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Plaquette ordered phase and quantum spin liquid in the spin-1/2 J1-J2 square Heisenberg model[1] SHOUSHU GONG, WEI ZHU, Department of Physics and Astronomy, California State University, Northridge, California, OLEXEI I. MOTRUNICH, Department of Physics, California Institute of Technology, Pasadena, California, MATTHEW P.A. FISHER, Department of Physics, University of California, Santa Barbara, California, DONGNING SHENG, Department of Physics and Astronomy, California State University, Northridge, California — We study the spin-1/2 Heisenberg model on the square lattice with first- and second-neighbor antiferromagnetic interactions J_1 and J_2. We use the density matrix renormalization group with implementing $SU(2)$ spin rotation symmetry and study the model accurately on open cylinders with different boundary conditions. With increasing J_2, we find a Néel phase, a plaquette valence-bond (PVB) phase with a finite spin gap, and a possible spin liquid in a small region of J_2 between these two phases. From the finite-size scaling of the magnetic order parameter, we estimate that the Néel order vanishes at $J_2/J_1 \simeq 0.44$. For $0.5 < J_2/J_1 < 0.61$, we find dimer correlations and PVB textures whose decay length grows strongly with increasing system width, consistent with a long-range PVB order in the two-dimensional limit. The dimer-dimer correlation function reveals the s-wave character of the PVB order. For $0.44 < J_2/J_1 < 0.5$, both spin and dimer orders are weak on finite-size systems and appear to scale to zero with increasing system width, which is consistent with a possible SL or a near-critical behavior. We compare and contrast our results with earlier numerical studies.

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