DMRG Study of the $S \geq 1$ quantum Heisenberg Antiferromagnet on a Kagome-like lattice without loops

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The Kagome quantum Heisenberg antiferromagnet, not only for spin $S = 1/2$ but for $S = 1$ and perhaps $S = 3/2$, is a prime candidate to realize a quantum spin liquid or valence bond crystal state. However, theoretical and computational studies for $S > 1/2$ are difficult and few. We consider the quantum Heisenberg antiferromagnet for $S \geq 1$ on the Husimi cactus, a graph of corner sharing triangles each of whose centers is a vertex of a Bethe lattice, using a DMRG procedure tailored for tree graphs [1]. Since the geometry is like the Kagome lattice locally, properties dominated by nearest-neighbor spin correlations should be captured by the same interactions on the Husimi cactus; on the other hand, since the cactus lacks loops, properties dependent on them cannot be captured. The cactus antiferromagnet is known to have a disordered valence bond state at $S = 1/2$ [2,3] but a three-sublattice coplanar ordered state in the large S limit [4]. Thus, our focus is the possible transition(s) that must occur with increasing S. Using this approach, we also investigate the phase diagram of the $S = 1$ quantum XXZ model with on-site anisotropy, which we expect to have a variety of phases similar to the kagome case [5]. This work is supported by the National Science Foundation through a Graduate Research Fellowship to R. Zach Lamberty, as well as grant DMR-0552461.

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