



Two-dimensional Dirac fermions in a topological Insulator

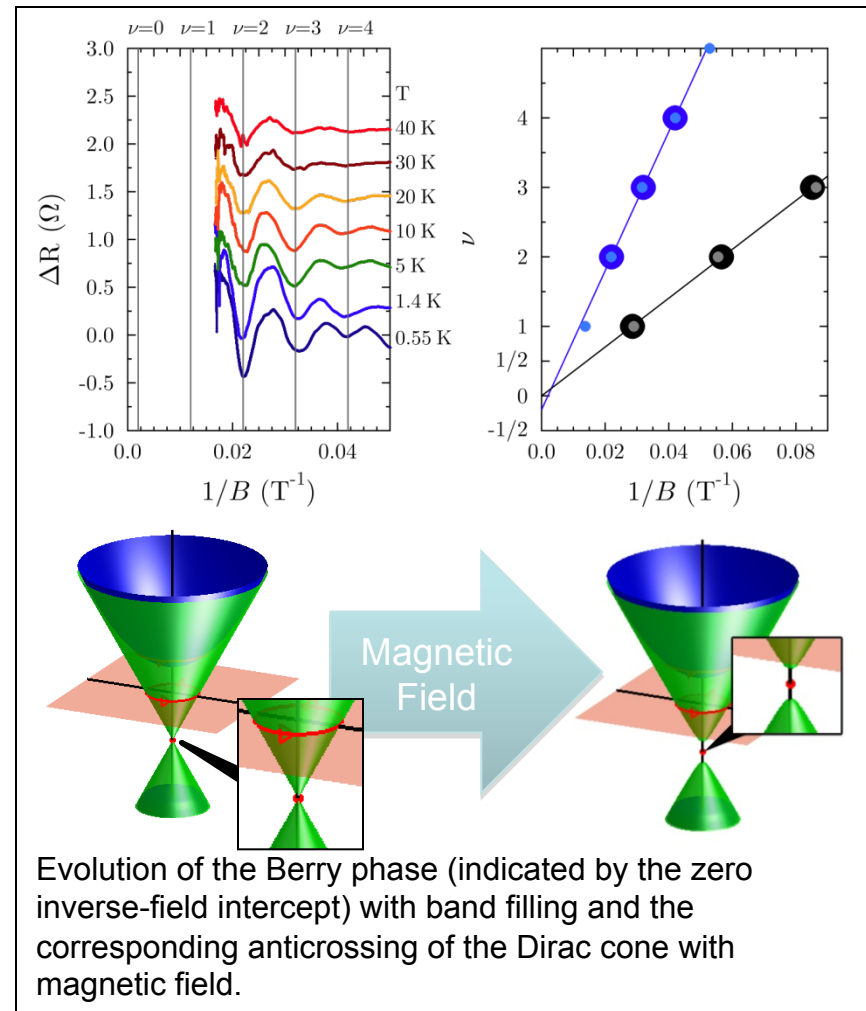
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Following the predicted existence of topologically insulating matter, a large number of surface-sensitive probes reported the existence of Dirac quasiparticles, similar to those in graphene, on the surface of single crystals of Bi_2Se_3 . Measuring the conductivity of this surface state is non-trivial because the conductivity of these compounds tends to be dominated by the bulk of the material due to chemical imperfection. Application of high magnetic fields collapses these bulk carriers to their lowest Landau level revealing the signature of the two-dimensional surface state. An important aspect of this quantum oscillation signature is that the berry phase evolves approaching the quantum limit, corresponding to the Zeeman energy lifting the degeneracy of the zeroth Landau level. This equates to a magnetic field induced mass (band curvature) arising from time reversal symmetry breaking anticrossing the upper and lower Dirac cones.



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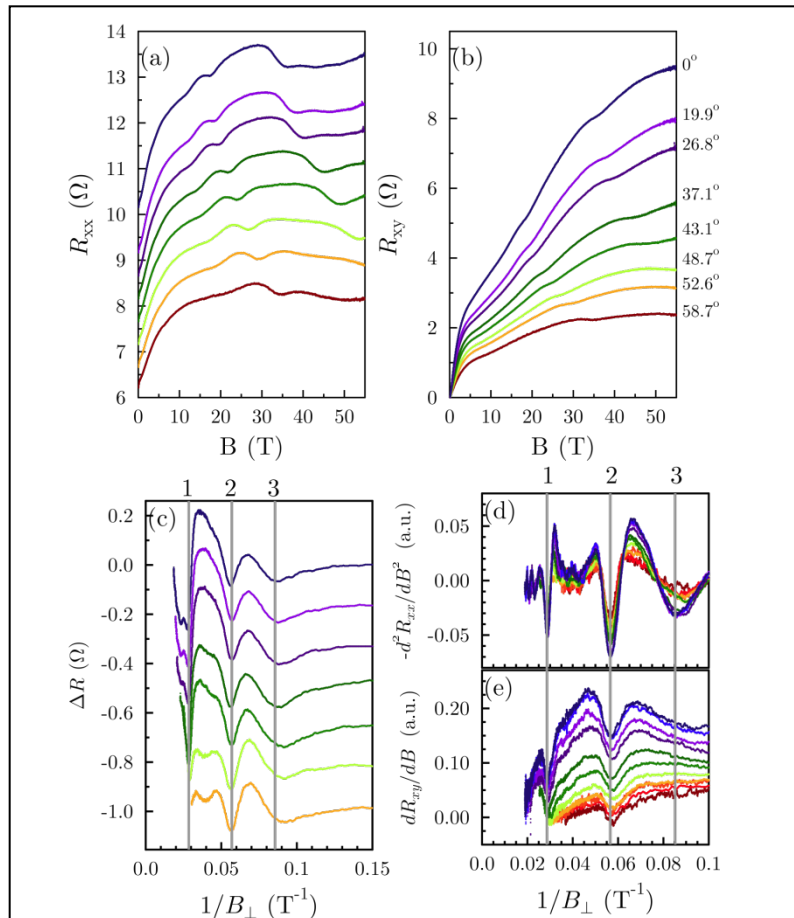


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Angular dependence of quantum oscillations: the dependence upon the component of field perpendicular to the surface indicates their 2D origin.

The topological insulator is a unique state of matter that possesses a metallic surface state of massless particles known as Dirac fermions, whose spin is coupled to their momentum. Due to the preservation of time-reversal symmetry, this coupling protects the wavefunctions against disorder and in principle allows dissipationless transport. The experimental realization of this state of matter in Bi_2Se_3 and Bi_2Te_3 has sparked considerable interest due both to their potential in novel spintronic devices and in the investigation of the fundamental nature of topologically non-trivial quantum matter.

Pulsed magnetic fields have enabled the the 2D quantum limit of the surface Dirac Fermions to be reached. In this limit, quantum oscillations corresponding to fractional Landau level filling are observed suggesting that correlation effects can be important in this new state of quantum matter.

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