

HgTe as a Topological Insulator

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HgTe is a zincblende-type semiconductor with an inverted band structure. While the bulk material is a semimetal, lowering the crystalline symmetry opens up a gap, turning the compound into a topological insulator.

The most straightforward way to do so is by growing a quantum well with (Hg,Cd)Te barriers. Such structures exhibit the quantum spin Hall effect, where a pair of spin polarized helical edge channels develops when the bulk of the material is insulating.

Our transport data[1-3] provide very direct evidence for the existence of this third quantum Hall effect, which now is seen as the prime manifestation of a 2-dimensional topological insulator.

To turn the material into a 3-dimensional topological insulator, we utilize growth induced strain in relatively thick (ca. 100 nm) HgTe epitaxial layers. The high electronic quality of such layers allows a direct observation of the quantum Hall effect of the 2-dimensional topological surface states[4,5]. Due to the screening properties of Dirac fermions, these states turn out to be decoupled from the bulk for a very wide range of densities[5]. This allows us to induce a supercurrent in the surface states by contacting these structures with Nb electrodes[6]. AC investigations indicate that the induced superconductivity is strongly influenced by the helical character of the charge carriers.

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