# Spécialité de Master « Optique, Matière, Paris »

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

## Proposition de stage

*Date de la proposition : 23 October 2015*


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

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|---|---|---|---|
| **Nom / *name*:** | **Cheneau** | **Prénom/ *first name* :** | **Marc** |
| **Tél :** | **01 64 53 33 39** | **Fax :** | |
| **Courriel / *mail*:** | **marc.cheneau@institutoptique.fr** | | |

**Nom du Laboratoire / *laboratory name*: Laboratoire Charles Fabry**

**Code d'identification : UMR8501** **Organisme :Institut d'optique & CNRS**

**Site Internet / *web site*: https://www.lcf.institutoptique.fr/Groupes-de-recherche/Optique-atomique**

**Adresse / *address:* 2, avenue Augustin Fresnel, 91127 Palaiseau**

**Lieu du stage / *internship place*: Institut d'optique**


**Titre du stage** / *internship title*: Setting up a new experiment for studying the relaxation dynamics of ultracold gases


Résumé / *summary*

Statistical mechanics is one of the most powerful constructions of physics. It predicts that the equilibrium properties of any system composed of a large number of particles depend only on a handful of macroscopic parameters, no matter how the particles exactly interact with each other. But the question of how many-body systems relax towards such equilibrium states remains largely unsolved. This problem is especially acute for quantum systems, which evolve in a much larger mathematical space than the classical space-time and obey non-local equations of motion.

Despite the formidable complexity of quantum dynamics, recent theoretical advances have put forward a very simple picture: the dynamics of quantum many-body systems would be essentially local, meaning that it would take a finite time for correlations between two distant regions of space to reach their equilibrium value. This locality would be an emergent collective property, similar to spontaneous symmetry breaking, and have its origin in the propagation of quasiparticle excitations.

The fact is, however, that only few observations directly confirm this scenario. In particular, the role played by the dimensionality and the range of the interaction potential between the particles is largely unknown. The concept of our research is to take advantage of the great versatility offered by ultracold atom systems to investigate experimentally the relaxation dynamics in regimes well beyond the boundaries of our current knowledge. We are currently constructing a new-generation quantum gas microscope experiment for strontium gases. Amongst the innovative experimental techniques that we are implementing is the electronic state hybridisation with Rydberg states, called Rydberg dressing.

During the internship you will set up the laser system used to cool the strontium gas to ultralow temperatures, which is a major part of the experimental set-up. The system will consist of tunable diode lasers emitting at 403, 461 and 689 nm, all locked to an ultrastable reference cavity and to a strontium absorption cell. In particular, the linewidth of the 689 nm laser will have to be reduced down to 100 Hz using fast servo-locking electronics, which is a challenging task in itself. The internship involves working with optics, lasers, electronics and computers. It is an ideal entry point to the physics of laser cooling and ultracold gases.

A PhD thesis would be a natural continuation of the internship. The aim of the thesis would be to complete the construction of the experimental set-up and start investigating the relaxation dynamics of our quantum gas.
Funding for the PhD is already available.


**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*: Funding already available**

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| Lumière, Matière, Interactions | **Yes** | Lasers, Optique, Matière | **Yes** |