

Spécialité de Master « Optique, Matière, Paris »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (**ne pas dépasser 1 page**)

Date de la proposition : 15 novembre 2016

Responsable du stage / internship supervisor:		
Nom / name:	BOULOUFA-MAAFA	Prénom/ first name : NADIA
Tél :	0169352064	Fax : 0169410156
Courriel / mail:	Nadia.bouloufa@u-psud.fr	
Nom du Laboratoire / laboratory name: Laboratoire Aimé Cotton		
Code d'identification :	UMR9188	Organisme :
Site Internet / web site:	http://www.lac.u-psud.fr/spip.php?rubrique77	
Adresse / address:	Bât 505, Université Paris-Sud, Orsay	
Lieu du stage / internship place:	Bât 505, Université Paris-Sud, Orsay	

Titre du stage / internship title: **Control of ultracold quantum gases with shielded interactions**

Résumé / summary

Control of ultracold quantum gases with shielded interactions

The research field of cold ($T < 1\text{K}$) and ultracold ($T \ll 1\text{mK}$) molecules is continuously expanding in many directions, involving an increasing number of groups throughout the world. This research field actually has initiated a "revolution in molecular physics" [Grimm2005] similar to the one induced by laser-cooling of atoms and Bose-Einstein Condensation (BEC) in dilute gases of weakly interacting ultracold atoms. Due to their much richer internal structure than atoms, ultracold molecules have opened the way towards fascinating researches and new possibilities for controlling quantum systems. A few examples are: (i) High-resolution molecular spectroscopy; (ii) Precision measurements for testing fundamental theories; (iii) Quantum information devices ; (iv) Elementary chemical reactions and (v) Many-body physics.

A major breakthrough has recently been achieved, as molecules in the lowest vibrational level of their absolute ground state have been formed either by PA and optical pumping [Viteau2008] or by MA followed by Stimulated Rapid Adiabatic Passage (STIRAP) [Danzl2008, Ni2008,]. While paving the way towards a new kind of ultracold chemistry, collisions, in particular inelastic collisions, in general limit the possibility to use such ultracold molecular samples for other purposes. Soon came the desire of suppressing collisions using electromagnetic fields. The basic idea is to couple the initial molecular state of the colliding atoms to a repulsive excited molecular state using laser light detuned to the blue of a resonant atomic transition, preventing the atoms to come close to each other [Suominen1995].

The goal of this project is to identify repulsive excited channels appropriate for optical shielding and to describe their coupling with the initial state of the colliding atom pair (K and Cs atoms or Na and Rb) in the framework of the dressed-state picture where the coupling of the involved molecular states is induced by the blue-detuned laser light with Rabi frequency and treated under the rotating wave approximation. The problem will be treated in the framework of a semiclassical Landau-Zener model whose robustness has been assessed [Suominen1995, Suominen 1996] which would readily provide an indication of the shielding efficiency usable in the experiments. The role of spontaneous emission will also be investigated as it may become a limit of the shielding process due to the very weak relative velocities of the atoms at ultralow temperatures.

Good knowledge of *Atomic and Molecular Physics* is required.

Good programming skills (e.g., Fortran, Mathematica) are desirable.

[Grimm2005] R. Grimm, Nature 435, 1035 (2005)

[Guo 2016] M. Guo, B. Zhu, B. Lu, X. Ye, F. Wang, R. Vexiau, N. Bouloufa-Maafa, G. Quémener, O. Dulieu and D. Wang, *Physical Review Letters* **116**, 205303(2016)

[Ni2008] K.-K. Ni, et al., Science, 322, 231 (2008)

[Viteau2008] M. Viteau, A. Chotia, M. Allegrini, N. Bouloufa, O. Dulieu, D. Comparat, P. Pillet, Science 321, 232 (2008)

[Suominen1995] K.-A. Suominen, M. J. Holland, K. Burnett, and P. Julienne, Phys. Rev. A 51, 1446 (1995)

[Suominen1996] K.-A. Suominen, et al., Phys. Rev. A 53, 1658 (1996)

Toutes les rubriques ci-dessous doivent obligatoirement être remplies

Ce stage pourra-t-il se prolonger en thèse ? Possibility of a PhD ? : OUI/YES

Si oui, financement de thèse envisagé/ financial support for the PhD: ED Paris-Saclay

Lumière, Matière, Interactions

OUI

Lasers, Optique, Matière

OUI

Fiche à transmettre (fichier pdf **obligatoirement**) sur le site <http://stages.master-omp.fr>