Abstract for an Invited Paper
for the DAMOP08 Meeting of
The American Physical Society

Controlling electron and nuclear spins in double quantum dots

JASON PETTA, Princeton University

Hyperfine interactions limit electron spin coherence times in GaAs quantum dots. By separating a spin singlet state on a chip, we measure an ensemble averaged spin dephasing time $T_2^*$ of 10 ns, limited by the contact hyperfine interaction with the GaAs host nuclei [1]. We use electrical control of the exchange interaction to drive coherent spin rotations. Exchange driven spin rotations are used to implement a “singlet-triplet spin echo” pulse sequence, which leads to a spin coherence time, $T_2$, exceeding 1 microsecond. We show that nuclear spins can be polarized by controlling two-electron spin states near the anti-crossing of the singlet (S) and triplet (T$_+$). An initialized S state is cyclically brought into resonance with the T$_+$ state, where hyperfine fields drive rapid rotations between S and T$_+$, ‘flipping’ an electron spin and ‘flopping’ a nuclear spin [2]. The resulting Overhauser field approaches 80 mT, in agreement with a simple rate-equation model. A self-limiting pulse sequence is developed that allows the steady-state nuclear polarization to be set using a gate voltage.


In collaboration with J. M. Taylor, A. C. Johnson, A. Yacoby, M. D. Lukin, C. M. Marcus, M. P. Hanson, and A. C. Gossard. Supported by DARPA and DTO.