



MASTER IN PHOTONICS – “PHOTONICS BCN” ERASMUS+ “EUROPHOTONICS-POESII”

MASTER THESIS PROPOSAL

Dates: April - September 2018

Laboratory: Ultracold Quantum Gases Group
Institution: ICFO-The Institute of Photonic Sciences
City, Country: Castelldefels (Barcelona), Spain

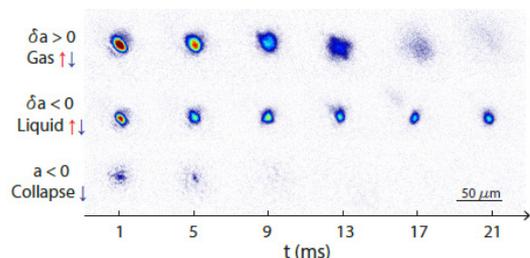
Title of the master thesis: High-resolution imaging for liquid droplets in a mixture of Bose-Einstein condensates

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Keywords: ultracold atoms, quantum optics, atomic physics, Bose-Einstein condensates, quantum liquid droplets, high-resolution imaging, interferometry

Summary of the subject (maximum 1 page):

In recent years ultra-cold atomic gases have emerged as a novel platform for the study of quantum many-body systems, giving access to phenomena originally studied in condensed-matter in a novel and highly controlled setting. In this context, our group focuses currently on the study of ultra-dilute quantum liquids obtained from mixtures of potassium Bose-Einstein condensates. These liquids are eight orders of magnitude more dilute than liquid helium, and form droplets that are self-bound in the absence of any external confinement [1, 2].



In order to observe and characterize accurately these quantum liquid droplets, which have a size of a few micrometers, a high-resolution optical system is required. The goal of this Master thesis will be to develop an improved imaging objective for the experiment and/or to explore new imaging schemes. Depending on the background, interests and abilities of the candidate

several projects are possible, including the development of an imaging scheme exploiting an atomic transition of shorter wavelength (405 nm vs. 767 nm), the interferometric characterization and optimization of the optical system or the development of an aberration correction system.

Interested candidates should contact Leticia Tarruell as soon as possible to define the exact project. For further information and references, please consult www.qge.icfo.es

[1] C. R. Cabrera, L. Tanzi, J. Sanz, B. Naylor, P. Thomas, P. Cheiney, L. Tarruell, “Quantum liquid droplets in a mixture of Bose-Einstein condensates”, [arXiv:1708.07806](https://arxiv.org/abs/1708.07806)

[2] P. Cheiney, C. R. Cabrera, J. Sanz, B. Naylor, L. Tanzi, L. Tarruell, “Bright soliton to quantum droplet transition in a mixture of Bose-Einstein condensates”, [arXiv:1710.11079](https://arxiv.org/abs/1710.11079)

Additional information :

* Required skills: The candidate should have a good knowledge of optics and atomic physics, and a strong motivation to perform experimental work.

* Miscellaneous: The project will be carried out in a small team of 4-5 people. The candidate will have his/her own project, but will participate in all group activities in order to maximize the learning experience.