MA 39: Weyl Semimetals

Time: Thursday 11:30–12:45 Location: HSZ 403

MA 39.1 Thu 11:30 HSZ 403

Topological spin textures stabilised by Weyl fermions — •Juba Bouaziz[1], Gustav Bihlmayer[1], Julie B. Staunton[2], and Stefan Blügel[1] — [1]Peter Grünberg Institut Forschungszentrum Jülich — [2]The university of Warwick

Rare-earth intermetallic (REI) constitute a playground for the realization of topological spin textures relying on Ruderman-Kittel-Kasuya-Yosida (RKKY) interactions between the localized 4f-moments [1]. In non-centrosymmetric REI, namely REAlGe (Si), the breaking of inversion symmetry generates Weyl nodes which display interesting topological properties. The Weyl fermions mediate highly anisotropic RKKY interactions leading to the emergence of Kitaev (KT) and Dzyloshinksii-Moriya (DM) interactions. The incommensurate magnetic order present in these systems can be tied to the nesting of topological Fermi pockets [2]. We perform a systematic first-principles analysis in the framework of the DFT+U for REAlGe (RE=Ce-Gd) and investigate the contributions of the different exchange interactions (isotropic, DM, and KT) to incommensurate order. The local crystal field coefficients are computed from first-principles as well and are used to evaluate the magneto-crystalline anisotropy. Finally, we employ atomistic spin-dynamic simulations and identify the magnetic phases that are stabilized in presence of an external magnetic field. Our analysis aims at drawing a direct connection between the topology of the electronic band structure and the topology of the spin structures in real space. [1] J. Bouaziz et al. PRL 128, 157206 (2022) [2] J. Gaudet et al. Nat Mat 20, 1650 (2021)

MA 39.2 Thu 11:45 HSZ 403

Pressure induced ferromagnetic collapse and valence instability in EuB_6 — •Leonardo Kutelak[1], Raimunda Sereika[2], Gilberto Fabbris[3], Gustavo Lombardi[1], Daniel Haskel[3], Narcizo Souza Neto[1], Priscila Rosa[4], Wenli Bi[2], and Ricardo Reis[1] — [1]Brazilian Synchrotron Light Laboratory (LNLS), Brazilian Center for Research in Energy and Materials (CNPEM),Campinas, Sao Paulo, Brazil — [2]University of Alabama at Birmingham - Birmingham, AL 87545, USA — [3]Advanced Photon Source, Argonne National Laboratory, Argonne, Illinois 60439, USA — [4]Los Alamos National Laboratory - Los Alamos, NM 87545, USA

The only ferromagnetic rare earth hexaboride, EuB_6, presents previously reported interesting behavior such as a two-step magnetic transition below 15 K[1] and magnetic polarons up to 40 K[!]. Most recently, it was proposed that EuB_6 may host non-trivial electronic behavior near Fermi surface presenting either Weyl Points or nodal lines depending upon magnetization ordering and direction. We show evidences for EuB_6 ferromagnetic collapse above 20 GPa with mean valency increase by X-ray spectroscopy techniques. No signs for structural phase transitions were observed in high pressure X-ray diffraction. This opens up new possibilities for fine tuning topological properties utilizing pressure in rare earth hexaborides.

[1]Süllow, Structure, et al. Physical Review B 57.10 (1998): 5860. [2]Pohlit, Merlin, et al Physical review letters 120.25 (2018): 257201. [3]Nie, Simin, et al. Physical Review Letters 124.7 (2020): 076403.

MA 39.3 Thu 12:00 HSZ 403

High pressure studies of the topological Hall effect on CeAlGe — •Mario M. Piva[1], Jean C. Souza[2], Gustavo A. Lombardi[3,1], Kevin R. Pakuszewski[4], Cris Adriano[4], Pascoal G. Pagliuso[4,5], and Michael Nicklas[1] — [1]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [2]The Weizmann Institute of Science, Rehovot, Israel — [3]Brazilian Synchrotron Light Laboratory (LNLS), Campinas, Brazil — [4]"Gleb Wataghin" Institute of Physics, Campinas, Brazil — [5]Los Alamos National Laboratory, Los Alamos, USA

The Weyl semimetal CeAlGe is an excellent playground to investigate non-trivial topologies in real and momentum space due to the presence of a topological magnetic phase [1]. Our findings show that, the THE in CeAlGe is sensitive to slight stoichiometric variations, similar to its magnetism [2]. The observed change of a single THE region to two distinct regions upon application of external pressure is in agreement with previous reports [3]. Remarkably, we find that application of high pressures leads to the appearance of a THE even in samples where it was absent at ambient pressures.

