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Atom sorting in a 3D optical lattice[1] AISHWARYA KUMAR, TSUNG-YAO WU, FELIPE GIRALDO MEJIA, DAVID S. WEISS, Pennsylvania State University — We demonstrate perfectly filled 3D arrays of neutral atoms by moving individual atoms in a 3D lattice. Starting from a randomly half-filled 5x5x5 optical lattice of Cesium atoms, we implement the scheme proposed in Phys. Rev. A 70, 040302(R) (2004) in order to fill 5x5x2 and 4x4x3 sub-lattices. We start by imaging atoms with single site resolution, creating reliable occupancy maps, and projection sideband cooling the atoms so that they are in the vibrational ground state 89% of the time. A sorting algorithm then calculates and implements a sequence of high fidelity targeted state flips and state-dependent motion steps to fill a sub-lattice in real time. We achieve an average filling fraction of 0.96 and a perfect filling rate of 31% (27%) for a 5x5x2 (4x4x3) target sub-lattice. We have also characterized the errors in the sorting procedure and performed Monte-Carlo simulations to study the scalability of this scheme. The sorting procedure reduces the total entropy of the system by a factor of 2.44 and is analogous to a Maxwell's demon. It also initializes a neutral atom quantum computer.

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Aishwarya Kumar
Pennsylvania State Univ

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