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**Universal Control of Nuclear Spins via Anisotropic Hyperfine Interactions** JONATHAN S. HODGES, JAMIE C. YANG, CHANDRASEKHAR RAMANATHAN, DAVID G. CORY, Massachusetts Institute of Technology — Nuclear spins are appealing as qubits in quantum information processing given their long coherence times; however these systems still require an efficient means of initial state preparation and state measurement. Many proposals rely on a localized electron spin coupled to the nuclear spins via the hyperfine interaction for aiding in initialization and read-out. When the hyperfine interaction between electron and nuclear spins has an anisotropic coupling, we describe how universal control over the combined subsystems can be attained by driving only the electron spin transitions. Building on the GRAPE [1] method for quantum control, we propose a method for modulating solely the electron spin that allows for faster, more robust quantum operations on the nuclear spins than would be achieved by addressing the nuclear spins directly. We experimentally demonstrate these ideas in a test bed system of one S=1/2 electron spin and one I=1/2 nuclear spin and show that a universal set of gates can be achieved on this system. Also, we present preliminary results on our ability to polarize the combined system by controlling polarization transfer from the electron to the nuclear spin in the presence of electron spin relaxation.

[1] N. Khaneja et al., J. Magn. Reson. 172, 296 (2005)

Jonathan S. Hodges
Massachusetts Institute of Technology

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