Quantum point contact as a probe of a topological superconductor — Michael Wesemann, Anton Korchinov, Jan Dahlhaus, and Carlo Beenakker — Institut-Lorentz, Universiteit Leiden, The Netherlands

We calculate the conductance of a ballistic point contact to a superconductor with spin-orbit coupling in a parallel magnetic field. The conductance $G$ as a function of contact width or Fermi energy shows plateaus at half-integer multiples of $4e^2/\hbar$ if the superconductor is in a topologically nontrivial phase, supporting Majorana fermions. In contrast, the plateaus are at the usual integer multiples in the topologically trivial phase (without Majorana fermions). Disorder destroys all plateaus except the first, which remains precisely quantized, consistent with previous results for a tunnel contact. The advantage of a ballistic contact over a tunnel contact as a probe of the topological phase is the strongly reduced sensitivity to disorder.

Interplay of bulk and edge states in transport of topological insulators — Rolf W. Reinthal and Ewelina M. Hankiewicz — Faculty of Physics and Astrophysics, University of Würzburg, Würzburg, Germany

We study ballistic transport in two-terminal metal/quantum spin-Hall insulator (QSHI)/metal junctions within the effective four band model (conduction/heavy hole bands) [1, 2]. We show that the conductance signals originating from the bulk and the edge contributions are not additive. While for a long junction the transport is determined by the edge states contribution, for a short junction, the conductance signal is built from both, bulk and edge states, in the ratio which depends on the width of the sample. Further, the conductance for short junctions shows a non-monotonic behavior as a function of the sample length in topological insulator regime [3]. Suprisingly this non-monotonic behavior of conductance can be traced to the formation of an effectively propagating solution which is robust against scalar disorder. Our predictions should be experimentally verifiable in HgTe QWs and BiSe thin films.

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Landau levels in a topological insulator — Peter Schwab and Michael Dzierzawa — Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany

Two recent experiments successfully observed Landau levels in the tunneling spectra of the topological insulator Bi$_2$Se$_3$. To mimic the influence of a scanning tunneling microscope tip on the Landau levels we solve the two-dimensional Dirac equation in the presence of a localized electrostatic potential. We find [1] that the STM tip not only shifts the Landau levels, but also suppresses for a realistic choice of parameters the negative branch of Landau levels.

HgTe quantum wells and surfaces of three-dimensional topological insulators support Dirac fermions with a single-valley band dispersion. In this work we conduct a comparative theoretical study of the weak antilocalization in HgTe quantum wells (QWs) and topological surface states. The difference between these two single-valley systems comes from a finite band gap (effective Dirac mass) in HgTe quantum wells in contrast to gapless (massless) surface states in topological insulators. The finite effective Dirac mass implies a broken internal symmetry, leading to suppression of the weak antilocalization in HgTe quantum wells and transition to the weak localization regime as a function of the gap or carrier density. Further we show how the difference in the behavior of the weak localization corrections for HgTe QWs allows to distinguish topological versus normal insulators. On the other hand, the topological surface states exhibit specific weak-antilocalization magnetocconductivity in a parallel magnetic field due to their exponential decay in the bulk. The relevant experiments will be discussed.

We acknowledge the financial support of the German DFG Grant HA5893/1-2.

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**Supersymmetry and Ballistic Transport in Topological Insulators**

**HL 9.11** Mon 12:15  H 3010

**Supersymmetry and Ballistic Transport in Topological Insulators with Ferromagnetic Domain-walls** — Christian Wielles and Wolfgang Belzig — Universität Konstanz, Fachbereich Physik, 78457 Konstanz, Germany

We consider the surface Dirac Fermions of a topological insulator with a proximity induced ferromagnetic domain wall (DW). We present an exact analytical treatment to discuss the spectrum, bound states and the ballistic conductance of the system with a DW in the in-plane and out-of-plane configuration. In the latter case of the "mass" DW, we find oscillations in the conductance due to a function of the wall width and we find for certain widths the DW to be completely reflectionless. We will use the language of supersymmetry to reveal that the dispersion of the surface Dirac Fermions together with the specific DW profile gives rise to these interesting features.

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**Aspects of electron-electron interactions and spin-conservation in topological insulators**

**HL 9.12** Mon 12:30  H 3010

**Aspects of electron-electron interactions and spin-conservation in topological insulators** — Stephan Rachel — Department of Physics, Yale University, New Haven, CT 06520, USA

We consider topological insulators on the honeycomb lattice and investigate the effect of electron-electron interactions and breaking of $S_z$ spin-symmetry. We compare (i) non-interacting bandstructures with and without conserved spin, (ii) the regime of moderate interactions as well as (iii) the corresponding spin models. We find in all interaction-regimes qualitative differences between conserved and broken $S_z$ spin-symmetry. The origin of these differences is explained. Eventually we discuss which of the effects are generic and which are specific for the honeycomb lattice.

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**Tuning the Fermi velocity of Dirac cones: Towards an anomalous quantum Hall effect on the surfaces of topological insulators?**

**HL 9.10** Mon 12:00  H 3010

Lars Fritz, Matthias Sitte, and Achim Rosch — Universität zu Köln, Institut für theoretische Physik, Zülpicher Strasse 77, 50937 Köln

Long-range Coulomb interaction can trigger an instability of two-dimensional Dirac fermions, the so-called chiral symmetry breaking. Three-dimensional topological insulators host two-dimensional helical Dirac fermions on their surfaces. We investigate whether long-range Coulomb interaction, controlled by the dimensionless coupling constant $\alpha = e^2/(4\hbar c v_F)$, can induce surface ferromagnetism thereby gapping the surface metal. This is accompanied by an anomalous quantum Hall effect without explicit breaking of time-reversal invariance by an external magnetic field. We find that the prerequisite for observing this effect is to reduce the Fermi velocity $v_F$ of the surface Dirac fermions while keeping the bulk dielectric constant $\epsilon_r$ finite. We discuss under which conditions this can be achieved.

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**Luttinger Liquid Physics and Spin-Flip Scattering on Helical Edges**

**HL 9.13** Mon 12:45  H 3010

**Luttinger Liquid Physics and Spin-Flip Scattering on Helical Edges** — Martin Hohenadler and Farha Assaad — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Würzburg, Deutschland

We investigate electronic correlation effects on edge states of quantum spin Hall insulators within the Kane-Mele-Hubbard model by means of quantum Monte Carlo simulations. In accordance with Luttinger liquid theory, we find dominant transverse spin fluctuations with an interaction dependent power law and the expected doping dependence. For strong electronic correlations, bulk states become important, and high-energy spectral features beyond Luttinger liquid theory emerge. Inelastic spin-flip scattering leads to graphene-like edge state signatures, and transfers spectral weight from low to high energies causing a suppression of charge transport.