

## Doctoral INPhINIT - INCOMING Fellowship Programme 2021 Call for applications

**Position:** Ultra-high-energy cosmic ray and neutrino detection in astroparticle physics

**Leader:** Enrique Zas ([zas@fpaxp1.usc.es](mailto:zas@fpaxp1.usc.es))

### Centre description

The Galician Institute of 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 2nd 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, the Pierre Auger Observatory and LIGO at present.

The experimental groups at IGFAE coordinate the Spanish participation in the LHCb Collaboration at CERN (being the third group in size in the Collaboration), in the Pierre Auger Observatory, and in the GSI/FAIR nuclear facility. Members of the Institute have relevant participation in the LHCb upgrade planning and the HL-LHC activities. Besides, they are involved in the design of future facilities like in the EIC and FCC physics cases, the LHeC project development and planning, etc. In the last years, a new line has also been opened with the building of a new facility (L2A2) 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, with groups working on QCD, string theory and, more recently, on BSM, holds an excellent international reputation, with participation in many international committees, invitations to plenary talks in top conferences and large-impact publications. The institute holds two ERC grantees, one StG and one StG+AdG.

## Research project and research line description

The study of Ultra-High-Energy Cosmic Rays (UHECR) has been one of the main priorities in Astroparticle Physics for the past two decades. Particles with energies above  $10^{18}$  eV and even exceeding  $10^{20}$  eV have been detected since the 1960s. There are long-standing questions in High Energy Astrophysics regarding their production mechanisms, their sources and their primary composition.

The Astroparticle Physics group at IGFAE-Maria de Maeztu is well known for its long-standing role in the search of neutrinos and from its pioneering work on the calculation of coherent radio pulses from high energy showers. It consists of 4 senior members, a post-doc in hiring process and PhD students and it is carrying out several research lines in the field of Astroparticle Physics:

- Analysis of data collected with the Pierre Auger Observatory, the largest and most accurate UHECR detector in the world. In particular: reconstruction of high-zenith angle cosmic-ray-induced shower events to determine their energy spectrum, composition and arrival direction distribution; search for high-energy neutrinos in the context of multi-messenger astrophysics (including searches in collaboration with other installations such as LIGO); and interpretation of cosmic-ray data collected with the AERA radio detector of Auger and its future Radio Upgrade.
- The development of simulations to accurately account for the coherent radio-emission from showers in any environment, including dense media such as ice, salt or planet rock or more rarified environments such as the atmosphere, which act as the target where particle interactions take place and the showers develop.
- Phenomenology of cosmic-ray and neutrino detection in Astroparticle Physics, particularly the study of neutrino interactions and prospects and design-concepts of high-energy neutrino (and cosmic ray) observatories using all available techniques, namely particle arrays, fluorescence, Cherenkov and radio detectors.

## Job description

The successful candidate is expected to join the Astroparticle Physics group at IGFAE – Maria de Maeztu unit of Excellence and the corresponding PhD programme at Univ. of Santiago de

Compostela. She/he will get involved in a project in one (or more) of the above lines of research, which will be decided based on her/his profile. The projects span a wide range of possibilities ranging from analysis of data from the Pierre Auger Observatory, characterization of different radio signals in a variety of environments, developing simulations of radio pulses improving or extending existing ones, calculating expected rates of events in different experimental facilities and studying new design arrangements to optimize the detection of neutrinos.

We are seeking a highly-motivated PhD student who has taken courses on Particle Physics (experimental and theoretical) and/or Astroparticle Physics. The ideal candidate should have very good computing skills in C++, ROOT, python, etc. Previous experience with Monte Carlo simulations and a good knowledge of statistics will be most valued as well as any experience related to the any of the above lines of research. A good level of English language, capability to work in a group of people, and availability to travel is required.