Abstract
A topological insulator is a material with a bulk excitation gap generated by the spin orbit interaction, which is topologically distinct from an ordinary insulator. This distinction, characterized by a Z_2 topological invariant, necessitates the existence of gapless electronic states on the sample boundary, which have important implications for electronic transport. In two dimensions, the topological insulator is a quantum spin Hall insulator, which is a close cousin of the integer quantum Hall state. In this talk we will outline the theory of this phase and describe two recent experiments in which its signatures have been observed. (1) Transport experiments on HgTe/HgCdTe quantum wells have demonstrated the existence of the edge states predicted for the quantum spin Hall insulator. (2) Photoemission experiments on the semiconducting alloy Bi_{1-x} Sb_x have observed the gapless surface states predicted for a three dimensional topological insulator. We will close by arguing that the proximity effect between an ordinary superconductor and a topological insulator leads to a novel two dimensional interface state which may provide a new venue for realizing proposals for topological quantum computation.