Abstract for an Invited Paper
for the MAR10 Meeting of
The American Physical Society

Dissipationless transport in the quantum spin Hall insulator

HARTMUT BUHMANN, Physikalisches Institut, University Wuerzburg

The increasing understanding of topological phases in condensed matter physics, which was initiated by the quantum Hall effect, has inspired the search for other topological states, especially, in the absence of magnetic fields. As one example the quantum spin Hall (QSH) effect has been proposed for systems with time reversal symmetry and spin-orbit interactions.[1,2)] In a two-dimensional system this new state is characterized by an insulating bulk and two counter-propagating helical edge states. These Kramers pairs fulfill time reversal symmetry and account for a quantized conductance and spin currents propagate without dissipation. It turned out that HgTe-based quantum well (QW) structures are most suitable candidates for a successful experimental realization.[3)] In this presentation, the HgTe QW band structure properties and experimental requirements are discussed which lead to the observation of quantized spin polarized edge channel transport, one of the main signatures of the QSH effect.[4,5)] Experiments will be presented that demonstrate the stability of the quantized conductance and its non-local character.[6)] Furthermore, it is possible to show evidence for the spin polarization of the QSH edge channels in an all-electrical measurement[7)] which demonstrates the potential of the QSH effect for possible spin injection and detection application in spintronics devices. 1) C.L. Kane and E.J. Mele, Phys. Rev. Lett **95**, 226801 (2005). 2) B.A. Bernevig and S.C. Zhang, Phys. Rev. Lett. **96**, 106802 (2006). 3) B.A. Bernevig, T.L. Hughes, and S.C. Zhang, Science 314, 1757 (2006). 4) M. König *et al.*, Science **318**, 766 (2007). 5) M. König *et al.* Journ. Phys. Soc. Japn. **77**, 031007 (2008). 6) A. Roth *et al.*, Science **325**, 294 (2009). 7) C. Brüne *et al.*, in preparation.