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Title: **Phase diagram of the S=1/2 Heisenberg model on the Cairo pentagonal lattice**

We present an exact diagonalization study of the S=1/2 antiferromagnetic Heisenberg model on the Cairo pentagonal lattice. This the dual of the Shastry-Sutherland lattice and has been discussed in the past by Raman, Moessner and Sondhi [1] as a possible new candidate for having a spin liquid ground state. More recently a version of this model has been realized in the Bi2Fe4O9 system[2]. Here we investigate a variant with two different types of exchange couplings and follow the evolution of the ground state as a function of their ratio x. This strategy allows us to understand the nature of a number of phases and derive effective models for their description with and without a magnetic field. Of particular interest is a phase with two interpenetrating subsystems of spins which can be effectively described by a J1-J2 model on the square lattice in the regime of large J2/J1, together with an additional 4-spin exchange term K that appears in fourth order of perturbation theory. This brings about a surprising order-by-disorder mechanism whereby the collinear phase selected by quantum fluctuations in J1 competes with an orthogonal four-sublattice state favored by K.

References:
[1] K. S. Raman, R. Moessner, and S. L. Sondhi, Phys. Rev. B 72, 064413 (2005)
[2] E. Ressouche, V. Simonet, B. Canals, M. Gospodinov, and V. Skumryev, Phys. Rev. Lett. 103, 267204 (2009)