MA 24: Weyl Semimetals (joint session MA/TT)

Time: Tuesday 14:00–15:30 Location: POT/0361

MA 24.1 Tue 14:00 POT/0361

Ferrimagnetism and the causes of discontinuous magnetic behavior in Kagome Weyl-semimetal Co3Sn2S2 — •Abdul-Vakhab Tcakaev[1], Benjamin Katter[1], Stefan Enzner[2], Eugen Weschke[3], Sebastian Wintz[3], Gohil S. Thakur[4], Michael Ruck[4], Giorgio Sangiovanni[2], and Vladimir Hinkov[1] — [1]Experimentelle Physik IV, Fakultät für Physik und Astronomie, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany — [2]Computational Quantum Materials, Fakultät für Physik und Astronomie, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany — [3]Helmholtz-Zentrum Berlin for Materials and Energy, Albert-Einstein-Straße 15, 12489 Berlin, Germany — [4]Technical University of Dresden, Helmholtzstr. 10 01069 Dresden

The Kagome Weyl semimetal Co3Sn2S2 shows puzzling magnetic anomalies that have been interpreted as hidden phase transitions. Combining element-specific XMCD, SQUID magnetometry, STXM, DFT, and inelastic neutron scattering, we establish a ferrimagnetic ground state in which Co moments are partially compensated by antiparallel Sn moments and stabilized by strong uniaxial magnetocrystalline anisotropy. Temperature-dependent XMCD and STXM show that the discontinuous drop of remanent magnetization on zero-field warming arises from abrupt domain nucleation controlled by demagnetization effects, rather than from an intrinsic change of the spin structure. This yields a consistent microscopic picture of the magnetism in Co3Sn2S2 relevant for its Weyl and anomalous Hall properties.

MA 24.2 Tue 14:15 POT/0361

High-field THz Probing of the Crossover between Weyl and Weyl-Kondo Physics in $Mn_{3+x}Sn_{1-x}$ — •Erik W. de Vos[1], Zekai Chen[1], Debankit Priyadarshi[1], Anusree V. Puleri[2], Uri Vool[2], Claudia Felser[2], Edouard Lesne[2], and Manfred Fiebig[1] — [1]Department of Materials, ETH Zurich, Zurich, Switzerland — [2]Max-Planck-Institute for Chemical Physics of Solids, Dresden, Germany

We present temperature-dependent high-field THz spectroscopy measurements on a substitution series of the noncollinear antiferromagnet $Mn_{3+x}Sn_{1-x}$. When the Mn substitution is increased from x=0 to x=0.5, $Mn_{3+x}Sn_{1-x}$ has been found to transition from a pure Weyl semimetal to a Weyl-Kondo insulator. This is accompanied by the emergence of a hybridization gap of 10.2 meV [1]. Our study uses high-field THz radiation to probe and drive the non-linear response of $Mn_{3+x}Sn_{1-x}$ through the onset of Kondo-driven correlations. Via this high-field resonant excitation, we directly probe the dynamic response across the transition from a Weyl semimetal to a Weyl-Kondo insulating state.

[1] Sci. Adv. 6, eabc1977 (2020)

MA 24.3 Tue 14:30 POT/0361

Peierls-induced topological Weyl semimetal in $PtBi_2$ — •Anders C. Mathisen[1], Stefanie S. Brinkman[1], Xin L. Tan[1], Øyvind Finnseth[1], Fabian Göhler[1], Chul-Hee Min[1], Jens Buck[2], Kai Rossnagel[2], Grisha Shipunov[3], Anna Isaeva[3], Jorge I. Facio[4], and Hendrik Bentmann[1] — [1]Center for Quantum Spintronics, Department of Physics, NTNU, Norway — [2]Kiel University & DESY, Germany — [3]Institute of Physics, University of Amsterdam, The Netherlands — [4]Instituto Balseiro, National University of Cuyo, Argentina

$PtBi_2$ is attracting interest because of its exotic electronic properties, including bulk Weyl nodes, Fermi-arc surface states, and unconventional surface superconductivity. The emergence of Weyl nodes in materials is commonly attributed to accidental crossings between non-degenerate valence and conduction bands, while little emphasis has been placed on the physical mechanisms that induce Weyl physics. Recent theory indicates that reduced translational symmetry in the Peierls-distorted crystal structure of $PtBi_2$ constitutes a mechanism for the formation of Weyl nodes [1]. In this talk, we will present an investigation of the bulk electronic structure of $PtBi_2$ using soft X-ray angle-resolved photoelectron spectroscopy. Based on an analysis of the spectral weight across wide regions in momentum space, we show how the Peierls-distortion in $PtBi_2$ promotes the formation of Weyl nodes.

