HgTe a topological insulator

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The increasing understanding of topological phases in condensed matter physics, which was initiated by the quantum Hall effect, has inspired the search for further topological states, especially, in the absence of magnetic fields. As an example a new topological insulator state, the quantum spin Hall (QSH) effect, was proposed for two-dimensional electron system with strong spin-orbit coupling.[1,2] This new state is characterized by an insulating bulk and two counter-propagating helical edge states. These so-called Kramers pairs account for a quantized conductance and propagate spin currents without dissipation. After the successful experimental demonstration of the QSH effect[3], the concept of topological insulators was extended to three-dimensional systems[4] where Dirac-like surface states dominate electronic and optical excitations resulting in new exotic properties.

In this presentation, the material system of mercury-telluride (HgTe) is introduced. The first experimental realization of a two-dimensional topological insulator (TI) state is shown[4,5,6] and the first transport characterization of a three-dimensional TI is presented.[7] Furthermore, it is possible to show evidence for the spin polarization of the QSH edge channels in an all-electrical measurement which demonstrates the potential of the QSH effect for spin injection and detection in spintronics applications.

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