# Spécialité de Master « Optique, Matière, Plasmas »

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

## Proposition de stage

*Date de la proposition : 24/10/2012*


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

Nom / *name*: **AMO** Prénom/ *first name* : **ALBERTO**

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**Nom du Laboratoire** / *laboratory name*: **Laboratoire de Photonique et Nanostructures**

Code d'identification : UPR20 Organisme : CNRS

Site Internet / *web site*: http://www.lpn.cnrs.fr/fr/GOSS/CFMC.php

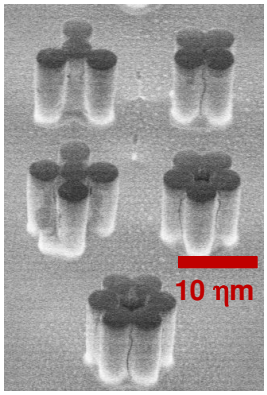
Adresse / *address:* Route de Nozay, Marcoussis

Lieu du stage / *internship place*: **Laboratoire de Photonique et Nanostructures**

**Titre du stage** / *internship title*: **Photons in a honeycomb lattice: visualising the properties of graphene**


Résumé / *summary*

Semiconductor microcavities are an excellent platform to study non-linear optical phenomena and the quantum fluid properties of boson condensates. The eigenstates of this system are polaritons, half-light/half matter particles arising from the strong coupling between excitons and photons confined in an optical cavity. Thanks to their very light mass ($10^{-4}$ times the electron mass) these bosons can form Bose-Einstein condensates at temperatures much higher than in atomic gases (10K for polaritons vs 100nK for atoms). Bose condensation is at the origin of fascinating phenomena like superfluidity, or the formation of quantized vortices and solitons, which we have recently demonstrated with polaritons (see references below).




*Hexagonal microstructure (bottom) that will be used as building block for the honeycomb lattice. The upper structures are other systems to study coupled polariton condensates.*

The technological facilities available at Laboratoire de Photonique et de Nanostructures (LPN) allow fabricating microcavities in almost any given geometry. In the framework of this internship (and follow-up thesis) we propose to study polaritons in a honeycomb lattice. The honeycomb lattice is a hexagonal structure present in materials such as graphene. Graphene is a carbon structure that has revolutionized the transport of electrons thanks to its extraordinary properties. Some of them are a linear dispersion resembling that of relativistic massless particles or ballistic transport immune to disorder. These effects are very hard to study in transport experiments of electrons in graphene sheets. With polaritons in a honeycomb lattice, we will study these exceptional properties with photonic particles and directly visualize them by looking at the light emitted from the structure. In the internship/thesis we will study ballistic transport of photons and polaritons in a graphene-like lattice, new types of photon tunnelling phenomena, and superfluidity effects.

The internship will be experimental and it will involve work in an optics microscopy laboratory at cryogenic temperatures. We are a very dynamic team including international PhD students and post-docs. Our studies will be performed in closed collaboration with theoretical groups in the framework of several national and European projects.



- "Superfluidity of polaritons in semiconductor microcavities", A. Amo et al., Nature Physics **5**, 805 (2009)
- "Spontaneous formation and optical manipulation of extended polariton condensates", E. Wertz et al., Nature Physics **6**, 860 (2010)
- "Polariton superfluids reveal quantum hydrodymic solitons", A. Amo et al., Science **332**, 1167 (2011)
- "All-optical control of the quantum flow of a polariton superfluid", D. Sanvitto et al., Nature Photonics **5**, 610 (2011)


**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***:** **European project, approval pending**

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| Lasers et matière | **YES** | Lumière, Matière : Mesures Extrêmes | **YES** |
| Optique de la science à la technologie | **YES** | Plasmas : de l'espace au laboratoire | **NO** |

*Fiche à transmettre (fichier pdf **obligatoirement**) sur le site http://stages.master-omp.fr*