CRYST³: Emergent Physics With Cold Atoms in a Hollow-Core Photonic Crystal Fiber

Luisa Fernanda Loranca Cruz[a*], Andrea Bertoldi[a]

1. Laboratoire Photonique, Numérique et Nanosciences (L2PN) – Univ. Bordeaux - CNRS – Institut d'Optique Graduate School – France

* luisa.loranca-cruz@institutoptique.fr «Luisa Fernanda Loranca Cruz»'

Abstract: CRYST³ is a project that seeks to build on state-of-the-art research at the frontier of quantum many-body physics of atoms and photons, fiber photonics and ultracold atoms. The objective is to cool (at temperatures of the order of the microkelvin) and load Rubidium 87 atoms into a hollow core photonic crystal fiber (HCPCF) hermetically sealed, using a protocol relying on dark-states and gray molasses in the presence of a large differential light shift [1]. Once the atoms will be in the fiber we expect to observe and characterize the emergence of spontaneous crystallization of the atoms and the photons, caused by scattering of light by long-range interactions between the atoms mediated by the light field and at the same time by the scattering of light in a collective way that results in a superradiant emission, breaking the translation symmetry, as theoretically foreseen in [2]. The absence of boundaries in the direction of the fiber enables us to use the continuum of electromagnetic modes of the light in free space, unlike a cavity that sets a specific mode. This promises the rise of new technologies and numerous research lines.

[1]Naik, D. S., Eneriz-Imaz, H., Carey, M., Freegarde, T., Minardi, F., Battelier, B., & Bertoldi, A. (2020). Loading and cooling in an optical trap via hyperfine dark states. Physical Review Research, 2(1), 013212.
[2]Ostermann, S., Piazza, F., & Ritsch, H. (2016). Spontaneous crystallization of light and ultracold atoms. Physical Review X, 6(2), 021026.

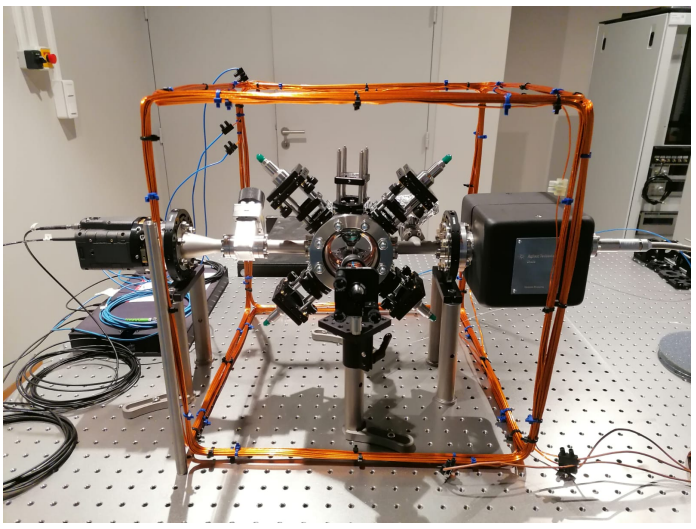

Figure 1 : Experimental setup