TT 27: Topological Semimetals 2

Time: Tuesday 14:00–15:45 Location: HSZ 103

TT 27.1 Tue 14:00 HSZ 103

Deformation of the Fermi surface of NbP under uniaxial strain — •Clemens Schindler, Jonathan Noky, Marcus Schmidt, Claudia Felser, and Johannes Gooth — Max Planck Institut für Chemische Physik fester Stoffe, Dresden, Deutschland

The Weyl semimetal NbP has recently gained a lot of attention due to its peculiar magnetotransport properties. The low cyclotron masses and long relaxation times in the cleanest single-crystalline samples give rise to an extremely large magnetoresistance and pronounced Shubnikov-de Haas (SdH) oscillations at moderate magnetic fields. In this study, we report on the study of the SdH oscillations under uniaxial strain using a three-piezo stack apparatus, combined with ab initio calculations of the band structure. We demonstrate the breaking of fourfold degenerate electron and hole pockets into twofold degenerate ones due to the breaking of the underlying fourfold rotational symmetry of the lattice. The direct, reversible application of uniaxial strain to materials with a sensitive Fermi surface therefore opens a playground for the symmetry manipulation of the electronic waves, in contrast to the application of hydrostatic pressure as well as the indirect determination of the strain dependence of the Fermi surface via magnetostriction oscillations.

TT 27.2 Tue 14:15 HSZ 103

Shubnikov-de Haas oscillations in the Weyl type-II semimetal WTe_2 — •Jasper Linnartz[1], Claudius Müller[1], Martin Bremholm[2], Nigel Hussey[1], and Steffen Wiedmann[1] — [1]High Field Magnet Laboratory (HFML-EMFL), IMM, Radboud University, Nijmegen, the Netherlands — [2]Department of Chemistry and iNANO, Aarhus University, Aarhus, Denmark

The transition metal dicalcogenide WTe_2 in the Td phase is a Weyl type-II semimetal. By analyzing the Shubnikov-de Haas oscillations superimposed on the quadratic magnetoresistance in WTe_2 up to 30 T and their temperature-dependent amplitude, we determine the Fermi surface and extract the cyclotron masses of the individual pockets.

Following the high resolution quantum oscillation thermopower experiments [1], we determined in total four individual pockets. Above a threshold magnetic field, we discover orbits due to magnetic breakdown due to nested electron and hole pockets which is confirmed by a cyclotron mass analysis.

[1] Z. Zhu et al., Phys. Rev. Lett. 114, 176601 (2015)

TT 27.3 Tue 14:30 HSZ 103

Disorder-induced coupling of Weyl nodes in WTe_2 — •Steffen Sykora[1], Johannes Schoop[1], Bernd Büchner[1,2,3], Christian Hess[1,3], Romain Giraud[1,4], and Joseph Dufouleur[1,3] — [1]IFW Dresden, 01069 Dresden, Germany — [2]Institute for Solid State Physics, TU Dresden, 01069 Dresden, Germany — [3]Center for Transport and Devices, TU Dresden, 01069 Dresden, Germany — [4]Universite Grenoble Alpes, CNRS, CEA, Grenoble-INP, INAC-Spintec, F-38000 Grenoble, France

We consider theoretically the finite coupling between Weyl nodes due to residual disorder. The results are compared with quantum transport measurements in a WTe_2 nanoflake where the transport time (backscattering) is related to the quantum life time (elastic mean free path) giving evidence for the anisotropic scattering of quasiparticles. Scattering processes within the material specific band structure are evaluated using a renormalization method allowing us to infer a rather short correlation length ($\xi \sim 5$ nm) of the disorder, in agreement with an analytical approach neglecting scattering between different pockets. Our finding indicates that, if intra-node scattering is dominating over inter-node scattering, the coupling between Weyl nodes is significant, a key issue for the observation of many topological properties.

TT 27.4 Tue 14:45 HSZ 103

Anisotropic magnetoresistance and the planar Hall effect in antiperovskite thin films — •Dennis Huang[1], Hiroyuki Nakamura[2], and Hidenori Takagi[1,3,4] — [1]Max Planck Institute for Solid State Research, 70569 Stuttgart, Germany — [2]University of Arkansas, Fayetteville, Arkansas 72701, USA — [3]University of Stuttgart, 70569 Stuttgart, Germany — [4]University of Tokyo, 113-0033 Tokyo, Japan

Anisotropic magnetoresistance (AMR) and the planar Hall effect (PHE) have garnered increasing attention as probes of the chiral anomaly in Dirac and Weyl semimetals, or helical surface states in topological insulators. However, these techniques are sensitive to additional effects, such as orbital magnetoresistance, and a more detailed understanding of such contributions is needed. Here, we measure AMR and the PHE in thin films of the antiperovskite Sr_3SnO grown by molecular beam epitaxy. Sr_3SnO is predicted to host both massive 3D Dirac fermions and topological surface states protected by mirror symmetry. We investigate the dependence of AMR and the PHE on magnetic field, temperature and film thickness, as well as their relationship to weak (anti)localization.

