Is quantum phase transition a coherent process?

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Quantum phase transitions are transitions between distinct many-body ground states, and are of extensive interest in research ranging from condensed matter physics to cosmology. Key features of the phase transitions include a stage with rapidly growing new order, called inflation in cosmology, followed by the formation of topological defects.

Based on Bose-Einstein condensates of cesium atoms in a shaken lattices [1], we report the observation of universal scaling of quantum critical dynamics [2], and inflationary dynamics across a quantum phase transition [3]. In particular, the inflation manifests in the exponential growth and high harmonic generations of density waves and populations in well-resolved momentum states. After the inflation stage, extended coherent dynamics is evident in the relaxation process.

We present an intuitive description of the quantum critical dynamics in our system and demonstrate the essential role of phase fluctuations in the formation of topological defects.

[1] Colin V. Parker, Li-Chung Ha, Cheng Chin, Nature Physics **9**, 769 (2013).
[2] Logan W. Clark, Lei Feng, Cheng Chin, Science **354**, 606 (2016).
[3] Lei Feng, Logan W. Clark, Anita Gaj, Cheng Chin, arXive:1706.01440.