Master 2: *International Centre for Fundamental Physics*

INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: Laboratoire Kastler Brossel
CNRS identification code: UMR 8552
Internship director'surname: Paul Indelicato
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Internship location: Laboratoire Kastler-Brossel, UPMC, 4 Place Jussieu, 75005

Thesis possibility after internship: YES/~~NO~~
Funding: ~~YES~~/NO If YES, which type of funding:

Tests of QED with highly charged ions and muonic atoms

From dark energy and dark matter, to neutrino oscillations and more, there is growing evidence that the Standard Model is not complete. Precision atomic physics experiments are a privileged ground for searching for new physics that would appear as small deviations from the predictions of quantum electrodynamics (QED). Simple, few charged particle systems are pursued, as these can be described most completely by the QED theory. Our group is a leader in two highest-precision x-ray spectroscopy experiments on this front: 1) highly charged, few-electron ions at Jussieu in Paris and 2) muonic atoms at the JPARC accelerator facility in Japan.

The internship will focus on the Paris experiments, where the ions of interest are produced in a plasma source and part-per-million precision spectroscopy is performed with a double crystal spectrometer. The student will take experimental data extending to higher-field (i.e. higher Z) systems, measuring transitions in Ar, Kr, Fe, and Xe, to test QED predictions and respond to questions linked to stellar observations and large discrepancy between theory and experiment for key systems like Ne-like Fe. Data analysis will be performed using Bayesian methods, in collaboration with M. Trassinelli (INSP).

In the long-term, the student will also have the opportunity to participate in development and data analysis for the muonic atom experiments in Japan. In these experiments, a muon has replaced an electron, and the new "exotic atom" features very large fields that enhance QED effects. A quantum transition edge sensing microcalorimeter detector is used to measure transitions between Rydberg states in muonic atoms for high-field QED tests, and searches for beyond standard model physics.

The Internship can be continued into a PhD, with possible extensions of these subjects subjects in the framework of the SPARC (Stored Particle Collaboration) for highly charged ions at GSI in Germany, or with antimatter systems at CERN.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: ~~YES~~/NO Macroscopic Physics and complexity: ~~YES~~/NO
Quantum Physics: YES/~~NO~~ Theoretical Physics: YES/~~NO~~