TT 27.5 Tue 15:00 HSZ 103

Magneto-optical study of the Dirac semimetal Cd_3As_2 in Voigt geometry — •Seulki Roh[1], Ece Uykur[1], Tobias Biesner[1], Lucky Maluna[1], Alex Nateprov[2], Martin Dressel[1], and Artem Pronin[1] — [1]1. Physikalisches Institut, Universität Stuttgart, 70569 Stuttgart, Germany — [2]Institute of Applied Physics, Academy of Sciences of Moldova, Academiei str. 5, 2028 Chisinau, Moldova

The three-dimensional Dirac semimetals possess Dirac points, which can be considered as a superposition of two Weyl points in reciprocal space. Under a magnetic field, the spin degeneracy can be lifted and a pair of Weyl points with opposite chiralities connected by a zeroth Landau level appears, enabling the charge transfer between the two Weyl points - the so-called chiral pumping effect. In this study, Cd_3As_2 was investigated by optical spectroscopy under external static magnetic field, **B**. The Voigt geometry was employed to parallelize the electric field of incident light, **E**, and the static magnetic field. In the **E** perpendicular to **B** configuration, we observed a pronounced Voigt resonance due to the splitting of the plasma edge. In the $\mathbf{E} \parallel \mathbf{B}$ geometry, we detected an increase of the Drude spectral weight, which could be caused by the chiral pumping effect. In the talk, we will discuss the possible relation between this effect and our observations in more detail.

TT 27.6 Tue 15:15 HSZ 103

Field-induced electron-hole tunneling in nodal-line semimetals revealed by quantum oscillations — •Claudius Müller[1], Thomas Khouri[1], Maarten van Delft[1], Sergio Pezzini[1], Yu-Te Hsu[1], Maxim Breitkreiz[2], Leslie Schoop[3], Antony Carrington[4], Nigel Hussey[1], and Steffen Wiedmann[1] — [1]High Field Magnet Laboratory (HFML-EMFL), IMM, Radboud University, Nijmegen, the Netherlands — [2]Dahlem Center for Complex Quantum Systems and Fachbereich Physik, Freie Universität Berlin, Germany — [3]Department of Chemistry, Princeton University, New Jersey, USA — [4]H. H. Wills Physics Laboratory, University of Bristol, UK

We report an investigation of de Haas-van Alphen quantum oscillations in the nodal-line semimetal ZrSiS via capacitive magnetometry measurements in high magnetic fields up to 35 T. By carrying out a full angle dependence, we are able to determine the Fermi surface (FS) of ZrSiS which complements but extends the original Shubnikov-de Haas measurements reported in [1]. For H//c, we observe a complex oscillation spectrum originating from individual electron and hole pockets, as well as oscillations caused by magnetic breakdown (MB). The MB orbits can be seen as a manifestation of Klein tunneling in momentum space, first reported in HfSiS [2], although in a regime of partial transmission due to a small spin-orbit gap between adjacent pockets. Comparison of our experimental observations with theoretical predictions provides us with a full picture of the electronic ground state.

[1] S. Pezzini et al., Nature Physics 14, 178 (2018)

[2] M. van Delft et al., Phys. Rev. Lett. 121, 256602 (2018)

TT 27.7 Tue 15:30 HSZ 103

Magneto-optical probe of the fully gapped Dirac band in ZrSiS — •E. Uykur[1], L. Z. Maulana[1], L. M. Schoop[2], B. V. Lotsch[3,4], M. Dressel[1], and A. V. Pronin[1] — [1]1. Physikalishces Institut, Universität Stuttgart, 70569, Stuttgart, Germany — [2]Department of Chemistry, Princeton University, Princeton, NJ, 08544, USA — [3]Max Planck Institute for Solid State Research, 70569 Stuttgart, Germany — [4]Chemistry Department, University of Munich (LMU), 81377 München, Germany

In this study, we present a far-infrared magneto-optical study of gapped nodal-line semimetal ZrSiS in the magnetic fields up to 7 T. Surprisingly, the magneto-optical spectra of ZrSiS can be explained within a simple 2D gapped-Dirac band model. Results demonstrate the inter- and intra-band transitions developing as $\sqrt{B}$ with increasing B-field. The gap and Fermi velocity parameters can be extracted from the magneto-optical study are also consistent with the literature for the mentioned compound. Considering the average response over the Fermi surface is reflected in the optical studies, the narrow distribution of the parameters is expected. Finally, we will present a peculiar field-independent feature appearing in the spectra that might be related to the nodal-line nature of ZrSiS.