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Excited-State Spectroscopy and Control of Single Spins in Diamond[1]

G.D. FUCHS[2], Center for Spintronics and Quantum Computation, University of California, Santa Barbara, CA

Nitrogen Vacancy (NV) defect centers in diamond are a promising system for spin-based applications in quantum information and communication at room temperature. Using a combination of optical microscopy and spin resonance, the spin of individual NV centers can be initialized, manipulated and read out. These techniques have been used to study the long room temperature spin coherence times of NV centers as well as their interactions with nearby electrical and nuclear spins. There remain significant challenges, however, both in understanding the physics of these defects as well as the development of technologies based on their quantum properties. In particular, knowledge of the detailed structure of the orbital excited-state, which continues to be an active research area, is critical to ultra-fast quantum control schemes. Here we present recent experiments using single-spin resonant spectroscopy of the excited-state of an NV center at room temperature.[3] We observe these spin levels over a broad range of magnetic fields allowing for a direct measurement of the zero-field splitting, g-factor and transverse anisotropy splitting. The latter of these is nearly zero in the ground-state spin levels, but plays an important role in the excited-state. In addition, we find strong hyperfine coupling between the nitrogen nuclear spin and the NV electronic spin in the excited-state. These findings will be discussed in the context of quantum control of single and coupled spins in diamond.

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[2]In collaboration with V. V. Dobrovitski, R. Hanson, A. Batra, C. D. Weis, T. Schenkel, and D. D. Awschalom.

[3]G. D. Fuchs, V. V. Dobrovitski, R. Hanson, A. Batra, C. D. Weis, T. Schenkel, and D. D. Awschalom, *Phys. Rev. Lett* **101**, 117601 (2008).