

Research Topic for the ParisTech/CSC PhD Program

***Field : Physics, Optics**

Subfield: Quantum technologies

Title: Controlling spontaneous emission of quantum emitters

ParisTech School: Institut d'Optique Graduate School

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Short description of possible research topics for a PhD:

Recent progress in the field of nanophotonics allow controlling spontaneous emission of light by atoms or molecules using subwavelength systems such as cavities or antennas. This line of research allows designing systems to generate single photon sources that will be used for implementing quantum technologies and study fundamental aspects of light matter interaction at the nanoscale. We have recently explored the possibility to perform quantum optics using surface waves propagating along metal-vacuum interfaces called surface plasmons [1,2]. We have also explored the possibility to tune light emission by quantum dots using plasmonic antennas [3,4].

The project of this PhD is to develop a new line of research exploring light emission by defects in h-BN. h-BN is a 2D material analogous to graphene. In these systems, it has been discovered recently that vacancies can produce localized defects which can be used as single photon sources with remarkable properties. In particular, these systems are extremely bright and can be used at ambient temperature, two key advantages as compared to NV centers in diamond. However, little is known about these defects. We will explore how it is possible to control the polarization, lifetime and emission direction of these emitters using nanostructures playing the role of nanoantennas.

Required background of the student:

We are seeking a highly motivated student with a master in Physics. The physics involved in the topic includes optics, nanophotonics and quantum optics.

The student will do numerical modelling of the electromagnetic fields in a nanostructure, nanofabrication in a clean room of the emitters and the nanoantennas, single photon measurements (spectroscopy, correlation measurements).

List of 5(max.) representative publications of the group:

1. Single-plasmon interferences, MC Dheur, E. Devaux, T.W. Ebbesen, A. Baron, JC Rodier, JP Hugonin, P. Lalanne, JJ Greffet, G. Messin, F. Marquier, *Science Advances* **2**, e1501574 (2016).
2. Anti-coalescence of bosons on a lossy beam splitter, B. Vest, M.C Dheur, E. Devaux, A. Baron, E. Rousseau, J.P. Hugonin, J.J. Greffet, G. Messin, F. Marquier, *Science* **356**, 1373 (2017)
3. Non-blinking quantum dot with a plasmonic nanoshell resonator
Botao Ji et al. *Nature Nanotechnology* **10**, p 170 (2015)
4. Controlling Spontaneous Emission with Plasmonic Optical Patch Antennas, C. Belacel et al. *Nanoletters* **13**, p 1516 (2013) **DOI:** 10.1021/nl3046602