MM 40: Transport in Materials: Diffusion, Charge, or Heat Conduction IV

Time: Friday 10:15–12:30 Location: SCH/A216

MM 40.1 Fri 10:15 SCH/A216

Quantum oscillation and tunable charge density wave of kagome metal ScV6Sn6 — •Changjiang Yi, Xiaolong Feng, Chandra Shekhar, and Claudia Felser — Max Planck Institute for Chemcial Physics of Solids

Compounds with kagome lattice structure are known to exhibit Dirac cones, flatbands, and van Hove singularities, which host versatile quantum phenomena. We investigate the magnetoelectric transports along with the theoretical calculations of, a nonmagnetic charge-density wave (CDW) metal. ScV6Sn6 exhibits Shubnikov de Haas quantum oscillations, which help to shape the Fermi-surface (FS). The Dirac band is demonstrated along with a nonzero Berry phase. In addition, the compound also shows the anomalous Hall-like behavior up to the CDW phase transition. Under Cr substitution and hydrostatic pressure, the CDW is largely suppressed. The suppression of CDW phase under pressure can be well captured by our first-principles calculations, evidenced by the lift of imaginary phonon bands. The MR and Hall resistance behave differently under Cr substitution and pressure. Our study reveals that the anomalous Hall-like behavior arises from the kagome lattice and persists as long as the lattice is maintained.

MM 40.2 Fri 10:30 SCH/A216

Investigating UAHE in layered delafossite by high-energy electron irradiation. — •Elina Zhakina[1,2], Philippa McGuinness[2], Romain Grasset[3], Seunghyun Khim[2], Marcin Konczykowski[3], and Andrew Mackenzie[2,4] — [1]Department of Applied Physics and Quantum-Phase Electronics Center (QPEC), The University of Tokyo, Bunkyo, Tokyo, Japan — [2]Max Planck Institute for Chemical Physics of Solids — [3]Laboratoire des Solides Irradis, CEA/DRF/IRAMIS, Ecole Polytechnique, CNRS, Institut Polytechnique de Paris, Palaiseau, France — [4]Scottish Universities PhysicsAlliance, School of Physics & Astronomy, University of St. Andrews, St. Andrews, United Kingdom

PdCrO2 belongs to the delafossite family of extremely pure triangular lattice metals. While its Pd layers are metallic, the CrO2 layers are Mott insulating and order antiferromagnetically below 37 K. PdCrO2 [1]. It exhibits an unconventional anomalous Hall effect (UAHE), the origin of which has been the focus of substantial critical discussion. To investigate the origin of UAHE, we conducted a systematic study of the influence of point defects on the Hall effect of PdCrO2, the results of which are reported here. We introduced point-like defects into focused ion beam-sculpted microstructures of PdCrO2 by irradiating them with high-energy electrons. Comparing the results of UAHE as a function of disorder, we demonstrate UAHE behaviour attributed to its extrinsic origin.

MM 40.3 Fri 10:45 SCH/A216

Anisotropic anomalous Hall effect in distorted kagome GdTi3Bi4 — •Avdhesh Kumar Sharma[1], Bo Tai[1], Subhajit Roychowdhury[2], Premakumar Yanda[1], Ulrich Burkhardt[1], Xiaolong Feng[1], Claudia Felser[1], and Chandra Shekhar[1] — [1]Max Plank Institute for chemical physics of solids, Dresden, Germany — [2]Indian institute of science education and research, Bhopal, India

GdTi3Bi4 crystallizes in layered Ti-based kagome nets intertwined with zigzag Gd chains along the a-axis and orders antiferromagnetically below 15 K. Here, we present the temperature and field-dependent electrical transport of GdTi3Bi4 in different directions. The material exhibits anomalous Hall conductivity of 410 Ω-1 cm-1 at 2 K for B || c and it is completely absent for B || a, despite the similar magnetization observed in both orientations. This behavior is quite contradictory, as anomalous Hall effect (AHE) typically scales with the magnetization. Through first principles calculations, it is demonstrated that in the presence of time reversal symmetry broken by the Gd 4f sublattice and spin orbit coupling, the magnetization direction controls the orbital mixing in the Ti t_2g bands, relocating Berry curvature hot spots and producing the observed orientation selective anomalous Hall conductivity (AHC). The results establish GdTi3Bi4 as platform for investigating new avenues of AHE, such as directional AHE, and thus shed new light on the intricate coupling between magnetic and electronic structures, paving the way for exploring novel quantum phenomena.

MM 40.4 Fri 11:00 SCH/A216

Nernst effect in superconducting Weyl semimetal t-PtBi2 — Federico Caglieris[3], •Michele Ceccardi[1], Dmitriy Efremov[1], Grigory Shipunov[1], Iryna Kovalchuk[1,4], Saicharan Aswartham[1], Arthur Veyrat[1,5], Joseph Dufouleur[1,7], Daniele Marré[2,3], Bernd Büchner[1,7], and Christian Hess[1,6,7] — [1]IFW Dresden — [2]University of Genoa — [3]CNR SPIN — [4]Kyiv Academic University — [5]LPS Orsay — [6]Wüppertal University — [7]TU Dresden

Topological materials are among the most promising areas of research in Condensed Matter Physics, offering breakthroughs in dissipationless electronics or in error-free quantum computing. The combination of non-trivial topology and superconductivity opens to novel quantum devices. The discovery of intrinsic materials where such properties appear together represent a frontier in modern condensed matter physics. Trigonal PtBi2 has recently emerged as a possible candidate, being the first example of superconducting type-I Weyl semimetal. However, several aspects of this promising compound still need to be unveiled, concerning its complicated band structure, the actual role of Weyl points in determining its electronic properties and the nature of the superconducting transition. In the work, we experimentally investigated t-PtBi2 single crystals and exfoliated flakes by means of the Nernst effect, which has been demonstrated to be a powerful probe for study the fermiology of complex materials.

