Quasiparticle interference imaging of magnetic-field tuned states in the strontium ruthenates.

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In strongly correlated electron materials, the electronic, spin, and charge degrees of freedom are closely intertwined. This often leads to the stabilization of emergent orders that are highly sensitive to external physical stimuli promising opportunities for technological applications. This is exemplified in the perovskite ruthenates, where this sensitivity manifests in dramatic changes of the physical properties with subtle structural details of the RuO_6 octahedra, stabilizing enigmatic correlated ground states, from a hotly debated superconducting state via electronic nematicity and metamagnetic quantum criticality to ferromagnetism.

In my talk, I will discuss how the rotation of the RuO_6 octahedra in the surface layer of Sr_2RuO_4 generates new emergent orders not observed in the bulk material.[1] Through atomic-scale spectroscopic characterization of the low-energy electronic states, we can identify four van Hove singularities in the vicinity of the Fermi energy which we can link to intertwined nematic and checkerboard charge order. Tuning of one of these van Hove singularities by magnetic field is demonstrated, suggesting that the surface layer undergoes a Lifshitz transition at a magnetic field of ≈32T. The results establish the surface layer of Sr_2RuO_4 as an exciting 2D correlated electron system and highlight the opportunities for engineering the low-energy electronic states in these systems.

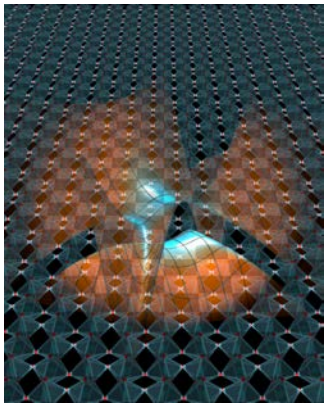

Fig. 1: Structure of the van Hove singularity in the surface layer of Sr_2RuO_4.

The understanding of the quasi-particle interference of Sr_2RuO_4 [2] can be transferred to members of the Ruddlesden-Popper series with higher *n*. I will show preliminary results for $Sr_4Ru_3O_{10}$, where we can identify the quasi-particle interference from the spin-minority bands and discuss the interplay of spin-orbit coupling and orthorhombicity for its properties.

[1] Carolina A. Marques, Luke C. Rhodes, Rosalba Fittipaldi, Veronica Granata, Chi Ming Yim, Renato Buzio, Andrea Gerbi, Antonio Vecchione, Andreas W. Rost, Peter Wahl, Magnetic-field tunable intertwined checkerboard charge order and nematicity in the surface layer of Sr_2RuO_4, Adv. Mat. **33**, 2100593 (2021).

[2] A. Kreisel, C. A. Marques, L. C. Rhodes, X. Kong, T. Berlijn, R. Fittipaldi, V. Granata, A. Vecchione, P. Wahl, P.J. Hirschfeld, Quasiparticle Interference of the van-Hove singularity in Sr_2RuO_4, npj Quantum Materials **6**, 100 (2021).