Chern insulators from heavy atoms on magnetic substrates

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Since the work of Haldane[1] twenty-five years ago, it has been known that two-dimensional insulating systems with spontaneously-broken time reversal symmetry and spin-orbit coupling can have non-zero Chern numbers. Recently, there has been a renewed theoretical and experimental interest in finding an experimentally realizable example of such a Chern insulator, which would display much of the physics of the Quantum Hall effect without requiring large magnetic fields or low temperatures. We propose a new strategy for constructing Chern insulators, which consists of depositing atomic layers of elements with large spin-orbit coupling (e.g., Bi) on the surface of a magnetic insulator. We argue that such systems will typically have isolated surface bands with non-zero Chern numbers. If these overlap in energy, a metallic surface with large anomalous Hall conductivity (AHC) will result; if not, a Chern-insulator state will typically occur. Thus, our search strategy reduces to looking for examples having the Fermi level in a global gap extending across the entire Brillouin zone. We verify this search strategy and identify several candidate systems by using first-principles calculations to compute the Chern number and AHC of a large number of such systems on MnTe, MnSe, and EuS surfaces. Our search reveals several promising Chern insulators with gaps of up to 140 meV.

[1] F.D.M. Haldane, Phys. Rev. Lett. **61**, 2015 (1988).