# Spécialité de Master « Optique, Matière, Plasmas »

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

## Proposition de stage

*Date de la proposition : 09/10/2013*


**Responsable du stage** */ internship supervisor*:

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|---|---|---|---|
| Nom / *name*: | BRUNE | Prénom/ *first name* : | Michel |
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**Nom du Laboratoire** / *laboratory name*: Laboratoire Kastler Brossel

Code d'identification :UMR8552 Organisme : CNRS

Site Internet / *web site*: www.cqed.org

Adresse / *address:* 24 rue Lhomond, 75005 Paris

Lieu du stage / *internship place*: Equipe « Electrodynamique des systèmes simples »


**Titre du stage** / *internship title*: Adaptive and non-local photon-number measurement of light in cavities


Résumé / *summary*

A superconducting cavity allows us to store a microwave field of several photons for a fraction of second without losing them. Coupling this field to a stream of atoms, excited to high-lying Rydberg states and crossing the cavity one by one, makes it possible to realize many thought experiments proposed by the founders of the quantum mechanics to illustrate its highly non-intuitive consequences. Our experimental setup implements a very simple quantum system and allows us to perform fundamental experiments. They contribute to a better understanding of the quantum properties of microscopic objects and of their absence in the classical macroscopic world.

With very long cavity damping times, we can store photons long enough to count them without destroying them, thus realizing a quantum non-demolition measurement of their number. This photon-number counting requires typically 100 atoms each interacting with a field in a predefined way and bringing only partial information on its state. The first goal of the proposed internship is the realization of an *adaptive* quantum measurement requiring much less atoms and thus being much faster. This is an essential feature when measuring higher quantum numbers, which decay faster. The proposed method consists of adapting, in real time, the parameters of interaction and detection of every single atom based on the information on the photon field acquired so far with the previous atoms.

The internship project will mainly consist in participating in the experiments on the adaptive quantum measurements, analyzing the obtained data, as well as simulating and optimizing the experimental protocol. During his internship the student will familiarize himself with various experimental techniques, including cryogenics, laser and microwave excitation of Rydberg atoms, data acquisition, real-time experiment control, simulation of quantum optics experiment, etc.

In addition to the internship, the proposed PhD project aims to the study of *non-local quantum phenomena*, present in the micro-world and absent in the macro-world. Its main tasks will be the realization of a two-cavity experimental setup and the extension of the methods and properties of local quantum measurements to their non-local counterparts. This will be realized by letting the atoms to interact successively with both cavity fields, thus entangling them. After this operation, the two fields cannot be treated separately and should be considered as one non-local quantum-mechanical object. Some exotic states, *e.g.* with all photons simultaneously only in the first cavity and only in the second one, will be studied.


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

**Si oui, financement de thèse envisagé/** *financial support for the PhD***: Oui/** *YES*

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| Lasers, Optique, Matière | **OUI** | Lumière, Matière : Mesures Extrêmes | **NON** |
| Plasmas : de l'espace au laboratoire | **NON** | | |

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