Major Research Plan

The Major Research Plan focuses on key basic scientific issues with strategic importance to the nation and major frontier areas and gives high priority identified on the basis of the capability and advantages of the country. Rather than individual project, the Major Research Plan is designed to be a program cluster which contains a number of projects with relatively identical objectives for innovative research resources integrity in order to explore the possible breakthroughs in the identified areas.

The Major Research Plan follows the principle of "definite objective, stable support, integration and refinement and leap-forward development". The funding period for Major Research Plan projects is 8 years in general.

Applicants should meet the following eligibilities:

(1) Having experience of undertaking basic research projects;

(2) Bearing a senior academic position (title).

Post-doctors in station and graduate students are not eligible to apply. Researchers without affiliation to a research institution or whose home institutions have not been registered at NSFC cannot apply.

One applicant may submit no more than one application in the same year (excluding Integrated Program and Strategic Research Program); and grantees of the Major Research Plan program are not allowed to apply for the same program in the following year.

Applicant should be the actual responsible person for the Major Research Plan program, and there is only one responsible person for one project under the Major Research Plan Program.

The number of applications one applicant may submit shall comply with the requirements defined in the annual Guide to Programs.

The Major Research Plan is framed with three types of programs, namely, the Fostering Program, Key Program and Integrated Program, of which each one is open to application. Proposals shall be prepared in accordance with the requirement for the Major Research Plan and outlines for proposal preparation, featuring interdisciplinary research, emphasizing on the contributions to solving key scientific issues and fulfilling the overall goals of the Major Research Plan. Applicants should select "Major Research Plan" for the column of the funding type in the application form of proposal, and Fostering Program, Key Program, or Integrated Program for the column of sub-type, and give the titles of the Major Research Plan in the annotation. Proposal is not accepted in case of incorrect selections or without any selections.

Generally, duration for Fostering Program project is 3 years, for Key Program project is 4 years, and that for Integrated Program project is determined by the Steering Committee of each Major Research Plan according to the actual

need. For Fostering Program project and Key Program project, the collaborative organizations involved may not exceed 2 in number. The number of collaborative organizations involved in one Integrated Program project may not exceed 5. The Integrated Program project will not be counted in limitations of total number of NSFC funded projects applied and undertaken for senior academic title holder, and main participants must be the actual contributor to the Integrated Program project, and total number of main participants may not exceed 9.

Regulations on sharing of data and information should be observed in order to achieve the overall scientific objectives and multi-disciplinary integration of the Major Research Plan.

Each Major Research Plan should hold an academic workshop or seminar on related areas so as to strengthen academic exchange and achieve the overall scientific objectives and integration of disciplines. The principal investigator of the granted projects is required 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 this Guide to Program.

Precision Measurement Physics

Precision measurement physics is the basis and frontier areas of modern physics development, and the result of integrating scientific exploration and precision measurement techniques, and the basis of national needs on relevant precision measurement. This major research plan aims at special target of precision measurement physics, along the line of atomic, molecular and photonic research, and to construct new system of highly stable precision measurement, explore new concept and new principles of precision measurement physics, develop higher precision measurement method and technology, improve precision of measuring basic physical parameters and test the range of application of basic physical principles at higher precision level.

I. Scientific targets

Overall scientific target: to further improve research capability of China in precision measurement area, promote development of precision measurement physics, increase international impact of disciplines in precision measurement physics, reach leading level in some areas, and strengthen the right of speech of the Chinese scientists in the world in basic physical constant measurement and basic physical quantities. Provide key concept, method and technology basis for national needs such as navigation and positioning, time keeping, resources exploration, national defense, etc. Build a high standard research team for China.

Specific scientific target: improve existing experimental system, increase measurement precision; construct new system of atomic and molecular cooling, propose new principles and new method for atomic and molecular cooling for precision measurement; break the standard quantum limit in measurement, reach the international leading level in noise compression; make the uncertainty in time frequency measurement to the level of 10-18, time frequency comparison and transfer precision higher than 10-19; make measurement value of more physical constants enter CODATA; and achieve international leading results in testing of physical laws such as equivalent principle and Newton's reverse square law, etc.

On the basis of experimental measurements, achieve new discoveries, new understanding, new mechanism, and propose new concepts and new views.

II. Key scientific problems

1. Principles, method and technologies of measurement breaking the standard quantum limit
2. New principles and method breaking the existing atomic frequency standard precision
3. New mechanism and technology breaking the atomic precision control and molecular cooling

III. Application and funding in 2015

In 2015, we received 54 applications, among them, 19 were for Key Program projects, 35 for Fostering Program projects. After expert review, we funded 8 Key Program projects, 16 Fostering Program projects. Total direct cost funding was 42.8 million yuan.

