



Weekly Seminar

Electronic conduction properties of indium tin oxide: Single-particle and many-body transport

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Time: 4:00pm, May. 21, 2014 (Wednesday)

时间: 2014年5月21日 (周三) 下午4:00

Venue: Room 607, Conference Room A, Science Building 5

地点: 理科五号楼607会议室

Abstract

Indium tin oxide (Sn-doped $\text{In}_2\text{O}_{3-\delta}$ or ITO) is a very interesting and technologically important transparent conducting oxide. This class of material has been extensively investigated for decades, with research efforts mostly focusing on the application aspects. The fundamental issues of the electronic conduction properties of ITO from room temperature down to low temperatures have rarely been addressed thus far. Studies of the electrical-transport properties over a wide range of temperature are essential to unraveling the underlying electronic dynamics and microscopic electronic parameters. We show that one can learn rich physics in ITO material, including the semi-classical Boltzmann transport, the quantum-interference electron transport, as well as the many-body Coulomb electron-electron interaction effects in the presence of disorder and inhomogeneity (granularity). To fully reveal the numerous avenues and unique opportunities that the ITO material has provided for fundamental condensed matter physics research, we demonstrate a variety of charge transport properties in different forms of ITO structures, including homogeneous polycrystalline thin and thick films, homogeneous single-crystalline nanowires, and inhomogeneous ultrathin films. In this manner, we not only address new physics phenomena that can arise in ITO but also illustrate the versatility of the stable ITO material forms for potential technological applications. We emphasize that, microscopically, the novel and rich electronic conduction properties of ITO originate from the inherited robust free-electron-like energy bandstructure and low-carrier concentration (as compared with that in typical metals) characteristics of this class of material. Furthermore, we notice that a low carrier concentration leads to slow electron-phonon relaxation. We focus our discussion on the metallic-like ITO material.

About the Speaker

Prof. Juhn-Jong Lin received his scientific training at National Chiao Tung University (B.S., 1979), Purdue University (Ph.D., 1986), University of Michigan (Post-doc, 1986–1987), and University of Virginia (post-doc, 1987–1988). He was a faculty at the National Taiwan University (1988–1997) before joining the faculty at the NCTU in 1997. He is a Distinguished Professor at the NCTU and a fellow of the Physical Society of Republic of China (Taiwan). His research areas cover the low temperature physics, mesoscopic physics, and quantum electron transport in low-dimensional systems.