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Cavity Exciton-Polariton mediated, Single-Shot Quantum Non-Demolition measurement of a Quantum Dot Electron Spin SHRUTI PURI, PETER MCMAHON, YOSHIHISA YAMAMOTO[1], E. L. Ginzton Laboratory, Stanford University, Stanford, California 94305, USA — The quantum non-demolition (QND) measurement of a single electron spin is of great importance in measurement-based quantum computing schemes. The current single-shot readout demonstrations exhibit substantial spin-flip backaction. We propose a QND readout scheme for quantum dot (QD) electron spins in Faraday geometry, which differs from previous proposals and implementations in that it relies on a novel physical mechanism: the spin-dependent Coulomb exchange interaction between a QD spin and optically-excited quantum well (QW) microcavity exciton-polaritons. The Coulomb exchange interaction causes a spin-dependent shift in the resonance energy of the polarized polaritons, thus causing the phase and intensity response of left circularly polarized light to be different to that of the right circularly polarized light. As a result the QD electron's spin can be inferred from the response to a linearly polarized probe. We show that by a careful design of the system, any spin-flip backaction can be eliminated and a QND measurement of the QD electron spin can be performed within a few 10's of nanoseconds with fidelity 99:95%. This improves upon current optical QD spin readout techniques across multiple metrics, including fidelity, speed and scalability.

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