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Experiments on hole spins in quantum dots

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A single electron in a nano-sized quantum dot is so strongly quantized that the interaction with the phonons is highly suppressed. This leads to potentially long spin dephasing times, ideal for applications in quantum information. However, the hyperfine interaction, the interaction of the electron spin with the spins of the host nuclei, leads to a rapid loss of spin coherence and this presently represents the largest stumbling block in quantum dot spin physics. An alternative to an electron spin is a hole spin. The p-like atomic part of the hole wave function conveniently goes to zero at the locations of the atomic nuclei, removing the contact part of the hyperfine interaction. Could it be the case that a heavy hole spin is more coherent than an electron spin in a self-assembled quantum dot? Optical experiments will be presented on single hole spins, exploring the spin relaxation time with an optical pumping experiment and the spin dephasing time with coherent population trapping. The results are very encouraging: both the hole spin T1 and T2* times are surprisingly large.