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Quantum Criticality and Dynamics in Two-dimensional Bose Gases XIBO ZHANG, LI-CHUNG HA, The University of Chicago, CHEN-LUNG HUNG, California Institute of Technology, SHIH-KUANG TUNG, CHENG CHIN, The University of Chicago — Quantum criticality emerges when a many-body system is in the proximity of a continuous phase transition driven by quantum fluctuations. In the quantum critical regime, exotic, yet universal properties are anticipated; ultracold atoms provide a clean system to test these predictions. We report the observation of quantum criticality with two-dimensional (2D) Bose gases in optical lattices [1]. Based on in situ density measurements, we observe scaling behavior of the equation of state at low temperatures, locate the quantum critical point, and constrain the critical exponents ($z = 2.2^{+1.0}_{-0.5}$ and $\nu = 0.52^{+0.09}_{-0.10}$; the predicted values are $z = 2$ and $\nu = 0.5$). We observe a finite critical entropy per particle ($\sim 2k_{\mathrm{B}}$) carrying a weak dependence on the atomic interaction strength. We also study the dynamics of 2D gases by measuring the evolution of the static structure factor after quenching the atomic interaction near a Feshbach resonance. The high-resolution imaging system allows us to resolve the correlation of the density fluctuations with a spatial frequency up to 3.5 $\mu\mathrm{m}^{-1}$. Our experiment provides an excellent testground to explore quantum criticality and critical dynamics with ultracold atoms.

[1] X. Zhang et al., arXiv:1109.0344.

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