Quantum magnetism on the Cairo pentagonal lattice

Ioannis Rousochatzakis
IFW Dresden Dresden, 01171 Dresden, Germany

In this talk I will present our recent analytical and numerical study [1] of the antiferromagnetic Heisenberg model on the Cairo pentagonal lattice, the dual of the Shastry-Sutherland lattice with a close realization in the $S = 5/2$ compound $Bi_2Fe_4O_9$ [2], and more recently in $Bi_4Fe_5OF_{13}$ [3].

We consider a model with two symmetry-inequivalent exchange couplings, and investigate the nature of the ground state as a function of their ratio x and the spin S. After establishing the classical phase diagram, we switch on quantum mechanics in a gradual way that highlights the different role of quantum fluctuations on the two inequivalent sites of the lattice. The most important findings for $S = 1/2$ include: (i) a surprising interplay between a collinear and a four-sublattice orthogonal phase due to an underlying order-by-disorder mechanism at small x (related to an emergent J_1-J_2 effective model with $J_2 \gg J_1$), and (ii) a non-magnetic and possibly spin-nematic phase with d-wave symmetry at intermediate x.

References:

[1] I. Rousochatzakis, A. M. Luchli, and R. Moessner, Phys. Rev. B 85, 104415 (2012)
[2] E. Ressouche, V. Simonet, B. Canals, M. Gospodinov, and V. Skumryev, Phys. Rev. Lett. 103, 267204 (2009)
[3] Artem M. Abakumov et al, arXiv:1210.2822