

Spécialité de Master « Optique, Matière, Plasmas »

Stage de recherche

Proposition de stage

Date de la proposition : 22/10/2014

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Lieu du stage / internship place: Departement de Physique de l'ENS, 24 rue Lhomond, 75005 PARIS			

internship title: Quantum Optics in complex media

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.

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.

In this project, we aim at showing that complex media can be an interesting platform for multimode quantum information processing. We have already shown how a Fock state can be guided and entanglement generated at arbitrary positions. The internship will consist in exploring what happens when pairs of indistinguishable photons propagates inside a medium and how wavefront shaping makes it possible to generate multiphoton entangled states at will.

Figure 1 : Fock state control through a scattering medium (a) quantum interference between two arbitrary speckle positions where a single photon is focused (b) CCD image and (c) density matrix of the output state, confirming entanglement.

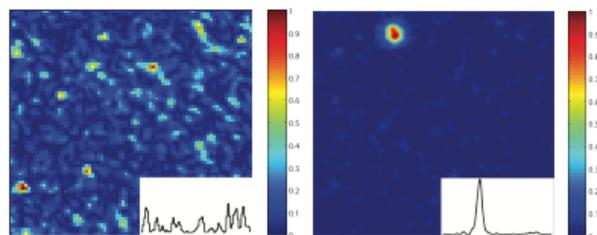
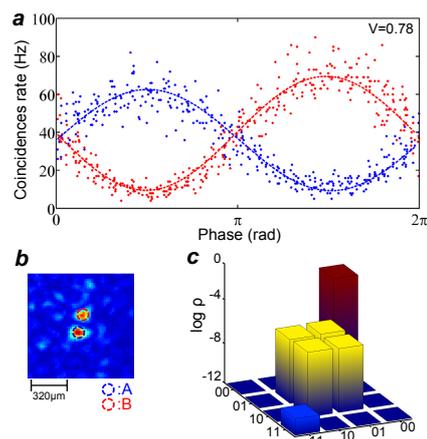


Figure 1 : Speckle Figure before (left) and after (right) wavefront shaping, showing the ability to control light and deliver it through a complex medium.

In the long run (a PhD thesis) we will explore how such random medium can be a viable alternative to conventional waveguide-based linear quantum information, be it for quantum computing or quantum random walks experiments for instance.

Reference : H. Defienne, et al. Single-photon entanglement generation by wavefront shaping in a multiple-scattering, Optics Letters (2014)

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			