Weekly Seminar

Exploring novel ferromagnetic and superconducting orders via proximity effect in material heterostructures

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Abstract

Proximity effect in multilayer heterostructures allows the creation of electronic excitations or quasiparticles with mixed physical characters that is usually impossible to be obtained in a single material. For example, it allows quasiparticles with combined characters of superconductivity, ferromagnetism, and spin-orbit coupling etc. As a result, unconventional electronic excitations can be built. In particular, inducing superconductivity into well-defined metallic surface band with giant spin-obit coupling and Zeeman splitting have been shown as candidate for Majorana fermion [1]. In this talk, I will first present our most recent results in building novel ferromagnetic ground states of Dirac electrons in graphene [3], as well as inducing ferromagnetic order in topological insulators (TI) [2]. They further exemplify a precise and clean approach in modulating the spins of two-dimensional materials using the local exchange magnetic field. These experiments are done in heterostructures of graphene/EuS or TI/EuS with EuS a typical ferromagnetic insulator. Secondly, I will present our device based heterostructure platform for creating and detecting Majorana fermions using the nanowires of epitaxial gold heterostructure. By means of electron tunneling spectroscopy, I will demonstrate the unconventional superconductivity induced in the two-dimensional surface states of gold [4], in one dimensional gold nanowire, as well as possible tunneling signatures that may hint the Majorana fermion.

References:

[1.] Potter, A. C. and Lee, P. A., Topological superconductivity and Majorana fermions in metallic surface states, *Phys. Rev. B* **85**, 094516 (2012)

[2.] Wei, P., Katmis, F., Assaf, B. A., Steinberg, H., Jarillo-Herrero, P., Heiman, D. & Moodera, J. S., Exchange-Coupling-Induced Symmetry Breaking in Topological Insulators, *Phys Rev Lett*