Non-canonical spin glass of polyhedral spin models on quasi-regular lattices

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Abstract.
Spin glass (SG) is an important subject in condensed matter physics and has long been a challenge for many optimization algorithms in finding its ground state energy\cite{1}. The so-called non-canonical spin glasses (SG's) with various spin models have recently attracted considerable attention \cite{2,3,4,5,6}. This is a new type of SG system, different from the canonical one where both ferromagnetic (FM) and antiferromagnetic (AF) couplings exist. A non-canonical SG is a purely AF system having spins residing on a random connectivity lattice. The example of non-canonical SG’s is the AF Ising model on a scale free network, which was first considered by Bartolozzi et al. \cite{2}. A random connectivity lattice in the form of quasi-regular lattice can be obtained by randomly rewiring each site of a regular lattice to one or two of its next nearest neighbors. Accordingly, there exist abundance of triangular structures, whereby AF couplings lead the spins to be frustrated. The system therefore inherited the main ingredients of spin glass, i.e., the randomness and frustration. As discreteness is important in phase transition, here we consider spin models with polyhedral symmetry, the underlining symmetry of such Platonic structures as cubic, icosahedron and dodecahedron. The counterpart model with continuous symmetry, the Heisenberg model, has been reported to exhibit no finite temperature SG phase \cite{4,5,6}. By using Monte Carlo method with Replica Exchange Algorithm, we calculated the overlapping order parameter, which is a commonly used quantity in searching for the existence of SG phase. Using finite scaling method, we estimate the critical exponents and temperatures of the observed SG phase transition.

REFERENCES