(BL206/2025_IST-ID)

Post-Doctoral Research Fellowships

Applications are open for 1 Post-Doctoral Research Fellowships, within the framework of project GRAVITAS (101052587) - IST-ID (1801P.01220.1.01)/CENTRA, financed by european funds (HORIZON EUROPE) under the following conditions:

Scientific Area: Astronomy and Astrophysics

Admission Requirements:

a) *to hold a PhD degree obtained in the 3 years previously to the submission of the fellowship application;*

b) *to have carried out the research work that led to the PhD degree in a different entity from the host institution of the fellowship;*

c) *Not to exceed, with this fellowship contract, including the possible renovations, an accumulated period of 3 years in this type of fellowship, continuously or with interruptions;*

d) *Not to have previously held a post-doctoral fellowship from IST-ID.*

Workplan: The researcher will work on gravitational waves and the physics of black holes, including searches for physics beyond general relativity and the standard model, as well as understanding the predictions of general relativity in the context of black holes.

The ringdown phase of binary black hole mergers is described by linearised gravitational perturbations on a black hole background. This linear behaviour is characterized by a superposition of damped sinusoids known as quasinormal modes. The frequencies of these modes are fully determined by the properties of the remnant black hole. Thus, measuring this behaviour in a gravitational wave signal would be a strong test of consistency with General Relativity, as well as an independent measurement of the mass and spin of the black hole remnant. When black holes merge they are greatly distorted, and not necessarily well described by this linearised perturbation model. When and how they transition from this dynamic, non-linear, 'merger' phase to the linear 'ringdown' phase is an open question. The progress made in this field over the last few years has provided an estimate of the magnitude of various non-linear effects in ringdown. However, many questions remain unanswered. Among those is at what point a fixed frequency description (with the inclusion of extra non-linear fixed frequencies) breaks down. In his/her work the researcher must be able to use a combination of numerical techniques and analytic perturbation theory to model more accurately the ringdown phase of black hole mergers, determining the non-linear contributions to the gravitational wave signal. Boson clouds theoretically can be formed via superradiance around a black hole. Black hole superradiance is a process by which particles can extract energy from a black hole. Should they exist, these clouds would emit gravitational waves as well as potentially alter the dynamics in binary black hole mergers and affect the black hole spin population. Using these phenomena, gravitational wave astronomy allows us to use black holes as indirect detectors for evidence of ultralight bosons. The development of waveform models for boson clouds has made possible more sensitive searches for ultralight bosons. The project is particularly interested in the implications for binary follow up searches, where the binary merger event gives a measurement of the mass and spin of the remnant, and a corresponding boson mass window where signals are expected to be detectable. The researcher must work with the LVK collaboration on refining these gravitational wave searches to further constrain the parameter space of physics beyond the Standard Model. The project is also interested in the recent work on extreme mass ratio inspirals (EMRIs) in the presence of a boson cloud. Although the cloud is not expected to always survive the disruption of a second black hole, if the cloud does survive, it will have some impact

on the orbital dynamics. The researcher must investigate how numerical calculations might inform currently perturbative calculations for EMRIs in environments.

Legislation and Regulations: Statute of Scientific Research Fellow, approved by Law nr. 40/2004, of August 18, as worded by Decree-Law nr. 123/2019, of August 28 and https://dre.pt/application/file/a/127230968. IST-ID Regulation of Scientific Research Fellowships, available on https://ist-id.pt/files/sites/43/regulamento-de-bolsas-da-ist_id-2.pdf

Workplace: The work will be developed at CENTRA of Instituto Superior Técnico under the scientific supervision of Prof. Vitor Manuel dos Santos Cardoso.

Duration: The research fellowship will have the duration of 24 months. It's expected to begin in November 2025, and may be eventually renewed up to the maximum duration of the project, with the limit of 36 months, including the duration of the initial contract.

Monthly maintenance allowance: According to the values for Research Fellowships awarded by the financing program, the amount of the monthly maintenance allowance is € 2128,00, being the payment method an option of the Fellow by Wire Transfer.

Selection methods: The selection methods will be the following: *Curriculum evaluation, individual interview* with the respective weight of 50%+50%.

Composition of the selection Jury: Prof. Vitor Cardoso, Prof. Ilídio Lopes, Prof. David Hilditch.

Announcement/ notification of the results: The final evaluation results will be communicated to all applicants by email.

Application deadline and formalization: The call is open from September 1 until October 5, 2025.

It is mandatory to formalize applications with the submission of the following documents: i) B1 Form – Fellowship application (https://ist-id.pt/concursos/bolsas/); ii) *Curriculum Vitae*; iii) academic degree certificate; iv) motivation letter

Applications must be submitted to the email*:* vitor.cardoso@tecnico.ulisboa.pt