Master QLMN (Quantum, Light, Materials and Nano Sciences)

Proposition de stage / Internship proposal

Date de la proposition :November 1st 2022

Responsable du stage / internship supervisor:

Nom / *name*: VEST Prénom/ *first name* : Benjamin

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Nom du Laboratoire / *laboratory name*:

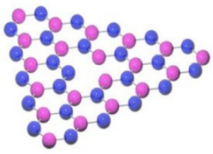
Etablissement / *institution* : Lab. Charles Fabry Code d'identification : UMR 8501

Site Internet / *web site*: https://www.lcf.institutoptique.fr/en/quantumnano

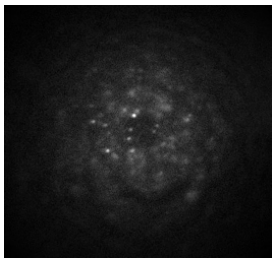
Lieu du stage / *internship place*: 2 av Fresnel, 91127 Palaiseau

Titre du stage / *internship title*: **Quantum light emission with color centers in 2D materials**

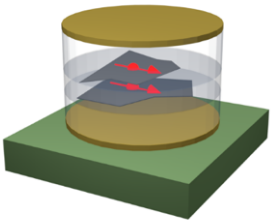
The most elementary quantum state of light is a single photon. Emission of a single photon can be achieved using a two-levels system and controlling its excitation. An important issue is to control the emission mode and the emission time. This can be achieved by **controlling the environment and the excitation of the emitter.**



Hexagonal Boron Nitride (h-BN) is a 2D material that hosts colored centers emitting single photons in the visible range. To avoid dephasing processes and obtain a narrow emission line called zero phonon line (ZPL), it is usually required to operate single photon sources at cryogenic temperatures. h-BN has the remarkable property of displaying a very large ZPL at ambient temperature making it a good candidate for single photon emission in less constraining temperature conditions[1].



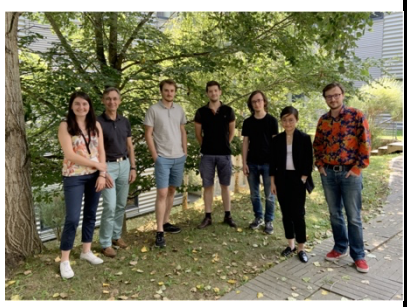
Moreover, the 2D nature of hBN enables to envision original strategies to achieve coupling between color centers and nanostructures for the control of single photon emission via Purcell effect. Micro-manipulation of 2D materials is well-known, and is based on the use of transfer stations to build 2D heterostructures. These methods however do not incorporate imaging techniques enabling the localization of defects while they are manipulated. **The goal of the internship is to develop a setup dedicated to the characterization of quantum light emission via scanning confocal mapping samples. This setup will be designed in order to implement functionalities that will combine, on the same instrument, functionalities dedicated to the manipulation of 2D layers containing emitters, and localization of the very same emitters.**



The longer term goal of the project is **to demonstrate deterministic positioning of emitters around nanostructures** with unprecedented accuracy in order to fabricate complex structures. For instance, one could stack two emitters in close proximity to control spontaneous emission. Their mutual coupling provides a means to control in time domain the emission [2] : this single photon emitting system with an adaptable bandwidth could be useful to build quantum memories, able to store and release quanta on demand.

A PhD can follow the internship, and will investigate the indistinguishability of the photon flux [3], as well as the control of spontaneous emission from hBN with engineered nanostructures.

About us : The Quantum Nanophotonics and Plasmonics team investigates **the physics and engineering of spontaneous light emission** (fluorescence, incandescence, electroluminescence, at different scales (quantum regime with single photon and single atoms, condensates, collective effects, photon condensates, condensed matter).



[1] Tran, T. T., et al.. (2016). Quantum emission from hexagonal boron nitride monolayers. *Nature nanotechnology*, *11*(1), 37-41.

[2] Shlesinger, et al. (2019). Time-Frequency Encoded Single-Photon Generation and Broadband Single-Photon Storage with a Tunable Subradiant State, Optica 8, 95 (2021).

[3]Akbari et al (2022), «Lifetime-Limited and Tunable Quantum Light Emission in h-BN via Electric Field Modulation » Nano Lett.2022, 22, 19, 7798–7803 ; https://doi.org/10.1021/acs.nanolett.2c02163

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : YES**

Si oui, financement de thèse envisagé ou acquis / *financial support for the PhD* **?**

Requested funding	***X***	*Doctoral school competitive exam grant*	***X***