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Hierarchical mean-field approach to the J_1-J_2 Heisenberg model on a square lattice LEONID ISAEV, GERARDO ORTIZ, Indiana University, Bloomington IN, USA, JORGE DUKELSKY, Instituto de Estructura de la Materia - CSIC, Madrid, Spain — We study the quantum phase diagram and excitation spectrum of the frustrated J_1-J_2 spin-1/2 Heisenberg Hamiltonian. A hierarchical mean-field approach, at the heart of which lies the idea of identifying *relevant* degrees of freedom, is developed. Thus, by performing educated, manifestly symmetry preserving mean-field approximations, we unveil fundamental properties of the system. We then compare various coverings of the square lattice with plaquettes, dimers and other degrees of freedom, and show that only the *symmetric plaquette* covering, which reproduces the original Bravais lattice, leads to the known phase diagram. The intermediate quantum paramagnetic phase is shown to be a (singlet) *plaquette crystal*, connected with the neighbouring Néel phase by a continuous phase transition. We also introduce fluctuations around the hierarchical mean-field solutions, and demonstrate that in the paramagnetic phase the ground and first excited states are separated by a finite gap, which closes in the Néel and columnar phases. Our results suggest that the quantum phase transition between Néel and paramagnetic phases can be properly described within the Ginzburg-Landau-Wilson paradigm.

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