TT 61: Topology – Poster

Time: Wednesday 15:00–17:00 Location: P4

TT 61.1 Wed 15:00 P4

Topological Surface States for the Implementation of a Landau Level Laser — •Olivier Fayet[1], Jean-Noël Fuchs[2], and Piéchon Frédéric[1] — [1]Laboratoire de physique des solides, université Paris-Saclay et CNRS, Orsay, France — [2]Laboratoire de physique théorique de la matière condensée, Sorbonne Université et CNRS, Paris

Landau levels have since long been proposed for the implementation of a tunable laser in the THz regime. However, rapid non-radiative relaxation processes (Auger processes, disorder) are preventing population inversion. The former may to some extent be circumvented by the choice of a material with a non-equidistant Landau levels spectrum, e.g. in bilayer graphene or in the surface states of a topological heterojunction, called Volkov-Pankratov states. Under a strong magnetic field, the latter are quantised into Landau levels, recently observed in transport and spectroscopic measurements at the LPENS (Paris), based on predictions from the LPS theory group. To study the possibility of obtaining laser emission with these states, a detailed study of the different life times fo electrons in the associated Landau level is required.

TT 61.2 Wed 15:00 P4

Investigating Electrical and Thermal Hall Effect in Topological Insulators — •Karan Singh, Rohit Sharma, Yongjan Wang, Yoichi Ando, Achim Rosch, and Thomas Lorenz — II. Physikalisches Institut, Universität zu Köln, Zülpicher Strasse 77, D-50937 Köln, Germany

3D topological insulators are characterized by a bulk band gap and topologically protected gapless surface states formed by massless Dirac fermions. However, chemical disorder produces spatially fluctuating electric potentials, forming "charge puddles" that allow current to flow through the bulk [1]. With decreasing temperature, charge puddles localize, turning the sample electrically insulating. But these charge puddles remain thermally coupled via phonons and can be probed by the thermal Hall transport measurements [2]. In this work, we grew single crystals of $TlBi_{0.3}Sb_{0.7}Te_2$ and performed electrical and thermal transport measurements. The material shows a metal-semiconductor transition near 100 K and electron-like carriers at all temperatures. Notably, the thermal Hall conductivity (k_{xy}) measured on the same sample deviates from the Wiedemann-Franz law. After subtracting the electronic thermal contribution, the residual thermal Hall signal indicates that heat transport in this system involves contributions beyond conventional electronic carriers.

Work supported by the German Research Foundation via Project No. 277146847-CRC1238 (Subprojects A02 and B01).

[1] O. Breunig et al., Nat. Comm. 8, 15545 (2017).
[2] R. Sharma et al., Phys. Rev. B 109, 104304 (2024).

TT 61.3 Wed 15:00 P4

Synthesis and characterisation of Yb-doped $TlBiSe_2$ delafossite — •Manuel Schulze[1], Isadora Neme[2], Jörg Sichelschmidt[2], Helge Rosner[2], Michael Baenitz[2], and Thomas Doert[1] — [1]Faculty of Chemistry and Food Chemistry, TUD Dresden University of Technology, 01062 Dresden — [2]Max Planck Institute for Chemical Physics of Solids, 01187 Dresden

$TlBiSe_2$ is a three-dimensional (3D) topological insulator with a unique single Dirac cone at the Brillouin-zone centre [1]. $TlYbSe_2$ represents a prototype 2D triangular-lattice quantum spin liquid candidate [2]. Combining the two materials through partial substitution of Bi and Yb provides an interesting platform to investigate the interplay between unconventional electronic and magnetic properties. Polycrystalline samples of the solid-solution series $Tl(Bi,Yb)Se_2$ were synthesised by melting the elements in a rotary setup to enhance homogenisation. Powder X-ray diffraction and Rietveld refinement reveal systematic shifts in the lattice parameters, confirming continuous substitution. First Electron Spin Resonance (ESR) measurements on $Tl(Bi_{0.95}Yb_{0.05})Se_2$ show metallic Yb^{3+} lines with hyperfine structure as expected for a magnetically diluted system. Future work will additionally focus on NMR spectroscopy together with magnetisation and specific-heat studies to analyze the evolution of magnetic and electronic correlations across the series.

[1] K. Kuroda et al., Phys. Rev. Lett. 105, 146801 (2010).
[2] T. Fujii et al., Phys. Rev. B 112, 024426 (2025).

