# TT 35: Topology: Poster

Time: Wednesday 15:00–18:00 Location: P3

TT 35.1 Wed 15:00 P3

**Conductive surface states in single-crystalline FeSi** — •Philip Schröder, Gilles Gödecke, Julius Grefe, Stefan Süllow, and Dirk Menzel — Institut für Physik der Kondensierten Materie, Technische Universität Braunschweig, Mendelssohnstr. 3, 38106 Braunschweig, Germany

The small-gap semiconductor FeSi exhibits an insulating ground state over a wide temperature range [1]. Notably, electric resistivity measurements imply the opening of a metallic transport channel at lowest temperatures, which historically has been attributed to conductivity among impurity levels [2]. However, recent transport studies on high-quality flux-grown FeSi single crystals discuss the conductive behavior in terms of metallic [3] and magnetic [4] surface states. We present (magneto-)resistance measurements on tri-arc Czochralski-grown FeSi single crystals in dependence of the sample thickness. The controlled manipulation of the surface-to-volume ratio by successive grinding of the specimen under investigation allows for separation of the bulk resistivity and the superimposed contribution of the surface channels. An effective two-channel model has been applied to approximate the upper limit of the surface conductivity.

[1] V. Jaccarino et al., Phys. Rev. 160, 476 (1967).
[2] S. Paschen et al., Phys. Rev. B 56, 12916 (1997).
[3] Y. Fang et al., Proc. Natl. Acad. Sci. U.S.A. 115, 8558 (2018).
[4] K. E. Avers et al., Phys. Rev. B 110, 134416 (2024).

TT 35.2 Wed 15:00 P3

**Fabrication and characterization of topological insulator-based SET** — •Omargeldi Atanov, Junya Feng, and Yoichi Ando — Physics Institute II, University of Cologne, Cologne, Germany

When a topological insulator (TI) Josephson junction is driven through a topological phase transition, the ground-state parity of the system is expected to change, potentially due to the fusion of Majorana bound state (MBS) pairs. Measuring the individual parity of MBS pairs is a critical step in understanding the mechanisms behind these parity changes and for more complex braiding operations. We present the fabrication and characterization of single-electron transistors (SETs) based on bulk-insulating BiSbTeSe2 flakes, which also serve as the material for TI Josephson junctions. This approach simplifies the process flow of the devices and improves fabrication yield. Initial characterization of devices demonstrates well-formed Coulomb diamonds that confirms the robust charge quantization and SET performance. These results pave the way for integrating SETs with TI Josephson junctions and measuring MBS parity in the near future.

TT 35.3 Wed 15:00 P3

**Bulk and surface electron scattering in disordered $Bi_2Te_3$ probed by quasiparticle interference** — •Vladislav Nagorkin[1,2], Sebastian Schimmel[1,2], Paul Gebauer[3], Anna Isaeva[1,4,5,6], Danny Baumann[1], Andreas Koitzsch[1], Bernd Büchner[1,3], and Christian Hess[1,2] — [1]IFW Dresden, Germany — [2]Bergische Universität Wuppertal, Germany — [3]TU Dresden, Germany — [4]University of Amsterdam, The Netherlands — [5]TU Dortmund, Germany — [6]Research Center "Future Energy Materials and Systems", UA Ruhr, Germany

We present low temperature scanning tunneling microscopy and spectroscopy studies of the electronic properties of the topological insulator $Bi_2Te_3$. The high-resolution differential conductance maps were measured in a relatively large energy range and allowed to reveal the quasiparticle interference in this material. We interpret our experimental data by comparing them with the modeled quasiparticle interference patterns with the use of the spin-selective joint density of states approach including the intricate three-dimensional spin texture of this material. Based on that, the topological properties are clearly demonstrated by the linear energy dispersion of the dominant scattering vector and the absence of the backscattering. In addition, non-dispersive scattering modes were detected and interpreted by scattering involving both surface and bulk states. This allowed us to approximate the bulk energy gap range in our samples. Finally, we show that the above-mentioned findings are robust against the external magnetic field of magnitude up to 15 T.

TT 35.4 Wed 15:00 P3

**Planar Hall and Anomalous Planar Hall Effects up to Room Temperature in t-$PtBi_2$** — •Ankit Kumar — IFW Dresden

In topological semimetals, Hall measurements provide an important charge transport footprint of the non-trivial geometric properties of the electronic wavefunctions. In Weyl semimetals, the planar Hall effect (PHE) – the appearance of a transverse voltage when coplanar electric and magnetic fields are applied – is a direct consequence of the longitudinal linear magnetoconductance associated with the chiral anomaly of Weyl fermions, and is quantified by the large Berry curvature of Weyl nodes. The anomalous Hall effect is fully determined only by the location in the Brillouin zone and topological charge of the Weyl nodes. Time-reversal invariance prohibits any anomalous Hall signal in the large class of non-magnetic Weyl semimetals thereby leaving the PHE as the only Hall diagnostic tool of Weyl physics, at least in the linear regime. This complicates the identification of non-magnetic topological semimetals by charge transport experiments.

