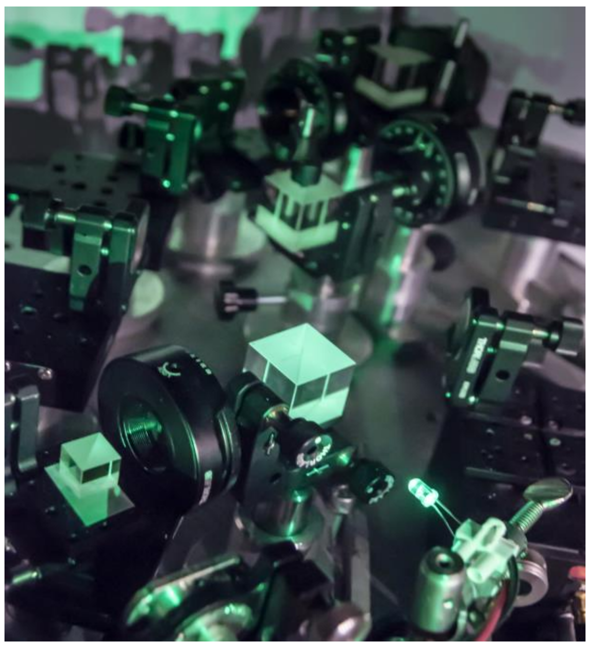
# Q@TN
# Colloquium



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# Shallow silicon vacancy centres with lifetime-limited optical linewidths in diamond nanostructures

**February 02, 2024 – h 14:00**

**Aula A102 – Povo 1 – Via Sommarive n. 5**

Abstract:

Silicon vacancy centres (SiV), especially negatively charged SiV (SiV-), in diamond is a promising, yet underexplored candidate for single-spin quantum sensing. The advantages over other wellestablished quantum sensors are twofold.
First, their stability, excellent optical properties and long spin coherence time at cryogenic temperature extend the applicability of diamond-based quantum sensors at sub-kelvin temperatures and tesla-range magnetic fields.
Second, it offers the option of all-optical manipulation of its spin states, allowing the application where the use of microwaves is restricted.
A key ingredient for such applications is the ability to perform all-optical, coherent addressing of the electronic spin of single, near-surface SiV- centres. Here, we present a robust and scalable approach for creating individual, ~50 nm deep SiV- with lifetime-limited optical linewidths in diamond nanopillars through an easy-to-realize and persistent optical charge-stabilization scheme. [1,2,3]
The latter is based on prolonged 445 nm laser illumination that enables continuous photoluminescence excitation spectroscopy without the need for any further charge stabilization or repumping.
Our results constitute a key step toward the use of near-surface, optically coherent SiV- for sensing under extreme conditions, and offer a powerful approach for stabilizing the charge-environment of diamond colour centres for quantum technology applications. Moreover, owning to the narrow linewidth of our SiV, we demonstrate that individual, spectrally distinct SiVs among a small ensemble in a nanopillar can be addressed with resonant excitation, expanding the range of usefulness of diamond probes.
Meanwhile, photon correlation measurements upon different resonant excitation reveal the orbital population dynamics within the fine structure ofSiV-.
The combination of antibunching and bunching dynamics in the SiV resonant fluorescence autocorrelation trace is elucidated through the incorporation of the quantum regression theorem and the solution of the Lindblad master equation for a four-level system.

References

1. H. Natascha, et al. Phys. Rev. Applied 14 (2020), 064007
2. R. E. Evans, et al. Phys. Rev, Applied 5 (2016), 044010
3. J. A. Zuber, M. Li, et al., Nano Lett. 23 (2023), 10901–10907

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