Kibble-Zurek scaling and its breakdown for spontaneous generation of Josephson vortices in Bose-Einstein condensates

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Abstract:

Atomic Bose-Einstein condensates confined to a dual-ring trap support Josephson vortices as topologically stable defects in the relative phase. We propose a test of the scaling laws for defect formation by quenching a Bose gas to degeneracy in this geometry. Stochastic Gross-Pitaevskii simulations reveal a $-1/4$ power-law scaling of defect number with quench time for fast quenches, consistent with the Kibble-Zurek mechanism. Slow quenches show stronger quench-time dependence that is explained by the stability properties of Josephson vortices, revealing the boundary of the Kibble-Zurek regime. Interference of the two atomic fields enables clear long-time measurement of stable defects, and a direct test of the Kibble-Zurek mechanism in Bose-Einstein condensation.

References:

1. Shih-Wei Su, *et al*, arXiv:1302.3304