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 : 29/09/2018

Responsable du stage / *internship supervisor*:

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

Code d'identification : UMR CNRS 8112 Organismes : UPMC / CNRS / Observatoire de Paris

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

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

Lieu du stage / *internship place*: LERMA (UPMC) Tour 32-33 3ème étage

Titre du stage / *internship title*: **Nuclear spin Conversion of molecular hydrogen trapped on icy surfaces**

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-based telescopes. The abundances of *ortho-* and *para-* H_2 are known to play a strong role in the chemistry of hydrogenated molecules like H_2O, NH_3, or c-C_3H_2. It is then crucial to understand and quantify the physical processes that may influence these abundances in the interstellar medium, especially on the surface of the icy mantles of interstellar grains. 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**?

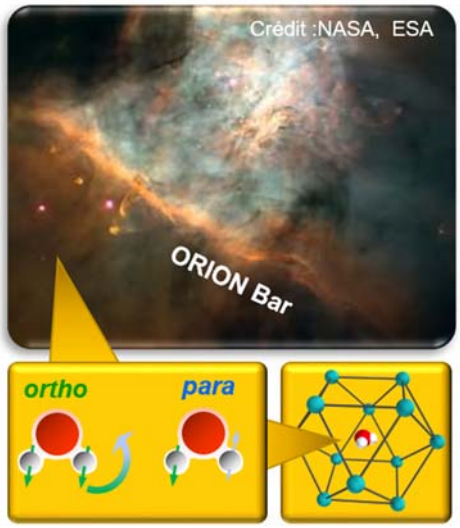

Figure. *Schematic illustration of the nuclear spin states of molecules, Nuclear Spin Conversion process and typical regions of space where the molecules are observed (here Orion bar).*

During this internship, we propose to develop with the members of the research group a set-up under high vacuum to investigate the nuclear spin conversion of molecular hydrogen H_2 trapped on icy surface and the equilibration of the quantum nuclear spin states when the molecules are released in the gas by thermal desorption. 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 (She) 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 H_2 and water. This work could be then extended in a PhD work in close collaboration with astronomers to investigate the role of the OPR of hydrogenated molecules in the Interstellar Medium and Comets. Collaboration with the University of Sherbrooke (Québec) is also envisaged.

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**

Lumière, Matière, Interactions	**X**	Lasers, Optique, Matière	**X**