Quasiperiodic and disordered antiferromagnets

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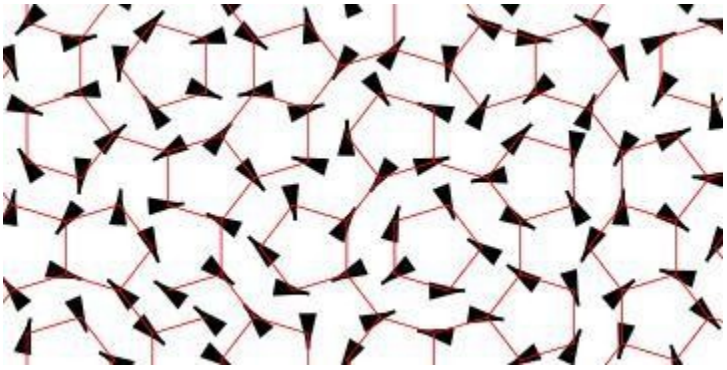
The ground state properties and the real space variations of the strength of quantum spin fluctuations in lattices and quasiperiodic tilings have been intensively studied in collaboration with S. Wessel. We investigated in a series of papers the ground state properties and excitation spectrum of the antiferromagnetic Heisenberg model in two dimensional quasicrystals including the Penrose tiling. Important properties of the quasicrystal : self-similarity, five-fold symmetry and local isomorphism lead to a complex but highly organized ground state. The methods used include spin wave theory, renormalization group, and Quantum Monte Carlo [Szallas2008,2009a,2009b]. When next nearest



Snapshot of one of the minimum energy spin configurations on a frustrated two-dimensional antiferromagnet, obtained by Monte Carlo simulation (from Motz et al, 2011)

neighbor interactions are added [Jagannathan, 2009c], or when the system is diluted, frustration effects appear. We have investigated fractal structures with pentagonal cells, resembling those obtained by atomic deposition on surfaces of icosahedral quasicrystals, by analytical calculation and numerically by Monte Carlo [Motz2011, see fig. 9]. This research topic, to which we have made significant contributions for over a decade, is described in review articles [Jagannathan, 2010,2012].

The effect of disorder in such antiferromagnets has been studied in collaboration with B. Douçot, and S.Wessel. Quasicrystals can exhibit a form of highly localized defect, a local flip between two local configurations. The antiferromagnetic order parameter decreases when this type of disorder increases [Szallas2009b, 2009c]. In periodic samples, phason flip disorder, on the contrary, causes antiferromagnetic order to increase – an unusual behavior for disordered antiferromagnets [Jagannathan2011].

Key publication

A. Jagannathan, “Quasiperiodic Heisenberg antiferromagnets in two dimensions”, Eur. Phys. J. B 85, 68 (2012)