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 :

Responsable du stage */ internship supervisor*:

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Nom du Laboratoire / *laboratory name*: Laboratoire de Physique des Lasers

Code d'identification :UMR 7538 Organisme : CNRS / Université Paris 13

Site Internet / *web site*: http://www-lpl.univ-paris13.fr
Adresse / *address:* 99 avenue J.-B. Clément 93430 Villetaneuse
Lieu du stage / *internship place*: Laboratoire de Physique des Lasers

Titre du stage / *internship title*: ***Towards the first observation of parity violation in chiral molecules by laser spectroscopy***

Résumé / *summary :* Three among the four fundamental interactions of nature (the electromagnetic, strong and gravitational interactions) conserve parity and are invariant under space inversion. However the weak interaction breaks this symmetry. Parity violation (PV) by the weak interaction is an essential ingredient of the standard model of particle physics, and its theoretical and experimental study has, up to now, essentially been limited to high energy physics and to the study of a few heavy atoms. Nevertheless, according to a theoretical proposal published in 1974, PV should lead to small energy differences between the two enantiomeric mirror image states of a chiral molecule. To date, no experiment has reached the sensitivity required to observe this tiny difference. The weakness of the effect represents a very difficult experimental challenge.

Our group is developing an ultra-high resolution infrared laser spectroscopy experiment (CO_2 laser, wavelength ~10µm) which will enable us to compare frequencies of the same rovibrational transition of two enantiomers. It will be based on a quantum optics technique called Doppler-free 2-photon Ramsey interferometry which requires to realise a matter wave interferometer on a supersonic jet of chiral molecules. With this setup we should reach a sensitivity of 10^{-15} in fractional value, that is to say observe, for a ~30 Thz rovibrational transition, a frequency difference of ~10 mHz between the right- and the left-handed molecule.

Long term issues for this project are the comparison of measurements with the electro-weak theory and the standard model, as well as the role of weak interaction in the origin of homochiral life (strong quantity imbalance between left- and right-handed biomolecules), a subject of debate. During this internship, the student will participate to ultra-high resolution spectroscopy experiments on chiral and achiral organo-metallic complexes. Supersonic beam spectroscopy of methyltrioxorhenium (MTO) will be carried out. MTO is an ideal test molecule, for which the synthesis of chiral derivatives considered for the PV test is currently under progress. Saturated absorption jet-spectroscopy, a major step towards the ultimate test, will be aimed for. We recently received samples of chiral derivatives of MTO, fullfilling alll the requirements of the ideal candidate molecule for a PV test. Laser spectroscopy of these new molecules will be started. This will require setting up suitable detection optical systems with the associated eletronics. In order to remove the constraint imposed by the narrow spectral window of CO_2 lasers, working with quantum cascade lasers (QCLs) seems very promising. The student will take part in testing and operating a new QCL-based infrared spectrometer, with which frequency measurements will be performed for the first time, with a view to install it on the main experiment.

The student will be supervised by a researcher, a postdoc and two PhD students working on the setup.

Toutes les rubriques ci-dessous doivent obligatoirement être remplies

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***: Allocation Ministère**

Lasers et matière	**X**	Lumière, Matière : Mesures Extrêmes	**X**
Optique de la science à la technologie	**X**	Plasmas : de l'espace au laboratoire	**X**

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