Title: Unconventional electronic ground states in single- and infinite-layer Ruddlesden-Popper iridates

Abstract:

Iridium oxides (iridates) present a promising platform to investigate the interplay between electron-electron and spin-orbit interactions, thanks to its comparable energy scales of spin-orbit coupling, Coulomb repulsion and electronic bandwidth [1]. The Ruddlesden-Popper iridate series $Sr_{n+1}Ir_nO_{3n+1}$ represents a particularly interesting materials family, in which the strength of electron correlations and dimensionality can be tuned via varying layer number n and a versatile electronic ground states can be realized therein. For example, the single-layer compound Sr_2IrO_4 ($n = 1$) is a spin-orbit-assisted antiferromagnetic Mott insulator [2] whereas the infinite-layer compound $SrIrO_3$ ($n = \infty$) is a topological semimetal with lattice-symmetry-protected Dirac points. In this talk, I will discuss the evolution of low-temperature electronic ground states in electron-doped Sr_2IrO_4 [3] and the discovery of Fermi surface in $SrIrO_3$ by means of quantum oscillations [4]. In electron-doped $Sr_{2-x}La_xIrO_4$, we find that the effective carrier number undergoes a dramatic increase across a critical doping level $x_c \approx 0.16$, at which the quasiparticle effective mass shows a pronounced enhancement. These characteristics closely resembles the pseudogap phenomenology in superconducting cuprates, yet no superconductivity has so far been realized in the iridates, suggesting the pseudogap is a common feature of doped quasi-2D Mott insulators and not linked to the emergence of superconductivity. In $SrIrO_3$, we have mapped out its Fermi surface using quantum oscillation measurement, and find it to be consistent with bandstructure calculations with robust Dirac crossings near the Fermi level, albeit the quasiparticle effective mass is substantially enhanced and indicative of strong correlations in this topological semimetal. Interestingly, a T-linear, strange-metallic component to its low-temperature resistivity, hinting at the possibility of a coexistence between a Fermi-liquid and strange metallic sector in its electronic ground states.

Reference

[1] Rau *et al, Annu. Rev. Condens. Matter Phys.* 7:195-221 (2016)
[2] Kim et al., *Science* **345**, 187-190 (2014)
[3] Hsu *et al.*, *Nature Physics* **20**, 1596-1602 (2024)
[4] Hsu *et al.*, *npj Quantum Materials* **6**:92 (2021)

Biography Dr Hsu received his BSc in Materials Science and Engineering from National Tsing Hua University in Taiwan, MS in Materials Physics from Linköping University in Sweden, and PhD in Physics from Cambridge University in the UK. In 2018 he moved to the High Field Magnet Laboratory at Radboud University in Nijmegen, the Netherlands as a postdoc researcher, and he is currently a research scientist at Radboud University working with Prof. Nigel Hussey. In 2024 he joined NTHU Physics as an Assistant Professor and start his own group. His current research interests include complex oxides, unconventional superconductivity, anomalous metallicity, and high-sensitivity experiments under high magnetic fields.