Freie Universität Berlin

Colloquium
Dahlem Center for Complex Quantum Systems

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Transport in Topological Insulators

Location: Hörsaal A (1.3.14)

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Abstract:

An emergent topic in physics is the discovery of new phases of matter. The quantum Hall state has been the first state of matter that is not classified by symmetry breaking but forms a topologically distinct phase, which is unaffected by small perturbations. In the last few years, another class of materials where topology plays a crucial role has emerged in physics, the so- called topological insulators [1]. Topological insulators (TIs) have a bulk energy gap that separates the highest occupied band from the lowest unoccupied band like in ordinary insulators. However, the edge (for 2D TIs) or the surface (for 3D TIs) of a topological insulator exhibits gapless electronic states that are protected by time reversal symmetry.

In this talk I will focus on transport properties of topological insulators in two different regimes: (1) when the Fermi energy probes the helical edge states (counter-propagating gapless spin edge states) or the gapless surface states and (2) when the Fermi energy is deep in the conduction band where the material behaves as a metal with Dirac-like band dispersion (doped topological insulator regime) [2]. In both of these regimes, the Dirac-like Hamiltonian (Dirac fermions) governs the physics of the system.

In the first regime, I will discuss the magnetotransport properties of the helical edge channels. I will show that in two-dimensional topological insulators in the quasiballistic regime, the spin edge channels do not mix in a magnetic field transverse to the quantum well, but they persist in strong quantizing fields when the Fermi level lies in the gap [3]. With the shift of the Fermi level into the Landau-quantized conduction band, I will analyze a transition between topological insulator and quantum Hall regimes.

In the second regime of doped topological insulators, I will talk about original crossover between symplectic and unitary classes in weak localization corrections as a function of the carrier concentration for a zero magnetic field in HgTe/CdTe quantum wells [4].

[1] M. Z. Hasan and C. L. Kane *Rev. Mod. Phys.* **82** 3045 (2010). X.-L. Qi, S. C. Zhang arXiv: 1008.2026 (2010).

[2] B. Büttner, C. X. Liu, G. Tkachov, E. G. Novik, C. Brüne, H. Buhmann, E. M. Hankiewicz, P. Recher, B. Trauzettel, S. C. Zhang and L.W. Molenkamp *Nature Physics* **7**, 418 (2011).

[3] G. Tkachov and E. M. Hankiewicz *Phys. Rev. Lett*. **104**, 166803 (2010).

[4] G. Tkachov, E. M. Hankiewicz arXiv:1102.4512 (2011).