DS 46: Topological Insulators I (Joint session of DS and HL, organized by HL)

Time: Thursday 14:45–17:15 Location: H10

DS 46.1 Thu 14:45 H10

Topological Dirac Semimetal in strained HgTe — •Tomáš Rauch[1], Steven Achilles[1], Jürgen Henk[1], and Ingrid Mertig[1,2] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle (Saale), Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, D-06120 Halle (Saale), Germany

HgTe, one of the most intensively investigated materials in the context of topological insulators, is a semimetal with zero energy band gap when considered as a three-dimensional material. Applying uniaxial strain in [001] direction changes the situation dramatically [1]. Under compressive strain HgTe becomes a strong topological insulator featuring typical Dirac cone shaped surface states at the $\overline{\Gamma}$ point of the surface Brillouin zone. On the other hand, applying a tensile strain makes HgTe a topological Dirac semimetal with a pair of doubly-degenerate Dirac cones located along the k_z axis of the bulk Brillouin zone.

By combined *ab initio* and tight-binding electronic structure calculations we investigate the bulk and surface electronic properties of three-dimensional HgTe in the topological Dirac semimetal phase. This includes calculating the bulk band structure, topological invariants, and the electronic structure of the (100) surface, at which the associated non-trivial surface states emerge.

[1] T. Rauch *et al.*, Phys. Rev. Lett. **114**, 236805 (2015)

DS 46.2 Thu 15:00 H10

Tight-Binding Approach towards an Effective Model for InAs/GaSb Quantum Wells — •Matthias Sitte[1], Karin Everschor-Sitte[1], and Allan MacDonald[2] — [1]Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudingerweg 7, 55128 Mainz — [2]The University of Texas at Austin, Department of Physics, 2515 Speedway, Austin, TX 78712-1192

Topological insulators have attracted a great deal of attention as a new quantum state of matter in the last decade. The first realizations of 2D TIs were HgTe/CdTe quantum well heterostructures, but in recent years another class of semiconductor heterostructures — namely InAs/GaSb quantum wells — was shown to yield 2D TIs as well. Compared to the HgTe/CdTe-based systems they have many advantages, most prominently a continuously tunable band structure via external electric fields and stronger proximity coupling to superconductors. We perform empirical tight-binding calculations on these systems to study how topological properties are changed by varying external control parameters such as electric fields or well thicknesses.

DS 46.3 Thu 15:15 H10

Negative Magnetoresistance of $TlBi_xSb_{1-x}Te_2$ — •Oliver Breunig, Zhiwei Wang, Fan Yang, Alexey Taskin, and Yoichi Ando — II. Physikalisches Institut, Universität zu Köln

In the family of the ternary II-V-VI_2 compounds several materials have been identified as topological insulators. In the n-type $TlBiTe_2$ a topological surface state has been found, yet it is hardly accessible for transport studies due to the overlap with the bulk bands. Theoretical studies suggest that upon substituting Bi by Sb a narrow bulk band gap opens while preserving a single Dirac cone at the Γ point, leading to a possible realization of a bulk-insulating system with an exposed Dirac point.

Single crystals of $TlBi_xSb_{1-x}Te_2$ were grown by a modified Bridgman technique using high-purity starting materials. They were characterized by ICP/EDX as well as transport measurements. For intermediate values x we find insulating transport properties and a surprisingly strong negative magnetoresistance. We present our crystal growth results of $TlBi_xSb_{1-x}Te_2$ and discuss the origin of the observed large negative magnetoresistance.

DS 46.4 Thu 15:30 H10

Landau level spectroscopy of the 3D topological insulator Sb_2Te_3 — •Stefan Wilfert[1], Oliver Storz[1], Paolo Sessi[1], Thomas Bathon[1], Konstantin Kokh[2], Oleg Evgen'evich Tereshchenko[2], and Matthias Bode[1] — [1]Physikalisches Institut, Experimentelle Physik II, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany — [2]Novosibirsk State University, 630090 Novosibirsk, Russia

Sb_2Te_3 is a prototypical three-dimensional topological insulator (TI) with intrinsic *p*-doping, which leads to a Dirac point lying well above the Fermi level [1]. We performed energy-dependent quasi-particle interference mapping and scanning tunnel spectroscopy in high magnetic fields up to 12 T on this compound, where both methods allow to obtain the energy dispersion. In contrast to the much more studied TIs Bi_2Te_3 [2] and Bi_2Se_3 [3], Sb_2Te_3 shows Landau levels with both negative and positive Landau level indices. This enables to analyze in more detail the energetic broadening of the Landau levels, which may lead to a better understanding of the physical limits of quantum coherence in this type of materials.

