TT 70: Correlated Electrons: Charge Order

Time: Friday 9:30–10:45 Location: HSZ 103

TT 70.1 Fri 9:30 HSZ 103

Interplay of superconductivity and charge-density-wave in $NbSe_2$ at high pressures — •Owen Moulding, Israel Osmond, Takaki Muramatsu, and Sven Friedemann — University of Bristol, Bristol, UK

The transition metal dichalcogenide $NbSe_2$ has well-documented charge density wave (CDW) and superconducting transitions at 33 K and 7 K at ambient pressure. The CDW transition is suppressed under high pressure and is absent beyond its quantum critical point (QCP). The effect of this QCP on superconductivity is of great interest and stimulates discussions on the relation between superconductivity and the CDW order. So far, resistivity, magnetic susceptibility, and X-ray measurements have explored the vicinity of this QCP and they indicate a weak relation between superconductivity and the CDW: either a weak competition between CDW order and superconductivity or a weak promotion of superconductivity by fluctuations at the CDW QCP.

Here, we present high-pressure Hall effect measurements as a clear probe of the CDW order and trace the CDW transition to higher pressures than previously measured with transport methods. The sign-change in the Hall coefficient marking the CDW transition is suppressed. Above the critical pressure of the CDW, the Hall effect remains hole-like consistent as observed by ARPES. We observe the superconducting temperature increase with pressure and then saturate beyond the critical pressure of the CDW at 4.8 GPa, indicating weak competition between superconductivity and charge order.

TT 70.2 Fri 9:45 HSZ 103

Collapse of layer-dimerization in 1T-TaS_2 — Quirin Stahl[1], Maximilian Kusch[1], Gaston Garbarino[2], Norman Kretzschmar[2], Kerstin Hanff[3], Kai Rossnagel[3], Jochen Geck[1], and •Tobias Ritschel[1] — [1]TU Dresden — [2]ESRF, Grenoble — [3]CA Universität zu Kiel

Photo-induced switching between collective quantum states of matter is a fascinating rising field with exciting opportunities for novel technologies. Presently very intensively studied examples in this regard are nanometer-thick single crystals of the layered material 1T-TaS_2, where picosecond laser pulses can trigger a fully reversible insulator-to-metal transition (IMT). This IMT is believed to be connected to the switching between metastable collective quantum states, but the microscopic nature of this so-called hidden quantum state remained largely elusive up to now. Here we determine the latter by means of state-of-the-art x-ray diffraction and show that the laser-driven IMT involves a marked rearrangement of the charge and orbital order in the direction perpendicular to the TaS_2-layers. More specifically, we identify the collapse of inter-layer molecular orbital dimers, which are a characteristic feature of the insulating phase, as a key mechanism for the non-thermal IMT in 1T-TaS_2, which indeed involves a collective transition between two truly long-range ordered electronic crystals.

TT 70.3 Fri 10:00 HSZ 103

The nature of the charge density wave in $TiSe_2$ — •Adam Kłosiński[1], Jans Henke[2], Krzysztof Wohlfeld[1], and Jasper van Wezel[2] — [1]University of Warsaw, Krakowskie Przedmieście 26/28, 00-927, Warsaw, Poland — [2]University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands

Recently a charge density wave (CDW) was observed in a momentum resolved EELS (M-EELS) experiment on $TiSe_2$. According to the model proposed for $TiSe_2$ the CDW present in the system is transversal [1]. However, it is known that M-EELS is not sensitive to transverse CDWs [2]. Here we calculate the M-EELS response of $TiSe_2$ using a minimal model. We show that one can observe not only longitudinal but also transversal components of a CDW, for M-EELS is a surface-sensitive technique.

[1] F. J. Di Salve et al., Phys. Rev. B 14, 4321 (1976)
[2] S. Vig et al., SciPost Phys. 3, 026 (2017)

TT 70.4 Fri 10:15 HSZ 103

Strain-induced charge ordering in LiV_2O_4: Phase competition in a geometrically frustrated system — •Ulrike Niemann[1,2], Yu-Mi Wu[1], Minu Kim[1,2], and Hidenori Takagi[1,2,3] — [1]Max Planck Institute for Solide State Research, Stuttgart, Germany — [2]Institute for Functional Matter and Quantum Technologies, University of Stuttgart, Germany — [3]Department of Physics, University of Tokyo, Japan

LiV_2O_4 has been attracting considerable interest over two decades as the first heavy fermion system hosted by a 3d transition metal oxide. Nevertheless, the underlying physics, leading to this exotic heavy fermion state is yet unknown, but is frequently discussed in the framework of geometric frustration.
We stabilised thin films of LiV_2O_4 with different levels of strain-induced lattice deformations in order to directly probe the importance of the geometric frustration on the heavy fermion phase. Under such anisotropic strain, we found a transition from a heavy-fermion metal in a fully relaxed thin film to a charge-ordered insulator in a moderately strained thin film, proving the underlying phase competition and criticality. This demonstrates the importance of geometric frustration inherited in the spinel lattice as origin of this unconventional heavy fermion and further establishes LiV_2O_4 as an ideal model system for tuneable charge ordering.

TT 70.5 Fri 10:30 HSZ 103

Disorder-Free Localisation and Mobility Edges in a Long Ranged Falikov-Kimball Model — •Thomas Hodson[1] and Johannes Knolle[1,2] — [1]Imperial College London — [2]Technische Universität München

We study the interplay of long range interactions and disorder-free localisation in a generalised Falikov-Kimbal model. The power law interactions induce a charge density wave (CDW) phase transition at non-zero temperature in the ionic degrees of freedom. The CDW splits the spectrum of the electronic degrees of freedom and thermal fluctuations about it lead to an unusual mobility edge in one dimension for the electronic degrees of freedom. The two point correlator of this emergent disorder potential can be tuned via the temperature of the system.

Using a combination of exact diagonalisation and Markov Chain Monte Carlo we compute the energy resolved localisation properties of the electrons in one dimension. The finite size scaling of the energy resolved inverse participation ratio and the localisation length computed via a transfer matrix approach both provide numerical evidence for the existence of a mobility edge in the system. We compare the localisation behaviour to a simple Anderson model with spatially correlated binary disorder potential.