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Orbital order and spin waves in the Kugel-Khomskii model[1]

TAMAR PEREG-BARNEA, WEI-CHENG LEE, ALLAN MACDONALD, University of Texas at Austin — The Kugel-Khomskii model, introduced in the seventies, attempts to describe transition metal oxides in which orbital degeneracy plays an important role in ground state properties. The model provides a qualitative description of pseudocubic perovskites like $LaTiO_3$ and $YTiO_3$ in which the three t_{2g} d-orbitals are thought to be active at low energy. We investigate the cubic t_{2g} Kugel-Khomskii model in the limit of strong electron-electron interaction (on-site Hubbard U). We use perturbation theory with small hopping parameter (t/U) to derive an effective large pseudospin Hamiltonian with 6 degrees of freedom on each site (2 spins X 3 orbitals). In this model the t_{2g} orbital structure combined with cubic symmetry leads to hopping that depends on both the orbital label and the bond direction. We find the classical (mean-field) ground state manifold systematically and derive a spin wave theory to account for quantum fluctuations. The theory proceeds beyond leading order in order to capture the coupling between the spin and orbital degrees of freedom of the system. This approach leads to better understanding of the quantum-mechanical ground state, it's energy and symmetries.

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