

2pm, **April 10th**, Room 1201

**Mode Locking of Electron Spin Coherence in Singly
Charged Quantum Dots**

Dr. Alexander Efros

Naval Research Laboratory

Fast dephasing of electron spins in an ensemble of quantum dots is detrimental for applications in quantum-information processing. We show that dephasing can be overcome by using a periodic train of light pulses to synchronize the phases of the precessing spins, and demonstrate this effect in an ensemble of singly charged (In,Ga)As/GaAs quantum dots [1]. We first discuss the physical mechanism of this synchronization in a quantum-dot ensemble [2, 3]. A periodic train of circularly polarized light pulses from a mode-locked laser synchronizes the precession of the spins to the laser repetition rate, transferring the mode-locking into the spin system. The mode-locking technique allows us to measure the single-spin coherence time to be 3 microseconds [1], which is four orders of magnitude longer than the ensemble dephasing time of 400 picoseconds. The technique also offers the possibility of achieving all-optical coherent manipulation of spin ensembles, in which electron spins can be clocked by two trains of pump pulses with a fixed temporal delay. After this pulse sequence, the quantum-dot ensemble shows multiple bursts of Faraday rotation signals, whose repetition period agrees well with developed theory. The nuclei in these experiments act constructively, leading to the nuclear-induced frequency-focusing effect, which moves the electron-spin precession into dephasing-free subspace [4]. This effect has the potential for focusing all precession frequencies of the quantum-dot ensemble to a single precession mode.

[1] A. Greilich, D. R. Yakovlev, A. Shabaev, Al. L. Efros, I. A. Yugova, R. Oulton, V. Stavarache, D. Reuter, A. Wieck, and M. Bayer, *Science* **313**, 341 (2006).

[2] A. Greilich, R. Oulton, E. A. Zhukov, . A. Yugova, D. R. Yakovlev, M. Bayer, A. Shabaev, Al. L. Efros, I. A. Merkulov, V. Stavarache, D. Reuter, and A. Wieck, *Phys.Rev. Lett.*, **96**, 227401 (2006).

[3] A. Shabaev, Al. L. Efros, D. Gammon, and I. A. Merkulov, *Phys. Rev. B* **68**, 201305(R) (2003).

[4] A. Greilich, A. Shabaev, D. R. Yakovlev, Al. L. Efros, I. A. Yugova, D. Reuter, A. D. Wieck, and M. Bayer, *Science* **317**, 1896 (2007).

Host: Min Ouyang