Spécialité de Master « Optique, Matière, Plasmas »

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

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 06/11/2014

Responsable du stage / *internship supervisor*:

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Site Internet / *web site*: www.lpa.ens.fr

Adresse / *address:* 24 rue Lhomond, 75005 Paris

Lieu du stage / *internship place*: Ecole Normale Supérieure, 24 rue Lhomond, 75005 Paris

Titre du stage / *internship title*: **Optical spectroscopy of graphene quantum dots and nano-meshes.**

Graphene, the first truly two-dimensional material available at low cost has brought considerable breakthroughs in a number of domains ranging from high speed electronics to metrology and many others are to come. However, for some applications such as logical electronics or opto-electronics the lack of a band gap is a real issue. When a material is reduced to nanoscale dimensions, the electronic confinement induces original size-dependent properties. One famous example is the semiconductor quantum dots (QDs) where the confinement of electrons leads to a quantization of the energy levels analogous to atoms. The size reduction is not the only way to open a gap in graphene. Theoretical studies have predicted that a regular pattern of holes in 2D graphene (nano-mesh, GNM) can open a bandgap in the structure and an experimental proof based on selective etching of graphene was described recently. However, this top-down approach does not permit to control the edges and the oxidation states of GQDs, or GNMs. In order to truly control the morphology of these nano-structures at the atomic scale, the bottom-up approach is the best way to proceed. For this PhD work, we will rely on state-of-the-art samples produced through a very innovative chemical approach recently developed by our partner at CEA.

In such gapped nanostructures, giant excitonic effects can be anticipated (such as those reported in monolayer dichalcogenides), associated with large exciton binding energies and a deviation from the usual hydrogenic Rydberg series of the excitonic states. Moreover, the interaction with the environment (solvent or substrate) will lead to spectral shifts and broadening revealing the screening of coulomb interactions and associated dephasing processes, which are essential to the working of future devices based on these materials.

As it is the case for all colloidal nano-objects, ensemble measurements are subject to averaging effects that can blur out important physical effects (polarization response, homogeneous linewidth, etc.). Therefore, we will carry out temperature-dependent optical experiments at the single nano-object scale. Light intensity correlation experiments will also be carried out to test the potentiality of GQDs as single photon sources. Indeed, a real 0D confinement should lead to sub-poissonian statistics which is characterized by the antibunching behavior observed in Hanbury Brown and Twiss experiments.

The student must have a strong background in solid state physics and experimental optics and a strong motivation for experimental work.

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

Si oui, financement de thèse envisagé/ *financial support for the PhD*: **ED PIF**

Lasers, Optique, Matière	**oui**	Lumière, Matière, Interactions	**oui**
Plasmas : de l'espace au laboratoire	**non**		