Table of Contents

Sommario

Curriculum 1 - Observation of the Universe

- (1A) Multi-wavelength observations of Galactic and extragalactic compact objects and transients (CUP -)

Funding institution: Scuola Universitaria Superiore IUSS Pavia
Doctoral site: Scuola Universitaria Superiore IUSS Pavia
Contact: Paolo Esposito [paolo.esposito@iusspavia.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

This position involves working on Galactic and extragalactic compact objects (white dwarfs, neutron stars and black holes) and astrophysical transients. Specifically, the scholarship is intended to study cutting-edge fields such as magnetars, ultra-luminous X-ray sources, bursts from compact objects, fast radio bursts, gamma-ray bursts, and tidal disruption events. The successful candidate will work on the analysis of data at all wavelengths from space and ground-based instruments, on their interpretation, and on the optimization of observation and data mining strategies. It will also be possible to participate in the development of new observatories and instruments.

- (1B) Support for Data Reduction and Analysis of the Euclid Mission (CUP -)

Funding institution: Istituto Nazionale di Astrofisica - INAF
Doctoral site: Istituto Nazionale di Astrofisica - INAF, Osservatorio Astronomico di Trieste
Contact: Andrea Zacchei [andrea.zacchei@inaf.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

This PhD project focuses on the development / update of algorithms used in the analysis of data from the Euclid mission, with particular emphasis on pipelines developed under Italian responsibility within the ground segment. The candidate will contribute to photometric and/or spectroscopic data processing, including analysis of systematics, validation, and quality control. Activities will involve the development of new algorithms, its integration into the pre-defined Euclid data processing system. The project will be carried out in collaboration with national and international teams, offering exposure to advanced computational tools and large-scale data infrastructures. The candidate will also have the opportunity to participate in the scientific exploitation of Euclid data.

- (1C) Study of charged particle fluxes with the HEPD02 detector of the Limadou/CSES-02 experiment (CUP -)

Funding institution: University of Turin - UNITO
Doctoral site: University of Turin - UNITO
Contact: Stefania Maria Beolé [stefania.beole@unito.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The PhD project is devoted to the analysis of data from the Limadou/CSES-02 experiment, with particular emphasis on the measurement of charged particle fluxes using HEPD-02. The research activity will focus on measuring the fluxes of electrons, protons, and light nuclei in the low- and medium-energy range.

A central objective will be the spectral and temporal reconstruction of these fluxes as a function of orbital position, geomagnetic conditions, and solar activity.

Particular emphasis will be placed on the study of the HEPD-02 direction detector, an innovative MAPS pixel tracker designed to reconstruct the arrival direction of particles. The analysis will combine tracking information, clustering in the silicon detector, and calorimetric variables to improve the identification of charged particle species. Selection and classification algorithms will be developed and optimized, also through multivariate techniques and deep learning approaches.

The results will be compared with previous data from the Limadou collaboration and with models of cosmic-ray propagation and magnetospheric physics.

- (1D) Study of the fundamental properties of antimatter in the ALPHA experiment at CERN (CUP -)

Funding institution: University of Brescia - UNIBS
Doctoral site: University of Brescia - UNIBS
Contact: Germano Bonomi [germano.bonomi@unibs.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

Experimental study of the fundamental properties of antimatter, with particular emphasis on antihydrogen, within the ALPHA collaboration. The research aims to test the fundamental principles of physics through precision spectroscopic measurements of antihydrogen, comparing its energy levels with those of hydrogen in order to verify CPT symmetry, ultimately connected with the origin of the Universe. A further central objective concerns the study of the gravitational interaction between matter and antimatter, a topic of major importance for fundamental physics, cosmology, and theories beyond the Standard Model. The project combines the development and use of advanced instrumentation, state of the art observational techniques, and high complexity data analysis within a strongly interdisciplinary framework that integrates particle physics and atomic physics.

