Spécialité de Master « Optique, Matière, Paris »

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

Proposition de stage

Date de la proposition : 08/11/2016

Responsable du stage */ internship supervisor*:

Nom / *name*:	Bouchoule	Prénom/ *first name* :	Isabelle
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Nom du Laboratoire / *laboratory name*: Laboratoire Charles Fabry

Code d'identification :UMR 8501 Organisme :Institut d'Optique/CNRS

Web site : www.lcf.institutoptique.fr/Groupes-de-recherche/Optique-atomique/Experiences/Puce-atomique

Adresse / *address:* 1 avenue Augustin Fresnel, 91127 Palaiseau Cedex

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

Titre du stage / *internship title*: **Experimental study of the out-of-equilibrium dynamics of 1D Bose gases**

Ultracold atomic gases, produced with a very high degree of control of the parameters, are used as model systems of quantum degenerate gases. Degenerate gases are obtained when the de Brooglie wave-length is larger than the mean inter-particle distance, such that the quantum nature of the particles play an essential role. For instance, physics depends strongly on the fermionic or bosonic nature of the atoms. In presence of interactions, even though the system is described by the simplest possible Hamiltonian, presence of entanglement renders its solutions and theoretical description extremly difficult, making experimental studies highly desirable. A remarkable feature of cold atom gases is their very low coupling to environment. This enable the study of out-of-equilibrium dynamics of quantum isolated systems, a subject poorly explored yet, that raises many theoretical questions. To bring the system out-of-equilibrium, one procedure consists in rapidly modifying a parameter of the system, realizing a quench. The subsequent evolution can then be monitored. Does the system relax towards a new equilibrium configurations ? How do correlation function evolve ? Those questions trigger many theoretical and experimental work since a few years. In the atom-chip experiment at LCF, we participate to this effort and we recently show the phenomenon of self-reflexion of the cloud when the compression mode of the cloud is excited.

On our experiment, Rubidium87 atoms (of bosonic nature) are confined in magnetic traps realized by current-carrying micro-wires deposited on a substrate, the atom-chip. Highly anisotropic geometries are naturally realized, atoms being guided along a wire by a very strong transverse confinement, together with a much weaker longitudinal confinement. Approaching atoms a few micron away from the wires, very strong transverse confinements are obtained and we reach the one-dimensional (1D) regime where the transverse degrees of freedom are frozen. We thus study the physics of 1D Bose gases. In the reduced 1D description of the gas, the strength of the interactions depends both on the scattering length, characterizing the interactions in the 3D world, and the transverse confinement. Our experiment offers the possibility to modify independently the transverse and the longitudinal confinement. Modifying the transverse confinement, we can modify the strength of the interactions of the 1D gas. If the modification is fast enough, the gas can be brought in an out-of-equilibrium situation. We propose to monitor the evolution following such a quench of the interaction strength. For this purpose, we will rely on the diagnostics that have been developed on our experiment. On the one hand, using absorption images, we measure longitudinal density profiles, as well as in-situ density fluctuations, linked to the two-body correlation function. At equilibrium such measurements permit to characterize the regime of the gas. On the other hand, using a magnetic lens, we image the cloud in the momentum space. We can then measure the momentum distribution and its fluctuations. Those diagnostics will permit us to follow the gaz dynamics. During the internship, the student will work on the experiment, together with the PhD student. He or she will participate to the data acquisition, as well as their analysis.

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : No**

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

Lumière, Matière, Interactions	**YES**	Lasers, Optique, Matière	**YES**		