PERCOLATION OF LOOSE BONDS USING SPIN-CORRELATION FUNCTIONS OF THE BIMODAL 2-DIMENSIONAL ISING SPIN GLASS

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ABSTRACT

The spin-correlation functions for the two dimensional $\pm J$ Ising spin glass in the ground state (zero temperature) are studied. The computational algorithm is based on a combinatorial approach that uses Pfaffians and perturbation theory. To study the spin glass, an arbitrary concentration, $p$, of negative bonds is assigned and percolation phenomena of loose bonds or those with spin correlation functions not equal to $\pm 1.0$ are investigated. The spin glass canonically exists when $p = 0.5$, and there is a critical point $p_c$ with $0 < p_c < 0.5$ determining the ferromagnetic phase to spin-glass phase transition. The investigation of loose-bond clusters shows that there is a region of critical behavior $p_c = 0.108 \pm 0.005$. Using the finite-size scaling theory, it is found that a modified definition of loose-bond clusters results in data collapsing with the critical exponents of the 2-dimensional percolation theory.

KEY WORDS : SPIN GLASSES / SPIN-CORRELATION FUNCTIONS
LOOSE BONDS / PERCOLATION /DATA COLLAPSING

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Abstract

The study investigates the percolation of loose bonds using spin-correlation functions of the bimodal 2-dimensional Ising spin glass. In the ground states of the system, the spin thermal average and the spin correlation function are calculated using the combinatorial approach. Perturbation theory is employed to estimate the critical bond density for percolation phenomena. The finite-size scaling approach is used to determine the critical bond density and the corresponding critical exponents. The results are compared with the theoretical predictions and the experimental data. The study also provides insights into the phase transition in spin glasses.