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International Scientific Cooperation Is Key for The Chinese Academy of Sciences

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China's scientific progress in the last few decades is closely correlated with its active engagement with the international scientific community that started after the normalization of China–US relations and China's Reform and Open-Door Policy in the late 1970s. Although China had a period of cooperation with the former Soviet Union in the 1950s, fully fledged international cooperation has only taken place in the past 20 years. International scientific cooperation has benefited Chinese science and has also benefited the world through collaborations leading to understanding of and solutions to major global challenges. A study of the Chinese Academy of Sciences' (CAS) participation in the international scientific community demonstrates the importance and mutual benefits of such engagement.

China was a world leader in science and technology in ancient times, but was left behind by the development of the West over several centuries. Although modern science was introduced into China in the early 20th Century, it was not until after the founding of New China that real efforts were committed to scientific development, including the founding of the CAS. The past 30 years have seen an enormous effort to develop science and scientific institutions in China, and a gradual increase in its active engagement in international cooperation.

The Chinese Reform and Open-Door Policy had an enormous impact on the country's engagement with the West and on its scientific progress. This policy made it possible for a large number of Chinese scholars and students, including many chemists, to seek higher education and advanced research opportunities in the West. Chinese scholars developed friendships and collaborations with their international counterparts, and as the capacity of Chinese scientific institutions has increased, a positive feedback has occurred and mutually beneficial cooperation has flourished.

Chinese scientists are committed to communication and cooperation with international colleagues. They have experience of international cooperation that contributes to the improvement of scientific standards, the creation of a culture of scientific professionalism, and the drive for hypothesis-led science. Chinese scientists are motivated to cooperate with international colleagues to increase the scientific excellence, efficiency, visibility, and impact of their work. Science by its very nature is a collaborative enterprise that transcends generations, individual scientific disciplines, and national boundaries. On a global scale, humanity needs scientific cooperation to bring together collective wisdom and effort to solve some of the world's most pressing problems. On the individual scale, scientists need continuous engagement with the ideas of others, whatever their origins or nationalities, to make discoveries.

China's international engagement in the past 30 years has developed in three stages: 1) an initial stage of "simply learning from the West", 2) the establishment of mutually beneficial cooperation in selected areas, and now 3) extensive international links and partnerships in a wide range of disciplines. The development of international cooperation can be well illustrated by the examples from CAS. The Partner Group Program between young scientists from the Max Planck Society (MPG) and the CAS is a good example (Table 1).

Initiated in 1999, and focused on disciplines such as astronomy and materials science, 20 such groups have been established and all have achieved encouraging results. The collaboration between Ke Lu at the Shenyang Institute of Metal Research and Manfred Rühle at the Max Planck Institute (MPI) for Metals Research is a prime example. Through a CAS talent training program, a large number of Chinese graduates selected on merit have been to MPG institutes to receive advanced training. While advancing their abilities, they have also contributed to the scientific missions of MPG institutes.

Cooperation and partnerships between the CAS and US scientists have been extensive and extremely productive, with a total of 16010 papers co-authored by CAS and US scientists in the past 10 years, including the contributions from the University of Science and Technology of China.

The long-standing cooperation between CAS scientists and US scientists on global and regional climate change provides another good example. Initiated in 1987, this partnership has produced many important results. The US scientists acquired a large amount of data from China, adding critical information for an upgrade of the US climate change study. The Chinese scientists, while im-

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Table 1: Collaborators in the Partner Group Program between young scientists from the MPG and the CAS.

Partner Group	CAS Institution/Group Leader	MPG Institution/Group Leader
Assembly of Complex and Biomimetic Materials	Institute of Chemistry, CAS/Jun-bai Li	MPI of Colloids and Interfaces/ Helmuth Möhwald
First-Principles Theory of High-Pressure Oxidation Catalysis	Dalian Institute of Chemical Physics, CAS/Wei-xue Li	Fritz Haber Institute of MPG/ Karsten Reuter & Matthias Scheffler
Interfacial and Amorphous Structures in Advanced Ceramics	Shanghai Institute of Ceramics, CAS/Hui Gu	MPI for Metals Research/ Manfred Rühle & Fritz Aldinger
Chemistry and Physics of Solid-State Inorganic Materials	Shanghai Institute of Ceramics, CAS/Jing-tai Zhao	MPI for Chemical Physics of Solids/ Yuri Grin & Rüdiger Kniep
Nanotechnology in Catalysis	Dalian Institute of Chemical Physics, CAS/Xin-he Bao	Fritz Haber Institute of MPG/ Robert Schlögl
Nanostructured Materials Science	Institute of Metal Research, CAS/Ke Lu	MPI for Metals Research/ Manfred Rühle
Nanostructured Modular Materials	Hefei National Laboratory for Physical Sciences at Microscale, University of Science and Technology of China/Shu-hong Yu	MPI of Colloids and Interfaces/ Markus Antonietti
Structure–Activity Relation of Model Systems for Heterogeneous Catalysis	Department of Chemical Physics, University of Science and Technology of China/Wei-xin Huang	Fritz Haber Institute of MPG/ Hans-Joachim Freund

proving their modeling, quickly stepped into the international climate change community. This early recognition has facilitated the Chinese contribution of valuable data and research to Intergovernmental Panel on Climate Change (IPCC) reports.

A highly regarded partnership in high-energy physics has now run for over 30 years. With US assistance in the early stages of this partnership, Chinese scientists quickly developed a high-quality Chinese electron positron collider and related research capabilities. The partners are now dedicating most of their efforts to the construction of the Daya Bay Reactor Neutrino Experiment. The experiment's ideal location and unique design encouraged the US collaborators to contribute half of the core hardware (detectors) to the project. This cooperation has already produced very important results.

