FRONTIERS IN OPTICAL COHERENT AND ULTRAFAST SCIENCE
A NATIONAL SCIENCE FOUNDATION PHYSICS FRONTIER CENTER AT
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A nugget from FOCUS:

Title: Optically Induced and Detected Spin Coherence: Quantum information storage in a semiconductor quantum dot

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We have successfully shown that we can optically induce and detect electronic spin coherence in single electron semiconductor quantum dots. This works sets the stage for demonstrating coherent control, qubit initialization for quantum computing, and arbitrary qubit rotation. It also forms the foundation for the development of a scalable solid state system. The current work builds on our earlier studies demonstrating short lived quantum coherence between exciton pseudo-spin states. The coherence is short lived because it is limited by the fast electron-hole recombination time. In a doped quantum dot, however, the energy level structure is similar to that of a classic three-level lambda system.

Coherent transient pump-probe measurements create a spin coherence using a Raman excitation scheme. Figure 1 shows the optically induced and detected spin coherence for, both, ensemble measurements and measurements on a single dot. Decay of the envelope is due to decoherence which, in the case of the single dot, is most likely due to electron-nuclear spin diffusion. In the data, an anomalous dependence on the Zeeman splitting of the spin states of, both, the beat amplitude and phase was shown to be due to a new physical effect not seen in these types of experiments in atomic systems. The dependence is due to an interference effect from spontaneously generated coherence. Such spontaneously generated coherence is usually not allowed in atomic systems because of the selection rules that result from spherical symmetry. This symmetry is broken in the quantum dots in the presence of a magnetic field and this allows for spontaneously generated coherence due to spontaneous emission from the trion state.
The results are published in PRL in 2005.

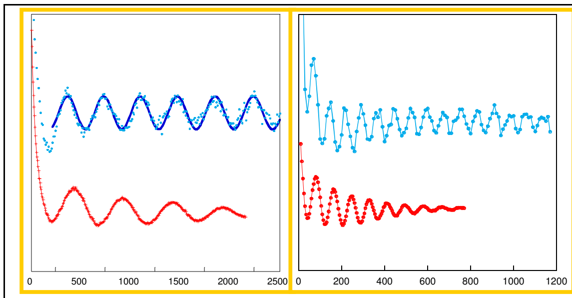	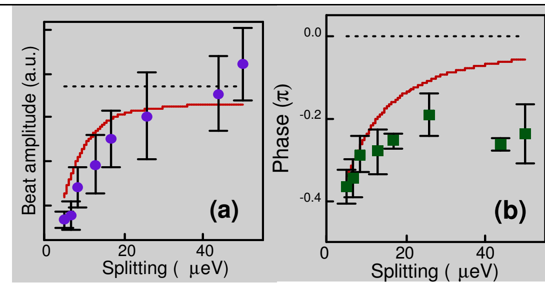
Figure 1. Quantum beat data showing optically induced and detected electron spin coherence of a single electron in a quantum dot. The lower trace represent an ensemble measurement, the upper trace is a single dot.	Figure 2. An anomalous dependence on the Zeeman splitting of the amplitude and phase of the beats (the normal theory is the dashed line) is shown to be due to spontaneously generated spin coherence. The correct theory is shown in red.