Master 2: *International Centre for Fundamental Physics*

INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: Laboratoire Charles Fabry, Institut d'Optique
CNRS identification code: UMR 8501
Internship director'surname: GREFFET Jean-Jacques / VEST Benjamin
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Internship location: Laboratoire Charles Fabry 2 av Fresnel, 91127 Palaiseau
Thesis possibility after internship: **YES**
Funding: **TBD** which type of funding: EDOM doctoral school grant

Title : Quantum light emission with colored centers in h-BN.

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 two dimensional material that may host colored centers emitting in the visible. It has been shown that these centers can emit single photons. Most colored centers emitters have a broad emission spectrum due to the concomitant emission of phonons. In order to avoid this dephasing process and obtain a narrow emission line called zero phonon line (ZPL), it is usually required to operate 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 goal of the internship is to develop a setup to study light emission by the h-BN centers. The confocal setup will image the sample to localize the emitting centers. It will be coupled to a high-resolution spectrometer. A setup to measure the intensity correlations with single photon detectors will also be implemented. If time permit, we will explore possible techniques to tune the emission frequency.

The final goal 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].

A PhD can follow the internship with two parts:
- Quantum light emission by colored centers in hBN.
- Quantum metamaterials for light emission.

[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 sources and broadband quantum memories based on a tunable one-dimensional atom. *arXiv preprint arXiv:1905.06912*.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics:	**YES**	Soft Matter and Biological Physics:	**NO**
Quantum Physics:	**YES**	Theoretical Physics:	**NO**