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Variational wave functions for the $S = 1/2$ Heisenberg model on the anisotropic triangular lattice: Spin liquids and spiral orders

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By using variational wave functions and quantum Monte Carlo techniques, we investigate the complete phase diagram of the Heisenberg model on the anisotropic triangular lattice, where two out of three bonds have super-exchange couplings J and the third one has instead J'. This model interpolates between the square lattice and the isotropic triangular one, for $J'/J \leq 1$, and between the isotropic triangular lattice and a set of decoupled chains, for $J/J' \leq 1$. We consider all the fully-symmetric spin liquids that can be constructed with the fermionic projective-symmetry group classification [Y. Zhou and X.-G. Wen, arXiv:cond-mat/0210662] and we compare them with the spiral magnetic orders that can be accommodated on finite clusters. Our results show that, for $J'/J \leq 1$, the phase diagram is dominated by magnetic orderings, even though a spin-liquid state may be possible in a small parameter window, i.e., $0.7 < J'/J < 0.8$. In contrast, for $J/J' \leq 1$, a large spin-liquid region appears close to the limit of decoupled chains, i.e., for $J/J' < 0.6$, while magnetically ordered phases with spiral order are stabilized close to the isotropic point.

[1] E. Ghorbani, L.F. Tocchio, and F. Becca, PRB 93, 085111 (2016).

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