Quantum optics with color centers in hBN

Aymeric Delteil
C. Fournier, D. Gérard, A. Nuñez, J. Barjon, S. Buil, J.-P. Hermier
Université Paris-Saclay, UVSQ, CNRS, GEMaC, 78000 Versailles, France
aymeric.delteil@uvsq.fr

Solid-state quantum emitters are key building blocks for scalable quantum technologies, including communication, computing, and sensing. Wavelength reproducibility and optical coherence are essential for applications based on indistinguishable photons. High-quality single-photon sources in van der Waals materials further offer promising opportunities for integration.

We recently demonstrated the local generation of quantum emitters ("B centers") in hexagonal boron nitride (hBN) with reproducible wavelength and high-quality photophysics in the visible range [1]. The B centers are created by local irradiation in a scanning electron microscope. They exhibit narrow and reproducible spectra, with a stable and bright emission in the visible range.

I will present their photophysical properties and optical control, including coherence, indistinguishability and quantum efficiency, inferred using quantum optics techniques, such as resonant laser excitation combined with photon correlations, resonance fluorescence, Hong-Ou-Mandel interference and the Purcell effect. I will also present their controlled integration into monolithic photonic devices. Altogether, the controlled generation of coherent quantum emitters in a 2D material opens appealing perspectives in quantum photonics, with applications in optical quantum technologies.

References

[1] C. Fournier *et al.* Nature Communications **12**, 3779 (2021)
[2] C. Fournier, *et al.*, Phys. Rev. B **107**, 195304 (2023)
[3] D. Gérard, S. Buil, J.-P. Hermier, A. Delteil, Phys. Rev. B **111**, 085304 (2025)
[4] D. Gérard *et al.*, Nature Communications **17**, 1843 (2026)

Figures

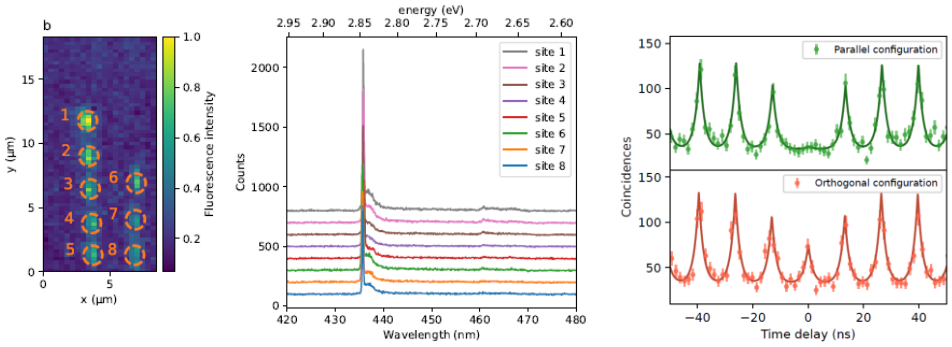

Figure 1: (a) Confocal photoluminescence map showing color center luminescence in 8 irradiation sites. (b) Emission spectra of the eight sites, revealing similar narrow emission lines. (c) Hong-Ou-Mandel interference of zero-phonon line photons showing high indistinguishability.