Doctoral INPhINIT - INCOMING Fellowship Programme 2021 Call for applications

Position: Exploring dark sectors with the LHCb experiment at CERN

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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 Standard Model of Particle Physics (SM) is currently a very successful theoretical construction to explain the dynamics of particles at the most fundamental level. Despite its success, different theory and experimental arguments make us believe that the SM is not the final theory, so that physics Beyond the SM (BSM) are yet to be discovered.

In this project, we will search for new light particles whose existence would be a sign of BSM physics. For this, we will use the data collected by LHCb, one of the four big detectors of the LHC. Located at CERN, the LHC is the largest particle collider ever built. LHCb is a forward spectrometer whose acceptance and specific features make it complementary to the rest of the LHC experiments.

LHCb is very sensitive to models including dark sectors, consisting of new, light, weakly-coupled particles that do not interact with the known forces and would be very rarely produced at colliders. The goal of this project will be finding such dark particles in their decay to leptons, namely muons or electrons. The discovery of dark particles would have a huge scientific impact. Even if these are not found, this project will allow to set strong bounds in the theoretical models describing these dark sectors.

The project will first involve improving the trigger, reconstruction and identification capabilities of soft electrons and muons, typically produced by the decay of the new particles targeted by this project. Then a full search will be completed using the whole dataset collected by LHCb before 2019.

The project will take place within the USC HEP group. The HEP group includes several senior members, postdocs and PhD students. Most of the USC HEP group is involved in LHCb, where it has become one of the largest of the collaboration. Furthermore, the group counts on exceptional computing facilities. This includes the Spanish TIER-2 centre for the LHCb experiment and a local TIER-3, employed in the physics analyses carried out by the group.

Job description

As part of the USC HEP group, the candidate will be a member of the LHCb collaboration. As such, they will have access to the data collected by the detector, which will be used to complete their PhD. In the same regard, they will benefit from the advantages of being part of CERN and the University of Santiago. This includes, but it is not limited to, use of professional software, different types of training and advice for their career. The results of their research will result in several publications. Moreover, the technical developments achieved by the candidate, concerning, for instance, the improvements in the reconstruction of leptons, will be also important for several other scientific results from LHCb.

The candidate is expected to be based at the USC, but very frequent trips and stays at CERN are foreseen. The periods at CERN will account for (at least) 30% of their PhD time. During these periods at CERN, the candidate will be also asked to perform monitoring activities during the data taking and other service tasks needed for the collaboration. Furthermore, the candidate will attend one or two international conferences every year during their PhD. There, they will present the result of their work and other results from the LHCb collaboration.

The funded PhD student is expected to be a physicist with some background in particle physics, experimental physics and statistics. Moreover, they should have very good computing skills. Good knowledge of python is desirable. C++ knowledge would be a complement. Moreover, they should have notable communication abilities, since they are expected to present the results of their job very frequently, both in internal LHCb meetings and at international conferences. In the same regard, good writing skills are important for this position, since the candidate will have to write numerous reports and notes including their work. For the same reason, excellent knowledge of English is crucial too.