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Optical lattice-based addressing and control of long-lived neutral-atom qubits NATHAN LUNDBLAD, TREY PORTO, IAN SPIELMAN, RADU CHICIREANU, WILLIAM PHILLIPS, JQI/NIST/UMD — Many proposed quantum computational platforms are driven by competing needs: isolating the quantum system from the environment to prevent decoherence, and easily and accurately controlling the system with external fields. For example, neutral-atom optical-lattice architectures provide environmental isolation through the use of states that are robust against fluctuating external fields, yet external fields are inherently useful for qubit addressing. Here we demonstrate a technique to address qubits formed from a pair of field-insensitive states by transferring the qubit into a *different* pair of field-insensitive states. A spatially inhomogeneous external field allows the addressing of particular "marked" elements of a qubit register, leaving unmarked qubits unaffected, despite the presence of crosstalk or leakage of the addressing field. We demonstrate this technique in an ensemble of ^{87}Rb atoms and show that we can robustly perform single-qubit rotations on qubits located at addressed lattice sites. This precise coherent control is an important step forward for lattice-based neutral-atom quantum computation, and is applicable to state transfer and qubit isolation in other architectures using field-insensitive qubits.

Nathan Lundblad
JQI/NIST/UMD

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