

Postprint of Overview of the Chinese Academy of Sciences Strategic Priority Research Program (Category B)

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Abstract

The Chinese Academy of Sciences organizes and implements Strategic Pilot Science and Technology Special Projects (abbreviated as “Pilot Projects”), which are divided into two categories: A and B. Category B Pilot Projects focus on targeting directions where new technological revolutions may occur and rapidly developing emerging, interdisciplinary, and frontier directions, achieving world-leading original results, occupying the commanding heights of future science and technology, and forming cluster advantages.

Full Text

Preamble

Strategic Priority Research Program of the Chinese Academy of Sciences: An Overview of the CAS Strategic Priority Research Program (Category B)

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The Chinese Academy of Sciences (CAS) organizes and implements the Strategic Priority Research Program (hereinafter referred to as the “Pilot Program”), which is divided into Categories A and B. Category B Pilot Programs focus on targeting potential directions of new scientific and technological revolutions and rapidly developing emerging, interdisciplinary, and frontier fields to achieve world-leading original results, occupy the commanding heights of future science and technology, and form cluster advantages.

1. Basic Situation

During the 12th Five-Year Plan period, with strong support from the Ministry of Finance, Ministry of Science and Technology, and other relevant state departments, CAS oriented itself toward the frontiers of world science and technology, concentrated outstanding talent teams, and leveraged multidisciplinary comprehensive advantages to deploy initiatives across physics, chemistry, materials science, information technology science, earth science, life science, and other fields. CAS subsequently launched 15 Category B Pilot Programs, including “Coherent Control of Quantum Systems,” “Brain Functional Connectome and Brain-Inspired Intelligence Research,” and “Multi-sphere Interactions on the Tibetan Plateau.”

In 2016, in accordance with the spirit of the National Science and Technology Innovation Conference and the requirements of the CAS Party Group, Category B Pilot Programs further strengthened top-level design and overall planning, aligning more closely with national and CAS strategic priorities. After more than two years of organization and evaluation, nine new Category B Pilot Programs were launched, including “Frontier Research on Ultra-Intense Lasers and Fusion Physics.” By the end of 2016, a total of 24 Category B Pilot Programs had been initiated, with basic details provided in Table 1. Currently, approximately 84 CAS-affiliated units and 29 external units undertake research tasks at the sub-project level and above, with more than 6,000 permanent staff members deployed.

2. Program Organization and Management

Under the leadership of the CAS Party Group and the guidance of responsible institute leaders, the Frontier Science and Education Bureau (hereinafter referred to as the “Frontier Bureau”) has consistently aimed to orient itself toward international scientific frontiers and promote the output of major original achievements. The Bureau adheres to a system of chief scientist responsibility and emphasizes top-level design. In light of the forward-looking and original research characteristics and practical needs of Category B Pilot Programs, the Bureau strengthens project process management and dynamic adjustment, continuously improves program operation and management mechanisms, formulates scientific organizational management guidelines, and ensures the output of major achievements.

2.1 Strengthening Program Regulation Construction

CAS has formulated management measures and implementation rules for Category B Pilot Programs, further completing the construction of institutionalized and operational management mechanisms. These primarily include personnel selection and assessment mechanisms, academic exchange and summary mechanisms, organic integration and coordination mechanisms between projects, and internal program assessment and evaluation mechanisms. Each pilot program

actively conducts annual academic exchange meetings, strengthens annual summary and assessment work, and ensures effective program advancement.

2.2 Establishing Program Expert Groups and Advisory Committees

Each pilot program establishes an overall expert group and an advisory committee according to its own research and management characteristics. The overall expert group is led by the chief scientist and generally includes research and management backbone members such as project leaders, who work collectively to strengthen program organization and guidance. The advisory committee is generally composed of renowned domestic and foreign experts (including management experts) who provide important consulting recommendations for the smooth implementation of pilot programs.

