Heisenberg SU(N) models for cold atoms

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Systems of multicolor fermions have recently raised considerable interest due to the possibility to experimentally study those systems on optical lattices with ultracold atoms [1]. To describe the Mott insulating phase of N-colors fermions, one can start with the SU(N) Heisenberg Hamiltonian. In the case of one particule per site, the SU(N) Heisenberg Hamiltonian takes the form of a Quantum permutation Hamiltonian. We have developped a method [2] to implement the SU(N) symmetry in an Exact Diagonalization algorithm using standard Young tableaux[3], which are shown to form a very convenient basis to diagonalize the problem. It allowed us to prove that the ground state of the Heisenberg SU(5) model on the square lattice is long range color ordered [2] (cf. Fig. 1), to study the plaquette phase [4] occuring in the honeycomb lattice for SU(6) atoms and the chiral spin liquids on the triangular lattices with artificial gauge fields for various N. Finally, we have generalized the method to Density Matrix Renormalization Group [5] to numerically investigate the generalizations of the Haldane conjectures to SU(N) spin chains [6].

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FIGURES

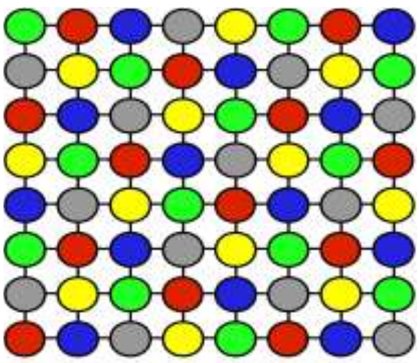

Figure 1: Neel-ordered state for the SU(5) Heisenberg model on the square lattice.