Spécialité de Master « Optique, Matière, Plasmas »

Stage de recherche

Proposition de stage

Date de la proposition : 22/10/2014

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Code d'identification :	Organisme :	UMR8552	
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Lieu du stage / *internship place*: Departement de Physique de l'ENS, 24 rue Lhomond, 75005 PARIS			

internship title: **Wavefront shaping for ultra-deep non-linear microscopy**

Scattering of light in heterogeneous media, for instance the skin or a glass of milk, is usually considered an inevitable perturbation or even a nuisance. Through repeated scattering and interferences, this phenomenon seemingly destroys both the spatial and the phase information of any laser illumination. At the spatial level, it gives rise to the well-known "speckle" interference patterns. From an operative point of view, scattering greatly limits the possibility to image or manipulate an object with light through or in a scattering medium.

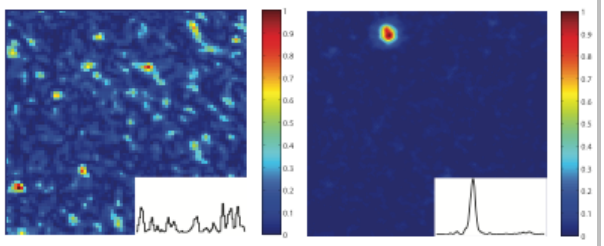

Figure 1 : Speckle Figure before (left) and after (right) wavefront shaping, showing the ability to control light and deliver it through a complex medium.

Multiple scattering is a highly complex but nonetheless deterministic process: it is therefore reversible, in the absence of absorption. Speckle is coherent, and can be coherently controlled. By « shaping » or « adapting » the incident light, it is in principle possible to control the propagation and overcome the scattering process. This domain is the main focus of our team « imaging in complex media » at Laboratoire Kastler-Brossel, supported by a 5 year ERC grant. It is particularly relevant for the field of biomedical imaging, because tissues are highly scattering media where conventional imaging techniques are inherently limited to superficial investigations.

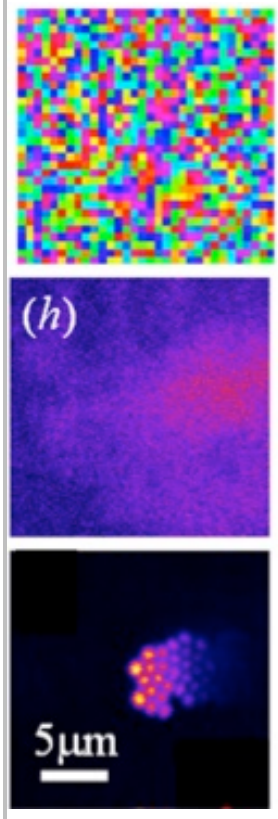

Figure 2 : figure taken from Ref 2 of wavefront shaping correction below a 400 microns thick brain slice (top) wavefront correction masks (colors correspond to phase) (middle) two photon image without correction (bottom) image after wavefront shaping optimization

The goal of the internship will consist in developing fast wavefront shaping techniques, able to compensate for the short decorrelation time of biological samples, and apply them to deep imaging, in combination with non-linear microscopy techniques. The applicant will need a strong taste for challenging experiment, combining not only complex physics concepts but also optics and microscopy, and interested in applying these concepts to biological imaging.

Reference :

Tang, J., Germain, R. N., & Cui, M. (2012). Superpenetration optical microscopy by iterative multiphoton adaptive compensation technique. PNAS, 109(22), 8434–8439. doi:10.1073/pnas.1119590109

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***: Bourse Doctorale**

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