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Competing quantum paramagnetic ground states of the Heisenberg antiferromagnet on the star lattice BOHM-JUNG YANG, ARUN PARAMEKANTI, YONG BAEK KIM, University of Toronto — We investigate various competing paramagnetic ground states of the Heisenberg antiferromagnet on the two dimensional star lattice which exhibits geometric frustration. Using slave particle mean field theory combined with a projective symmetry group analysis, we examine a variety of candidate spin liquid states on this lattice, including chiral spin liquids, spin liquids with Fermi surfaces of spinons, and nematic spin liquids which break lattice rotational symmetry. Motivated by connection to large-N SU(N) theory as well as numerical exact diagonalization studies, we also examine various valence bond solid (VBS) states on this lattice. Based on a study of energetics using Gutzwiller projected states, we find that a fully gapped spin liquid state is the lowest energy spin liquid candidate for this model. We also find, from a study of energetics using Gutzwiller projected wave functions and bond operator approaches, that this spin liquid is unstable towards two different VBS states — a VBS state which respects all the Hamitonian symmetries and a VBS state which exhibits $\sqrt{3} \times \sqrt{3}$ order — depending on the ratio of the Heisenberg exchange couplings on the two inequivalent bonds of the lattice. We compute the triplon dispersion in both VBS states within the bond operator approach and discuss possible implications of our work for future experiments on candidate materials.

Bohm-Jung Yang
University of Toronto

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