Spécialité de Master "Optique, Matière, Plasmas"
Stage de recherche

Proposition de stage			
Date de la proposition : 28/10/2019			

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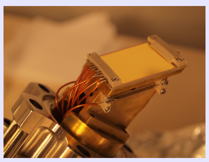
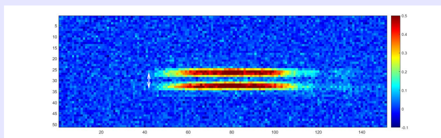
Lieu du stage : Institut d'Optique			

Titre du stage : Spatially resolved measurement of the quasi-particles distribution in a one-dimensional Bose gas

(a)  (b) 

(a) : Atom-chip used to manipulate atoms, covered by a miror. (b) : Image of a one-dimensional cloud. Both the cloud and its mirror image are seen.

Non-equilibrium physics of quantum body systems is an extremely large and complex subject, very active since a few years. Many progress were made recently, addressing in particular transportation properties, spread of correlations or the understanding of the notion of relaxation and the emergence of thermodynamics. Among N-body quantum systems, one-dimensional gases, besides their relevance for describing existing systems such as electrons in carbon nanotubes or guided photons, are particularly interesting in many ways. First, quantum correlations are typically amplified in such systems. In addition, powerful theoretical and numerical tools are available. Finally, some one-dimensional models are integrable models. This is the case of the model of one-dimensional Bosons with contact interactions, called the Lieb-Liniger model. Integrable systems are characterized by the existence of quasi-particles of infinite life. The existence of these quasi-particles makes the non-equilibrium dynamics of integrable systems very peculiar, preventing in particular the relaxation to a state described by the Gibbs ensemble. A recent major theoretical advance is the development of the generalized hydrodynamic theory which describes the large-scale dynamics of integrable systems taking into account the conservation of all the quasi-particles. In this theory, the system is described, at each position, by a local distribution of quasiparticles and their time evolution is governed by continuity-like equations. It has long been thought that the quasi-particles, introduced as a mathematical object, were impossible to detect. However, a recent experimental breakthrough shows that it is possible to measure the quasi-particle distribution for the Lieb-Liniger model. This breakthrough opens up very interesting perspectives for the experimental study of out-of-equilibrium dynamics. However, it will be necessary, to probe the dynamics of non-homogeneous systems, to have a local measure of the distribution of quasi-particles.

The atomic chip team of the " quantum gas " group of the Charles Fabry Laboratory studies Rubidium gases confined in magnetic traps made by electric currents running into micro-wires deposited on a chip. Very large confinements allow to freeze transverse degrees of freedom and atomic clouds are very well described by the Lieb-Liniger one-dimensional model, as the team's previous works have shown. The objective of this internship will be to set up, on the experiment, a spatial selection of a part of the cloud, which will allow a local measurement of the quasi-particle distribution. The idea is to illuminate the atoms that we want to remove with a selection beam that performs optical pumping to a hyper-fine state in which the atoms are expelled from the magnetic trap. The student will study the relevant physical parameters to achieve this selection. He will then work on the experimental implementation of this technique. Spatial formatting the selection beam will be performed with a computer-programmable matrix of micro-mirrors.

Ce stage pourra-t-il se prolonger en thèse ? : Oui	
Si oui, financement envisagé :	Bourse de l'école doctorale

Laser, optique, matière :	×	Lumière, Matière, Interactions	×