-resonators and associated control systems for precise sensing of single-particle systems such as single atoms, single molecules, and single solid defects. The proposed research is also expected to study the basic theory of interaction between optical micro-resonators and single atoms, molecules, and solid defects for highly precise measurement and management and control of single-particle systems.

(3) Research on high-quality optical resonators for purification and characterization of high-performance laser light sources

The proposed research is expected to study the mechanical structure of optical resonators with high stability and the construction method of high-quality optical resonators. The proposed research is also expected to focus on the purification and precise characterization of high-performance laser light by integrating optical, electronic, mechanical and vacuum technologies with reference to the developed highly stable and high-quality optical resonators; improving laser light coherence, noise, and other qualities through high-quality resonator control technologies.

The application of this integration project should include the above three aspects, centering on the project topic of "Research on the development and application of high-performance optical resonator" to carry out in-depth and systematic research. The expected results should include principles, methods, technology, and experimental platform.

Key priority research areas:

1. Research on the theory and method of network big data analysis (F02)

Aiming at solving the problems of network big data analysis, such as large structures, week information supervision, and rapid dynamic evolution, the proposed research is expected to focus on efficient algorithms for large-scale graph representation learning and develop learning and inference methods for network big data in weak supervision environment. The proposed research is

also expected to construct multi-granularity temporal modeling theory and methods for network big data evolution to improve the efficiency, accuracy, and robustness of network big data analysis, and validate the application in the social recommendation.

2. Research on antimonide single-mode high-power lasers (F04)

The proposed research is expected to meet the crucial demands of quantum light sources in quantum technology by focusing on 1.95-micron semiconductor laser devices. Centering on the quantum well structure of antimonide semiconductor, the proposed research is expected to focus on the optimization of the luminescence of antimonide quantum wells and the constraints of the thermal field of the laser on the output linewidth and output power, studying the design and preparation of high-power fiber-coupled output components for single-mode lasers, and developing devices with a continuous output power of larger than 0.5 w and linewidth of less than 0.1nm at room temperature. The proposed research is also expected to study the integration of the pump optical path and waveguide, examine the detection efficiency and noise characteristics of the single-photon conversion on laser pump, and complete the demonstration of its single-photon detection in quantum communication.

3. Research on full-spectrum photoelectric detection technology of silicon carbide with adaptability to extreme environments (F04 or F05)

The proposed research is expected to develop silicon carbide full-spectrum photodetectors with adaptability to extreme environments to address the low tolerance problems of conventional semiconductors in extreme environments with strong radiation and high temperatures. The proposed research is expected to study the effects of doping elements and different concentrations on the electrical parameters of substrates, and to further explore the physical mechanisms and regulation laws of the electrical parameters of substrates on the performance of silicon carbide-based metal-semiconductor-metal photodetectors. The proposed research is expected to use surface plasmon polariton nanostructure to improve the UV response performance of the silicon carbide photodetector, broaden the response band of silicon carbide photodetector to near-infrared band based on surface plasmon polariton nanostructure for full-spectrum detection.

4. Research on low-quality data improvement methods (F02 or F06)

The proposed research is expected to address the low-quality problems of weak labeling and noise of real-world data in machine learning, studying the data quality improvement methods based on data distribution characteristics, developing a multi-level theoretical framework for data quality improvement through data-information-knowledge integration, and forming system of the methods for data anomaly detection. Scientific evaluation methods of data quality are also expected to be established, and providing guarantees for the efficient use and analysis of big data.

5. Rapid construction of large-scale virtual networks and simulation and analysis of service interaction behavior (F02)

The proposed research is expected to study adaptive detection technologies of cyberspace devices for topological information acquisition, rapid recurrence, and construction of trusted network environments of large-scale networks in cyberspace, providing visualization tools and methods for cyberspace analysis. The proposed research is expected to focus on the architecture of network traffic/service and user behavior simulation system to simulate scenario-based multi-level and all-round integrated Internet behavior. The proposed research is also expected to study network attack path planning techniques under large uncertainties for rapid search of network attack paths of infrastructure, developing trusted computing network environment construction methods with active immunity, and providing research demonstration and support for simulation of environment for information technology project and security evaluation.

6. Big data-based technology for accurate prediction of toxic chemical gas hazards in complex urban environments (F02 or F06)

Using big data and machine learning technology, the proposed research is expected to study geometric modeling of the complex environment with buildings, modeling of the micro wind field in a complex environment, and accurate assessment technology of toxic chemical gas hazards. The proposed research is also expected to develop models and algorithms for smoke plume diffusion in different release forms (multi-point source, diffused source, non-point source) and different release modes (transient, continuous), addressing the difficulty and lack of accuracy of toxic chemical gas hazard prediction in complex urban scenes, so as to provide technical support for the scientific disposal of toxic chemical gas leakage accidents.

7. New quantum devices for the strong coupling of multiple atoms and optical microcavities (A21 or A22)

Based on the new principles and technologies of new quantum devices for strong coupling of multiple atoms and optical microcavities, and methods for strong coupling between optical microcavities and multiple neutral atoms and quantum regulation techniques, the proposed research is expected to realize the strong coupling between multi-atom and deterministic atom arrays inside the cavities. The proposed research is also expected to prepare quantum states and develop weak optical non-reciprocal devices based on the strong coupling system between multi-atom and optical microcavities; study multi-bit quantum registers for the strong coupling between deterministic atom arrays and optical cavities for efficient storage and reading of quantum bits in the registers and efficient quantum storage of quantum networks.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Shanxi province.

iv. Applied basic research on industrial intelligence, robotics, medicine, aviation, and other key scientific issues to meet the major demands of enterprises in Liaoning province with in-depth cooperation with local enterprises.

Key priority research areas:

1. Research on the methods of micro and nano additive and subtractive manufacturing of new robotic flexible electronic skin (E03 or E05)

The objective is to develop safe and sensitive collaborative robots in industrial production in Liaoning province with focus on the flexible sensor and enable natural interaction and safe operation of collaborative robots. The proposed research is expected to explore the sensitization enhancement mechanism of skin-inspired perception and the design theory of structural optimization of sensors, making breakthroughs in the key technologies of signal crosstalk and decoupling analysis, and establishing the micro and nano manufacturing method and system of flexible devices. The aim is to realize the preparation of flexible skin-inspired sensors with high sensitivity and high spatial and temporal resolution and multi-channel signal acquisition, and verify the application on collaborative robots.

2. Research on the diagnosis of abnormal quality in the whole process of rolling and the optimization of multi-process coordination (F03)

The objective is to meet the demand for quality control of the strip rolling process in the Liaoning steel industry and address the occurrence of abnormal quality problems in the complex rolling process. The proposed research is expected to establish a deep sensing system of key indicators for different level, working conditions, and processes, studying data-driven diagnosis of process fault states and abnormal quality, developing multi-loop coordinated optimization methods for process status and abnormal quality diagnosis and dynamic feedback to realize cross-process dynamic repairment and graded fault tolerance control, and verify the study through the application in the strip rolling process.

3. Research on the data and mechanism combined driven process optimization of high-end metal materials (E01, E04, or E05)

The proposed research is expected to focus on the process optimization of high-end metal materials in the non-ferrous metal industry in Liaoning, studying the data and mechanism combined driven process modeling and process optimization methods to explore unclear production process mechanism and improve the stability of product quality of high-end metal materials, such as wide titanium alloy plates and zirconium-copper cake materials used in aviation, nuclear power, and marine engineering. The proposed research is also expected to study the following topic: machine learning robust models and high-performance algorithms for imbalanced imprecise industrial data, composition-process-organization-property related modeling methods driven by data and mechanism, reinforced learning methods for optimization of the parameter of the high-end metal material production process, inverse optimization methods to meet material property requirements, and optimization systems of high-end metal material process.

4. Research on theoretical methods and key technologies for accurate imaging of medical photon-counting CT (F01)

The proposed research is expected to focus on the important industrial products of photon-counting CT in Liaoning province, studying theory, methods, and key technology of artificial intelligence-based medical photon-counting CT accurate imaging to address the problems of difficulty in acquisition of massive weak signals, low accuracy in low dose image reconstruction, and massive image data management. The proposed research is also expected to explore the distribution and perturbation law of massive multi-energy photon signals in the modeling for the intelligent correction of multi-energy channel spectral distortion and pulse buildup; study the intelligent reconstruction theory method from multi-energy projection to energy spectrum image for accurate imaging of low-dose/multi-energy channel medical photon-counting CT; and study the intelligent analysis technology of energy spectrum image to assist clinical diagnosis.

5. Research on the building of the knowledge system of safe fine chemical production and intelligent safety monitoring methods (F03)

For the safe production in Liaoning province and with the focus on multi-source heterogeneous data characteristics of safety management information in the full process of fine chemical production, the proposed research is expected to study the construction method of the safety knowledge system based on knowledge graph and production safety monitoring method based on knowledge reasoning, solving basic safety issues such as equipment safety, process device safety, and operation safety, enabling the intelligent analysis of safety track monitoring and risk traceability in the whole process of fine chemical production, developing an intelligent safety management decision-making platform for the whole process of fine chemical production, and completing the application verification.

6. Research on the intelligent broadband communication technology with maritime air, space, and land integration (F01)

Aiming at the intelligent information service demand of maritime communication, navigation, and supervision of intelligent ships/unmanned ships and intelligent shipping in Liaoning province, the proposed research is expected to explore mechanisms to address resource constraints in the maritime intelligent broadband communication network, explore the mechanism of efficient and reliable information transmission and technology for cross-visual range ship-ship opportunity communication networking and network self-healing mechanism, studying maritime air-space-space full node intelligent interconnection technology and network intelligent modeling in a complex maritime environment. The proposed research is expected to realize maritime broadband all-digital communication, developing the prototype of the intelligent broadband communication network, and conduct tests and demonstration for the system performance.

7. Research on basic theory and key technology of autonomous control and self-maintenance of maritime vessels in complex waters (F03)

The proposed research is expected to focus on intelligent ships for safe, reliable, and autonomous operation in the complex maritime environment in Liaoning province, exploring the theory and technology of perception of navigation environment with high-reliability, multi-modal ship group cooperation in dense traffic flow, and autonomous collision avoidance of ships in complex waters. The proposed research is also expected to study real-time monitoring, precise fault diagnosis, and remaining life of power system and equipment operation status by using multi-source heterogeneous ship operation data for the appropriate use, maintenance of ships, and to estimate the remaining service life, so as to enable safe and reliable operations of marine traffic ships in complex waters.

8. Aerodynamic optimization design of data-driven transonic wind tunnel and research on daerodynamic measurement technology (A09)

The proposed research is expected to focus on the large continuous transonic wind tunnel in Liaoning province, addressing the problems of low numerical calculation efficiency for the aerodynamic design of high-speed moving targets and lack of in-depth utilization of aerodynamic experimental data, studying end-to-end calculation technology for aerodynamic calculation based on historical experimental data and numerical calculation results to improve the efficiency of aerodynamic calculation; The proposed research is also expected to study the scale self-similarity of aerodynamic law, and the correlation between the spatial gradient distribution of numerical calculation and the change of calculation scale, improve the aerodynamic measurement technology of wind tunnel balance by directly introducing the experimental calibration data of equipment measurement or gas properties into the aerodynamic calculation and verify it in common scenarios.

9. Research on self-adaptive methods for mobile robots in complex environments (F01 or F03)

The proposed research is expected to address the problem of long-term autonomous environmental adaptability of mobile robots for inspection and security scenarios, studying methods 3D modeling and multi-level environment mapping for large-scale complex scenes, the technology of autonomous scene understanding, and long-haul autonomous environment adaptation of mobile robots, developing the functions of the robot in positioning, obstacle avoidance, path planning and autonomous operation in complex environments, and verifying the application of the robot in changing environments or places with emergency situations.

10. Research on the industrial Internet information physical system (F03)

The proposed research is expected to address the need for the construction of the smart factory, with information-physical integration, focusing on the data collection of the manufacturing process, construction of information system, development of manufacturing implementation system, and production line reconstruction technology for the development of the information physical system for auto parts manufacturing process, and systematic solutions for the information physical system for the discrete manufacturing industry.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Liaoning province.

v. Basic and key technology research on electronic information, medical instruments, optoelectronic materials and devices, automotive electronics, automotive internet, and other industries with local characteristics in Jilin province.

Key priority research areas:

1. Mechanism and the key technology of microwave-light wave integrated communication for space applications (F05)

Aiming at space network nodes with high speed, multi-function, and miniaturized size, the proposed research is expected to focus on microwave photonics information transceiver theory, microwave photonics information exchange technology, integrated optical carrier microwave

channel forwarding technology, the key technology of common aperture transceiver for microwave and lightwave, so as to make breakthroughs in the microwave and lightwave link fusion antenna, switching and forwarding technology of new theory, new system, and new methods.

2. Super-resolution 3D reconstruction of medical image and dense viewpoints true 3D dynamic light field display (F01)

Aiming at the medical imaging for data of difficult and complicated cases with high-definition for volumetric display and dynamic observation, the proposed research is expected to focus on cooperative segmentation of medical tomographic sequences and precise localization of lesions with joint intra- and inter-layer consistency constraints, fine modeling of 3D digital lesions based on finite geometry and local oversampling of texture information, real-time generation of dense viewpoints stereoscopic meta-image arrays that accommodate image quality and display performance of light field imaging, and high-resolution light field display of lesion using novel display device, technology, and optimal lens array design, so as to provide theoretical and technical support for accurate image observation of difficult and complicated cases.

3. Energy-heat synergistic optimization and control method of fuel cell hybrid electric vehicle in the low-temperature environment (E07 or E12)

Aiming at improving the performance of fuel cell hybrid vehicles in the low-temperature environment of cold winter in northern China to guarantee their normal function, the proposed research is expected to study the low-temperature dynamic characteristics and electric-thermal coupling mechanism of the composite power system composed of fuel cell-power cell/supercapacitor in a low-temperature environment. The proposed research is also expected to study the strategy for controlling the thermal energy balance and energy-heat real-time cooperative optimization control method of the composite power system and the whole vehicle, so as to ensure the control of fast and efficient cold start and efficient and comfortable operation of fuel cell hybrid vehicles in the low-temperature environment for actual road conditions.

4. High-efficiency broadband near-infrared luminescent materials and key LED technologies for their conversion (E02)

The proposed research is expected to focus on efficient broadband near-infrared LED light source technology based on luminescent material conversion to develop miniaturized and efficient broadband NIR light sources in solid-state for agricultural products and food spectroscopy. Aiming at improving the efficiency and broadening the spectral band of light-emitting materials in this type of LED, the proposed research is expected to study the mechanism and key technology for enhanced luminous efficiency of materials, the principle and method of regulation and control of spectrum and spectral band broadening, and the law of luminous material property on the performance of LEDs, so as to provide design methods and technical support of new light sources for the portable detection of agricultural products and food safety.

5. Theory and key technology of wireless sensing between sets and vehicles of the high-speed rail (F01)

Aiming at the challenges of thorough perception and reliable communication among high-speed rail vehicles, the proposed research is expected to use wireless communication network technology to make the high-speed rail vehicles more intelligent, lightweight, and flexible for grouping. The proposed research is expected to study the method of wireless thorough sensing and interactive sensing between sets and vehicles with high dynamic in complex communication environment using cluster sampling, building a platform of wireless network control, monitoring, and diagnosis for rail vehicles, and providing theoretical and technical support for the wireless network system of new generation high-speed rail vehicles.

6. Research on key technology of fast and intelligent cooperative transmission of safe networking of small satellites in low orbit (F01)

The proposed research is expected to address the real-time transmission problem of the application of satellite in-orbit data, focusing on the mechanism to reduce massive data transmission congestion and optimization technology of traffic control of low-orbit small satellite cluster, intelligent routing technology for the cooperative transmission of highly dynamic and highly differentiated networks of low-orbit small satellite cluster networks. The proposed research is also expected to focus on low orbit small satellite cluster data cooperative safe transmission, wireless open communication, the technology of cooperative distribution of large-scale data, multi-link concurrent intervention, and control technology to enable high-speed transmission of data and reduce the network congestion.

7. Key technology for homogeneous integrated optoelectronic chips based on third-generation compound semiconductors (F04)

Based on the key technology of third-generation compound semiconductor, the proposed research is expected to focus on the physical mechanism and regulation of the coexistence of luminescence and detection in quantum well diode devices, the consistency of high-speed modulation and detection response in quantum well diode devices, and the low-loss and high-efficiency optical coupling between the light source, optical waveguide, and detector on the chip.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Jilin province.

vi. Basic research on quantum information, artificial intelligence, new communications and intelligent networks, blockchain in the new generation, chips, and other key scientific issues in the post-Moore era for digital economic development in Zhejiang Province.

Key priority research areas:

1. Research on efficient design methods for integrated microsystem integration (F04)

The proposed research is expected to focus on the technology of multi-parameter and multi-functional chip fusion on heterogeneous substrates for microsystems and integration technologies in the post-Moore era, making breakthroughs in common fundamental theories and key technologies such as multi-integration process modeling, interconnected structures, multi-field effect characterization and rapid calculation, and intelligent design. The proposed research is also expected to focus on scalable reusable design and integration, and validate the research results in electronic information enterprises in Zhejiang province.

2. Research on high-speed low-loss coherent optical transceiver chips and devices (F04)

The proposed research is expected to develop high-speed low-loss coherent optical transceiver chips and devices based on the near-infrared semiconductor chip technology, focusing on device design and silicon-based chip integration technology based on III-V compound semiconductors, thermo-optical polymers, thin-film lithium niobate and other materials to develop core modules of optical transceiver integrated on silicon-based chips with heterogeneous material devices. The proposed research is also expected to study the mechanism of the influence of heterogeneous integration of multiple material devices on chips on laser linewidth, coherent optical signal noise, and error rate, explore the mechanism of noise suppression to achieve high signal-to-noise ratio coherent optical transmission and roll out the application in Zhejiang.

3. Interpretable AI theory and methods for proteomics in precision medicine (A06)

Aiming at the defects of the current proteomics phased technology approach, the proposed research is expected to explore the basic theory of data science, focusing on mass spectrometry image analysis and diagnosis and interpretable neural network models, making breakthroughs in the key technologies of big data analysis and interpretability based on artificial intelligence and establishing a new paradigm of protein spectrometry image and proteomics research and big data analysis methods, and exploring the application of novel drug targets in healthcare in Zhejiang

province.

4. Robot vision synthesis and learning theory in the open scene (F03 or F06)

Aiming at the strategic demand of AI-enabled economic development in Zhejiang, the proposed research is expected to study the theory of general robot operation learning and the methods of multi-intelligence knowledge sharing and learning model migration, and construct the image generation model of complex scenes under the constraint of common knowledge. The proposed research is also expected to study the visual synthesis method that combines multimodal data to build rich object relationships and develop the theoretical and methodological framework of human-machine-object fusion perception and collaborative decision making, and conduct the validation research of application in medical diagnosis, crop picking and other scenarios in Zhejiang.

5. Basic research on fiber optic communication and sensing integrated network (F01)

The proposed research is expected to focus on the new distributed acoustic sensing mechanism and intelligent signal analysis technology based on traditional city backbone fiber optic communication network for the development of the smart city in Zhejiang province, forming communication and sensing integrated network architecture of city brain fiber optic. The proposed research is also expected to study real-time fusion sensing technology of video/sound big data for monitoring complex urban life scenarios and all-weather urban disaster warning, and conduct demonstration and verification in Zhejiang.

6. GaN-based high electron mobility transistor design and preparation and key technology of isolation property (F04)

The proposed research is aimed at developing broadband power semiconductor technology in Zhejiang, focusing on the demand for chip energy efficiency and size in the post-Moore era, studying the key scientific issues of design and preparation of high electron mobility transistors (HEMTs) based on gallium nitride (GaN) broadband semiconductor materials, exploring the mechanism of device blocking and conduction for the development of HEMT arrays with self-isolation property. The proposed research is also expected to develop GaN power amplifier circuits and CMOS heterogeneous integrated circuits, and conduct validation studies on consumer electronics and new energy vehicles in Zhejiang to promote the integration and miniaturization of GaN power devices.

7. Key technologies of interoperability and scalability of blockchain for multi-chain convergence (F02)

Focusing on the convergence application demands of inter-chain data transmission, identification, storage, operation, and verification of multi-source and heterogeneous blockchain systems, the proposed research is expected to focus on inter-chain synergy theory, cross-chain consensus model, threat blocking mechanism, cross-chain value transfer and privacy protection, cross-domain auditing and supervision technology to address the problems of segmentation and isolation and improve the interoperability and cross-chain security among different blockchains, and realize the interconnection of different blockchain systems and conduct the verification through applications in electronic invoicing and other fields in Zhejiang province.

8. Key technology for group intelligent perception and capability enhancement in edge environment (F06)

Aiming at improving the digital governance capability in Zhejiang province, the proposed research is expected to study the model and mechanism of large-scale mobile group perception with heterogeneous data fusion, focusing on key technologies, including the efficient deployment of perception devices in complex edge environments, real-time perception in low-complex environment, highly robust compressed perception, multimodal cooperative perception, cross-device cooperative computing theory, and mobile group feature recognition. The proposed

research is expected to develop a set of intelligent perception and collaborative computing systems for the perception of group movements in the edge environment for the application of anti-riot, large-scale public events, and major events management in Zhejiang Province.

9. Research on the long-range dynamic imaging and sensing based on quantum correlated optical fields (A22 or A24)

Aiming at the development of the digital economy and demands for high-quality digital images of artificial intelligence in extreme environments in Zhejiang province, the proposed research is expected to focus on the multi-parameter correlation effect of the quantum light field on the target, the multiple dissociation mechanism and reconstruction algorithm of signals of the dynamic image in the quantum light field, the mechanism of quantum light field action on the transfer function and other key issues, making breakthroughs on the limit of the scattered particle noise and diffraction and realizing the dynamic identification and control of quantum imaging in long-distance and extreme environments and imaging and target sensing of very weak signals under high interference, so as to provide the theoretical basis and innovative strategies for high-quality imaging and sensing in extreme environments.

10. Research on quantum optical force technology and its inertial sensing (A24)

Centering on the construction demands of the major scientific equipment for quantum sensing and precision measurement in Zhejiang province, and with the focus on quantum optical force, atomic system synthesis and other quantum sensing systems, the proposed research is expected to focus on basic theoretical and key technology of the interaction mechanism of quantum optical force and solid-state sensing units, optical force cooling mechanism, quantum sensing noise and measurement model, to realize quantum optical force cooling, manipulation and access to sensing information, noise modeling and separation of micro and nano solid-state media under high vacuum conditions The proposed research is also expected to explore the new technology for the development of new quantum sensor devices and instruments with high-precision and conduct application verification.

11. Theory and method of highly customized industrial internet for equipment clusters (F03)

The proposed research is expected to study the theory and method of highly customized industrial internet of the next-generation based on 5G/B5G as requested by the internet development strategy in Zhejiang province and to accommodate the demands of equipment in complex application scenarios, focusing on the scientific problems, including collaborative computing model of advanced equipment clusters, flexible reengineering methods of edge devices, semantic interactive algorithm encapsulation technology, real-time interaction models between equipment with understandable intentions, measurement and control algorithm with high reliability of wireless network based on deep learning, so as to provide theoretical and technical support for the transformation and upgrading of the manufacturing industry in Zhejiang province.

12. Research on mathematical methods in the field of big data and artificial intelligence (A06)

The proposed research is expected to focus on the medical image reconstruction problem in the field of big data and artificial intelligence in Zhejiang, by combining basic mathematical theories such as Fourier analysis and probability statistics, propose an interpretable mathematical model that conforms to the laws of human cognition and, and establish a systematic mathematical foundation theory. The proposed research is also expected to design fast and effective calculation methods for these mathematical models and perform systematic mathematical theoretical analysis.

13. Mobile coverage and massive address access technology of internet of things of low-orbit satellite (F01)

For the development of wide-area mobile internet of things and telematics in Zhejiang

province, the proposed research is expected to focus on the general performance limits of large-scale access in the mobile environment, low-latency authorization-free random access protocols and highly reliable short packet transmission technologies, making breakthroughs in the technologies of the multi-beam shaping transmission of low-orbit satellites and beam splitting non-orthogonal multiple access, to enable the seamless coverage of wide-area mobile devices and realize efficient transmission and reliable access of large-scale mobile internet of things devices.

14. Research on high-precision sensing technology based on 5G/B5G signals (F01)

Centering on the demands of the construction of new infrastructure of 5G/B5G network and its innovative application in Zhejiang province, the proposed research is expected to focus on distributed high-precision positioning, identification, and sensing technology of multi-base stations, making breakthroughs in key technologies including 5G/B5G signal transmission characteristics and its interaction mechanism with the environment, communication-sensing integrated waveform design, distributed array high-precision positioning and fusion identification, so as to enhance the positioning, identification, and sensing of the 5G/B5G networks.

15. Key technologies for blockchain security and data privacy protection based on national standard system (F02)

The proposed research is expected to study blockchain cryptographic security theory and blockchain supervision technology in response to the frequent security threats in blockchain technology applications. The proposed research is expected to focus on the basic theory and key technologies of secure and efficient blockchain cryptography based on the integration of national standard system and biometric features, forming a new blockchain cryptographic algorithm system that is decentralized, autonomous, controllable, supervisable, and supports non-interactive zero-knowledge proof, so as to realize the privacy protection and the supervision of identity information and data assets of blockchain user in the computation process, providing basic theory support and innovative technology application of blockchain security such as independent and controllable digital identity and data privacy protection for E-commerce and other digital economic platforms in Zhejiang province.

