

Fiber Integrated Nitrogen Vacancy Probes: Magnetic Gradiometry and Stimulated Fluorescence Quenching

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Nitrogen-vacancy (NV) color centers in diamond have proven to be a robust solid-state quantum system. We leverage this unique system which allows us to manipulate and polarize an electron spin at room temperature using optical radiation to create a compact dual core fiber magnetic gradiometry probe. Magnetic gradiometry measurements have the advantage that they are insensitive to spatially uniform magnetic field backgrounds while still allowing high-spatial resolution variations in magnetic fields. Our previous work used two separate fibers to preform gradiometry measurements with a spatial resolution of 0.5 mm [1]. By integrating the two fibers into a single dual core photonic crystal fiber (see Fig. 1) we have increased the spatial resolution of our gradiometry measurements to 4 microns.

We also are reporting an observed stimulated fluorescence quenching seen in our system when we illuminate the NV diamond with infrared light [2]. We see that an increase in infrared power results in a decrease in ODMR photoluminescence (see Fig 2). This result can open a path toward a novel stimulated emission depletion (STED) regime for super-resolution microscopy.

- [1] S M Blakley, I V Fedotov, S Ya Kilin, and A M Zheltikov. Room-temperature magnetic gradiometry with fiber-coupled nitrogen-vacancy centers in diamond. *Optics Letters*, 40(16):3727, aug 2015.
- [2] S. M. Blakley, A. B. Fedotov, J. Becker, N. Altangerel, I. V. Fedotov, P. Hemmer, M. O. Scully, and A. M. Zheltikov. Stimulated fluorescence quenching in nitrogenvacancy centers of diamond: temperature effects. *Optics Letters*, 41(9):2077, may 2016.

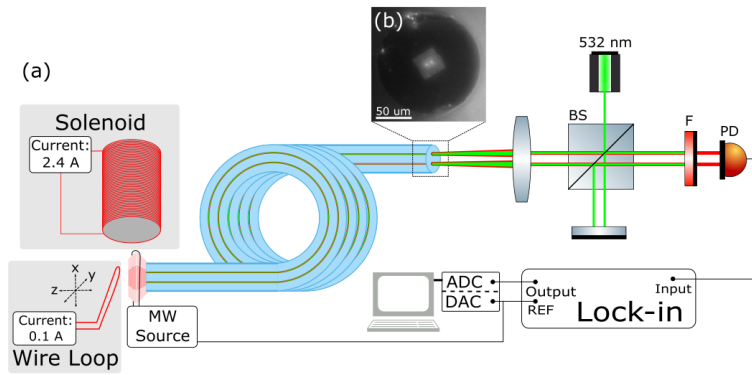


Figure 1: (a) A schematic of the dual core fiber gradiometry experiment. We used a beam splitter (BS) to split the ND:YAG 532 nm pump laser into each fiber core. The NV fluorescence was isolated using a long-pass filter (F) and collected on a photodiode (PD). The optically detected magnetic resonance (ODMR) spectrum was measured using lock-in detection observed as dips in NV fluorescence collected at PD. (b) An image of the dual core photonic crystal fiber with 4 μm spacing between cores.

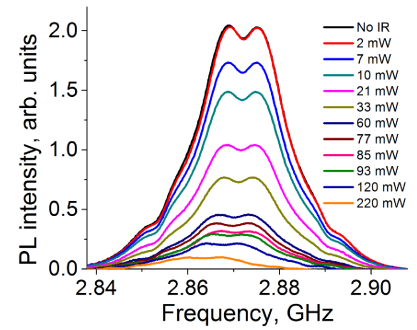


Figure 2: NV ODMR spectra measured in the presence of both the 532 nm pump and infrared radiation. We keep the pump power constant and vary the infrared power from 2 to 220 mW. Fluorescence quenching is seen as infrared power increases.