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Orbital Excitation Blockade and Algorithmic Cooling of Strongly Correlated Quantum Gas MING TAI, Harvard University, WASEEM BAKR, Massachusetts Institute of Technology, PHILIPP PREISS, RUICHAO MA, JONATHAN SIMON, MARKUS GREINER, Harvard University — Ultracold quantum gases in optical lattices provide a rich experimental toolbox for simulating the physics of condensed matter systems. Here we present a new blockade effect that employs the orbital dependence of the interaction between bosons in optical lattices to manipulate the onsite occupation in a strongly interacting quantum gas. We induce coherent orbital excitations by modulating the lattice depth and observe interaction-induced energy shifts in the modulation resonances. By sweeping the modulation frequency across several resonances we can deterministically remove atoms on individual sites based upon initial occupation. Using this number filtering approach, we have demonstrated algorithmic entropy removal from a high-temperature gas to the point that it Bose-condenses. This algorithmic cooling can be used to bring quantum gases to the pico-Kelvin regime required for observing strong correlations. Further applications of these methods include preparation of high fidelity quantum registers, imaging strongly-correlated quantum gases, and generation of entangled orbital states.

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