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Master thesis proposal

Title: Controlling artificial atoms with light in hexagonal boron nitride

Keywords: point defects, photo-doping, boron nitride

Scientific description: 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.

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Techniques/methods in use: Optics / Microscopy / UV
Applicant skills: background in condensed matter physics, quantum physics, and optics.
Industrial partnership: No
Internship supervisor: Guillaume CASSABOIS, guillaume.cassabois@umontpellier.fr
Internship location: Team « Solid-State Quantum Technologies », Laboratoire Charles Coulomb, Montpellier.
Possibility for a Doctoral thesis: **Yes (secured funding)**