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Colloquium
Dahlem Center for Complex Quantum Systems

HgTe as a Topological Insulator

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Abstract:

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]. Moreover, on contacting these structures with Nb electrodes, a supercurrent is induced in the surface states.

[1] M. König, et al., Science **318**, 766 (2007).
[2] A. Roth, et al., Science **325**, 294 (2009).
[3] C. Brüne, et al., Nature Physics **8**, 486 (2012).
[4] C. Brüne, et al., Phys. Rev. Lett. **106,** 126803 (2011).