16. Research on the basic theories and common technology of intelligent development of blockchain application and supervision (F02)

Aiming at the systematic application of blockchain technology in Zhejiang province, the proposed research is expected to address the scientific issues of self-organization, self-supervision, and self-correction in the regulation and development of blockchain applications, focusing on the structure and quantitative model of intelligent blockchain regulation system, theory and technology of automatic analysis method and automatic maintenance of blockchain applications, and safe retrieval technology and audit method of blockchain contents for regulation, building intelligent basic algorithm library and safety and security verification testing platform, providing the theoretical model and supporting technology for intelligent development and supervision.

17. Multi-body quantum information processing and quantum simulation (A24)

Using experimental research platforms for studies of superconducting quantum bits, ultracold atoms and photonic crystals in Zhejiang province, the proposed research is expected to explore ways to combine different physical systems including superconducting quantum bits, ultracold atoms, and photonic crystals, developing hybrid quantum systems with long coherence time, high integration, stable operation, and strong nonlinearity. The proposed research is expected to focus on novel quantum effects in non-Hermitian systems, realize non-trivial topological phases, and study multi-body quantum physics; develop methods for preparing and measuring multi-body entangled states of quantum and quantum machine learning algorithms based on existing systems; simulate and calculate the energy and dynamics of molecular ground states and try to solve quantum simulation problems that are difficult for classical computers and single quantum systems.

Applicants are encouraged to conduct research on the above topics in collaboration with universities, research institutes, and enterprises in Zhejiang province.

vii. Applied basic research on quantum information and communication, artificial intelligence, electronic information, and other key scientific issues in Anhui province.

Key priority research areas:

1. Quantum algorithms for fluid dynamics computation (A05, A09 or A24)

The proposed research is expected to design and develop quantum algorithms for fluid dynamics computation, explore the advantages of the quantum algorithms in time, space, and interrogation complexity, and conduct validation on quantum virtual machines and domestic quantum computers.

2. Research on key technologies for intelligent transmission of immersive video (F01 or F02)

Aiming at the demands of large bandwidth, low latency, and high reliability for the network transmission of immersive video, the proposed research is expected to establish a personalized user experience model for immersive video transmission; study content-based intelligent wireless transmission architecture in combination with 5G/B5G key communication technologies to improve resource utilization efficiency; study efficient network measurement means and intelligent transmission control mechanism based on SDN architecture for the immersive video, to ensure user experience of immersive video transmission across networks.

3. Fundamental theory and key technology of multimodal cooperative intelligent perception for autonomous driving (F06)

The proposed research is expected to address the problems of heterogeneous and multiple sources of perceptual data, dimensional explosion, and variable scenarios in autonomous driving, studying the methods of multimodal spatio-temporal fusion perception in dynamic, complex, diverse, and low-identification environments, exploring dynamic adaptive perception models with scene changes, fusion and understanding of multimodal perceptual data, and build a low-latency and highly reliable information perception, fusion, computation, and understanding mechanisms based on terminal-edge-cloud collaboration and vehicle-road collaboration. Eventually, the proposed research is expected to build a driverless verification platform based on low-energy consumption intelligent perception technology, multi-state information fusion technology, spatio-temporal scene prediction technology, and deep reinforcement learning technology for the efficient and accurate cognition and understanding of typical events such as emergency and changing scenes.

4. Research on the construction of high-performance quantum codes (A06)

The proposed research is expected to focus on the construction method and error correction performance of quantum constacyclic codes, revealing the connection between classical constacyclic codes and quantum error correction codes, clarifying the intrinsic fault tolerance and error correction mechanism of quantum constacyclic codes, constructing new types of quantum error correction codes such as high-performance entanglement-assisted quantum codes and quantum synchronization codes based on constacyclic codes, establishing the theory of quantum constacyclic error correction codes for any quantum bit system from two-state to multi-state, so as to provide the theoretical basis for quantum communication and quantum computing.

5. Analysis and understanding of multimedia dialogues in multimodal environments (F02 or F06)

Aiming at robotics service and multimedia intelligent education in Anhui province and the rest of China, the proposed research is expected to study the multimedia dialogue interaction technology in the large-scale multimodal information environment based on real objects, relationships, spatial orientation and text dialogue context in images, achieve efficient analysis and

understanding of multimedia interactive dialogue and bridge the gap between computer vision and natural language processing, develop mobile multimedia dialogue system, so as to demonstrate interdisciplinary integration in artificial intelligence and promote the rapid development of robotics industry and the systematic construction of multimedia intelligent education in Anhui and the rest of China.

6. Sea surface and target composite scattering characteristics of regional inhomogeneous evaporative waveguides (F01)

The proposed research is expected to study the influence law of the sea surface background on the radar detection of sea surface immersion and semi-immersion in waveguides and the skimming targets, the propagation characteristics of electromagnetic waves under inhomogeneous evaporative waveguides and the efficient calculation method of sea surface and target composite scattering, especially focusing on and analyzing the effects of multiple scattering and multipath propagation, edge diffraction and masking of low grazing angle scattering on the propagation and scattering properties. With the verification results of the actual measurement data in the South China Sea, the proposed research is also expected to study the prediction and forecast of wave environment and wave propagation law in the regional inhomogeneous evaporative waveguide, and the complex sea surface and target compound electromagnetic scattering law under complex sea conditions, so as to meet the development demands of radar over-the-horizon target identification and detection in Anhui province.

7. Fundamental theory and methods of evolutionary computing for smart logistics (F06)

Taking into consideration of the new development features of smart logistics in Anhui province and the rest of China, the proposed research is expected to study large-scale, highly restricted, dynamic and robust evolutionary optimization methods and develop the basic theory and methods of evolutionary computing for smart logistics. Aiming at addressing the complex problems of smart logistics in different scenarios, the proposed research is expected to make breakthroughs in the theories and methods of evolutionary computing in large-scale, highly restricted, dynamic and robust optimization, and provide important technical support for the development of smart logistics in Anhui province.

8. Key technologies for multimodal detection and cross-scale biomanufacturing of neural tissues (E05)

To address the widespread demands for nerve tissue transplantation in the treatment of spinal cord nerve injury in paralyzed patients, the proposed research is expected to focus on the bio-fabrication and detection methods of artificial nerve tissues with in-vivo function, developing controllable cross-scale bio-fabrication technologies at the nanoscale, and in situ, simultaneous, and multimodal detection technologies. The proposed research is also expected to study the interaction mechanisms between multiple substances in nerve tissues at different scales, so as to provide a theoretical basis for the bio-fabrication of artificial nerve tissues.

9. Research on control methods and key technologies for upper limb rope traction rehabilitation robot (F06)

The proposed research is expected to focus on the basic theory and methods of the new generation of upper limb rope traction rehabilitation robot, making breakthroughs in the key technical problems such as restricted joint space, insufficient flexibility of the structure and unfriendly interaction of training, developing the control system of the upper limb rope traction rehabilitation robot and a commercial prototype with clinical value and industrialization prospect.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Anhui province.

viii. Basic research on semiconductor optoelectronic devices, artificial intelligence, big

data, marine communications, network information security in Fujian province.

Key priority research areas:

1. Key technology for safe privacy protection and intelligent analysis of multi-source data (F02)

For the development of the digital industry in Fujian province and the collaborative safe development of the digital economy and smart cities across the Taiwan Strait, the proposed research is expected to focus on basic scientific issues and key common technologies related to data security and privacy protection, such as data authentication, secured data transmission, and reliable data sharing, study the collaborative representation and cleaning of cross-network and cross-media big data across the Taiwan Strait and new methods for mining hot events and sensitive contents in media.

2. Advanced semiconductor materials and devices for future display (F04)

To meet the technological demands of the display industry in Fujian province, the proposed research is expected to focus on the design optimization of green laser light sources and array structures based on polarized crystals and GaN crystals, and printed TFT devices integrated with display/driver/interaction, making breakthroughs in technical bottlenecks such as laser dissipation spots with high efficiency and TFT light-emitting materials and device structures, and developing laser projection modules and other future display technologies.

3. Design and manufacture of new micro-scale information memory (F04)

For the development of the optoelectronic information industry in Fujian province, the proposed research is expected to design and manufacture controllable ion-based storage materials with high-performance based on ion transport under the action of external fields, and reveal the working mechanism of new resistive memory devices.

4. Robust visual analysis and understanding for public safety in the strait region (F02 or F06)

Aiming at the bottlenecks of public security and intelligent monitoring in the Fujian and Taiwan region, the proposed research is expected to study robust target detection and tracking, pedestrian re-identification in the complex environment with low-quality images, develop new-generation image and video quality evaluation technologies to provide theoretical basis and technical support for maintaining social stability and security in Fujian and surrounding areas.

5. Research on key scientific issues of maritime and underwater detection and networking communications (F01)

For the smart maritime construction in Fujian province, the proposed research is expected to focus on the basic scientific issues, including intelligent perception, target detection, highly reliable communication, flexible networking, underwater optical imaging, anti-jamming fast communication, and network electronic countermeasures in the complex maritime and underwater environment.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Fujian province and cooperate with scientists from Taiwan region to promote cross-strait scientific and technological cooperation and exchanges.

ix. Basic and applied research on the terahertz wave source, optical switch matrix with high-performance, radio frequency components for 6G communication equipment and other key scientific issues for the development of special optoelectronic industry and electronic manufacturing industry in Hubei province.

Key priority research areas:

1. Research on the design theory and method of terahertz wave source of high power gyrotron (F01)

To address the fundamental theory and design issues in the development of high-power

terahertz sources, the proposed research is expected to focus on three aspects of research, including high-speed electron injection generation and compressor theory, electron cyclotron pulsation theory, high magnetic field regulation and radiation detection methods, exploring the unstable operating factors of gyrotron in high magnetic field, and laying the theoretical and technical foundation for the development of compact high-power terahertz wave sources above 1 THz/1kW.

2. Research on optical switch matrix with ultra-low power consumption, ultra-high density and ultra-high capacity (F05)

By combining the new material optical field modulation principle with silicon-based optical waveguides, the proposed research is expected to study the physical mechanism of ultra-low-power optical switching at joules per bit to reduce the huge power consumption of large-port optical switching matrix. The proposed research is also expected to develop the optical switch matrix with high-density by adopting the principle of the parity-time system breaking principle to solve the problem of high-density integration of large-port optical switch matrix. Adopting the principle of transformation optics, the proposed research is also expected to develop the multimode waveguide small size waveguide network to solve the problem of large-capacity transmission of large port optical switch matrix, so as to provide technology reserve and result transformation for Hubei optical communication industry, and enhance the innovation ability of optoelectronics enterprises in Wuhan Optics Valley and its international influence.

3. Key technology of high-performance RF filter for 6G communication (F04)

Based on the characteristics of high-performance RF filters with ultra-high operating frequency, large bandwidth and low insertion loss, the proposed research is expected to use the piezoelectric single crystal thin film as the research object to study the key scientific issues of lattice mismatch, interfacial stress and defects in the preparation process, providing the scientific basis for the development of high-performance RF filters. The proposed research is also expected to address the key scientific issues of the complex constitutive relationship between high-performance filters and resonators, study the vibration modes of highly coupled resonators and their acoustic propagation mechanisms, providing the scientific basis for the development of high-performance RF filters and resonators. The proposed research is also expected to further address the key scientific issue of the influence of external circuits on high performance filters, with external circuits as the research object to study the electrical theoretical model and the composition and optimization of the circuits, providing a scientific basis for the development of high performance RF filters. To ensure the high efficiency and reliability of the resonator preparation process, the proposed research is expected to use the MEMS process to study the process parameters and process flow in order to provide a scientific basis for the development of high-performance RF filters and resonators.

4. Research on the aerodynamic properties and capture mechanism of virus-carrying aerosol particles (F03)

In order to meet the demands of filtering the transmission of virus-carrying aerosol particles, the proposed research is expected to focus on the quantum effect of virus-carrying aerosol particles and the interaction law and mechanism of electrons and aerosol particles in the field emission field to obtain the kinetic characteristics of aerosol particles in the field emission field space and the capture mechanism of aerosol particles, based on which to develop a field emission system based on microelectromechanical system technology with polymer flexible microcone array cathodes, which will provide basic theory and key technical support for the upgrading of the domestic medical protection industry.

5. Beidou/pseudo-satellite/inertial navigation fusion precision positioning and intelligent formation control for public vehicles (F03)

For the public vehicle control of intelligent transportation construction in Hubei province,

the proposed research is expected to focus on multi-source fusion precision positioning and formation of Beidou + pseudo-satellite + inertial navigation of public vehicles in the urban complex road environment and the technology of its control, so as to guarantee the continuous and accurate acquisition of space-time information of vehicles in the urban complex environment, reducing the reliance of networked vehicles on high-cost sensors, and providing basic technical support for the development of vehicle-road cooperation and active vehicle control scheme.

6. Miniaturized calcium ion optical clock harnessing mercury ion microwave clock timekeeping system (A18 or A22)

Using the optical clock to generate time scale by harnessing the microwave clock fully combines the advantages of ultra-high accuracy of the optical clock and the long-term continuous operation rate of the microwave clock. Given our country's long-term and urgent demand for high-precision time scale for the construction of high-precision time and frequency system, especially for the construction of Beidou satellite navigation system, it is urgent to carry out the research in the field of optical time scale by harnessing microwave clock. The development of high-precision atomic clocks is also an important means for research on basic scientific problems such as the measurement of fundamental physical constants and the testing of fundamental physical laws. The proposed research is expected to further accelerate the construction of the national time and frequency system with civil-military integration, give full play to the advantages of science and technology, build the first-level site platform of time and frequency system in Hubei province, and carry out experimental research on the next-generation time-keeping atomic clocks.

7. Research on key fundamental issues of semiconductor room temperature hydrogen sensors (F04)

To address the key fundamental issues of semiconductor room temperature hydrogen sensors, the proposed research is expected to study the macroscopic preparation technology of low-dimensional oxide nanomaterials and their cross-scale composite systems and new methods and processes for sensor construction, explore the microscopic mechanisms of hydrogen-sensitive properties of the material from the atomic scale. The proposed research is also expected to study the constitutive relationships between material surface interface properties, device structure configuration and sensor hydrogen-sensitive performance, develop the nonlinear mathematical model of sensor hydrogen-sensitive response, explore the signal acquisition and adaptive nonlinear correction techniques, and study the sensor performance optimization strategies for different application scenarios to provide an experimental basis and scientific basis for the development of sensors for safety detection of hydrogen energy.

8. Non-classical properties and quantum precision measurements of quantum-bound systems under optical manipulation (A22)

Based on atoms or molecules under laser manipulation and quantum-bound systems such as quantum dots or diamond color centers under microwave manipulation, the proposed research is expected to focus on the characteristics of non-equilibrium quantum dynamics, quantum correlations under non-linear mechanisms, quantum phase transitions and novel physics, suppression of quantum regulation and decoherence, and new quantum measurement schemes and quantum precision measurement techniques. Cutting-edge experimental projects with application potentials will be given high priority for support.

9. Theory and methods for ground testing of high precision space inertial sensors (A29)

The proposed research is expected to establish the theory system of ground testing for the performance index of high precision inertial sensors such as satellite gravity measurement and space gravitational wave detection, evaluating and suppressing the influence of ground environment on the testing, to realize the function testing and performance verification of high precision space inertial sensors for the development and testing of high precision space inertial

sensors.

10. Key technology of silicon-based optical transceiver chip at Tb/s level (F01)

To meet the demand of the core optoelectronic chip for the optical communication industry, the proposed research is expected to focus on the ultra-high-speed (rate ⩾ 100GBaud) new silicon optical modulation and detection technology, on-chip optical multi-dimensional multiplexing and regulation technology, high-speed high-density integrated packaging technology and ultra-high-speed optical transmission and interconnection system, making breakthroughs in bottlenecks of chip rate, integration, power consumption, providing the technical basis for communication networks, data centers, 5G and the localization of key devices of the industries to promote the upgrading of the optical communication industry in Hubei province.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Hubei province.

x. Applied basic research on computing and information processing in the fields of autonomous control, intelligent network connection, information security to meet the demands of information technology for the industrial and social development in Hunan province.

Key priority research areas:

1. Research on the key technology of multimodal perception and autonomous decision-making of urban intelligent buses (F03 or F06)

Aiming at the active safety technology of urban intelligent buses, the proposed research is expected to study the intelligent perception method of multimodal migration learning under dynamic road conditions and the intelligent driving behavior decision-making method of deep reinforcement learning in an open environment. The proposed research is also expected to focus on the control method of driving and braking system with adaptive iterative learning capability, the design of integrated vehicle-road-human navigation model based on the integration of data-driven and mechanism simulation; the construction of the key technology system of autonomous operation of intelligent buses based on multimodal intelligent perception and autonomous decision-making in complex scenarios, and verify and test the application in typical scenarios to support intelligent urban transportation.

2. High-performance computational simulation and simulation of the doping process of ion-injection of silicon carbide semiconductor (F02)

To meet the demands of domestic replacement of high-end equipment in the chip industry and with the consideration of the complexity of the doping process of ion injection into silicon carbide semiconductor, the proposed research is expected to study high-performance computing theory and methods for simulation of the doping process of ion generation, transport and injection into silicon carbide, focusing on ion data grid division and parallel computing model, parallel iterative solution algorithm of ion motion and highly scalable parallel algorithm based on autonomous processors, making breakthroughs in the simulation of load balancing on heterogeneous million-core computing platforms based on random task scheduling with the efficiency of one million cores of key parallel algorithms achieving more than 30%.

3. Key technology for wireless power supply and intelligent control of deep-sea autonomous operation robot (F03)

To address the key problems of energy supply and intelligent control the underwater operation of deep-sea operation robots for long period, the proposed research is expected to study underwater efficient radio energy transmission and intelligent robot energy management technology, develop deep-sea underwater charging pile and robot wireless power conversion system to solve the problems of heat dissipation, insulation and sealing in high voltage environment, study target identification, path planning and power positioning of robots in a deep-sea environment, realizing

the autonomous and accurate alignment of the robot with the charging pile, and conducting test and verifications in the underwater environment.

4. Research on the key technology of energy-efficient neuromorphic processors based on new principle devices (F04)

To meet the demands of high computing power, low power consumption intelligent processor for its new-generation development and based on the advantages of hafnium-based ferroelectric and other new electronic materials and devices, the proposed research is expected to focus on the key technology of new neuromorphic processor with low-power consumption, making breakthroughs in technology of high-density integration of device array, high parallelism neuromorphic processor architecture design and key technology of physical unclonable security of processor, exploring new paths for the disruptive development of the physical foundation of information technology.

5. Key technology of engineering computing software for domestic high-performance computers (F02)

Aiming at the demands for efficient parallel computing of autonomous engineering computing software on domestic high-performance computers, the proposed research is expected to focus on the numerical simulation of physical processes, fluid computing, scalable parallel algorithms for large integer decomposition, and core performance modeling of irregular memory access computing for the collaborative optimization for autonomous computing chip architecture, study automatic optimization technology of engineering computing software, and develop prototype systems for performance tests.

6. Research on the basic theory and method of engineering graphics data security for network collaborative manufacturing (F02)

Aiming at the security demands of engineering graphic data storage and collaborative interaction in the network collaborative manufacturing, the proposed research is expected to study the security theory and model of engineering graphic data, retrievable encryption, reversible watermarking of the encrypted domain, ownership protection, cross-media source tracing (including format conversion, recording, etc.), completeness authentication and security interaction between collaborative subjects and other technologies and methods to realize the static and dynamic security of engineering graphic data in the network collaborative manufacturing for independent and controllable engineering graphics data security to support the development of network collaborative manufacturing in construction machinery industry in Hunan province.

7. Theoretical modeling and design methodology for high-performance power semiconductors based on insulated gate bipolar transistors (IGBTs) (F04)

Aiming at the demands for highly reliable and low power consumption power chips in emerging strategic industries such as aerospace, electric vehicles and new energy, the proposed research is expected to focus on the theory and methods of IGBT-based high-performance power semiconductor chip design. Using IGBT low-power consumption and high-speed switching characteristics, the proposed research is expected to study the technology of high-voltage resistance, high current, and high-speed conversion power of semiconductor, making breakthroughs in high-temperature resistance, radiation resistance with high reliability, study parallel computing simulation technology of power semiconductor chip to support the independent and controllable development of high-performance power semiconductor chips.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Hunan province.

xi. Basic research on information transmission, data storage, resource collaboration, electronic equipment development, and other key scientific issues in Guangdong province.

The average funding (direct costs) for Integration Projects is about 15 million yuan per

project. The main research areas include:

1. Theory and methods of high-performance distributed intelligent medical imaging (F01)

Aiming at addressing the problems of high hardware cost of medical imaging systems, difficulty in updating advanced algorithms, and difficulty in supporting the application of imaging big data technology with scattered data, the proposed research is expected to establish the theory and method system of intelligent acquisition of detection data of distributed terminal devices and distributed medical intelligent imaging, making breakthroughs in the traditional single imaging mode, and creating a high-performance distributed cloud-based intelligent medical imaging system.

The main research contents should include:

(1) Research on the intelligent acquisition method of detection data of distributed terminal equipment

The proposed research is expected to focus on individualized ultra-low-dose CT scanning protocols and high-speed MRI data acquisition for diagnosis, creating intelligent acquisition methods for distributed CT and MRI detection data, and solving the problems of data acquisition normalization, light-weight edge computing, and high-speed transmission of massive data for distributed terminal devices.

(2) Intelligent imaging theory and method of ultra-low-dose CT

The proposed research is expected to explore the distribution and perturbation law of the massive weak detection photon signals of ultra-low-dose CT, creating the theory of error modeling of detection data and high-fidelity correction method based on noise generation mechanism, study the intelligent selection method of adaptive reconstruction strategy for the diagnosis, establish the theory and method of ultra-low-dose CT reconstruction based on big data and artificial intelligence technology to realize distributed sub-millisievert cloud-based CT intelligent imaging.

(3) Research on the theory and method of high-speed MRI intelligent imaging

The proposed research is expected to study the signal distribution and redundancy pattern of MRI multi-sequence images, creating an improved design method for sparse sampling scheme in MRI multi-sequence collaborative imaging, studying the personalized MRI multi-sequence collaborative imaging method for diagnosis. The proposed research is also expected to establish the theory and method of ultra-sparse sampling MRI reconstruction based on big data and artificial intelligence technology for the ultra-fast MRI multi-sequence real-time dynamic imaging.

The application of this integration project should include the above three aspects, centering on the project topic of “Theory and Methods of High-Performance Distributed Intelligent Medical Imaging”. The expected results should include papers, patents, imaging systems, and demonstration applications.

Key priority research areas:

1. Research on the development of hollow-core optical fiber with ultra-low-loss and low latency and related communications (F05)

Aiming at improving the capacity, reducing the latency and energy consumption for information transmission, the proposed research is expected to explore the loss limit of hollow-core fiber, develop hollow-core fiber with lower loss than solid fiber and corresponding prototype system, and verify the intrinsic advantages of low nonlinearity, low latency, and low Rayleigh scattering properties of the hollow fiber and the advantages of communication capacity and distance product of hollow fiber, providing technical support to solve the “channel capacity crisis” in specific applications.

2. Theory and key technology of network resource collaboration for intelligent communication (F01)

To meet the demands of intelligent communication in the future of the internet of things, the

proposed research is expected to clarify the interaction mechanism of multi-dimensional network resources, study the cooperative scheduling method of heterogeneous network resources, design an integrated transmission scheme for network computing and communication, making breakthroughs in the distributed coding and decoding technology based on shift plus and sawtooth decoding, wireless transmission technology based on air computing theory, and intelligent signal processing technology based on computing, providing a new method for future intelligent communication.

3. Theory and method of detection and recognition of target with ultra-high-speed inspired by brain structure and function (F06)

The proposed research is expected to draw on brain structure and function, study the theory and methods of spiking neuron network computation inspired by brain structure and function at three levels: individual neurons, neural loops, and large-scale networks solving challenging visual problems such as the detection, tracking, and recognition of the high-speed moving object. The proposed research is expected to focus on the computational model of pulse neuron dendrites, neural loop dynamics, and learning and memory for large-scale spiking neuron network inference, so as to systematically form a set of spiking neuron network computational theory, providing the basis for establishing technology and system for real-time detection, tracking, recognition and behavior understanding of moving objects with ultra-high-speed.

4. Research on the theory and key technology of active control of vibration of flexible axial drive structure of intelligent equipment (F03)

To address the problem of elastic vibration generated by the high-speed motion of flexible axial drive structures in intelligent equipment, the proposed research is expected to establish an infinite-dimensional ordinary differential-partial differential (ODE-PDE) coupled model that can characterize the vibration features and complex working conditions of flexible axial drive structures and conduct parameter identification, design state and disturbance observers to achieve accurate estimation and compensation of feedback signals and disturbances, study the theory and key technology of adaptive control of vibration of axially driven structures under multiple constraints, so as to enable the cooperative control of trajectory tracking, force control, and vibration suppression, and the accurate control of vibration.

5. Research on the methods of ultra-large density DNA data storage (F02)

The proposed research is expected to explore the correlation between insertion/deletion errors of DNA storage channels and structural properties of information sequences for future storage of massive data, study channel modeling incorporating DNA synthesis process, making breakthroughs in the technology of efficient error control for insertion/deletion of errors and sequence optimization design restricted by the DNA structures, providing new methods for future storage of massive data.

