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 : 17/10/2018

Responsable du stage / *internship supervisor*:

Nom / *name*:	KARR	Prénom/ *first name* :	Jean-Philippe
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Nom du Laboratoire / *laboratory name*: Laboratoire Kastler Brossel

Code d'identification : UMR 8552 Organisme : UPMC/CNRS/

Site Internet / *web site*: http://www.lkb.upmc.fr/iontrap/

Adresse / *address:* 4 place Jussieu, Case 74, 75252 Paris Cedex 05

Lieu du stage / *internship place*: Tour 13, couloir 13-12, 2ème étage

Titre du stage / *internship title*:

Schrödinger and Dirac equations for simple molecules

The theory of quantum electrodynamics (QED) has led to extremely precise theoretical predictions, which have been verified by similarly accurate experiments. Well-known examples are the electron's anomalous magnetic moment or the spectrum of the hydrogen atom. A current challenge for theory is to reach such high levels of accuracy in three-body systems like the H_2^+ ion (or its isotope HD^+), the simplest molecule in nature [1]. The goal is to explain the results of high-resolution spectroscopy experiments that are in progress in several groups [2,3] (including ours). Comparison between theory and experiment may improve determinations of fundamental physical constants such as the proton-to-electron mass ratio m_p/m_e and shed light on the well-known "proton-radius puzzle".

The **internship** will focus on the Schrödinger equation, with the aim of constructing a "non-adiabatic" electronic energy curve and testing its quality.
The main objective of the **PhD** will be to advance the theoretical accuracy by calculating yet unevaluated QED contributions. A non-perturbative method to calculate the one-loop self-energy correction will be developed, relying on numerical resolution of the Dirac equation for an electron in a two-center potential.

[1] V.I. Korobov, L. Hilico, and J.-Ph. Karr, *Fundamental Transitions and Ionization Energies of the Hydrogen Molecular Ions with Few ppt Uncertainty*, Phys. Rev. Lett. **118,** 233001 (2017).
[2] J. Biesheuvel et al., *Probing QED and fundamental constants through laser spectroscopy of vibrational transitions in HD^+*, Nature Commun. **7**, 10385 (2016).
[3] S. Alighanbari et al., *Rotational spectroscopy of cold and trapped molecular ions in the Lamb–Dicke regime*, Nature Phys. **14**, 555 (2018).

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***: EDPIF**

Lumière, Matière, Interactions	**OUI**	Lasers, Optique, Matière	**OUI**