M2 internship in experimental nuclear and atomic physics

Test of a detection setup for the MORA project

Why are we living in a world of matter? What is the reason for the strong matter – antimatter asymmetry we observe in the Universe?

The MORA (Matter's Origin from the RadioActivity of trapped and oriented ions) project aims at searching for possible hints, by a precise measurement of the so-called D correlation in the nuclear beta decay of spin oriented ions. With an aimed sensitivity close to 10^{-5}, this measurement offers a large window to the search for sources of CP violation at much higher level than predicted by the Standard Model. It will be particularly sensitive to the existence of Leptoquarks which are hypothetical particles actively sought after at LHC.

Technically, MORA uses an innovative in-trap orientation method which combines the high trapping efficiency of a transparent Paul trap with beta-NMR laser orientation techniques (see schematic overview in Fig.1).

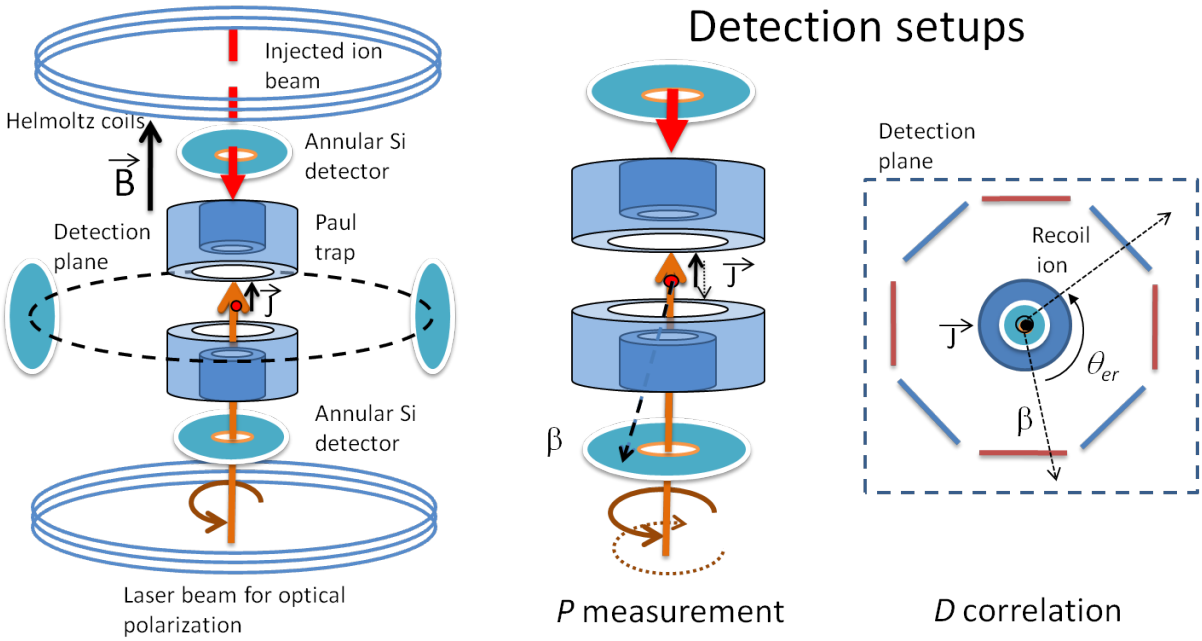

Figure 1: In trap optical polarization and detection setup. The ion cloud, materialized by the red disk in the pictures, is confined in the center of the trap. The spin orientation is obtained by an excitation of the hyperfine structure of the ions of the cloud by a circularly polarized laser beam. The degree of spin orientation of the ion cloud is monitored by a difference of count rates in the two annular Si detectors on the axis of the trap. The D correlation is measured in the azimuthal plane of the trap by an arrangement of Phoswhich and Micro-Channel-Plate detectors for the detection of beta particles and recoil ions, respectively.

The project will first focus on the proof-of-principle of the in-trap laser orientation technique, before the actual measurement of the D correlation in the decay of $^{23}Mg^{+}$ ions is undertaken. The first tests will be done at JYFL (Finland), before the apparatus

moves back to GANIL, taking benefit of the laser systems of the future DESIR facility and of the intense beams from SPIRAL 1.

The Master student will take in charge preliminary tests of the detection setup of MORA. A precise characterization of the performances of the detection setup is essential to evaluate some of the systematic effects which could limit the sensitivity of the D correlation measurement. The detection setup, shown in Fig. 1, is consisting of Micro-Channel Plate detectors for detecting recoiling ions and of two types of detectors for the beta particles: Si detectors in the axis of the trap for measuring the spin orientation degree, and Phoswhich detectors in the azimuthal plane for measuring the D correlation. A first Monte Carlo simulation of the detection setup via common tools such as GEANT 4 should be started. The master student will benefit from the support from the local teams from GANIL and LPC Caen.

Expected skills:

- Interest in fundamental physics
- Skills in instrumentation, detector physics, numerical methods
- Good communication skills and curiosity will also be valued

The master thesis work could be followed by a PhD thesis.

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