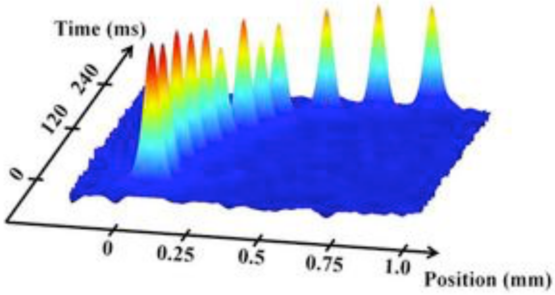
M1/M2 in Experimental Quantum Physics
Ultracold atoms at Institut d'Optique

Bose-Einstein condensates in arbitrary potentials

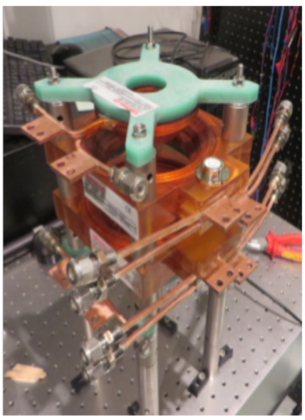
Our group is experienced in controlling interspecies interaction in potassium 39 condensates, in reduced dimensionalities (1D and 2D) and in introducing disorder by laser speckle. We can thus probe the properties of a variety of interacting quantum systems. Our apparatus allows for the production of Bose-Einstein condensates in a few seconds, and for highly sensitive imaging. 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 in the production of bright solitons, i.e. one-dimensional self-trapping condensates that do not diffuse in the absence of any trap because of attractive interaction (see figure).

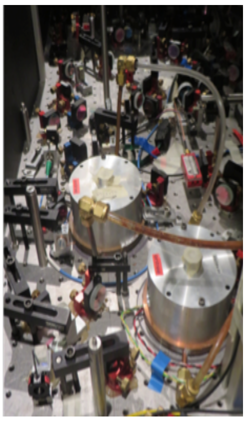
We now focus our activities on the study of quantum droplets, i.e. self-bound mixtures of two condensates (with attractive interspecies and repulsive intraspecies interaction) that have recently been discovered. Interestingly, such droplets exist in the absence of a trapping potential because of a vanishing mean-field term that competes with quantum fluctuations. The latter thus play an unusual dominant role in a dilute system. Although the quantum droplets remain a dilute gas, allowing a precise theoretical description, they are predicted to demonstrate a liquid like behavior, i.e. a flat density profile.



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

In the internship, we would like to develop a new tool: the ability to impose arbitrary potentials on the atoms and therefore to modify the trapping geometry. This can be done by using a digital micro-mirror device (DMD), a matrix composed of mirrors that can be individually addressed. The intern will design and realize a setup to be installed on the experiment. The challenge will mostly be in constructing an optical setup with minimal aberrations and good performances including despite the fact that the optical access will be share with the imaging system. The computer control of the device will also be a part of the internship. Test of the setup will include the production of box as well as point-like disorder potentials, which will be useful especially useful in the context of our research.





The intern will devote most of his work on the development and tests of the DMD system. He will also be able to get to know the fascinating world of an ultracold atom experiment.

Please contact Thomas Bourdel for more information
E-mail : Thomas.bourdel@institutoptique.fr
Tel : 01 64 53 33 35
Institut d'optique, 2 av. A. Fresnel, 91120 Palaiseau