

Magnetic polarons due to spin-length fluctuations in d^4 spin-orbit Mott systems

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Abstract

The polaron, a quasiparticle formed by a charge carrier "dressed" by a cloud of environmental excitations, is a foundational concept in condensed matter physics. While the canonical example involves an electron coupled to lattice phonons, analogous quasiparticles can emerge in doped Mott insulators, where the charge carrier instead couples to excitations of the magnetic background.

In this talk, we will first review the general concept of polarons, from classic electron-phonon systems to magnetic variants. We will then focus on a specific and highly non-trivial environment: a d^4 spin-orbit coupled Mott insulator. In these systems, strong spin-orbit coupling and electronic correlations conspire to create on ion level a non-magnetic $J=0$ singlet state and low-energy excitations in the form of a magnetic $J=1$ triplet. The ground state is then a superposition of these two states, creating a soft-spin system with significant fluctuations of the magnetic-moment length. This interesting state forms antiferromagnetic background which can be viewed as our "vacuum".

We theoretically investigate the behavior of a single mobile hole doped into this fluctuating vacuum. We demonstrate that the dynamical interaction of the hole with the spin-length fluctuations leads to the formation of a magnetic polaron. We then provide an analysis of polaron creation, detailing the contributing types of excitations and the employed processes, leading to a simplified explanation of the polaron's origin. In the end we are able to explain why spin-length fluctuation dominates over more traditional magnons as electron partner in polaron creation.