TT 61.4 Wed 15:00 P4

Berry curvature induced giant anomalous and spin texture driven Hall responses in the layered Kagome antiferromagnet $GdTi_3Bi_4$ — •Shobha Singh[1], Shivam Rathod[1], Rong Chen[2], Lipika Lipika[1], Sneh Sneh[1], Rie. Y Umetsu[3,4], Yan Sun[2], and Kaustuv Manna[1] — [1]Department of Physics, Indian Institute of Technology Delhi, New Delhi 110016, India — [2]Shenyang National Laboratory for Materials Science, Institute of Metal Research, Chinese Academy of Sciences 72 Wenhua Road, Shenyang 110016, China. — [3]Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan — [4]Center for Science and Innovation in Spintronics, Tohoku University, Sendai 980-8577, Japan

Here, we present the single-crystal growth, magnetization, and electrical transport characterizations of the van der Waals-like layered antiferromagnet $GdTi_3Bi_4$.The system exhibits pronounced field-induced first-order phase transitions. Comprehensive frequency, temperature, and field-dependent ac susceptibility measurements, and Hall analysis, reveal the formation of a spin-cluster-like glassy magnetic phase attributed to noncoplanar spin textures. Additionally, the system demonstrates a colossal anomalous Hall conductivity ($\sigma_{xy} = 8652$ $\Omega^{-1}cm^{-1}$ at 2 K). Detailed scaling analyses reveal the coexistence of skew scattering and intrinsic Berry-curvature contributions to the anomalous Hall effect. First-principles calculations highlight a flat band near the Fermi level, with f-electrons of the Gd ion contributing a large intrinsic Hall response.

TT 61.5 Wed 15:00 P4

Temperature and pressure dependant structural studies of $PtBi_2$ — •Esteban Aguirre García[1], Swarnamayee Mishra[1,2], and Jochen Geck[1,2] — [1]Institute of Solid State and Materials Physics, Technical University Dresden, 01062 Dresden, Germany — [2]Würzburg-Dresden Cluster of Excellence ct.qmat, Technical University Dresden, 01062 Dresden, Germany

Trigonal $PtBi_2$ is a non-centrosymmetric Weyl semimetal (space group P31m) in which strong spin-orbit coupling and broken inversion symmetry lift the degeneracy of linearly dispersing bands, providing a natural setting for topological superconductivity. While bulk $PtBi_2$ becomes superconducting only at very low temperatures of about 0.6 K, an enhanced and robust surface superconducting state with a critical temperature of 5 K or higher has been shown to emerge from the Fermi arc surface states, accompanied by a sizeable superconducting gap. In this work, high resolution single crystal X-Ray diffraction is employed as a function of temperature and pressure, which allows us to correlate structural features of the trigonal phase with the presence of surface superconductivity and to identify possible symmetry based mechanisms that can support topological pairing.

TT 61.6 Wed 15:00 P4

Nonlinear Hall effect in magnetic B_2O compounds — •Maximilian Phielepeit[1], Ivan Volkau[1], Yannis Ullrich[1,4], Marc A. Wilde[1,3], Andreas Bauer[1,3], Andreas Schnyder[4], and Christian Pfleiderer[1,2,3] — [1]Technical University of Munich (TUM) — [2]MCQST, Munich — [3]TUM Zentrum für Quantum Engineering — [4]Max Planck Institute for Solid State Research

A novel theoretical framework decomposes second-order nonlinear Hall conductivity into four quantum geometric contributions: the nonlinear Drude weight (NLD), the Berry curvature dipole (BCD), the interband quantum metric dipole (interQMD) and the intraband quantum metric dipole (intraQMD) [1]. In systems with C_3^z-symmetry, the BCD and interQMD terms are forbidden, which allows for the selective isolation of the NLD and intraQMD contributions [1]. We seek to investigate these contributions in magnetic B_2O systems, which host a C_3^z-rotational axis along the [111] crystallographic direction [2]. In this work, we perform nonlinear Hall measurements with two different magnetic field directions.

