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Special Guest Lectures

What do the Rich Magnetic Structures of Iron-Based Superconductors Teach Us About Their Electronic Structure?

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Abstract:
The recent discovery of iron-based high temperature superconductors (Fe-SC) 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, leading to diverse (and mostly inconsistent) descriptions in the field. In this talk, the puzzling nature of magnetic and lattice phase transitions of Fe-SC is investigated, aiming at a simple picture that describes the underlying physics. First, 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. Second, the rich magnetic properties across the Fe-based superconducting families are explained via a unified model that encapsulates the essential roles of itinerant and local electrons with double-exchange effects. Interestingly, unlike the typical behavior in the manganites, the ferromagnetic correlation is fond significantly higher in energy, leaving superconductivity the only viable phase to relieve entropy at low temperature upon doping.

Speaker's Bio:
Wei Ku received his Ph.D. in Physics from the University of Tennessee in Knoxville in 2000 and his BS from Tamkang University in 1991. His research interest is realistic understanding of the rich electronic/magnetic/optical properties of condensed matter, using first-principles quantum many-body theory. Special focus is placed to systems with stronger quantum correlation that renders classical or mean-field treatments inadequate.