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Charge noise and spin noise in a semiconductor qubit RICHARD WARBURTON, ANDREAS KUHLMANN, JULIEN HOUEL, Department of Physics, University of Basel, Switzerland, ARNE LUDWIG, ANDREAS WIECK, Ruhr University Bochum, Germany — Developing semiconductor spin qubits involves dealing with noise. Spin noise arising from the fluctuating nuclear spins results in electron spin dephasing and decoherence. Charge noise also results in dephasing and decoherence via the spin-orbit interaction and the electric field dependence of the g-factors. We have used resonance fluorescence from a single optically-active quantum dot as a local, minimally-invasive probe of the noise. Our technique is sensitive to 4 decades of noise over 6 decades of frequency. We present a method which allows us to distinguish between charge noise (a fluctuating electrostatic potential) and spin noise (a fluctuating effective magnetic field): we show how the two noise sources result in different optical signatures. The charge noise dominates at low frequencies, the spin noise at higher frequencies. The charge noise spectrum following neither a Lorentzian nor a 1/f-behaviour can be understood by considering an ensemble of 2-level fluctuators located close to the quantum dot. Crucially, both sources of noise decrease rapidly with increasing frequency. The consequences for the quantum dot are profound: at high frequencies (above 10 kHz) the noise is sufficiently small that we achieve ideal optical linewidths (the Fourier transform limit).

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