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Kinetic equations and time correlation functions of critical fluctuations

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Abstract

Near the critical point the characteristic time of motion associated with certain degrees of freedom experiences an enormous slowing-down. This circumstance gives rise to a possibility of constructing a kinetic equation to describe such slowed-down motions of the system, which corresponds to the Boltzmann equation of dilute gases which describes slow variations of the single-particle distribution function. We accomplish the derivation of kinetic equations with the aid of a generalized Langevin equation due to Mori. The theory is illustrated by deriving kinetic equations obeyed by critical fluctuations in isotropic and planar Heisenberg ferromagnets, an isotropic Heisenberg antiferromagnet, the liquid helium near the $\hat{\lambda}$ point, and a binary critical mixture. The kinetic equations conform to the dynamical scaling whenever it holds, and are valid in the hydrodynamic as well as in the critical regimes. The kinetic equations are then used to

Loading jax/output/SVG/jax.js to determine time correlation functions of critical

fluctuations. In particular, in the case of a binary critical mixture, the selfconsistent equation can be used to obtain the diffusion constant and the decay rate of concentration fluctuation in the critical regime, which are expressed in terms of shear viscosity, and the results are in good numerical agreement with those of the recent light scattering experiments. The theory also leads to the modification of the Fixman correction $[1 + (q\hat{\rho})^2]$ to $[1 + (35)(q\hat{\rho})^2]$ when $q \hat{a}; k$ where q and k are the wavenumber and inverse correlation range of the concentration fluctuation, respectively.



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