Title: In-Site Observation of Quantum Phase Transition and Quantum Transports in Optical Lattices

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Abstract:
Bose-Hubbard model describes one of the simplest realizations of a quantum phase transition, a phase transition that occurs even at zero temperature.
Near the phase boundary (critical point), quantum criticality, resembling that of Ising-type magnetics in higher dimensions, is expected to emerge with a full universal behavior. In particular, fluctuations and correlations are expected at all length scales.

Our observation of atomic density profiles in optical lattices provides a powerful tool to determine all relevant thermo-dynamical quantities, as well as density fluctuations and density-density correlations [1, 2]. I will describe our efforts to identify the superfluid-Mott insulator phase boundary, to extract quantum fluctuations and correlations, and also discuss the prospects to identify and characterize quantum criticality and universality based on trapped quantum gases in an optical lattice.

References:
[1] Quantum phase transition from a superfluid to a Mott insulator in a gas of ultracold atoms, M. Greiner, O. Mandel, T. Esslinger, T. W. Hänsch, and I. Bloch, Nature 415, 39 (2002).
[2] In situ observation of incompressible Mott-insulating domains in ultracold atomic gases, N. Gemelke, X. Zhang, C.-L. Hung, and C. Chin, Nature 460, 995 (2009).