Experimental Discovery of several classes of Topological Insulators and related Superconductors using Spin-sensitive novel spectroscopic methods

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The topological insulator is a fundamentally new phase of quantum matter, which exhibits exotic quantum-Hall-like behavior even in the absence of an applied magnetic field and unlike the quantum Hall liquids can be turned into superconductors [1]. In this talk, I will briefly review the first experimental discovery and realization of the topological insulator in Bi-Sb [2,3], and then report our discovery a new generation of topological insulators with order-of-magnitude larger bulk band gaps and a single spin-helical surface Dirac cone [4,5,6] and experimentally demonstrate *all* defining properties of topological insulators such as (1) Topological Spin-Textures [3,5,6], (2) Spin-momentum helical locking [3,6], (2) Non-trivial Berry's phases [3,6], (3) Absence of backscattering or no U-turn [5,7], (4) Protection by time-reversal symmetry [1,5], (5) Room temperature topological order [6], (6) Superconductivity and Magnetism in doped topological insulators [8,9].

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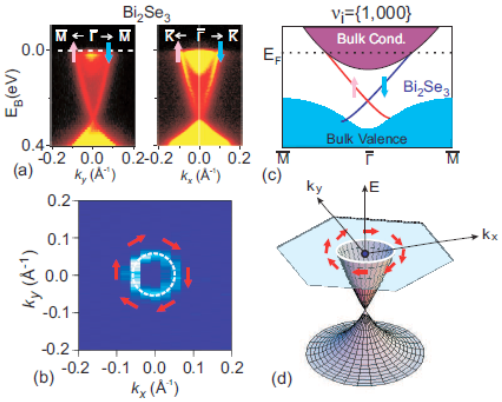

Figure 1: First direct measurement of Z_2 Topological Order : Helical Dirac fermions with spin-textures and p Berry's phase observed at 300K (room temperature) in the largest gap topo. insulator Bi_2X_3 (X=Se/Te).