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Cooling and Near-equilibrium Dynamics of Atomic Gases across the Superfluid-Mott Insulator Transition XIBO ZHANG, CHEN-LUNG HUNG, NATHAN GEMELKE, CHENG CHIN, University of Chicago — Achieving low enough temperature is necessary for atoms in an optical lattice to probe ground state many-body physics. Experimentally, the lattice potential is gradually ramped up; adiabaticity of the ramp determines the final temperature of the atomic cloud. Here we study the temperature and dynamics of Cesium 133 atoms across the bosonic superfluid (SF) to Mott insulator (MI) transition. We show that lattice ramps developed to ensure only local adiabaticity can yield samples far from global thermal equilibrium. An intriguing local cooling effect is observed during this process. From a finite-temperature density fit derived in the MI regime, we find that temperature can drop significantly at the center of the sample. In addition, the inner and outer temperatures take a long time (over one second) to converge. Possible mechanisms for the local cooling near the cloud center include the Joule-Thomson effect of cooling a Bose gas, as well as locally isentropic cooling due to the vanishing of SF critical temperature near the quantum critical point. Our work provides new prospects to observe novel quantum phases at very low temperature.

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