MA 9: Weyl Semimetals

Time: Monday 11:30–13:15 Location: POT 6

MA 9.1 Mon 11:30 POT 6

Strong Correlations in Pyrochlore-Iridates based on the example of Y2IrO7 — •Johannes Graspeuntner — TU Graz, Österreich

Pyrochlore-Iridates have attracted some attention after being proposed to host topological non-trivial states. In this talk we will investigate one example of this class of materials, namely Y2IrO7, and study the effect of strong electronic correlations on the electronic structure. We will investigate the validity of one-band description using only the effective j=1/2 states around the Fermi energy, as compared to a complete treatment of the full t2g shell, where a closer look is taken on the AIAO magnetic ordering on the frustrated Pyrochlore lattice. Furthermore, we will discuss short-ranged non-local correlation effects via a cluster-DMFT treatment.

MA 9.2 Mon 11:45 POT 6

Quadrupolar Weyl metal in magnetically ordered pyrochlore iridates — •Konstantinos Ladovrechis[1], Bitan Roy[2,3], and Tobias Meng[1] — [1]Institut für Theoretische Physik and Würzburg-Dresden Cluster of Excellence ct.qmat, Technische Universität Dresden, 01062 Dresden, Germany — [2]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden, Germany — [3]Department of Physics, Lehigh University, Bethlehem, Pennsylvania 18015, USA

Pyrochlore iridates are a class of materials in which the confluence of electronic interactions and emergent topology leads to a plethora of exotic states of matter. In this work, we study an effective low-energy Luttinger model accounting for a quadratic band touching (QBT) around the Γ point, and study interaction-induced instabilities of the QBT. In particular, we analyze the impact of a new type of magnetic order transforming under the T_{2u} irreducible representation of the cubic point group. This magnetic order is of octupolar character. It breaks time-reversal symmetry but is inversion-invariant, and thus for example stabilized quadrupoles of Weyl points on different planes in the Brillouin zone. By classifying these unconventional electronic structures, we comment on experimental signatures of this new magnetic order in itinerant pyrochlore iridates, for example in transport experiments.

MA 9.3 Mon 12:00 POT 6

Spin, angle and time-resolved photoemission studies of WTe_2 — •J. Schusser[1,2], L. Nicolaï[1], M. Fanciulli[2,3], M.-i Lee[2], Z. El Youbi[2,4], M. C. Richter[2], O. Heckmann[2], D. Bresteau[3], T. Ruchon[3], K. Hricovini[2], and J. Minár[1] — [1]NTC, U. of West Bohemia, Czech Republic — [2]LPMS, U. of Cergy-Pontoise, France — [3]ATTOLab, CEA, France — [4]DLS, Harwell Campus, United Kingdom

Mo dichalcogenides are probably the most studied TMDCs by virtue of being appealing for various possible reasons suchlike spin or valley pseudospin and their interactions. W-based counterparts are on the other hand evincing much stronger spin-orbit coupling due to which all the spin-related effects are more stable at room temperature and thus more feasible for application. WTe_2, the type-II Weyl semimetal candidate is in particular interesting due to the possibility of having spin-differentiated Weyl points above Fermi energy. We have conducted several pump-probe experiments following the evolution of the band dispersion in the vicinity of X and Y points of WTe_2 and TR-SARPES experiments in the part of Brillouin zone where the presence of Weyl points is predicted. The study was supported by Ab-initio one-step model photoemission calculations using SPR-KKR package and compared to experiment the remarkable agreement of which helps us to disentangle the subsequent relaxation processes. We have also conducted a preliminary band structure calclulations of $HfTe_2$ revealing the high potential of SPR-KKR package for calculating the band dispersion of layered materials by including geometry effects of the experiment as well as the polarization and energy of the incoming light.

MA 9.4 Mon 12:15 POT 6

Spin and orbital texture of the Weyl semimetal $MoTe_2$ studied by spin-resolved momentum microscopy — •Kenta Hagiwara[1], Xin Liang Tan[1], Philipp Rüssmann[1], Ying-Jiun Chen[1,2], Koji Fukushima[3], Keiji Ueno[3], Vitaliy Feyer[1], Shigemasa Suga[4,1], Stefan Blügel[1], Claus M. Schneider[1,2], and Christian Tusche[1,2] — [1]Peter Grünberg Institut, Forschungszentrum Jülich, 52425 Jülich — [2]Fakultät für Physik, Universität Duisburg-Essen, 47057 Duisburg — [3]Department of Chemistry, Saitama University, 338-8570, Saitama, Japan — [4]ISIR, Osaka University, 567-0047, Osaka, Japan

Weyl semimetals host chiral fermions in solids as a pair of non-degenerate linear dispersions with band crossing points in bulk. These Weyl points are protected by crystal symmetry, forming a Fermi arc, which is a connection between a pair of Weyl points with opposite chirality at the surface. Momentum microscopy provides two dimensional photonelectron maps of the in-plane crystal momentum over the whole Brillouin zone, simultaneously. Together with an imaging spin filter, we have revealed the spin-resolved electronic structure of the type-II Weyl semimetal $1T_d$ $MoTe_2$ in the full Brillouin zone. Combined with the use of differently polarized light, we have revealed the spin texture and the orbital texture of the Weyl cones in comparison with first-principles calculations. We give evidence that a pair of Weyl cones exhibits a strong circular dichroism with reversed sign, indicating the different charge of the respective Weyl points in the Fermi surface.

