Abstract for an Invited Paper
for the MAR10 Meeting of
The American Physical Society

Tunable topological insulators with a single spin-polarized surface Dirac cone

DAVID HSIEH, Princeton University

The topological insulator is a fundamentally new time-reversal-invariant topologically ordered phase of matter, which exhibits exotic quantum-Hall-like behavior even in the absence of an applied magnetic field. These materials are characterized by a spin-orbit coupling induced bulk energy gap and an odd number of spin-polarized Dirac cones localized on their surfaces. In this talk, I will review the first experimental realization of the topological insulator in $Bi_{1-x}Sb_x$[1,2], and then report our recent experimental discovery and findings of a new generation of topological insulators with order-of-magnitude larger bulk band gaps and a single spin-helical surface Dirac cone [3,4]. I will also discuss a novel 'effective gating' technique that can be used to optimize the insulating properties of the bulk, and to tune the Dirac carrier density on the surfaces of these new topological insulators [5]. These experiments pave the way for future transport based studies of topological insulator devices, and offer the potential for a graphene-like revolution to take place for topological insulators. [1] "A topological Dirac insulator in a quantum spin Hall phase", D. Hsieh et al., Nature 452, 970 (2008). [2] "Observation of unconventional quantum spin textures in topological insulators", D. Hsieh et al., Science 323, 919 (2009). [3] "Observation of a large-gap topological-insulator class with a single Dirac cone on the surface", Y. Xia et al., Nature Phys. 5, 398 (2009). [4] "Observation of time-reversal-protected single-Dirac-cone topological-insulator states in Bi_2Te_3 and Sb_2Te_3", D. Hsieh et al., Phys. Rev. Lett., 103, 146401 (2009). [5] "A tunable topological insulator in the spin helical Dirac transport regime", D. Hsieh et al., Nature 460, 1101 (2009).