TT 67: Topological Insulators II (joint session DS, HL, MA, O, TT, organized by HL)

Time: Thursday 14:45–16:45 Location: POT 251

TT 67.1 Thu 14:45 POT 251

Visualizing the response of Weyl semimetals to Coulomb and magnetic perturbations — •Thomas Bathon[1], Paolo Sessi[1], Yan Sun[2], Florian Glott[1], Zhilin Li[3], Hongxiang Chen[3], Liwei Guo[3], Xialong Chen[3], Markus Schmidt[2], Claudia Felser[2], Binghai Yan[2], and Matthias Bode[1] — [1]Experimentelle Physik II der Universität Würzburg, Würzburg — [2]Max Planck Institute for Chemical Physics of Solids, Dresden — [3]Institute of Physics at the Chinese Academy of Sciences, Peking

Weyl semimetals are a new class of topological materials which led to the emergence of Weyl physics in condensed matter. While photoemission successfully identified Weyl surface states with unique Fermi arcs, their fundamental microscopic properties, such as scattering mechanisms, persistence of spin-coherence, and the reaction to external perturbations, have not been widely investigated so far.
Here, we use TaAs to address these important aspects at the atomic scale by scanning tunneling microscopy and spectroscopy. We deliberately introduce external adatoms to test the response of this class of materials to well-defined Coulomb and magnetic perturbations. We demonstrate that, contrary to topological insulators, they are effectively screened in Weyl semimetals. Our analysis demonstrates that intra- as well as inter-Fermi arc scattering events are strongly suppressed. Additionally, we show that the existence of large parallel segments of spin-split trivial states facing each other makes possible, through scattering, to revert both the propagation direction while simultaneously flipping the spin state, strongly limiting its coherence.

TT 67.2 Thu 15:00 POT 251

Investigation of topological states in proximitized superconducting 2d materials — •Petra Högl, Denis Kochan, Tobias Frank, Martin Gmitra, and Jaroslav Fabian — Insitute for Theoretical Physics, University of Regensburg, 93040 Regensburg, Germany

Recently, the appearance of helical edge states in graphene in transition-metal dichalcogenides has been predicted [1]. The presence of these quantum spin Hall states is a precursor for topological insulators. We theoretically investigate such 2d systems proximitized to a s-wave superconductor. As predicted by Fu and Kane [2] the combination of 2d topological insulators and superconductors can lead to the formation of Majorana states. This work has been supported by the Int. Doctorate Program Topological Insulators of the Elite Network of Bavaria, DFG SFB 689, GRK 1570, and by the EU Seventh Framework Programme under Grant Agreement No. 604391 Graphene Flagship.

[1] M. Gmitra, D. Kochan, P. Högl, J. Fabian, Phys. Rev. B 93, 155104 (2016)

[2] L. Fu and C. L. Kane, Phys. Rev. B 79, 161408(R) (2009)

TT 67.3 Thu 15:15 POT 251

Tuning Quantum Transport and Interference in Topological Nanowires — •Vincent Sacksteder[1] and Quansheng Wu[2] — [1]W155 Wilson Building, Royal Holloway University of London, Egham Hill, Egham, TW20 0EX, United Kingdom — [2]Theoretical Physics and Station Q Zurich, ETH Zurich, 8093 Zurich, Switzerland

We study the magnetoconductance of topological insulator nanowires in a longitudinal magnetic field, including Aharonov-Bohm, Altshuler-Aronov-Spivak, perfectly conducting channel, and universal conductance fluctuation effects. We show that changing the Fermi energy can tune a wire from from ballistic to diffusive conduction and to localization. In both ballistic and diffusive single wires we find both Aharonov-Bohm and Altshuler-Aronov-Spivak oscillations with similar strengths, accompanied by quite strong universal conductance fluctuations (UCFs), all with amplitudes between 0.3 and 1 conductance quanta. This contrasts strongly with the average behavior of many wires, which shows Aharonov-Bohm oscillations in the ballistic regime and Altshuler-Aronov-Spivak oscillations in the diffusive regime, with both oscillations substantially larger than the conductance fluctuations. We also show that in long wires the perfectly conducting channel is visible at a wide range of energies within the bulk gap. We present typical conductance profiles at several wire lengths, showing that conductance fluctuations can dominate the average signal. Similar behavior will be found in carbon nanotubes.

