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Topological defects in the O(2) model out of equilibrium

Content

We present a study of the 2- and 3-dimensional O(2) model, or XY model, out of equilibrium through Monte Carlo simulations. In particular, we analyze the dynamics of the topological defects of the system (vortices) when we linearly lower the temperature at various cooling rates, starting above the critical temperature, T_c, down to $T < T_c$. We test Zurek's prediction for the scaling behavior of the density of topological defects that remains after a cooling procedure for a system that undergoes a second order phase transition. We find that the remnant density depends on the cooling rate with a power law, in partial agreement with Zurek's prediction. This property is independent of the Monte Carlo algorithm that we choose. Still, the exact scaling behavior depends on the algorithm. A power law has also been observed in experiments of systems with continuous phase transitions. This approach could be extended to estimate the density of cosmic strings that persist from the expansion and cooling of the early universe, by simulating a more realistic model.

Summary

We present a study of the 2- and 3-dimensional O(2) model, or XY model, out of equilibrium through Monte Carlo simulations. In particular, we analyze the dynamics of the topological defects of the system (vortices) when we linearly lower the temperature at various cooling rates, starting above the critical temperature, T_c, down to $T < T_c$. We test Zurek's prediction for the scaling behavior of the density of topological defects that remains after a cooling procedure for a system that undergoes a second order phase transition. We find that the remnant density depends on the cooling rate with a power law, in partial agreement with Zurek's prediction. This property is independent of the Monte Carlo algorithm that we choose. Still, the exact scaling behavior depends on the algorithm. A power law has also been observed in experiments of systems with continuous phase transitions. This approach could be extended to estimate the density of cosmic strings that persist from the expansion and cooling of the early universe, by simulating a more realistic model.

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