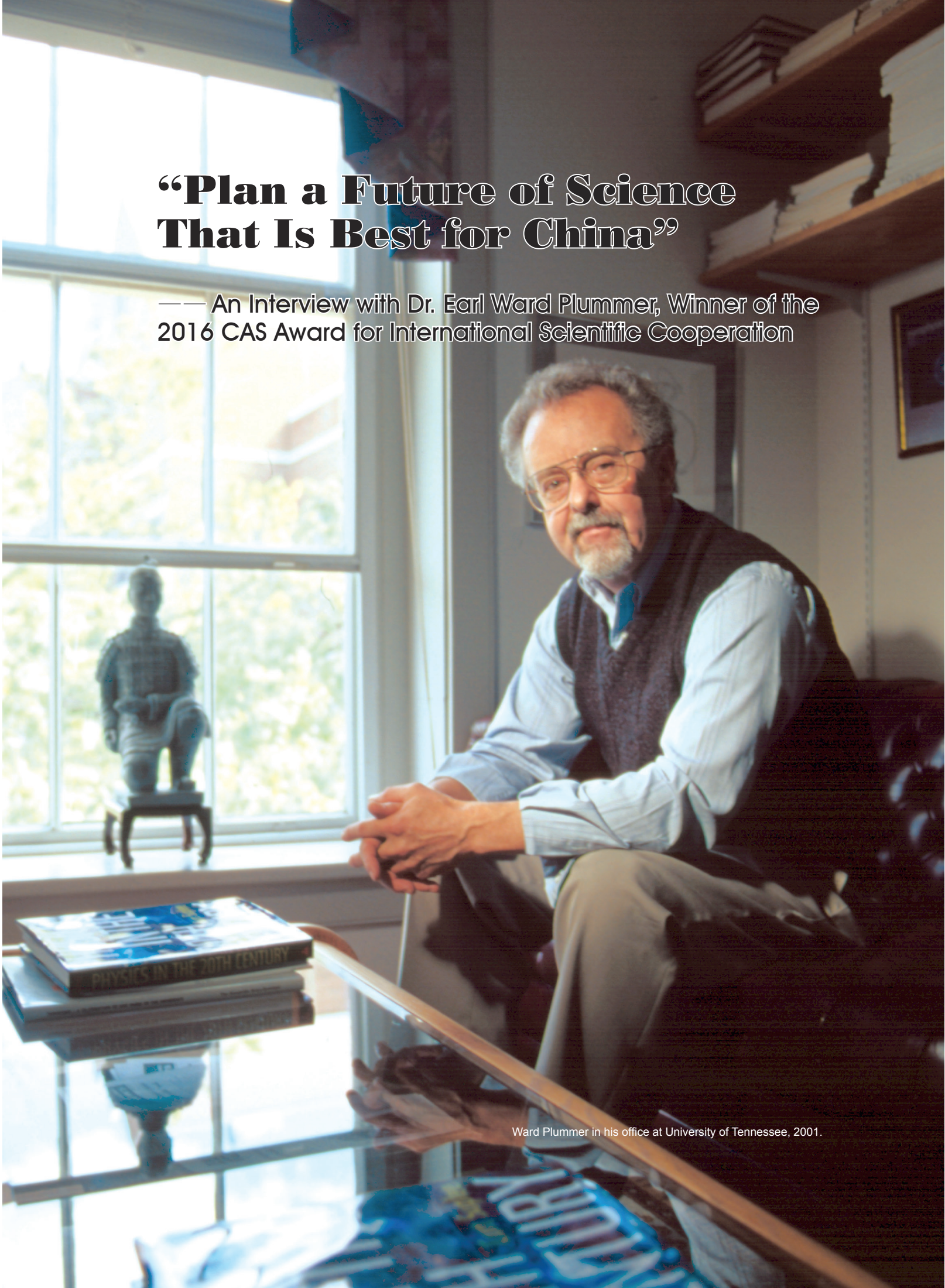
"Plan a Future of Science That Is Best for China"

—— An Interview with Dr. Earl Ward Plummer, Winner of the 2016 CAS Award for International Scientific Cooperation

