Ph.D. in **Test of quantum electrodynamics in strong Coulomb field**

The purpose of this internship/Ph.D thesis is to test bound-state Quantum Electrodynamics (QED) predictions in the regime of strong Coulomb fields and, in particular, the contribution of the bound electron-electron interaction in few-electron heavy highly charged ions (He-like and Li-like uranium, with only two and three bound electrons, respectively). The different contributions will be measured by high-accuracy X-ray spectroscopy of n=2 → n=2 intra-shell atomic transitions.

The measurement will be performed at the gas target of the ESR storage ring at the GSI Helmholtzzentrum (Darmstadt, Germany) for which 16 days of beam-time have been approved for the next beam-time period in 2020-21. The excited He-like ions of interest will be efficiently populated via electron capture from a N_2 target into initially H-like ions. Intra-shell emission in Li-like uranium can be more efficiently obtained by excitation in the same gaseous target. By an appropriate choice of the beam velocities, the intra-shell x-ray lines from He- and Li-like uranium, appearing near 4.5 keV, will be Doppler shifted to have the same energy in the laboratory reference frame. Two optimized Johann crystal spectrometers with a resolution of a few eV and viewing the same x-ray source under observation angles of ± 90° will serve as accurate wavelength comparators. With an anticipated accuracy of 0.2 eV on the absolute energy of He-like U transition and 0.08 eV on the relative energy difference between the transitions in He- and Li-like U, this experiment will test with unprecedented sensitivity both quantum-electrodynamics (QED) and electron correlation effects in He-like systems in the extremely strong field provided by the uranium nucleus.

The main tasks of the proposed Ph.D. are:

- A preliminary assembling of the twin spectrometers and measurement of their performances in terms of resolution and efficiency. In this step, the new position sensitive detectors and the new system for the calibration (X-ray tube coupled with a zinc fluorescence target) will be tested (here in Paris and mainly at the GSI Helmholtzzentrum).
- Set-up of the spectrometers at the ESR gas-jet target with control of the stability over several days/weeks and of the data acquisition system and synchronization with the accelerator cycle (at the GSI Helmholtzzentrum).
- Data acquisition during the beam time and check the stability of the two spectrometers with zinc florescence spectra acquisition.
- Analysis of the acquired data. The data will be analyzed by adapted home-made programs. In particular, Bayesian methods with the use of Poisson likelihood will be implemented.

Techniques involved: High-accuracy X-ray spectroscopy, beam-time at a large accelerator facility, data analysis with Bayesian methods

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