6. Research on collaborative intelligent driving for unmanned vehicles (F03)

For the development of future unmanned networked vehicle systems, the proposed research is expected to study the organizational framework for multi-vehicle intelligent group collaboration, self-learning behavior patterns in large-scale open environments, and interconnected vehicle incentive mechanisms in complex environments for the large-scale group intelligence in open and dynamic complex environments. The proposed research is also expected to study the visual and information perception and human-computer interaction mechanisms and methods of intelligent networked vehicles for efficient and safe adaptive cooperative perception and control.

7. Research on the security control and attack detection technology of blockchain (F02)

The proposed research is expected to study technology, models, and architectures for security control of distributed ledgers such as blockchain, methods and technologies to control the recording and guarantee the results of distributed ledgers in a zero-trust environment, study theories of detection for malicious transactions and other attacks on distributed ledgers, and methods and

technologies for real-time monitoring, intelligent identification and active discovery of malicious transactions. The proposed research is also expected to study robust models for malicious transactions on distributed ledgers, and methods and technologies for the robustness of bookkeeping and real-time intervention of malicious transactions during attacks on distributed ledgers.

8. Research on methods of intelligent analysis for multimodal medical images (F06)

To meet the demands of intelligent medical image analysis, the proposed research is expected to study the simultaneous multi-target segmentation of multimodal medical images and 3D image construction methods, the accurate alignment methods based on multimodal image data. The proposed research is also expected to develop robust base theory and intelligent pathology modeling for multi-source small medical sample learning, providing interpretability and solving the uncertainty modeling problems for intelligent medical image analysis systems.

9. Basic research on the theory of algorithm for energy internet construction and the application of new material devices (E07)

For the development of energy internet in smart cities and the implementation of the strategy of "Internet+" Smart Energy Action Plan of China, the proposed research is expected to build the energy network, establishing the integrated energy system models and algorithm theory, developing new materials and devices for modern power grid construction, creating a new model of economic, efficient and safe energy production and transmission and big data platform. The proposed research is also expected to focus on multi-vector distributed energy storage model, the basic model of the integrated energy system and optimal configuration theory, autonomous operation mechanism of low-voltage power ubiquitous internet of things, third-generation semiconductor devices, and power grid applications for the construction of smart cities in Guangdong-Hong Kong-Macao Greater Bay Area.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Guangdong province.

xii. Basic and applied research on big data of different ethnic groups, photoelectric information processing, Beibu Gulf marine sensors, and other key scientific issues for the strategic development and innovation of the information technology industry in Guangxi Zhuang Autonomous Region.

Key priority research areas:

1. Research on diversified data security aggregation and intelligent computing methods in multiethnic industries (F02)

The proposed research is expected to study theory and technology of data security aggregation and collaborative intelligent computing using multi-source big data in industry fields with multi-ethnic regional features of Guangxi, studying technologies of safe fusion and utilization of big data in industry fields and collaborative intelligent processing of multiethnic languages, supporting collaborative machine learning of distributed data resources, fusion and dynamic evolution of cross-domain knowledge graph, and the application of intelligent resources of multi-objective fusion of in the industry, addressing the key scientific issues of data security and privacy protection in the efficient computing in intelligent applications of the industry.

2. Research on the theory and method of large-scale multidimensional measurement and calibration based on grating interferometer (F05)

Aiming at the characteristics of high-precision and ultra-complex targets for the measurement, the proposed research is expected to focus on large-scale multidimensional grating interferometry measurement method to establish the theoretical model of large-travel multidimensional measurement based on the grating interferometer, establish the dynamic error model for grating splicing and grating interferometer switching in large-scale measurement, study

the influence mechanism and calibration method of large-scale grating interferometry error, addressing the error modeling, error correction, error distribution and other key scientific and technical problems in large-scale high-precision multidimensional measurement, providing the theoretical basis for the research and application of large-scale multidimensional grating interferometry.

3. Research on scientific issues related to integrated multi-parameter monitoring of the marine environment (F01)

The proposed research is expected to focus on the technology of multiparameter monitoring of the marine environment for the development of marine environmental monitoring in Beibu Gulf in Guangxi, studying multi-sensor technologies including temperature, salinity, depth and magnetic field of the marine environment, addressing key scientific and technological problems such as integration of multi-sensor networks and sea-sky-land cooperative communication. The proposed research is also expected to study the sensor mechanism and information cooperative transmission mechanism to facilitate the integrated sensing and detection of multiple parameters in the marine environment, providing the theoretical basis and technical reserve for the construction of a rapid monitoring network and system for the "Internet of Things at Sea" in the Beibu Gulf region.

4. Research on key scientific issues of fast and highly sensitive photoelectric sensors for coronavirus (SARS-CoV-2) detection (F05)

The proposed research is expected to address the need for rapid and highly sensitive detection of coronavirus in air droplets amid the lasting pandemic of COVID-19, exploring the conversion mechanism from coronavirus and probe binding information to recognizable photoelectric information, studying key scientific and technical issues such as the design and fixation method of highly sensitive and specific biological probes, the conversion mechanism of biological photoelectric information, and the accurate identification of photoelectric information, so as to provide the theoretical basis for the rapid and highly sensitive photoelectric detection of coronavirus.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Guangxi Zhuang Autonomous Region.

xiii. Basic and applied research on comprehensive health data transmission, wireless communication systems, microelectronics, optoelectronics, and other key scientific issues in Chongqing.

Key priority research areas:

1. Research and validation of sign information sensing and transmission mechanism of body area networks (F01)

To address the key fundamental issues for the high-quality development of comprehensive health industry in Chongqing, the proposed research is expected to focus on the body area networks (BAN), studying the intelligent prediction model of the near-body channel, flexible sensing method of physical sign characteristics, the dynamic security mechanism of health data, resource scheduling and allocation strategy, and lightweight communication system, to form circuit IP cores of analog front-end, RF transceiver, digital baseband, and health classification, develop and verify the performance of BAN SoC in compliance with IEEE 802.15.6 standard, and build an autonomous BAN core technology system for the natural, continuous, safe and reliable sensing and transmission of health data.

2. Research on electromagnetic transmission characteristics and network optimization theory and methods in the mountainous metropolitan (F01)

The proposed research is expected to obtain the basic environment data of the geography-climate-electromagnetic in areas with traits of typical mountainous cities through grid-based, long-period, multi-system standard tests, studying the complex electromagnetic

environment factors of multi-service coexistence and high-density coverage, the geographical factors of high buildings, mountains, and rivers on electromagnetic wave transmission, developing statistical models and channel transmission theories applicable to electromagnetic wave transmission in mountainous cities with complex electromagnetic environment, providing theoretical and standard support for the design, optimization, and application of 5G and wireless communication systems in the future in Chongqing and other mountainous cities.

3. Research on the large-scale optical network technology in optical FPGA chips (F05)

Aiming at the core technology demands of optical FPGA chips for large-scale optical networks, the proposed research is expected to focus on the coupling, transmission, mutual disturbance mechanism, and controllability of multi-physical fields of optical, electrical, and thermal integrated on-chip systems, providing the theoretical basis for the control of the optoelectronic logic systems of the optical FPGA chip. The proposed research is also expected to study the customized process technology of optical FPGA based on silicon-based optoelectronic CMOS process platform and study the consistency and stability of the processing and preparation of large-scale optoelectronic chips.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Chongqing.

xiv. Basic research on electronic information, network security, artificial intelligence, and other key scientific issues in Sichuan Province.

Key priority research areas:

1. Intelligent breast cancer diagnosis and treatment method customized for different ethnic groups in Sichuan (F06)

There are 56 ethnic groups living in Sichuan in China. The incidence and treatment of breast cancer for women of different ethnic groups demonstrate different characteristics. The proposed research is expected to take into consideration the distribution of different ethnic groups and the demands for artificial intelligence and intelligent medical care in Sichuan, addressing key clinical issues such as the prediction of the risk for breast cancer, population screening, early diagnosis, and prognosis, studying artificial intelligence methods based on multimodal medical big data, and building an intelligent whole-cycle platform for multi-ethnic breast cancer diagnosis and treatment.

2. Uncertainty theory and application of electromagnetic transmission in non-uniform media (A05 or A06)

Most of the changes and effects of electromagnetic fields or electromagnetic waves lack sufficient mathematical calculation conditions for mathematical modeling. The underlying reason is that the untenable ideal assumption of “uniform medium” and “definite conditions” destroyed linearity which is essential for the solution of the classical Maxwell equation. The proposed research is expected to study the theory and application of nonlinear and uncertainty problems in electromagnetic fields under non-ideal conditions in mathematics, physics, and engineering technology.

3. Research on the key technologies of millimeter-wave nanoelectromechanical resonators based on two-dimensional materials (F01)

Combining the characteristics of electronic information in Sichuan, the proposed research is expected to study physical field distribution of two-dimensional material parameters in the millimeter-wave band and the dynamic evolution law of device transport performance, design and prepare two-dimensional millimeter-wave nanoelectromechanical resonators, establish and improve the millimeter-wave frequency band mechanical vibration measurement technology, and realize the mechanical vibration test in the millimeter-wave frequency band. The proposed research is also expected to establish a multi-physical field equivalent circuit model in the millimeter-wave frequency band, and explore the implementation of weak resonant signal extraction and realization

of high-precision phase adjustment chip circuit.

4. Research on the key technology of high-capacity millimeter wave on the optical carrier for railway (F05)

Aiming at the construction and development of broadband information infrastructure for high-speed railroads and the Sichuan-Tibet railway, the proposed research is expected to study key technology of high-capacity optical carrier millimeter-wave communication technology, focusing on the core optoelectronic devices, high-mobility signal regulation, system architecture, and models, so as to make breakthroughs in the key bottlenecks of wireless communication with high-capacity and high-mobility on the railway, and support the development and implementation of transportation, intelligent railway, and 5G/B5G.

5. Research on three-dimensional heterogeneous integration for applanation-oriented inorganic sensing-stimulation integrated devices (F01)

Centering on the development demands of intelligent medical care in Sichuan province, the proposed research is expected to focus on the integrated three-dimensional heterogeneous integration of ductile and flexible apposable sensing and stimulation devices based on inorganic functional materials, making breakthroughs in the regulation of heterogeneous interfaces with different materials, three-dimensional multilayer device construction, intelligent feedback regulation of sensing signals based on stimulation and other key scientific issues to promote the upgrading and development of electronic information industry in Sichuan province.

6. Key technology and method for autonomous visual aid rehabilitation for Alzheimer's disease patients (F01)

To meet the urgent demands for smart health and intelligent rehabilitation for the severe aging population in Sichuan, the proposed research is expected to focus on the mechanism of Alzheimer's disease visual-assisted rehabilitation and the attention model of cognitive impairment, breaking through the key technical bottlenecks of first-view behavior analysis of the high dynamic scene and memory assistance, building an independent wearable visual-assisted rehabilitation verification platform, and providing important technical support for intelligent rehabilitation and diagnosis of Alzheimer's disease.

7. Theory and method of collaborative management and controlled sharing of big data assets for government affairs (F02)

Focusing on the big data aggregation and circulation problems for the development of Sichuan big data center, the proposed research is expected to focus on the key technologies such as the blockchain-based unified representation of multi-dimensional data assets and cross-chain sharing trust creation mechanism, data quality identification method, data value assessment method, data sharing access, data security control method, to form a model of data bank management and sharing, providing new theoretical and technical support for the multi-party aggregation, cross-chain collaboration and controlled sharing of big data for government affairs in Sichuan province.

8. Research on the flexible ultraviolet detection and the technology of multifunctional optoelectronic device with the new display (F04)

Aiming at the major development demands of the new display industry in terms of flexibility, multi-function, integration in Sichuan province, the proposed research is expected to focus on flexible ultraviolet detection and new display multi-functional optoelectronic device integration technology, focusing on the study of flexible detection and display principles, the design of organic semiconductor materials for efficient photoelectric-electro-optical conversion, the structure of high-performance devices and other cutting-edge basic scientific issues, to promote the development of new display technologies in electronic information in Sichuan province.

9. Construction theory and key technology of intelligent manufacturing of industrial

control security system for military and civil aviation (F02 or F03)

To meet the demands of system availability and data security of intelligent manufacturing of military and civil aviation, the proposed research is expected to focus on the theory and method of flexible reconfigurable security system architecture for differentiated military and civil use, diversified platforms, and complex applications. The proposed research is also expected to focus on key technologies such as multi-source heterogeneous system-level security information collection with physical layer fusion, autonomous synchronization of non-swinging security policies, whitelist modeling and pattern matching of flexible system operation modes.

10. Research on the theory and method of signal processing for broadband receivers based on sub-Nyquist sampling (F01)

The proposed research is aimed at the bottleneck problem of the sampling frequency of analog-to-digital converter devices of broadband digital receivers with large instantaneous bandwidth for the development of electronic information in Sichuan province, studying the new sub-Nyquist sampling signal processing theory and method applicable to the dense spectrum, low signal-to-noise ratio environment, breaking through the limitations of Nyquist's sampling theorem and offering solutions for real-time, low-power consumption electronic monitoring.

Applicants are encouraged to conduct research on the above topics in collaboration with universities and research institutes in Sichuan province.

Joint Fund for Corporate Innovation and Development

The Joint Fund for Industrial Innovation and Development is jointly funded by the NSFC and the industries. It aims to, by taking into consideration of the urgent needs in the industrial development, give play to the guiding role of the National Natural Science Fund, attract and gather the nation's scientific research forces and focus on the basic research into core scientific issues in key technology areas. It intends to integrate the knowledge innovation system and technology innovation system and advance the independent innovation capabilities of Chinese enterprises.

In 2021, the Joint Fund for Industrial Innovation and Development calls for proposals of the "Key Project" and "Integration Project" with a funding duration of four years. The average direct funding for the "Key Project" is 2.6 million yuan per project. The direct funding for the "Integration Project" will be specified in this *Guide*.

I. Energy Area

Key Project

China Petroleum and Chemical Corporation (SINOPEC)

1. The formation mechanism of the strike-slip fault system in the plate and its control effect on oil and gas migration and accumulation

2. Research on new principles and methods for improving oil and gas recovery

3. Research on petrophysical characteristics and seismic response mechanism of deep shale gas

4. Basic research on safe construction and high-efficiency fracturing for deep and ultra-deep shale gas development

5. Research on the preparation of carbon-coated metal nanocomposite and its catalytic

mechanism

6. Research on the law of ring-opening transformation of targeted hydrogenation of polycyclic aromatic hydrocarbons and high-efficiency catalytic technology

7. Biosynthetic basis of important synthetic polymer monomers

8. Research on the bifunctional organic catalytic system for the synthesis of green polyester for high-end use

9. Technology on Biodegradable material

10. Basic research on the safe operation of the hydrogen energy industry chain

China National Offshore Oil Corporation (CNOOC)

1. Coupling mechanism of Pacific plate subduction and Mesozoic-Cenozoic petroliferous basins in the East China Sea

2. The basic theory and technology of high-efficiency development of steam huffing and puffing of heavy oil with a large distance on the sea and subsequent transfer drive

3. Mechanism of tapping the potential of offshore "double high" oil and gas fields

4. Research on coupling mechanism and control technology of formation and wellbore pressure in controlled pressure drilling and completion of deepwater floating platform

5. Floating platform structure safety assessment based on monitoring data

6. Basic theories and experimental methods of deep sound logging while drilling

7. Research on the basic theory and method of advanced MEMS seismic sensors

8. Basic research on the efficient development of fractured high oil-bearing condensate gas reservoirs

9. Study on the monitoring and control mechanism of hydrate blockage during deep-water oil and gas and hydrate mining

10. The basic problems of the complex flow and heat exchange of natural gas under pressure liquefaction in the new FLNG plant

11. Research on beam-slab-shell theory of LNG storage tanks of ultra-large volume

12. Basic research on carbon dioxide oriented synthesis of alcohols

13. Efficient basis with low energy consumption for the separation of aromatics and non-aromatics

14. Research on the reaction mechanism of butadiene dihydroformylation to adipic acid and high-efficiency catalyst system

15. Research on the reaction mechanism of the direct conversion of naphthenic intermediate base crude oil into chemicals and the digital twin system

16. Basic research on dry reforming of CO2-rich natural gas in the South China Sea with low-carbon alkanes

China General Nuclear Power Group (CGN)

1. Research on liquid metal embrittlement (LME) and fracture failure mechanism of ferritic martensitic stainless steel in lead-bismuth environment

2. Experimental modeling theory and sensitivity of modeling criteria for whole effect of reactor R&D

3. Evaluation and development of key constitutive models for safety analysis of pressurized water reactors

4. Study on the deformation law of the 316 stainless steel under high temperature and its influence on the weakening coefficient of fatigue level

5. Research on the radiation-induced corrosion resistance of nickel-based alloys

6. Study on the high temperature mechanical properties and failure mechanism of

coated zirconium alloy

7. Research on fretting corrosion behavior and damage mechanism of heat exchange tubes of steam generators in pressurized water reactor under multi-factor coupling

8. Research on the irradiated microstructure and performance evolution and regulation mechanism of reactor pressure vessel steel under the high-energy pulse current

9. Steam generator 3D digital twin model construction and intelligent fault diagnosis research (The first application code should be selected from the subordinate code of E05)

10. Research on the evaluation method of the post-weld heat treatment of the thick-walled structure of nuclear power equipment

11. The coupling mechanism of and performance research on complex multi-phase flow of control valve with multi-stage and multi-channel cage structure

12. The theoretical design and experimental verification of solid-phase porous materials used for capture of radioactive gaseous effluents Kr and Xe

13. The mechanism and technology of containment filtration and emission based on micro-nano bubbles

14. High-efficiency pyrolysis of radioactive waste resin and mineral inclusion technology

15. Research on multi-field coupling damage mechanism of stainless steel material based on synchrotron radiation technology

16. Study on friction damage mechanism and restraint method of key moving pairs of nuclear emergency diesel generator

17. Research on the microstructure evolution and forming mechanism of zirconium alloy pressure resistance welded joints

18. Study on the influence mechanism of surface fouling on critical heat transfer of nuclear fuel and the influence of specific fouling level on thermal-hydraulic design benchmark of reactor

19. The chemical form and migration of Po in the environment of lead, bismuth and inert gas

20. New frontier materials and technologies for radiation detection and protection

21. Experimental study on the mechanism of interaction between high-pressure water and liquid lead-bismuth alloy

II. Artificial Intelligence Area

Key Project

China Electronics Technology Group Corporation (CETC)

1. Heterogeneous fusion generation and recognition technology of digital content in multimodal network

2. Research on the detection method of hidden text information in mobile social networks

3. Research on the reasoning and traceability of information regarding security event under low-resource conditions

4. Research on multilingual event analysis and situational awareness methods for minor languages

5. Research on the intelligent perception of target voice and privacy protection technology in the mobile internet environment

6. Cross-modal target recognition and behavior understanding in restricted environments

7. Safe artificial intelligence algorithm and verification with enhanced privacy protection

8. Research on key technologies of individual behavior awareness and evaluation based on machine vision

9. Modeling, prediction and intelligent decision-making of emerging infectious diseases based on the infectious network of metropolitan population

10. Research on the risk assessment and intervention of individual/group psychological stress for major public emergencies

11. Research on key technologies on general intelligent wireless multi-target perception and monitoring

12. Agile and intelligent identification technology for regional unsteady electromagnetic hotspots

13. Theory and method of intelligent game confrontation in complex electromagnetic environment

14. The basic theory and method of attack and defense of electromagnetic space countermeasures sample

15. Research on the mechanism and method of intelligent cognitive cooperative communication and networking of distributed heterogeneous network

16. Research on intelligent reasoning and decision-making mechanism for complex environments

17. Research on theories and methods of biometrics generation and safety

18. Content understanding technology for cross-modal question and answer on small-screen smart terminals

19. Research on intelligent detection and perception technology of compound eye array camera for target surveillance

20. Theories and methods of intelligent detection and tracking of weak and small targets based on deep learning

21. Intelligent inversion and downscaling technology of key meteorological elements

22. Multi-phase flow intelligent online detection based on multi-sensor information fusion and artificial intelligence learning

23. The intelligent perception and recognition method of cross-media, cross-domain, and cross-modal water pollution

24. Research on key technologies of user behavior modeling based on causality and cognitive reasoning

25. Research on intelligent acoustic signal recognition method based on high-precision coupled propagation model of ocean-sound field

26. Large-scale attribute heterogeneous graph representation and mining method

27. Visual computing and intelligent analysis for social media information

28. Comprehensive perception of complex public safety events and efficient coding of event semantics based on wide-field and high-resolution video

29. Target-related automated learning technology for unknown complex scenarios

30. Visual-language mutual generation technology based on common sense reasoning

31. Theories and methods of visual target understanding in complex spatiotemporal environment

32. Continuous goal perception and learning in a dynamic and open environment

33. Knowledge-driven automatic generation method and technology of massive heterogeneous content

34. The security protection and optimization method of federated learning model for

multi-agent collaboration

35. Continuous deep learning model construction in a multi-task environment

36. Multifunctional fusion chip architecture technology for intelligent information processing

37. Key technology of high-performance online learning AI chip

38. Environment detection and intelligent decision-making technology of underwater autonomous vehicles

39. The key technology of smart chip for intelligent monitoring of bearing status

40. Research on high-performance compilation technology of AI processor

41. Research on the key technology of smart chip of frequency selective surface

42. Research on the management mode and application of digital transformation and innovation capability improvement of extra-large industrial enterprises

III. Aerospace Area

China Aerospace Science and Technology Corporation (CASC)

Integration project

The average direct funding for integration project is about 11 million yuan per project. The research areas include:

1. Theories and methods of intelligent perception and autonomous evasion of spacecraft orbital threats

Based on the background requirements of intelligent perception and autonomous evasion of spacecraft orbital threats, proposals should focus on the research of spacecraft threat feature extraction and expression, decision feedback mechanism and performance evaluation, and architecture and model of intelligent autonomous control system, as well as complete the verification of system integration, and lay the theoretical and methodological foundation for the continuous and stable operation of spacecraft. Proposals should carry out in-depth and systematic research under the theme of "Theories and Methods of Intelligent Perception and Autonomous Evasion of Spacecraft Orbital Threats", and should include the following four research aspects in the same proposal:

(1) Modeling mechanism of intelligent autonomous control system for orbital threat avoidance

Proposals should study the modeling theory and methods of perception, decision-making, and execution of intelligent behaviors in orbital threat avoidance tasks, and set up the expression model of perception, decision-making, and execution of intelligent behaviors; study the description and optimization of the multi-level and multi-loop associations among perception, decision-making and execution, and build the architecture of intelligent autonomous control system for perception-decision-execution; study the evolution mechanism of the intelligent autonomous control system over time and space, reveal the function mechanism of the intelligent autonomous control system, and establish the intelligent and autonomous control system model following the process of perception-decision-execution.

(2) Fusion perception and hierarchical cognition of threat behavior in complex space environment

In view of the dynamic and unknown space environment and orbital threat targets with uncertain behaviors, proposals should focus on research into learning and expression of environment and target behavior characteristics based on multi-source heterogeneous data, and develop the fusion perception technology of threat behavior in complex space environment; study the threatening behavior prediction and cognition ranking methods based on multimodal characteristics at different dimensions including target form and motion mode, and achieve the

prediction of threat target behavior and the quantitative evaluation of threat level.

(3) Feature-based feedback and control mechanism of systematic decision and closed-loop performance evaluation

Proposals should research on the system decision feedback mechanism based on threat behavior characteristics; comprehensively consider the constraints of spacecraft's scheduled mission, orbit, maneuverability, computing power, security, etc., research on the optimization and performance evaluation methods of threat avoidance strategies under complex and multi-constraint conditions, and autonomous generation of threat avoidance and optimal control strategies; study the performance measurement and evaluation methods of the stability, robustness, and optimality of the closed-loop system under the control of feature-based system decision feedback, and develop the performance evaluation system of the intelligent and automatic closed-loop control system following the process of perception-decision-execution.

(4) Simulation verification and evaluation of intelligent perception of orbital threats and autonomous evasion

In view of the needs of intelligence perception and autonomous evasion of spacecraft orbital threat, proposals should research into the simulation verification method of the intelligent and automatic closed-loop control system following the process of perception-decision-execution with multi-level and multi-loop correlation; develop the simulation verification and evaluation system of intelligent perception of orbital threats and autonomous evasion, and carry out comprehensive verification test; study the evaluation system and method of intelligent and autonomous control system, and formulate the quantitative rating of the system.

2. Basic research on smart operation and precise control of intelligent space mechanisms based on multi-source information fusion

In view of the difficult problems of precise identification of unstructured targets, identification of environmental stiffness and reproduction of operating skills under complex lighting conditions and narrow space, proposals should study the feature identification of multi-source information fusion and on-orbit intelligent operation planning methods, the law of effect of unknown spatial environment stiffness to the dynamic characteristics of end operation. Proposals should study operational skill mapping and knowledge acquisition behavior simulation method based on teaching, carry out the ground integration verification of typical scenes, and lay a theoretical foundation for the on-orbit application of space dexterity operations. Proposals should carry out in-depth and systematic research under the theme of "Basic Research on Smart Operation and Precise Control of Intelligent Space Mechanisms Based on Multi-source Information Fusion", and should include the following 5 research areas in the same proposal:

(1) Environment perception and on-orbit intelligent operation planning based on multi-source information fusion

In view of the fusion of multi-source sensor information such as vision, force and touch, proposals should research into the precise identification of geometric features of unstructured targets under complex lighting conditions, on-line identification and prediction of contact stiffness and damping characteristics; research into the dynamic behavior optimization and safe path planning of intelligent organizations of typical operations such as grasping, alignment, and screwing.