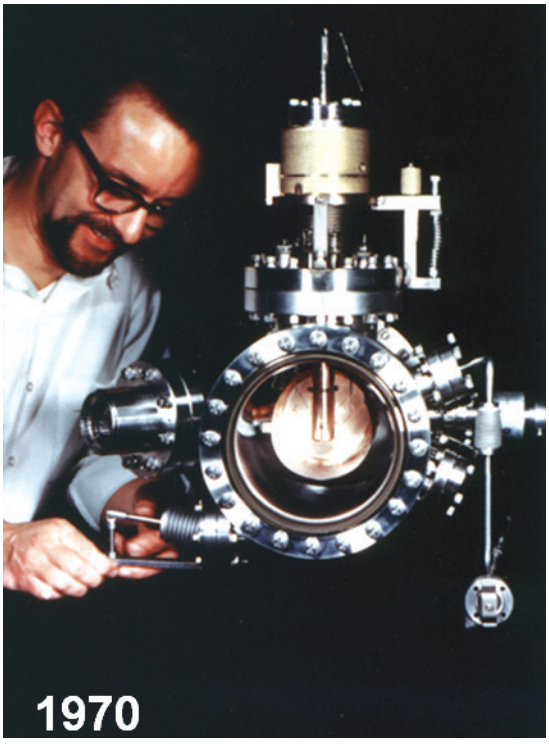


Ward Plummer in his office at University of Tennessee, 2001.

Earl Ward Plummer is a professor at the Department of Physics and Astronomy, Louisiana State University. As an eminent scientist in condensed matter physics, he has developed advanced high-resolution observation methods by focusing on investigations of the phenomena associated with the unique environment at a surface or interface. His research findings in tunneling spectroscopy of single atoms at the surface, photoelectron spectroscopy and low-dimensional electron systems enjoy extremely high International visibility. To date, he has published more than 400 scientific articles and been quoted by other scholars over 17,000 times. He has been elected to the US National Academy of Sciences and is a fellow of the American Academy of Arts and Sciences.

Dr. Plummer's cooperation with CAS started more than 15 years ago. He was the chief scientific adviser when the International Center for Quantum Structures was founded at the CAS Institute of Physics (IOP). He also served as foreign adviser at the High Magnetic Field Laboratory under the Hefei Institutes of Physical Science, was leader of the International expert panel for evaluating the Institute of Physics' 13th Five-Year Plan (2016-2020), and sat on the judging panel for many important awards. Thanks to his active coordination and strong support, the International Center for Quantum Structures has brought together a good number of top young Chinese scientists, many of whom have become leading figures in the academic community, thus laying a solid foundation for advancing China's research capabilities in condensed matter physics.

Over the years, he has promoted substantive cooperation in science and technology as well as talent cultivation between CAS and Louisiana State University. He led an International research team based at IOP and received a great deal of financial support from Chinese government and CAS for this purpose. His team published a total of some 30 articles in top International journals, including *Science*, *PNAS* and *PRL*, and helped nurture many young researchers. With his help, IOP worked with his University to push ahead with dual degree programs. He mentored scores of Chinese graduate and postdoctoral students. In recent years, he made annual visits to China, collaboration with scientist at IOP, giving lectures and workshops and participating in talent cultivation. He made remarkable contributions to CAS's endeavor to build a talent pool of professionals with international vision.



Ward Plummer at the former US National Bureau of Standards, now NIST, in 1970. He and coworkers were using a field emission instrument to collect data and study the surface states of Tungsten. (Photo courtesy Ward Plummer)

Dr. Plummer has also actively promoted cooperation with CAS on many important international occasions. He once delivered a special report on his cooperation experience with China at a high-level forum on France-US cooperation on science and technology. This year, he accompanied US energy officials on a visit to China, and introduced collaboration with CAS in detail. This contribution played a positive role in consolidating and deepening the strategic cooperation between CAS and the US Department of Energy.

How did your cooperation with China start in the first place?

Dr. Plummer: My collaboration with Chinese scholars began very early in my career. In 1975 I hosted my first Chinese graduate student, who has recently been elected to the us National Academy of Sciences. During subsequent years, more than 40% of my Ph.D. students and postdoctoral fellows have been of Asian ancestry. Half of these collaborators have returned to Asia, primarily China, but also to Korea, Japan, and

Indonesia. This exchange of scientists coming to the US and returning to China has created life-long partnerships especially with IOP in Beijing. My connection with and fostering of scientific leaders in China has assured a constant stream of very talented scholars working in my laboratory and allowing me and my students to benefit for the expertise at IOP.

