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Gapless and gapped spin liquids in frustrated spin-1/2 models

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We present our recent numerical calculations on the Heisenberg model on various two-dimensional lattices, showing that gapped and gapless spin liquids may be stabilized in highly-frustrated regimes. The magnetically disordered phases can be described by considering Abrikosov fermions coupled to gauge fields. This approach gives a flexible and transparent representation of a myriad of states, ranging from valence-bond solids to spin liquids with different properties, including chiral order. For the Kagome lattice, we find that a gapless U(1) spin liquid with Dirac cones is competitive with previously proposed gapped spin liquids [1,2] also when small second- (J_2) and third-neighbor (J_3) antiferromagnetic couplings are considered on top of the nearest-neighbor (J_1) super-exchange [3-5]. For the J_1-J_2 model on finite clusters, a gapped Z_2 spin liquid can be stabilized in presence of a finite J_2 super-exchange, with a substantial energy gain with respect to the gapless U(1) Dirac spin liquid. However, this energy gain vanishes in the thermodynamic limit [4]. The presence of J_3 favors a chiral spin liquid with non-trivial magnetic fluxes and $C = 1/2$ fractionalized Chern number [5].

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