Seminar Schedule

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Date: Mar. 25, (Tue.) 14:00～

Room: Seminar room, 2nd floor, prefab bldg

The physics of SU(4) Heisenberg models

In the first part of the talk we give a short overview of the SU(4) symmetrical Heisenberg models: why are they interesting, what happens in the one-dimensional chain and ladder systems, and two-dimensional square lattice. We emphasize the role of the SU(4) singlet plaquettes, which constitute a kind of crystal for the ladder and square lattice.

In the second part we give a more detailed account of the ground state properties and excitation spectra of the SU(4) symmetric Heisenberg model on the triangular lattice. The model is motivated by the low-temperature properties of $LiNiO_2$, a Mott insulator with orbital degeneracy described by the symmetric Kugel-Khomskii model on a triangular lattice. To lift the degeneracy of the corresponding classical model (the antiferromagnetic 4-state Potts model) we have included antiferromagnetic coupling constants between nearest (J_1) and next-nearest (J_2) neighbors. The effect of quantum fluctuations has been studied by three different methods:

(i) The SU(4) spin wave theory shows that a four-sublattice LRO is stable as long as $J_2/J_1 > 0.1$, below which it is destroyed by quantum fluctuations.

(ii) Variational calculations in the subspace of resonating SU(4) plaquette singlets including up to two Lánczos steps are shown to provide an accurate description of the low-energy sector of the $J_2 = 0$ case.

(iii) Using exact diagolization on 12-site clusters, the tower of low-energy states implied by LRO is identified for $J_2/J_1 = 0.2$, and is missing for $J_2/J_1 = 0$.

Putting together (i)-(iii), we have strong evidence for a quantum phase transition at a finite value of J_2/J_1 between a spin-orbital liquid and a four-sublattice ordered state.

Finally, we speculate on possible scenarios for the model on the cubic lattice.

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