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Quantum Anomalous Hall Effect in Hetero Magnetic Topological Insulator Structures[1]

KANG WANG, UCLA

The quantum anomalous Hall effect (QAHE), which has the quantized Hall conductance of h/e^2 in the absence of external field, was expected to happen in a magnetic 3-D topological insulators (TIs) system. In this talk, we report recent progress of QAHE-related physics in the TRS-breaking field. In the first part, we show the generation of robust magnetism by doping magnetic ions (Cr) into the host $(Bi_xSb_{1-x})_2Te_3$ materials. With gate-controlled magneto-transport measurements, we demonstrate the presence of both the hole-mediated RKKY coupling and carrier-independent van Vleck magnetism. By adjusting the Cr doping concentration and Bi/Sb ratio, we establish an effective way to experimentally approach to the QAHE region. The second part of this talk discusses the manipulation of surface-related magnetism in the modulation-doped TI/Cr-doped TI heterostructures. We investigate the role of massive surface Dirac fermions in the bulk RKKY mediation process. Both our theoretical models and experimental results reveal that the topological surface-related magnetic order can be either enhanced or suppressed, depending on the magnetic interaction range between the surface states and Cr ions. Based on such TI heterostructures, we also demonstrate the magnetization switching via giant spin-orbit torque induced by the in-plane current. Finally, in order to make these effects observable at 300K, we describe the use of magnetic proximity effects to manipulate the surface magnetism of TI. These results not only demonstrate additional important steps to further explore fundamental properties of the TRS-breaking TI systems but also may help the realization of many functionalities of TI-based spintronics applications.

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