



PhD project : Ultracold atom experiment for plasma physics

Supervisor : Romain Dubessy – CIML group

Mail : romain.dubessy@univ-amu.fr

Lab : Physique des interactions ioniques et moléculaires UMR7345, Marseille, Campus de Saint-Jérôme¹.

Keywords : laser cooling and trapping, ultracold neutral plasma, photo-ionization

We are looking for a highly motivated PhD student to start a new experiment **at the frontier of quantum and plasma physics** [1]. We will create a laser cooled sample of neutral Calcium atoms confined in a magneto-optical trap, at milli-Kelvin temperatures. This sample will then be photo-ionized and the dynamics of the resulting plasma of Calcium ions and electrons will be investigated using absorption imaging. We aim at:

- demonstrating for the first time the control of the initial plasma distribution, thanks to optical shaping of the photo-ionization laser pulse, following a recent proposal [2],
- studying collisions between ultracold plasmas,
- applying laser cooling and trapping to a ultracold plasma [3].

The PhD student will contribute to the construction of an original platform implementing an analog simulator of a strongly coupled plasma, aiming at controlling all the microscopic parameters in a bottom-up approach. The project is fully funded for the three years of the PhD and we expect to hire a post-doc in January 2026 to strengthen the team working on this project.

The successful candidate will join a team of about ten people, including two PhD students and two postdocs, working on three experimental platforms all dedicated to the study of laser cooled atom and ions for basic research and applications. He/She will be offered the opportunity to attend a PhD school on ultracold atom physics in Fall 2025 ([in Les Houches, near Chamonix](#)). The CIML group is part of the European ion trapping network.

Acquired skills: the student will learn state of the art laser control technology, including frequency stabilization on an atomic reference and beam shaping thanks to a spatial light modulator, as well as ultra-high vacuum technology and experiment control.

Prerequisites: a good knowledge of quantum mechanics is required and prior practical experience in optics or lasers is appreciated.

[1] Ultracold neutral plasmas, T.C. Killian, T. Pattard, T. Pohl, J.M. Rost, Phys. Rep. **449**, 77-130 (2007).

[2] Sculpted ultracold neutral plasmas, V.S. Dharodi, M.S. Murillo, Phys. Rev. E **101**, 023207 (2020).

[3] Laser cooling of ions in a neutral plasma, T.K. Langin, G.M. Gorman, T.C. Killian, Science **363**, 61-64 (2019)

¹ Saint-Jérôme campus can be reached by public transportation from the city centre in less than 25 minutes and the University can help PhD students coming from out of Marseilles to find accommodations.