Coffee Break

TT 67.4 Thu 16:00 POT 251

time-reversal-breaking topological phases in anti-ferromagnetic Sr_2FeOsO_6 films — •Xiao-Yu Dong[1,2], Sudipta Kanungo[3,4], Binghai Yan[2,3], and Chao-Xing Liu[5] — [1]Department of Physics and State Key Laboratory of Low-Dimensional Quantum Physics, Tsinghua University, Beijing 100084, P.R.China — [2]Max-Planck-Institut für Physik komplexer Systeme, 01187, Dresden, Germany — [3]Max-Planck-Institut für Chemische Physik fester Stoffe, 01187 Dresden, Germany — [4]Center for Emergent Matter Science (CEMS), RIKEN, 2-1, Hirosawa, Wako, Saitama 351-0198, Japan — [5]Department of Physics, The Pennsylvania State University, University Park, Pennsylvania 16802-6300, USA

In this work, we studied time-reversal-breaking topological phases as a result of the interplay between anti-ferromagnetism and inverted band structures in anti-ferromagnetic double perovskite transition metal Sr_2FeOsO_6 films. By combining the first principles calculations and analytical models, we demonstrate that the quantum anomalous Hall phase and chiral topological superconducting phase can be realized in this system. We find that to achieve time-reversal-breaking topological phases in anti-ferromagnetic materials, it is essential to break the combined symmetry of time reversal and inversion, which generally exists in anti-ferromagnetic structures. As a result, we can utilize an external electric gate voltage to induce the phase transition between topological phases and trivial phases, thus providing an electrically controllable topological platform for the future transport experiments.

TT 67.5 Thu 16:15 POT 251

Surface state-dominated photoconduction and THz-generation in topological Bi_2Te_2Se-nanowires — •Marinus Kundinger[1], Paul Seifert[1], Kristina Vaklinova[2], Klaus Kern[2,3], Marko Burghard[2], and Alexander Holleitner[1] — [1]Walter Schottky Institut and Physics-Department, Technical University of Munich, Am Coulombwall 4a, D-85748 Garching, Germany — [2]Max-Planck-Institut für Festkörperforschung, Heisenbergstraße 1, D-70569 Stuttgart, Germany — [3]Institut de Physique, Ecole Polytechnique Fédérale de Lausanne, CH-1015 Lausanne, Switzerland

Topological insulators constitute a fascinating class of quantum materials with non-trivial, gapless states on the surface and trivial, insulating bulk states. In revealing the optoelectronic dynamics in the whole range from femto- to microseconds, we demonstrate that the long surface lifetime of Bi_2Te_2Se-nanowires allows to access the surface states by a pulsed photoconduction scheme and that there is a prevailing bolometric response of the surface states. The interplay of the surface state dynamics on the different timescales gives rise to a surprising physical property of Bi_2Te_2Se-nanowires: their pulsed photoconductance changes polarity as a function of laser power. Moreover, we show that single Bi_2Te_2Se-nanowires can be used as THz-generators for on-chip high-frequency circuits at room temperature. Our results open the avenue for single Bi_2Te_2Se-nanowires as active modules in optoelectronic high-frequency and THz-circuits.

We acknowledge financial support by the DFG priority program SPP 1666 'topological insulators'.

TT 67.6 Thu 16:30 POT 251

THz radiation induced helicity sensitive photocurrents in type-II GaSb/InAs quantum well structures — •Helene Plank[1], Johanna Pernul[1], Tanja Hummel[1], Georg Knebl[2], Pierre Pfeffer[2], Martin Kamp[2], Susanne Mueller[3], Thomas Tschirky[3], Sergey A. Tarasenko[4], Werner Wegscheider[3], Sven Höfling[2,5], and Sergey D. Ganichev[1] — [1]Terahertz Center, University of Regensburg, Regensburg, Germany — [2]Technische Physik University of Würzburg, Würzburg, Germany — [3]ETH Zurich, Solid State Physics Laboratory, Zurich, Switzerland — [4]Ioffe Institute, St.Petersburg, Russia — [5]University of St. Andrews, St. Andrews, United Kingdom

We report on the observation of terahertz radiation induced helicity sensitive photocurrents in GaSb/InAs quantum wells in the inverted regime. The photocurrent reverses its direction upon switching the circular polarization from left- to right-handed. The origin of the photocurrent depends on the experimental geometry and the Fermi energy position. For illuminating the sample centre, it stems from asymmetric scattering of free carriers excited by electric THz field [1]. At normal incidence or for Fermi energies in the gap it vanishes. The situation changes at the sample edges, where is it observed for both cases. We show that this edge current is caused by optical excitation of helical edge states in 2D topological insulators. The observed sign inversion upon changing the photon helicity is attributed to selection rules of optical transitions. We discuss the photocurrent behaviour and present microscopic models. [1] H. Plank *et al.*, Physica E **85**, 193 (2017).