Spin Noise of Electrons and Holes in Self-Assembled Quantum Dots

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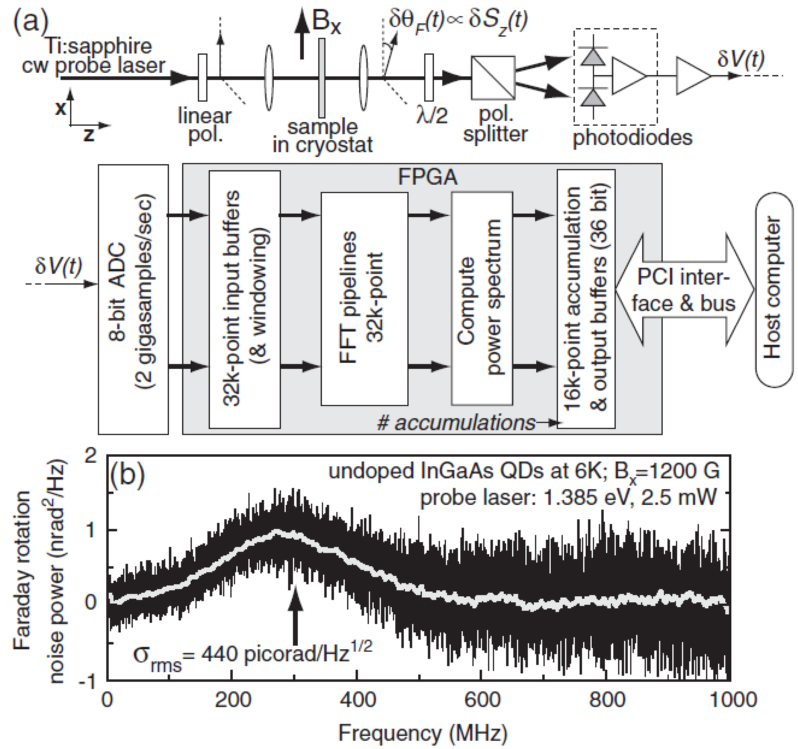
- The dynamic properties of electron and hole spins in semiconductor quantum dots (QDs) are actively investigated for potential applications in spintronics and quantum computing. Optical pump-probe studies have proven invaluable in this regard, directly revealing the g-factors and coherence decays of spins in QDs. In principle, however, these important properties are *also* accessible via alternative measurement approaches based on "spin noise", in which the intrinsic spin fluctuation spectra of the spins – if measurable – also reveal this dynamical information, in accord with the Fluctuation-Dissipation Theorem. In general, spin noise signals scale favorably as the number of measured spins *N* decreases (falling only as sqrt(N)), suggesting their use as viable probes of few-spin systems.



- We measure spin noise in ensembles of InGaAs QDs at low temperatures. We employ a spin noise spectrometer based on a sensitive optical Faraday rotation magnetometer that is coupled to a digitizer and field-programmable gate array, to measure and average noise spectra from 0–1 GHz continuously in real time with sub-nanoradian/root-Hz sensitivity (see Figure). Both electron and hole spin fluctuations generate distinct noise peaks, whose shift and broadening with magnetic field directly reveal their g factors and dephasing rates within ensemble. Large, energy-dependent anisotropies of the in-plane hole *g*-factor are clearly exposed, reflecting systematic variations in the average QD confinement potential.