2.3 Implementing Dynamic Program Adjustment

Dynamic adjustment is an important guarantee for the smooth implementation of Strategic Priority Pilot Programs, timely completion of milestone tasks, and achievement of major outputs. In the process of organizing and advancing Category B Pilot Programs, CAS closely monitors new national situations and requirements, as well as new changes and progress in scientific frontiers, using these as objective and fundamental bases for dynamic adjustment. Simultaneously, with reference to mid-term evaluation performance assessments, internal program work inspection results, and expert consulting opinions, timely, scientific, and efficient dynamic adjustments are made in research funding, personnel teams, research directions, and organizational structures.

Furthermore, Category B Pilot Programs fully embody the essence of piloting and trial implementation, truly playing a “pilot” supporting role in the establishment of major national strategic-level projects. Through forward-looking research conducted by CAS that takes the lead, major national scientific and technological projects have been driven to be established at the national strategic level. With support from the Category B Pilot Programs “Coherent Control of Quantum Systems” and “Brain Functional Connectome and Brain-Inspired Intelligence Research,” “Quantum Communications and Quantum Computers” and “Brain Science and Brain-Inspired Research” have been included as major national scientific and technological projects in the 13th Five-Year Plan Outline. The preliminary deployment of the Category B Pilot Program “Multi-band Gravitational Wave Universe Research” has played an important driving and supporting role in the launch of relevant national programs.

2.4 Strengthening Communication Within and Between Programs

Each Category B Pilot Program holds at least two program-level work meetings annually. Program summary meetings focus on summarizing research progress from the previous year and compiling annual work progress reports, while program deployment meetings focus on discussing research progress and compiling

work plans for the following year based on the current year's work plan implementation.

Additionally, the Frontier Bureau organizes an annual work meeting for Category B Pilot Programs, where program leaders report overall progress and work plans to institute leaders and relevant departments. The Bureau also strengthens communication between programs to promote interdisciplinary collaborative research.

2.5 Strengthening Program Publicity

To publicize the progress of Category B Pilot Programs in a timely and systematic manner, the Frontier Bureau launched the *Category B Pilot Program Dynamics* in 2014, covering four sections: program management, academic exchange, achievement progress, and international developments. The publication reports on the scientific research and management work of each Category B Pilot Program quarterly. Meanwhile, a special column has been opened on the Frontier Bureau's webpage for publicity and reporting.

2.6 Strengthening Program Funding Management

Each pilot program attaches great importance to budget formulation, adjustment, execution, and final accounting in accordance with the *Implementation Rules for the Management of Funds for the Chinese Academy of Sciences Strategic Priority Research Program (Trial)*. The programs improve funding management and approval processes to ensure legal and compliant use of funds and guarantee the successful completion of tasks at all program levels.

3. Achievements

Over the five years since implementation, Category B Pilot Programs have achieved a batch of internationally leading frontier scientific research results. Eight achievements, including "Condensed Matter Physics," "Quantum Communications," "Neuronal Cell Targets," and "Health Effects and Regulation of Environmental Pollution," have been listed as CAS's signature major progress during the 12th Five-Year Plan period. Research results from the "Topological and Superconducting Novel State Regulation" and "Coherent Control of Quantum Systems" programs respectively won the first prize of the National Natural Science Award in 2013 and 2015. The work on "Realizing Quantum Teleportation of Multiple Degrees of Freedom in a Quantum System" and "Discovery of Weyl Fermions" were both selected as top ten breakthroughs in *Physics World* in 2015.

Program Progress Examples:

Coherent Control of Quantum Systems: Focusing closely on research objectives, the program has conducted systematic research on quantum communication, quantum computing, and quantum simulation based on light and cold

atomic systems, molecular systems, and solid-state systems, achieving a series of innovative research results with important international impact. The program has published more than 120 research papers in top international academic journals such as *Science* and *Nature*, receiving high praise from domestic and foreign peers and being featured multiple times as cover papers or cover headline papers in *Nature* sub-journals (Figure 1 [Figure 1: see original paper]). Program achievements have provided core scientific and technological support for the smooth implementation of major national scientific research projects and tasks such as the CAS Strategic Priority Pilot Program “Quantum Science Experimental Satellite” and the National Development and Reform Commission’s quantum secure communication “Beijing-Shanghai Trunk Line” technology verification and application demonstration project, making quantum communication a cutting-edge technology with world-leading levels in China.

