Spécialité de Master « Optique, Matière, Paris »

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

Proposition de stage

Responsable du stage */ internship supervisor*: **Dr. Fabien Vialla / Pr. Natalia Del Fatti**

Tél : 04 72 44 81 82
Courriel */ mail*: fabien.vialla@univ-lyon1.fr

Nom du Laboratoire / *laboratory name*: **Institut Lumière Matière (iLM) - FemtoNanoOptics group**

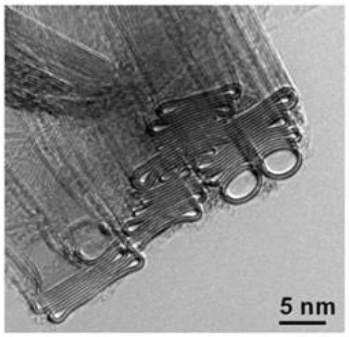
Code d'identification : UMR5306 Organisme : Université Claude Bernard Lyon 1
Site Internet / *web site*: http://ilm.univ-lyon1.fr/femtonanooptics
Adresse / *address:* Bâtiment Kastler, 10 rue Ada Byron, 69622 Villeurbanne CEDEX, France
Lieu du stage / *internship place*: Campus LyonTech-La Doua (LYON)

Optical response of a single nanostructure under extreme pressure conditions

Is it possible to "see" a nanostructure with a size much smaller than optical wavelengths? Can one perform a thorough study of its physical properties using only optical means?

In order to meet this fundamental challenge, the FemtoNanoOptics group in Institut Lumière Matière (iLM) has developed an original optical technique: **spatial modulation spectroscopy** [1]. It allows for the observation of single nanostructures with a size as small as a few nanometers, by measuring the direct transmission or reflection of a focused laser beam. This novel technique was recently used to perform the **first measurement of the absorption cross section of single carbon nanotubes** under ambient pressure and temperature conditions. This study unveiled the strong influence of the nanotube environment, in particular the substrate over which the nanotube lies, through spectral shift and broadening of the excitonic resonances [2].

This master project consists in extending this previous work to **high pressure conditions** (~10 GPa). Under these extreme conditions, the shape and the structure of nanostructures can be heavily modified, leading to deep alterations of their physical properties. This is of strong importance in the case of carbon nanotubes since ensemble measurements already evidenced that high hydrostatic pressure can induce a radial collapse.



Imagerie électronique d'un fagot de nanotubes de carbone, où certains nanotubes présentent une déformation de leur structure [4]

The study of these behaviors at the single nanotube scale requires disruptive instrumental developments. To this end we recently conceived and implemented a **unique experimental setup** based on a miniature diamond anvil cell that allows to perform spatial modulation spectroscopy under high hydrostatic pressure. We applied this technique to study for the first time the optical absorption of single metallic nanoparticles under high pressure [3]. The student will follow up on this work aiming **towards the first optical monitoring of the collapse of a single carbon nanotube**. Experimental observations will be compared to theoretical models.

This project is supported by the French National Research Agency – ANR's TRI-CO **collaborative project** between Institut Lumière Matière (A. San Miguel from SOPRANO group and our group), Institut Néel (Grenoble), CIRIMAT (Toulouse) and ARKEMA company.

This internship can be extended into a PhD, with the exploration of different original nanostructures such as two-dimensional materials (graphene, …).

[1] Animation movie on the Spatial Modulation Spectroscopy technics on the group homepage.
[2] J.C. Blancon et al., Nature Comm. 4, 2542 (2013) ; H.N. Tran et al., Phys. Rev. B 95, 205411 (2017)
[3] F. Medeghini et al., ACS Nano 12 (10), 10310–10316 (2018) [4] M. Motta et al., Adv. Mater. 19, 3721 (2007)

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***: Fellowship « école doctorale »**

Lumière, Matière, Interactions	**X**	Lasers, Optique, Matière	**X**