Spécialité de Master « Optique, Matière, Plasmas »

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

Proposition de stage

Date de la proposition : 28 Novembre 2014

Responsable du stage / *internship supervisor*: **Pierre-Jean NACHER et Geneviève TASTEVIN**
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Nom du Laboratoire / *laboratory name*: **Laboratoire Kastler Brossel**
Code d'identification : UMR 8552 | Organisme : ENS / CNRS / Paris 6 / Coll. de France
Site Internet / *web site*: http://www.lkb.ens.fr/-Helium-polarise-et-fluides-
Lieu du stage / *internship place*: ENS 24 rue Lhomond 75005 Paris, pièce L164 / P5

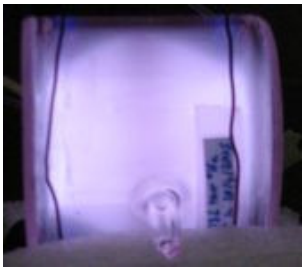
Optical pumping in helium plasmas: new tools and challenges

Context - In a helium plasma, a variety of excited states can be populated by electronic impact. The RF discharges used for optical pumping (O.P.) of He typically promote a small fraction of the atoms to the metastable 2^3S state. By O.P. on the 2^3S-2^3P transition (1083 nm) at room temperature, a very high nuclear polarisation of ^3He can be obtained (thanks to metastability exchange, a binary collisional process in which metastable and ground state He atoms exchange electronic-only excitation and orientation), which finds applications in various fields: lung MRI, spin filters for neutron beams, targets for high energy physics, etc.

Our recent work on O.P. has revealed that the polarisation currently achieved in pure ^3He gas, systematically lower than expected at high light intensity, is limited by a strong enhancement of nuclear relaxation due to the 1083 nm excitation. The objective, now, is to find the physical process(es) responsible for the extra loss of angular momentum. We need new optical tools for quantitative investigation of the changes induced in the plasma by O.P. and for direct monitoring of the time evolution of the distribution of atoms among the Zeeman sublevels of the involved ^3He excited states.

Internship projects - The internship will provide an opportunity for hands-on experience with light polarisation analysis, absorption and line shape measurements for excited species.

- Using tunable laser diodes (at 1083 and 706 nm), the student will probe and study the (re)distribution of angular momentum the 2^3P state during O.P.
- The abundance of 2^3S atoms is usually low (< a few ppm) and spatially non uniform in the rf plasma. The student will focus on the optimisation of the amount of pump light power absorbed by the gas, which essentially determines the O.P. rate, at fixed gas pressure.



Read more: http://www.lkb.ens.fr/Sujet-P-O-des-plasmas-d-He

PhD work - The primary challenge is to explain the increase of angular momentum loss which has been systematically observed (ultimately, of course, it is desirable to find a way to control or neutralise the source(s) of this laser-enhanced loss). The work will focus on the search for both the underlying physical process(es) and a way to quantitative describe its (their) contribution(s) to O.P. dynamics, in order to improve the available numerical models and make them fully reliable.

To this aim, experimental investigations may require new and complementary diagnoses, even in the so-called standard O.P. conditions (^3He gas at mbar pressure, room temperature, and mT field). The work may also involve comparative studies for various gas pressures, at high and low magnetic field, in pure ^3He or in isotopic ^3He-^4He mixtures. Emerging applications, such as high-sensitivity ^3He magnetometry, also provide new challenges. Some aspects of pioneering work on ^3He O.P. at low temperature performed at LKB may deserve to be revisited, with the improved experimental and theoretical tools.

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***: via l'ED**

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