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Quantum State Tomography via Continuous Measurement of Laser Cooled Cesium Atoms AARON SMITH, BRIAN ANDERSON, HECTOR SOSA, POUL JESSEN, University of Arizona, CARLOS RIOFRIO, IVAN DEUTSCH, University of New Mexico — Quantum State Tomography (QST) is the process of reconstructing an unknown quantum state from the outcomes of a sufficiently complete series of measurements. To improve the speed and accuracy of QST, we have developed and implemented a new protocol based on weak continuous measurement and dynamical control. In our experiment, an ensemble of Cs atoms are prepared in identical quantum states within the ground hyperfine manifold, driven by a combination of static, rf and μw magnetic fields, and simultaneously probed by coupling the atomic spin to the polarization of a near-resonant optical probe field. A continuous measurement of the probe polarization yields an informationally complete measurement record that can be inverted to obtain an estimate of the unknown hyperfine state. We have reconstructed the full density matrix for a number of randomly chosen test states, using computer algorithms based either on least squares fitting or compressed sensing. Both approaches perform similarly and reconstruct our test states with an average fidelity around 90%, limited primarily by errors in the applied drive fields.

Aaron Smith
University of Arizona

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