(2) Soft contact and smooth control between space actuators and the environment

In view of the precise operation and control of intelligent mechanisms under narrow space, proposals should study the influence of the stiffness of the unknown space environment on the dynamic characteristics of the terminal operation; study the dynamic control perturbation method of the intelligent mechanism under the changing terminal contact stiffness.

(3) Man-machine operation skill acquisition and transfer learning

By imitating human operating skills, proposals should study theories and methods of dexterous operation behavior modeling, knowledge acquisition and skill mapping of intelligent institutions; study the skill acquisition and transfer learning algorithm of multi-type deep neural network fusion, and develop basic operation sequence database of intelligent institutions, based on the action pose image sequence and the corresponding force/torque map.

(4) Comprehensive design optimization of skill-based modular and reconfigurable end tools

In view of terminal operation tasks with diversified functions, proposals should research into modular, reconfigurable, and quickly replaceable light and small terminal operation tool set and integrated electromechanical interface, and focus on the comprehensive design and structural optimization of terminal tool types with functions such as auxiliary guidance, positioning, clamping, and screwing, thus establishing standards for fine-operational end tools.

(5) Integrated demonstration and verification of typical spatial dexterous operation scenarios

In view of needs for spacecraft equipment replacement and long-term care of the load, proposals should meet the unstructured targets of no signs in space, complex contours, and multi-point and multi-domain contacts in the operation process, carry out the integration demonstration and verification of typical fine operations of space intelligent structure, and lay a theoretical and methodological foundation for the on-orbit application of high-precision and high-reliability dexterous operations.

3. Research on the wave rider principle, method and application of high-order three-dimensional bow-shock theory

Proposal should focus on scientific issues including the need for aerodynamic configurations with higher lift-drag ratios for near space vehicles, insufficient understanding of three-dimensional bow shock in the theory of wave-carrier body design, the principle of wave multiplication by local osculating with current deflection, and aerodynamic reverse design method of complex three-dimensional arch shock multiplier. Proposals should complete corresponding numerical simulation analysis and high Mach number wind tunnel test research, to provide theoretical and method support for further improving the aerodynamic performance of high lift-drag ratio aircraft in adjacent space. Proposals should carry out in-depth and systematic research under the theme of research on the wave rider principle, method and application of high-order three-dimensional bow-shock theory and include the following 4 research areas in the same proposal.

(1) High-order 3D bow-shock theory and 3D bow shock characteristics

Proposal should focus on research out of the framework of linear shock theory, and develop a three-dimensional bow-shock theory that can take into account changes in the local circumferential and flow direction of the shock; derive the aerodynamic and thermodynamic parameters before and after the three dimensional bow-shock and their higher derivative relations, develop a unified theory of high-order three-dimensional bow shock theory, carry out the research of the characteristics of the three-dimensional bow shock wave under uniform and non-uniform flow conditions using the first-order, second-order, and third-order information and characteristics.

(2) Three-dimensional shock wave shape’s wave rider principle and current deflection wave rider design method

Proposals should carry out research on the principle and design method of three-dimensional shock wave multiplier, aim at three-dimensional shock wave with non-uniform composite curvature in flow direction and span direction, and upgrade the traditional cone-guided and osculating wave multiplier design (axisymmetric, quasi-three-dimensional) to a complete three-dimensional wave rider principle; establish the design method of the current deflection wave rider, expand the design connotation of the wave rider; combine the current deflection wave rider design method with the three-dimensional bow shock theory, and obtain an inverse problem solving method for arbitrary

three-dimensional shock waves and an inverse design method for three-dimensional complex wave multipliers.

(3) The design method of the waverider shape with a high volume rate and riding on a complex three-dimensional bow-shock

In view of low volume ratio of traditional cone-guided and osculating wave-riding aircraft, proposals should carry out the shape design of the adjacent space wave multiplier with high lift-to-drag ratio and high volume rate based on the complex three-dimensional bow shock wave shape; quantitatively construct and evaluate the three-dimensional bow shock wave that changes the local circumferential and flow direction curvature, develop a design program that can reasonably select and optimize the shape of the three-dimensional bow shock surface, and propose a shape of a wave-rider in adjacent space that has a high volume ratio and rides on a complex three-dimensional bow shock wave.

(4) Wind tunnel test of three-dimensional bow shock wave in adjacent space

Proposal should carry out a test of a three-dimensional bow-shock wave rider in a hypersonic wind tunnel, assess the correctness of the mathematical theory of the three-dimensional bow shock wave in terms of principle, and analyze the consistency of the second-order and third-order physical information back and behind the wave with the theory under uniform and non-uniform incoming flow conditions using high-confidence test technology; carry out the aerodynamic performance assessment test of the three-dimensional bow shock waverider, verify the lift-to-drag ratio performance of this type of waverider, the main three-dimensional shock wave characteristics, and the refined flow field structure, etc., and provide theoretical and methodological support for the subsequent design of three-dimensional near-space wave-riding vehicle.

4. Basic research on the manufacturing of connecting ring components for large aluminum-lithium alloy rocket tanks

In view of key structure in urgent need of breakthroughs for the next-generation launch vehicle—2 195 high-strength aluminum-lithium alloy storage tank connecting ring components, proposals should conduct in-depth study of the macroscopic and microscopic effects of high-performance aluminum-lithium alloy crystallographic orientation and anisotropy under the action of complex energy fields, reveal the singular evolution mechanism and damage mechanism of grain boundaries and phase boundaries in complex rheological states, as well as scientific issues such as the suppression of multi-component segregation behavior of welded joints, and the mechanism of macro and microstructure and performance regulation. Proposals should develop new principles, new technologies and new processes for the manufacture of high-strength aluminum-lithium alloy large-scale components, overcome the problems of poor formability, uneven three-directional performance, and low welding performance of large-scale high-strength aluminum-lithium alloy components, and establish the technology model for the high-strength aluminum-lithium alloy lightweight storage tank connecting ring assembly. The tensile strength of the samples at room temperature is $\geqslant$520MPa, the yield strength is $\geqslant$500MPa, the elongation is $\geqslant$6%, and the welding strength coefficient is $\geqslant$0.7. Proposals should carry out in-depth and systematic research under the theme of basic research on the manufacturing of connecting ring components for large aluminum-lithium alloy rocket tanks, and should include the following 4 research areas in the same proposal.

(1) Macro and micro characterization and process design of the crystallographic orientation and anisotropy of high-strength aluminum-lithium alloys under the action of complex energy fields

Proposals should focus on the high-strength aluminum-lithium alloy rheological crystal multi-scale orientation effect and high-performance characteristic microstructure formation conditions and manufacturability; macro and micro modeling and process design of crystal orientation and microstructure property diversity laws under complex energy fields of high-strength

aluminum-lithium alloy.

(2) The evolution law of grain boundary and phase boundary and damage suppression in complex rheological state of the special-shaped cross-section connecting ring of large-scale aluminum-lithium alloy

Proposals should focus on the multi-scale interface genetic evolution, damage mechanism and suppression in the whole process of complex rheological manufacturing of aluminum-lithium alloy special-shaped cross-section connecting ring; multi-objective microstructure and mechanical properties mapping rules and regulation of each manufacturing link of aluminum-lithium alloy special-shaped cross-section connecting ring.

(3) The multi-element segregation, structure and performance evolution and regulation of welding joints of aluminum-lithium alloy connecting ring components

Proposals should focus on the multi-component solidification segregation behavior and cross-scale evolution mechanism and regulation of the aluminum-lithium alloy connecting ring assembly during welding; the joint geometric configuration of the aluminum-lithium alloy connecting ring assembly and the synergistic mechanism and regulation of the multi-component microstructure and mechanical properties.

(4) The structural optimization design and application evaluation of the connecting ring assembly of the aluminum-lithium alloy storage tank based on the adaptability of the formation and welding process.

Proposals should focus on the structural robustness and lightweight design of the connecting ring assembly taking into account the material micro orientation and the performance gradient of the welded joint; the hierarchical test verification and engineering application evaluation system of the high-strength aluminum-lithium alloy connecting ring assembly.

Key Project

China Aerospace Science and Technology Corporation (CASC)

1. The theory and method of intelligent control of rigid-flexible hypersonic vehicle

2. Research on high-precision thermophysical properties and heat transfer mechanism of supercritical fluid under extreme conditions of near-space spacecraft

3. Research on the stability and flow control of asymmetric cloud-like cavitations of large-scale revolving bodies

4. Research on the mechanical effects of multi-medium coupling and load reduction mechanism of large-scale rotating bodies entering water at high speed

5. Research on intelligent and autonomous collaborative decision-making and control of high-speed aircraft clusters under multi-field coupling conditions

6. Research on the emergence mechanism of aircraft cooperative behavior based on physics and information space

7. Research on the intelligent control method of launch vehicle based on online incremental learning

8. Study on the mechanism and promotion method of high-energy fuel hydration reaction and water mixing combustion

9. Research on the efficient combustion mechanism of solid rocket scramjet

10. Research on theory and method of on-orbit adaptive evolution of spacecraft control software

11. Research on the mechanism of all-optical neural network for space-based intelligent remote sensing applications

12. Research on the intelligent emergence and operation mechanism of distributed heterogeneous space-based information system

13. Research on high-cooling refrigeration system for aerospace vehicles in ultra-low temperature area

14. Research on the dynamic stability and nonlinear trajectory optimization method of Jupiter multi-celestial system

15. Research on active and passive coupling ultra-high temperature heat protection system under extreme aerodynamic heating environment

16. Research on complex flow interference and separation kinetics with embedded retrograde separation

17. The construction process of the lunar environment load-carrying structure and the influence of its mechanical and thermal characteristics

18. Additive manufacturing of spacecraft high-performance aluminum alloy

19. Research on protective coatings for the key hot end components of the new power system engine with high temperature ablation resistance, high efficiency heat insulation, and large strain tolerance

20. Service performance research of high thermal conductivity carbon/carbon composite material design under extreme environments

21. Research on ultrafast laser processing method of TiN thin film for high-precision rotor gyro motor

22. Research on the performance regulation mechanism and interconnection reliability of ultra-micro-scale multi-reinforced micro-bump of aerospace integrated circuit

23. Basic research on high-fit mirror milling of large and extremely weak rigid surfaces

24. Fundamental research on uniform assembly of solid direct force motors with multiple connections of heterogeneous materials

25. Research on penetration information transmission technology for the detection of shallow minerals on the moon's surface

26. Research on the theory and method of multi-target neural network for real-time processing of on-board remote sensing data

27. Research on the mechanism of combustion instability of liquid oxygen kerosene and the scale effect of its control

28. Research on coupling mechanism and control method of liquid film cooling flow and heat transfer in space engine

29. Research on generation and enhancement mechanism of semiconductor bridge electric explosion plasma

30. Research on the evolution law of material genome in the aging process of high-energy solid propellant

31. Research on coupling mechanism and control method of noise in cross-basin regulation and control of spatial minimal thrust

32. The basis of design criteria and key technologies for the super-elastic load domain of the deep space exploration vehicle structure

33. The influence mechanism and prediction method of space environment on the on-orbit accuracy of large-scale deployment structures

34. Sampling mechanism and optimized control method of extraterrestrial subsurface star rock complex body

35. Self-excited oscillation of gas-liquid coaxial centrifugal nozzle and its effect on combustion stability

NSAF Joint Fund

Jointly set up by NSFC and the China Academy of Engineering Physics (CAEP), the Fund is aimed to encourage and mobilize scientists and teams from universities and research institutes nationwide to focus on core fundamental issues of relevant areas addressing the national strategic demands, carry out forward-looking research on multidisciplinary cross-integration, promote openness and exchanges, cultivate excellent talent of scientific research, and upgrade the ability of scientific and technological innovation.

In 2021, the NSAF Joint Fund plans to fund two types of projects, namely "Fostering Project" and "Key Project". The Fostering Project aims to expand the open sharing of the National Science Facility built by the China Academy of Engineering Physics and promote exchanges and cooperation. The Key Project focuses on key bottlenecks in the field of national strategic demand, interdisciplinary innovations that may be applied in the future, and prospective and disruptive basic research. The Fostering Program has an average direct funding of 500,000 yuan per project for 3 years; the Key Program has an average direct funding of 3 million yuan per project for 4 years.

I. Fostering Project

The fund aims to enable scientific researchers to carry out scientific research based on China's Mianyang Research Reactor and its neutron scientific platform, "Xingguang III" laser device, high average power terahertz free electron laser device, and micro-nano technology platform. Before submitting the application, the applicant should communicate with the institution where the relevant device is located, fully understand the performance, status, and user time allocation of the dependent device, and is encouraged to conduct the collaborative research with researchers in the institution where the device is located. The main funding areas include:

1. Research on scientific and technological issues related to Mianyang research reactor and its neutron science platform;

2. Research on scientific and technological issues related to the "Xingguang III" device;

3. Research on scientific and technological issues related to high average power terahertz free electron laser devices;

4. Research on science and technology issues related to micro/nano technology platform.

II. Key Project

The Fund mainly supports research on cutting-edge interdisciplinary and disruptive concepts such as functional materials with high environmental adaptability, sensing technology for complex scenes, micro/nano surface reconstruction technology for material performance improvement, and quantum sensing science. The applicants and research teams should have a good research foundation in relevant research fields. The research content listed in this *Guide* is not required to be fully covered, but the research focus should be highlighted to be able to accurately identify and solve one or several key scientific problems.

1. Functional materials with high environmental adaptability

The Fund aims to integrate theories and methods of materials science, nuclear science, chemistry and other disciplines, and to address the major basic scientific issues of material applications in environments such as long-term force heat, low-dose irradiation, complex atmospheres, and high overloads. Proposals should study the response behavior and mechanism of materials in complex environments, and develop material theory. Proposals should develop new design methods and advanced preparation techniques adapted to complex environments, and create

new functional materials such as nuclear materials, energetic materials, special polymer materials, new battery materials, atmosphere control materials, and structural support materials with high environmental adaptability. The ultimate goal is promoting the innovative development of materials science and technology oriented to the specific needs of the country. Main funding areas include:

(1) Study on the control of the thermal and thermal properties of polymer bonded explosives and its mechanism;

(2) Multi-scale structural design and performance customization of polymer materials;

(3) Strengthening and toughening design of lithium-based hydride and damage behavior in complex environment.

(4) Study on multifunctional composite metal material system

2. Intellisense technology for complex scenes

The Fund aims to explore how to integrate sensing, detection, artificial intelligence and micro-nano manufacturing technologies to develop intelligent sensing principles and methods for multi-physical quantity sensing and accurate detection under complex conditions, thereby building a new generation of intelligent sensing systems and enhancing comprehensive intelligent perception and autonomous decision-making capabilities in complex electromagnetic environments. The research in this direction will promote the innovative development of intelligent sensing technology through meeting application demand. The main funding areas include:

(1) Research on on-line monitoring technology for state changes of multi-layer complex structures;

(2) Research on composite sensitive intelligent micro-sensor technology;

(3) Intelligent information processing models and architectures for complex environments.

3. Micro-nano surface reconstruction technology with improved material properties

The Fund aims to integrate materials science, surface/interface science and micro/nano technology to process and manipulate the material surface at the micro-nano scale, to achieve the purpose of material surface morphology reconstruction, organization structure regulation, environmental adaptability improvement, specific function design, etc., and to improve the comprehensive performance of nuclear materials, energetic materials, polymer materials and other functional materials in specific use environments. The main research contents involve micro-nano scale effects and applications of materials, micro-nano scale organization structure regulation mechanism and characterization, surface micro-nano structure and functional design, etc. The main funding areas include:

(1) Surface reconstruction and activity regulation of hydrogen storage materials;

(2) Surface reconstruction and surface interface regulation of energy storage materials;

(3) Functional design and preparation of active metal surfaces.

4. Quantum sensing science and technology for information security

The Fund aims to focus on the basic scientific issues of quantum perception technology and reliability of complex physical systems to carry out a full-chain research of structure construction and analysis, dynamic response, stability and reliability. The main funding areas include:

(1) Research on generally reliable information perception and safe sharing;

(2) High precision spectroscopy of spatio-temporal quantum measurement;

(3) Research on intelligent evaluation method of dynamic uncertainty of complex system.

Joint Fund for Civil Aviation Research

The Joint Fund of Civil Aviation Research is jointly set up by NSFC and the Civil Aviation Administration of China (CAAC). The Fund is aimed to attract researchers across China to

participate in basic research for the sustainable development of aviation science and technology, so as to foster high level scientific talents, enhance the ability of indigenous innovation in the aviation industry, promote the integration of knowledge and technological innovation, and contribute to the building of China into a nation with strong aviation industry.

As a component of the National Natural Science Fund, the Joint Fund is open to all scientists across China. Researchers in non-aviation sectors are encouraged to carry out collaborative researches with those in aviation sectors.

Funding plan and priority areas in 2021

In 2021, the Joint Fund of Civil Aviation Research is going to support a number of Key Program Projects in the following 21 priority areas. Average funding (direct costs) for each project will be 2.1 million for 4 years. Qualified researchers are welcomed to apply for this fund according to the research scope and requirements listed in the Guide.

1. Key technologies of the goal-oriented intelligent maintenance of aero-engine workshop

The proposed research is expected to address the difficulty in guaranteeing the repair objectives of aero-engine, carry out research on key technologies such as engine repair target decomposition, target-oriented workshop maintenance and assembly process decision making, and intelligent inspection of maintenance quality, establish technologies, methods, models and software systems for target-oriented engine workshop intelligent maintenance decision, and carry out application verification in aero-engine maintenance workshop.

2. Risk assessment and prevention and control strategies for the transmission of infectious diseases via aviation transportation

The proposed research is expected to address the needs of civil aviation system for timely and effective prevention and control of outbreaks of infectious diseases, reduce the risk of transmission and spread of infectious diseases during civil aviation transportation, establish methods for early warning and assessment of the diseases transmission risk, conduct research on scientific prevention and control strategies, build risk monitoring and early warning models and assessment and decision-making systems for diseases transmission via aviation transportation, and improve the key decision-making capabilities and the ability of civil aviation to respond to public health emergencies.

3. Theory of security risk identification and protection of civil aviation airborne system

The proposed research is expected to address the network intrusion threat and information security protection needs of integrated airborne systems. Topics include: risk identification and early warning technology and risk feature profiling method of airborne system network intrusion, identification and protection technology of deception risk from non-authorized information sources, airworthiness security process and airworthiness compliance method of airborne system, cloud-edge-end fusion security sensing network construction technology of airborne system based on intelligent algorithms, the development of risk prevention technology verification platform of airborne system network intrusion, and the technical method system to support airborne system network security design and airworthiness validation.

4. The combustion characteristics of aviation kerosene and theory and methods of airworthiness certification

The proposed research is expected to address the rapidly increasing demand for new aviation alternative fuels in civil aviation, provide advanced theoretical support for the airworthiness certification, storage and refueling of aviation alternative fuels, study the combustion performance and mechanism of aviation alternative fuels, establish an innovative comprehensive performance assessment model for airworthiness certification of new aviation kerosene such as jet

fuel made from direct coal liquefaction, and develop the theory and methods of airworthiness certification, storage and refueling of aviation alternative fuel based on big data analysis as well as carry out the application verification.

5. The key technology of automatic ultrasonic inspection of complex surface array of large composite materials

The proposed research is expected to solve the problem of ultrasound detection of traditional array based on the characteristics of large complex surface composite structures, develop automatic and intelligent array ultrasound detection technology and method, and carry out application verification. Topics include: the excitation acceptance method of ultrasound synthetic sound beam for complex surface array; the scanning path planning method of multi-degree-of-freedom robotic arm for array ultrasound detection, and the imaging method of composite material defects based on three-dimensional visualization.

6. Key technology and validation of autonomous spacing control for air traffic

To meet the demand for safe and efficient control of aircraft spacing under intensive traffic, the proposed research is expected to carry out research on the following topics: key technologies such as airborne incremental safety posture processing, four-dimensional trajectory reachability calculation and distributed conflict-free control, distributed/centralized integrated control and performance evaluation of aircraft spacing, the principle verification system of autonomous air traffic interval control, and verification of autonomous interval control in combination with application scenarios such as flight path tailing, multi-aircraft arrival sequencing, landing and etc.

7. Research on the theory and application techniques of assessing the core competency system of Chinese civil aviation pilots based on evidence-based principles

The proposed research is expected to address the competency needs of Chinese civil aviation pilots, solve problems of the core competency assessment and training improvement of pilots, establish a model of pilot competency based on multi-source data fusion, study the evolution and intervention methods of the core competency of pilots, develop evidence-based training programs to enhance core competency of pilots, and form a complete set of theory and application technology to improve the core competency of Chinese civil aviation pilots.

8. Research on laser integrated repair technology and evaluation system for civil aircraft

The proposed research is expected to address the demand for continuous airworthiness of civil aircraft, solve the problems of practicality, effectiveness and quality evaluation of aircraft components in service, carry out research on laser integrated repair technology, construct the multi-physical field and multi-scale coupled solution models, realize the precise control and regulation of organization, defects and stress in the repair process, and build an evaluation and standard system for laser integrated repair quality of civil aircraft in line with airworthiness guidelines.

9. Research on the mechanism and key technology of laser online degumming process of airport runway

The proposed research is expected to address the major demand for efficient and high quality degumming of airport runways, carry out research on key technologies such as high-frequency, high-energy, narrow pulse-width all-solid-state laser degumming technology, the multi-energy field assisted high-energy laser rapid degumming process, the ultra-wide laser scanning and intelligent control, multi-target degumming quality evaluation, develop the prototype of continuous laser assisted pulsed laser degumming, and carry out verification and evaluation.

10. The integration and optimization of intelligent recovery of airline flights under the new business model

The proposed research is expected to address the needs of the new air transportation

industry under the concept of One Order, solve the problems of digital modeling of flights and passengers, modeling of the relationship between flight operations control and revenue, and intelligent optimization of flight recovery considering flight revenue, which are compatible with the NDC standard and the concept of One Order. The proposed research is also expected to study the flight and passenger digital twin modeling technology, the dynamics of air transportation system under the new business model, the interaction mechanism between flight revenue and flight recovery strategy, and the optimization method of flight recovery and revenue integration, and carry out application verification.

11. The optimization of civil aviation flight operation and resource allocation based on operation monitoring network

The proposed research is expected to address the problems of insufficient data sharing, unscientific resource allocation, and low operational efficiency of civil aviation flights, study the interactive sharing method of multi-source and multi-dimensional flight operation data based on the civil aviation operation monitoring network, construct a multi-body resource allocation and optimization model, study the comprehensive efficiency assessment and collaborative intelligent optimization technology of flight operation, develop the corresponding prototype system, and carry out application verification for typical scenarios.

12. Mechanisms and key technologies for false alarm-resistant fire detection in the cargo hold of civil aviation aircraft

The proposed research is expected to address the needs of false alarm-resistant fire detection technology for civil aviation aircraft cargo hold, solve the problems of unclear causes of false alarm in fire detection systems, difficulties in distinguishing fire smoke and interference sources, lack of anti-interference performance test technology, etc., carry out studies on the false alarm analysis model of fire detection system, the light scattering characteristics of smoke and interfering aerosol, the characteristic parameter change pattern of fire smoke, false alarm-resistant fire detectors for aircraft cargo hold, airworthiness test verification technology of false alarm resistance performance and etc., and carry out application verification.

13. Theory and methods of ATC system network security threat perception

The proposed research is expected to address the vulnerability of the ATC system and the related threat to flight safety, study the modeling of ATC system threat, internal and external threat detection and dynamic adaptive security assessment of ATC system, propose methods such as analysis of key business information flow, multi-dimensional dynamic detection of unknown threats based on ATC domain knowledge, active reproduction of threat intelligence in ATC intranet, develop the threat-perception validation platform for network security of ATC system and carry out application validation.

14. Key technology of health management of general aero-engine by fusing multi-source information

The proposed research is expected to address the needs of piston aero-engines to improve operational safety and reduce operation and maintenance costs, carry out research on multi-source information fusion and failure mechanism modeling, fault diagnosis and retrieval, health assessment and characterization, and life-cycle-oriented reliability design of piston aero-engines, build a health management method system and application platform for aviation piston engines, and carry out application verification.

15. Scientific bird strike prevention at airports based on accurate perception of bird activity

The proposed research is expected to address the demand of aircraft takeoff and landing safety at civil airports, solve the problems of precise detection and identification under the coupling effects of complex environments, low accuracy of bird strike risk prediction, and weak intelligence

of prevention strategy, carry out research on real-time precise sensing of bird activities by deep integration of radar and photoelectricity, early warning assessment of bird strike risk in complex low-altitude flight environment, and intelligent risk prevention and control by multiple means, develop the prototype system of collaborative bird strike prevention for flight area, and carry out application verification..

