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

Joe Becker[1], Sean Blakley[1], Ilya Fedotov[1,2,3], Andrey Fedotov[1,2,3], and Aleksei M. Zheltikov[1,2,3]

[1] *Department of Physics and Astronomy, Texas A&M University, College Station, TX 77843-4242 USA*
[2] *Physics Department, Intl. Laser Center, M. V. Lomonosov Moscow State University, Moscow 119992, Russia*
[3] *Russian Quantum Center, Skolkovo, Moscow Region 143025, Russia*

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 measurements of 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.

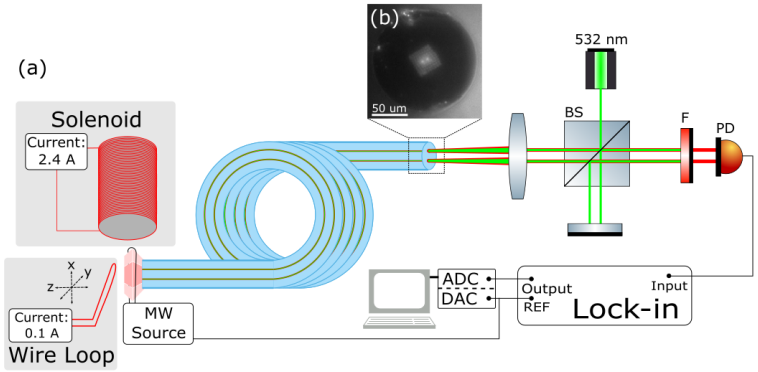

Figure 1: (a) A schematic of the dual core fiber gradiometry experiment. We used a beam splitter (BS) to split the ND:YAG 532 nm pump laser into each fiber core. The NV fluorescence was collected using the same fiber then isolated using a long-pass filter (F) and collected on a photodiode (PD). The optically 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.

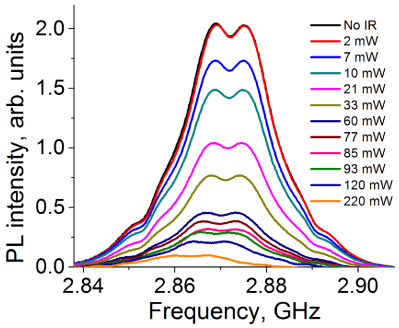

Figure 2: NV ODMR spectra measured in the presence of both the 532 nm pump and infrared radiation. We keep the pump power constant and vary the infrared power from 2 to 220 mW. Fluorescence quenching is seen as infrared power increases.