Quantum Interference Theory of Magnetoresistance in Topological Materials

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Topological insulator and semimetal have attracted much attention and witnessed impressive theoretical and experimental breakthroughs in the past decades. Recently, an intriguing magnetic field-driven crossover from positive to negative magnetoresistance (MR) has been widely observed in variety of topological materials, where a notch-shaped longitudinal MR appears in the vicinity of the zero magnetic field and turns into a negative MR when the magnetic field exceeds some critical value. The origin of the notch at small field is not completely understood and may arise from quantum interference effect or the Zeeman energy. The large negative longitudinal MR at higher field is commonly attributed to the chiral anomaly and regarded as a crucial transport signature for Weyl fermions but some other mechanisms are also proposed. In this talk, I will introduce a quantum interference theory for magnetoresistance in topological materials. Strong competition between weak localization and weak anti-localization is uncovered in the massive and massless Dirac particles in topological materials, in which the conduction bands and the valence bands are strongly coupled. This will be reflected through the non-monotonic behaviors of magnetoresistance in these materials. Some mechanisms are also discussed.

References

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