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Ferro-Orbital Order and Rich Magnetic Structures of Iron-Based Superconductors

The recent discovery of iron-based high temperature superconductors has reignited the intense interest in the unresolved relationship of anti-ferromagnetism and high temperature superconductivity. Unlike the well known case of the cuprates, however, the magnetic properties of the Fe-pnictides are much richer, and a simple picture that describes the underlying physics is not yet available.
In this talk, the puzzling nature of magnetic and lattice phase transitions of iron pnictides is investigated via a first-principles Wannier function analysis of representative parent compound LaOFeAs. A rare ferro-orbital ordering is found to give rise to the recently observed highly anisotropic magnetic coupling, and drive both phase transitions—without resorting to widely employed frustration or nesting picture. The revealed necessity of the additional orbital physics leads to a correlated electronic structure fundamentally distinct from that of the cuprates. In particular, the strong coupling to the magnons advocates active roles of light orbitons in spin dynamics and electron pairing in iron pnictides. Finally, a simple model will be presented that unifies the rich magnetic properties across the Fe-based superconducting families that emphasizing the essential role of orbital freedom with double-exchange effects, leading to many new questions concerning strongly correlated metals.
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136 Jorgensen Hall

Host:
Prof. Peter Dowben
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