Spécialité de Master « Optique, Matière, Paris »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 17/10/2018

Responsable du stage / *internship supervisor*: **François Fras**

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Nom du Laboratoire / *laboratory name*:

Code d'identification :UMR 7504 — Organisme :CNRS -Université de Strasbourg

Site Internet / *web site*: http://www.ipcms.unistra.fr/

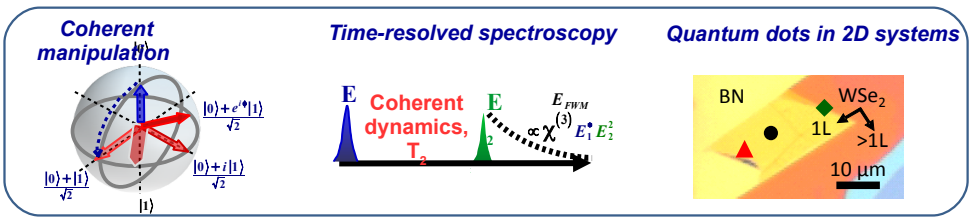
Adresse / *address:* IPCMS Département d'optique ultra-rapide et de nanophotonique

Lieu du stage / *internship place*: Strasbourg

Titre du stage / *internship title*: **Quantum properties of single Qbits confined in 2D materials**

Quantum dot (QD) solid-state systems, confined in the three dimensions, are candidates of choice for the realization of robust Qbits and efficient single photon emitters. These building blocks play a central role in the emerging field of quantum science and technologies such as light flux metrology, boson sampling, quantum secure communication schemes and quantum linear simulation [1]. Additionally such systems are of great interest for fundamental quantum optics experiments.

In this context, the recent discovery [2] of quantum dots hosted in two dimensional materials (2DM) opens appealing perspectives: (i) they inherit exceptional properties from 2D materials (strong light-matter interaction, photon-extraction efficiency, tunable properties), and (ii) they offer a strong potential for quantum behavior and single photon emission at room temperature, which is essential for practical implementation of quantum technologies. Still, although QDs in 2DM generate considerable interest, their fundamental and coherent properties, and the control of the latter deserve further exploration.



(Left) Coherent control and evolution of the quantum state represented in the Bloch sphere. (Middle) Scheme of the corresponding time-resolved experiments in four-wave mixing configuration (Right) Quantum dots hosted at the interface of hBN and WSe2 monolayers (data provided by S. Lorchat and S Berciaud).

Our projects aims to investigate the quantum behavior of single QDs hosted in 2DM. In particular we will explore the light-matter interaction at a nanometer scale and the coherent dynamics of the excitonic Qbits. We will study the role played by the crystalline environment in the decoherence processes of Qbits. The possibility to highlight and manipulate quantum couplings between distinct quantum dots will be also investigated.

Nevertheless, accessing such intrinsic properties at a single system level remains a great challenge. To this end, a fore-front time-resolved optical experiment based on spectral interferometry and optical heterodyning [3, 4], will be performed and developed. Such an experiment allows to probe and address resonantly single quantum states with ultrafast optical pulses.

Our project also involved theoretical and modelisation aspects concerning decoherence processes and optical quantum manipulations. The internship student will be fully involved in the experimental part. According to her/his motivation the trainee could also take part in the theoretical aspects.

[1]N. Aaronson *et al.* Proc. 43rd Annual ACM Symposium on Theory of Computing 333–342 (ACM, 2011)

[2]A. Srivastava *et al. Single photon emitters in exfoliated WSe2 structures* Nature Nanotechnology 10, 491 (2015)

[3] F. Fras *et al Multi-wave coherent control of a solid-state single emitter* Nature Photonics 10, 155–158 (2016)

[4]D Wigger *et al. Exploring coherence of individual excitons in InAs quantum dots ..* Phys. Rev. B 96, 165311 (2017)

Toutes les rubriques ci-dessous doivent obligatoirement être remplies

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

Si oui, financement de thèse envisagé/ *financial support for the PhD*: **Doctoral school ED182**

Lumière, Matière, Interactions	**Yes**	Lasers, Optique, Matière	**Yes**

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