Quantum anomalous Hall states on decorated magnetic surfaces

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Twenty-five years ago, Haldane [1] pointed out the possibility that a 2D crystalline insulator with broken time-reversal symmetry could exhibit a quantized Hall conductivity in the absence of an external magnetic field, potentially at room temperature. Despite the enormous recent interest in topological insulators of the non-magnetic type, it is only recently that an experimental realization of Haldane's "quantum anomalous Hall" (QAH) or "Chern insulator" state has been claimed. Specifically, the group of Ref. [2] demonstrated the QAH state at low temperature in a thin film of a topological insulator doped with magnetic impurities. I shall report on our recent work [3] in which we propose a different possible route to the QAH state formed by the deposition of a fractional monolayer of heavy atoms (providing strong spin-orbit coupling) onto the surface of an insulating ferromagnet or antiferromagnet (providing broken time-reversal symmetry). We demonstrate the concept by carrying out first-principles calculations of layers of Au, Hg, Pb, Bi, etc. on magnetic substrates such as MnSe, MnTe, and EuO, showing that the QAH state can be attained in this way, with band gaps sometimes extending above 100 meV. While the particular surfaces that we have studied may prove to be thermodynamically unstable, we believe this general strategy may eventually lead to room-temperature QAH systems.

[1] F.D.M. Haldane, Phys. Rev. Lett. **61**, 2015 (1988).
[2] C.-Z. Chang et al., Science **340**, 167 (2013).
[3] K.F. Garrity and D. Vanderbilt, Phys. Rev. Lett. **110**, 116802 (2013).