4th CDS Seminar

Date: February 4th (Wed.), 2026
Time: 14:00 -15:30
Place: 2F Seminar Room, Nanoscience Joint Lab., RIKEN

Atomic scale imaging of emergent quantum states

Prof. Peter Wahl

SUPA, School of Physics and Astronomy, University of St Andrews, St Andrews
Physikalisches Institut, Universität Bonn, Bonn

A characteristic property of quantum materials is that their ground state is highly sensitive to external stimuli, making it possible to control their ground states. This property makes them in principle highly desirable for applications, however in many cases we do not understand the ground state sufficiently well to be able to control it at will. Studying their low energy electronic structure by low temperature scanning tunnelling microscopy and spectroscopy had proven a very successful route to connect microscopic models to macroscopic properties in these materials. It relies on real space maps of the differential conductance, from which, via quasiparticle interference, information about the electronic structure can be extracted
In my talk, I will show a few examples of strongly correlated electron materials, where we have achieved linking the microscopic and macroscopic properties [1-3]. The successful interpretation of quasiparticle interference relies on realistic simulation of the experimental data starting from microscopic models. I will discuss how this is done in practice [4], and what, in my view, the remaining challenges are to fully unravel the correlated electron problem.
This work was done in close collaboration with C.A. Marques, L.C. Rhodes, W. Osmolska, H. Lane, I. Benedičič, and M. Naritsuka and the group of Prof Phil King.

References
[1] M. Naritsuka *et al.*, Compass-like manipulation of electronic nematicity in $Sr_3Ru_2O_7$, PNAS **120**, e2308972120 (2023).
[2] C.A. Marques *et al.*, Spin-orbit coupling induced Van Hove singularity in proximity to a Lifshitz transition in $Sr_4Ru_3O_{10}$, npj Quant. Mat. **9**, 35 (2024).
[3] C.A. Marques *et al.*, Emergent exchange-driven giant magnetoelastic coupling in a correlated itinerant ferromagnet, Nat. Phys. **21**, 1243 (2025).
[4] P. Wahl *et al.*, calcQPI: A versatile tool to simulate quasiparticle interference, arxiv:2507.22137 (2025).

For those who do **NOT** have a RIKEN ID, please contact:

Tetsuo Hanaguri
Tel. 050-3502-2815
Email: hanaguri@riken.jp

Correlation Design Science