INTERNSHIP PROPOSAL

Laboratory name: Laboratoire de Physique des Lasers
CNRS identification code: UMR 7538
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Internship location: Institut Galilée- USPN- 99 avenue Jean-Baptiste Clément 93430 Villetaneuse
Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ANR

Superfluid quantum gases in bubble traps

The Bose-Einstein Condensate group at the Laboratoire de Physique des Lasers group produces a superfluid degenerate bosonic gas confined in a bubble-like potential obtained by a combination of static magnetic fields and a radio-frequency field [1]. The bubble-shape of the trap allowed us to explore different geometries like two-dimensional trapping [2], ring geometries [3,4,5] (Fig. 2) and curved traps [5]. We have developed tools to excite the system, either by magnetic/radiofrequency control [3,4,5], or by optical tools such as an optical laser spoon capable of creating a local perturbation of the quantum gas [4]. These tools enable us to rotate the condensate to study superfluid properties or dynamically alter the landscape as seen by the atoms, so as to put them out of equilibrium. By sending additional radio-frequency fields on the condensate, one can duplicate the bubble trap in a concentric manner [6] (Fig. 1). This configuration gives access to new experimental possibilities, as making the two quantum gases interfere, and allowing tunneling between the two quantum gases.

The aim of the internship will be to progress in the experimental realization of these two concentric bubble traps, and ultimately transferring a Bose-Einstein condensate onto each bubble.

The internship can be followed by a PhD with a funding secured by an ANR grant. The topic of this PhD will be to study the superfluid dynamics of a rotating condensate at the surface of the bubble trap, the influence of the quantized vortices generated, and more generally the out-of-equilibrium properties of this system.

The student will acquire know-how on an ultra-cold atom experiment and benefit from stimulating interaction with the larger ultra-cold atom group of around 15 people including four other experiments plus a theorist. Our group is a member of QUANTIP, a leading network of quantum technology groups in the Paris region in the field of quantum technologies.

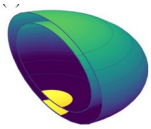

Fig 1: Concentric bubble traps. Taken from [6]

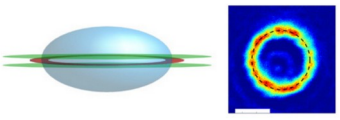

Fig 2 : (Left) Hybrid bubble trap/optical trap. (Right) Resulting ring Bose-Einstein condensate Taken from [4].

References :
[1] Barry M Garraway and Hélène Perrin 2016 J.Phys.B:At.Mol.Opt.Phys. 49 172001
[2] K Merloti *et al* 2013 NewJ.Phys. 15 033007
[3] Y. Guo *et al*, Phys. Rev. Lett. **124**, 025301
[4] M. de Goër de Herve *et al* 2021 J.Phys.B:At.Mol.Opt.Phys. 54 125302
[5] Y. Guo *et al* 2022 NewJ.Phys. 24 093040
[6] T. L. Harte, *et al*., Phys. Rev. A **97**, 013616

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: NO