Chez Pierre

Presents ...

Monday, February 14, 2011
12:00pm
MIT Room 4-331

SPECIAL CHEZ PIERRE SEMINAR

Greg D. Fuchs
University of California, Santa Barbara

"High-Speed Manipulation of Single Electronic and Nuclear Spins in Diamond"

Nitrogen vacancy (NV) center spins in diamond have emerged as a promising solid-state system for quantum information processing and precision metrology at room temperature. Fast, coherent control and storage of quantum information is crucial due to the practical need for fault tolerance. We first present experiments probing gigahertz rate spin dynamics of single NV centers driven by an intense microwave field generated in lithographically patterned coplanar waveguides [1]. In this unusual regime, spin rotation occurs at a rate comparable to Larmor precession. Coherent spin flips still occur, but on sub-nanosecond timescales — faster than expected conventionally. Extending this approach, we fabricate a high-bandwidth two-axis vector magnet on diamond to coherently swap the quantum state of a single NV center electronic spin to the associated nitrogen nuclear spin [2]. These spin-control techniques also allow us to study the spin of single NV centers in their orbital excited-state (ES) [3, 4]. We demonstrate ES Rabi oscillations and use multi-pulse resonant control to differentiate between phonon-induced dephasing, orbital relaxation, and coherent electron-nuclear interactions. These experiments provide insight into the coherence and dynamics of NV center spins as well as providing tools for coherently manipulating and storing quantum information in a scalable solid-state system.

[1] G. D. Fuchs, V. V. Dobrovitski, D. M. Toyli, F. J. Heremans, D. D. Awschalom, Science 326, 1520 (2009).
[2] G. D. Fuchs, G. Burkard, P. Klimov, D. D. Awschalom, in preparation (2011).
[3] G. D. Fuchs, V. V. Dobrovitski, R. Hanson, A. Batra, C. D. Weis, T. Schenkel, and D. D. Awschalom, Phys. Rev. Lett. 101, 117601 (2008).
[4] G. D. Fuchs, V. V. Dobrovitski, D. M. Toyli, F. J. Heremans, C. D. Weis, T. Schenkel, and D.D. Awschalom, Nat. Phys. 6, 668 (2010).