MAR11-2010-001574

Abstract for an Invited Paper
for the MAR11 Meeting of
the American Physical Society

Theory of surface phenomena in topological insulators

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Recently discovered topological insulators (TIs) are materials with bulk bandgap and robust gapless surface states protected by topological invariants that characterize their bulk band structure. After a brief introduction to the physics of TIs I will describe recent theoretical advances in understanding the behavior of surface electrons in the presence of both magnetic and non-magnetic impurities, surface steps, as well as magnetic and superconducting coating. The key property of the topological surface states – absence of backscattering from non-magnetic defects – leads to a number of features that stand in a stark contrast to the physics of ordinary non-topological states. Among these are vastly enhanced transmission through crystal steps, absence of quasiparticle interference patterns caused by non-magnetic impurities and formation of a gap in the presence of magnetic impurities.