TT 35.5 Wed 15:00 P3

**Instabilities driven by electron-electron interactions** — •Eva López Rojo, Julia Link, and Carsten Timm — TU Dresen, Germany

We develop a formalism to study the effect of strong electron-electron interactions in a Weyl semimetal. In this poster, we present the findings for the case of two doped Weyl cones with opposite chirality. For this purpose, we employ a path integral formalism to study different instabilities that could take place. Instead of the charge density wave proposed in the literature, the leading instability for strong inter-valley interactions is found to be a spin density wave, which still has the potential to host axion physics.

TT 35.6 Wed 15:00 P3

**The Effect of Interface Disorder on the Tunnel Conductance Across Weyl Semimetal Interfaces** — •Haoyang Tian[1], Vatsal Dwivedi[2], Adam Yanis Chaou[2], and Maxim Breitkreiz[2] — [1]Institut für Theoretische Physik, Universität zu Köln, Zülpicher Str. 77a, 50937 Köln, Germany — [2]Dahlem Center for Complex Quantum Systems and Fachbereich Physik, Freie Universität Berlin, 14195 Berlin, Germany

The chiral anomaly in Weyl semimetals is responsible for various anomalous transport phenomena. In tunnel junctions between Weyl semimetals with staggered Weyl node projections, the chiral anomaly leads to a magnetic-field activated magnetotransport. In this work, we discuss the effect of interface disorder on the magnetotransport across such a tunnel junction employing a semiclassical Boltzmann approach. Our results show that, compared to conventional transport channels, the topological connectivity of interface Fermi arcs ensures that anomalous magnetotransport exhibits stronger robustness against disorder. Additionally, interface disorder enhances magnetic breakdown, a quantum tunneling effect, between the Fermi arcs.

TT 35.7 Wed 15:00 P3

**Impact of decoherence on the Kitaev honeycomb model** — •Alexander Sattler and Maria Daghofer — Universität Stuttgart, 70550 Stuttgart, Germany

Quantum spin liquids (QSL) are phases of matter with unique properties, including quantum fluctuations, frustration, entanglement, fractionalized excitations, and the absence of long-range order. A rare example of an exactly solvable, strongly interacting two-dimensional model with a QSL ground state is the Kitaev honeycomb model (KHM). This model describes spin-1/2 particles on a honeycomb lattice with direction-dependent Ising-like interactions. The KHM with open boundaries supports edge-localized Majorana zero modes that are robust to certain types of disorder. Quantum systems are inherently coupled to their environment, necessitating the study of the KHM properties in open systems, where environmental interactions, such as decoherence, can influence their features. To study this, we analyze the KHM in a cylindrical geometry while modeling environmental coupling using the Lindblad master equation to simulate decoherence. By examining changes in the dispersion relation, entropy, fidelity, purity and spectral gap over time, we evaluate how environmental interactions affect the properties of the KHM.

TT 35.8 Wed 15:00 P3

**Andreev reflection and interferometry of fractional quantum Hall edge states** — •Tom Menei, Daniele Di Miceli, and Thomas L. Schmidt — Department of Physics and Materials Science, University of Luxembourg

Recent experimental work has demonstrated that it is possible to couple superconductors (SCs) to quantum Hall (QH) systems, both at integer and fractional filling fractions. Due to the strong required magnetic fields and the presence of disorder and Abrikosov vortices in the SC, the theoretical modeling of such QH/SC interfaces is not trivial, especially in the case of fractional QH states. In our work, we use the Laughlin edge state theory and realistic models of the superconductor to derive the coupling mechanism at QH/SC interfaces. We explore the effects on normal and Andreev reflection and discuss possible experimental implications.

TT 35.9 Wed 15:00 P3

**Variational Trial States for Fractional Chern Insulators** — •Giacomo Amadore — LMU, Munich, Germany

Early on, Laughlin's wave functions and other variational trial states provided deep physical insights into the nature of fractional quantum Hall (FQH) systems. One particularly fruitful approach in motivating such trial states is based on the composite fermion description of the FQH problem in the continuum. In contrast, variational states describing fractional Chern insulators in lattice systems remained scarce. While existing methods can construct lattice analogs of familiar FQH states, these states are not generally expected to be the ground state of simple discretized FQH Hamiltonians, but instead a parent Hamiltonian is only constructed a posteriori. To address this limitation, we propose a conceptually different approach motivated by the possibility to study FQH physics in optical lattice experiments realizing the Hofstadter-Bose-Hubbard model. We derive trial states for the ground state of this specific Hamiltonian by turning hard-core bosons into composite fermions through the attachment of a single flux quantum and deriving an effective Hamiltonian for the composite fermions coupled to a dynamical gauge field. To benchmark our findings, we compare the variational energies of different ansätze to (quasi-)exact numerical results. We anticipate that our preliminary results provide a promising starting point for further variational studies and investigations of lattice analogs of FQH systems.