[1] Ulrich et al., arXiv:2506.17386 (2025)
[2] Hall et al., Phys. Rev. B 104 (2021)

TT 61.7 Wed 15:00 P4

Magnetic Properties of Single Crystal $MnNb_2O_6$ — •Florian Kübelbäck[1], Leo Maximov[1], Andreas Bauer[1], and Christian Pfleiderer[1,2,3] — [1]School of Natural Sciences, Technical University of Munich, Garching, Germany — [2]Heinz Maier-Leibnitz-Zentrum (MLZ), Technische Universität München, Garching, Germany — [3]Munich Center for Quantum Science and Technology (MCQST), Technical University of Munich, Garching, Germany

$CoNb_2O_6$, with effective $S = \frac{1}{2}$ Ising chains, is a benchmark system for quasi-one-dimensional magnetism and field-induced quantum phenomena [1]. Its isostructural analogue columbite $MnNb_2O_6$ contains $S = \frac{5}{2}$ Mn^{2+} ions arranged in zig-zag chains and is expected to realise a more classical regime of low-dimensional magnetism [2, 3].

We have grown high-quality $MnNb_2O_6$ single crystals using the optical floating-zone technique. Magnetization measurements reproduce the antiferromagnetic transition at $T_N \approx 4.4$ K and reveal anisotropy with the *c*-axis acting as the hard direction, consistent with the recently refined phase diagram [4]. Field sweeps for $H \parallel c$ show a spin-flop transition near 1.8 T.

These results establish $MnNb_2O_6$ as a clean, anisotropic antiferromagnet and a promising classical counterpart to the quantum $S = \frac{1}{2}$ chain material $CoNb_2O_6$.

[1] R. Coldea et al., Science 327, 5962 (2010)
[2] L. M. Holmes et al., Solid State Communications 11, 409 (1972)
[3] O. V. Ni elsen et al., J. Phys. C 9 (1979)
[4] R. Maruthi et al., J. Phys.: Condens. Matter 33, 345801 (2021)

TT 61.8 Wed 15:00 P4

Dirac Quantum Hall States on (Reciprocal) Curved Surfaces
— •Maximilian Fürst — University of Regensburg, Regensburg, Germany

Three-dimensional topological insulator nanowires in an axial magnetic field B host peculiar Dirac-type quantum Hall surface states. Spatial variations in the wires' cross sections allow for shaping curved surfaces and hence for highlighting imprints of geometry and curvature, and their interplay, in the corresponding quantum Hall spectra [1, 2]. We discuss the peculiar spectral and magnetic properties of these systems. We show that these are composed of two classes, one asymptotically insensitive to the surface shape, scaling with B-field like regular quantum Hall states in the plane, and the other with an asymptotic B-field dependence intimately related to the wire geometry. Moreover, we demonstrate that a curved nanowire surface possesses a reciprocal partner nanowire surface such that the respective quantum Hall spectra are dual to each other upon exchanging angular momentum and magnetic flux. Notably, a cone-shaped nanowire, and the Corbino quantum Hall geometry as a limiting case, has a reciprocal partner wire with a dual quantum Hall spectrum that is B-field independent, with corresponding non-magnetic quantum Hall-type eigenstates. We support our analytical findings by numerical results for B-field ranges and wire geometries within reach of current experiment [3].

[1] R. Kozlovsky et al., Phys. Rev. Lett. 124, 126804 (2020)
[2] M. Fürst et al., Phys. Rev. B 109, 195433 (2024)
[3] I. Dusa et al., arXiv:2503.17166 (2025)

TT 61.9 Wed 15:00 P4

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

Recent experimental work has demonstrated the possibility of coupling superconductors (SCs) to quantum Hall (QH) systems at both integer and fractional filling factors. However, the theoretical modelling of such QH/SC interfaces remains challenging due to the strong magnetic fields required and the presence of disorder. In this work, we develop a theoretical framework based on fractional QH edge state theory and incorporate realistic models of the superconductor to derive the effective coupling mechanisms at the interface. We analyse the resulting normal and Andreev reflection processes, as well as correlations probed through interference between multiple edge states across the QH/SC interface, and discuss their signatures in transport experiments.

