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Special Issue: Basic Research Developments

NSFC President Talks on NSFC

In a recent interview, Yang Wei, President of the National Natural Science Foundation of China (NSFC), answered questions regarding adjustment of China's S&T programs and reform of the use of national S&T funds. He first introduced "three synchronizations" of China's basic research development – synchronization of improvement of quantity and quality of basic research achievements, synchronization of development of research universities and the Chinese Academy of Sciences, and synchronization of domestic research and international collaboration. Taking the third synchronization as an example, he showed a diagram of China's international collaboration network in basic research, which indicated that, compared to 2009,

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China further strengthened international collaboration in basic research and increasingly took the center stage in 2013, with its centrality increasing from 0.6 to 0.757, providing a strong evidence of China's rapid progress in basic research. In this process, science funds have made undisputable contributions. In fact, some of the most important research breakthroughs in recent years, such as the observation of quantum anomalous Hall Effect and Tianhe-1 supercomputer, were initially funded by NSFC.

China's fiscal spending on basic research has been increasing year by year. According to data, China's basic research spending increased from RMB 15.576 billion in 2006 to RMB 55.5 billion in 2013, representing an average annual growth of approximately 20%. According to Yang Wei, how to evaluate basic research has become a tricky issue. Unlike technology projects with definite indicators, basic research projects are featured by long duration, great difficulty, high risk and high return. The Higgs boson, for example, received no serious attention for more than ten years after its proposal was first raised, and it is only in recent years, with the confirmation of its existence in labs more than fifty years after the preliminary research, that it has become an international frontier research subject. In 2011, the 25th NSFC Drives Basic Research at Universities anniversary of NSFC, China completed the largest ever integrated S&T performance evaluation – International Evaluation of Science Fund Grant and Management Performance. The evaluation was completed by a third party jointly commissioned by NSFC and the Ministry of Finance. In 2014, NSFC commissioned the National Center for Science & Technology Evaluation (NCSTE) of the Ministry of Science and Technology to evaluate the performance of existing basic research projects under the evaluation framework. According to the characteristics and laws of basic research projects and for the purpose of optimizing grant management, the evaluation conducted full-process target setting, monitoring and evaluation of the decision-making, management and performance of existing projects. Through a series of activities including performance data analysis, affiliated organization investigation, applicant satisfaction survey, random project inspection, and expert appraisal, the evaluation eventually came up with project performance reports and performance evaluation reports.

Various reform measures introduced by NSFC in recent years have also been meant to improve grant performance. Most noteworthily, according to the recently issued a Method of fund management of national natural science projects, affiliated organizations may disburse indirect expenses such as water, electricity, heating and performance according to specific provisions rather than only taking a 5% management fee as in the past, professional service fees are uncapped rather than being capped at 15% in the past, and the expenses on meeting, travel and international exchange may be disbursed conjunctively as long as the total budget is not exceeded. The Method promulgated a series of monitoring and management measures concerning fund use, including requirement for establishing a reasonable performance management and evaluation mechanism, and a commitment, credit and open mechanism of fund management.

(Source: Science and Technology Daily,
June 2, 2015)

NSFC Drives Basic Research at Universities

NSFC, which divides projects into three categories, i.e. research, talent and environment, has become a major source of funds for researchers at universities to conduct basic research.

According to data, funds granted to universities account for more than 70% (more than 80% for the Department of Health Sciences of NSFC) of the total funds granted by NSFC every year. In some universities, grants from NSFC account for approximately 70% of their total funds for basic research, and there are also some universities that devote 70% of their research funds to basic research. The stable and steadily increasing funds

for basic research activities at universities have enabled researchers to carry out promising research endeavors. In addition to showing Chinese universities' increasing S&T innovation strengths, the aforementioned figures have also fully shown the importance and indispensability of NSFC to basic research activities at universities. At present, basic research in China's universities is still mainly reliant on grants from NSFC, which is set to play an increasingly important role in driving basic research activities at universities.

Since the establishment of NSFC, universities have not only become an important provider of basic research in China's national innovation system but also operated comprehensively and profoundly in the system in fields of S&T, education, economy and society through cooperation with the business and science communities. A great number of important S&T results conducive to national development and livelihood improvement have been achieved.

Thanks to decades' of consistent support to NSFC, Chinese universities' S&T innovation capability has seen a substantial improvement. In terms of the output of science papers, an important measure of knowledge innovation capability, the number of high-level international science papers published by researchers at universities has been increasing year by year and now accounts for more than 62% of China's total, and the quality and quantity have been improving simultaneously.

