INTERNSHIP PROPOSAL

Laboratory name: Laboratoire Aimé Cotton
CNRS identification code: UMR9025
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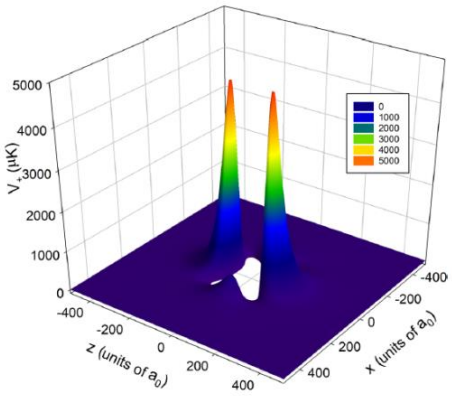
Internship location: Bâtiment 505, rue du Belvédère, Campus d'Orsay, 91405 Orsay

Thesis possibility after internship: YES
Funding: NO If YES, which type of funding: EDOM, QuanTip

Three-body interactions in molecular Bose-Einstein condensates

More than 25 years after the formation of ultracold molecules at Laboratoire Aimé Cotton (LAC) in Orsay [1], the first molecular Bose-Einstein condensate (BEC) was created this year in 2024 in the USA [2]. To achieve this, the experimental team used a microwave shielding technique between two molecules [3], technique that we proposed and investigated back in 2018 [4] during a previous Master 2 internship. As in atomic BECs (see the 2001 Nobel Prize in Physics [5]), collisions between three particles are also important to understand. This Master 2 internship will consist of theoretical and numerical investigations on three-body interactions of the molecules in the presence of the microwave. We will determine the conditions under which three-body protection can be efficient. The Master 2 internship can be pursued in our lab by a PhD thesis.



An effective model for the potential energy between two ultracold molecules as a function of their relative distance [Lassablière, Quéméner, Phys. Rev. A 106, 033311(2022)]. We want to find a similar repulsive potential to protect the molecules from three-body interactions.

It is recommended to have a good knowledge in Quantum Mechanics and in Atomic and Molecular Physics, especially in the Quantum Theory of Collisions (for a comprehensive lecture, see [6]). Programming skills are also required. We program in Fortran 90, a language that is relatively quick to learn, especially if you already have some knowledge of other languages such as C, Matlab, Mathematica, Python ...

[1] Fioretti et al., Phys. Rev. Lett. 80, 4402 (1998), "Formation of cold Cs2 molecules through photoassociation"
[2] Bigagli et al., Nature 631, 289 (2024), "Observation of Bose-Einstein condensation of dipolar molecules"
[3] Science & Vie n°1284, "On a créé le premier condensat de Bose-Einstein moléculaire", Septembre 2024
[4] Lassablière, Quéméner, Phys. Rev. Lett. 121, 163402 (2018), "Controlling the scattering length of ultracold dipolar molecules"
[5] Cornell, Wieman, Rev. Mod. Phys. 74, 875 (2002), "Nobel Lecture: Bose-Einstein condensation in a dilute gas, the first 70 years and some recent experiments" ; Ketterle, Rev. Mod. Phys. 74, 1131 (2002), "Nobel lecture: When atoms behave as waves: Bose-Einstein condensation and the atom laser"
[6] Quéméner, https://arxiv.org/abs/1703.09174

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