TT 61.10 Wed 15:00 P4

Topologically nontrivial phase induced by disorder in a one-dimensional system
— •Lars Emmrich and Michael Potthoff — Department of Physics, University of Hamburg, Germany

The Su-Schrieffer-Heger model with additional local, uncorrelated, binary-alloy site disorder of strength W is a prototypical model for studying the phase diagrams of disordered topological band insulators. With the topological-Hamiltonian approach and with the twisted-boundary-conditions approach, we employ two complementary techniques to compute the winding number ν, a topological invariant. Starting from the topologically nontrivial phase with $\nu = 1$ in the clean limit ($W = 0$), we find that, as W increases, the system undergoes a transition to a trivial phase with $\nu = 0$, followed by a second transition to a nontrivial phase with $\nu = 1$. Importantly, the latter phase cannot be connected continuously to the clean limit and thus represents a novel, disorder-induced phase, because the nontrivial topology is carried by the zeros of the single-electron Green's function.

TT 61.11 Wed 15:00 P4

Topological phases in the bosonic Haldane-Hubbard model
— •Hannah Carolina Dürschmidt, Ajesh Kumar, and Achim Rosch — Institute for Theoretical Physics, University of Cologne, Zülpicher Straße 77, 50937, Köln, Deutschland

We study the interacting bosonic Haldane–Hubbard model at half filling, using a self-consistent parton mean-field approach. Within this framework, we map out the phase diagram and identify superfluid, Mott-insulating, and topological phases. The primary focus is on the effects of long-range interactions, which can cause spontaneous breaking of lattice translation symmetry. In addition to Mott insultaing states, we investigate topological phases with a finite Hall conductivity.

TT 61.12 Wed 15:00 P4

Lattice defects in topological phases of matter
— •Alexander Gavrishev[1,2], Alexander Wong[2], Henry Davenport[2], Andres Perez Fadon[2], and Frank Schindler[2] — [1]Max Planck Institute for the Physics of Complex Systems — [2]Imperial College London

The defect response of topological materials offers a potential starting point for experimental probes of topology; while many comprehensive results exist for simple lattice defects in non-interacting topological matter, an analogue for interacting topological phases is missing. As a first step in this direction, we present exact diagonalisation results for lattice dislocations in a fractional Chern insulator.

TT 61.13 Wed 15:00 P4

The influence of fluctuations on the microwave response of multiterminal topological Josephson junctions
— •Gleb Seleznev and Wolfgang Belzig — Universität Konstanz, 78457 Konstanz, Germany

In recent years, it has been demonstrated that multiterminal Josephson junctions (MTJJs) can realize topological states of matter in synthetic dimensions defined by the superconducting phases. In this setting, topology is hosted by Weyl singularities in the spectrum of Andreev bound states (ABS) and is characterized by a nontrivial Chern number, which manifests itself in a quantized transconductance between two superconducting leads. Moreover, the Chern number leaves signatures in the dissipative part of the microwave response function, and can therefore be directly extracted using microwave spectroscopy.

In realistic experimental conditions, however, various types of fluctuations may obscure the observation of these topological properties. In this work, we investigate the role of thermal fluctuations and finite broadening of the ABS, which have a dominant effect in the large-gap limit, on the microwave response of MTJJs. We focus especially on the vicinity of the Weyl points, where the system is most sensitive to external perturbations. As a result, we demonstrate that the redefined Chern number is reduced, while other topological signatures become smeared by fluctuations.

TT 61.14 Wed 15:00 P4

Further Evidence of a Tomonaga-Luttinger Liquid in the Au/Ge(001) Surface Reconstruction
— Nico Kubetschek, •Ulrike Kürpick, Johann Tonhäuser, Till-Jakob Stehling, Marcel Schlesag, and René Matzdorf — University of Kassel, Institute of Physics, Heinrich-Plett-Str. 40, Kassel D-34132, Germany

We investigated the Au/Ge(001) surface reconstruction using scanning tunneling microscopy (STM) and spectroscopy at 77 K and 5 K. Local density of states maps reveal quasi-one-dimensional channels, which are oriented almost perpendicular to the Au-induced nanowires visible in STM topographic images. Spectroscopic analysis shows a characteristic power-law dependence, indicative of Tomonaga-Luttinger liquid behavior [1,2]. An increased power-law exponent is measured when these channels are interrupted by embedded Co-Au-induced nanorods [3]. The results are consistent with the existence of a Tomonaga-Luttinger liquid in a deeper layer of the Au-induced surface reconstruction.

[1] S.-I. Tomonaga, Prog. Theoret. Phys. 5, 544 (1950);
[2] J. Luttinger, J. Math. Phys. 4, 1154(1963).
[3] M. Schlesag et al., Phys. Rev. B 110, 195412 (2024).