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Probing Phases and Quantum Criticality using Deviations from the Local Fluctuation-Dissipation Theorem[1] ERIC DUCHON, The Ohio State University, YASUYUKI KATO, Los Alamos National Laboratory, NAOKI KAWASHIMA, University of Tokyo, NANDINI TRIVEDI, The Ohio State University — One of the major open questions in the study of ultracold atom systems is how to obtain the finite temperature phase diagram of a given Hamiltonian directly from experiments.[2] Previous work in this direction required quantum Monte Carlo simulations to directly model the experimental situation in order to extract quantitative information, clearly defeating the purpose of an optical lattice emulator. We propose a new method that utilizes deviations from a local fluctuation dissipation theorem to construct a finite temperature phase diagram, for the first time, from local observables accessible by *in situ* experimental observations. Our approach extends the utility of the fluctuation-dissipation theorem from thermometry to the identification of quantum phases, associated energy scales and the quantum critical region. We test our ideas using large-scale quantum Monte Carlo simulations of the two-dimensional Bose Hubbard model.[3]

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[2]Q. Zhou, et al., *Phys. Rev. Lett.* **103**, 085701 (2009).
[3]Y. Kato, et al., *Nature Physics* **4**, 592 - 593 (2008).

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