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**Quantum tomography of near-unitary processes in high-dimensional quantum systems** NATHAN LYSNE, HECTOR SOSA MARTINEZ, POUL JESSEN, University of Arizona, CHARLES BALDWIN, AMIR KALEV, IVAN DEUTSCH, University of New Mexico — Quantum Tomography (QT) is often considered the ideal tool for experimental debugging of quantum devices, capable of delivering complete information about quantum states (QST) or processes (QPT). In practice, the protocols used for QT are resource intensive and scale poorly with system size. In this situation, a well behaved model system with access to large state spaces (qudits) can serve as a useful platform for examining the tradeoffs between resource cost and accuracy inherent in QT. In past years we have developed one such experimental testbed, consisting of the electron-nuclear spins in the electronic ground state of individual Cs atoms. Our available toolkit includes high fidelity state preparation, complete unitary control, arbitrary orthogonal measurements, and accurate and efficient QST in Hilbert space dimensions up to $d = 16$. Using these tools, we have recently completed a comprehensive study of QPT in 4, 7 and 16 dimensions. Our results show that QPT of near-unitary processes is quite feasible if one chooses optimal input states and efficient QST on the outputs. We further show that for unitary processes in high dimensional spaces, one can use informationally incomplete QPT to achieve high-fidelity process reconstruction (90% in $d = 16$) with greatly reduced resource requirements.

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