

Abstract Submitted
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Observation of quantum criticality with ultracold atoms¹ CHENG CHIN, University of Chicago — As the temperature approaches absolute zero, thermal fluctuations of observables cease and quantum fluctuations dominate. Competition between different energies, such as kinetic energy, interactions or thermodynamic potentials, can induce a quantum phase transition between distinct ground states. Near a continuous quantum phase transition, the many-body system is quantum critical, exhibiting scale invariant and universal collective behavior. We report the observation of quantum critical behavior in a two-dimensional Bose gas in optical lattices near the vacuum-to-superfluid quantum phase transition. We observe universal scaling of the equation of state at sufficiently low temperatures, locate the quantum critical point, and determine the critical exponents. The universal scaling laws also allow determination of thermodynamic observables. Our experiment provides a prototypical method to study quantum criticality with ultracold atoms, and prepares the essential tools for further study on quantum critical dynamics.

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