O 23: Poster Session II: Topology and symmetry-protected materials

Time: Monday 13:30–15:30 Location: P

O 23.1 Mon 13:30 P

Discovery of chiral topological semimetals with multifold fermions and long surface Fermi-arcs — •Niels B. M. Schröter — Swiss Light Source, Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland

Chiral topological semimetals (which possess neither mirror nor inversion symmetries) are a new family of topological materials that are expected host numerous novel phenomena, such as multifold fermions with large topological charge, long Fermi-arc surface states, and a quantized response to circularly polarized light. However, until recently, all known topological semimetals crystallized in space groups that contain mirror operations, which means that the aforementioned phenomena must vanish.

Here, I will present evidence from angle-resolved photoelectron spectroscopy that a family of chiral intermetallic catalysts, including PtAl and PdGa, are chiral topological semimetals. We directly visualize the multifold fermions in these compounds and show that they carry the largest possible Chern number that can be realized in any solid by imaging their extremely long surface Fermi-arcs and resolving a spin-orbit coupling induced band splitting. We also show experimentally that there is a direct relationship between the handedness of the crystal structure and the electronic chirality (i.e. the Chern number sign) of the multifold fermions. This finding demonstrates that structural chirality can be used as a control parameter to manipulate phenomena that are sensitive to electronic chirality, such as the direction of topological photocurrents.

O 23.2 Mon 13:30 P

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[1,4], 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]Saitama University, 338-8570, Saitama, Japan — [4]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 topology, 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.

O 23.3 Mon 13:30 P

Observation of backscattering induced by magnetism in a topological edge state — •Berthold Jaeck[1,2], Yonglong Xie[1,3], Bogdan Andrei Bernevig[1], and Ali Yazdani[1] — [1]Princeton University, Joseph Henry Laboratories and Department of Physics, Princeton, USA — [2]Present Address: The Hong Kong University of Science and Technology, Department of Physics, Clearwater Bay, Kowloon, Hong Kong — [3]Present Address: Harvard University, Department of Physics, Cambridge, USA

We have investigated the effects of time-reversal symmetry breaking on the topological edge state of bismuth. Using spectroscopic imaging and spin-polarized measurements with the STM, we have compared quasiparticle interference (QPI), occurring in the edge state of a pristine bismuth bilayer with that occurring in the edge state of a bilayer, which is terminated by ferromagnetic iron clusters. Our experiments on the decorated bilayer edge reveal an additional QPI branch that can be associated with spin-flip scattering across the Brioullin zone center between time-reversal band partners. The observed QPI characteristics exactly match with theoretical expectations for a topological edge state, having one Kramer's pair of bands. Our results provide further evidence for the non-trivial nature of bismuth and, in particular, demonstrate backscattering inside a helical topological edge state induced by broken TRS through local magnetism (1).

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(1) B. Jäck *et al.*, PNAS 117 (28), 16214-16218 (2020)

O 23.4 Mon 13:30 P

Unveiling the complex band structure of the potential non-symmorphic topological insulator $TaNiTe_2$ — •Tim Figgemeier[1], Jennifer Neu[2], Simon Moser[3], David J. Singh[4], Theo M. Siegrist[2,5], Hendrik Bentmann[1], and Friedrich Reinert[1] — [1]Experimentelle Physik VII, Universität Würzburg — [2]National High Magnetic Field Laboratory, Tallahassee, Florida — [3]Experimentelle Physik IV, Universität Würzburg — [4]University of Missouri, Columbia, Missouri — [5]College of Engineering, FAMU-FSU, Tallahassee, Florida

$NbNiTe_2$ and $TaNiTe_2$ are layered van-der-Waals systems. While $NbNiTe_2$ was discussed as a Weyl-semimetal candidate lately [1,2], $TaNiTe_2$ (space group #53, *Pmna*) is predicted to be a topological insulator with non-symmorphic crystal structure, characterized by a topological inavriant of $Z_4 = 1$, that have rarely been studied experimentally up to now [3]. In this study we investigated the electronic structure of $TaNiTe_2$ by means of angle-resolved photoemission (ARPES) experiments and first-principles calculations. Systematic photon-energy- and polarization-dependent measurements allow us to disentangle the highly complex band structure. Furthermore, we discuss indications for the presence of a topological surface state.

[1] Wang et al., PRB 95, 165114 (2017)
[2] Neu et al., PRB 100, 144102 (2019)
[3] Vergniory et al, Nature 544, 480-450 (2019)

O 23.5 Mon 13:30 P

Molecular beam epitaxy and spectroscopy on the antiferromagnetic topological insulator $(MnBi_2Te_4)(Bi_2Te_3)$ — •Philipp Kagerer[1,2], Celso Fornari[1,2], Sebastian Buchberger[1,2], Sergio Luiz Morelhao[3], Raphael Crespo Vidal[1,2], Abdul Tcakaev[4,2], Volodymyr Zabolotnyy[4,2], Eugen Weschke[5], Vladimir Hinkov[4,2], Martin Kamp[6], Bernd Büchner[2,7,8], Anna Isaeva[2,7,8], Hendrik Bentmann[1,2], and Friedrich Reinert[1,2] — [1]Exp. Physik VII, Uni Würzburg — [2]Würzburg-Dresden Cluster of Excellence ct.qmat — [3]Inst. de Fisica, Univ. de Sao Paulo — [4]Exp. Physik IV, Uni Würzburg — [5]HZB Berlin — [6]Phys. Inst. and RCCM, Uni Würzburg — [7]Leibnitz IFW Dresden — [8]Inst. für Festk.- und Materialphysik, TU Dresden

With the discovery of $MnBi_2Te_4$ as the first antiferromagnetic topological insulator, the material systems has emerged as a candidate for applications in quantum technologies [1]. Presently, the interplay between magnetism and topology in this compound is not fully understood. We have established the MBE-growth of $(MnBi_2Te_4)(Bi_2Te_3)$ heterostructures on BaF_2 as a basis for further research into the magnetic and electronic properties of these compounds [2]. MBE allows us to access and tailor various structural as well as electronic material properties and may give access to the underlying physics. We will present a study on the growth of the compound including an analysis of XRD patterns, as well as photoemission and XMCD/XLD results.
[1] M.M. Otrokov et al., Nature 576, 416 (2019) [2] P. Kagerer et al., JAP 128, 135303 (2020)