IV. Key funding research areas in 2016

This Major Research Plan will focus on core scientific problems and support projects in the form of “Fostering Program” and “Key Program”. We shall fund the applications having explorative and new ideas in the form of “Fostering Program” and the applications having original ideas, good research accumulation and prospects of making breakthroughs in the form of “Key Program”. This Major Research Plan will last for 8 years, and the project selection and funding will be done in the first 5 years. In 2016 we plan to allocate direct cost funding of 3.2-4 million yuan per project for 4 years for Key Program, and 0.8-1 million yuan per project for 3 years for Fostering Program. The research directions are listed below.

Key Programs

Target of integration: applicants may choose all or part of the contents in each research direction. The main research directions are listed below.

1. Studies on quantum correlation measurement exceeding standard quantum limit

Main research contents:

(1) Precision quantum measurement based on quantum correlation systems such as photon and atoms (including ions): construct multi particle (photon or atom) self spincompression or entanglement. Use quantum correlation or non linear interactions between particles to demonstrate measurement precision exceeding standard quantum limit on phase change, reach or break Heisenberg limit.

(2) New principles and new methods of quantum precision measurement: explore other new principles and new methods of multi particle quantum correlation and quantum measurement that may break the standard quantum limit, including but not limited to new means such as quantum weak measurement to realize amplification of weak signals and quantum feedback control technology, and use experiment to demonstrate the increased resolution of small phase and quantum signals. Research target is to realize measurement that breaks the standard quantum limit, and achieve the world leading level in noise compression.

(3) Development of quantum correlation precision measurement technology: use quantum correlation system and principles such as photon and atom, develop relevant precision measurement technology with high precision, high sensitivity and high resolution. Include but not limited to new quantum interferometer, gravimeter, gyroscope and magnetometer, so as to achieve higher precision measurement of various physical quantities

(such as time, frequency, gravity, the rotation of the Earth, magnetic field, velocity, temperature, etc.) and quantum state and quantum operations.

2. Studies on principles and methods of precision measurement based on super cold atom and molecules

Main research contents:

(1) Preparation of super cold molecules (including ions) system and principles and methods for use in precision measurement; study method of applications of special energy level properties in precision measurement physics.

(2) Precision spectrum and super fine structure of diatom and dimolecule, precision measurement of highest confined state order in base state diatom and dimolecle and calibration of relevant low energy impact properties.

(3) Computation and experimental studies on the atomic and molecular structures related to precision measurement.

3. High precision testing of basic physical laws

Main research contents:

(1) High precision testing of quantum electro dynamics (such as experiment of hydrogen or hydrogen like atomic spectrum, measurement of hydrogen or hydrogen like atomic spectrum and computation of quantum electro dynamics, Lamb shift experiment and computation for correlative systems).

(2) Explore new physical quantity or interaction of time inversion and parity violation (such as high precision measurement of electron, neutron and atomic electric moment, new interaction force between spin polarized atoms and non polarized atoms in small scale), spectrum studies on low energy anti mass (such as trapped anti hydrogen atom) and comparison with corresponding mass.

4. High precision measurement of physical constants and physical parameters

Main research contents:

(1) High precision measurement of basic physical constants (such as fine structure constant, Planck constant h, Rydberg constant R) and possible changes with time and space.

(2) High precision measurement of basic physical parameters (such asmass ratio of proton and electron, radius of proton's charge, eigen parameters such as charge, mass, magnetic moment, life of atom and molecules, and parameters of atomic interactions).

5. High precision atomic frequency markers

Main research contents:

(1) Generation of high precision time frequency. Study and solve the physical and technical problems affecting the uncertainty and stability of atomic frequency markers; develop a complete system of high performance optical atomic clock (focusing on atomic and ion systems other than calcium, strontium and aluminum); and method and technology high precision measurement based on UTI.

(2) High precision frequency comparison and transfer. Study method and technology of high performance optical frequency source, optical frequency signal transfer path and relay, construct system of remote opticalfiber or space optical frequency signal transfer and comparison better than existing optical frequency atomic clock stability; new method and new technology of ultr high precision microwave frequency transfer; and technology of high performance transfer clock frequency comparison and measurement.

Fostering Programs

Addressing issues in precision measurement physics, conduct studies in frontier areas of new physical system, new principles, new methods and new technologies for special problems in precision measurement physics. Applications should have clear scientific problems, new physical ideas and specific ways of solving the problem. For projects having

good research results and clear and important scientific issues to be further studied, we shall give continued support through Key Programs or Integration Programs later.

