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DMRG study of the spin-1/2 J1-J2 Honeycomb Antiferromagnetic Heisenberg Lattice[1] SHOUSHU GONG, DONGNING SHENG, Department of Physics and Astronomy, California State University Northridge, Northridge, California, 91325, USA, MATTHEW FISHER, Department of Physics, University of California, Santa Barbara, California 93106, USA — A possible quantum spin liquid state has been revealed in the Hubbard model on the honeycomb lattice by Quantum Monte Carlo study, which has stimulated a lot of recent interest in the quantum spin models on honeycomb lattice. In a recent paper (Phys. Rev. B 84, 024406 (2011)), the J1-J2-J3 Heisenberg model has been studied by exact diagonalization (ED), establishing a rich phase diagram with the Neel and plaquette valence-bond crystal (VBC) phases depending on couplings J2 and J3, while it remains unclear if there is a featureless spin liquid phase exists in such a model. Here, by implementing DMRG method with the full rotational SU(2) symmetry, we study the J1-J2 Heisenberg model on honeycomb lattice at larger sizes. We analyze the spin-spin and dimer-dimer correlation functions for different sizes and extrapolate the structure factors to the thermodynamic limit to determine the nature of the quantum state. Our results suggest that the intermediate phase (with J2/J1$\sim$0.2-0.35) may be a spin liquid phase with vanishing spin/dimer correlations at the large distance limit. The nature of such a phase will be explored based on comparison with variational wavefunctions.

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