MAR13-2012-020008

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Spin-orbital quantum liquid on the honeycomb lattice[1]

PHILIPPE CORBOZ, Theoretische Physik, ETH Zurich, Switzerland

The symmetric Kugel-Khomskii can be seen as a minimal model describing the interactions between spin and orbital degrees of freedom in transition-metal oxides with orbital degeneracy, and it is equivalent to the SU(4) Heisenberg model of four-color fermionic atoms. We present simulation results for this model on various two-dimensional lattices obtained with infinite projected-entangled pair states (iPEPS), an efficient variational tensor-network ansatz for two dimensional wave functions in the thermodynamic limit. This approach can be seen as a two-dimensional generalization of matrix product states - the underlying ansatz of the density matrix renormalization group method. We find a rich variety of exotic phases: while on the square and checkerboard lattices the ground state exhibits dimer-Néel order and plaquette order, respectively, quantum fluctuations on the honeycomb lattice destroy any order, giving rise to a spin-orbital liquid. Our results are supported from flavor-wave theory and exact diagonalization. Furthermore, the properties of the spin-orbital liquid state on the honeycomb lattice are accurately accounted for by a projected variational wave-function based on the pi-flux state of fermions on the honeycomb lattice at 1/4-filling. In that state, correlations are algebraic because of the presence of a Dirac point at the Fermi level, suggesting that the ground state is an algebraic spin-orbital liquid. This model provides a good starting point to understand the recently discovered spin-orbital liquid behavior of $Ba_3CuSb_2O_9$. The present results also suggest to choose optical lattices with honeycomb geometry in the search for quantum liquids in ultra-cold four-color fermionic atoms.

[1]We acknowledge the financial support from the Swiss National Science Foundation.