[1] C. Seibel *et al.*, Phys. Rev. Lett. **114**, 066802 (2015).
[2] Y. Okada *et al.*, Phys. Rev. Lett. **109**, 166407 (2012).
[3] T. Hanaguri *et al.*, Phys. Rev. B **82**, 081305 (2015).

30 min. Coffee Break

DS 46.5 Thu 16:15 H10

Aharonov-Bohm effect in the 3D topological insulator HgTe — •Johannes Ziegler[1], Dmitriy Kozlov[1,2,3], Dmitry Kvon[2,3], Nikolay Mikhailov[2], Sergey Dvoretsky[2], and Dieter Weiss[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Germany — [2]A.V. Rzhanov Institue of Semiconductor Physics, Novosibirsk, Russia — [3]Novosibirsk State University, Russia

We present our progress in the investigation of the Aharonov-Bohm effect in ring and nanowire structures, fabricated from high-mobility strained 80 nm HgTe films with a wet etching technique. The nanostructures are equipped with topgates to allow tuning of the Fermi level E_f and are measured in a dilution cryostat.

The focus lies on Topological Insulator nanowires, where it is expected that the magnetic flux Φ through the wire leads to both Φ_0 and $\Phi_0/2$ periodic oscillations [1]. Φ_0 $(= h/e)$ periodic oscillations are expected to occur in the ballistic regime for a large range in E_f. For ballistic devices, both minima and maxima of the conductance are expected at $\Phi = \Phi_0/2$ with varying E_f. In the case of diffusive transport, Φ_0 periodic oscillations are expected for E_f close to the Dirac point, while tuning E_f away from the Dirac Point leads to $\Phi_0/2$ $(= h/2e)$ periodic oscillations.

[1] J.H. Bardarson *et al.*, Phys. Rev. L **105**, 156803 (2010)

DS 46.6 Thu 16:30 H10

Emergence of quantum spin Hall and half-topological states at Graphene/TMDC heterostructures — •Denis Kochan, Martin Gmitra, Petra Högl, and Jaroslav Fabian — Institute for Theoretical Physics, University of Regensburg, Germany

We discuss orbital and spin-orbital proximity effects emerging in graphene deposited on a monolayer transition-metal dichalcogenides (TMDCs: MoS2, MoSe2, WS2, WSe2) and analyze the impact on spin transport in such graphene/TMDC heterostructures. First-principles investigations show that graphene on MoS2, MoSe2, and WS2 has a topologically trivial band structure, while graphene on WSe2 exhibits inverted bands. The essential low energy physics can be well described by a symmetry inspired realistic tight-binding Hamiltonian. We predict topologically protected helical edge states for graphene zigzag nanoribbons on WSe2, demonstrating the emergence of the quantum spin Hall effect. Our model also features "half- topological states", which are protected against time-reversal disorder on one edge only. Unlike in pristine graphene, the proximity spin-orbit coupling in graphene on TMDCs is significant (orders of meV), making the predicted effect testable experimentally.

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DS 46.7 Thu 16:45 H10

Chiral Magnetic Effect in an Interacting Weyl Semimetal — •Matthias Puhr, Semen Valgushev, and Pavel Buividovich — Universität Regensburg, D-93053 Regensburg, Deutschland

We present results of a mean-field study of the chiral magnetic effect in a simple model of a parity-breaking Weyl semimetal. Our model is given by the lattice Wilson-Dirac Hamiltonian with on-site repulsive interaction and a constant chiral chemical potential term. We find a non-trivial behaviour of the chiral magnetic conductivity (CMC) and observe an increase, a decrease and even a change of sign depending on the interaction strength. The absolute value of the CMC never exceeds the value for the non-interacting gapless Hamiltonian. Our model exhibits a phase transition to a phase with spontaneously broken parity (Aoki phase, axionic insulator phase) and we observe a strong suppression of the CMC in the parity broken phase.

DS 46.8 Thu 17:00 H10

Negative magneto-resistivity in finite-size samples of Weyl semimetals — Pavel Buividovich, Matthias Puhr, and •Semen Valgushev — University of Regensburg, Regensburg, Germany

We numerically study Chiral Magnetic Effect and magneto-resistivity in a slab of parity-breaking Weyl semimetal modeled by Wilson-Dirac hamiltonian with open boundary conditions and subjected to the external magnetic field parallel to the boundaries. We find that the density of CME current is locally non-zero and strongly localized near the boundaries, where it approaches conventional value $j = \mu_5 B/2\pi^2$. We calculate the magneto-resistivity in a physical setup when parallel magnetic and electric fields are applied to the sample and discuss our results in the context of recent experiments on negative magneto-resistivity in Weyl semimetals.