Formally, my collaboration with scientists associated with CAS began in October of 2000, with the opening of the International Center for Quantum Structure (ICQS) at IOP in Beijing. Here you can see a picture of the Center's opening ceremony that shows me seated with Dr. BAI Chunli, who would become the President of CAS in 2011. Standing is a distinguished set of Chinese scholars, five of them would subsequently be elected to the CAS, and four would serve as presidents of top universities, one as vice president. Three have been attracted back to China through the "Thousand Talents Program" and one received the 2016 "Award of Future Science." Especially important to my involvement are long-time friends and colleagues Prof. ZHANG Zhenyu (3rd from right), then at Oak Ridge National Laboratory, now at University of Science and Technology of China and Prof. WANG Enge (5th from right), then director of IOP and founder of ICQS.

Ward Plummer (back row, yellow shirt) at the Tantalus Light Source in Wisconsin in late 1970s. The person in front was Plummer's postdoc Wolfgang Eberhart who went back to Germany and became the director of BESSY I and BESSY II. The person on the left is Brian Tonner, Plummer's student and now working at the University of Central Florida. (Photo courtesy Ward Plummer)

Opening ceremony of the International Center for Quantum Structure (ICQS) at the Institute of Physics on October 30, 2000.

How did the partnership benefit both sides?

Dr. Plummer: When ICQS began in 2000, a distinguished set of international researchers were invited to come to China once a year (me included), to advise and to collaborate. Of the four from the US, three have been elected to the National Academy of Sciences and on to the National Academy of Engineering.

In the beginning, the benefit was primarily for the Chinese, but as time went by we truly benefited. I had a constant flow of high quality students and postdocs from China. Recently, I have really benefitted from the collaboration. I have been a PI or Co-PI on two funded proposals, and we have been able to build equipment in China that I do have access to in the US.

The two proposals are: (1) emergent functionality in novelly architectured complex materials: engineering at the atomic scale, led by ZHANG Jiandi (LSU) and I, supported by IOP from 2011 to 2014, and (2) the control of growth of oxide artificial low dimensional structures and their quantum phenomena, also led by me and ZHANG, with support from the Key External Cooperation Program of the Bureau of International Cooperation, CAS between 2014 and 2016.

In fact, ICQS was such a success that the idea was cloned later by Peking University (International Center for Quantum Material), and USTC (International Center for Quantum Design). The collaborations have also been expanded to include other universities in the US.

How do you see China's progress in science and its challenges ahead?

Dr. Plummer: China has made tremendous progress in science during the last couple decades. This progress is easy to quantify in the number of invited talks at international meeting, and the number of papers published in high profile journals. China has been very successful in attracting distinguished scientists back to China, leading major programs. At the same

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time the country has built major user facilities, such as synchrotrons, neutron sources, and high magnetic field laboratories. The plans for new campuses, institutes, and universities are breath taking.

However, when you are growing so fast, there are always growing pains. China has to plan it scientific future based on an evaluation of what is best for China, not copying a format adapted by US or Europe. For example, there is much discussion in China about "National Laboratories," but in my view it is essential to understand the strengths and weakness of the national laboratories in both the US and Europe. In many aspects, this is a question of top down or bottom up organization of science. I would argue that most of the great discoveries are done by individuals not institutions, so if you build BIG centers in China, it is imperative to protect the individuality of the scientists. During my scientific career the best example of this philosophy was Bell Laboratories, a collection of very talented individuals, who when something exciting happened worked together. The role of the leadership seemed to be to hire the very best and reward them for working together.

In the US, in my view, the most successful national laboratories are the ones who are intimately coupled to a university. In this way the national laboratory and the university benefit from each other. What is happening in China at the present time is that the CAS is creating its own universities to couple with its national laboratories, for example the University of CAS. This means the traditional universities are competing with the national laboratories for students, not working together. Will the hierarchical structure of the Max Planck Institutes in Europe serve the Chinese research endeavor?

China has tremendous talent in the young scientists. Learn how to take full advantage of this talent. Expand programs that fund earlier career research awards, and set up prestigious awards for young scientists.

What are your suggestions for young researchers in China?

Dr. Plummer: Take full advantage of the globalization of science. It is always wise to spend some time in other countries, to see and understand different approaches to science.