INTERNSHIP PROPOSAL

(One page maximum)

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Thesis possibility after internship: **YES**
Funding: **SECURED** If YES, which type of funding: **ANR**

Controlling artificial atoms with light in hexagonal boron nitride

Hexagonal boron nitride is an ultrawide-bandgap semiconductor with fascinating properties. Besides its widespread use as a passive 2D material in graphene devices and van der Waals heterostructures [Gei13], hexagonal boron nitride is also emerging as an exciting material in its own right, offering novel material properties that enable a broad range of optical, electro-optical and quantum optics functionalities in various spectral domains. It is a natural hyperbolic material in the mid-infrared range, it hosts defects that can be engineered for single-photon emission and quantum sensing in the visible domain, and it exhibits exceptional performances in the deep-ultraviolet for a new generation of emitters and detectors in the UV-C range [Cal19]. In this rapidly expanding context, the controlled incorporation of impurities is still in its infancy while being a major issue, on the one hand for the creation of artificial atoms for quantum technologies, and on the other hand for classical applications where doping is required.

The aim of this project is to understand and control a newly discovered effect of photo-assisted activation of impurities in hexagonal boron nitride. Recent photo-conductivity measurements [Per23] have revealed a striking persistence of the conductivity of hexagonal boron nitride when the illuminating laser is switched off, thus pointing out for a photo-induced modification of the structure of the artificial atom itself. Complementary electrical and optical experiments will be performed by means of the worldwide unique scanning confocal cryo-microscope developed in Montpellier and operating at the diffraction limit in the UV-C spectral range, at wavelengths down to 200 nm [Val20,Rou21]. Experiments will be compared to advanced *ab initio* calculations for testing local photo-induced relaxation effects of the host lattice.

[Gei13] A. K. Geim and I. V. Grigorieva, Nature 499, 419 (2013).
[Cal19] J. Caldwell, I. Aharonovich, G. Cassabois, J. Edgar, B. Gil, and D . Basov, Nat. Rev. Mat. 4, 552 (2019).
[Per23] A. Perepeliuc *et al.*, App. Phys. Lett. 122, 263503 (2023).
[Val20] P. Valvin, T. Pelini, G. Cassabois, A. Zobelli, J. Li, J. H. Edgar, and B. Gil, AIP Adv. 10, 075025 (2020).
[Rou21] A. Rousseau, L. Ren, A. Durand, P. Valvin, B. Gil, K. Watanabe, T. Taniguchi, B. Urbaszek, X. Marie, C. Robert, and G. Cassabois, Nano Lett. 21, 10133 (2021).

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