Internship in GANIL

CP – violation in nuclear β-decay: data analysis for the MORA project

Internship summary:

The goal of the internship is a contribution to the development of simulation tools for the analysis of the first experiments undertaken within the frame of the Matter's Origin from RadioActivity (MORA) project [1]. The MORA project gathers experts of ion manipulation in traps and laser orientation methods for searches of New Physics (NP) in nuclear beta decay, looking for possible hints to explain the matter-antimatter asymmetry observed in the Universe. The precise measurement of the so-called triple *D* correlation is sensitive to Time reversal violation, and via the CPT theorem, to CP violation. As such, the *D* correlation in nuclear beta decay is a complementary probe to the electric dipole moment of the neutron. It is particularly sensitive to the existence of Leptoquarks, which are hypothetical gauge bosons appearing in the first theories of baryogenesis, and in numerous theories beyond the Standard Model.

The symmetries of the MORA detection system and the well-controlled parameters of the trapped and polarized ion cloud permit to aim at a final sensitivity of a few 10^{-5} on *D*. Such a sensitivity is about one order of magnitude better than present limits on *D*, from measurements in neutron and ^{19}Ne decay. It should permit, in addition to look for signs of CP violation, to probe for the first time the so-called Final State Interaction (FSI) effects. The FSI effects, caused by the electromagnetic interaction of the recoiling nucleus with the β particle, are expected to mimic a tiny non-zero *D* at a level which varies from 10^{-5} to 10^{-4}, depending on the decaying nucleus. Their estimates rely on rather old calculations (1970's), which are presently being revised within the MORA project.

The ultimate sensitivity of MORA depends on how well systematic effects are kept under control. To this intent, dedicated studies and analysis tools have to be developed. One of the first milestone of the MORA project is the precise monitoring of the polarization degree of the ions confined in the trap, which are spin-oriented thanks to their repeated interaction with a laser light. Experimentally, the monitoring of the polarization degree consists in the continuous measurement of the beta asymmetry[1]. The aim of the internship will be to study the systematic effects that may affect the polarization degree measurement, and consequently, the *D* correlation measurement, with the GANIL MORA team.

Position details: Internship with the GANIL MORA team, consisting of a PhD student, a postdoctoral fellow, and 2 physicists.

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Desired skills: skills and interests in numerical methods and data analysis

[1] *The MORA project*, P. Delahaye, E. Liénard, I. Moore et al., Hyp. Int. (2019) 240:63; arXiv:1812.02970

[1] The beta assymetry was used in the late 1950's by Wu and coworkers for the discovery of parity violation in weak interaction.