Topological and Superconducting Novel State Regulation: The program has organized and implemented a new R&D model of “theoretical prediction + material preparation + property measurement,” based on international fundamental frontiers and fully utilizing the charge, spin, and orbital degrees of freedom of electrons. It has achieved a batch of major original scientific results in topological, superconducting, and novel state regulation fields. For example, it discovered for the first time a completely new quantum state—topological semimetals (Dirac/Weyl)—and realized for the first time Cr-based and Mn-based compound superconductors. The program has published more than 500 SCI papers in *Science*, *Nature*, and other journals, with multiple researchers receiving important domestic and international science and technology awards such as the Matthias Prize (the highest award in the international superconducting materials field) and the TWAS Physics Prize.

Brain Functional Connectome and Brain-Inspired Intelligence Research: Through nearly four years of research, important progress has been made in neural circuits and subcortical pathways for sensory information processing, neural circuits and brain regions for emotion and depression, brain structure and intellectual development, non-human primate animal models for neurological diseases, and research technologies for brain functional mapping. The program has published more than 400 papers in academic journals such as *Nature*, *Science*, and *Cell*, generating high domestic and international impact.

Multi-sphere Interactions on the Tibetan Plateau: Research on the basic characteristics, processes, and mechanisms of interactions among various spheres on the Tibetan Plateau has achieved new scientific breakthroughs in the timing and mode of India-Eurasia continental collision, paleoaltitude of plateau uplift, and the influence of westerly and monsoon systems and their environmental effects, bringing China’s Tibetan Plateau research to a world-leading level. Research results have achieved major social impact, forming consultation reports and environmental white papers based on program achievements and completing scientific assessments of environmental changes on the Tibetan Plateau, which have received high attention from Party and state leaders and

local governments.

Hadal Trench Frontier Scientific and Technological Issues Research and 攻关: The program focuses on frontier scientific issues of hadal trenches, establishing China’s hadal trench disciplinary systems in biology, ecology, and geoscience, as well as technical systems to support hadal trench scientific research and technological 攻关. In 2016, the “Hadal Trench” program executed China’s first comprehensive 10,000-meter hadal trench scientific expedition, achieving China’s first unmanned deep diving and exploration in 11,000-meter-class hadal trench regions, marking China’s entry into the era of 10,000-meter deep-sea technology (Figure 2 [Figure 2: see original paper]).

4. Future Outlook

At the 2016 National Science and Technology Innovation Conference, General Secretary Xi Jinping pointed out three major directions for scientific and technological innovation: facing world science and technology frontiers, facing the main economic battlefield, and facing major national needs. Regarding the orientation toward world science and technology frontiers, China must further consolidate its scientific and technological foundation and rank among the world’s leaders in important scientific and technological fields. China must strengthen innovation confidence, maintain the ambition to be a world leader, and truly make efforts in “unique, original, and pioneering innovation” to produce major original innovative achievements.

Looking to the future, Category B Pilot Programs will, in accordance with the unified deployment of CAS’s 13th Five-Year Plan Outline, carefully consider whether their scientific research work targets major scientific problems, whether it focuses on establishing new theories, and whether it fosters new disciplinary development directions. The programs will conduct dynamic adjustments to their established goals to truly lead international frontiers. As a national team in scientific and technological innovation, CAS will continuously promote innovative leaps in China’s scientific research endeavors, live up to the expectations of the Party Central Committee and the State Council, and contribute to the construction of an innovative country.

Note: Figure translations are in progress. See original paper for figures.

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