ABSTRACT: “Spin noise” spectroscopy is a recently developed optical technique for passively measuring the spin dynamics of electrons and holes via their intrinsic random spin fluctuations. In accord with the fluctuation-dissipation theorem, the frequency spectrum of this spin noise alone reveals dynamic properties such as spin dephasing times and Landé g-factors. In contrast to conventional methods for measuring spin dynamics, spin noise techniques do not drive, excite, or perturb the system away from thermal equilibrium. This talk will discuss the application of spin noise spectroscopy to electrons in bulk GaAs, and to holes confined in singly charged InGaAs quantum dots. The former is a well-studied system, in which we verify all the basics of spin noise spectroscopy. The latter system is considered a promising candidate for solid-state qubits. Owing to their \( p \)-type wavefunctions, holes experience much less hyperfine interaction with lattice nuclei as compared with confined electrons, leading in principle to longer spin decoherence times. The spin noise data [1] reveal long hole spin correlation times (~400 ns) in zero magnetic field, that further increase to ~5 microseconds as hole-nuclear coupling is suppressed with small applied fields (< 100 G). Importantly, the lineshape of the noise spectrum evolves from Lorentzian to power-law, indicating a crossover from exponential decay to very slow inverse-log spin dynamics. We model the influence of nuclear quadrupolar coupling on hole spin dynamics, and find a good agreement with the experimental data [2].


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