Spécialité de Master « Optique, Matière, Paris »

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

Proposition de stage

Date de la proposition : 28 – 11 - 2017

Responsable du stage / *internship supervisor*:

DE WILDE **Yannick**

Tél:0180963084

yannick.dewilde@espci.fr

Nom du Laboratoire / *laboratory name*:

Institut LANGEVIN, ESPCI Paris - CNRS

Site Internet / *web site*: https://www.institut-langevin.espci.fr/yannick_de_wilde

Adresse / *address:* 1, rue JUSSIEU, 75005 PARIS

Lieu du stage / *internship place*: Institut Langevin

3D tomographic reconstruction of light scattered around nanostructures and complex media

Our group has recently developed an off-axis holographic microscope coupled with a near-field scanning optical microscope (NSOM). Based on the Fourier analysis of the pattern formed by the interference between the light scattered by a nanostructured sample and a reference laser beam, and measured with a CCD camera, it is possible to reverse numerically the propagation of the electromagnetic field towards the sample and to calculate its amplitude and phase in any plane between the sample and the CCD camera [Optics letters 36, 849 (2011)]. We have recently demonstrated this method to perform a tomographic 3D reconstruction of the EM field produced by surface plasmon polaritons excited from a NSOM aperture tip, which radiate with well-defined angles in a glass substrate, as shown in the Figures below (paper submitted).

The success of this experimental demonstration opens numerous further developments which we will start to explore during the master internship, followed by a PhD thesis:

- Combined with nanomanipulation techniques, NSOM provides a unique way to tune the interaction between nanostructures, metallic or not, by performing a fine adjustment of their relative position. Our holographic NSOM should allow one to study in details coupled EM resonators, or complex systems involving multiple scattering events such as granular materials. We will measure experimentally the near-field transmission matrix of a complex medium, which relates linearly the input and output EM modes at subwavelength scales, and we will study the influence of the local disorder of a sample on its far-field radiation pattern.

- Since infrared detector matrices have become affordable, we plan to extend the 3D holographic reconstruction method to infrared wavelengths. Optical lithography and bottom up self-assembling methods allow one to produce complex microstructured materials whose structuration is de facto subwavelength sized when illuminated with infrared radiation. The high control of the sample morphology at micron scales should allow one to reveal totally novel properties of matter, such as electromagnetic transparency of dense disordered materials which exhibit specific spatial correlation properties [Optica, 3, 376 (2016)].

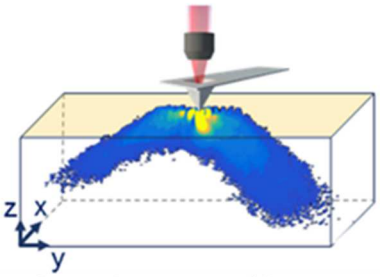

Figure: 3D tomographic reconstruction of EM radiation associated to surface plasmons.

The research will be co-supervised by 3 experimentalists (Y. De Wilde, V. Krachmalnicoff, I. Izeddin) and one theorist (R. Carminati), in collaboration with the Nanostructures and Optics group of Prof. A. Maitre (INSP), the Holographic microscopy group of Prof. G. Tessier (Neurophotonics Lab.), and other teams in Paris area.

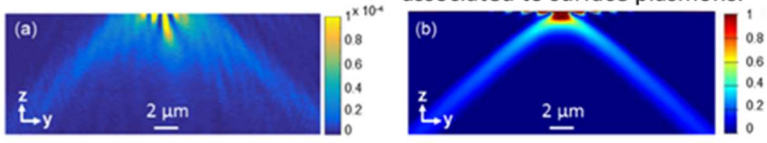

Figure: 2D cross sections. (a) Experiments, (b) EM simulations.

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***:** Application to a grant will be necessary, but so far it has not been an issue if the student is talented. The options are: DGA, Ecole Doctorale, ANR, foreign students grant (special ESPCI program), ...

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