16. Key technologies for accurate evaluation of air pollutant emissions from airports based on monitoring data and models

The proposed research is expected to address the needs of airport atmospheric environment management, solve the problems of real-time accurate monitoring of aircraft emissions under typical working conditions and the lack of airport air pollution data, carry out studies on optical telemetry monitoring of aircraft pollution emissions under typical working conditions such as bench test and on-wing operation, grid-based sensing of the spatial distribution of airport air pollution source, and airport air pollution dispersion model, develop the data-driven optimization of airport air quality model, establish the online three-dimensional monitoring system and dynamic emission inventory of airport air pollution, as well as the airport air quality evaluation and forecasting system, and carry out application validation in major airports in China.

17. The mechanism and airworthiness requirements of coordinated and integrated control of aircraft engine thrust and safety limits

The proposed research is expected to address the needs for coordinated and integrated control of aero-engine thrust and safety limitation and for the establishment of aero-engine control airworthiness requirements, carry out studies on the characteristics of aero-engine steady state and transition state, the mechanism of the integration of steady state control and transition state control in aero-engine thrust control, the mechanism of coordination and integration of aero-engine thrust control and safety limitation control, propose the coordinated and integrated control method of aero-engine thrust control and safety limitation control, and formulate the planning proposal of aero-engine control autonomous airworthiness regulation.

18. Assessment of the impact of new interference on GNSS civil aviation applications and air-ground cooperative classification detection and locating technology

The proposed research is expected to address the urgent demand for the detection and locating of new GNSS interference that affects the safe operation of civil aviation, carry out studies on the interference impact assessment system and method for GNSS civil aviation applications, automatic monitoring and coarse locating technology of GNSS interference sources based on flight data analysis, and interference detection and locating method based on UAV platform. The research is also expected to develop an air-ground cooperative interference classification detection and locating system for civil aviation operation.

19. Key technology of understanding and predicting passenger behaviors at airports based on edge-cloud collaboration

The proposed research is expected to address the demand for intelligent passenger security control at airports, solve the core scientific problems of passenger behavior understanding and prediction in large and complex airport scenarios, conduct research on real-time passenger behavior sensing, passenger behavior understanding and prediction in multiple perspectives across scenarios, and the edge-cloud collaborative working mechanism for passenger security management, develop the prototype system for passenger behavior-based security management suitable for integrated operation of terminals of hub airports, and carry out application validation.

20. Key technologies for monitoring and early warning of flight safety risks caused by human factors based on big data

The proposed research is expected to address the demand of monitoring and early warning of flight safety risks and solve the problems of imprecise and unsystematic risk monitoring of

human factors in flight safety. Topics include: the identification of flight risk characteristics based on big data of operation and individual characteristics, the construction of risk-related pilot psychological characteristics dimension, risk-related pilot portrait technology, pilot safety status monitoring model and early warning system of flight safety risks.

21. Key technology of multi-scale intelligent situational awareness for civil aviation control operation safety

The proposed research is expected to solve the current problems of inadequate perception of civil aviation control operation situation and inaccurate trend prediction, carry out research on key technologies such as multi-source heterogeneous data fusion, knowledge map database construction, security situation perception, dynamic data visualization and data security protection, achieve breakthroughs in the perception and early warning of civil aviation control operation security situation and control operation quality monitoring, develop intelligent monitoring system for civil aviation control operation security, and carry out application verification.

Joint Fund for Water Science of the Yangtze River

The Joint Fund of Water Science of the Yangtze River is jointly set up by NSFC, Ministry of Water Resources of the People's Republic of China and the China Three Gorges Corporation. The Fund is aimed to make full play of the guiding role of the National Natural Science Fund, attract and mobilize researchers of universities and research institutes across China to research on the theoretical basis and applicable technologies to solve the key water science problems related to the water security and green development of the Yangtze River economic belt, open up new research directions and contribute to the improvement of original innovation capacity in water science in China.

In 2021, the Fund is going to support a number of Key Program Projects in the following priority areas. Average funding (direct costs) for each project will be 2.6 million for 4 years.

Priority areas in 2021

1. Simulation of hillside runoff and formation mechanism of mountain torrents in the upper reaches of the Yangtze River (D01, D05, or D07)

The proposed research is expected to focus on the spatial variability of runoff and simulation of hillside torrents in the upper reaches of the Yangtze River, study the scale effect of distributed simulation of runoff yield, construct the distributed watershed hydrological model of mountain torrents based on hillside runoff simulation, explore the quantitative identification of mountain torrent factors, propose a comprehensive threshold index system for mountain torrent prediction and early warning, evaluate the distribution pattern of mountain flood risks in the upper reaches of the Yangtze River, and provide scientific support for scientific and efficient management of mountain flood risks and the construction of disaster prevention system for the upper reaches of the Yangtze River.

2. Interactions between the Three Gorges Reservoir and regional climate change (D01, D05, or D07)

The proposed research is expected to focus on the influences of the Three Gorges Reservoir on regional climate, study the source-sink characteristics, trends and causes of large-scale circulation system and water vapor transport, convergence and divergence; explore the influences and affected scope of Three Gorges reservoir water storage on regional temperature and evaporation, reveal the equilibrium relations between regional water vapor advection transport

source and local evaporation source, clarify the mechanism of regional water circulation; establish the land-atmosphere coupling model based on high-resolution regional climate model to analyze the climate effect of the underlying surface change of the Three Gorges reservoir.

3. Evolution of soil and water loss in Three Gorges Reservoir area and its causes and comprehensive control measures (D01or D07)

The proposed research is expected to analyzes the trend of soil erosion in the Three Gorges Reservoir area after the operation of the Three Gorges reservoir, focus on the problems of soil erosion in the transition zones of special ecological areas such as reservoir bank zone, water level fluctuating zone and flood plain, study the causes of soil erosion and its relationship with plant communities, explore the plant resources in the reservoir area, reveal the physiological characteristics and response mechanism of plant stress resistance, discuss the effects of vegetation on the control of water level fluctuating zone and flood plain, and provide scientific support for comprehensive control measures of soil and water loss.

4. Earthquake prevention and disaster reduction of cascade hydropower stations in the upper reaches of the Yangtze River (E08 or E09)

The proposed research is expected to focus on the cascade hydropower stations and engineering geological bodies in the upper reaches of the Yangtze River, address the problem of disaster chain caused by strong earthquakes, and provide theoretical and technological support for the operation safety, earthquake prevention and disaster reduction and emergency rescue of cascade hydropower stations in the upper reaches of the Yangtze River. Topics include: identification of earthquake and geological disaster sources of the Yangtze Basin, the evolution and failure mechanism of dam behavior under the scenario of strong earthquake-induced disaster chain, the earthquake damage of cascade hydropower stations and engineering geological bodies, the evolution mechanism of the earthquake-geological disaster-flood chain, and the risk assessment system.

5. Theory and method of flood resource operation in Yangtze River Basin (E09)

The proposed research is expected to focus on the joint dispatching mode of reservoirs in the upper and middle reaches of the Yangtze River and the key technical problems of flood resource operation, provide key technical support for the scientific decision-making of the joint operation of reservoirs in the upper and middle reaches of the Yangtze River. Topics include: the real-time joint optimal flood operation theory of cascade reservoirs based on forecast and pre-discharge; principles and methods of systematic and optimal allocation and coordination of reservoir capacity; the comprehensive cost-benefit ratio of cascade reservoir capacity; the weight and order of each reservoir in flood control; the dynamic control methods of limited water level in flood season; the mathematical model and the risk analysis model of the optimal allocation of storage capacity for the real-time joint operation of cascade reservoirs in different forecast periods.

6. Dynamic process of water and sediment and its ecological and environmental effects in the lower reaches of Jinsha River (E09 or E10)

The proposed research is expected to focus on the complex adjustment and change of water and sediment process after the operation of cascade hydropower stations on Jinsha River. Topics include: the dynamic process of water and sediment of reservoirs and the effect of sediment on ecology and environment; the evolution pattern of unsteady flow of reservoirs and downstream channel of dams; the movement characteristics of wide graded sediment in mountain rivers under different water and sediment conditions; the interaction mechanism between sediment and ecological/environmental factors; the response mechanism of ecological environment to sediment transport and reservoir deposition; and the ecological and environmental effects of wide graded sediment in mountainous rivers.

7. Coupling simulation and evolution mechanism of hydrological and hydraulic

processes and control factors in permafrost region of the Yangtze River source (D01 or D07)

The proposed research is expected to provide scientific support for ecological protection and flood prevention and control in the source region of the Yangtze River. Topics include: the dynamic process monitoring and inversion of the key hydrological and hydraulic elements, the pattern of frozen soil degradation, the physical mechanism of ice-water phase change and the water cycle process in the typical data lacking areas of the source region of the Yangtze River; the prediction model of snowmelt runoff erosion, the coupling simulation model of water-ice-sediment interaction, quantitative study of the ice-water/water-sediment process effect and response mechanism associated with the water-sediment process.

8. Evolution mechanism and prevention of reservoir landslide under sudden rainstorm (D01, D02, D05 or D07)

Topics include: outfield monitoring of sudden rainstorm in the Three Gorges Reservoir area; the probability prediction method of sudden rainstorm in the Three Gorges Reservoir area; key coupling technologies of rainstorm model and hydrological model in the landslide area of the Three Gorges Reservoir; the disaster mechanism of typical landslides caused by the rainstorm evolution process in the Three Gorges Reservoir area; the identification method of landslide evolution process under the condition of sudden rainstorm; the new technologies integrating ecological protection and control structure for the prevention of landslide in the Three Gorges Reservoir area.

9. Check and evaluation of characteristic water level after reservoir operation (E09)

The proposed research is expected to focus on hydropower stations and reservoirs in the middle and upper reaches of the Yangtze River. Topics include: the new theory, methods and application of different frequencies of flood in the uncontrolled area of hydraulic complex, the theoretical framework and models for determining the characteristic water level of the reservoir group as a whole, the optimal characteristic water level combination of the reservoir group in the middle and upper reaches of the Yangtze River under different scenarios; the comprehensive operation objectives of flood control, power generation, shipping, water supply and ecology, the characteristic water level of reservoirs in the middle and upper reaches of the Yangtze River that meets the current and future demand based on the joint operation model and comprehensive benefit simulation analysis of different characteristic water level combinations of reservoirs.

10. Rainstorm flood forecast based on coupling meteorological and hydrological models for the Yangtze River Basin (D01 or D05)

The proposed research is expected to study the coupling mechanism of meteorology and hydrology in the upper reaches of the Yangtze River under the changing environment, analyze the causes of rainstorm changes, develop the rainstorm forecasting model based on the coupling of surface and atmospheric variables and the flood forecasting model considering the regulation and storage of upstream reservoirs in the upper reaches of the Yangtze River, put forward the flood probability forecasting method based on multi model combination in the upper reaches of the Yangtze River, improve the accuracy and prediction period of flood forecasting for the Three Gorges Reservoir.

11. Mutual influence mechanism of water quantity and quality and regulation of water system connection between Yangtze River and Taihu Lake (D01 or D07)

The proposed research is expected to focus on the Yangtze River and Taihu lake basin, study the evolution of the Yangtze River-Taihu Lake connectivity and the water resources exchange under the influence of human activities. Topics include the cooperating response between the Yangtze River and Taihu Lake Basin, the mathematical model of water quantity and quality of the middle and lower reaches of the Yangtze River and Taihu Lake Basin, the threshold value of key indicators of water quantity and quality regulation to achieve the benefits of both the Yangtze River and Taihu lake basin in different wet and dry years, and the scheduling scheme, water quantity control and

water source protection measures of water conservancy projects for the water safety of the Yangtze River and Taihu Lake Basin.

12. Consistency analysis of hydrological data under the influence of human activities (E09)

The proposed research is expected to focus on the important nodes, typical tributaries and regions of the main stream of the Yangtze River. Topics include: the consistency and variation characteristics of hydrological series such as precipitation and runoff, the causes of the consistency variation of hydrological data; the mechanism, degree and pattern of the influences of human activities, such as hydrological monitoring network, large and medium-sized water conservancy projects and urbanization, on the consistency of hydrological data, and evaluation of the impact of data consistency variation on regional flood control and water resource safety; the theory and methods of dealing with the consistency variation of hydrological data.

13. Total material flux of the Yangtze River and ecosystem health diagnosis in key vulnerable areas (E09 or E10)

The proposed research is expected to address the new problems of multi-functional coordination and river ecosystem health of the Yangtze River. Topics include the establishment of a spatiotemporal matching big data platform of total factors and total material flux of the Yangtze River based on the total factor monitoring data of the whole Yangtze River from the source area to the estuary; the pattern and causes of water quality changes of the Yangtze River in recent decades; the spatial distribution and response relations of abiotic and biotic components in the water and sediment media of the Yangtze River; the method system of the sustainability evaluation and ecosystem health diagnosis for the “golden waterway” of the Yangtze River; and the protection plan of the typical ecological sensitive areas of the Yangtze River.

14. Sustainable utilization of water resources and risk control of water resource exploitation in Hanjiang River Basin (D01, D05 or D07)

The proposed research is expected to focus on the water resources security and risk control of the Hanjiang River Basin under the influences of the South-to-North Water Diversion Project and climate change, study the evaluation method of the impact of changing environment on water resources in the water exporting area, analyze the security risk of water resources in Hanjiang River under different water transfer scales and different climate change scenarios, study the water transfer strategy and risk control theory under the scenario of sustained large-scale drought, develop the theory of the value of water resources and ecosystem service, propose the quantitative analysis method, policy framework and implementation route of water resource protection and compensation, and provide scientific support for the sustainable utilization of water resources in the Hanjiang River Basin and the water supply safety of the South-to-North Water Diversion Project.

15. Eco-environmental effects and regulation of water conservancy and hydropower projects in the Yangtze River Basin (E09 or E10)

The proposed research is expected to study the change characteristics and evolution trend of river habitat system under the influence of large-scale water conservancy and hydropower projects in the upper and middle reaches of the Yangtze River, explore the deposition, transformation and transportation process of key biogenic elements and main pollutants in the reservoir and their impacts on the reservoir and downstream, reveal the temperature changes in the high dam reservoir and the lower reaches of the river and their impacts on aquatic organisms, and propose a multi-dimensional control method for the eco-environmental effects of large-scale water conservancy and hydropower projects in the upper and middle reaches of Yangtze River based on the distribution pattern of large-scale water conservancy and hydropower projects and the multi-source long-range monitoring data of hydrology, water environment and water ecology.

16. Ecological response mechanism and dynamic regulation of the water system

connection projects in the middle and lower reaches of the Yangtze River (E09 or E10)

The proposed research is expected to study the ecological response mechanism of the water system connection projects of rivers, lakes and reservoirs in the middle and lower reaches of the Yangtze River based on the water system connection pattern of middle-sized river-connected lake group in the middle and lower reaches of the Yangtze River, construct the ecological model of the regional water system, explore the dynamic control methods of the sluice pumping station water conservancy projects which benefit flood control, ecological flow and water circulation, and provide scientific support for the restoration of the regional hydrodynamic connectivity of the middle and lower reaches of the Yangtze River.

17. The monitoring, assessment and restoration of ecological environment of the Yangtze River Economic Zone under the influence of small hydropower stations (E09)

The proposed research is expected to address the ecological problems caused by small hydropower stations in the Yangtze River economic belt. Topics include: hydrological ecological response relationship of small hydropower stations, the monitoring and evaluation of ecological impact of small hydropower stations in small watershed, and the theory and methods of ecological restoration of rivers with small hydropower stations.

18. The evolution pattern of the waterways of river-connected lakes of the Yangtze River (D01 or D07)

The proposed research is expected to address the environmental problems caused by lake reclamation and siltation in the middle and lower reaches of the Yangtze River, carry out studies on the water-sediment balance and siltation of lakes, study the lake siltation states and change patterns in different stages of the past one hundred years based on the establishment of siltation database, identify the natural and human causes of lake siltation, analyze the evolution mechanism of lake siltation and its impact on the river-lake relations, predict future siltation scenarios, and provide scientific support for enhancing the flood regulation and water conservation function of lakes.

19. Identification, prediction, prevention and control of piping risk (E09)

The proposed research is expected to focus on the typical section of piping risk of the Yangtze River, and provide theoretical basis and technical support for the fast identification and prediction of dike piping and the improvement of flood control and rescue. Topics include: the algorithm for the accurate monitoring and rapid identification of the dike piping, the prediction and analysis model of the development trend of the dike piping; the conditions and mechanism of the occurrence and development of dike piping based on on-site monitoring, physical model test and numerical simulation methods; the intelligent network monitoring and real-time pre-warning technology of the dike piping; the dynamic calculation model of the flood caused by dike piping, and the risk intelligent map and risk control method of dike break flood.

20. The mechanism of unbalanced sediment transport and fluvial channel patterns evolution in the downstream channel of the Three Gorges Reservoir (E09)

The proposed research is expected to focus on the downstream channel of the Three Gorges Dam, study the change pattern of water and sediment under the condition of unbalanced sediment transport, reveal the main influencing factors and mechanical mechanism of water and sediment variation, explore the mechanism and prediction model of the evolution of different fluvial channels under unbalanced sediment transport conditions, analyze the pattern and trend of the saturation recovery process of different sizes of sediment in the downstream channel of the dam, predict the balance process and long-term evolution trend of different patterns of fluvial channels under new water and sediment scenarios, and put forward regulation methods and restoration measures of water and sediment for unbalanced channels.

21. The river-lake relationship and flood control and disaster reduction for the downsteam reaches of the Three Gorges (E09)

The proposed research is expected to address the problem of frequent occurrence of regional flood in the downstream reaches of the Three Gorges, and provide scientific and technical support for the flood control and disaster reduction of the region. Topics include: the temporal-spatial variation pattern and causes of flood in Dongting Lake Basin, Poyang Lake Basin and the main tributaries of the lower reaches of Yangtze River; the flood wave regulated by the reservoir impoundment and the propagation characteristics of flood composed of water from different rivers and lakes; region-specific hydrological process simulation model and the hydrodynamic evolution coupling model; the influences of river-lake relation change, flood storage capacity of rivers and lakes, reservoir group scheduling and impoundment, sluice gate pumping and drainage on the typical flood process; the causes of high flood level and the influence mechanism of flood characteristic factors; the regional flood characteristics and flood control strategy under the influence of underlying surface change and human activities.

22. Protection of aquatic organisms in the middle and lower reaches of the Yangtze River and ecological regulation of the Three Gorges Reservoir (C03)

The proposed research is expected to address the need of protecting endangered fish and other aquatic organisms in the downstream reaches of the Three Gorges, carry out studies on the impacts of the Three Gorges reservoir operation on the distribution, behavior, migration, physiology and genetics of endangered fish and other aquatic organisms, analyze the interaction between key life-history of fish and other aquatic organisms and the eco-hydrological conditions, explore the mechanism underlying the dynamic changes of endangered fish and other aquatic organisms, and put forward the ecological operation strategy of the Three Gorges reservoir to meet the protection needs of aquatic organisms in the downstream reaches.

23. Causes of waterlogging and flood control measures in large cities along the middle and lower reaches of the Yangtze River (E09)

Topics include: the spatiotemporal variation of extreme rainfall and waterlogging in large cities in the middle and lower reaches of the Yangtze River under changing environment; the analysis of the exposure, vulnerability and risk factors of flood disaster based on the urban development, underlying surface conditions, hydrological and hydrodynamic characteristics and water network regulation and storage system, the causes and mechanism of flood disaster; the multi-scale and multi factor flood risk assessment model; the comprehensive evaluation method of waterlogging disaster in the middle and lower reaches of the Yangtze River, the real-time assessment of waterlogging risk and loss; the comprehensive countermeasures of adaptive flood control and waterlogging removal, flood resource utilization in the middle and lower reaches of the Yangtze River in the changing environment, and the approaches and key technologies to enhance the resilience of cities.

24. Bank slope protection structure and its stability for the middle and lower reaches of the Yangtze River (E09)

The proposed research is expected to study the bank slope deformation-collapse mechanism and the interaction mechanism of water-revetment structure-riverbank soil under the coupling effects of rainfall, water erosion and high groundwater level, put forward a new sheet pile ecological revetment technology suitable for different slope soil structure and different water flow conditions; study the damage process and failure mechanism of ecological revetment structure under complex factors; put forward new design of ecological revetment structure and bank stability evaluation methods, develop new methods and technologies of bank protection with strong erosion-resistant and ecological protection performance, and provide scientific support for the design and long-term safe operation of bank slope protection projects.

25. Big data fusion model and intelligent decision-making of water security of the middle and lower reaches of the Yangtze River (D01)

The proposed research is expected to focus on the integrated simulation and intelligent decision making of water security of "lakes, reservoirs, riverside areas and city groups" along the mainstream of the Yangtze River, study the mechanism of united presentation model and AI native fusion management engine for massive multi-source heterogeneous water security data sets; develop multi-process and multi-dimensional water system knowledge mapping technology and mining technology of dynamic evolution of water security scenarios, develop the water system simulation technology based on the integration of big data and AI, as well as the prediction/pre-warning theory and methods and decision support for emergency control, so as to provide scientific support for the integrated simulation system and intelligent decision making for the Yangtze River.

26. Evolution of water system and geomorphology of lakeside areas and seawalls in Yangtze River Delta (D01, D06 or D07)

The proposed research is expected to systematically study the changes of the river-lake system of the lower reaches of the Yangtze River, such as the mainstream channel, Taihu Lake, Hongze Lake, Qiantang River and canals from 1500 to 2000, and reveal the relations between the water system and water conservancy projects in the Yangtze River Delta from the middle of the Ming Dynasty to the end of the 20th century. Topics include: the simulation of a series of hydrological dynamics in the past 500 years, including Taihu Lake and its upstream and downstream rivers, Hongze Lake and Li canal system; the influences of the changes of water system on the lakeside areas and seawalls, including the influences of river and lake changes on the polder system in the east of Taihu Lake, the influence of the changes of the Yellow River and the Huai river system and Lixiahe river system on the seawall stack in the northern Jiangsu, the influences of the changes of estuary and seawalls on polder field, etc.

27. The evolution pattern and ecological effect of floodplain habitats in Jingjiang section of the Yangtze River (C03)

The proposed research is expected to address the ecological problems of the continuous decline of aquatic habitats and biodiversity in the Yangtze River, study the influence process and adaptive mechanism of representative species in the Jingjiang section affected by the continuous evolution of the key aquatic habitats and floodplain based on the long-term specie dynamics and habitat monitoring data, and put forward strategies of habitat protection and active restoration for representative species.

28. Flood prevention, tide control and water supply in the Yangtze River Estuary under the condition of sea level rise (E09)

Topics include: the sea-level rise and evolution of the East China Sea under the background of global warming; the water-salt dynamic exchange mechanism and spatial-temporal distribution characteristics of the Yangtze River Estuary; the risks of seawater intrusion and water supply security under the influences of sea-level rise and land subsidence, as well as their impact on the flood control and tide resistance of the existing engineering system; changes of the exposure degree, vulnerability and resilience of the estuary area under the background of sea-level rise; calculation method of standard seawall design and risk control measures to adapt to global change.

29. Evolution pattern and comprehensive management of the Yangtze River Estuary (D01, D05, D06 or D07)

Topics include: the mechanism underlying the impact of flood and typhoon storm surge on the water and sediment movement and the river regime evolution in the Yangtze River estuary under the influences of global change and human activities; the transmission effect of continuous scouring of the upstream river on the stability of the Yangtze River port line and shoal channels; the quantitative evaluation of the effects of various protection projects in the Yangtze River estuary and the contribution of shoal groups to the river regime stability; the construction technology and

dredged soil utilization technology for embankment, channels, shoals and water sources; the comprehensive utilization and protection mode of estuarine resources, and the comprehensive control measures of the Yangtze River estuary.

30. New method to construct the water network in Yangtze River Delta Urban Agglomeration (E09)

Topics include: the quantitative analysis of the threshold value of water demand of the social/economic development and ecological environment based on the spatial-temporal distribution of water resources in the Yangtze River Delta region; the evaluation method of regional sustainable development ability under natural conditions and the evaluation index system of the effectiveness of water physical network to ensure the comprehensive water security of flood control, water supply, ecology, environment and shipping; the quantitative evaluation method of the effectiveness of the water physical network and optimization of the network planning from the perspective of the adaptability of water conservancy projects to resources, social economy and ecological environment.

31. Strategies for collaborative improvement of ecosystem services in Poyang Lake (D01)

The proposed research is expected to study the change and development trend of the relationship between the Yangtze River and Poyang Lake caused by the impoundment and operation of the Three Gorges reservoir, evaluate the lake ecosystem service function, reveal the process and mechanism of the impact of the river-lake relationship change on the lake ecosystem service function, identify the risks and level of the changes of the Poyang Lake ecosystem service function, and put forward the strategy and routes of the multi-objective collaborative improvement of the ecosystem service of Poyang Lake.

32. Mechanism and prediction of drought in the Yangtze River Basin (D01 or D05)

The proposed research is expected to study the impact mechanism of the air-sea and air-land interactions on the formation of drought in the Yangtze River Basin under the climate change and human activities, explore methods and models of dynamic forecast of drought at different temporal and spatial scales, and provide evidences for drought risk management.

Ye Qisun Science Fund

Aiming at the implementation of the strategy of innovation-driven development and making full use of the guiding role of the NSFC, the Ye Qisun Science Fund is set up to attract and mobilize science and technology resources in the society to conduct fundamental, frontier and exploratory research to meet the demands in industrial science and technology development. It also aims to promote the integration and development of modern engineering technology and basic science, solving groundbreaking basic science problems and improving independent innovation capacity.

