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Resonating-valence-bond trial wave functions (and beyond) for frustrated quantum magnets

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Quantum spin models with frustrating exchange interactions are believed to support a variety of unusual ground states that have no classical analogue and are most naturally described in the language of fluctuating singlet pairs (valence bonds). Despite an abundance of theoretical proposals, however, there is still no definitive numerical approach that can be used to put these ideas on a firm footing.

In this talk, I focus on the square-lattice quantum Heisenberg model with frustrating next-nearest-neighbour interactions (J_1 - J_2 model). This model has a zero-temperature critical coupling ratio that separates a conventional quantum antiferromagnetic phase from a strongly frustrated, magnetically disordered phase. I discuss the prospects for approximating the ground state — up to, and potentially through the transition — using elaborated resonating-valence-bond trial wave functions that go beyond the conventional ansatz in a number of ways. These modifications include in-simulation determination of the Marshall convention, the inclusion of explicit bond-bond correlations, and application of additional Monte Carlo projection steps.