- (1E) Gamma-ray astronomy with the next-generation observatories ASTRI and CTAO (CUP -)

Funding institution: Scuola Universitaria Superiore IUSS Pavia & National Institute for Astrophysics - INAF
Doctoral site: Scuola Universitaria Superiore IUSS Pavia
Contact: Paolo Esposito [paolo.esposito@iusspavia.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The ASTRI (Astrofisica con Specchi a Tecnologia Replicante Italiana) mini-array is a system of Cherenkov telescopes designed to observe the sky in the ultra-high-energy gamma-ray band (1–200 TeV). Its objectives are to study cosmic ray accelerators at extreme energies, known as PeVatrons. Although the array is scheduled for completion in mid-2027, data collection is already underway using a fraction of the infrastructure.

ASTRI plays a fundamental role as a precursor to the CTAO (Cherenkov Telescope Array Observatory), the major international project destined to become the largest gamma-ray observatory of the coming decades.

The selected PhD candidate will join the team dedicated to the development of both instruments, ASTRI and CTAO, and will have the opportunity to participate actively in the analysis and publication of data collected by ASTRI. The ideal candidate will develop a solid theoretical understanding of the astrophysical systems under study and, at the same time, gain experience in Cherenkov data collection and analysis techniques.

Curriculum 2 – Earth and the Sun-Earth system

- (2A) Foundation models for anomaly detection of ionospheric phenomena and correlation with seismo-induced events (CUP -)

Funding institution: Fondazione Bruno Kessler - FBK
Doctoral site: Fondazione Bruno Kessler - FBK
Contact: Andrea Di Luca [adiluca@fbk.eu]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The Limadou project gathers some Italian institutions participating in the China Seismo Electromagnetic Satellite (CSES) mission. CSES consists of a constellation of satellites, designed to pursue the deepest campaign of observation of the ionosphere. One of the most important scientific goals of the mission is to look for correlations between transient phenomena in the ionosphere and seismic events. The successful candidate will develop and apply state-of-the-art machine learning techniques to enhance the detection of ionospheric anomalies and their potential correlations with seismic activities. In particular, the research will focus on employing foundation models that can interpret complex patterns in space and time observations. Candidates with a strong background in data science, machine learning, and space physics are encouraged to apply. This position offers the opportunity to work with leading experts and institutions, including collaborations with INFN-TIFPA and Fondazione Bruno Kessler.

Intellectual Property Notice for PhD candidates under the UniTrento-FBK Agreement

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Transfer of Intellectual Property Rights. FBK will establish agreements with PhD students regarding the transfer of intellectual property rights related to their research results.

Collaboration with UniTrento. If UniTrento academic staff contribute to research results obtained through PhD scholarships funded by FBK, the determination of IP shares will be defined through separate written agreements based on each party's contribution. PhD students are required to collaborate with UniTrento in all necessary activities related to the joint management of IP.

- (2B) Development of space weather tools using the CSES1/2 Constellation (CUP -)

Funding institution: Istituto Nazionale di Geofisica e Vulcanologia - INGV

Doctoral site: Istituto Nazionale di Geofisica e Vulcanologia – INGV, Roma section
Contact: Marco Cristoforetti [mcristofo@fbk.eu]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

Space weather forecasting using data from the CSES1/2 constellation. The Sino-Italian constellation, comprising the CSES1 and CSES2 satellites – which have been operating in pair since 2025 and as individual satellites since 2018 – provides a large amount of high-precision data on: the magnetic field (static and low-frequency), electric field (static and low-frequency), trapped particles and plasma to develop forecast models and enhance Space Weather services. In particular, the data from CSES2 are collected across the entire polar orbit, reaching high latitudes which are particularly sensitive to disturbances of heliospheric origin. These are unique data of their kind which will contribute both to space weather forecasting and to the warning systems developed within the context of the INGV's Centre for Space-based Earth Observations (COS).

