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Quantum Control and Measurement in the 133Cs Full Hyperfine Ground Manifold BRIAN ANDERSON, AARON SMITH, HECTOR SOSA, POUL JESSEN, Center for Quantum Information and Control, College of Optical Science, University of Arizona., CARLOS RIOFRIO, IVAN DEUTSCH, Center for Quantum Information and Control, Dept of Physics, University of New Mexico —
Quantum systems with Hilbert space dimension greater than two (qudits) are often considered as carriers of quantum information. The use of qudit systems could prove advantageous for information processing tasks, provided that good laboratory tools for robust qubit manipulation and readout can be developed. We have successfully implemented a protocol for arbitrary state mapping in the 16-dimensional hyperfine ground manifold of the Cesium 133 atom, using only DC, rf and microwave magnetic fields and thus avoiding the photon scattering and decoherence characteristic of schemes that rely on optical fields. Our control waveforms are designed to provide robustness against errors and inhomogeneities in the control fields, and this has allowed us to achieve state mapping fidelities of 98% or better in the laboratory. We have developed a procedure involving successive applications of state mapping waveforms, allowing us to separate qudit initialization and readout errors from state mapping errors, and thus to reliably measure state mapping fidelities in excess of 99%.

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