Characterization of Color Center in Diamond for Quantum Sensing

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2nd Cycle Integrated Project in Engineering Physics

Nieder group | Ultrafast Bio- and Nanophotonics

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Motivation

2025: International Year of Quantum Science and Technology

Health & Wellbeing: Quantum photonics is advancing medical imaging and diagnosis

Quantum sensors in biomedical applications: magnetometry based on nitrogen-vacancy (NV) centers in diamond

Why?

- **Diamond's biocompatibility and chemical inertness**
- **The stability of NV centers over a wide range of conditions**
- **Integration of NV centers into devices with short sensor-to-sample distances**

Proposed Worked

- **NV color centers will be characterized to evaluate their suitability for sensing applications**
- **NV centers created with 3 distinct methods: ion implantation, high-temperature irradiation and femtosecond laser processing**

Main goal: Investigate how the fabrication techniques influence the NV properties

1st - Fluorescence Characterization of NV Centers in Diamond

2nd - Application: Magnetic Sensing with NV Centers

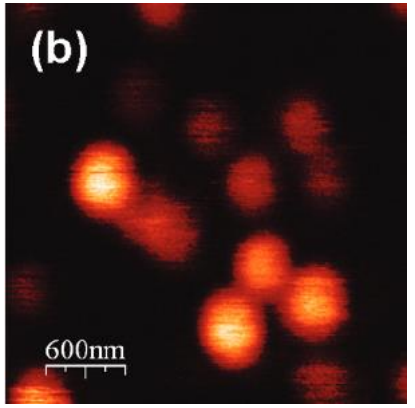
Fluorescence Characterization Techniques