Main research directions are:

1. Noise mechanism and method of reduction in precision measurement physics
2. New principles of high precision atomic frequency marker
3. High precision transport and comparison of time frequency
4. Studies on atomic molecular structures and precision spectrum line
5. New principles and new methods of quantum measurement
6. Principle and methods of ultra cold atomic molecular precision measurement
7. New method of high precision testing of basic physical laws
8. New methods of high precision measurement of physical constants and physical parameters
9. Studies on key unit technology of precision measurement physics
10. New scheme and new technology of detecting gravitational wave

V. Basic selection criteria

1. Research contents should meet the requirement of this guide, and research and experiments should be creative, and focus on scientific problems in precision measurement physics based on atomic, molecular and photonic techniques.

2. We encourage exploratory studies in frontier areas, and give preferential support to original research on new ideas, new systems, new methods and new technologies in precision measurement physics.

3. Studies are mainly of the experimental type, but please pay attention to combining theory and experiments, and research targets should be higher measurement precision

4. We encourage multi interdisciplinary research, especially between mathematical physics, information, and geosciences.

5. We encourage international cooperation.

VI. Notes to applications

1. Please read this guide carefully before writing the application. This research plan aims at forming a research project group. Applications should have clear key scientific problems, and close relations with the problems given in this guide, and emphasize on contributions to the overall objectives and the key scientific issues of this research plan.

2. Please select the proper application code.

The Change of the Tibetan Plateau's Land-Atmosphere Coupled System and its Effects on Global Climate

The Tibetan Plateau (TP), as an important factor controlling atmospheric circulation and its change, have profound impacts on regional and global climate change through energy and water cycles. In accompany with the deepening research of global climate change, the TP's land-atmosphere coupled system with the increasing significance of its impacts on global climate has become a research frontier in the international community of climate and the earth system science. More research on the TP's influences upon disastrous weather and climate change in China will improve the ability of disastrous weather forecast and climate prediction.

I. Scientific goal

This Major Research Plan (MRP) is designed to explore the mechanism of the TP's impacts on the global climate and climate change, improve the regional and global weather/climate prediction capability, move the atmospheric research in China on the Tibetan Plateau into the world arena with a group of leading scientists in the advanced research teams making greater contribution to the sustainable socio-economic development.

The overall target of this MRP is to understand the TP's land-atmosphere coupled process, the cloud precipitation and water cycle processes and the troposphere-stratosphere exchange process over the TP, develop the TP's database and assimilation system, improve the numerical models of regional and global climate systems, and to reveal the mechanism of TP's impacts on regional and global energy/water cycles.

II. Key scientific issues

The key scientific issues to be addressed in this MRP are how the TP's land-atmosphere coupled system influences the Asian and global climate system? This plan will be focused on the following 3 critical scientific issues.

1. The regulation of the TP topography in the global atmospheric circulation

It is to investigate the land surface process and land-atmosphere interactions over the TP; dynamic effects of multi-scale topography of the plateau and their impacts; and topographic effects of the plateau on the general circulation.

2. Impacts of the changing TP's land-atmosphere coupled system on the global energy/water cycles

It is to explore cloud precipitation physics and atmospheric water cycle over the TP; linkage of energy to water cycle over the TP and its impacts; mechanism of impacts of the plateau's land-atmosphere coupled processes on monsoons, energy/water cycles; collaborative influences of the TP and oceans on the regional and global climate changes; and interactions of troposphere and stratosphere over the TP.

3. Mechanism of influences of the TP's land-atmosphere coupled system on disastrous weather and climate in China

The research will be focused on the mechanism of the influences of the TP's land-atmosphere processes on disastrous weather in China; impacts of multi-sphere interactions on Asian monsoons and droughts/floods in China; impacts of the TP on global monsoons and climate anomalies; and the key techniques for weather and climate system models, physical processes, data reanalysis and data assimilation.

III. Key research priorities and directions in 2016

The total fund for the MRP in 2016 is approximately 30 million yuan. For those projects, which have shown innovative research concepts and encouraging early-stage findings, and still need further exploratory research work for an extended period, will be funded through the "Fostering Program" with the duration of 3 years and the average direct funding level of about 0.8 million yuan per project. For those projects, which have demonstrated sound research ground work and accumulations, and have proposed in-depth systematic research on well-defined and innovative but important scientific issues, will be funded through the "Key Program" with the duration of 4 years and the average direct funding of approximately 3 million yuan per project. It is the fourth year of the Major Research Plan. Based on the arrangement and overall schedule of the Key Program and Fostering Program supported in the past three years, the expert group, through discussion and investigation, decide that, integrated and synthesized research will be gradually carried out from 2016, to more timely summarize the early-stage studies, and to better integrate/complement the

content/advantages of different projects. The duration of the "Integrated Program" will be 3 years with the average direct funding of approximately 3 million yuan per project.

