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Zhi-Xun Shen

Emerging Properties of Quantum Matter - Case Studies of Topological and Superconducting Phases

Emerging properties in quantum matter is a major theme of modern physics, with the promise that insights gained would have implications far beyond these materials. This talk will address two interesting examples - topological insulators and high-temperature superconductors.

A class of new quantum matter, so-called topological insulators, has unique properties. It has a symmetry-protected surface state in the absence of time-reversal symmetry breaking, leading to dissipationless edge currents. The strong spin-orbit coupling provides an interesting way to manipulate spin through orbital current. This new class of materials provides a platform for the study of novel physics as well as an opportunity for potential new technologies. After a brief tutorial, angle-resolved photoemission spectroscopy (ARPES) data will be discussed, focusing on the following: i) realization of a large gap topological insulator with a single Dirac cone, ii) creation of a massive Dirac fermion on the surface of a topological insulator with broken time-reversal symmetry, and iii) observation of a single Dirac cone topological surface state in a candidate topological superconductor.

The second part of the talk will report recent advances in the study of cuprate superconductors. It is now exactly 100 years since superconductivity was discovered and it took 45 years before a complete theory was formulated. High-T_c superconductivity was discovered 25 years ago and it remains a major unsolved physics problem today. Recent ARPES results that suggest phase competition is a central piece of the cuprate physics will also be discussed.

Zhi-Xun Shen is the Paul Pigott Professor in Physical Sciences of Stanford University, a member of the executive committee and senior fellow of the Precourt Institute for Energy, and a Professor of Electrical Engineering by courtesy. He is Chief Scientist of SLAC National Accelerator Laboratory and the first director of the Stanford Institute for Materials and Energy Sciences, a joint institute between SLAC and Stanford University. Prof. Shen has created a body of literature that advances our understanding of quantum matter, in particular the physics of high-temperature superconductivity. He has more than 300 publications and H citation index of 64, with six of his papers identified by the citation tracking algorithm of the ISI as among the most cited recent physics papers in its periodic surveys. His work has been recognized by the Kammerlingh Onne Prize, the E.O. Lawrence Award, and the Oliver E. Buckley Prize. He is a co-inventor of numerous patents, including the non-resonance near-field microwave impedance microscopy technology that is finding application in a range of materials, and earned the Takeda Foundation Techno-Entrepreneurship Award. For his co-invention of Photon Enhanced Thermionic Emission for Concentrator Solar Energy Conversion and other works, he was recognized as a Finalist for Energy Technology by World Technology Network in 2010. Shen was a member (and vice chair) of the Basic Energy Science Advisory Committee of the U.S. Department of Energy. He was the chair of Science Advisory Committee for the Advanced Light Source of the Lawrence Berkeley National Laboratory (97-99).

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