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State Mapping and Unitary Transformations in the Cesium Hyperfine Ground Manifold HECTOR SOSA MARTINEZ, AARON SMITH, BRIAN ANDERSON, POUL JESSEN, University of Arizona, CARLOS RIOFRIO, IVAN DEUTSCH, University of New Mexico — Quantum systems with Hilbert space dimension greater than two (qudits) provide an alternative to qubits as carriers of quantum information, and may prove advantageous for quantum information tasks if good laboratory tools for qudit manipulation and readout can be developed. We have successfully implemented a protocol for arbitrary quantum state-to-state mapping in the 16 dimensional hyperfine ground manifold of Cesium 133 atoms using only DC, rf and microwave magnetic fields to drive the atomic evolution. Experimentally we achieve a state-to-state average mapping fidelity of better than 99%, averaged over a sample of randomly chosen initial and target states. Current work involves designing and implementing unitary transformations. We have successfully used the GRAPE algorithm to design unitary operators that can be implemented with the same experimental framework as state mapping.

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