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Charge and spin noise from semiconductor quantum dots

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Improving the quantum coherence of solid-state systems that mimic two-level atoms, for instance spin qubits or single-photon emitters using semiconductor quantum dots, involves dealing with the noise inherent to the device. Charge noise results in a fluctuating electric field, spin noise in a fluctuating magnetic field at the location of the qubit, and both can lead to dephasing and decoherence of optical and spin states. We investigate noise in an ultrapure semiconductor device using a minimally invasive, ultrasensitive local probe: resonance fluorescence from a single quantum dot. We distinguish between charge noise and spin noise through a crucial difference in their optical signatures. Noise spectra for both electric and magnetic fields are derived from 0.1 Hz to 100 kHz. The charge noise dominates at low frequencies, spin noise at high frequencies. The noise falls rapidly with increasing frequency, allowing us to demonstrate transform-limited quantum-dot optical linewidths by operating the device above 50 kHz.