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Mesoscopic effects in quantum phases of ultracold quantum gases in optical lattices[1] LINCOLN D. CARR, Colorado School of Mines and Joint Quantum Institute, National Institute of Standards and Technology, M.L. WALL, Colorado School of Mines, D.G. SCHIRMER, Colorado School of Mines and Joint Quantum Institute, National Institute of Standards and Technology, R.C. BROWN, J.E. WILLIAMS, CHARLES W. CLARK, Joint Quantum Institute, National Institute of Standards and Technology — We present a wide array of quantum measures on numerical solutions of one-dimensional Bose- and Fermi-Hubbard Hamiltonians for finite-size systems with open boundary conditions. Specifically, for the Bose-Hubbard Hamiltonian we calculate number, quantum depletion, local von Neumann entropy, generalized entanglement or Q measure, fidelity, and fidelity susceptibility; for the Fermi-Hubbard Hamiltonian we also calculate the pairing correlations, magnetization, charge-density correlations, and antiferromagnetic structure factor. Our numerical method is imaginary time propagation via time-evolving block decimation. As part of our study we provide a careful comparison of canonical versus grand canonical ensembles and Gutzwiller versus entangled simulations. The most striking effect of finite size occurs for bosons: we observe a strong blurring of the tips of the Mott lobes accompanied by higher depletion, and show how the location of the first Mott lobe tip approaches the thermodynamic value as a function of system size.

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