TT 38: Topological Semimetals I

Time: Wednesday 9:30–11:15 Location: H 3010

TT 38.1 Wed 9:30 H 3010

Anomalous Nernst effect in the topological and magnetic material $MnBi_4Te_7$ — •Michele Ceccardi[1,2], Alexander Zeugner[3], Laura Folkers[3,4], Christian Hess[3,4,5], Bernard Buechner[3,4], Daniele Marré[1,2], Anna Isaeva[4,6], and Federico Caglieris[1,2,4] — [1]University of Genoa, Italy — [2]CNR Spin; Genoa, Italy — [3]TU Dresden, Germany — [4]IFW Dresden, Germany — [5]University of Wuppertal, Germany — [6]University of Amsterdam, Nederland

The recently discovered magnetic topological insulators $(MnBi_2Te_4)(Bi_2Te_3)n$, n = 0-4, are an ideal playground to study the influence of magnetic properties on band topology, giving access to diverse quantum states in a single compound. In the low temperature-antiferromagnetic state and vanishing magnetic field, the n = 1 system is a topological insulator protected by a combination of time reversal and a translation symmetries. It has been argued that, when the antiferromagnetic phase is forced to a the fully spin polarized state by the application of an external magnetic field, this system develops Weyl cones in the conduction band, which become accessible in presence of an intrinsic electronic doping. In this work, we experimentally prove the raising of field-induced Weyl state through the detection of an intrinsic anomalous Nernst effect in a bulk single crystal of $MnBi_4Te_7$.

TT 38.2 Wed 9:45 H 3010

Negative magnetoresistance in the Weyl semimetal $TaRhTe_4$ — •Mahdi Behnami[1], Helena Reichlova[1,2,3], Saicharan Aswartham[1], Grigory Shipunov[1], Dmitriy Efremov[1], Vilmos Kocsis[1], Marina Putti[4,5], Federico Caglieris[1,4], and Bernd Büchner[1,2] — [1]IFW Dresden, P.O. Box 270116, 01171 Dresden, Germany — [2]Institut für Festkörper- und Materialphysik, Technische Universität Dresden, 01062 Dresden, Germany — [3]Institute of Physics ASCR, v.v.i., Cukrovarnick a 10, 162 53, Praha 6, Czech Republic — [4]CNR-SPIN, 16152 Genova, Italy — [5]Department of Physics, University of Genoa, 16146 Genova, Italy

$TaRhTe_4$ is a type-II Weyl semimetal, hosting minimal Weyl points in close proximity to the Fermi level [1]. One of the most intriguing transport phenomena associated with Weyl physics is the chiral anomaly-induced negative magneto-resistance observed when magnetic and electric fields are parallel [2]. In this study, we employ a systematic measurement approach, measuring magnetoresistance along various crystallographic directions. We observe a negative sign, considered a signature of the chiral anomaly, but notably, this effect is present only along certain directions. Furthermore, this negative magneto-resistance persists up to room temperature, suggesting that $TaRhTe_4$ possesses unique properties within the emerging family of Weyl semimetals.

[1] G. Shipunov et al., J. Phys. Chem. Lett. 12, 28 (2021) 6730
[2] A. Niemann et al., Sci Rep 7 (2017) 43394

TT 38.3 Wed 10:00 H 3010

Electronic structure in the Dirac nodal-line semimetals $TaNiTe_5$ and $TaPtTe_5$ — •Maximilian Daschner[1], Friedrich Malte Grosche[1], and Ivan Kokanović[1,2] — [1]Cavendish Laboratory, University of Cambridge, Cambridge CB3 OHE, United Kingdom — [2]Department of Physics, Faculty of Science, University of Zagreb, Zagreb, Croatia

Among the nodal-line semimetals (NLSMs), Dirac nodal lines (DNLs) that are robust against spin-orbit coupling (SOC) rarely occur in (quasi) one-dimensional materials. A family of exfoliable, strong in-plane anisotropic, nonmagnetic, ternary transition semimetal tellurides, Ta-based $TaMTe_5$ (M=Ni, Pt) [1,2], has recently been shown to host nodal lines with fourfold degeneracy.

Here [3] we investigated the Fermi surface and carrier mass in $TaNiTe_5$ and $TaPtTe_5$ using magnetization and magnetic torque measurements in high-quality single crystals at fields of up to 15T. Quantum oscillations have been tracked for fields along the three crystallographic axes, supplemented by rotation studies in the b-a and b-c planes, and were interpreted with reference to band structure calculations within density functional theory.

[1] Z. Hao et al., Phys. Rev. B 104 (2021) 115158
[2] S. Xiao et al., Phys. Rev. B 105 (2022) 195145
[3] M. Daschner et al., submitted (2023)

TT 38.4 Wed 10:15 H 3010

Quantum Oscillations in AlPt: Experimental Validation and Insights into the Electronic Structures — Nico Huber[1], •Simon Röder[1], Andre Deyerling[1], Ivan Volkau[1], Andreas Bauer[1,2], Fabian Jochum[1], Christian Pfleiderer[1,2,3], and Marc A. Wilde[1] — [1]Technical University of Munich (TUM) — [2]TUM Zentrum für Quantum Engineering (ZQE) — [3]Munich Center for Quantum Science and Technology (MCQST)

B20 compounds, including AlPt, CoSi and PdGa, show a variety of interesting physical phenomena attributed to their complex electronic structure [1,2]. They host topologically non-trivial multifold crossing points and nodal planes [3] that influence the physical responses. AlPt exhibits a strong spin-orbit coupling predicted to have a distinct impact on its properties. A precise knowledge of the Fermi surface is key for their understanding and to date only limited information is available in the literature [4]. In this work, we report on previously undetected quantum oscillation frequencies in AlPt. We probed the de Haas-van Alphen effect using cantilever-based torque magnetometry in magnetic fields up to 18T and at temperatures down to 1.5K. We compare our findings with first-principle calculations and confirm the predicted band structure by matching the experimentally detected frequencies, their angular dependence and effective masses to extremal orbits on the Fermi surface.

