Critical dynamics of spontaneous symmetry breaking in a homogeneous Bose gas

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Abstract

Kibble-Zurek theory models the dynamics of spontaneous symmetry breaking, which plays an important role in a wide variety of physical contexts, ranging from cosmology to superconductors. We explored these dynamics in a homogeneous system by thermally quenching an atomic gas with short-range interactions through the Bose-Einstein phase transition. Using homodyne matter-wave interferometry to measure first-order correlation functions, we verified the central quantitative prediction of the Kibble-Zurek theory, namely the homogeneous-system power-law scaling of the coherence length with the quench rate. Moreover, we directly confirmed its underlying hypothesis, the freezing of the correlation length near the transition. Our measurements agree with a beyond-mean-field theory and support the expectation that the dynamical critical exponent for this universality class is z = 3/2.

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