Tomography and decoherence of electronic spin qubits confined in semiconductor quantum dots.

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Quantum dots are arguably the best interface between matter spin qubits and flying photonic qubits. Using quantum dot devices to produce joint spin-photonic states requires the electronic spin qubits to be stored for extended times. Therefore, the study of the coherence of spins of various quantum dot confined charge carriers is important both scientifically and technologically. In this talk I will report on spin dephasing measurements performed on five different forms of electronic spin qubits confined in the very same quantum dot [1]. I will describe all optical techniques to measure the spin dephasing of the confined electron, hole and that of a long-lived electron-heavy-hole pair (the dark exciton). Our results are in agreement with a central spin theory which attributes the dephasing of the carriers' spin to their hyperfine interactions with the nuclear spins of the atoms forming the quantum dots. We demonstrate that the heavy hole dephases much slower than the electron. We also show, both experimentally and theoretically, that the dark exciton dephases slower than the heavy hole, due to the electron-hole exchange interaction, which partially protects its spin state from dephasing. In addition, I will describe a novel all optical spin tomography measurement technique and its application in characterization of spin-photon entanglement and the process map in a device for deterministic generation of a cluster state of entangled photons [2].

[1] D. Cogan, O. Kenneth, N. H. Lindner, G. Peniakov, C. Hopfmann, D. Dalacu, P. J. Poole, P. Hawrylak, and D. Gershoni, "Depolarization of Electronic Spin Qubits Confined in Semiconductor Quantum Dots". Phys. Rev. **X 8**, 041050 (2018)

[2] I. Schwartz, D. Cogan, E. R. Schmidgall, Y. Don, L. Gantz, O. Kenneth, N. H. Lindner, and D. Gershoni. "Deterministic generation of a cluster state of entangled photons." Science, **354**, 434 (2016).