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Construction of a Quantum Matter Synthesizer JONATHAN TRISNADI, MICKEY MCDONALD, KAI-XUAN YAO, CHENG CHIN, James Franck Institute, Enrico Fermi Institute, and Department of Physics, University of Chicago — We report progress on the construction of a new platform to manipulate ultracold atoms. The Quantum Matter Synthesizer will have the capability of deterministically preparing 2D arrays of atoms with single site addressability. Cesium atoms will first be transferred to a science cell via a moving 1D lattice, where they are loaded into a magic-wavelength, far-detuned 2D optical lattice. Two NA=0.8 microscope objectives surround the science cell from above and below. Optical tweezers (formed by a digital micromirror device) and a 2D lattice potential are projected through the upper objective, and imaged with the lower objective. Site-resolved fluorescence images of the initial atomic distribution are taken using the upper objective. Additionally, we report on a new scheme to detect atoms with sub-optical wavelength resolution. Starting from cesium atoms in a 3D optical lattice, we superimpose along one axis a standing wave of resonant light which can optically pump the atoms to a different hyperfine state suitable for imaging. The dependence of imaged atom number on relative phase between the trapping and pumping lattices is strongly related to the single atom density profile within a lattice site.

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