Quantum Phase Transitions in Skewed Two Legged Ladders

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ABSTRACT

Quantum Phase Transitions (QPT) in spin chains has been well studied. However, spin or Fermion ladders have not attracted the same attention. Our earlier studies on fused azulenes [1], which can be viewed as a two-legged ladder with skewed rungs, showed surprising ground states as the system size increased. In order to understand this phenomenon in detail, we studied general two legged ladders with skewed rungs in spin systems. The quantum phases of these systems are obtained using exact diagonalization of systems with up to 26 spins and by density-matrix renormalization-group calculations to 500 spins. The ladders have isotropic antiferromagnetic (AF) exchange $J_2 > 0$ between first neighbors in the legs, variable isotropic AF exchange J_1 between some first neighbors in different legs, and an unpaired spin per odd-membered ring when $J_1 >> J_2$. Ladders with skewed rungs and variable J_1 have frustrated AF interactions leading to multiple quantum phases: AF at small J_1, either ferromagnetic or AF at large J_1, as well as bond-order-wave phases or reentrant AF (singlet) phases at intermediate J_1 [2].

References:

1. "Fused azulenes as possible organic multiferroics", S Thomas, S Ramasesha, K Hallberg, D Garcia, Physical Review B 86 (18), R180403 (2013).

2. "Quantum phases of frustrated two-leg spin-1 2 ladders with skewed rungs", G Giri, D Dey, M Kumar, S Ramasesha, ZG Soos, Physical Review B 95 (22), 224408 (2017).