MAGNETIC PROPERTIES OF STRONGLY CORRELATED MULTI-ORBITAL SYSTEMS

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Past experience in strongly correlated quantum systems, especially Cu-based materials, showed that the high-temperature superconductivity is closely connected to a bad-metal state and a nearby antiferromagnetic order. As such, there has been a considerable effort devoted to the understanding of the electron correlation effects and the associated magnetism. The aforementioned investigations are overwhelmingly done within the paradigmatic model of interacting spinful fermions on a lattice, i.e., the single-band Hubbard model. In this context, the analysis of lower dimensional systems, such as chains and ladders, provided useful information to better contrast theory with the experiments. One reason is that the theoretical many-body calculations based on model Hamiltonians can be accurately performed in one dimension, particularly numerically.

The magnetic properties of the multi-orbital system, relevant for Fe-based materials, are much less explored. Iron-based superconductors display a variety of phases originating in the multi-orbital nature of iron itself, and as a consequence, in the competition between electronic, orbital, and spin degrees of freedom. Prominent among these novel effects is the orbital-selective Mott phase, where electronic correlations cause a unique mixture of metallic and insulating behaviour. Also, from the magnetism perspective, recent inelastic neutron scattering experiments on the low-dimensional iron-based compounds revealed the existence of exotic block-magnetism, i.e., magnetic order of the form ↑↑↓↓↑↑↓↓. Although there have been several neutron scattering publications on such compounds, there involved only a crude theoretically analysis via the spin-wave theory.

The primary goal of this project is to develop on the static and dynamic (energy-resolved) properties of multi-orbital systems with the emphasis on its magnetic properties and the role of Hund's coupling. One can expect that the competition of the latter and Coulomb interaction can lead to a novel type of frustrated magnetism. In the generic scenario, magnetic frustration emerges from the failure of the system to simultaneously fulfil conflicting local requirements. Such systems are an extensive field of research both from the theoretical and experimental perspectives. Furthermore, a nontrivial magnetic order in the vicinity of high-T_c superconductivity can lead to topological effects. As a consequence, identifying the static and dynamic properties of the low-dimensions multi-orbital system is a crucial effort.