In 2021, the Ye Qisun Science Fund is going to support a number of key projects, with an average funding budget (direct cost) of 2.6 million yuan per project for 4 years.

1. Research on multi-physical field coupling method of carbon fiber surface for carbon/heat-resistant carbon composites (E02)

2. Research on combustion instability mechanism of four-component hydroxy-terminated polybutadiene propellant (HTPB) propellant (E06)

3. Heat and mass transfer mechanism of spray active cooling in long-term high heat flux environment (A09)

4. Research on boiling heat transfer mechanism of high heat flux flow in confined

space of complex electronic systems (E06)

5. Research on combustion control and regulation mechanism of wide-speed-range multi-mode ramjet engine (E06)

6. Research on mechanism of fault effects and fault-tolerant control method of reusable launch vehicles (E12)

7. Intelligent joint optimization method of electromagnetic radiation and diffuse reflectance characteristics of radio frequency aperture (F01)

8. Research on the failure mechanism of reusable lightweight thermal protection materials in high dynamic environments (E02)

9. Research on distributed magnetic detection identification and location methods for underwater targets (F03)

10. Research on aluminum-based solid particle/supercritical water reaction mechanism (B08)

11. Research on the mechanism of strong electromagnetic coupling and decoupling method of platform and antenna (F01)

12. Method of active consumption and suppression of pulse power in power systems with limited capacity (E07)

13. Research on the data-driven simulation models of multi-physical domain aircraft utility systems (F03)

14. Research on the mechanism of the influence of atmospheric turbulence on precision laser light field and the and method of suppression (A22)

15. Research on high torque density motor and driving technology of electric propulsion system (E07)

16. Research on aerodynamic flow control mechanism of highly blended wing body aircraft (A09)

17. Research on bionic controllable adhesion effects under high-speed airflow disturbance (A09)

18. Basic research on the failure mechanism and service life prediction of thermal-fluid-solid coupling in distributed electro-drive hydraulic system (E05)

19. Study on the cooling mechanism of two-phase flow with coupled fluid-solid-electromechanical coupling heat transfer under high heat flux flow (E06)

20. Research on high-efficient thermoelectric conversion and supporting structure integration (E02)

21. Machine learning-based method for monitoring delamination damage of composite materials (A08)

22. Research on the mechanism of super-resolution detection and spectral imaging based on optical field construction (A22)

23. Research on real-time optimization of beam parameters and adaptive compensation of transceiver control for one-to-many laser communication on the dynamic platform (F01)

24. Research on the mechanism of wear and corrosion resistance of high-strength metal helical connection structures in marine environment (E05)

25. Research on manufacturing precision and performance evolution law of large aluminum alloy thin-wall complex structure (E05)

26. Research on the mechanism of impurity-flow field coupling in the large wind tunnel and the method of regulating flow field characteristics (A09)

27. Research on the transition acoustic mechanism in the gas-liquid two-phase boundary layer at high Reynolds number (A09)

28. Research on the modeling of physical features of low-frequency passive sonar target recognition (F01)

29. Research on the stabilization mechanism of the liquid-gas interface in high hydrostatic pressure and liquid flow environments (A09)

30. Research on vibroacoustic coupling mechanism and regulation method of high stiffness composite structures (A08)

31. Research on the motion mechanism of the recovery process of unmanned surface vehicles in complex wave environment (E11)

32. Research on intelligent collaborative control and decision-making method of unmanned surface vehicle cluster for complex mission (F03)

33. Research on the mechanism of the influence of interlayer stress on the performance of second-generation high-temperature superconducting magnets (A08)

34. Research on the mechanism of bionic coupling and mapping of low-frequency vibration isolation structure (A07, A08, A09 and A10)

35. Research on the control method and mechanism of highly intensified combustion of marine diesel engines (E11)

36. Research on safety assessment methods and damage mechanism of complex load connection structures in the marine environment (E05)

37. Research on the sensitivity and corrosion behavior of welding pores of high-magnesium rare-earth (Er) containing aluminum (E05)

38. Research on self-organization and cooperative control of underwater unmanned clusters through weak connectivity and weak perception (F03)

39. Research on the pressure-charging characteristics and the mechanism of gas-liquid mixing and condensation with high non-condensable gas content (E06)

40. Local strong magnetic blow effect and its control of alloy steel welding (E05)

41. Research on the wear mechanism of diesel engine cylinder head under low sulfur conditions (E01)

42. Research on the mechanism and prediction model of multiphase coupling flow of salt-containing gas-liquid in the gas admittance system of the gas turbine (A09)

43. Research on the mechanism of in-service damage of the inner wall of typical thick-walled steel pipe (A08)

44. Research on the coupling mechanism and performance evaluation model of the turbocharged system based on pressure gain combustion (E06)

45. Research on the energy release kinetics of TKX-50-based complex (B05)

46. Research on the physical characteristics of the surface interface of large-scale desktop InGaAs focal plane detectors (F04)

47. Research on the optimization method of gain stability of electron bombarded active pixel sensor (F04)

48. Research on Al/Cu high-speed sliding electrical contact interface control (E01)

49. Research on film formation mechanism and performance of nano-insulating coatings with bondable interconnecting microfine gold wires (E13)

50. Research on the dynamics and mechanism of eddy current magnetic damping (A07 or A09)

51. Research on the flight stability of high-speed rotary aircraft (A07 or A09)

52. Basic research on chromium-free passivation of copper alloy surfaces (B02)

53. Research on the identification and characterization method of craniocerebral injury under the high-speed impact (F01)

54. Research on the nano-reinforcement mechanisms for ultra-high tensile steels (E01)

55. Research on the method of sputter deposition of long-life high temperature resistant hard coatings on the inner wall of slender steel pipes (E01)

56. Research on high wind resistance adaptive aerodynamic layout and control method for the unmanned aerial vehicles (UAV) (E12)

57. Research on the mechanism of the disturbance of stability of the rotary-wing opening of the aircraft (A09)

58. Basic research on continuous forming of local upsetting of ultra-high tensile steel case with pulse current assistance (E05)

59. Research on sensitivity enhancement method of ultraviolet detector in fire suppression and explosion prevention system (F05)

60. Research on the mechanism of distribution and cluster formation of Ag atom in photo-thermal-refractive glass (E02)

61. Research on unmanned aerial vehicle (UAV) swarm target identification method with incomplete information (F01)

62. Research on the homogenization property of large-size ultra-low expansion microcrystalline glass (E02)

63. Research on the coupling mechanism of chemical cracking of supercritical alcohols and heat mass transfer of hydrocarbon fuel at microscale (E06)

64. Research on the dynamic thermal behavior of gears and the mechanism of lubricant failure of gear tooth surface deterioration (A08)

65. Composition design of AlNbTiZr (Mo, Ta) high entropy alloy and the mechanism of thermal deformation control mechanism (E01)

66. Research on multi-body dynamics of high-speed high-temperature bearing cage based on oil-solid coupling (A07)

67. Research on the formation mechanism and suppression of soot particles in complex swirl spray flame (E06)

68. Research on nonlinear instability and wear mechanism of flexible foil gas bearing under high temperature and high speed conditions (E05)

69. Laser additive manufacturing and toughening mechanism of niobium silicide particle reinforced high entropy alloys (E01)

70. Research on the decay mechanism of self-locking performance of self-locking nut under strong vibration in wide temperature domain (E05)

71. Research on the residual stress and deformation mechanism of nickel-based single crystal high-temperature alloy blade (E01)

72. Research on the frictional ignition mechanism of titanium-aluminum compounds considering thermal-mechanical-fluid coupling (E06)

Joint Fund for Meteorology

The Joint Fund for Meteorology was jointly established by the NSFC and the China Meteorological Administration (CMA) to implement the important instructions of General Secretary Xi Jinping on meteorological work, accelerate meteorological science and technology innovation, strengthen basic research, focus on solving and breaking through important scientific problems closely related to the core technology of meteorological industry, cultivate outstanding talents, enhance independent innovation capability, and promote high-quality development of China's meteorological service.

As a part of NSFC's funds, the application, evaluation, management and use of funds of the

Joint Fund for Meteorology will be implemented in accordance with the Regulations of NSFC, NSFC's rule on Funding Management and NSFC's Rule on Joint Fund Management of Funds of NSFC-Funded Projects.

In the year 2021, the Joint Foundation for Meteorology will focus on the urgent needs of high-quality development of meteorology, focusing on the core areas of numerical forecast model development, catastrophic weather mechanism and forecasting, and artificial intelligence meteorological applications, and will accept applications for the following 17 research directions. The direct funding intensity is 2.6 million yuan per project, and the duration is 4 years from January 1, 2022 to December 31, 2025.

I. Key technologies of numerical weather prediction model

1. Research on key technologies of high-resolution regional numerical forecasting model

In view of the demand for regional high-precision forecasting, the application should improve the fine weather forecasting capability in specific regions by improving the key technologies of regional high-resolution numerical forecasting, developing local high-order reconfiguration-type algorithms compatible with regional high-resolution models; developing the calculation scheme of model physical processes applicable to kilometer to sub-kilometer resolution; improving the model simulation scheme for complex subsurface such as large urban clusters and high-resolution terrain; and developing the data assimilation technology and application scheme suitable for kilometer-scale resolution.

2. Research on key technologies of global variable-resolution model weather simulation

The application should explore the local area variable resolution simulation technology based on global atmospheric model, and conduct model applicability research for specific areas, study the effects of different variable resolution grid generation methods and encryption types on simulation effects; study the dynamical algorithms, physical schemes and coordinated physics-dynamics coupling strategies suitable for variable resolution simulation; explore the variable resolution model configuration methods adapted to local areas, and the internal sensitivity of variable resolution models for atmospheric wet processes such as clouds and precipitation.

3. Evaluation of kilometer-scale high-resolution numerical prediction models

In view of the difficult needs such as short-time proximity forecast and early warning within 24 hours and seamless refinement of meteorological forecast operations, the applications should study the object-based and process-oriented evaluation methods and indicators; evaluate the simulation capability of high-resolution numerical forecast models for the spatial-temporal synergistic characteristics of high-impact weather and its evolution process, quantitatively diagnose the characteristics and causes of model uncertainty for key regions and key processes, and improve the refinement of disaster weather forecasting capability.

4. Research on the growth mechanism of initial value error of convective distinguishable numerical forecasting and ensemble forecasting method

The application should address the uncertainty of high-resolution regional numerical forecasting, study the influence process and nonlinear evolution characteristics of initial error at different scales based on the kilometer-scale regional numerical forecasting model, obtain the three-dimensional initial perturbation structure of multi-scale nonlinear growth, construct a model random error perturbation model based on the multi-scale error characteristics of precipitation process and fully consider the uncertainty of wet physical process and develop the convective-scale ensemble forecasting method.

5. Research on the key technology of radiative transfer model

The application should address the shortcomings of the quantitative application of satellite

data in China, research on the full-band vector radiative solution scheme, establish a general optical parameter calculation theory for aerosol-cloud-precipitation non-spherical particles; establish a theory and calculation scheme for ocean surface emissivity based on the dual-scale roughness model; develop a complex surface emissivity inversion method based on satellite data, and establish a high-precision surface emissivity data set for specific regions such as the Qinghai-Tibet Plateau.

6. Research on 3D wind field resolution and assimilation method of satellite hyperspectral sounding

The application should develop a 3D atmospheric wind field inversion algorithm based on the radiance observation in the water vapor absorption band of the detector based on the high frequency observation characteristics of the hyperspectral atmospheric sounder data of the wind cloud satellite; establish an error estimation and quality control scheme for the 3D wind field under different atmospheric states; establish an error estimation scheme for the assimilation of the 3D wind field; and quantitatively evaluate the contribution of the satellite 3D wind field to the numerical prediction of disaster weather.

II. Theory and methods of disaster weather monitoring and forecasting

7. Research on key technologies of high-density networked weather radar application

The application should focus on the radar networks already deployed in China, carry out research on data quality and consistency issues, networking methods, develop system deviation revision methods and attenuation revision methods based on a combination of artificial intelligence and traditional methods; develop high spatial and temporal resolution of echo intensity fusion, precipitation phase identification, and heavy precipitation estimation methods; invert three-dimensional wind fields, and carry out research on key technologies for cyclone identification and early warning such as tornadoes.

8. Lightning multidimensional characteristics and its relationship with the spatio-temporal configuration of thunderstorm structure research

Research on 3D lightning positioning system with lightning channel imaging capability, and methods for integrated observation of thunderstorms and lightning activity based on dual-line polarization weather radar; research on the development process of lightning channels in thunderstorm clouds, spatial and temporal patterns, as well as the intensity and location of lightning activity and other multi-dimensional features and their interconnection; research on the spatial and temporal configuration of lightning multi-dimensional features and thunderstorm flow field, precipitation structure and charge structure; and research on the numerical simulation method of lightning process with the fusion of lightning multi-dimensional information.

9. Research on methods and techniques for adaptive observation of catastrophic weather

The application should focus on catastrophic weather processes, identify the pre-signals affecting their occurrence and development; develop integrated meteorological observation station network evaluation techniques based on observation-forecasting interaction; focus on collaborative observation of sensitive areas of specific weather systems; and carry out application analysis of key sensitive areas and sensitive elements of catastrophic weather.

10. Research on the triggering mechanism and forecasting methods of warm-zone rainstorms

The application should make full use of various observation data to study the triggering mechanism and evolution process of warm-zone rainstorms, establish the theory and method of warm-zone rainstorm forecasting, and lay the scientific foundation for improving the forecast capability of warm-zone rainstorms.

11. Research on the evolution mechanism of strong storms

The application should study the internal dynamics, thermal and cloud-precipitation microphysical structure characteristics of convective storms at different scales; carry out research on the dynamics and thermal processes and their interactions during the triggering and evolution of strong storms; and develop identification and early warning technologies for disaster-causing strong convective weather such as downwash storms and tornadoes.

12. Research on the evolution mechanism and forecasting method of persistent extreme heavy precipitation in the basin

The application should focus on the difficulties in forecasting disaster-causing extreme heavy precipitation processes in the basin, conduct research on the evolution characteristics and mechanisms of continuous extreme heavy precipitation processes; develop theories and methods for refining extreme heavy precipitation forecasts; study the interaction mechanism between continuous heavy precipitation and basin floods, and provide scientific basis for mitigating basin floods.

13. Refined evolution of weather processes and forecasting methods

The application should focus on the demand for developing "accurate and digital" weather forecasting services, study the refined evolution of high-impact weather processes, and carry out the refined evolution of typical weather processes under complex subsurface conditions such as large cities and urban clusters, local topography and land and sea distribution; base on numerical models, develop refined and objective forecasting methods for high-impact weather. The application should be based on the numerical model, develop refined objective forecasting methods for high impact weather, and provide scientific theoretical and technical support to promote the refinement level and accuracy of weather forecasting.

14. Research on the evolution of local heavy precipitation in typical complex terrain and forecasting methods

The application should focus on the difficult problem of localized heavy precipitation forecasting in typical complex terrain, conduct research on the refined precipitation characteristics of complex terrain; assess the simulation capability of operational numerical forecasting systems for precipitation in typical complex terrain, recognize and understand the deviation characteristics and sources of operational numerical forecasting systems; and propose a revision scheme technology applicable to the interpretation of numerical forecasting results in typical complex terrain.

III. Artificial intelligence meteorological application technology

15. Research on the key technology of rapid intelligent identification and forecasting of sudden disaster weather

The application should focus on the difficulties of rapid identification of sudden disaster weather, be based on multi-source meteorological observation data and artificial intelligence comprehensive diagnosis technology, research on minute level disaster weather phenomenon intelligent identification technology, establish short-time heavy precipitation, thunderstorm wind, hail and tornado and other disaster weather intelligent identification model, carry out intelligent refinement of multi-source data quality control and product algorithm research, develop high spatial and temporal resolution gridded short-time heavy precipitation, develop gridded short-term forecasting techniques and methods for strong convection such as gale, lightning and hail with high temporal and spatial resolution.

16. Research on the applicability and interpretability of artificial intelligence algorithms in atmospheric science

The application should view of the uncertainty of the application of artificial intelligence

algorithms in atmospheric science and the black-box characteristics of deep learning models for weather prediction, study the applicability of different artificial intelligence algorithms in atmospheric science based on the spatial and temporal variability of atmospheric science data and multi-scale physical processes, select and develop artificial intelligence algorithms suitable for the field of meteorology, carry out research on the interpretability of deep learning algorithms for weather prediction models, and establish artificial intelligence models with certain physical interpretability for weather prediction, that provides the theoretical and technical systems of artificial intelligence weather forecasting and prediction algorithms with certain physical interpretability.

17. Research on artificial intelligence prediction technology of heavy precipitation process during flood season

The application should focus on the difficulties of extended period forecasting of heavy precipitation process in flood season, use deep learning and other artificial intelligence methods to extract precursor signals of heavy precipitation in flood season based on multi-model results and live observations, explore the aggregation scheme and application strategy of intelligent prediction results, and build an intelligent prediction model of heavy precipitation process in flood season that meets the business needs.

Joint Fund for Earthquake Science

The Joint Foundation for Earthquake Science is jointly funded by the Natural Science Foundation of China (NSFC) and the China Earthquake Administration (CEA) to attract and bring together outstanding talents in related research fields nationwide to conduct fundamental, prospective, and innovative research on frontier scientific problems and key technical issues in several areas of earthquake science.

In 2021, the Joint Foundation for Earthquake Science will be funded in the form of key projects. The average direct cost is 2.8 million yuan per project, and the funding period is 4 years, and the research period should be “from January 1, 2022 to December 31, 2025”.

I. New Technologies, Theories and Methods for Earthquake Monitoring and Prediction

1. Research on the identification, mechanism and prediction of strong earthquake hazard of interseismic creep in Sichuan-Yunnan fault zone (D02 or D04)

The application should aim at uncertainty of the distribution of interseismic occlusion and creep-slip and the seismic recurrence cycle of important ruptures in Sichuan and Yunnan areas, carry out comprehensive studies through InSAR, continuous GPS observation in the near field of faults and LiDAR measurements, such as rock low-velocity-high-speed friction experiments, seismic geological surveys, and model inversion, the interseismic creep-slip and stick-slip mechanisms to identify and clarify the role of seismogenic and seismic control of important ruptures in Sichuan and Yunnan areas, and reveal the refined sliding patterns and coupling mechanisms of ruptures, studies of the seismic recurrence cycle of ruptures, and the strong-earthquake hazard prediction should be carried out for providing the strong-earthquake hazard determination of important ruptures.

Note: The projects supported by this research direction should fulfill the Agreement of Data and Results Remittance of Scientific Research Projects in China Earthquake Science Experimental Field.

2. Study on the determination of strong earthquake incubation stages in different fault

segments of typical tectonic zones (D02, D03 or D04)

The application should address the problem of large uncertainty in time prediction in medium- and long-term earthquake prediction, select typical active tectonic zones in Sichuan and Yunnan regions, determine the gestation stages of each fault section based on the strong earthquake recurrence model and the strong earthquake departure time rate, and analyze the characteristics of regional deformation, fault motion, seismic activity, fault stress, and deep and shallow material transport in different gestation stages using geodetic and seismic data, as well as numerical simulation, inversion, and model calculation, as well as establish an effective method for determining the gestation stages of strong earthquakes in a comprehensive study.

Note: The projects supported by this research direction should fulfill the Agreement of Data and Results Remittance of Scientific Research Projects in China Earthquake Science Experimental Field.

3. Research on rapid determination technology of seismic parameters based on artificial intelligence (D02 or D04)

The application should address the needs of earthquake early warning, earthquake quick reporting and aftershock detection, research on data denoising, microseismic and aftershock detection methods and techniques based on ground shaking observation data combined with artificial intelligence technology, as well as methods for rapid prediction of large earthquake magnitude and rapid determination of small earthquake source mechanism, and techniques and methods for earthquake early warning, felt range and intensity distribution based on real-time multi-source heterogeneous big data from smart mobile devices and the internet using artificial intelligence technology, as well as demonstration application in Sichuan and Yunnan regions.

Note: The projects supported by this research direction should fulfill the Agreement of Data and Results Remittance of the Scientific Research Projects of the China Earthquake Science Laboratory Field. The China Earthquake Administration shares the intellectual property rights of the funded project results.

4. Research on seismic monitoring and mechanism induced by fracturing in oil and gas reservoirs (D02 or D04)

The application should aim at the problem of oil and gas development in Sichuan and Yunnan areas that may induce earthquakes and form disasters, research and develop low-cost, high-density and high-precision seismic observation technologies, as well as in-depth study the characteristics of seismic activity induced by oil and gas reservoir fracturing, conditions and mechanisms of destructive earthquakes and the probability of seismicity, and development of seismic disaster risk prevention technologies for providing scientific and technological support for national energy strategic security and sustainable development.

Note: The projects supported by this research direction should fulfill the Agreement of Data and Results Remittance of Scientific Research Projects in China Earthquake Science Experimental Field.

5. Exploration of gas geochemical characteristics mechanism and seismic prediction method in active fracture zones (D02, D03 or D04)

The application should aim at the transport mechanism and geochemical anomaly genesis of deep earth gases during earthquake incubation, surface flow observation, continuous observation by deep well observatory and isotopic composition analysis of gas samples are used in important active fracture zones in Sichuan and Yunnan regions, combined with high-temperature and high-pressure experimental techniques to reveal the differences in emission rates, spatial and temporal characteristics and subsurface sources of surface-released gases in fracture zones, and study the relationship between gas transport processes and subsurface temperature and pressure conditions, rock composition and stress loading, for establishing a gas geochemical-based

earthquake prediction method.

Note: The projects supported by this research direction should fulfill the Agreement of Data and Results Remittance of Scientific Research Projects in China Earthquake Science Experimental Field.

6. Research on real-time monitoring methods and evolution of non-tectonic earthquakes based on historical big data and artificial intelligence (D02 or D04)

Research on real-time monitoring methods for non-tectonic earthquakes such as explosions, landslides, collapses, oil and gas fracturing, and impact ground pressure, etc. Research on real-time seismic phase detection, source type identification, precise location determination, and source mechanism inversion methods based on historical big data and artificial intelligence to establish a better non-tectonic earthquake monitoring method system and provide support for effective monitoring of non-tectonic seismic events.

II. Seismotectonic and Seismogenic Environment

1. Seismogenic model of the western China foreland rupture zone (D02 or D04)

The application should focus on the complexity, multiplicity and hazards of strong earthquakes breeding, occurrence and rupture in the foreland rupture zone of the western China, construct a reasonable three-dimensional structural model of the foreland rupture zone by applying tectonic geology, geomorphology, chronology and geodesy, limit the spatial and temporal distribution of accumulated deformation of multiple strong earthquake cyclones (10,000-year-millennium scale), study the decadal-scale interseismic deformation field and isoseismic deformation field, explore the relationship between the present-day interseismic locking state, locking depth, stress-strain accumulation and fault sliding loss of the fault, and establish a seismic model of the foreland rupture zone.

2. Study on the activity habit and recurrence characteristics of major earthquakes in Sichuan-Yunnan region (D02)

The application should aim at the absence and incompleteness of near-surface seismic rupture relics of strong uplift erosion in Sichuan-Yunnan region, be based on the high-precision stratigraphic sequence and micro-geomorphic synergistic analysis technology to study the mutual relationship between strong erosion and micro-geomorphic formation near typical active ruptures, the complementarity and completeness of paleoseismic geological and geomorphic records, the geometrical structural features and sliding processes of ruptures, as well as seismic rupture segmentation and cascade rupture behaviors, for providing an in-depth understanding of seismic rupture habits and exploring strong earthquake recurrence models.

Note: The projects supported by this research direction should fulfill the Agreement of Data and Results Remittance of Scientific Research Projects in China Earthquake Science Experimental Field.

3. Research on microseismic detection and localization methods and deep and shallow deformation of active rupture zones in Sichuan and Yunnan (D02 or D04)

The application should aim at the problem of activity and deformation characteristics of deep and shallow parts of the seismically dangerous active rupture zones in Sichuan and Yunnan earthquake scientific experimental site, carry out comprehensive observations such as dense seismic arrays for developing microseismic detection, tremor signal detection and high-precision positioning technology and obtaining deformation characteristics of deep and shallow parts of the rupture zones, mechanical states, distribution of concave and convex bodies and their relationship with the medium structure to assess the strong seismic hazard of the rupture zones.

Note: The projects supported by this research direction should fulfill the Agreement of Data and Results Remittance of Scientific Research Projects in China Earthquake Science Experimental

Field.

4. Strain distribution patterns and interactions of different strike-activated ruptures (D02 or D04)

The application should aim to determine the spatial and temporal distribution of displacement and sliding rate of active ruptures based on the active tectonic research method, explore the strain distribution, tectonic pattern conversion and strong earthquake triggering relationship between active ruptures of different trends, and develop new methods and theories of seismic hazard analysis of the interaction between active ruptures of different trends.

5. Research on the prediction theory and technical methods of dormant volcano re-eruption (D02, D03 or D04)

The application should be based on the special tectonic background of volcanic activity in mainland China, carry out research on deep tectonic and dynamical processes of volcanoes, characteristics and causal mechanisms of seismic activity in volcanic regions, present-day activity status of dormant volcanic magma houses and risk assessment of volcanic eruptions, and develop prediction theories and technical methods for re-eruptions of dormant volcanoes for providing theoretical basis and technical support to volcanic eruption prediction, early warning and disaster emergency response.