Key research directions in 2016 include:

1. Studies on the assimilation of the land-atmosphere coupled data from the TP's multi-source land-atmosphere observations (especially the Third TP Observations)
2. Studies on the key physical processes in the TP's land-atmosphere coupled system numerical models (especially the TP's lake/wet land, gravity wave drag, boundary layer, radiation and stratospheric physical and chemical processes)
3. Mechanisms of the TP's atmospheric heat source formation in the TP's land-atmosphere coupled processes and the effects of the heat source on the disastrous weather in the downstream areas
4. Dynamical processes in the TP's convective precipitations and numerical studies on the processes; multi-scale change characteristics of the TP's complicated topography and the water cycle in the surrounding areas, and their effects on weather and climate
5. Effects of the TP's land-atmosphere coupled processes on the global and regional energy and water cycles
6. Effects of the TP on the interactions between the global tropospheric and stratospheric planetary waves; weather/climate effects of the TP on the transportation of atmospheric material in the troposphere and stratosphere (water vapor, aerosols, ozone, etc.)
7. Synergistic effects of the TP's land-atmosphere coupled system and ocean on the global climate
8. Influences of the interactions between low and middle latitude systems on the TP's dynamical and thermodynamic structures and their effects on weather and climate

Key directions for the integrated research in 2016

The integrated research will focus on the following three projects.

(1) Synergistic effects of the TP's land-atmosphere coupled processes and ocean on the regional energy/water cycles and global climate

It is to examine the main factors controlling the TP's atmospheric heat source and its variation; roles of transient processes in the synergistic effects of TP and sea-land-atmosphere interactions on the global climate change; mutual feedbacks among basic flow, TP's stationary wave and circulation anomalies of ocean and atmosphere, and their effects on the global climate anomaly. Integrated research will be carried out based on the related projects which have been approved.

(2) TP's multi-source information fusion, data assimilation and numerical model development

Based on the key and fostering projects that have already been carried out, a TP's reanalysis dataset integrating multi-source data will be established. Integration will focus on the data of atmosphere, land, ice/snow and hydrology from satellite remote sensing, sounding and surface observations, to produce a reanalysis product by combining modern observations, assimilation and frontier technologies; this product will have good quality control, many variables, large spatial coverage, long time span, high spatial and temporal resolution, etc. Integrate parameterizations of the TP's atmospheric physics and land surface processes and the uncertainties of the parameterizations, based on the key and fostering projects that have already been carried out. Improve high-resolution general circulation models and simulation performance of climate models in the TP area.

(3) Construction of the sharing platform of the TP's atmospheric multi-source integrated data

The platform construction will focus on the integration of the TP's long-term

meteorological service observations, data of atmospheric and land processes observed in all previous atmospheric science experiments, satellite remote sensing climate products, global and regional reanalysis products, and data products from the projects on atmospheric and land data analysis and reanalysis (supported by "The Change of the Tibetan Plateau Land-Atmosphere Coupled System and its Effects on Global Climate"). Study the TP's multi-source information storage models and construct the TP's multi-source information data bases. Study and establish data standard specifications that support integration of multi-source data, data management and data sharing. Design scalable system architecture and a uniform data interface, and build a standard, unified and open application platform for resource sharing of the TP's atmospheric multi-source information. The platform is required to satisfy the research of the current plan and future research/service.

IV. Notes to application

(1) Before filling in the Project Application Form, applicants should carefully read the guidelines. The theme selected in the Project Application Form should conform to the implementation principles set for this Major Research Plan, and description should be given to the scientific issues that are most relevant to the guidelines, including potential contributions to solve the key scientific issues and achieve the overall objectives of this Major Research Plan. The objectives and contents given in the Project Application Form should target at the key scientific issues of this Major Research Plan, highlight the limited goal and emphasize on specific research on innovative points and frontiers of basic scientific issues. Any applications that do not conform to the guidelines will not be accepted. Those who have been involved in other relevant scientific research project(s) should demonstrate the differences and relations between this proposal and other project(s) in the "Research Foundation" part of the Project Application Form.

(2) Targeting at specific scientific issues to be addressed, applicants may freely identify a project title, research contents, a research scheme and the corresponding fund required in support of the research work by clarifying the point for making a new breakthrough and innovative concept(s) based on analyses of research findings that are available nationally and internationally.

(3) Be sure that a corresponding application code should be selected according to the specific content of the research project to be applied for. "Major Research Plan" is selected in the "Funding Categories" column of the Project Application Form, "Fostering Program Project" or "Key Program Project" in the "Subcategory Description" column, and "the Change of the Tibetan Plateau Land-Atmosphere Coupling System and its Effects on Global Climate" in the "Explanatory Note" column. Any applications with incorrect or no selection will not be considered.

(4) Pay attention to the mutual support relationship with other projects in this research plan during the project execution process.

(5) The Department of Earth Sciences is responsible to accept applications.