Spécialité de Master « Optique, Matière, Paris »

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

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : Octobre 2018

Responsable du stage / *internship supervisor*:

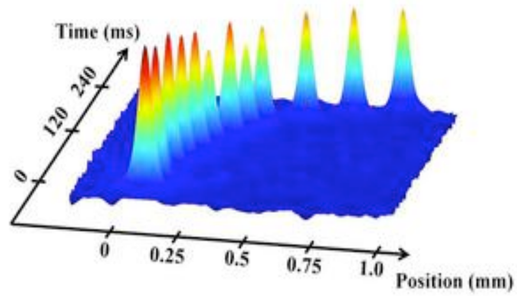
Nom / *name*: Bourdel Prénom/ *first name* : Thomas
Tél : 01 64 53 33 35 Fax :
Courriel / *mail*: Thomas.bourdel@institutoptique.fr

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

Code d'identification :UMR9501 Organisme :Institut d'optique, Univ. P11, CNRS
Site Internet / *web site*: https://www.lcf.institutoptique.fr/lcf-en/Research-groups/Atom-optics/Experiments/Interaction-and-disorder
Adresse / *address:* 2 av. A. Fresnel, 91120 Palaiseau
Lieu du stage / *internship place*: Institut d'optique

Titre du stage / *internship title*: Bose-Einstein condensâtes with variable interactions and disorder

Our group is experienced in controlling interspecies interaction in potassium 39 condensates, in reduced dimensionalities (1D and 2D) and in introducing disorder by laser speckle. We can thus probe the properties of a variety of interacting quantum systems. Fast magnetic field sweeps permit to accurately and quickly change the scattering length that is the only parameter characterizing interaction at low temperatures. This ability is clearly demonstrated is the production of bright solitons, i.e. one-dimensional condensates that do not diffuse in the absence of any trap because of attractive interaction. We can also zero the interaction efficiently creating ideal quantum gases



Non-dispersive propagation of a 39K bright soliton.
S. Lepoutre et al., PRA 94, 053626 (2016)

We are experts in the control of condensates at extremely low energies below the nanokelvin. This is especially interesting for studies linked to disorder physics. Anderson localization is the absence of diffusion due to multiple scattering of atoms behaving as waves at ultralow temperature. This phenomenon is a one-body effect and is behaving very differently as a function of the dimension. The understanding of the competition between Anderson localization and interaction is a long standing complex problem that we can address in our experiment. In this respect, we have for example studied the propagation of bright solitons in disorder (EPL 117, 10007, 2017).

During a master internship, we will first study genuine Anderson localization (without interaction) in the presence of an acceleration. In this case, Anderson localization picture is predicted to be modified (PRA 97, 013613). The eigenstates should exhibit power-law behavior as a function of space rather that exponential. For too strong acceleration complete delocalization is expected even in 1D. The intern is expected to learn how to operate the experiment by himself and then analyze the data.

The internship could continue for a PhD thesis on related subjects. Anderson localization in real 2D space for example remain to be observed, and the competition between superfluidity and disorder can be explored for repulsively interacting systems (Nat. Physics 6, 900, 2010). In addition, our ability to detect small atom numbers, will allow us to explore beyond mean-field physics in various contexts: dissociation of bright solitons after an interaction quench (PRL 119, 220401, 2017)., or production of 1D quantum droplets quantum gases that behaves like a liquid due to quantum fluctuations (PRL 117, 100401, 2016).

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*: **Simmons foundation**

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