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Synthesis of Arbitrary States of Large Atomic Spins by Quantum Control SOUMA CHAUDHURY, University of Arizona, Tucson, SETH MERKEL, TOBIAS HERR, IVAN DEUTSCH, POUL JESSEN — A spin 1/2 system is fully controllable by applying geometric rotations with magnetic fields, however for larger spins typical for alkali atom ground states, one needs additional unitary transformations to achieve controllability. We demonstrate universal quantum control of the spin-angular momentum associated with the lower hyperfine ground state of individual 133Cs atoms (F=3), by driving the system with magnetic fields and a rank-2 tensor light shift induced by a near-resonant laser field. A relatively simple optimization routine can be used to design time dependent controls that transform an initial fiducial state $|F = 3, mf = 3\rangle$ into a desired target state. In a series of experiments we have used this procedure to generate a broad range of target states, including squeezed and other non-classical states. In general we achieve yields (fidelity of the actual state relative to the target state) in the range $\sim 85\% - 90\%$, limited mostly by errors in the control fields and by light scattering. We compare this approach to an adiabatic method of synthesizing spin-squeezed states and discuss its applications relating to quantum information and metrology.

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