Stage de Master 2 / Master 2 internship

4 mois minimum, à partir de février-mars 2020 / minimum 4 months, from february-march 2020

Proposition de stage / Internship project

Date: 26/09/2019

Responsable du stage / *internship supervisor*:

Nom / *name*: SALIERES Prénom/ *first name* : Pascal

Tél : 01 69 08 63 39 Fax :

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Nom du Laboratoire / *laboratory name*: Laboratoire Interactions, Dynamiques et Lasers (LIDYL)

Code d'identification : Organisme : CEA

Site Internet / *web site*: http://iramis.cea.fr/LIDYL/

Adresse / *address:* LIDYL, Bat. 522, CEA-CNRS-Université Paris Saclay, 91191 Gif sur Yvette

Lieu du stage / *internship place*: CEA-Orme des Merisiers

Title: Generation of attosecond pulses for the study of ultrafast gas ionization

Summary :

The student will generate attosecond pulses using an intense Titanium:Sapphire laser. These ultrashort pulses will be used to investigate the ultrafast ionization dynamics of atomic and molecular gases, and in particular, to measure in real time the ejection of electronic wavepackets.

Detailed summary :

Recently, the generation of sub-femtosecond pulses, so-called attosecond pulses (1 as=10^{-18} s), has made impressive progress. These ultrashort pulses open new perspectives for the exploration of matter at unprecedented timescale. Their generation result from the strong nonlinear interaction of short intense laser pulses (~20 femtoseconds) focused in gases. High order harmonics of the fundamental frequency are produced, covering a large spectral bandwidth in the extreme ultraviolet (XUV) range. In the temporal domain, this coherent radiation forms a train of 100-attosecond pulses [1]. The generation of isolated attosecond pulses requires shortening the fundamental laser pulses to few-cycle duration (5-10 fs) using the 'post-compression' technique, currently under installation at ATTOLab.

With such attosecond pulses, it becomes possible to investigate the fastest dynamics in matter, i.e., electronic dynamics that occur naturally on this timescale. Attosecond spectroscopy thus allows studying fundamental processes such as photo-ionization, in order to answer questions such as: how long does it take to remove one electron from an atom or a molecule? The measurement of attosecond ionization delays is currently a "hot topic" in the scientific community. In particular, the study of the ionization dynamics close to resonances gives access to detailed information on the atomic/molecular structure, such as the electronic rearrangements in the remaining ion upon electron ejection. It becomes possible to observe in real time the buildup of resonance profiles [2,3].

The experimental work will include the development/operation of a setup installed on the FAB1 laser of the Excellence Equipment ATTOLab allowing: i) the generation of attosecond XUV pulses, ii) their characterization using quantum interferometry, iii) their use in photo-ionization spectroscopy (electron detection). The theoretical aspects could also be developed. The student will be trained in ultrafast optics, atomic and molecular physics, and will acquire a good mastery of charged particle spectrometry. The continuation on a PhD project is advised.

[1] Y. Mairesse, et al., Science **302**, 1540 (2003)

[2] V. Gruson, et al., Science **354**, 734 (2016)

[3] L. Barreau, et al., Phys. Rev. Lett. **122**, 253203 (2019)

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

Si oui, financement de thèse envisagé/ *financial support for the PhD***: CEA or EDOM fellowship**