III. Fundamentals of Seismic Resilience Technology Applications

1. Key issues of seismic safety of civil engineering infrastructure through/across faults (E08, E09 or E11)

The application should aim at the cross-fault safety and disaster mitigation needs of civil engineering structures and infrastructure construction crossing or spanning faults to carry out research on the dynamic characteristics of fault surfaces and the relative motion law between fault surfaces during earthquakes, the mechanism and characterization parameters of fault misalignment, and reveal the load model of civil engineering structures with fault misalignment and the damage action and disaster-causing mechanism for providing theoretical and technical basis for the analysis and design of large civil engineering structures crossing/spanning faults.

2. Study on the simulation of quasi-real-time ground shaking field based on time evolution process (D04)

The application should focus on the different demands on the accuracy and timeliness of the ground shaking field at different stages during and after the earthquake, using the ground shaking observation records, be based on the methods of source inversion, numerical simulation, artificial intelligence and big data analysis and the method of rapid matching of source templates, carry out research on the ground shaking field prediction method based on the source characteristics, real-time ground shaking and earthquake warning, and the rapid generation method of the ground shaking field integrating the ground shaking observation and seismic wave propagation process, so as to reveal the characteristics and spatial distribution law of strong shaking, explore the model and method of prediction, warning and rapid reporting of the quasi-real-time ground shaking field based on the time evolution process, as well as carry out demonstration applications.

3. Research on seismic effects of building nonstructural components design based on seismic toughness (E08, E09 or E11)

The application should aim at the seismic design of building structures and their functional non-structural systems that have been developing rapidly in recent years in the process of urbanization, study the effects of multiple factors such as site type, ground vibration characteristics, structure type, ductile energy dissipation capacity of non-structural components, etc., research on the seismic response amplification laws of multi-story structural floors of different lateral force resistance systems, single-point independent and multi-point distributed non-structural systems, and

establish a floor seismic action determination method that is suitable for the seismic performance of non-structural components of buildings and to ductile design needs in China for providing the foundation for the development of a new generation of building seismic ductile design theory.

4. Research on urban and rural seismic hazard resilience evaluation based on seismic monitoring and structural arrays (E08, E09 or E11)

The application should aim at the high complexity, importance and vulnerability of urban and rural engineering systems, develop efficient and refined simulation technology and dynamic evaluation theory based on earthquake monitoring and structural table array, study typical important building damage identification and early warning methods, realize dynamic monitoring, rapid early warning, accurate prediction and evaluation of urban and rural earthquake hazards, and establish a resilience evaluation system related to sustainable social and economic development.

5. Study on seismic safety assessment of non-bedrock nuclear power plant sites (E08, E09 or E11)

The application should view the seismic safety needs of China's nuclear power plant site expansion from bedrock sites to non-bedrock sites, study the characteristics of the ground vibration wave field of complex non-bedrock sites under different seismic environments, propose the mechanism and analysis method of the non-linear dynamic interaction of site-foundation-structure, carry out the site sensitivity analysis and safety assessment of the dynamic response of non-bedrock sites and nuclear island structures, and provide a basis for the site selection and construction of inland nuclear power plants in China.

Joint Fund for Smart Grid

The Joint Fund for Smart Grid is jointly founded by NSFC and State Grid Corporation of China. The aim for this Joint Fund is to give full play of the NSFC's guiding role in the researches; enhance the combination among the industry, academia and research; attract and mobilize the excellent science and technology resource in society to carry out the fundamental and cutting-edge researches to fulfil the national energy requirement; promote the self-innovation capability and core competitiveness in Chinese power industry.

In 2021, this Joint Fund plans to fund two types of projects, namely Integration Project and Key Project. The funding period should be uniformly filled as "January 1, 2022 to December 31, 2025". The integration project has an average direct funding of 12 million yuan per project for 4 years; and the key project has an average direct funding of 2.6 million yuan per project for 4 years.

I. Integration Projects

The applicant may submit proposals in any of the following two funding areas and decide the title and research plan for the project independently.

1. Commutation principle, novel fully-controlled devices and key technologies of commutation failure mitigation for DC transmission system

Research area: DC transmission system and DC grid

Research purpose and significance: Commutation failure is one of the most important factors threatening the safety of multi-infeed DC systems. However, due to the inherent characteristics of thyristors, it is difficult to significantly reduce the risk of commutation failure by the existing conventional methods. Therefore, the project should propose a novel commutation principle by adding some fully-controlled devices to the conventional line-commutated converters. It aims to achieve auxiliary commutation and forced commutation. The project should carry out

research on the parameter adjustment method of the large-capacity reverse blocking fully-controlled devices, and the hybrid topology control method based on fully-controlled devices and thyristors. Then not only the commutation failure mitigation is effectively suppressed, but also the safe operation level of multi-infeed DC systems is greatly improved.

Scientific Objects: Achieve breakthrough of the theoretical and technical bottlenecks in the research and development of large-capacity reverse blocking fully-controlled devices. Establish an accurate and fast simulation model of the reverse blocking fully-controlled device, and propose a fast analysis method. Reveal the failure mechanism of the reverse blocking fully-controlled device. Propose the analysis, optimization and adjustment methods of key parameters involving device structure, process and package. Develop a novel type of large-capacity reverse blocking fully-controlled device. On this basis, put forward a novel commutation principle and a hybrid topology including fully-controlled devices and thyristors. Propose the electro-magnetic transient and multi-physical field analysis and suppression method of the converter based on the hybrid topology including fully-controlled devices and thyristors. Develop a 100 kV level converter valve based on the new topology, providing theoretical foundation and technical support of the development and large-scale application of converters mitigating commutation failure.

Main research contents:

(1) Accurate and fast simulation modeling and analysis method of the reverse blocking fully-controlled device;

(2) Parameter optimization, adjustment method and development of large-capacity reverse blocking fully-controlled device;

(3) Research on the hybrid commutation principle, topology and control method based on the fully-controlled devices and thyristors for commutation failure mitigation;

(4) Multi-physical fields analysis and valve development of the novel converter based on hybrid topology including fully-controlled devices and thyristors.

2. Fundamental analysis theory and control method for transient stability of AC-DC hybrid system with significant penetration of renewable generation

Research area: Bulk power system operations

Research purpose and significance: The greater penetration of renewable generation and large capacity HVDC interties have introduced a significant change to the physical structure of traditional power system, further the controls of the above power electronics devices have fundamentally altered the system dynamic behavior and transient stability mechanism. The electro-mechanical time-scale flux dynamics interactions in traditional systems, supplemented with the electro-magnetic time-scale switching operations of rigid power electronics controls, excited complex transient behaviors in an AC-DC hybrid system disturbed by a fault, the dynamic behavior of the system is very hard to be characterized; Power electronic devices have changed the operating environment of voltage/frequency regulation of power systems, its fast controls and LVRT strategy interwind with system response, making it difficult to understand the transient stability mechanism of AC-DC hybrid systems, and uneasy to categorize the dominant instability form; the high controllability and low disturbance immunity of power electronics devices suggest that, the existing stability control methods can hardly meet the systematic stability control requirements of random changing of fault patterns and multi-time scale and across region coupling of transient processes. This project is determined to investigate the transient stability analysis theory of AC-DC hybrid systems with greater penetration of renewable generation, and to study the stability control methods with consideration to the re-design of power electronics devices, the project is about to develop technology and control methods to provide theoretical foundations and technical support for power systems under energy structural transition.

Scientific Objects: Establish dynamic characteristics description and efficient simulation

method for AC-DC Hybrid System with significant penetration of renewable generation; Reveal the physics-theoretic mechanism and dominant instability behavior of transient stability, develop theory and accurate evaluation method for transient stability; Based on different transient stability objectives, recommend evaluation method for power electronics devices re-design procedure and multi-hierarchy system control method.

Main research contents:

(1) Transient process high-fidelity modeling and efficient simulation for AC-DC Hybrid System with significant penetration of renewable generation;

(2) Transient stability physics-theoretic mechanism and dominant instability characteristics of AC-DC Hybrid System with significant penetration of renewable generation;

(3) Transient stability analysis and accurate evaluation method for AC-DC Hybrid System with significant penetration of renewable generation;

(4) Power electronics device re-design and multi-hierarchy stability control method for AC-DC Hybrid System.

II. Key Projects

The applicant may submit the proposal in any of the following 16 funding areas and decide the title and research plan for the project independently.

(1) Fault characteristic analysis method and relay protection principle of the high-proportion renewable energy power system;

(2) Basic theory and enhancement ways for power grid resilience;

(3) Failure mechanism and failure evolution of solid insulation under pulsed electric field;

(4) Energy internet multi-parameter sensing and intelligent perception theory and method;

(5) Situation awareness and cooperative interaction mechanism of AC and DC power distribution system;

(6) Theory and methods of intelligent dispatch for massive flexible resources in regional power grid;

(7) Theory and method on warning and defense of power system extreme events;

(8) Power transformer mechanical and thermal stability analysis and monitoring considering accumulation effect;

(9) Research on packaging materials and process of high temperature high voltage SiC power electronic devices;

(10) The analysis method on the evolution of power grid cyber physical system;

(11) Theories and methods of side-cloud collaborative computing and data security and credible sharing of power internet of things;

(12) Coordinated planning and optimized operation of regional energy internet;

(13) Energy internet cyber-physical cross-domain attack security early warning theory and method;

(14) Theory and approach for analysis of short circuit current in the power system with high penetration of power electronics in source, grid and load;

(15) Basic theory and key technology of novel DC power flow controller;

(16) Theory and method of dynamic allocation of power internet of things resources.

Joint Fund of Nuclear Technology Innovation

The Joint Fund of Nuclear Technology Innovation is jointly set up by NSFC and the China

National Nuclear Corporation. The Fund is aimed to maximize the guiding effect of the National Natural Science Fund, attract and mobilize researchers across China, strengthen basic research on leading technologies that meet the national strategic need of nuclear technology, promote the sustainable development and the improvement of independent innovation capacity of the nuclear industry.

In 2021, the Joint Fund of Nuclear Technology Innovation is going to support a number of Key Program Projects. Average funding (direct costs) for each project will be 2.8 million for 4 years. The funding period is from January 1, 2022 to December 31, 2025.

1. The structure of exotic nuclei and related detection techniques (A27)

The internal structure of exotic nuclei, and the experimental methods to generate exotic nuclei; accurate measurement of energy, lifetime and mixing ratio for gamma transitions of excited nuclear states.

2. Theory and experiment of unstable nuclear reaction mechanism (A27)

Mechanism of transfer reactions and fragmentation and spallation reactions in the unstable nuclear reaction; the energy level properties of the excited states of the unstable nuclear reaction products; the detector array technology with large solid angle coverage.

3. Detection methods of fission debris and in-beam nuclear spectroscopy of fission products (A27)

Advanced fission debris detection methods; coincidence measurement technology of fission debris and fission prompt gamma rays, nuclear data measurement of fission products and fission mechanism.

4. Theory of nuclear yield analysis of fission products (A27)

Physical theory and experiments on fast neutron induced fusion of Th-232, U-238; theoretical research on fission product nuclear yield, kinetic energy and fission neutron spectrum distribution; evaluation and uncertainty analysis method of fission yield; physical correlation research of multiple post-fission observations based on AI.

5. Mechanism of proton acceleration driven by ultra-fast and ultra-intense laser (A28)

Theoretical simulation of the mechanism of proton acceleration driven by ultra-fast and super-intense laser; experiment of high current quasi monoenergetic proton beam driven by ultra-fast and super-intense laser; research on ultra-fast proton radiography.

6. Principles of beam matching of high power cyclotron and FFAG (A28)

Research on parameter matching between MW-level high power proton cyclotron and isochronous FFAG accelerator; transverse and longitudinal beam matching technology of high power FFAG and cyclotron; space charge effect and beam loss control technology in high power beam matching process.

7. Physical mechanism of fast ion energy deposition and transport in fusion plasma (A29)

Research on fast ion energy deposition location and transport process in high performance fusion plasma (plasma current greater than 1mA, normalized beta $\beta N > 2.5$); high time resolution ($< 10\ \mu s$) fast ion spectral imaging.

8. Refined real time calculation method of external radiation dose (A30)

The pose deformation method of the panel model based on the principle of differential mapping, the automatic adjustment method of the panel model under the guidance of motion capture; the direct calculation theory of the panel model based on tetrahedron partition, the parallel algorithm of Monte Carlo GPU.

9. Mechanism of high efficiency and high resolution two dimensional position sensitive semiconductor neutron detection (A28 or A30)

The physical model of neutron nuclear reaction and charge collection of dual-sided

microstructured semiconductor neutron detectors; the influence of neutron conversion material, microstructure size and electrode pattern on the detection efficiency and two-dimensional position resolution of the detector; the method and algorithm of limit position resolution.

10. Micro-scale dosimetry mechanism of ionizing radiation in semiconductor materials (A30)

The energy deposition efficiency of ionizing radiation in micro-scale semiconductor materials and its influencing factors; the interaction mechanism and screening method between ionizing radiation and semiconductor materials in micro area; the cell-scale radiation dose characterization and tissue equivalent pattern of semiconductor materials.

11. Detection imaging method of nuclear fuel fission products under nuclide interference (A30)

The key factors and mechanism of nuclide interference on detection system in strong radiation environment; the nuclide interference suppression technology of fission products of nuclear fuel; the dynamic calibration and imaging reconstruction method of detector.

12. Mechanism and assessment method of radiation damage of new photoelectric devices such as CCD and LED (A30)

The damage mechanism of CCD in radiation environment; the damage assessment method of CCD in radiation environment; the displacement damage mechanism of LED in radiation environment; the damage assessment method of LED in radiation environment.

13. The calculation methods and application of neutronics for new reactors (A27 or A28)

The full-spectrum neutron-photon coupling transport, burnup calculation and nuclear design method under complex physical fields; ultra-fast and high-precision neutronics calculation methods based on deep learning.

14. Boiling critical and bubbling characteristics in narrow channel with local concentration of heat flux (A28)

The critical characteristics of high-temperature and high-pressure boiling under local concentration of heat flux; temperature distribution and its influence on bubbling mechanism and threshold of the critical front wall ; the local multiphase conjugate coupling heat transfer mechanism near bubbling location.

15. High precision prediction method and evolution of PWR Core behavior under high burnup and complex transient conditions (A28)

The high precision numerical calculation and efficient parallel algorithm of physical-thermal-fuel-system numerical values; the coupling mechanism of multi-level and multi physical fields such as the neutron field, temperature field, stress field, hydrochemical field and flow field, and the evolution pattern of reactor core; the uncertainty transfer mechanism and comprehensive verification of multi physics coupling numerical calculation under high burnup and complex transient conditions.

16. Generation mechanism and behavior of radioactive dust in high temperature gas cooled reactor (A28)

The formation mechanism and composition characteristics of radioactive dust in high temperature gas cooled reactor loop, the transport and deposition behavior of radioactive dust in high temperature gas cooled reactor loop, and the interaction behavior between dust and typical nuclides.

17. Key scientific issues of novel silicon micro strip detector based on heterojunction (A28)

The modulation mechanism of work function and band gap of heterojunction thin film materials; the design and simulation of device structure of two-dimensional heterojunction silicon

micro strip; the carrier transport mechanism of heterojunction silicon micro strip; the research and development of large area silicon micro strip detector and integrated front-end electronics; the electrical characteristics and anti-radiation performance of heterojunction detector.

18. The analysis, prediction and optimization of human performance under severe accidents in nuclear power plants (A28)

Human performance prediction, cognitive load assessment and simulation methods under severe accidents; cognitive and behavioral characteristics, typical failure modes and impacts of operators under high pressure; metacognition and group decision-making model and influencing factors of distributed teams; analysis technology and optimization methods of system task, communication and information network in severe accidents.

19. Theory and method of multi field coupling extraction of uranium and thorium (B06)

The coupling method of physical and chemical fields such as magnetic field, electric field and ultrasonic wave; the competitive coordination ability, the equation of stability state and the stability transformation mechanism of uranyl ions ; the solid-liquid reaction mechanism and migration behavior of uranium and thorium in the physical-chemical coupling environment.

20. Phase reconstruction of glass/ceramic solidification at high temperature high level liquid waste (B06)

The mechanism of "cold cap" reaction of glass/ceramic solidification of high level liquid waste; the phase reconstruction mechanism in the process of glass/ceramic solidification of high level liquid waste calcinate; and the control of high-temperature phase reconstruction process of high level liquid waste.

21. Solid phase adsorption of nuclide ions in molten salt (B06)

Solid phase adsorption behavior of high temperature resistant adsorbent for neptunium, plutonium and other nuclides in molten salt; the bonding mechanism of the adsorbent and radionuclides; the purification and treatment of molten salt by solid phase adsorption method.

22. The dissolution method and mechanism of new nuclear fuels such as carbides and nitrides (B06)

The analysis and mechanism of dissolution products of new nuclear fuels; the dissolution method of new nuclear fuels.

23. Theory and verification of high temperature metallurgical separation of actinides in spent nuclear fuel (E04)

The design and verification of technical route of high temperature metallurgical separation of actinides and other fission products in spent nuclear fuel.

24. Creation of new extractants and the extraction behavior of actinides and fission elements (B06 or B08)

The design, synthesis and characterization of new extractants; the extraction behavior of actinides and fission elements; new separation method of actinides in reprocessing.

24. Preparation, properties and application of actinide cluster compounds in nuclide recovery (B01, B05 or B06)

The preparation methods of actinide cluster compounds; the structure and properties of actinide cluster compounds; applied basic research based on cluster compounds.

26. Preparation and biological effect of radionuclide medicine and protective medicine (B06 or B07)

The preparation, separation and application of radiopharmaceuticals for diagnosis and treatment of major diseases; the design, synthesis and performance of drugs removing radionuclides.

27. Multi scale damage characteristics of carbon fiber composites under high stress

(E02, E03 or E13)

The macro damage evolution pattern of carbon fiber composites under high stress (greater than 1 500 MPa); the propagation pattern and mechanism of meso defects and damage; and the correlation between macro damage and meso damage.

28. Interface behavior and mechanism of low temperature diffusion bonding of zirconium based fuel cladding (E01, E04 or E05)

The interface dynamic behavior distribution of zirconium based fuel cladding at low temperature induced diffusion; the effect of quantitative introduction of inducers on the interface void closing; the interface bonding mechanism and the action mechanism of low temperature induced diffusion.

29. Radiation damage and service performance of non-oxide ceramic fuels (E02 or E13)

The radiation defects and microstructure evolution pattern of non-oxide ceramic fuels such as uranium nitride, uranium silicide or composite fuels; mechanism of migration, aggregation, swelling and release of fission gas; and the evolution mechanism of thermal and mechanical properties under radiation.

30. Interface sealing technology of heterogeneous inorganic-metal materials in radioactive medium (E01, E02, D04, E05 or E13)

The microstructure control of ceramic-metal and glass-metal heterogeneous interfaces under the condition of high temperature, high pressure and high radioactivity helium fluid; the generation and evolution mechanism of heterogeneous interface defects and their influences on service life; the helium molecular sealing mechanism, stress relaxation and detection mechanism of heterogeneous interfaces.

31. Radiation resistant and high temperature insulation acoustic materials (E02, E03 or E13)

The structure modelling and optimization of multi-media composite acoustic materials; the collaborative regulation mechanism of high-temperature insulation and damping energy consumption of multi-media composite acoustic materials; the structure design technology of radiation resistant high-temperature insulation acoustic materials and the coupling characterization technology of material properties.

32. Radiation damage behavior of nuclear magnesium alloy (E01 or E13)

The irradiation damage behavior and microstructure evolution of magnesium and magnesium alloy; influences of the composition and structure of heat-resistant magnesium alloy on the diffusion and migration behavior of fission gas; the mutual diffusion behavior of elements in magnesium/aluminum interface under irradiation environment, the interaction between irradiation defects and interface; the influences of irradiation defects on the thermal and high temperature mechanical properties of magnesium alloy.

33. Preparation of high performance polymer adsorbents by irradiation and the separation performance of high performance polymer adsorbents (E03 or E13)

The design and radiation synthesis mechanism of high-performance polymer adsorbents; the structure-activity relationship and mechanism of the adsorbents for the separation of radioactive strontium and cesium and harmful heavy metal ions such as cadmium, chromium and lead.

34. Migration and enrichment mechanism of uranium, molybdenum, selenium, rhenium and organic matter in sandstone type uranium deposits (D02 or D03)

The spatial distribution pattern and forms of uranium, molybdenum, selenium and rhenium in different zones of sandstone uranium deposits; the occurrence state of organic matter in different geochemical zones; the conditions, experiment and mechanism of co-migration, enrichment and precipitation of organic matter and uranium, molybdenum, selenium and rhenium.

35. The theory and method of precise dating of sandstone uranium deposits (D02 or D03)

The theory and approach of open system dating; accurate positioning of uranium mineral targets for sandstone dating; and calibration technology for sandstone uranium dating.

36. Migration mechanism of radionuclides in groundwater (D02, D03 or D07)

The factors and mechanism of the influence of three-dimensional circulation of groundwater on radionuclide migration; numerical simulation method of nuclide non-uniform convection dispersion process in groundwater.

37. Coupling mechanism of physical-chemical flow field for in-situ leaching of uranium in deep sandstone uranium deposits (D02 or D03)

The physical and chemical characteristics of deep sandstone uranium deposits; the method and mechanism of reservoir reconstruction for deep and low-permeability sandstone uranium deposits; and the coupling mechanism of seepage field-dispersion field-leaching field in in-situ leaching of deep sandstone uranium deposits.

38. Production and service performance of viscoelastic composite cladding (E01, E02, E03, E05 or E13)

The viscoelastic model of composite materials; modal characteristics of composite viscoelastic tubes; stability of composite viscoelastic tubes under long-time and high stress.

39. Mechanism of uranium/rare earth-associated mining resources and mechanism of processing and smelting polymetallic ores (D02)

Test and extraction of genetic characteristics of uranium/rare earth-associated polymetallic ores; factors and mechanism affecting mineral separation and leaching outcome; the influencing factors and mechanism of the separation and extraction of useful metals from complex leaching solution of polymetallic ore.

NSFC-Yunnan Joint Fund

The third phase of the NSFC-Yunnan Joint Fund is jointly established by NSFC and the Yunnan Provincial Government for the period from 2018 to 2022. It aims at maximizing the guiding effect of the National Natural Science Fund, attracting and bringing together talented scientists across the country to carry out basic research on important scientific issues and key technical problems that are closely related to the socio-economic and S&T development of Yunnan and surrounding regions, boosting the development of science and technology and the growth of scientific talents in Yunnan, improving the indigenous innovation capability and international competitiveness of universities and research institutes of Yunnan and promoting the sustainable development of regional economy and society.

In 2021, the NSFC-Yunnan Joint Fund calls for proposals of "Key Program Project" in the following priority research areas. Average funding (direct costs) for each project will be 2.4 million for 4 years. The NSFC-Yunnan Joint Fund is open to all researchers across China. Qualified researchers all over the country are welcomed to apply for this fund according to the research scope and requirements listed in this *Guide*.

I. Biodiversity conservation (L06)

i. Biodiversity

Priority research areas:

1. Exploration and protection of important biological resources in Yunnan (subject

reference code 2: C01, C02 or C04)

Proposals are expected to carry out multi-level and in-depth rescue investigations on the diversity of important biological resources in Yunnan and surrounding regions, establish key technologies and resource database for the monitoring and protection of biodiversity, analyze the biodiversity status, resources details and endangerment causes, explore the ecological and economic value of biological resources, and provide a scientific basis for the protection and sustainable utilization of biological resources.

2. Causes and maintenance mechanism of biodiversity in Yunnan (subject reference code 2: C03)

Proposals are expected to explore the relationship between biodiversity pattern and environmental factors in Yunnan in modern time and key periods of the geological history, study the relationship between biodiversity and ecosystem functions in key areas such as Gaoligong Mountain, analyze the mechanism of species formation and differentiation, interaction and co-evolution among species, and provide scientific support for the understanding of the causes and maintenance mechanism of biodiversity in Yunnan.

3. Adaptive evolution mechanism of species in the mountainous area of Southwest China (subject reference code 2: C03 or C06)

Proposals are expected to focus on the important biological species in the mountainous area of Southwest China, carry out multi-level and multidisciplinary research of the adaptation mechanism of species to special and extreme environment and the evolution mechanism of biological species differentiation and adaptive radiation, analyze the genetic basis of the evolution of important traits related to environment adaptation, and provide scientific evidences for the protection of regional species diversity.

ii. Agricultural and forest resources

Priority research areas:

1. Exploration and utilization of genes of key traits of important agricultural and forestry biological resources with distinctive characteristics in Yunnan (subject reference code 2: C01, C02, C04, C13, C15, C16, C17 or C19)

Proposals are expected to focus on the main crops and their wild related species, important forests and grasses, characteristic crops (flowers, fruits, vegetables, sugarcane, tea, traditional Chinese medicine, etc.), important livestock and poultry, aquatic resources, insect resources, and microbial resources, explore high-quality or characteristic germplasm resources, and study the genetic basis, regulation mechanism and quality formation mechanism of key traits (including functional metabolites).

