Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

Universal quantum control of two electron spin qubits via dynamic nuclear polarization HENDRIK BLUHM, SANDRA FOLETTI, Harvard University, DIANA MAHALU, VLADIMIR UMANSKY, Weizmann Institute of Science, AMIR YACOBY, Harvard University — Encoding a single logical qubit in the collective spin states of two electrons in a double quantum dot can provide subnanosecond electrically controlled gates that are fast enough to refocus dephasing due to slow fluctuations of the hyperfine field from the nuclei of the host material [1]. In this work, we experimentally demonstrate full quantum control of a GaAs two electron logical spin qubit. One fast electrical control axis resulting from coherently exchanging the two electrons has already been demonstrated [2]. We achieve coherent evolution around a second axis caused by a difference in the nuclear hyperfine fields felt by the two electrons. This field difference is obtained by dynamically polarizing the Ga and As nuclei by transferring spin from the electrons to the nuclei. It can reach up to several hundred mT and can be maintained in a steady state. We demonstrate rotations around this axis with a programmable frequency that can exceed 1 GHz. Using quantum state tomography enabled by both control axes, we characterize the evolution of the qubit state around a fixed but tunable combined axis. Our results establish full electrical quantum control at the single qubit level with gate times of a few nanoseconds. [1] Taylor et al., Nature Physics **1, 177 (2005). [2] Petta et al. Science 309, 2180 (2005).**

Hendrik Bluhm
Harvard University

Date submitted: 21 Nov 2008 Electronic form version 1.4