Contribution ID: **19** Type: **not specified**

Spins in InAs quantum dots: qubits, sensors, and photon sources

Monday, 23 September 2019 11:30 (20 minutes)

InAs quantum dots (QDs) are known for their strong optical transitions that lead to a nearly ideal source of single photons. Additional functionality comes from charging the QD with a single electron or hole spin that acts as a stationary quantum bit. In this presentation, I will discuss how a spin in a QD or in a pair of coupled QDs can be used for sensing mechanical motion and for generating tunable single photons. To sense motion, QDs have been incorporated into mechanical resonators, which couple to the dots through strain. When mechanical resonators are driven, the optical transitions of QDs shift significantly, and the spin states shift as well [1]. In single QDs, the hole spin shows much stronger coupling to strain than electrons spins, due to the stronger spin-orbit interaction. In coupled QDs, a pair of interacting electron spins can be made highly sensitive to strain gradients that change the relative QD energies [2]. To generate photons, we make use of the Raman spin-flip process, often enhancing the process by integrating the QDs into photonic crystal cavities [3]. The Raman process has the advantage of generating photons with properties determined by the drive laser and the spin properties. In this way, we are able to demonstrate spectral and temporal control over single photon wavepackets [4], with very low two photon emission probability and high indistinguishability. Finally, I will briefly discuss efforts that combine these topics, in which highly localized strain is used to tune multiple QD photon emitters into resonance within nanophotonic waveguides [5].

This work is supported by the U.S. Office of Naval Research, the Defense Threat Reduction Agency (grant no. HDTRA1- 15-1-0011) and the OSD Quantum Sciences and Engineering Program.

[1] Carter, S. G. et al. Spin-mechanical coupling of an InAs quantum dot embedded in a mechanical resonator. Phys. Rev. Lett. **121**, 246801 (2018).

[2] Carter, S. G. et al. Tunable coupling of a double quantum dot spin system to a mechanical resonator. Nano Lett. **19**, 6166–6172 (2019).

[3] Sweeney, T. M. et al. Cavity-stimulated Raman emission from a single quantum dot spin. Nat. Photonics **8**, 442–447 (2014).

[4] Pursley, B. C., Carter, S. G., Yakes, M. K., Bracker, A. S. & Gammon, D. Picosecond pulse shaping of single photons using quantum dots. Nat. Commun. **9**, 115 (2018).

[5] Grim, J. Q. et al. Scalable in operando strain tuning in nanophotonic waveguides enabling three- quantum-dot superradiance. Nat. Mater. **18**, 963–969 (2019).

Primary author: Dr CARTER, Samuel (US Naval Research Laboratory)

Co-authors: Dr BRACKER, Allan (US Naval Research Laboratory); Dr GAMMON, Daniel (joel.grim@nrl.navy.mil); Dr GRIM, Joel (allan.bracker@nrl.navy.mil)

Presenter: Dr CARTER, Samuel (US Naval Research Laboratory)

Session Classification: Parallel Track B - Experiment