CRITICAL PHENOMENA AND PHASE TRANSITIONS IN LARGE LATTICES WITHIN MONTE-CARLO BASED NON-PERTURBATIVE APPROACHES

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S u m m a r y

Critical phenomena and Goldstone mode effects in spin models with the $O(n)$ rotational symmetry are considered. Starting with Goldstone mode singularities in the XY and $O(4)$ models, we briefly review various theoretical concepts, as well as state-of-the-art Monte Carlo simulation results. They support recent results of the GFD (grouping of Feynman diagrams) theory, stating that these singularities are described by certain nontrivial exponents, which differ from those predicted earlier by perturbative treatments. Furthermore, we present the recent Monte Carlo simulation results of the three-dimensional Ising model for lattices with linear sizes up to $L = 1536$, which are very large as compared to $L \leq 128$ usually used in the finite-size scaling analysis. These results are obtained, using a parallel OpenMP implementation of the Wolff single-cluster algorithm. The finite-size scaling analysis of the critical exponent η, assuming the usually accepted correction-to-scaling exponent $\omega \approx 0.8$, shows that η is likely to be somewhat larger than the value 0.0335 ± 0.0025 of the perturbative renormalization group (RG) theory. Moreover, we have found that the actual data can be well described by different critical exponents: $\eta = \omega = 1/8$ and $\nu = 2/3$, found within the GFD theory.