Spécialité de Master « Optique, Matière, Plasmas »

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

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 12/12/2013

Responsable du stage / *internship supervisor*:

Nom / *name*:	MICHAUT	Prénom/ *first name* :	Xavier
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Nom du Laboratoire / *laboratory name*: Laboratoire de Physique Moléculaire pour l'Atmosphère et l'Astrophysique – futur LERMA2

Code d'identification : UMR CNRS 7092 Organisme : UPMC / CNRS

Site Internet / *web site*: www.lpmaa.jussieu.fr

Adresse / *address:* 4 Place Jussieu - Case courrier 76 - barre 32-33 – 3ème étage - 75252 Paris Cedex 5

Lieu du stage / *internship place*: LPMAA-LERMA2 (Paris6) and University of Sherbrooke (Canada)

Titre du stage / *internship title*: Selection and equilibration of nuclear spin states of hydrogenated molecules

Résumé / *summary*

The LPMAA that will merge with the LERMA to create the Laboratoire d'Etude du Rayonnement et de la Matière Asrophysique et Atmosphères (LERMA2) is developing laboratory experiments to understand processes involved in the evolution of the molecular matter present in space. Due to Pauli's exclusion principle, molecules like H_2, H_2O, H_2CO, NH_3 or CH_4, having protons in exchangeable positions, exist in several nuclear spin configurations. In the case of water, they are called *ortho* and *para* depending whether the spins of the protons are parallel (total nuclear spin *I=1*) or anti-parallel (*I=0*). In gaseous phase, each rotational state is associated with only one of the nuclear magnetic species and in the high temperature limit (above 50 K), it is known that 1/4 of the molecules are *para* while 3/4 are *ortho*. Below 50 K, the *Ortho-to-Para Ratio (OPR)* at equilibrium becomes strongly temperature-dependent. It is known that in cold media like coma of the comets or molecular clouds in the InterStellar Medium, the OPR does not systematically follow the thermodynamical statistics. This disequilibrium is poorly understood and interactions between gas and icy grains may have a crucial role to explain it. To experimentally answer to this question, it is needed to create in laboratory a controlled disequilibrium (or enrichment in one of the nuclear spin species) in gaseous phase before deposition on a cold substrate. While experimental set-ups allow the control of the OPR for H_2, using low temperature magnetic catalysis of nuclear spin conversion, only few allow the efficient nuclear spin enrichment ofthe medium for strongly polar molecules like H_2O. Efforts are made in the world to develop such techniques as the applications for the current highly puzzling astrophysics problematic, but also for new Nuclear Magnetic resonance (NMR) medical imaging, are important. During this internship, the student will participate to the development of experiments to enrich vapour water in one species (*ortho* or *para*) within a collaboration with Professor Patrick Ayotte (University of Sherbrooke - Canada). The student can be involved in the work performed in Sherbrooke in the context of an exchange program. In LPMAA-LERMA2 (France), a new method will be explored using optical pumping for molecules embedded in a noble gas solid at low temperature using IR pulsed laser beam. The nuclear spin states of water molecules will be probed using High Resolution Fourier Transform InfraRed Spectroscopy (FTIR). These techniques will be completed with experiments using magnetic lenses and UV Resonant Electron Multi Photon Ionization Spectroscopy (REMPI) under construction in the university of Sherbrooke (Canada). The measurements done with REMPI techniques will be simultaneously compared to measurements made with FTIR in cryogenic matrices.

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

Si oui, financement de thèse envisagé/ *financial support for the PhD***: MENRT (Co-tutelle envisaged with U. of Sherbrooke (Canada))**

Lasers, Optique, Matière	**OUI**	Lumière, Matière : Mesures Extrêmes	**OUI**
Plasmas : de l'espace au laboratoire			

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