Topological spintronics

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Tetradymite narrow band gap semiconductors (Bi_2Te_3, Bi_2Se_3, Sb_2Te_3, and their alloys) are now known to support topologically protected, two dimensional (2D) helical Dirac fermion surface states characterized by a spin-texture in momentum space [1,2]. Originally predicted by first principles calculations [3], spin- and angle-resolved photoemission spectroscopy firmly demonstrated [4,5] the linear dispersion and the "spin-momentum locking" of the 2D surface states in these three dimensional (3D) "topological insulators." More recently, the spin-momentum locking has also been measured using electrical transport measurements [6-10]. The spin-momentum locking of 2D helical Dirac states lends itself naturally to spintronic device applications that might exploit efficient spin--charge interconversion. This talk will first present an overview of concepts and experiments that explore the emergence of "topological spintronics," a potential device technology that exploits the strong spin-orbit coupling in topological insulators for efficiently manipulating the magnetization of a vicinal ferromagnet [11-15]. We will then focus on recent experiments that probe spin-charge interconversion at interfaces between a 3D topological insulator and an insulating ferrimagnet [16], with a particular view toward understanding how the spin Hall conductivity in topological insulators varies with chemical potential [17]. Finally, we address the interesting device possibilities presented by idealized topological insulator/ferromagnetic insulator devices [18] and discuss pathways aimed at testing such proposals.

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