Reverse-engineering electronic correlations in Iron superconductors

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I will discuss the strength of electronic correlations in the normal phase of Fe superconductors.

It will be shown that the agreement between a wealth of experiments and DFT+DMFT or similar approaches supports a scenario in which strongly-correlated and weakly-correlated electrons coexist in the conduction bands of these materials.

I will then reverse-engineer the realistic calculations and justify this scenario in terms of simpler behaviors easily interpreted through model results[1].

All pieces come together to show that Hund's coupling, besides being responsible for the electronic correlations even in absence of a strong Coulomb repulsion (and indeed being also essential to explain the magnetically ordered phases found in the phase diagrams) is also the origin of a subtle emergent behavior: orbital decoupling. Indeed Hund's exchange decouples the charge excitations in the different Iron orbitals involved in the conduction bands thus causing an independent tuning of the degree of electronic correlation in each one of them. The latter becomes sensitive almost only to the offset of the orbital population from half-filling, where a Mott insulating states is invariably realized at these interaction strengths. Depending on the difference in orbital population a different "Mottness" [2] affects each orbital, and thus reflects in the conduction bands and in the Fermi surfaces depending on the orbital content. This selective Mottness is put in perspective with the analogous differentiation of electronic correlation in k space found in the underdoped cuprates (see e.g. [3]) and a common phase diagram is sketched.

[1] L. de' Medici, "Weak and strong correlations in Iron superconductors", in "Iron-based Superconductivity", W. Yin and G. Xu Eds., Springer (November 2014).
[2] L. de' Medici, G. Giovannetti and M. Capone, PRL **112**,177001 (2014).
[3] E. Gull et al., Phys. Rev. B, **82**, 155101 (2010).