Spécialité de Master « Optique, Matière, Paris »

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

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 28/10/2016

Responsable du stage / *internship supervisor*:

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Nom du Laboratoire / *laboratory name*: Institut Langevin

Code d'identification : UMR 7587 Organisme : CNRS/ESPCI

Site Internet / *website*: https://www.institut-langevin.espci.fr/home?lang=en

Adresse / *address:* 1, rue Jussieu, 75005 Paris

Lieu du stage / *internship place*: 1, rue Jussieu, 75005 Paris

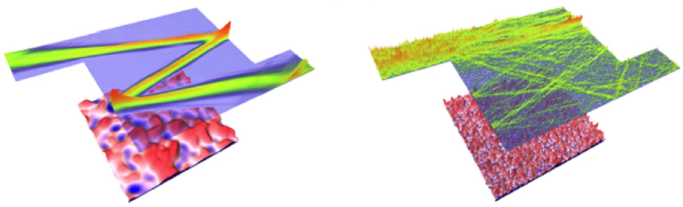
Titre du stage / *internship title*: Study of the Spatio-temporal Properties of Light Transmission in Complex Media

This internship is co-supervised by Arthur Goetschy (arthur.goetschy@espci.fr).

Disordered scattering media, such as a layer of white paint, force transmitted light to follow random trajectories. In practice, a coherent input beam gives rise to a speckle pattern, resulting from the interference of the different paths. The properties of such a system are usually studied through average quantities, using for instance the diffusion equation.

However, it is possible to characterize a system for a given realization of disorder. Regardless of the amount of disorder, a linear optical system can be characterized by its transmission matrix. The Langevin Institute conducted the first experiments resulting in the experimental measurement of the transmission matrix [1] of a disordered optical system. The acquisition is done using wavefront shaping techniques, which have attracted a considerable interest for applications in complex media in the past years [2]. This matrix contains all the information about the transmission properties of the system at a given wavelength.

More information can be gathered by measuring the transmission matrix at different wavelengths in a chosen bandwidth. It is then possible to construct the so-called Wigner Smith operator [3,4], that contains the spatial and spectral properties of light transport. In particular, it gives information about the statistics of the time of flight of the photons inside the medium and the spectral correlation of the field.



Two eigen-states of the Wigner-Smith operator in situation of weak (left) and strong disorder (right). Image from [3]

The intern will work with numerical simulations and experiments to characterize and study the Wigner-Smith operator in random scattering media. This subject is of great interest, both for its fundamental aspects, the properties of the Wigner-Smith operator having hardly been investigated in the context of scattering media, and for its applications, in particular for optical imaging and telecommunications.

[1] Popoff, S. M., et al. "Measuring the transmission matrix in optics: an approach to the study and control of light propagation in disordered media." Physical Review Letters 104.10 (2010): 100601.
[2] Mosk, Allard P., et al. "Controlling waves in space and time for imaging and focusing in complex media." Nature Photonics 6.5 (2012): 283-292.
[3] Rotter, S., Ambichl A. and Libisch F. "Generating particlelike scattering states in wave transport." Physical Review Letters 106.12 (2011): 120602.
[4] Carpenter, J., Eggleton J.B. and Schröder J. "Observation of Eisenbud–Wigner–Smith states as principal modes in multimode fibre." Nature Photonics 9.11 (2015): 751-757.

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*: **-**

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

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