Special Seminar

Dr. Gregory Fuchs

Center for Spintronics & Quantum Computation
University of California, Santa Barbara

Thursday, Dec. 2nd at 3:30 p.m. in Room 1315

ULTRAFAST MICROWAVE SPIN MANIPULATION OF SINGLE NITROGEN VACANCY CENTERS IN DIAMOND

Nitrogen vacancy (NV) center defects in diamond have emerged as a promising spin-based system for quantum information processing and precision measurement at room temperature. Fast, coherent control and storage of quantum states 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. In this unusual regime, spin rotation occurs on the same timescale as Larmor precession. Coherent spin flips still occur, but with 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. These spin-control techniques also allow us to observe and study the spin of single NV centers in their orbital excited-state (ES). In the frequency domain, we probe the ES NV center spin and discover enhanced coupling with the nitrogen nuclear spin. 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 states in solid-state systems.