Stage M2 au laboratoire de physique des lasers

Title: Implementation of an adaptive optical system for trapping dipolar quantum gases

Keywords: Adaptive optics, lasers physics, Fourier Optics, Quantum gases

Scientific description:

In the recent years the chromium team at LPL has pioneered studies of quantum magnetism using quantum gases of chromium atoms trapped in optical lattices. Chromium is a species which has a high permanent magnetic moment leading to significant dipolar interactions. Measurement of quantum correlations has led to original studies of quantum thermalization [1,2,3], a process in which an isolated system evolves towards equilibrium through the growth of entanglement. By controlling the depth of the optical lattices, it is possible to study the competition between dipolar interactions, contact interactions, and transport across the superfluid–Mott phase transition [4,5].

We are currently rebuilding the experiment to achieve new scientific objectives. In particular, we have acquired a spatial light modulator based on an array of micromirrors and known as digital micromirror device (DMD). DMDs enable the amplitude of the laser used for trapping atoms to be controlled at the micrometre scale, allowing the possibility to create trapping potentials with arbitrary shapes in the atomic plane. During the internship, the student will design and set up an adaptive optical system and then develop algorithms to generate and control the resulting potentials.

The student will interact with all team members: Lucas Lavoine (associate professor), Benjamin Pasquiou (CNRS engineer), Laurent Vernac (professor), Fatima Rahmouni (postdoctoral researcher) and Esther Fromm (PhD student). See https://gqm.lpl.univ-paris13.fr/ for recent publications and thesis of the team.

[1] S. Lepoutre et al., Nature Communications 10, 1714 (2019)

[2] Y. Aziz Alaoui et al., Phys. Rev. Lett. 129, 023401 (2022)

[3] Y. Aziz Alaoui et al., Phys. Rev. Lett. 133, 203401 (2024)

[4] T. Lauprêtre, et al., Phys. Rev. Lett. 136, 103401 (2026).

[5] T. Lauprêtre, et al., Phys. Rev. A 113, 033306 (2026).