2. The catastrophic mechanism and prevention and control strategy of important pests in agriculture and forestry in Yunnan (subject reference code 2: C14 or C19)

Proposals are expected to focus on important pests of agriculture and forestry in Yunnan, study the invasion process and catastrophic mechanism, the competitiveness of local species and pest alternative control mechanism, green prevention and control mechanism and restoration strategy, so as to provide a theoretical basis for the comprehensive management optimization and biosafety maintenance of important agricultural and forestry pests to ensure the ecological security of Yunnan.

3. Functions and the functioning mechanism of important agroforestry ecosystems in Yunnan (subject reference code 2: C03)

Proposals are expected to focus on Yunnan’s important agroforestry ecosystems and provide theoretical support for the function maintenance and restoration and improvement of important agroforestry ecosystems in Yunnan. Topics includes: advantages and mechanisms of the composite model of different species in the ecosystem; the influence mechanism of the interaction among

crops, soil, insects, and microorganisms on the ecological adaptability of agroforestry biological resources; the ability and mechanism of different models of agroforestry ecosystems to adapt to extreme climate.

4. Quality formation and control mechanism of agricultural and forestry products with distinctive characteristics of Yunnan (subject reference code 2: C20)

Proposals are expected to focus on the quality, flavor and food safety in the processing of agricultural and forestry products with distinctive characteristics of Yunnan, and provide theoretical support for the development of green food industry in Yunnan. Topics include: basic research on the change of chemical composition and flavor formation, the transformation of active factors, microorganisms regulation, and the control of food safety in the processing of agricultural and forestry products with distinctive characteristics.

II. Population and health (L02)

i. Basic and applied basic research on the discovery of active substances and development of vaccines aiming at promoting life and health and controlling major human diseases using resources with distinctive characteristics in Yunnan

Priority research areas:

1. Discovery, formation mechanism, structure optimization, green synthesis, function and pharmacological mechanism of active substances of biological resources with important medicinal value in Yunnan (subject reference code 2: H34 or H35)

Priority will be given to interdisciplinary research and application of new theories, technologies and methods. Basic research on the discovery of innovative drugs in Yunnan is encouraged, in particular in-depth study of natural active products and their analogues from Yunnan's biological resources with good preliminary research basis. However, research on the pre-approval standardization and pharmaceutical process of new drugs is not qualified for funding.

2. Applied basic research on innovative vaccines with distinctive characteristics in Yunnan (subject reference code 2: H11)

Proposals are expected to address the scientific issues and key technologies of vaccines of COVID-19 and infectious diseases of Yunnan and carry out applied basic research using Yunnan's unique experimental animals. Under the premise of ensuring biosafety and abiding by scientific ethics, priorities will be given to basic research with good transformation prospects, especially to innovative vaccines of the important infectious diseases affecting multi-age groups.

3. Active components and pharmacological mechanism of Chinese traditional medicine (ethnic medicine) with distinctive characteristics in Yunnan (subject reference code 2: H32)

Proposals are expected to study the active components and pharmacological mechanism of Chinese traditional medicine (ethnic medicine) of Yunnan using multidisciplinary theories, methods, techniques and means based on the theory and practices of traditional Chinese medicine (including ethnic minority traditional medicine), under the premise of ensuring clinic efficacy.

4. The conservation and sustainable utilization of medicinal animals and plants with distinctive characteristics in Yunnan (subject reference code 2: H32)

Topics include: the introduction, selection and breeding of medicinal animals and plants; the establishment of standardized breeding and planting techniques; the discovery of alternative resources.

ii. The pathogenesis, prevention and treatment of high-incidence diseases and major diseases in Yunnan

Priority research areas:

1. Researches on high-incidence diseases, endemic diseases, genetic diseases, drug addiction and withdrawal in Yunnan (subject reference code 2: H)

Topics include: the epidemiological characteristics and pathogenesis of the high-incidence diseases, endemic diseases, genetic diseases, and drug addiction; key therapeutic targets, early diagnostic markers, prognostic factors; new drugs, new interventions and translational medicine research from bench to the bedside.

2. The pathogenesis, diagnosis, prevention and treatment of major infectious diseases in Yunnan and cross-border regions (subject reference code 2: H21, H22 or H30)

Topics include: applied basic research on the epidemiological characteristics, pathogenesis, comprehensive control and long term impact on human body of major infectious diseases and their complications that seriously threat Yunnan, Southeast Asia and South Asia subcontinent; the identification, diagnosis and control of pathogens and pathogen vectors of new and emerging infectious diseases.

3. Construction and pathogenesis of Yunnan characteristic experimental animal models of major diseases (subject reference code 2: H)

Proposals are expected to construct major disease models, develop gene editing technology and methods for animal model construction, study the pathogenesis and interaction with environmental factors of major diseases such as Alzheimer's disease, Parkinson's disease, autism, and other new cognitive diseases, and major infectious diseases like COVID-19 using Yunnan characteristic experimental animals (non-human primate).

III. Comprehensive utilization of mineral resources and new materials (L07)

i. Exploitation and utilization of complex mineral resources and secondary resources

Priority research areas:

1. Green exploitation of Yunnan's dominant minerals and secondary resources such as aluminum, silicon, titanium, lithium, zinc and precious metals (subject reference code 2: E01, E02 or E04)

Proposals are expected to develop and improve basic of new technologies in mineral resources processing and metallurgy. Topics include: high-efficiency recovery and utilization of complex zinc oxide resources, exploitation of carbonate-hosted clay-type lithium deposits, beneficiation and metallurgy of low-grade bauxite resources, ZnO mineral materials in zinc concentrate, and comprehensive recovery of secondary resources of germanium and rare and precious metals.

2. Construction of database and intelligent metallurgy technology of aluminum, silicon, copper, tin, indium, germanium and other nonferrous metals with Yunnan characteristics (subject reference code 2: E01, E04 E06 or E13)

Proposals are expected to establish new material parameter database and professional database of the rich mineral resources in Yunnan such as tin and indium based on high-throughput experiments and calculations using intelligence and information technology, achieve breakthroughs in the theoretical and technical problems of "data perception, decision optimization and intelligent control" of the metallurgical process of non-ferrous metals, and solve the problems of high energy consumption and long cycle of material research and development.

ii. New materials and devices

Priority research areas:

1. Preparation and application of high-efficiency and low-cost silicon based solar cells, fuel cells and energy storage materials (subject reference code 2: E01, E02, E03, E04, E06 or E13)

Proposals are expected to carry out basic and applied basic research of new energy storage materials, new photoelectric materials, new energy battery materials, solve the key scientific problems of material design and structure, improve the energy conversion efficiency and energy

storage performance, and realize the comprehensive utilization of energy storage materials and devices in low latitude plateau areas.

2. The design, preparation and application of high-efficiency catalytic materials of precious metals and rare earth (subject reference code 2: E01, E02 or E13)

Proposals are expected to study the surface/interface effect of noble metal-oxide catalytic material system, solve the problem of low utilization of near-infrared light by photocatalytic materials, develop high-efficiency and low-cost noble metal catalysts, and provide new methods, new materials and new devices for the research and development of complete solar spectrum-responsive and high-efficiency photocatalytic materials.

3. The design, preparation and application of aluminum matrix co and other nonferrous metals and rare and precious metal composites (subject reference code 2: E01, E04 or E13)

Topics include: the evolution mechanism of microstructure of high entropy alloy under rapid solidification condition, the relationship between laser forming process, microstructure and performance control mechanism of high entropy alloy; the design, preparation and application of aluminum based, copper based and tin based nonferrous metal alloys based on thermodynamic calculation and composition optimization design; the thermal/dynamic mechanism of isothermal/non-isothermal stress aging, precipitation behavior of alloys, the mechanism of strengthening and toughening in the presence of multi structure precipitates, the controlled forming technology of ultra-light, high-strength and toughness advanced alloy thin trip.

IV. Resources and environment (L03)

i. Exploitation and utilization of resources and its environmental effects

Priority research areas:

1. The metallogenic mechanism and new exploration methods of mineral resources with distinctive characteristics of Yunnan (subject reference code 2: D02 or D03)

Proposals are expected to explore the universality and uniqueness of Yunnan's metallogenic system, reveal the deep structure and metallogenic dynamic process of the metallogenic systems with different geological structural background, establish metallogenic and prospecting models of deep minerals and new exploration methods, and provide the scientific support for the increase of resource reserves.

2. Environmental effects and ecological protection of major engineering construction and resource exploitation and utilization in Yunnan (subject reference code 2: D01, D02, D03 or D07)

Proposals are expected to study the multiple impacts of engineering construction on the complex ecological environment in Yunnan, reveal the environmental effects and ecological response mechanism of engineering activities, and provide scientific support for the reduction of adverse ecological environmental effects.

ii. Restoration and treatment of damaged environment

1. Environmental problems and ecological restoration of lakes and rivers in Yunnan Plateau (subject reference code 2: D01, D04 or D07)

Proposals are expected to study the complex eco-environmental problems of lakes and important rivers in Yunnan Plateau under the influence of human activities, including ecological degradation, environmental pollution and biodiversity loss, reveal the interaction mechanism and dominant factors, so as to provide theoretical support for lake management and river ecology maintenance.

2. Environmental effects of production activities in high element background value areas in Yunnan province and early warning of risks (subject reference code 2: D01, D03 or

D07)

Proposals are expected to study the influences of regional industrial and mining activities and agricultural production on the biogeochemical cycle process of important elements, analyze the environmental effects and action mechanism of such activities, and search for new approaches for early warning, prevention and control of environmental risks.

3. Environmental characteristics of dry-hot valleys in Yunnan province and the interaction mechanism between dry-hot valley and human activities such as water pumping (subject reference code 2: D01 or D07)

Proposals are expected to focus on the ecosystem of dry-hot valleys in Yunnan province, study the interaction between environmental characteristics and human activities such as water pumping, and the mechanism of ecological maintenance and restoration, so as to provide scientific support for the maintenance, restoration and early risk warning of typical ecosystems in the ecologically fragile areas of dry-hot valley.

iii. The responses and adaptation of the mountain environment in Yunnan Plateau to global change

1. Occurrence mechanism, monitoring and early warning, prevention and control of natural disasters in mountainous areas of Yunnan province (subject reference code 2: D01, D02, D04, D05 or D07)

Proposals are expected to study the natural and human factors inducing meteorological disasters, flood, earthquake, landslide, debris flow and forest fire, reveal the disaster mechanism of frequent disasters in recent years such as drought, fire, and geological disasters, and provide scientific support for the monitoring, early warning and control disaster sources.

2. Response and feedback of Yunnan ecosystems to global change (subject reference code 2: C03)

Proposals are expected to analyze the ecological response characteristics of typical forest ecosystems and important wetland ecosystems in Yunnan, study the productivity change and ecosystem function maintenance mechanism of main forest and wetland ecosystems, and provide scientific evidences for measures to deal with and adapt to global change.

NSFC-Shandong Joint Fund

The second phase of the NSFC-Shandong Joint Fund is jointly established by NSFC and the People's Government of Shandong Province (NSFC-Shandong Joint Fund) from 2017 to 2021. It aims at giving full play of the guiding role of NSFC, attracting and gathering outstanding scientists all over the country, promoting the development of Shandong Peninsula Independent Innovation Demonstration Zone and the Yellow River Delta Agricultural High-tech Industry Demonstration Zone, focusing on the basic research on the major S&T issues and key technology problems concerning the strategic development of economy, society and science and technology in Shandong Province and its surrounding areas. It tries to attract, cultivate, and gather groups of scientific talents to Shandong Province, enhance the independent innovation capability and international competitiveness of universities and research institutes in Shandong province, and promote the sustainable development of economy and society of Shandong province.

In 2021, NSFC-Shandong Joint Fund calls for proposals of "Key Project" with a direct funding of 3 million yuan per project for four years. Any eligible scientists and technicians over the country are encouraged to submit applications in accordance with research scope and requirements listed in this *Guide*.

I. Life Sciences

1. The eco-system study of the saline soil in the Yellow River Delta

Proposals should focus on the ecosystem restoration research, in particular from the perspective of the biological removal of salinization in the Yellow River Delta and the composition and function of the biological community in the wetland ecosystem of the saline alkali land, and provide scientific and technological support for the development and protection of the wetland in the Yellow River Delta. The main funding areas include:

(1) Ecological community and function of wetland ecosystem in the Yellow River Delta;

(2) Key technology and mechanism of biological improvement of the saline alkali land in Yellow River Delta;

(3) Biological removal and remediation techniques and mechanisms of salinization in the Yellow River Delta.

2. Breeding of new salt-resistant crops in the Yellow River Delta

In view of the natural status of soil salinization in the Yellow River Delta, proposals should use modern biological techniques to carry out the research on the molecular mechanism of crop salt tolerance and salt stress affecting crop quality as well as molecular marker assisted breeding, create excellent new germplasm and cultivate new crop varieties suitable for saline alkali land, and ensure food security in China. The main funding areas include:

(1) Molecular mechanisms of saline-alkali tolerance in crops and new germplasm.

3. Improving the quality and efficiency of mariculture

Based on the advantages of marine resources, proposals should focus on the conservation of germplasm resources of marine fish using modern biological technology, thus claiming the high ground of quality development while sparing no effort for the ocean development. The main funding areas include:

(1) Genetic analysis of excellent traits of dominant mariculture species and cultivation of new species;

(2) Regulation mechanism of nutrient metabolism of dominant species in mariculture.

II. Geosciences

1. Saline soil improvement in the Yellow River Delta

Based on the comprehensive treatment and utilization of saline-alkali land in the Yellow River Delta, proposals should focus on the study of the mechanism and key technologies concerning the saline soil improvement by use of engineering, agricultural, biological and chemical techniques, thus laying a geographical foundation for food safety and eco-security. The main funding areas include:

(1) Research on migration mechanism, effect and control technology of soluble matter in saline soil in the Yellow River Delta;

(2) Mechanism of nutrient enhancement in salinization farmland in the Yellow River Delta.

2. The protection mechanism of wetland ecosystem in the Yellow River Delta

Proposals should focus on the development and utilization of the resources in the region and the protection of the ecological environment, and carry out research on multi-scale ecosystems to provide scientific and technological support to improve the eco-value of wetlands in the Yellow River Delta. Main research areas include:

(1) Research on dynamic monitoring technology and ecological restoration mechanism of soil pollution in the Yellow River Delta;

(2) Research on the evolution and ecological protection mechanism of wetland in the Yellow River Delta;

(3) Research on remote sensing monitoring and forecasting atlas of soil salinization in the

Yellow River Delta;

(4) Analysis of pollution mechanism of pollutant particles in the Yellow River Delta.

3. The environment, ecology and climate of the Shandong offshore area

Proposals should focus on the major needs of offshore marine ecology and environmental protection and marine development in Shandong Province, conduct in-depth studies on the marine geological environment, the evolution of coastal ecosystems and disaster prevention and control, and provide scientific support for the ecological conservation and rational development of resources in the offshore area. Main research areas include:

(1) Environmental behavior and ecological effects of pollutants in Shandong coastal zone and offshore area;

(2) The evolution, regulation, evaluation and governance of Shandong coastal ecosystems in the context of human activities and natural changes;

(3) Research on the occurrence and control mechanism of typical disasters in Shandong coastal zone and offshore waters;

(4) Mechanism and prediction of marine environment and climate change in Shandong offshore area;

(5) Study on the evolution mechanism and increase of carbon sink in the typical ecological environment of Shandong coastal area;

(6) Groundwater-seawater interaction and its water resources and environmental effects;

(7) Corrosion mechanism and protection technology of Shandong marine environment.

4. Special mineral resources in Shandong

Proposals should focus on the formation mechanism and efficient and safe mining of characteristic mineral resources such as offshore gold mines, underground brines, oil and gas and geothermal heat in Shandong, conduct research on the basic theory of resource formation mechanisms and exploration and development technologies to provide scientific and technological support for the rational development of resources and industrial development. Main research areas include:

(1) Formation mechanism of special mineral resources in Shandong;

(2) Key technologies for exploration and exploitation of special mineral resources in Shandong.

5. Excavation and utilization of marine biological resources

Proposals should focus on the key technical bottlenecks in the transformation and upgrading of Shandong marine biological industry, contribute to the development and utilization of strategic resources of polar, oceanic and deep-sea marine organisms, as well as the development of biological products with high added value and independent intellectual property rights, thus comprehensively improving the utilization level of high-valued marine biological resources in Shandong and China. Main research areas include:

(1) Probe labeling and chemical sensing based on marine organisms and natural products;

(2) Microbial life process, active substance and resource utilization in extreme marine environment.

6. Marine environment monitoring technology

Proposals should focus on the common requirements for ocean observations of ocean environment elements with different characteristics in a complex ocean environment, and on the implementation of the “transparent ocean” major project, develop new theories, new technologies, and new methods suitable for target observation, information extraction and analysis with different characteristics, and carry out relevant research on key technologies. Main research areas include:

(1) New ocean observation technology for “transparent ocean”;

(2) Real-time online monitoring technology of the ecological environment of Shandong

coastal area.

III. Engineering and Materials Sciences

1. Marine environmental materials

Proposals should focus on the demand for key basic materials for engineering construction and resource development in the marine environment, conduct research on the design, preparation and application of new materials related to marine engineering equipment, marine engineering construction, marine monitoring, and resource utilization. Main research areas include:

(1) Research on high-performance metal materials and their adaptability to the marine environment;

(2) Design and preparation of high-durability marine engineering materials;

(3) Marine anticorrosive and antifouling materials and their applications;

(4) New materials, new technologies, and new methods for industrial water desalination;

(5) Development and application of key materials for deep-sea equipment.

2. Marine engineering

Proposals should focus on the needs of marine engineering construction in Shandong province, and carry out research on the application of modern engineering technology in subsea tunnels, coastal engineering and deep-sea platforms. Main research areas include:

(1) Integrated construction technology of ocean pasture and ocean energy development;

(2) Environmental catastrophe of coastal engineering and countermeasures for disaster prevention and mitigation;

(3) Marine structure construction and new detection/monitoring technology;

(4) Key technologies for surface forming and repairing of high-corrosion marine structures;

(5) Offshore floating platform and engineering equipment.

3. Marine equipment

Proposals should focus on the major needs for marine equipment regarding offshore oil and gas exploitation, efficient use of marine renewable energy, and seawater desalination, concentrate on the research of key and common technology, and provide support for the core technology for marine resource utilization, and breakthroughs in the independent design and manufacturing. In response to the common technical requirements of deep-sea equipment and underwater mobile equipment for energy supply and ocean energy conversion, develop core energy supply technologies that enable marine exploration equipment to have long-lasting endurance capabilities, and make breakthroughs in the technical bottleneck of efficient marine energy use. Main research areas include:

(1) Key technologies for the construction of offshore oil and gas production and transportation platforms and the manufacturing of main components;

(2) Key technologies for manufacturing composite materials for core components of marine equipment;

(3) Underwater vehicle/lander structure design and key technologies for high-precision and reliable operation;

(4) Large-capacity direct-drive electric propulsion technology of marine equipment;

(5) Marine energy supply and transmission of deepwater equipment.

IV. Particle physics

1. Experimental research on Alpha Magnetic Spectrometer (AMS)

AMS is located on the International Space Station and is the only large-scale magnetic spectrometer operating in outer space. Proposals should carry out basic research on the dark matter, antimatter and the origin of cosmic rays based on the AMS data center of Shandong Institute of

Advanced Technology. Main research areas include:

(1) Cosmic ray antimatter and dark matter;

(2) The composition, energy spectrum and origin of cosmic rays;

(3) The time evolution of cosmic ray intensity and its relationship with solar activity.

2. Advanced space particle detection technology

The special application environment of space science experiments encompasses stringent requirements on particle detection equipment. Proposals should carry out particle detection technology research and explore key core technologies for space science experiments. The main research areas include:

(1) Application of silicon microstrip detectors with high position resolution and high charge resolution in space science experiments;

(2) Space particle charge and track detection technology based on CMOS pixel sensor.

Appendix

Contact Information of NSFC Departments and Bureaus

Departments		Tel
Department of Mathematical and Physical Sciences		
Division of General Affairs and Strategic Planning		62326910 62326911
Division of Mathematical Sciences		62325025
Division of Mechanics		62327178
Division of Astronomy		62325940
Division I of Physical Sciences		62325055
Division II of Physical Sciences		62325069
Department of Chemical Sciences		
Division of General Affairs and Strategic Planning		62326906 62327111 62329320
Division I	Synthetic Chemistry	62327170 62328253
Division II	Catalysis and Surface/ Interface Chemistry	62327035
	Chemical Theory and Mechanism	62328382
Division III	Materials Chemistry and Energy Chemistry	62327111
Division IV	Chemical Metrology	62327173
	Environmental Chemistry	62327075
	Chemical Biology	62327169
Division V	Chemical Engineering and Industrial Chemistry	62327168
Department of Life Sciences		
Division of General Affairs and Strategic Planning		62326916 62327200 62329352
Division I	Microbiology	62329221
	Botany	62329135
	Zoology	62326914
Division II	Genetics and Bioinformatics	62329240
	Cell Biology	62327213
	Developmental Biology and Reproductive Biology	62329341
Division of Biomedicine	Immunology	62329341
	Neurosciences & Psychology	62329253
	Physiology and Integrative Biology	62329341

Departments		Tel
Division of Interdisciplinary Research	Biophysics and Biochemistry	62329246
	Biomaterials, Imaging and Tissue Engineering	62327194
	Molecular Biology and Biotechnology	62326915
Division of Environment and Ecology	Ecology	62329321
	Forestry and Grassland Science	62329573
Division of Agriculture and Food Sciences	Basic Agriculture and Crop Sciences	62327193
	Food Sciences	62326919
Division of Agricultural Environment and Horticulture	Plant Protection	62328882
	Horticulture and Plant Nutrition	62327197
Division of Agricultural Animal	Animal Husbandry	62327196
	Veterinary Science	62329585
	Aquatic Science	62329105
Department of Earth Sciences		
Division of General Affairs and Strategic Planning		62327157 62326900
Division I	Geographical Sciences	62327161
Division II	Geology	62327652
	Geochemistry	62327675
Division III	Environmental Geosciences	62327159
	Geophysics and Space Physics	62327619
Division IV	Marine Sciences	62328528
Division V	Atmospheric Sciences	62327654
Department of Engineering and Materials Sciences		
Division of General Affairs and Strategic Planning		62326887 62326884
Metallic Materials		62328301
Inorganic Non-Metallic Materials		62327144
Organic Polymer Materials		62327138
Metallurgy and Mining		62328335
Mechanical Sciences and Manufacturing		62327084

Department		Tel
Engineering Thermal Physics and Energy Utilization		62328359
Electrical Science and Engineering		62327131
Architectural Engineering and Civil Engineering		62327092
Hydraulic Engineering		62327137
Environmental Engineering		62328362
Marine Engineering		62327137
Transportation and Vehicle Engineering		62326887
New Materials and Generic Science of Materials		62328335
Department of Information Sciences		
Division of General Affairs and Strategic Planning		62327140
Division I	Electronics and Information Systems	62327147
Division II	Computer Sciences	62327807
Division III	Automation Sciences	62327149
Division IV	Information Devices and Optics	62327143
Department Management Sciences		
Division of General Affairs and Strategic Planning		62326898
Division I	Management Science and Engineering	62327156
Division II	Business Management	62326972
Division III	Macro Administration and Policy	62327152
	Economic Science	62326660
Department of Health Sciences		
Division of General Affairs and Strategic Planning		62328991 62328952 62328941
Division I	Breath, Blood, Cycling	62327215 62328962
Division II	Digestive, Urinary, Endocrine, Eye, ENT, Oral Sciences	62328790 62328680
Division III	Neurological, Psychiatric, Geriatric Medicine	62327199
Division IV	Reproductive, Perinatal, Neonatal, Medical Immunology	62327207
Division V	Medical Imaging, Biomedical Engineering, Special Medicine, Forensic Medicine	62327198
Division VI	Medical Microbiology and Infectious Diseases, Movement Disorders, Trauma, Burns, Surgery, Severe Acute Medicine, Laboratory Medicine, Rehabilitation Medicine	62329131 62328775
Division VII	Oncology (excluding hematological neoplasm)	62326924 62329157
Division VIII	Dermatology, Radiology, Preventive Medicine	62327195

Department		Tel
Division IX	Pharmacology	62327212
Division X	Traditional Chinese Medicine, Chinese Materia Medica, Integration of Traditional Chinese Medicine and Western Medicine	62328634 62328552
Department of Interdisciplinary Sciences		
Division of General Affairs and Strategic Planning		62328382
Division I	Material Sciences	62328382
Division II	Sciences of Intelligence and Intelligent Manufacturing	62327140
Division III	Life and Health Sciences	62329221
Division IV	Integrative Sciences	62328382
Bureau of Planning		
Division of General Affairs		62326980 62325277
Division of Programs		62329336 62328222 62327008
Division of Talent Fostering		62325562 62329133
Division of Interdisciplinary Sciences		62329897 62326872
Bureau of Finance		
Division of Budgeting		62328485
Division of Fund Accounting		62326760 62329112 62327225 62327229
Bureau of International Cooperation		
Division of Planning		62326943 62327001
Division of Asian, African and International Organizations Affairs		62325454 62326998
Division of American and Australasian Affairs		62325377 62326877
Division of European Affairs		62327014 62327017
Office of Hong Kong, Macao, and Taiwan Affairs		62327179
Service Center of Administrative Affairs		
General Office		62327218
Comprehensive Service		62326949
Center for Science Communication and Achievement Transformation		
General Office		62327204
Sino-German Center for Science Promotion		
Operator		82361200