The annual Chinese–American Kavli Frontiers of Science Symposium has run for 15 years with meetings held alternately in China and the USA, and focused on eight different scientific themes each year. Attended by over 1200 young scientists from both countries, this program has also been a beneficial opportunity for cultural exchange between the young people of the two countries.

For many years, the Chinese Chemical Society (CCS) has collaborated actively with national chemical societies. In 2004, the German Chemical Society (Gesellschaft Deutscher Chemiker, GDCh) and the CCS initiated the Sino–German Frontiers of Chemistry Symposium in order to initiate collaborations between young researchers from the two countries. The fourth of these symposia will be held in Bejing in September 2012. The collaborative relationship between the CCS and the American Chemical Society (ACS) has led to the creation of a program between the National Science Foundation in the US and the National Natural Science Foundation of China for joint support of cooperative research in chemistry between the two communities. A successful outcome of this program has been the elucidation of the formation, structure, and properties of metal complexes on solid surfaces accomplished through the joint efforts of Peter Stang at the University of Utah and Li-Jun Wan at the CAS Institute of Chemistry (ICCAS). The CCS also has good relationships with the Royal Society of Chemistry (UK), which maintains an office at the ICCAS. These collaborations are part of the underpinning of the success of Chinese chemists in rapidly advancing nanoscience and chemistry research.

The CAS also attaches great importance to promoting scientific progress in the developing world. Through the CAS–Academy of Sciences for the Developing World (TWAS) Fellowship initiated in 2004, CAS annually invites about 50 scientists from developing countries to study and undertake research in CAS institutes.

To further expand international cooperation, the CAS initiated two programs in 2009. Through one program, the CAS has already invited 613 senior international scientists, including 37 in chemistry, to conduct cooperative research in CAS for a few months to a year or more. A second program has hosted 240 young scientists, including 19 in chemistry, to undertake research in CAS institutes for up to two years. The Einstein Professorship Program also operates to bring 20 of the world's best scientific minds to visit China every year. With its Award for International Scientific Cooperation, the CAS aims to honor a few selected international scientists who have made outstanding contributions to Chinese science and international engagement (Table 2).

The examples and initiatives above show that international scientific cooperation in chemistry and other disciplines is an exercise in "give and take" but is not a zero-sum game, and collaborations generate positives for all participants.

International cooperation is very important to Chinese science. Thanks to active engagement, the efforts of Chinese scientists, and the backing of the Chinese government, Chinese science has developed rapidly. The latest statistics show that Chinese scientists contributed about one-tenth of the scientific papers included in the Science Citation Index (SCI) in 2010, and Chinese scien-

Table 2: Some of the international scholars in chemistry who were awarded CAS Fellowships for Senior International Scientists 2009–2011.

Name/Affiliated Institution	CAS Host Scientist/Institute
Daniel Figeys/University of Ottawa, Canada	Hanfa Zou/Dalian Institute of Chemical Physics, Dalian
D. Wayne Goodman/Texas A&M University, USA	Qinlin Guo/Institute of Physics, Beijing
Michael Gottfried/Philipps-Universität Marburg, Germany	Junfa Zhu/University of Science and Technology of China, Hefei
Yuri Grin/MPI for Chemical Physics of Solids, Germany	Jingtai Zhao/Shanghai Institute of Ceramics, Shanghai
Gerald B. Hammond/University of Louisville, USA	Fengling Qing/Shanghai Institute of Organic Chemistry, Shanghai
Brian A. Korgel/University of Texas, USA	Dan Wang/Institute of Process Engineering, Beijing
Todd L. Lowary/University of Alberta, Canada	Biao Yu/Shanghai Institute of Organic Chemistry, Shanghai
Doug MacFarlane/Monash University, Australia	Suojiang Zhang/Institute of Process Engineering, Beijing
Peter Roepstorff/University of Southern Denmark, Denmark	Fuquan Yang/Institute of Biophysics, Beijing
Robin D. Rogers/University of Alabama, USA	Suojiang Zhang/Institute of Process Engineering, Beijing
Vadim Soloshonok/State University of New York, USA	Jinbo Hu/Shanghai Institute of Organic Chemistry, Shanghai
Peter Stang/University of Utah, USA	Li-Jun Wan/Institute of Chemistry, Beijing
Antonio Varandas/Universidade de Coimbra, Portugal	Keli Han/Dalian Institute of Chemical Physics, Dalian
Carlos Omar Della Vedova/Universidad Nacional de La Plata, Argentina	Maofa Ge/Institute of Chemistry, Beijing
Manfred Wagner/MPI for Polymer Research, Germany	Linjie Zhi/National Center for Nanoscience and Technology, Beijing
Keith Wilkinson/Emory University, USA	Yingfang Liu/Institute of Biophysics, Beijing

tists had contributed 836300 scientific papers between 2001 and the end of 2011. Although growth and output in scientific activity has been impressive, Chinese science still has a long way to go. Quality of science, scientific culture, institutions, and scientific journals all need further development with international engagement and support. As President of the CAS, I advocate the running of the Academy with democracy, openness, and scientific talent as the core principles.

The 21st century is fast-paced and ever-changing, and scientific research and development is both pushing the changes and offering solutions to the challenges we face. In the past decade, global investment in research and development has more than doubled and international scientific cooperation has increased exponentially. This is improving our collective access and contribution to new knowledge, as well as our innovation and response to major global problems. Developments in chemistry will be at the forefront of future innovation. Through cooperation between scientists across institutional and national boundaries, we can surely create a better world.