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Quantum Diamond Spectrometer for Magnetic Field Sensing

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We build a quantum diamond spectrometer (QDS), outlined by Bucher et. al [1], to study the fluorescence of the nitrogen-vacancy (NV) center in diamond, a quantum defect that can be used as a qubit or quantum sensor. The QDS has several advantages to a traditional confocal microscopy, particularly in terms of measurement speed. The setup consists of a green laser excitation onto the diamond that is placed on an optical light guide for fluorescence detection. A microwave loop is then placed onto the diamond to deliver oscillating magnetic field to probe the NV center transition. Finally, permanent magnets are attached to a kinematic stage for tuning the transition energy of the NV center. With this setup, we can adjust the magnet distance, azimuthal angle, and polar angle with reference to the NV center axis for optimizing NV center fluorescence. We demonstrate measurements of NV center fluorescence as a function of microwave frequency and show the intensity drop at 2.87 GHz, showing the interaction at zero-field splitting, and measurements of the Zeeman splitting of NV center electronic spin from an external magnetic field in different orientations. The results can be used to perform vector magnetometry, which has potential applications in quantum sensing.

[1]. Bucher, D.B., Aude Craik, D.P.L., Backlund, M.P. et al. Quantum diamond spectrometer for nanoscale NMR and ESR spectroscopy. Nat Protoc 14, 2707–2747 (2019).

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