China has been ranking second in the world in the number of published science papers since 2006, with science papers receiving grants from NSFC accounting for 60.27% in 2014. The quality of China's science papers has been steadily improving over the past decade, with frequently cited papers (1% most cited science papers) accounting for 10.4% of the world's total, ranking fourth. Of the 128 Chinese authors of internationally frequently cited science papers in 2014, in particular, as high as 96.5% received grants from NSFC.

Facts have proven that NSFC has provided a strong support for S&T innovation at Chinese universities and that research projects funded by NSFC can most effectively promote the development of academic theories in various disciplines, the accumulation of academic achievements, the gradual formation of distinctive academic strengths, and the improvement of China's overall R&D capabilities. This provides a boost for carrying out other research projects, thus creating a positive cycle of research capacity building. And an increasing number of key laboratories and disciplines have been established in the process.

Meanwhile, NSFC has helped foster a lot of high-caliber research personnel while promoting the development of extensive academic disciplines. Through project competition and participation in key research projects, many Chinese researchers have not only solidified their knowledge and acquired advanced experiment techniques, but also developed a fearless and daunting spirit and international strategic forward-looking mindset.

(Source: Science and Technology Daily,
April 14, 2015)

Experts Talk on Basic Research

Long-term Basic Research Investment Required for Life Science Development

At the second S&T Innovation Forum jointly sponsored by Science and Technology Daily and the CPC Committee of the Ministry of Science and Technology held in the afternoon of April 9, Prof. Shi Yigong, member of the Chinese Academy of Sciences and Dean of the School of Life Sciences at Tsinghua University, gave a lecture themed on "The Future of Life Science and Human Exploration". According to Prof. Shi, essentially speaking, life science studies the phenomena of life and reveals the laws of vital activities and the essence of life. Its objects of study can be biomacromolecules such as proteins, nucleic acid molecules, cells, tissues and organs like the roots, stems and leaves of plants and internal organs of humans, and they can also be individual living beings like plants, animals and humans, even ecological systems and the biosphere.

When speaking of the percentage of government's research expenditure, Prof. Shi said that China's research spending on life sciences has been constantly increasing. The U.S. government allocates approximately 50% of its research spending on life sciences. NSFC allocated approximately 10% of its budget to life sciences in the 1990s, and the percentage has increased to more than 30% till now. In his opinion, the reason why China gradually increased its research spending on life sciences is that life sciences are closely related to everyday life and health and that long-term investment in basic research are needed to train top-notch talent and develop high-end innovative pharmaceuticals and biotechnologies.

(Source: Science and Technology Daily, April 10, 2015)

Basic ResearchWill Not Slow Down

China's economic development may slow down, but its investment in basic research must be guaranteed, according to CPPCC member Prof. Wang Meixiang at the Department of Chemistry, Tsinghua University. In spite of the steady increase of China's total research spending in recent years, the percentage of basic research spending in the total R&D spending was always as low as around 5% (4.8% in 2012 and 4.7% in 2013) for a long time.

The percentage of fiscal S&T spending on basic research (approximately 15%) have always been rather low and far lower than those in developed countries. In OECD countries, basic research accounts for approximately 20% of their total R&D spending, while in the U.S. the federal government's S&T spending is more than 50% allocated to basic research. In the future, China should gradually increase its investment in basic research by adjusting its S&T expenditure structure and try to double the percentage of spending on basic research in the total central fiscal S&T spending to 30% by 2020. To accomplish this goal, it is important to make adjustments to maintain steady support and an appropriate percentage of competitive allocation of funds based on the superiority of research projects. Specifically, China should take advantage of the reforms of S&T programs by further strengthening long-term steady support of national research bases on the basis of integration and

optimization of laboratories, platforms and projects, trying to increase the percentage of spending on basic research in the total R&D spending to not less than 70% and gradually lowering the percentage of competition-based fund allocation to below 30%. There are two channels of steady support: 1) earmarking stable fiscal expenditure on national labs and national key labs and 2) commissioning national labs and national key labs to undertake national key research projects with the integration of "project, base and talent".

(Source: Science and Technology Daily, March 4, 2015)

China Basic Research Updates

Mechanism of Critical Protease Causing Leukemia Unveiled for First Time

After four years of work, a research team at the Institutes of Biomedical Sciences Fudan University found for the first time the mechanism of a critical protein in the occurrence of leukemia. The finding has important implications for the development of medicines curing leukemia. The finding was published in the website of the prestigious Nature magazine.

