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Matched Bichromatic Optical Lattices for Quantum Information Processing with Ultracold Atoms SKYLER DEGENKOLB, ANDREAS KLINGER, NATHAN GEMELKE, KATHY-ANNE BRICKMAN SODERBERG, CHENG CHIN, University of Chicago — We construct a novel system to independently trap and control two atomic species in separate optical lattices for scalable quantum information processing. One species serves as qubits, storing quantum information, and one as messengers, mediating entanglement to distant qubits and performing the desired gate operations. The key component of the lattice system is a homemade blazed diffraction grating, which automatically matches the lattice constants, functioning as a beamsplitter whose output angle depends on wavelength. Laser intensities and detunings are chosen to discriminate between the two species, and the exclusively common-mode optics provide relative stability of the lattice site on the order of 10nm. Precise control of each lattice is realized by electro-optic phase modulation of the component beams, which allows messenger atoms to access many qubits in a hexagonal lattice. We demonstrate the ability to perform these steps at the timescale and fidelity required for quantum computation.

Skyler Degenkolb

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