15 min. break

MM 40.5 Fri 11:30 SCH/A216

Negative quadratic magnetoresistance generated by spin fluctuations in the metamagnetic bilayer strontium ruthenate Sr3Ru2O7 — •Bastien Michon[1,2], Elisa Auffray[1], Amir Meddas[1], Zhiqiang Mao[3], Freek Massee[1], Pascale Senzier[1], Claude Pasquier[1], and Siham Benhabib[1] — [1]Laboratoire de Physique des Solides - University of Paris-Saclay, Orsay, France — [2]SOLEIL synchrotron, Saint Aubin, France — [3]Eberly College of Science, The Pennsylvania State University, University Park, USA

The bilayer strontium ruthenate Sr3Ru2O7 hosts a metamagnetic transition around 8T and was widely studied for its quantum criticality characterized by its linear-in-temperature resistivity. While most prior work has focused on the magnetic field evolution of the resistivity exponent α, the magnetoresistance (MR) has received less attention. Our low-temperature relative MR measurements on high-purity single crystals reveal two key features absent from the literature:

1. a well-defined negative quadratic MR between 30 and 100K, consistent with enhanced spin fluctuations, and 2. a non-monotonic MR evolution at low temperature within the 1.6-12K range.

The metamagnetic MR peak around 8T reaches nearly 90% at the lowest temperatures, broadens with increasing temperature, shifts to lower fields, and completely disappears between 20-30K. At higher temperature, the MR changes sign and follows a perfect negative H* dependence, with maximum amplitude around 30-40K. These measurements provide the first detailed mapping of the MR in Sr3Ru2O7 across a broad temperature range and up to 14T.

MM 40.6 Fri 11:45 SCH/A216

Quantum Transport in Atomic-Sized Contacts Using Break-Junction Experiments — •Guillem Pellicer and Carlos Sabater — Department of Physics, University of Alicante

The study of atomic-sized metallic contacts is fundamental to understanding the limits of electronic transport at the nanoscale. We present a comparative analysis of electronic transport in atomic-sized contacts, contrasting the behavior of noble metals with that of reactive metals under both ambient conditions and inert atmospheres. We examine how environmental interactions influence the formation and stability of these nanocontacts, employing clustering algorithms to analyze these effects.

MM 40.7 Fri 12:00 SCH/A216

Atomic Transistor-Based Implementation of Logic Gates — •Merlin Schieler[1], Florian Schieren[1], Carlotta Buchner[1], Felix Frank[1], Ida Göbel[1], Katja Marschall[1], Fanqing Xie[1], Florian Wertz[1], and Thomas Schimmel[1,2] — [1]Institute of Applied Physics, Karlsruhe Institute of Technologie (KIT), 76131 Karlsruhe, Germany — [2]Institute of Nanotechnology, Karlsruhe Institute

of Technologie (KIT), 76344 Eggenstein-Leopoldshafen, Germany

An atomic-scale quantum conductance switch was demonstrated in our group which allows to open and close an electrical circuit by the controlled and reproducible reconfiguration of individual silver atoms within an atomic-scale junction. The only movable parts of the switch are the contacting atoms. The device is fabricated by electrochemical deposition of silver atoms between the source and the drain electrode. It is entirely controlled by an external voltage of a few millivolts applied to an independent gate electrode. Controlled switching was performed between a quantized, electrically conducting "on-state" exhibiting a conductance of $G_0 = \frac{2e^2}{h} \approx \frac{1}{12.9\,\mathrm{k\Omega}}$ or preselectable multiples of this value and an insulating "off-state". The device, which reproducibly operates at room temperature, represents an atomic transistor or relay, opening intriguing perspectives for the emerging fields of quantum electronics and logics on the atomic scale.

Here, we show a first demonstration of logical operations such as NAND and NOR with electrical circuits consisting of two atomic-scale quantum conductance switches.

MM 40.8 Fri 12:15 SCH/A216

Quantum transport in α-Sn atomic-sized contacts tuned by strain — Francisco Guzmán[1], Wynand Dednam[2], Andres Martinez-garcia[1], Enrico Lombardi[2], Carlos Untiedt[1], and •Carlos Sabater[1] — [1]University of Alicante — [2]University of South Africa

Tin (Sn) transitions from metallic β-Sn (above 286 K) to α-Sn (diamond-cubic, zero-gap semiconductor) below this temperature. α-Sn's electronic properties are theoretically tunable under strain, potentially yielding a Dirac semimetal or topological insulator. We experimentally investigated the quantum electronic transport of α-Sn nanocontacts at 4.2 K using a Scanning Tunneling Microscopy break junction (BJ) setup. Conductance measurements revealed three distinct groups via machine-learning clustering. Supported by Molecular Dynamics (MD) simulations and Density Functional Theory (DFT) calculations with Spin-Orbit Coupling (SOC), our findings demonstrate that atomic contact geometry is crucial for quantum transport in α-Sn, providing insights for spintronics applications.