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High Temperature Superconductivity: Past, Present and Future

The discovery of high temperature superconductivity (HTS) in the non-inter-metallic compounds $La_{2-x}Ba_xCuO_4$ at 35 K (1986) and $Yba_2Cu_3O_7$ at 93K (1987) has been ranked as one of the most exciting advancements in modern physics, with profound implications for technologies. Before 1986, the highest transition temperature (T_c) was found in the inter-metallic compound of Nb_3Ge at 23 K, a temperature achievable only with the aid of either the rare and expensive liquid helium or the not-so-safe liquid hydrogen. Superconductivity was then considered well understood and nothing more than a laboratory curiosity. Although several practical uses had been developed over the years, the full technological impact of superconductivity was not yet realized because of the low T_c. With the advent of HTS, the situation drastically changed. The superconductivity community was revitalized by the challenge to account for the occurrence of superconductivity at such a high temperature and the anomalous normal state properties in such an unusual class of materials. The newly discovered materials raised hope that a wide range of applications would soon become a reality. In the ensuing 15 years, extensive worldwide research efforts have resulted in great progress in all areas of HTS science and technology. For instance, more than 150 compounds have been discovered with a T_c above 23 K; the T_c has been advanced to a record high of 134 K in $HgBa_2Ca_2Cu_3O_{9-\delta}$ at ambient and 164 K under pressure; many anomalous properties have been observed; various models have been proposed to account for the observations; and numerous prototype devices have been made and successfully demonstrated. In spite of the impressive progress, the mechanism responsible for HTS has yet to be identified; a comprehensive theory remains elusive; the highest possible T_c is still to be found, if exists; and commercialization of HTS devices is not yet realized. In the present talk, I shall give a brief account of the discovery of HTS, summarize the current status, and point out the future prospects of HTS science and technology.

Dr. Paul C. W. Chu is currently serving as Professor of Physics and T. L. L. Temple Chair of Science at the University of Houston, and as President of Hong Kong University of Science and Technology. He was born in Hunan, China, and received the B.S. degree from Cheng-Kung University in Taiwan. After service with the Nationalist Chinese Air Force, he earned the M.S.

degree from Fordham University, Bronx NY, and completed the Ph.D. degree at the University of California at San Diego, all three degrees being in Physics. He has been working on Superconductivity, Magnetism, and Dielectrics.

After doing industrial research with Bell Laboratories at Murray Hill, New Jersey, Dr. Chu held an academic appointment at Cleveland State University. He assumed his appointment at the University of Houston in 1979. He was Director of the Texas Center for Superconductivity at the University of Houston between 1987 and 2001. He had also served as consultant and visiting staff member at Bell Labs, Los Alamos National Lab, the Marshall Space Flight Center, Argonne National Lab, and DuPont at various times.

He has been working on superconductivity since his days with Bernd T. Matthias at the University of California at San Diego. In January 1987, Dr. Chu and his colleagues achieved stable superconductivity at 93 K (-180 °C), above the critical temperature of liquid nitrogen (-196 °C). They continue to find new compounds with high transition temperatures. Recently, they again obtained stable superconductivity at a new record high temperature of 164 K (-109 °C) in another compound when compressed. Presently, he is actively engaged in the basic and applied research of high temperature superconductivity. His research activities extend beyond superconductivity to magnetism and dielectrics. His work has resulted in the publication of more than 460 papers in refereed journals.

He has been elected as a member of the National Academy of Sciences, the American Academy of Arts and Sciences, the Chinese Academy of Sciences (Beijing), the Academia Sinica (Taipei), the Third World Academy of Sciences, and the Electromagnetic Academy, and is a Fellow of the American Physical Society and the Texas Academy of Sciences. He has received honorary doctorates from Northwestern University, Fordham University, The Chinese University of Hong Kong, Florida International University, The State University of New York at Farmingdale, Hong Kong Baptist University, and Whittier College. In 1990 he was selected the Best Researcher in the U.S. by US News and World Report.

He has received numerous awards, including the National Medal of Science, the International Prize for New Materials, the Comstock Award, Texas Instruments' Founders' Prize, the Leroy Randal Grumman Medal, the World Cultural Council Medal of Scientific Merit, the New York Academy of Sciences' Physical and Mathematical Science Award, the Bernd Matthias Prize (M2S-HTSC), the Award of Excellence in Scientific Accomplishments (World Congress on Superconductivity), the St. Martin de Porres Award, the Esther Farfel Award (University of Houston), and the John Fritz Medal (American Association of Engineering Societies). He serves on the editorial boards of various professional journals and is a member of the board of directors of the Council on Superconductivity for American Competitiveness.