The longstanding mystery of how DNMT3A regulates DNA methylation was recently solved by a research team led by Prof. Xu Yanhui. According to their findings, there is a protease named DNMT3A in the human body which exists in inhibitory and active states in crystal structures, which explain DNMT3A's accurate regulation of DNA methylation. DNMT3A exists in two states – preparatory state and working state. When regulating DNA methylation, DNMT3A has two cells – functional cell and regulating cell. In the preparatory state, the regulating cell will bond with the functional cell and inhibit the latter's bonding with DNA, thus keeping DNMT3A in a low-activity state and ensuring that it will not form DNA methylation randomly. And histone H3 which exists widely in DNA will guide the functional cell away from the functional cell so that the functional cell is fully exposed and easily comes into contact with DNA. By this time, DNMT3A enters the high-activity working state. If lysine 4 of histone H3 is unmethylated, DNMT3A will not be activated. This mechanism is "smartly" utilized by the body. If the activity regulation mechanism fails, various diseases including leukemia will occur.

(Source: Science and Technology Daily, December 1, 2014)

Standards for Millimeter-Wave Power Formulated

Thanks to relentless efforts of Chinese researchers, China eventually established its national standards for millimeter-wave (MMW) power on April 10. As an emerging field of radiotelegraphy, MMW applications have made tangible progress in recent years, with MMW signal sources having becoming available in 110GHz and MMW network analyzers having reached the radio frequency limit of 300GHz and entered the THz range. Researchers have completed the formulation of the standards for 40GHz MMW and, using the all-new microcalorimeter technology, gradually established the standards for 75GHz MMW, and are establishing

the standards for MMW power as high as 110GHz by leveraging the thermoelectric calorimeter technology with thermistor mount-based power sensor.

Thermistor mounts have the advantages of quick response and easy installation but are poor in compatibility and face technical challenges as to how to improve the transmission efficiency of MMW signals and increase the signal to noise ratio of thermoelectric signals. By adopting symmetric dual-line design of microcalorimeter and thermopile sensing of transmission line loss, Chinese researchers have solved the issues of short-term fluctuation, long-term drift and efficiency benchmarking of microcalorimeters and developed a method based on "integration of circuit-breaker loss calculation and temperature measurement", which can accurately and reliably evaluate the impact of circuit-breaker loss and effectively reduce the measurement uncertainty of correction factors. Thanks to extensive innovations and adjustments, the system's measurement uncertainty has been reduced by 50%, reaching an internationally advanced level.

The standards for MMW power, formulated by the National Institute of Metrology of China, have reached 0.6% within the full band, the highest level in the world, and solved the issue of traceability of key measurements. Previously, the standards took part in the international key comparison conducted by the International Bureau of Weights and Measures and entered the bureau's international key comparison database. According to results of the comparison, seven countries including China reached 50GHz in their measurement traceability.

(Source: Science and Technology Daily, April 11, 2015)

Formation of Dirac Cones in SiC Silagraphene Revealed

Recently Prof. Liu Yi and his research team at the Department of Physics, Shanghai University discovered two new-structured SiC Silagraphenes that have Dirac cones in electronic band structures, providing a theoretical basis for the R&D and design of new nano electronics materials. The findings were published in the prestigious Journal of Physical Chemistry Letter.

The discovery of graphene was recognized with the Nobel Prize in Physics in 2010 not only because graphene is the first known stable 2D material, breaking the traditional belief that 2D materials are unstable, but also because it has unique Dirac cone structures where Dirac fermions transmit at a near-light speed, making it an ideal material for computer chips of the future. Therefore, people have placed a great hope on emerging electronic materials based on graphene.

Currently, however, the electronic industry is still based on silicon materials. Although Si graphene – Silylene – also has Dirac cones, but its atomic structure is not two-dimensional and not as stable as graphene. The two new SiC Silagraphenes both feature C–C and Si–Si atom pairs and possess Dirac cones. The study also proposes a pair coupling mechanism and the conditions required for Dirac cone formation. The criteria of judgment based on DF calculations are also successfully used to predict the presence of Dirac cones in other 2D binary Dirac fermion systems.

The new findings show that it is possible to adjust electrical properties of Silagraphene by changing its composition ratio and atom arrangement, something that is impossible for graphene or Si graphene. With better industrial compatibility and versatility of properties, SiC Silagraphene will provide a wide range of materials for nano electronics of tomorrow.

(Source: Science and Technology Daily, April 20, 2015)