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The spin-1/2 $J_1 - J_2$ Heisenberg antiferromagnet on a square lattice: a plaquette renormalized tensor network study¹

YING-JER KAO, JI-FENG YU, Department of Physics, National Taiwan University — We apply the plaquette renormalization scheme of tensor network states [Phys. Rev. E, **83**, 056703 (2011)] to study the spin-1/2 frustrated Heisenberg J_1 - J_2 model on an $L \times L$ square lattice with $L=8,16$ and 32 . By treating tensor elements as variational parameters, we obtain the ground states for different J_2/J_1 values, and investigate staggered magnetizations, nearest-neighbor spin-spin correlations and plaquette order parameters. In addition to the well-known Néel-order and collinear-order at low and high J_2/J_1 , we observe a plaquette-like order at $J_2/J_1 \approx 0.5$. A continuous transition between the Néel order and the plaquette-like order near $J_2^{c1} \approx 0.40J_1$ is observed. The collinear order emerges at $J_2^{c2} \approx 0.62J_1$ through a first-order phase transition.

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