This project has received funding from the European Unions Horizon 2020 research and innovation programme under the Marie Skłodwska-Curie grant agreement No 101019024.

[1] P. Puphal, *et al.*, Phys. Rev. Lett. **124** 017202 (2020); [2] P. Puphal, *et al.*, Phys. Rev. Mat. **3** 024204 (2019); [3] X. He, *et al.*, arXiv:2207.08442.

MA 39.4 Thu 12:15 HSZ 403

Magnetic and Electronic Structure of $Eu(Cd,Zn)_2P_2$ — •Sarah Krebber[1], Kristin Kliemt[1], Marvin Kopp[1], Charu Garg[1], Jens Müller[1], Kurt Kummer[2], Denis Vyalikh[3], and Cornelius Krellner[1] — [1]Institute of Physics, Goethe-University, Frankfurt (Main), Germany — [2]ESRF, Grenoble, France — [3]DIPC, Donostia-San Sebastián, Spain

The interplay of topology and magnetism has been of great interest in the last few years. The coexistence of both phenomena can be realized in europium based compounds with the 122 stoichiometry and a trigonal crystal structure ($P\overline{3}m1$). Recently, a spin fluctuation induced Weyl semimetal state in the paramagnetic phase of $EuCd_2As_2$ [1,2] and its tunability by pressure [3] was discovered. Furthermore, $EuCd_2P_2$ has been explored due to its colossal magnetoresistance [4], where the origin of the effect was explained by the formation of ferromagnetic clusters [5].

With the aim of studying the magnetic and electronic properties of $EuCd_2P_2$ compound in detail and finding similar effects in $EuZn_2P_2$ both systems were studied. Here, we present the successful crystal growth and characterization via magnetization, electrical transport, heat capacity and spectroscopy.

[1] Ma et al., Science Adv. 5, eaaw4718 (2019). [2] Jo et al., Phys. Rev. B 101, 140402(R) (2020). [3] Gati et al., Phys. Rev. B 104, 155124 (2021). [4] Wang et al., Adv.Mater., 33, 2005755 (2021). [5] Sunko et al., arXiv:2208.05499, (2022).

MA 39.5 Thu 12:30 HSZ 403

Novel thermo-electric transport channel in the conformal limit of tilted Weyl semimetals — Thorvald Ballestad[1], Alberto Cortijo[2], María Vozmediano[3], and •Alireza Qaiumzadeh[1] — [1]Center for Quantum Spintronics, Norwegian University of Science and Technology, Trondheim, Norway — [2]Universidad Autonoma de Madrid, Madrid, Spain — [3]Instituto de Ciencia de Materiales de Madrid, CSIC, Madrid, Spain

Recently, a new contribution to the Nernst current was proposed in 3D Dirac and Weyl semimetals, originated from quantum conformal anomaly [1,2]. In the present study, we analyze the effect of the tilt on the transverse thermo-electric coefficient of Weyl semimetals in the conformal limit, i.e., zero temperature and zero chemical potential. Using the Kubo formalism, we find a non-monotonic behavior of the thermoelectric conductivity as a function of the tilt perpendicular to the magnetic field, and a linear behavior when the tilt is aligned to the magnetic field. An "axial Nernst" current is generated in inversion symmetric materials when the tilt vector has a projection in the direction of the magnetic field. This analysis will help in the design and interpretation of thermo-electric transport experiments in recently discovered topological quantum materials [3].

[1] M. N. Chernodub et al, Phys. Rev. Lett. 120, 206601 (2018). [2] V. Arjona et al, Phys. Rev. B 99, 235123 (2019). [3] T. M Ballestad, A. Cortijo, M. A. H. Vozmediano, A. Qaiumzadeh, arXiv:2209.14331 (2022).