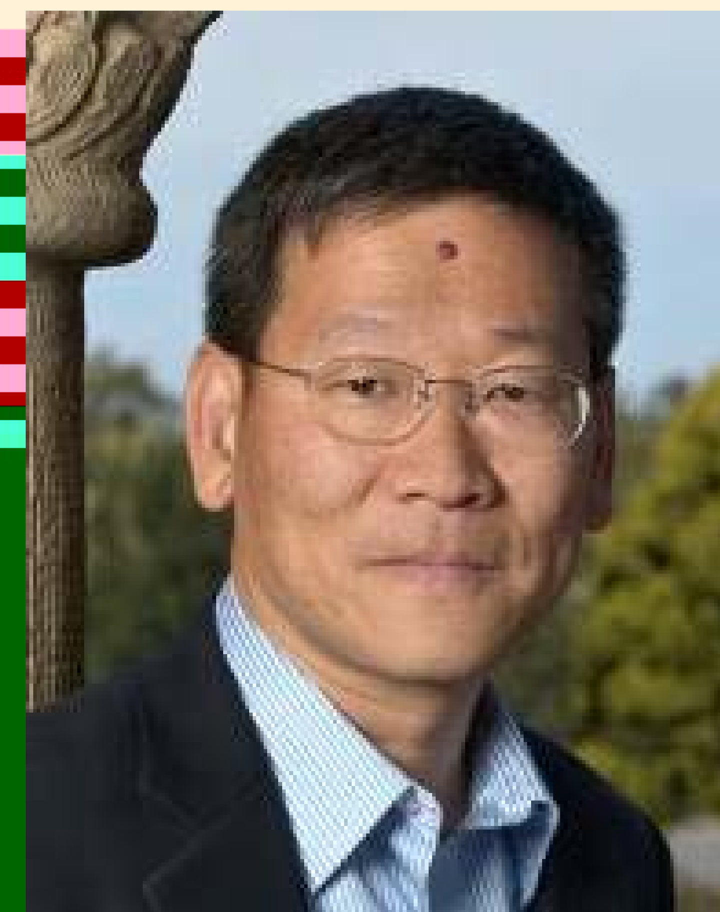
Bridging the Gap in High Temperature Superconductor

Time: 3:30pm, Oct. 18, 2011 (Tuesday)
Venue: Sunny Hall, Ying Jie Conference Center
Speaker: Prof. Zhi-Xun Shen (Standford University)



Abstract

Zhi-Xun Shen Department of Physics and Applied Physics Stanford University, CA94305 Stanford Institute for Materials and Energy Sciences SLAC National Accelerator Laboratory and StanfordUniversity Stanford, CA94305 It is now exactly 100 years since superconductivity was discovered and it took 45 years before a complete theory was formulated by Bardeen-Cooper-Schrieffer. Once understood, the impact has been felt far behind superconductivity itself, and superconductivity became a prime example of emerging properties in quantum system. High-Tc superconductivity in cuprate oxides was discovered 25 years ago and it remains a major unsolved physics problem today. The challenge of the cuprate research is symbolized by its complex phase diagram consists of states with extreme and unconventional properties in addition to unconventional superconductivity – such as Mott Hubbard insulating state, the peculiar pseudogap state, and so-called strange metal state. None of them are understood by conventional theory, thus compounding the difficulty to understand high-Tc superconductivity itself as these states are different manifestations of the same underlying physical system, making an integrated understanding a necessity. Angle-resolved photoemission spectroscopy (ARPES) has emerged as a leading experimental tool to address this problem. Over the last two decades, substantial progress towards understanding the cuprate problem has been made in concert with breathtaking progresses in ARPES technique. In this talk, I will use ARPES derived energy gap as a bridge to link the relationship between the different parts of the phase diagram, with focus on the complex relationship between pseudogap state and superconductivity. The result points to a trisected superconducting dome with interweaving states. In particular, our data is consistent with the presence of a quantum critical point, accompanied by strong dynamic competition between superconductivity and pseudogap state nearby. Such phase competition will likely emerge as a key signature of high-Tc physics, and suggests a revised phase diagram for cuprates that reconciles two conflicting versions currently used in the field.

References: ZX Shen et al., Phys. Rev. Lett. 70 1553 (1993) D.S. Marshall et al., Phys. Rev. Lett. 76, 4841 (1996) A.G. Loeser et al., Science, 273, 325 (1996) K. Tanaka, Science 314, 1910 (2006) W.S. Lee et al., Nature 450, 81 (2007) M. Hashimoto et al., Nature Physics 6, 414-418 (2010) R. He et al., Science, 331, 1579 (2011)

About the Speaker

Prof. Shen received his Ph.D. in Applied Physics from Stanford University in 1989, M.S. from Rutgers University in 1985, and B.S from Fudan University in 1983. He is the Paul Pigott Professor in Physical Sciences of Stanford University, and has been a Professor of Physics, Applied Physics, and SLAC Photon Science since 2000, an Associate Professor (1996-2000), and Assistant Professor (1992-1996). He is the Chief Scientist of SLAC National Accelerator Laboratory (2010-). He is also the founding Director of the Stanford Institute for Materials and Energy Sciences (SIMES) (2006-). Prof. Shen's research interest lies in the area of condensed matter and materials physics, as well as the energy applications of materials. His current research topics include: superconductivity and electronic materials, nano-structured diamond, photon enhanced thermionic emission for solar concentrator systems. He develops precision instrumentation, involving modern light sources, photoelectron, laser and microwave spectroscopy and imaging. Dr. Shen's awards include: American Physical Society Centennial Lecture (1999); Kammerlingh Onnes Prize (2000); The Takeda Foundation Techno-Entrepreneurship Award (2002); American Physical Society Fellow (2002); Invitee of Solvay Conference on Physics (2008); E.O. Lawrence Award (2009).

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