PhD position in nuclear instrumentation

Study of an innovative system dedicated to the production of ions from neutron deficient metallic short-lived isotopes

The study of rare and exotic isotopes is essential to understanding the nucleosynthesis of elements in the Universe. These nuclei, being no longer naturally available on Earth, may be studied in the laboratory through nuclear physics experiments. It is therefore comprehensible that the production of exotic nuclei is a key research axis at both national and international accelerators, namely SPIRAL1 (Système de Production d'Ions Radioactifs Accélérés en Ligne phase 1) at GANIL (France), ISOLDE at CERN (Switzerland) and ISAC at TRIUMF (Canada), among others.

For robust results an accelerator must be able to provide a sufficiently wide range of nuclei, allowing to explore characteristics and abundances of neighbouring nuclei and their inter-connections. Nuclei of moderate exotism, not so far from stable isotopes, are rather easy to study, whereas more exotic nuclei, with extremely short lifetimes, render then difficult to observe. Consequently, issues related to the exploration of highly exotic regions of the nuclide chart rapidly increases with the level of exotism.

A production technique known as the "ISOL method" (Isotope Separator On Line) is currently in use in several world-class laboratories and has been in operation at GANIL/SPIRAL1 for over 13 years. A recent upgrade presently being commissioned aims to enlarge the choice of the radioactive ion beam production, in terms of both intensities and varieties. To reach this goal and so preserve the position of GANIL/SPIRAL1 among the leaders in this field, new production systems with competitive performances or performances unattainable at other installations must be regularly designed.

The aim in this PhD work is to design, construct, test and optimize a new and competitive ion production system. Short-lived isotopes of condensable elements (half-lives up to 10 ms, masses within the 70-130 range a neutron deficient) at sufficiently intense rates to allow for nuclear experiments are a key objective.

The TULIP project, financed by an ANR grant (2019-2023) provides the framework of the present PhD opening. Three main steps include: the production of neutron deficient short-lived ions using exotic alkali beams, a current development to be tested on-line in the first half of 2020 at the accelerator ALTO, based at the IPN in Orsay. The M2 project, obligatory prior to a PhD opportunity, will be dedicated to these tests. The production of exotic Ag isotopes using laser ionization, will also be explored at the IPN in Orsay. Finally, the production of ^{100}Sn ions, which are particularly attractive for the nuclear physicist community, and challenging in terms of instrumentation, is the last part of the TULIP project. In general, fast and efficient advanced instrumentation developments will be tested at ALTO prior to operating at the national facility GANIL/SPIRAL1. This is the technical aim of this thesis project.

The PhD work will be conducted within the "Groupe Cibles Sources" (composed of 15 persons). This group is in charge of the design and operation of both stable and radioactive ion sources at GANIL. The PhD work will be performed mainly at GANIL (comprising roughly 250 technicians and physicists), and also implies a close collaboration with IPNO laboratory.

<u>Expected skills</u>:
Solid knowledge in atomic and nuclear physics. Knowledge in instrumentation techniques: static electric and magnetic field calculations, simulation of the propagation of charged

particles in these fields (knowledge of SIMION code or equivalent), base of electronic, vacuum techniques up to 10^{-7}mbar, mechanics (reading and conceiving basic computer assisted designs). Fluent French and English. Ability to present his (her) work.

Inquisitive; easy contact; ability to self-question; strongly involved in his (her) activities; creative; eager to master and lead his (her) activities; pronounced taste for rising to the challenge and solving experimental issues (at a PhD level). The candidate retained must be highly motivated, with a desire to gain autonomy in their work. A rigorous scientific approach is essential to this study, and involves a knowledgeable mix of questioning, discussing, autonomous learning from literature and ability to stimulate group discussion around issues to create a diagnostic and identify solutions.

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