Evidence for Fisher renormalization in the compressible ϕ^4-model

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Abstract

We present simulation results for a compressible ϕ^4-model on a simple cubic lattice with harmonic elastic energy and quadratic-linear coupling between order parameter and strain. Integrating out the elastic degrees of freedom in the standard way, one obtains an effective Hamiltonian expressed in terms of Fourier modes of the lattice spin field which displays a long-range interaction. While this situation is difficult to handle in conventional real-space Monte Carlo simulations, it is taylor-made for our recently developed Fourier Monte Carlo algorithm [1], which directly employs the discrete Fourier amplitudes $\tilde{s}(\mathbf{k})$ of the lattice spin configurations as its basic variables without making any reference to the underlying real-space spin configurations $s(\mathbf{x})$. In combination with a generalization of finite size scaling to systems for which a cutoff in $\mathbf{k}$-space is imposed, this leads to an efficient simulation algorithm for the study of fluctuation-induced first order transitions and deviations from standard critical behavior under different ensemble constraints. In the present class of systems we observe the former in the constant stress ensemble and for auxetic systems at constant strain. In contrast, for regular isotropic systems at constant strain we find strong evidence for Fisher-renormalized critical behavior and thus are led to predict the existence of a tricritical point [2].

[1] A. Tröster, Phys. Rev. B **76**, 012402 (2007).
[2] A. Tröster, Phys. Rev. Lett., accepted for publication (2008).