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Quantum Optimal Control of Nuclear Spin for Quantum Logic with Qudits[1] SIVAPRASAD OMANAKUTTAN, ANUPAM MITRA, IVAN DEUTSCH, Center for Quantum Information and Control, University of New Mexico — Quantum optimal control is a powerful tool for the robust realization of quantum information processing tasks such as preparation of nonclassical quantum states and implementation of unitary maps. We studied quantum optimal control of the the spin I=9/2 nucleus of 87Sr, an alkaline earth atom that has attracted substantial recent attention for metrology, quantum simulation and quantum computing. By employing nuclear spin magnetic resonance in the presence of a laser-induced nonlinear AC Stark shift, the system is controllable; we can design any SU(10) unitary matrix acting on the d=10 dimensional manifold of nuclear magnetic sublevels. We design control waveforms that generate the fundamental gates required for universal qudit logic gates. We also study experimental trade-offs including the affects of decoherence and robustness to imperfections.

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