Spectrally Resolved Emission Spectroscopy

1st: NV centers are excited using green light

2nd: The emitted light is recorded as a function of λ

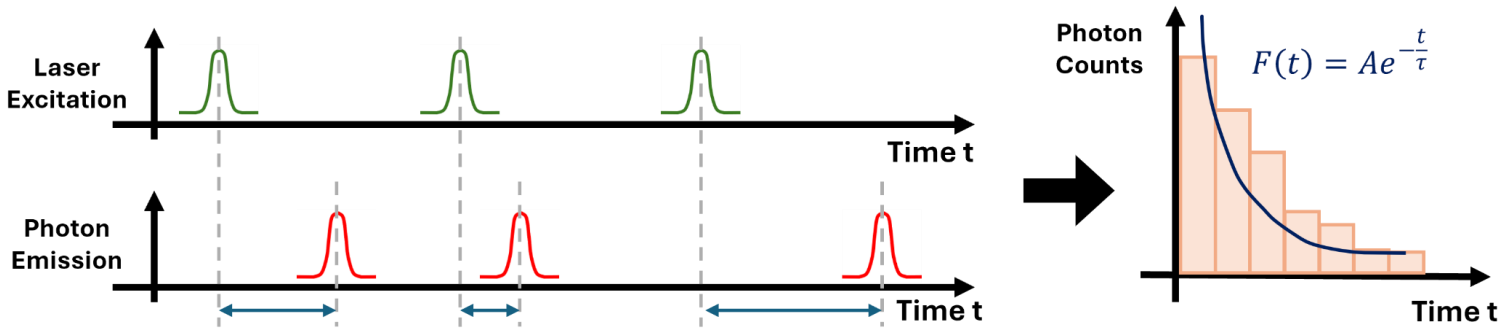
Fluorescence Spectrum

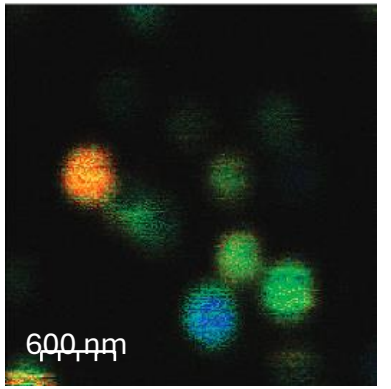


S. J. Tisler *et al*, ACS Nano 2009

Fluorescence Lifetime Spectroscopy

Fluorescence lifetime: average time that an NV^- center remains in the ES

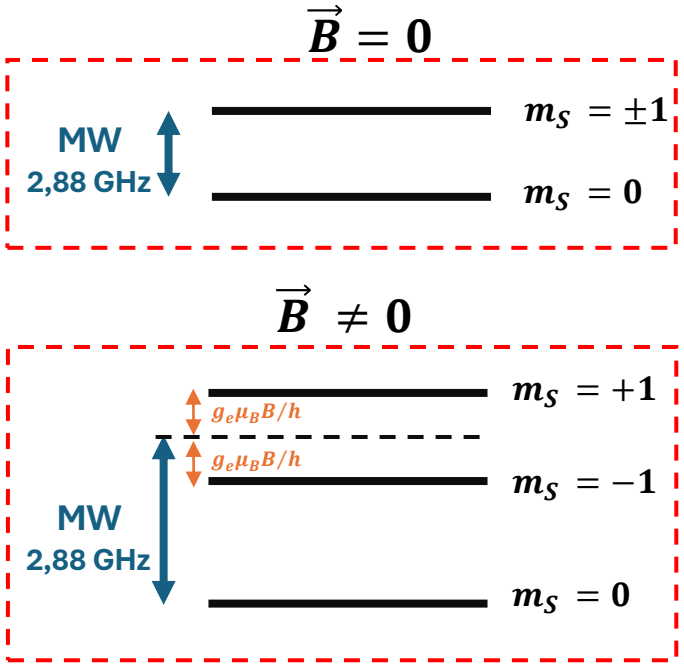


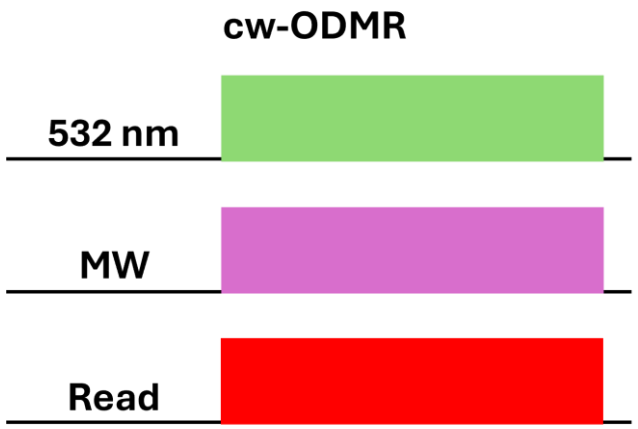


S. J. Tisler *et al*, ACS Nano 2009

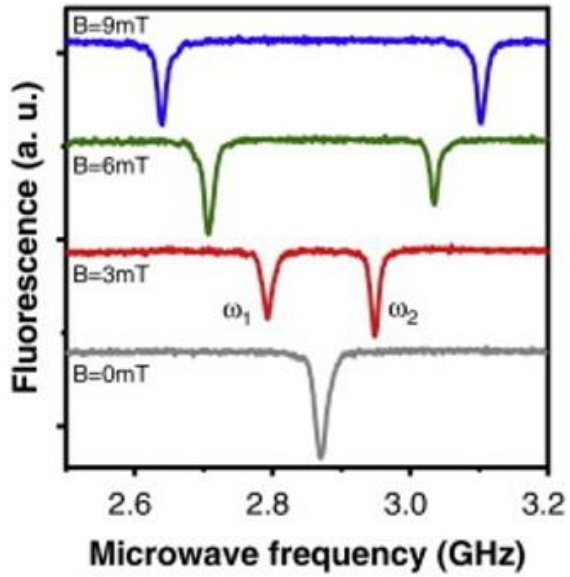
Optically Detected Magnetic Resonance (ODMR)

- It probes the electronic properties of the NV^- center
- Main protocol → continuous-wave ODMR:





G. Balasubramanian *et al*, COCHBI 2016



Thank you

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