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Quantum Phase Transitions and Quantum Criticality of Two-Dimensional Ultracold Quantum Gases CHEN-LUNG HUNG, XIBO ZHANG, PETER SCHERPELZ, NATHAN GEMELKE, CHENG CHIN, University of Chicago — Quantum phase transitions in two dimensions (2D) are expected to exhibit universal behavior near the critical point. Intriguing critical phenomena are predicted even at finite temperatures. The availability of 2D quantum gases of ultracold atoms provide appealing opportunities to explore both quantum and classical criticality. Prominent examples include the superfluid (SF) to Mott insulator (MI) transition of ultracold Bose gases in an optical lattice described by the Bose-Hubbard model, and the Berezinsky–Kosterlitz–Thouless transition for 2D Bose gases. We have experimentally realized such a 2D system by loading cesium-133 Bose-Einstein condensates into an optical potential which confines the atoms tightly in one direction, followed by ramping up of a 2D optical lattice to induce the SF-MI transition. We obtain high resolution in-situ images of these samples, revealing density distributions and fluctuations indicative of the local quantum phase and changes in the underlying Hamiltonian. We discuss the extension of these results to the experimental study of critical phenomena in an interacting 2D quantum gas.

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