Master 2 ICFP

Internship offer 2023/2024

Laboratory: Matériaux et Phénomènes Quantiques **(**MPQ UMR7162)
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Sympathetic laser cooling of the pair $^{88}Sr^{+}/^{9}Be^{+}$ in an ion trap: an experimental simulation of the trapping and cooling of antimatter ions (GBAR experiment)

Scientific project:

Laser cooled trapped ions are among the few physical systems in which quantum control has reached levels such that quantum information algorithms can be implemented (e.g. 2012 Nobel Prize for Physics awarded to David Wineland and Serge Haroche).

Quantum logic operations have also recently been used to develop a completely new spectroscopic technique (the quantum logic spectroscopy) that allow for unprecedented precision in optical clocks and, more generally, to address atomic or molecular transitions in species that cannot be directly laser-cooled. This technique is based on the so-called « sympathetic cooling » in which two species of ions are trapped in the same device and one of them is laser-cooled while the other is cooled through Coulomb interactions.

This technique will be implemented in an experiment at LMPQ (Quantum Information and Technologies/QITEe group) in the framework of a collaboration with LKB-jussieu (Trapped Ions group) with the pair of ions $^{88}Sr^{+}$ (cooler)/ $^{9}Be^{+}$ (spectroscopy ion). The project motivation is to study the behaviour of sympathetic cooling in a peculiar regime in which the mass ratio between co-trapped ions is quite high. This is the regime in which several future experiments will be performed such as the one proposed by the GBAR CERN collaboration devoted to understand the antimatter behaviour with respect to gravity and that includes the sympathetically cooling of an antimatter ion using laser-cooled matter ions.

During the proposed internship we will study the first experimental step consisting in the sympathetic cooling of $^{9}Be^{+}$ by a large number of $^{88}Sr^{+}$ ions in the so-called Doppler regime (Coulomb crystal).

Successful candidate should like atomic and molecular physics and have some background in optics. She / He will participate to the setup and operation of the optical bench dedicated to this experiment, with particular emphasis on the new UV laser for the cooling and addressing $^{9}Be^{+}$ ions.

Methods and techniques: laser cooling, ion trapping, metrology, laser spectroscopy,

Possibility to go on with a PhD ? YES
Envisaged fellowship ? PhD financed by an ANR grant of the ESPRIT project