Proposition de stage / Internship proposal

For Master QLMN (Quantum, Light, Materials and Nano Sciences)
or similar Master tracks

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

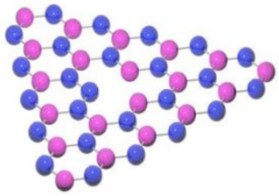
Site Internet / *web site*: https://www.lcf.institutoptique.fr/groupes-de-recherche/nanophotonique/themes-de-recherche/plasmonique-et-nanophotonique-quantique

Adresse / *address:* 2 av Fresnel, 91127 Palaiseau

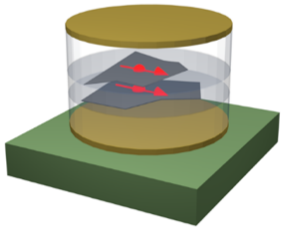
Lieu du stage / *internship place*: 2 av Fresnel, 91127 Palaiseau

Titre du stage / *internship title*: **Quantum light emission with colored centers in 2D materials – towards a quantum memory**

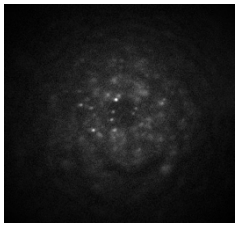
The most elementary quantum state of light is a single photon. Emission of a single photon can be achieved using a t levels system and controlling its excitation. An important issue is to control the emission mode and the emission time. T can be achieved by **controlling the environment and the excitation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



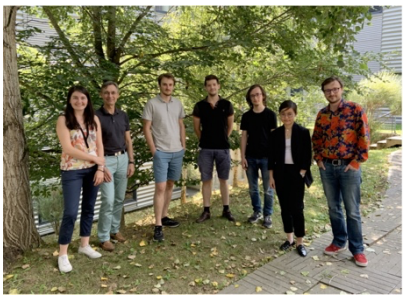
Hexagonal Boron Nitride (h-BN) is a 2D material that hosts colored centers emitting single photons in the visible range. In order to avoid dephasing processes and obtain a narrow emission line called zero phonon line (ZPL), it is usually required to operate single photon sources at cryogenic temperatures. 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].



The final goal of the project is to insert two emitters in close proximity in a cavity in order to take advantage of two effects to control spontaneous emission: coupling to the cavity and collective emission of the two coupled emitters. The **cavity** is useful to collect efficiently the mode, the strong **coupling with a second emitter** 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.



The goal of the internship is to develop a setup **to characterize quantum light emission and to perform localization microscopy of the hBN centers, in order to later implement possibilities to manipulate transfer and assemble hBN color centers with nanostructures**. If time allows, the candidate will also contribute to the design of nano-structures dedicated to the control of spontaneous emission of defect centers.



A PhD can follow the internship with two parts : a) Quantum light emission by colored centers in hBN b) Quantum metamaterials for light emission.
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 Subradiar State, Optica 8, 95 (2021).

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* **?**

Bourse EDOM ou JCJC