MA 9.5 Mon 12:30 POT 6

Unconventional Fermi arcs in an ultrathin complex magnet — •Ying-Jiun Chen[1,2], Jan-Philipp Hanke[1,3], Markus Hoffmann[1,3], Gustav Bihlmayer[1,3], Yuriy Mokrousov[1,3,4], Stefan Blügel[1,3], Claus M. Schneider[1,2], and Christian Tusche[1,2] — [1]Peter Grünberg Institut, Forschungszentrum Jülich, D-52425 Jülich — [2]Fakultät für Physik, Universität Duisburg-Essen, D-47057 Duisburg — [3]Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, D-52425 Jülich — [4]Institute of Physics, Johannes Gutenberg University Mainz, D-55099 Mainz

The discovery of topological states of matter has led to a revolution in materials research. When external or intrinsic parameters break certain symmetries, global properties of topological materials change drastically. A paramount example is the emergence of Weyl nodes under broken inversion symmetry, acting like magnetic monopoles in momentum space. In this talk, we demonstrate that under broken time-reversal symmetry open Fermi arcs appear at the surface of the complex magnet 2 ML Fe/W(110). Our spin- and orbital-resolved momentum microscopy experiments together with density functional theory give evidence that the Fermi-surface topology of the atomically thin ferromagnet is substantially modified by the hybridization with a heavy-metal substrate, giving rise to Fermi-surface discontinuities being bridged by the Fermi arcs. The hybridization points are attributed to a non-trivial "mixed" topology and induce hot spots in the Berry curvature, dominating spin and charge transport as well as magneto-electric coupling effects.

MA 9.6 Mon 12:45 POT 6

Infrared spectroscopy on the magnetic Weyl-semimetal $Co_3Sn_2S_2$ — •Felix Schilberth[1,2], Franz Mayr[1], Joachim Deisenhofer[1], Hiroyuki Nakamura[3], Mohamed Kassem[3], Sándor Bordács[2], and István Kézsmárki[1,2] — [1]Chair for Experimental Physics V, University of Augsburg, 86159 Augsburg, Germany — [2]Department of Physics, Budapest University of Technology and Economics, 1111 Budapest, Hungary — [3]Department of Materials Science and Engineering, Kyoto University, Kyoto 606-8501, Japan

We investigate the shandite $Co_3Sn_2S_2$, a ferromagnet with kagome lattice and a magnetic ordering temperature of 174 K. According to recent angle resolved photoemission spectroscopy (ARPES) studies, the bulk band structure of this material hosts Weyl-nodes and correspondingly the surface states form so-called Fermi arcs. Since the Fermi-Energy lies in the vicinity of the Weyl-nodes, large anomalous Hall-effect (AHE) was detected in $Co_3Sn_2S_2$. Here, we use infrared spectroscopy to uncover the low-energy electronic excitations of this compound. Regarding the kagome plane, our data reflects the anisotropy of the crystal structure for polarisations in- and out-of-plane. For both polarisations, the magnetic ordering causes a reconstruction of the electronic states in the vicinity of the Fermi-Energy. In addition, we investigate the spin dependent properties of the bands using magneto-optical Kerr-effect (MOKE) spectroscopy in the infrared-visible energy range. From these experiments, we determine both the diagonal and the off-diagonal parts of the conductivity tensor which allow us to identify the key features of the band structure responsible for the large AHE.

MA 9.7 Mon 13:00 POT 6

Giant anomalous Hall and Nernst effect in magnetic cubic Heusler compounds — •Jonathan Noky[1], Yang Zhang[2], Claudia Felser[1], and Yan Sun[1] — [1]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [2]Massachusetts Institute of Technology, Cambridge, USA

There is an ongoing search for materials with large anomalous Hall and Nernst effects. These effects can be utilized in applications for data storage, thermoelectric power generation, and a high temperature quantum anomalous Hall effect, when preparing them as thin films. A promising class of materials for this purpose are the Heusler compounds because they can be grown in thin films and have a high Curie temperature. In these systems, the interplay between magnetism and topological band structures leads to a strongly enhanced Berry curvature. This can consequently create large anomalous Hall and Nernst effects.

In this work, we provide a comprehensive study of the intrinsic anomalous transport properties for magnetic cubic full Heusler compounds and we illustrate that several Heusler compounds outperform the best so far reported materials. Additionally, the results reveal the general importance of mirror planes in combination with magnetism for giant anomalous Hall and Nernst effects, which should be valid for all linear responses (spin Hall effect, spin orbital torque, etc.) dominated by intrinsic contributions.