Towards the control of conduction and functionality of complex solids through orbital manipulation

Massimo Capone
International School for Advanced Studies (SISSA), Trieste

In the last decade, the discovery of superconductivity with remarkable critical temperature in iron- based superconductors has generated a huge interest in multi orbital materials which led to a number of discoveries about the physics of strong correlations in multi-orbital systems. Novel physcs arises when the Hund's coupling is sizable, including the possibility of orbital-selective physics, where electrons belonging to different orbitals can have very different physical properties and other anomalies of the metallic state which is often called a "Hund's metal".
In this talk I will review how the Mott physics is influenced by the Hund's coupling discussing the concepts of orbital differentiation and decoupling and their relevance to the normal state of the iron- based superconductors [1].

This will highlight how moderate and small changes in the orbital populations lead to drastic changes in the electronic properties, turning metals into insulators and viceversa, but also creating "selective insulators" in which some electrons are localised and others are mobile.

I will also shortly discuss how orbital-selective phenomena emerge in three-component fermionic fluids which can be realized with trapped ytterbium atoms where Raman processes connect the different flavours leading to an effective inter-component interaction [2]. Exploiting the huge degree of tunability and control of these systems we can define better protocols to be used in solid state systems.

References

[1] L. de' Medici, G. Giovannetti and M. Capone, Phys. Rev. Lett. 112, 177001 (2014); L. de' Medici and M. Capone, arXiv:1607.08468

[2] L. Del Re and M. Capone, arXiv:1708.00310