Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Dephasing and relaxation of central hole spins by nuclear spin baths in InGaAs quantum dots: role of nuclear quadrupolar coupling[1]
YAN LI, N.A. SINITSYN, A. SAXENA, D.L. SMITH, Los Alamos National Lab, D. REUTER, A.D. WIECK, Ruhr-Universitat Bochum, D.R. YAKOVLEV, B. MANFRED, University of Dortmund, S.A. CROOKER, Los Alamos National Lab — Single electron or hole spins in III-V semiconductor quantum dots (QDs) are promising candidates for solid-state qubits. Their coherence properties are typically governed by the hyperfine coupling between these "central" electronic spins and the dense surrounding bath of lattice nuclear spins. Theoretically this is a challenging problem due to its many-body and strongly-correlated nature. Here we measure the spin dynamics of holes in InGaAs quantum dots by detecting their intrinsic, random spin fluctuations while in thermal equilibrium, which reveals the spin correlation time scales τ_h and the functional form of bath-induced spin relaxation. In zero magnetic field, τ_h is very long ($\sim$400 ns) and decays exponentially, in marked contrast with recent theories. τ_h increases to $\sim$5 μs in small (100 G) longitudinal fields, and the spin dynamics evolve to a very slow $\sim$1/ln(t) decay [1]. We model the influence of nuclear quadrupolar coupling on spin dynamics in these strained QDs for both electrons and holes [2], and find a good agreement with experimental data when the quadrupolar coupling exceeds the hyperfine coupling strength. [1] Yan Li, N. Sinitsyn, et al., PRL 108, 186603 (2012). [2] N. Sinitsyn, Yan Li, et al., PRL 109, 166605 (2012).

[1]We acknowledge support from LANL LDRD program.

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Date submitted: 27 Nov 2012 Electronic form version 1.4