[1] Huber et al., Nature **621** (2023) 276 (2023)
[2] Schroeter et al., Nat. Phys. **15** (2019) 759
[3] Wilde et al., Nature **594** (2021) 374
[4] Saini et.al., Phys. Rev. B **106** (2022) 125126

TT 38.5 Wed 10:30 H 3010

Quantum oscillations of the quasiparticle lifetime due to interorbit coupling — •Louw Feenstra[1,2], Nico Huber[1], Michael Schmidlechner[1], Andreas Bauer[1,4], Christian Pfleiderer[1,3,4], and Marc A. Wilde[1,4] — [1]Technical University of Munich — [2]Ludwig-Maximilians-Universität München — [3]Munich Center for Quantum Science and Technology (MCQST) — [4]TUM Zentrum für QuantumEngineering (ZQE)

A recent study on CoSi [1] revealed quantum oscillations with a frequency corresponding to the semi-classically forbidden difference between two quasiparticle orbit frequencies. These difference frequency oscillations persist up to temperatures at which their constituent frequencies are completely suppressed by thermal damping. The existence and temperature stability of these oscillations are explained by oscillations of the quasiparticle lifetime mediated by a non-linear interband coupling [2]. Here, we report on a detailed investigation of a related compound exhibiting the same phenomenology. Through angular and temperature dependent measurements of the Shubnikov-de Haas effect, a difference frequency is clearly identified and its remarkable temperature stability confirmed. In contrast to CoSi, the constituent frequencies originate from two extremal orbits on an anisotropic Fermi surface pocket arising from a single band. We demonstrate tuning of the difference frequency by rotation of the applied magnetic field.

[1] N. Huber *et al.*, Nature **621** (2023) 276
[2] V. Leeb, J. Knolle, Phys. Rev. B **108** (2023) 054202

TT 38.6 Wed 10:45 H 3010

Determination of the Fermi surface of the topological semimetal PdGa using quantum oscillations — Nico Huber[1], •Ivan Volkau[1], Alexander Engelhardt[1], Andreas Bauer[1,3], Christian Pfleiderer[1,2,3], and Marc A. Wilde[1,3] — [1]Technical University of Munich (TUM) — [2]MCQST, Munich — [3]TUM Zentrum für Quantum Engineering (ZQE), Munich

Weyl semimetals have generated great interest in recent years due to their non-trivial topological characteristics like anomalous magneto-transport and unusual photogalvanic responses [1]. However, topological band degeneracies are not limited to points but can also be enforced on entire planes in reciprocal space [2], the so-called nodal planes (NPs). The experimental identification of NPs in the ferromagnetic state of MnSi [3] and its paramagnetic sibling CoSi [4] raises the question whether they can also be observed in other B20 compounds as theory predicts. In this work, we study the Fermi surface of PdGa us-

ing quantum oscillations. Shubnikov-de Haas and de Haas-van Alphen spectra were recorded at different orientations of the magnetic field up to 18 T and at temperatures down to 1.5K. The oscillation frequencies, angular dispersion, and effective masses taken together with the calculated magnetic breakdown orbits are in good agreement with first principle calculations, confirming the predicted electronic structure of this compound.

[1] Ma *et al.*, Nat. Mater. **15** (2016) 1140
[2] Furusaki *et al.*, Sci. Bull. **62** (2017) 788
[3] Wilde *et al.*, Nature **594** (2021) 374
[4] Huber *et al.*, Phys. Rev. Lett. **129** (2022) 026401

TT 38.7 Wed 11:00 H 3010

Electronic structure of the noncentrosymmetric B20-type compound HfSn — •Dijana Milosavljevic[1], Helge Rosner[2], and Annika Johansson[1] — [1]Max Planck Institute of Microstructure Physics, Halle, Germany — [2]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

We present a density functional study of HfSn, which belongs to the family of cubic B20 intermetallics. These materials are characterized by the absence of mirror and inversion symmetries of their crystal structures, leading to a chiral character that can accommodate a novel type of topological fermionic excitations and a wide range of exotic physical properties [1][2][3]. HfSn is the first known member of the B20 family with a transition metal from the fourth group and can only be synthesized at high temperatures [4]. Here, we present a detailed study of the electronic band structure and Fermi surface topology, employed then to construct an effective tight-binding model. Additionally, we investigate the influence of the structural details on the position of the multiply degenerate band crossings pinned at high symmetry points in the vicinity of the Fermi level. This study contributes not only to a better understanding of B20 compounds but also represents a guide to further experimental investigations, in particular those related to sample preparation.

[1] Fecher et al., Materials 17 (2022) 5812
[2] Chang et al., Nat. Mater. 17 (2018) 978
[3] Schröter et al., Science 369 (2020) 6500
[4] Schob et al., Acta Cryst. 17, 452