DS 7: 2D Materials and their Heterostructures IV

Time: Tuesday 11:15–12:30 Location: SCH A 316

DS 7.1 Tue 11:15 SCH A 316

THz-Light Canalization by means of Phonon Polaritons in 2D van der Waals Materials — •Maximilian Obst[1,2], Tobias Nörenberg[1,2], Gonzalo Álvarez-Pèrez[3], Thales V.A.G. de Oliveira[4], Alexey Nikitin[5], Pablo Alonso-González[3], J. Michael Klopf[4], Susanne C. Kehr[1,2], and Lukas M. Eng[1,2] — [1]TU Dresden, Germany — [2]Würzburg-Dresden Cluster of Excellence - EXC 2147 (ct.qmat), Germany — [3]University of Oviedo, Spain — [4]HZDR, Dresden, Germany — [5]DIPC, Donostia-San Sebastian, Spain

Hyperbolic phonon polaritons (PhP) in anisotropic, 2D van der Waals materials present a promising platform to shrink THz optics into nm-sized volumes, as they enable ultra-high field confinement. Recently, controlled PhP dispersion tuneability was demonstrated at MIR wavelengths by vertically stacking two α-MoO_3-flakes under a well-defined twist-angle θ, introducing a topological transition, where PhPs propagate along one distinct direction (so-called 'canalized propagation')[1].

In this talk, we explore the THz dispersion tunability in twisted bilayer MoO_3 at frequencies ranging from $\nu = 8.28$ to 9.38 THz, for which the existence of hyperbolic PhP has been demonstrated recently [2], and where longer (THz) wavelengths make strong confinement even more desirable. We demonstrate the transition from hyperbolic to elliptic propagation of these PhPs by varying both θ and ν and report the very first observation of canalized PhPs in the THz spectral range, i.e., for $\nu = 8.67$ THz and $\theta = 50°$.

[1] G. Hu et al., *Nature* **582**, 209 (2020).

[2] T.V.A.G. de Oliveira et al., *Adv. Mater.* **33**, 2005777 (2021).

DS 7.2 Tue 11:30 SCH A 316

Magnetically induced band splitting of the exfoliated antiferromagnet $MnPS_3$ revealed by temperature dependent μ-ARPES — •J. Strasdas[1], B. Pestka[1], M. Rybak[2], A. K. Budniak[3], N. Leuth[1], H. Boban[4], I. Cojocariu[4], D. Baranowski[4], V. Feyer[4], J. Avila[5], P. Dudin[5], Y. Amouyal[6], L. Plucinski[4], E. Lifshitz[3], M. Birowska[7], and M. Morgenstern[1] — [1]II. Institute of Physics B and JARA-FIT, RWTH-Aachen University, Germany — [2]Department of Semiconductor Materials Engineering Wrocław University of Science and Technology, Poland — [3]Schulich Faculty of Chemistry, Solid State Institute, Russell Berrie Nanotechnology insistute and Helen Diller Quantum Center, Technion, Israel Institute of Technology, Israel — [4]Forschungszentrum Jülich, Peter Grünberg Institute (PGI-6), Germany — [5]Synchrotron-SOLEIL, Université Paris-Saclay, France — [6]Department of Materials Science and Engineering, Technion, Israel Institute of Technology — [7]Institute of Theoretical Physics, University of Warsaw, Poland

We provide micron-scale angle-resolved photoelectron spectroscopy (μ-ARPES) of the exfoliated intralayer antiferromagnet (AFM) $MnPS_3$ above and below the Néel temperature in comparison with density functional theory (DFT) calculations. We demonstrate a splitting of parts of the Mn $3d_{z^2}$-bands induced by the AFM ordering in line with DFT results. Related changes of adjacent S 3p-bands indicate a competing FM superexchange contribution. This novel access to the electronic band structure is found to be transferable to other AFM MPX_3 materials (M: transition metal, P: phosphorus, X: chalcogenide).

DS 7.3 Tue 11:45 SCH A 316

Twistronics of high temperature superconductors — •Nicola Poccia — Leibniz Institute for Solid State and Materials Research Dresden (IFW-Dresden(

Ideally, one would like to have quantum technologies that could work at higher temperature and at the same time show all the advantages of a twisted architecture as for example its revolutionary degree of electronic tunability. However, highly tunable superconductors that operate above liquid nitrogen are either not yet showed up using multilayered graphene twisted heterostructures or the materials are very difficult to assemble in twisted heterostructures given their extreme sensitivity to the environmental conditions. Here we show a possible avenue towards the resolution of this problem, demonstrating how to engineer a new generation of the van der Waals heterostructures comprising atomically high temperature superconducting thin Bi2Sr2Can-1CunO2n+4 (where n = 1,2,3) crystals. The intended van der Waals constituent Bi2Sr2Can-1CunO2n+4 planes are twisted with respect to each other and make the Josephson junctions. We measure different quantum transport properties of the Josephson junctions in a wide range of twisted angles, indicating the high temperature superconducting topological nature of these systems. Finally, technological prospects on the realization of hybrid complex superconducting circuits will be given.

DS 7.4 Tue 12:00 SCH A 316

New magneto-polaron resonances in a monolayer of a transition metal dichalcogenide — Carlos Trallero-Giner[1,2], Darío G. Santiago-Pérez[3], and •Vladimir M. Fomin[1,4] — [1]Institute for Integrative Nanosciences (IIN), Leibniz IFW Dresden, D-01069 Dresden — [2]Havana University, Havana 10400, Cuba — [3]Universidad Autónoma del Estado de Morelos, CP 62209, Cuernavaca, Morelos, México — [4]Moldova State University, MD-2009 Chişinău, Republic of Moldova

For transition metal dichalcogenide (TMD) semiconductors, the behavior of the magneto-polaron resonances (MPRs) is revealed as a function of the phonon symmetry inherent in the system. It is shown that the renormalized Landau energy levels are modified by the interplay of the long-range Pekar-Fröhlich (PF) and short-range deformation potential (DP) interactions. This interplay leads to a new series of MPRs involving the optical phonons at the center of the Brillouin zone. The coupling of the two Landau levels with the LO and A_1 optical phonon modes provokes resonant splittings of double avoided-crossing levels giving rise to three excitation branches. To explore the interplay between the MPR, the electron-phonon interactions (PF and DP) and the couplings between adjacent Landau levels, a full Green's function treatment for the evaluation of the energy and its life-time broadening is developed. A generalization of the two-level approach is performed for the description of the new MPR branches. The obtained results are a guideline for the magneto-optical experiments in TMDs, where three MPR peaks should be observable.

DS 7.5 Tue 12:15 SCH A 316

Light driven magnetic transitions in transition metal dichalcogenide heterobilayers — •Michael Vogl[1], Swati Chaudhary[2,3,4], and Gregory Fiete[3,4] — [1]Department of Physics, King Fahd University of Petroleum and Minerals, 31261 Dhahran, Saudi Arabia — [2]Department of Physics, The University of Texas at Austin, Austin, Texas 78712, USA — [3]Department of Physics, Northeastern University, Boston, Massachusetts 02115, USA — [4]Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

We study strongly correlated phases of twisted transition metal dichalcogenide heterobilayers (tTMDs) subject to a period drive. Specifically, we employ Floquet theory to investigate how for this family of materials different forms of light can induce various magnetic phase transitions.