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 : 04/11/2015

Responsable du stage / *internship supervisor*:

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Nom du Laboratoire / *laboratory name*: Laboratoire d'Etude du Rayonnement et de la Matière Astrophysique et Atmosphères (LERMA)

Code d'identification : UMR CNRS 8112 Organismes : UPMC / CNRS

Site Internet / *web site*: http://lerma.obspm.fr/

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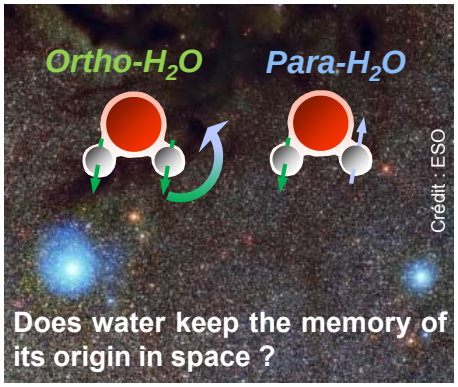
Lieu du stage / *internship place*: LERMA (UPMC)

Titre du stage / *internship title*: Selection of nuclear spin states of water molecules using optical pumping

Résumé / *summary*



Due to Pauli's exclusion principle, molecules like H_2, H_2O or CH_4 having protons in exchangeable positions exist in several nuclear spin configurations. In case of water, they are called *ortho* and *para* depending if 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. Under stellar radiations, comets and interstellar dust release in space a great variety of hydrogenated molecules detected from space or ground telescopes. Due to quantum properties of these species, the different nuclear spin families of molecules can be identified in the InfraRed Spectrum. Our research group leaded the GASOSPIN project for the study of the reequilibration of these peculiar families at low temperatures. Performed in physical conditions close to the ones found in space, the measurement will help to answer to the following question: is the disequilibrium observed between the relative abundance of nuclear spin families a clue of the thermal history of the hydrogenated molecules in space?

To investigate nuclear spin reequilibration, it is needed to enrich the medium with one of the nuclear spin species. While experimental set-ups allow the control of the OPR of H_2 using low temperature magnetic catalysis of nuclear spin conversion, only few allow enriching efficiently the medium with one of the other species for strongly polar molecules like H_2O. Our group in LERMA is working on optical techniques base on laser optical pumping for molecules embedded in a noble gas solid at low temperature.

During this internship, we propose to one student to develop the experiment of optical pumping in rare gas matrices. The student will have the opportunity to use and develop state-of-the-art laser-based non-linear techniques, and high resolution infrared techniques for the rotational spectroscopy of simple molecules. He(r) will develop skills in vacuum systems and very low temperature (< 10 K) processes. By the end of the internship, the student will be strongly familiar with spectroscopy of the nuclear spin states of water. This work could be then extended in a PhD work in close collaboration with astronomers in order to compare laboratory experiments and observations of OPR of H_2O in the Interstellar Medium and Comets.

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 – Labex Michem**

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

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