[1] S. Palumbo *et al.*, Interplay between inversion and translation symmetries in trigonal $PtBi_2$. Phys. Rev. B **112**, 205125 (2025)

MA 24.4 Tue 14:45 POT/0361

Phonon-driven axial fields enable terahertz Kerr rotation in WTe2 — •Soma Dutta, Vishal Shokeen, Ruslan Chulkov, David Muradas Belinchón, M. Venkata Kamalakar, Oscar Grånäs, and Hermann Dürr — Department of Physics and Astronomy, Uppsala University, Box 516, 75120 Uppsala, Sweden

Weyl semimetals provide a platform for studying the coupling between lattice dynamics and topological electronic structure through the motion of Weyl nodes and their associated Berry curvature (see Sie et al., Nature 565, 61, 2019). Here we report the observation of terahertz-frequency Kerr rotation in the non-centrosymmetric Weyl semimetal WTe_2, generated in the absence of an external magnetic field. Using ultrafast pump-probe polarimetry, we identify coherent oscillations at 0.24 THz and 2.4 THz that originate from interlayer shear vibrations and optical phonon modes, respectively. The 0.24 THz shear mode exhibits maximum amplitude along the a-axis and is strongly suppressed along b, indicating an odd mirror-symmetry character. By modeling the strain-induced modification of the Weyl-node separation, we show that this shear phonon produces an axial vector potential whose sign depends on the direction of atomic displacement. Spatial gradients of this axial potential generate a pseudo-magnetic field with a sign structure that naturally accounts for the observed phase inversion. Our results provide direct evidence for phonon-driven axial electromagnetic fields in a Weyl semimetal and demonstrate a route for ultrafast control of topological optical responses through coherent lattice motion. *Ab initio* calculations will further clarify the Kerr response mechanism.

MA 24.5 Tue 15:00 POT/0361

Magnetoconductance in Chiral Topological Semimetals — •Ricardo Manuel Sousa Barbosa and Annika Johansson — Max Planck Institute of Microstructure Physics, Weinberg 2, 06120 Halle (Saale), Germany

Chiral topological semimetals [1] are a class of quantum materials whose crystal symmetries enforce multifold band crossings with nonzero topological charge, hosting symmetry-protected chiral fermionic quasiparticles, long surface Fermi arcs, and enhanced optical and transport responses. These Weyl semimetals [2] are three-dimensional materials that exhibit multiple Weyl nodes that act as point-like sources and sinks of Berry curvature in momentum space, and provide a condensed-matter realization of the chiral anomaly [3], a field-induced nonconservation of electrons associated with a given Weyl node, which manifests as a positive longitudinal magnetoconductance.

We investigate the magnetotransport properties of compounds in space group 198 [4], which host four- and six-fold degenerate Weyl nodes at the Γ and R points, respectively, with Chern numbers up to ± 4. Using a semiclassical approach, we compute the resulting magnetoconductance, enabling a detailed analysis of the unconventional electronic responses characteristic of these materials.

[1] N.B.M. Schröter *et al.*, Nature Physics **15**, 759-765 (2019); [2] M. Z. Hasan *et al.*, Annu. Rev. Condens. Matter Phys. **8**, 289-309 (2017); [3] F. Bladuini *et al.*, Nat. Commun. **15**, 6526 (2024) [4] D.A. Pshenay-Severin *et al.*, J. Phys.: Condens. Matter **30**, 135501 (2018)

MA 24.6 Tue 15:15 POT/0361

Giant Anomalous Hall Effect Tuned by Atomic Order in Fe3Pt — •Yibo Wang and Enke Liu — Beijing National Laboratory for Condensed Matter Physics, Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China

The Berry curvature induced anomalous Hall effect (AHE) has attracted considerable interest in recent years [1,2]. In Fe3Pt, a nodal line situated near the Fermi level generates a pronounced Berry curvature hotspot [3], giving rise to an intrinsic anomalous Hall conductivity (AHC) of 1250 S/cm according to our measurement. Building on this large intrinsic contribution, we sought to enhance the total AHE by deliberately increasing the extrinsic AHC through control of atomic ordering. By annealing Fe3Pt samples at various temperatures and for different durations, we were able to tune the extrinsic AHC continuously from nearly 0 S/cm up to 550 S/cm. The most striking result was obtained for a specimen that was annealed for ten days; at 2 K this sample exhibited a total AHC of 1892 S/cm. This value is a significant value among magnetic topological materials and represents a 50 % increase over the intrinsic contribution alone. These findings confirm the success of the proposed strategy: leveraging a substantial intrinsic Berry curvature AHC and subsequently amplifying the total AHC through extrinsic AHC through mechanisms such as atomic engineering. The approach provides a practical pathway for achieving exceptionally large anomalous Hall responses in magnetic topological systems. [1]Nat. Phys. 14, 1125-1131 (2018). [2] Nat. Phys. 14, 1119-1124 (2018). [3] Adv. Mater. 35, 2301339 (2023).