Universal Oder Parameter for Second Kind Phase Transition

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Abstract: The order parameter for the study of the critical behavior at the second kind phase transition is proposed. The Monte Carlo algorithm for a calculation of percolation threshold for an existence of strong correlated phase at finite temperature was elaborated. Universal order parameter allows research a critical phenomena in ferromagnetic, antiferromagnetic and spin glass Ising model from uniform point of view.

Hamiltonian in Ising model

$$E(x) = -\sum_{i \neq j} J_{ij} x_i x_j + h \sum_i x_i$$

allows specify the J_{ij} as positive (ferromagnetic - FM), negative (antiferromagnetic - AFM) or alternating-sign value for given site under Gauss distribution (spin glass - SG). Let define the cluster as the incorporation of spins x_i, which ones are in ground state, or in simply law-energy state either. We use for Gibbs distribution only x_i, which ones are in percolation cluster at $h = 0$

$$P(X = x) = \frac{1}{Z(\beta)} \exp\left(-\beta E'(x)\right)$$

the probability, that the random variable X has value x at the given temperature, could be estimated. But there isn't a common analytical approach for a calculation of the percolation threshold today.

Therefore we use Monte Carlo algorithm for calculation of critical temperature, where percolation cluster exists for FM and SG Ising model on simple square lattice (z=4). We show that the proposed universal parameter of the order (for SG the using the word 'order' is convenient of course) give the same temperature Cure, when the cluster constructed from the spins which ones are in ground states. For fully frustrated ($\sum_{i \neq i}^{z} J_{ij} = 0$ in 99% sites) SG system and for the FM model, there is analog of 'paramagnetic Cure point' where transitions paramagnetic-spin glass and paramagnetic-superparamagnetic takes place.

We use the multystream scheme of the algorithmization and the calculation for lattice system 10^6 spins for different magnetic system (FM and SG) allows observe the practically nonanalytic behavior of the order parameter in the area of phase transition.

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