Spécialité de Master « Optique, Matière, Paris »

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

Proposition de stage

Date de la proposition : 7 novembre 2017

Responsable du stage / *internship supervisor*: Julien Laurat

Nom / *name*:	LAURAT	Prénom/ *first name* :	Julien
Tél :	01 44 27 30 64	Fax :	
Courriel / *mail*:	Julien.laurat@upmc.fr		

Nom du Laboratoire / *laboratory name*:

Code d'identification : UMR 8552 — Organisme : Laboratoire Kastler Brossel

Site Internet / *web site*: quantumoptics.fr

Adresse / *address:* 4 place Jussieu, Paris 05

Lieu du stage / *internship place*: UPMC

Coupling Atomic Arrays to Nanoscale Waveguides: Towards Quantum Non-Linear Optics

Deterministic interactions between single photons, i.e. quantum non-linear optics, is a long-standing goal in optical physics, with applications to quantum optics and quantum information science. However, single photons usually do not interact with each other and the interaction needs to be **mediated by an atomic system**. Enhancing this coupling has been the driving force for a large community over the past two decades. One pioneering approach is known as cavity quantum electrodynamics (CQED), where a single atom and a single photon can be strongly coupled via a high-finesse cavity. Cavity-QED led to a better understanding of fundamental aspects of light-matter interaction and to various seminal demonstrations.

Strong **transverse confinement in single-pass nanoscale waveguide** recently triggered various investigations for coupling **guided light and cold atoms,** without a cavity. Specifically, a subwavelength waveguide can provide a large evanescent field that can interact with atoms trapped in the vicinity. An atom close to the surface can absorb a fraction of the guided light as the effective mode area is comparable with the atom cross-section. This emerging field of **waveguide-QED** promises unique applications to quantum networks, quantum nonlinear optics, and quantum simulation.

The LKB team recently developed an experiment in this direction. Using a **nanofiber with a 400-nm diameter and a few thousands atoms trapped around**, the team recently realized a first all-fibered quantum memory for light. The team also demonstrated the very efficient reflection of single photons by an ordered one-dimensional array of trapped atoms and the heralding of single-collective atomic excitation in this platform.

The goal is now to **push further the accessible non-linearity** and to demonstrate in such waveguided-configuration quasi-deterministic single-photon emission and single-photon controlled optical switches and transistors, with applications to quantum state engineering and quantum networks.

References:

Demonstration of an optical memory for tightly guided light in an optical nanofiber, PRL 114, 180503 (2015).

Large Bragg reflection from 1D arrays of trapped atoms near a nanoscale waveguide, PRL 117, 133603 (2016).

See also: "Making a mirror from a line of atoms" in Optics and Photonics News.

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : yes**

Si oui, financement de thèse envisagé/ *Doctoral school or others*

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