CNMS DISCOVERY SEMINAR SERIES

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Iran Thomas Auditorium, 8600

Charge and Spin Transports at Surfaces of Strong Electron-Phonon/Spin-Orbit-Coupling Materials

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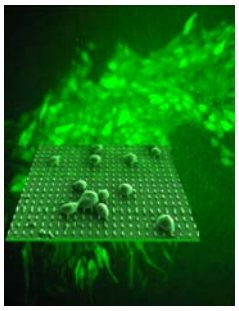

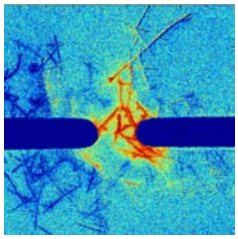

Abstract:

Transports of charge as well as spin at crystal surfaces are now intensively studied by various kinds of experiments. Surface electronic states are generally decoupled from the bulk states and therefore intrinsically low-dimensional. Furthermore, space-inversion symmetry is broken down at crystal surfaces. These effects provide rich physics of transport, especially on surfaces of strong electron-phonon-coupling (EPC) and spin-orbit-coupling (SOC) materials.

Monolayer of Indium-covered Si surface, Si(111)-R7xR3-In surface superstructure, is known to show a large electron-phonon coupling constant [1] and exhibit an energy-gap opening below about 3 K, which is assigned to be a superconducting gap [2]. We have recently confirmed by 'sub-Kelvin micro-four-point probe method' that this is the first example of 'monolayer superconductor'. The superconducting transition was very broad due to Kosterlitz-Thouless transition for a 2D system.

The surface-state bands are known to be spin-split of strong SOC crystals such as Bi and Bi alloys, which is called by Rashba effect [3-6]. Similar effect is observed on a special kind of materials called topological insulators such as BiSb, BiSe, and BiTe alloys. Some of them have spin-split Dirac-cone type surface-state bands. This implies that spin-polarized current will flow at the surfaces of such materials. In my presentation, by using samples of pure Bi [3-6], BiSb [7], BiSe [8,9], and BiTe, I will show that the surface-state bands are really spin-split and the Dirac-cone conductivity is directly measured by microscopic four-point probe method. An on-going project to detect the spin-polarization of surface current by using magnetic tips in a four-tip STM will be also introduced.

[1] S. Yamazaki, et al., Phys. Rev. Lett. **106**, 116802 (2011). [2] T. Zhang et al., Nature Phys. **6**, 104 (2010). [3] T. Hirahara, et al., Phys. Rev. Lett. **97**, 146803 (2006). [4] T. Hirahara, et al., Phys. Rev. B **76**,153305 (2007). [5] T. Hirahara, et al., Appl. Phys. Lett. **91**, 202106 (2007). [6] T Hirahara, et al., New J. Phys. **10**, 083038 (2008). [7] T. Hirahara, et al., Phys. Rev. B**81**, 165422 (2010). [8] Y. Sakamoto, et al., Phys. Rev. B**81**, 165432 (2010). [9] T. Hirahara, et al., Phys. Rev. B**82**, 155309 (2010).

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