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Coherent Optical Control of Quantum Dots: Spin Qubits and Flying Qubits[1]

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Coherent control of solid-state qubits lies at the heart of most quantum information architectures. In quantum dots (QDs), optical fields are an attractive medium for qubit manipulation and readout. The entanglement between a QD spin qubit and an emitted photonic qubit allows for the transport of quantum information between distant quantum memories via decoherence resistant photon channels. I will present recent experimental work showing the entanglement between a single electron spin confined to an InAs QD and its spontaneously emitted photon. This entanglement is significant for the further development of quantum information technologies using QDs and forms the foundation of on-chip technologies using photonic crystal pathways. In addition, I will discuss on-going work on teleportation of information from a single photon generated in a spontaneous parametric down conversion (SPDC) process to a QD spin through intermediate interference between the SPDC photon and the dot's emitted photon. The ability to integrate two quantum information platforms is not only exciting in its own right, but this technique could allow for an entanglement swapping bridge between other matter-qubit (ions, NV centers, etc.) based quantum memories.

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