TECHNISCHE UNIVERSITÄT DRESDEN

IFMP Institut für Festkörper- & Materialphysik

IFMP Seminar

Date: Tuesday, June 22, 2021, at 14:50

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Speaker: **Peter Wahl**

University of St. Andrews

Title: **From Selection Rules to Quasiparticle Tomography: Quasiparticle Imaging of Advanced Materials**

Abstract: Quasiparticle interference (QPI) imaging is well established to study the low-energy electronic structure in strongly correlated electron materials with unrivalled energy resolution. Yet, QPI is insensitive to some features of the surface electronic structure, most notably in the case of forbidden scattering vectors and towards features of the band structure in the direction normal to the sample surface.

In this talk I will discuss two examples for these two cases: QPI of the CoO_2 termination of the delafossite oxide $PdCoO_2$ and quasi-particle tomography of the bulk electronic structure of galena.

In the delafossite oxide $PdCoO_2$, the strong inversion symmetry breaking at the surface puts it into a limit of a Rashba spin-splitting dominated by the inversion symmetry breaking, rather than the more usual dominant spin-orbital coupling, leading to a notably different spin-orbital texture compared to conventional Rashba systems.[1] I will demonstrate that in this case the quasi-particle scattering is dominated by the spin selection rules. We find that the coherence length of quasiparticles puts the surface state into the correct regime[2] required for all-electric spin-control as realized in the Das-Datta spin transistor.[3]

While for the surface state of $PdCoO_2$, the 2D nature of the electronic states renders the interpretation of quasi-particle interference in terms of the surface electronic structure relatively straightforward, in the second example, I will discuss the QPI of the mineral galena. This material has cubic symmetry, which means that the electronic structure does not exhibit pronounced anisotropy between the high symmetry directions. An interpretation of QPI scattering patterns therefore needs to account for the full bulk electronic structure.

We find that the quasiparticle interference signal is dominated by scattering vectors which are parallel to the surface plane however originate from bias-dependent cuts of the 3D electronic structure. We develop a formalism for the theoretical description of the QPI signal and demonstrate how this quasiparticle tomography can be used to obtain information about the 3D electronic structure.[4]

[1] V. Sunko et al., Nature **549**, 492 (2017).
[2] C. M. Yim et al., Sci. Adv. **7**, eabd7361 (2021).
[3] S. Datta and B. Das, Appl. Phys. Lett. **56**, 665 (1990).
[4] C. A. Marques et al., arXiv:2103.09282 [cond-mat.mtrl-sci] (2021).

Host: D. Peets