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Quantum Information Processing with Atoms in Arrays of Dipole Potentials MALTE SCHLOSSER, JENS KRUSE, CHRISTIAN GIERL, CHRISTOPH EWEN, PETER SCHAUSS, GERHARD BIRKL, TU Darmstadt —

Quantum information processing with neutral atoms represents an important experimental approach complementing systems based on trapped ions. By using ultra-cold atoms in two-dimensional dipole trap arrays, one can realize highly controllable and scalable systems with long coherence times. In our experiment, we use sets of optical micro-potentials created by micro-fabricated lens arrays as the architecture for a scalable quantum processor. Due to the large lateral separation of neighboring potential wells, each trap is individually addressable. For flexible architectures, we implement a liquid crystal display in front of a microlens array as a pixel-addressable intensity modulator. By this we are able to control each potential well separately and produce arbitrary trap configurations. We demonstrate the flexible site-specific initialization and coherent manipulation of separated small ensembles of ^{85}Rb atoms in two-dimensional trap arrays by applying coherent Raman coupling between hyperfine ground states, representing the qubit states. Advanced schemes for scalable atom observation allow us to detect single atoms in two-dimensional sets of dipole traps with high efficiency and reliability.

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