

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

**Position:** Gravitational waves & multi-messenger astronomy

**Leader:** Thomas Dent ([thomas.dent@usc.es](mailto:thomas.dent@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 position is within the newly-formed Gravitational Wave Astronomy group of IGFAE which pursues analysis of data from the Advanced LIGO-Virgo network of detectors (<https://www.ligo.org>, <http://www.virgo-gw.eu>), to detect GW sources and analyse their implications for astrophysics, cosmology and fundamental physics. The group is connected to the established Astroparticle research line at IGFAE which has made significant contributions to ultra-high energy cosmic ray science with Pierre Auger Observatory; joint research will also be undertaken using multi-messenger observations in gravitational waves and electromagnetic, neutrino or other signatures. The primary target of the GW data analysis group is merger events of binaries consisting of ultra-compact objects, neutron stars and/or black holes, ranging from about the mass of the sun up to hundreds of times more massive. Such sources provided the first directly detected gravitational wave signals in 2015 from mergers of massive stellar black hole binaries, and subsequently the first confirmed the joint source of GW and electromagnetic radiation, the merger of two neutron stars detected in August 2017. The multi-messenger observation of this event provided unique insights into the physics of gamma-ray burst sources and into the probable origin of heavy elements in the Solar System, as well as improved measurements of the masses and sizes of neutron stars. The group's activities will include updated methods to efficiently detect new signals in future data from a global GW detector network; methods to evaluate possible joint sources of GW and electromagnetic and neutrino signals, as opposed to random coincidences between unrelated events; and investigations into the, as yet unknown, origin of the observed black hole binaries.

## Job description

The position is a PhD studentship extending over 3 years under the supervision of Dr Thomas Dent and another senior researcher of the Cosmic Particles and Fundamental Physics IGFAE's strategic area. The student will engage in analysis of data from the upcoming 3rd Observing run of the LIGO-Virgo GW detector network and possible subsequent runs, and evaluation of the scientific implications of the resulting observations, both in GW alone and in combination with the electromagnetic and high-energy cosmic ray/neutrino windows.

The student will co-author scientific papers with researches in IGFAE and in the LIGO-Virgo collaboration for publication in recognised journals and will present work at regional, national and international meetings in related fields. The work will require or help to extend the student's skills in computing, particularly in programming in Python and other advanced languages and in the use of high throughput and distributed data processing; in statistical methods and data science; and in stellar and high energy astrophysics and related topics. Appropriate technical and personal training will be provided through the institute as well as by travel to relevant graduate schools and other events or courses.