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

Date de la proposition : 01/11/2011

Responsable du stage / *internship supervisor*:

Nom / *name*:	Aubry	Prénom/ *first name* :	Alexandre
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Nom du Laboratoire / *laboratory name*: Institut Langevin ï ESPCI Paris Tech

Code dõidentification : UMR 7587 Organisme : CNRS - ESPCI ParisTech

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

Adresse / *address:* 10 rue Vauquelin ï 75005 Paris

Lieu du stage / *internship place*: Institut Langevin - 10 rue Vauquelin ï 75005 Paris

Titre du stage / *internship title*: **Recovering Greenõs functions from ambient optical noise in a diffusive medium**

Résumé / *summary*

Wave propagation in complex media has drawn a considerable attention in many domains of physics, ranging from optics or acoustics to solid-state physics, seismology or medical imaging. Conventional focusing and imaging techniques based on the Born approximation generally fail in strongly scattering media due to the multiple scattering events undergone by the incident wave-front. For instance, optical coherence tomography, which is based on low-coherence interferometry, can image biological tissues only over a depth of 1 or 2 mm below the surface, because the single scattering contribution is too weak to be detected at greater depths.

To address the problem of imaging strongly scattering media, we propose an alternative approach inspired by previous works in seismology and ultrasound. Past experiments have demonstrated that the cross correlation of the recordings of diffuse wave fields at two spatially separated points gives the time-domain Greenõs function between the two points, i.e., the wave field that would be observed at one point if a source were placed at the other. This approach turned out to be particularly powerful in seismology: by cross-correlating the ambient seismic noise recorded on various seismic stations, one can build highly resolved tomographic images of the earth crust [N.M. Shapiro et al., Science **307**, 1615, 2005].

The aim of this master internship would be to transpose this elegant approach to optics. The basic idea is to measure the white light ambient noise within a scattering medium at different locations by means of several optical fibers. The cross-correlation between the recorded fields is then performed by low-coherence interferometry and yields the time-resolved greenõs functions between each recording point. The last step consists in building an image of the medium from the ensemble of Greenõs functions measured between each recording point.

Compared to current imaging techniques in optics, our approach has the great advantage of being totally passive since we take advantage of the ambient optical noise for measuring the Greenõs functions. Unlike optical coherence tomography, our recording points are located within the medium, which allows in-depth imaging of the scattering medium.

The aim of this internship will be first to set-up the corresponding experiment. To that aim, we will take advantage of the Langevin institute expertise in low-coherence interferometry. The preliminary experiments will consist in studying simple scattering samples made of few scatterers to make the analysis simpler, before moving towards more complex media. The student should show great experimental skills in optics but also an in-depth knowledge of wave physics in general due to the multidisciplinary aspect of the project. It would be really appreciated that the student pursues this research project with a phD thesis. The latter one would be directed by Pr. Mathias Fink and Pr. Claude Boccara, supervised by Alexandre Aubry and Geoffroy Lerosey and its funding will be discussed during the internship.

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***: Bourse ED ou CNRS cofinancée**

Lasers et matière	**O**	Lumière, Matière : Mesures Extrêmes	**O**
Optique de la science à la technologie	**O**	Plasmas : de lõespace au laboratoire	