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Single spins in diamond: polarization, readout, and coherent control¹

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The Nitrogen-Vacancy (N-V) color center in diamond is well suited for studying electronic and nuclear spin phenomena, since its spin state can be both initialized and read out optically. Moreover, N-V center spins may allow for quantum information processing, as measurements have shown long room-temperature electron spin coherence times well into the microsecond regime. Here, we report on recent experimental progress towards coherent control and coupling of single spins in diamond. Using magneto-photoluminescence imaging and electron spin resonance (ESR) measurements at room temperature, we have investigated single N-V center spins that are coupled to electron spins of nearby nitrogen (N) defects. These N spins are optically inactive ('dark'), but can be detected via the N-V center, as the N-V and the N spins are coupled via the magnetic dipolar interaction. Some of the N-V centers are strongly coupled to only one single N spin, allowing the controlled polarization and readout of this single 'dark' N spin³. From time-resolved pump-probe measurements we find the relaxation time of the single N electron spin to be 75 microseconds at room temperature. More recently, we have demonstrated the coherent control of the N-V center spin using optical detection of pulsed ESR and spin echo techniques⁴. Using these tools at different static magnetic fields, we have found that the main source of decoherence for the N-V center spins in our sample is the dipolar coupling to the surrounding bath of N spins. These results pave the way towards room-temperature coherent control of coupled spin states in diamond.

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