

Title

Probing anomalous metallic behaviour near metal-insulator transitions in quantum materials

Abstract

The interactions among the macroscopic number of electrons in crystalline solids can lead to emergence of new states of matter that cannot be described by the properties of the individual constituents. Quantum materials, in which ‘emergent’ phenomena are manifest, have become a recent focus of condensed matter research. In this talk, I will review recent experimental discoveries of anomalous metallic behaviour in materials on the brink of metal-insulator transitions, probed via high magnetic fields created in highly controlled environments. In SmB_6 , an archetypal Kondo insulator with $4f$ electrons, the observation of magnetic quantum oscillations indicates the existence of a coherent Fermi surface within its insulating bulk [1], challenging the established distinction between a metallic and insulating state within the Landau-Fermi liquid paradigm. In the cuprate superconductor $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ with a Mott-insulating parent state, definite signatures of Fermi surface and superconductivity are found to coexist in the underdoped regime [2], contrasting the strange metallic states with T -linear resistivity and H -linear magnetoresistance in the overdoped side [3]. Lastly, I will present new results of magnetotransport studies on infinite-layer nickelates, which reveal the anomalous metallic behaviour in this new model system for the study of unconventional superconductivity [4]. These results highlight the approach of exposing materials near metal-insulator transitions to high magnetic fields as a promising avenue for discoveries in quantum solids.

Reference

- [1] Tan *et al.*, *Science* **349**, 287 (2015)
- [2] Hsu *et al.*, *PNAS* **118**, e2021216118 (2021)
- [3] Ayres *et al.*, *Nature* **595**, 661 (2021)
- [4] Hsu *et al.*, *Phys. Rev. Res.* **3**, L042015 (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. His current research interests include complex oxides, unconventional superconductivity, topological transport, and developing high-sensitivity experiments under high magnetic fields.