

Doctoral INPhINIT - INCOMING Fellowship Programme 2019 Call for applications

Position: Exotic properties of nuclei at the drip-line with active targets

Leader: Beatriz Fernández (beatriz.fernandez.dominguez@usc.es)

Centre description

The Galician Institute for High Energy Physics (Instituto Galego de Física de Altas Enerxías, IGFAE) is a joint research institute of the University of Santiago de Compostela and Xunta de Galicia (the Galician Autonomous Government). It was officially created on July 2, 1999. The main goal of the Institute is to coordinate and foster the scientific and technical research in the field of High Energy Physics, Particle and Nuclear Physics and related areas as Astrophysics, Medical Physics and Instrumentation. Of primary importance is the planning and promotion of the relation with large experimental facilities, especially with CERN, GSI/FAIR and the Pierre Auger Observatory at present.

The experimental groups at IGFAE coordinate the Spanish participation in the LHCb Collaboration at CERN, the Spanish participation in the Pierre Auger Observatory, as well as the Spanish participation in the GSI/FAIR nuclear facility. Members of the Institute have a relevant participation in the LHCb upgrade planning, in the LHeC project development and planning, etc. In the last couple of years, a new line has also been open with the building of a new facility (LaserPET) at the University of Santiago de Compostela aiming to produce radioisotopes for medical use by a laser-induced plasma accelerator. Moreover, the theory section of the Institute holds an excellent international reputation, with participation in different international committees, invitations to plenary talks and large-impact publications.

Research project and research line description

Active targets are very versatile devices. They are based on the working principle of a Time Projection Chamber (TPC) where the gas volume is also used as the target. These detectors present several advantages over standard detection equipment. Their ability to work with

relatively thick targets without loss of resolution, their large efficiency and their low-energy threshold makes them suitable devices for nuclear physics and astrophysics experiments nowadays. In particular, experiments with radioactive beams and limited intensity performed in inverse kinematics are often combined with active targets to boost the luminosity of the reaction.

Up to now, some of the main limitations for studying nuclei far from the stability were: the low- beam intensities of radioactive isotopes, the straggling in solid targets and the relatively high threshold in particle-detectors. The FICA group at the IGFAE has started an experimental program that exploit the use of active targets in combination with weak beams, permitting the use of a thicker target without loss in resolution. The candidate will work on the approved experiments with Active Targets at different international facilities such as HIE-ISOLDE/CERN, SPIRAL/GANIL (France) and RCNP (Japan). The FICA group conducts an innovative research to measure exotic systems, so-far unobserved, at the proton and neutron drip-lines with active targets where new features of the nuclear forces enter into play. Several theoretical approaches have been developed with contradictory results. Therefore, nuclei at and beyond the drip-lines are a good testing ground for our understanding of the nuclear many-body systems.

The use of TPC's type of detectors is steadily growing worldwide and spans several fields from neutrino physics, nuclear astrophysics and medical physics.

Job description

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The program at the proton drip line focuses on the study of ^{33}K and ^{21}Al using resonant elastic scattering. These nuclei are expected to show very interesting features such as halo

structures, mirror symmetry breaking and narrow resonances in the continuum. In addition, they are important for the rapid- proton (rp) process of the nucleosynthesis, which takes place in the hydrogen burning stage in stellar scenarios. These two studies are already approved at GANIL and HIE-ISOLDE with the European active target ACTAR TPC. On the neutron-rich side, we will focus on the study of neutron-rich Carbon isotopes: ^{16}C and ^{18}C through single-nucleon transfer using the AT TPC active target developed at NSCL (EEUU).