Spécialité de Master « Optique, Matière, Plasmas »

Stage de recherche (4 mois minimum, à partir de début mars 2012)

Proposition de stage pour l'année 2011-2012 (ne pas dépasser 1 page)

Date de la proposition :

Responsable du stage / *internship supervisor*:

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

Code d'identification :UPR20   Organisme : CNRS

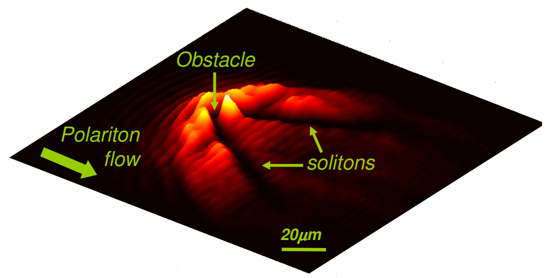
Site Internet / *web site*: **http://www.lpn.cnrs.fr/fr/GOSS/CFMC.php**

Adresse / *address:* Route de Nozay, 91460 Marcoussis

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

Titre du stage / *internship title*: **Quantum hydrodynamics of 1D polariton condensates**

Résumé / *summary*



Experimental observation of dark solitons in a 2D polariton condensate, formed when a polariton superfluid encounters an obstacle in its flowpath (ref. 4).

A fascinating property of bosons is their ability to massively occupy a single quantum state below a critical temperature. This is known as Bose-Einstein condensation and it is at the origin of superconductivity, superfluidity, or the formation of quantized vortices. Very recently, Bose-Einstein condensation has been achieved with polaritons, a new type of quasi-particles in semiconductors. Polaritons are half-light half-matter particles arising from the strong coupling between an exciton confined in a quantum well and a photon confined in a semiconductor microcavity, and can be created and manipulated with the use of laser excitation. Thanks to their extremely light mass (10^{-8} times that of the hydrogen atom) polariton condensation can be achieved at high temperatures, ranging from few kelvins to room temperature, compared to 10^{-7} K for the case of atomic condensates.

Our group has recently demonstrated polariton condensation in GaAs/GaAlAs semiconductor microcavities, and by engineering the shape of the cavities we have obtained condensation in 2D (planar microcavities), 1D (microwires) and 0D (micropillars). After these first demonstrations (ref. 1-2) we are now exploring original physical properties of condensates in 1D microwires. In this internship/PhD thesis, we propose the experimental study of the propagation of 1D polariton condensates. When encountering a potential barrier in their flowpath, the condensates develop quantized excitations. These excitations are the quantum analogue of the waves and whirlpools found in a flow of water passing around an obstacle. For instance, we plan to study the spontaneous formation of solitons (notch like density excitations –see figure for the case of a 2D polariton fluid), and the partial transmission and reflection of the condensate through the obstacle and other purely quantum mechanical process.

This work, at the front edge of international research, will be developed in collaboration with theory groups from Lasmea (Clermont-Ferrand) and Orsay, and with experimental groups from Institut d'Optique working on related subjects in atomic condensates.

[1] "Spontaneous formation and optical manipulation of extended polariton condensates", E. Wertz et al., Nature Physics **6**, 860 (2010)
[2] "Spontaneous formation of a polariton condensate in a planar GaAs microcavity", E. Wertz, et al., Appl. Phys. Lett. **95**, 051108 (2009)
[3] "Superfluidity of polaritons in semiconductor microcavities", A. Amo et al., Nature Physics **5**, 805 (2009)
[4] "Polariton superfluids reveal quantum hydrodymic solitons", A. Amo et al., Science **332**, 1167 (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*: **Project related or Ministry of Research fellowship.**

Lasers et matière	**X**	Lumière, Matière : Mesures Extrêmes	**X**
Optique de la science à la technologie	**X**	Plasmas : de l'espace au laboratoire	