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 :

Responsable du stage / *internship supervisor*:

Nom / *name*:	Barbosa de Aguiar	Prénom/ *first name* :	Hilton
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Nom du Laboratoire / *laboratory name*:

Code d'identification : Organisme : Département de Physique, ENS

Site Internet / *web site*:

Adresse / *address:* 24 rue Lhomond, Paris

Lieu du stage / *internship place*: Département de Physique, ENS

Titre du stage / *internship title*: **Developing a super-resolution scattering lens for nonlinear microscopy**

Résumé / *summary*

State-of-the-art nonlinear optical processes exploit label-free methodologies with unique capabilities, such as single-monolayer sensitivity and video-rate microscopy. In our group, we are performing fundamental research for increasing sensitivity, resolution and acquisition speed of various methods, such as Coherent Raman Scattering (CRS) and Sum-Frequency Generation, both exploiting the intrinsic vibrational spectrum of molecules [1]. We are also using these tools for advanced applications in soft matter, biophotonics and physical chemistry of interfaces, in collaboration with chemists and biologists. **Nevertheless, achieving resolution at the 100nm-scale still remains a very challenging topic in label-free approaches** [2].

Multiple scattering, otherwise seen as a nuisance in any optical device, can enable super-resolution. At the core of the proposed project lies the speckle pattern generated by complex scattering media. Recently, a series of remarkable examples [3] have shown how to harvest the best of multiple scattering for focusing scattered light beyond the diffraction-limit (aided by wavefront shaping techniques), using it for super resolution imaging, or potentially for super-penetration nonlinear microscopy [4].

Building upon recent work [4], this project aims at exploiting the speckle pattern for enabling future label-free super-resolution microscopy in nonlinear optical processes. However, creating a scattering lens for super-resolution applications in realistic biological systems is not a trivial task. The applicant will work on preparation and characterization of new scattering complex lenses, and its ultimate use for proof-of-principle microscopy applications. In a first step, these experiments will be performed in a linear and nonlinear fluorescence processes. The development of the project will be fully experimental (sample preparation and optical setup), and is related to an ongoing collaboration with other groups in France. Potentially, it may lead to a PhD project depending on funding available.

Candidates with strong interest in interdisciplinary research in Life, Physical and Analytical Chemical Sciences are highly welcomed. Basic programing (Matlab) and hands-on experience in optics are necessary. If you are interested, please contact me for further informal enquiries on the project.

[1] de Aguiar et al., *J. Am. Chem. Soc 133*, 10204 (2011) ; de Aguiar *et al., Opt. Express 23*, 8960 (2015).
[2] Watanabe et al., *Nat. Comm. 6*, 10095 (2015).
[3] Mudry *et al.*, *Nat. Phot. 6*, 312 (2012); (b) van Putten *et al., Phys. Rev. Lett. 106*, 193905 (2011).
[4] de Aguiar *et al. Phys. Rev. A 94,* 043830 (2016) ; de Aguiar *et al. arXiv:1511.02347* (2015).

Toutes les rubriques ci-dessous doivent obligatoirement être remplies

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**

*Fiche à transmettre (fichier pdf **obligatoirement**) sur le site http://stages.master-omp.fr*