- (2C) Characterisation of Solar Energetic Events through the Analysis of Multiband Time Series and Images from Ground-based and Space Observations (CUP C53C23001330005)

Funding institution: Istituto Nazionale di Astrofisica - INAF
Doctoral site: Istituto Nazionale di Astrofisica - INAF, Osservatorio Astronomico di Trieste
Contact: Valentina Alberti [valentina.alberti@inaf.it]
Funds: Project Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

This project focuses on the development of advanced techniques for analysing time series data to extract meaningful physical information about energetic solar events. By leveraging temporal variability, these methods enable the identification of underlying processes, characteristic timescales, and dynamics of the solar atmosphere. Complementing this approach, multiband imaging provides crucial spatial context, allowing for the localisation and morphological interpretation of the observed phenomena. The combined use of time series analysis and imaging thus offers a more comprehensive understanding of solar activity, enhancing our ability to interpret complex events through both their temporal evolution and spatial structure.

- (2D) Study of lithospheric deformations using imaging and non-imaging satellite data (CUP I53D24000060005)

Funding institution: University of Siena
Doctoral site: University of Siena
Contact: Riccardo Salvini [riccardo.salvini@unisi.it]
Funds: Project Funds / Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

Given the rapid technological evolution of space missions for Earth observation and the ongoing climate changes, the research project proposes the use of satellite data, combined with field checks and available geophysical databases, for the study of geological processes from the space. In

particular, the study of seismic and volcanic activities, as well as gravitational events, will be carried out through satellite techniques using optical passive images (RGB, multispectral and hyperspectral, mono and stereoscopic), active scenes (i.e., SAR) and emitters of opportunity. Furthermore, non-imaging data will be used to analyze the relationships between lithospheric deformations and the rapid variation of ionospheric and magnetospheric parameters.

- (2E) Study on the use of new observation technologies from space for spatially explicit estimation of forest variables (CUP F63C25000370005)

Funding institution: Agenzia Spaziale Italiana - ASI
Doctoral site: University of Florence
Contact: Gherardo Chirici [gherardo.chirici@unifi.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

Technological advancement in the field of observation from space now makes available more and more data sources with increasing spatial resolution, temporal frequency, and spectral and radiometric detail, whether passive (multi or hyperspectral) or active (radar) technologies. On the other hand, the source of data for deriving official estimates of descriptive variables of forest ecosystems (extent, biomass, pollutant removal, biodiversity) and their dynamics over time are based on traditional forms of ground surveys based on formal statistical sampling plans. The theme of the doctoral project is the development of modern systems for spatially explicit estimation of these forest variables by integrating ground surveys with multi-sensor remote sensing imagery, such as that acquired by the IRIDE satellite system, with machine learning and artificial intelligence algorithms. These methods may in the future provide an innovative new approach for developing new forest monitoring systems, including in the context of climate change scenarios.

- (2F) Solar Storm Tracking Models for the Moon and Mars (METEOLEM) (CUP F63C26000380001)

Funding institution: Italian Space Agency - ASI
Doctoral site: University of Calabria - UNICAL
Contact: Sergio Servidio [sergio.servidio@fis.unical.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The PhD project "Solar Storm Tracking Models for the Moon and Mars" (METEOLEM) aims to develop a predictive system for solar energetic particle (SEP) risk assessment in view of human exploration of the Moon and Mars. The project addresses this issue through a multiscale and interdisciplinary approach that integrates solar physics, heliospheric plasma physics, and turbulence theory. Using the PLUTO MHD code, a coronal mass ejection (CME) will be simulated to characterize magnetic reconnection processes responsible for particle acceleration, defining the source region, spectral distribution, and initial anisotropy. These data then serve as input for the EUHFORIA code, where magnetic field line tracking techniques determine the connectivity between the CME source region and the Moon and Mars, identifying the potentially most exposed areas. The critical breakthrough involves incorporating a sub-grid magnetic turbulence model into

field line tracking, using Monte Carlo techniques to simulate random walk and pitch-angle scattering. Realistic turbulence spectra and diffusion coefficients yield probabilistic particle flux distributions on lunar and Martian surfaces, accounting for both large-scale connectivity and micro-turbulence diffusion. The final output comprises risk maps for extreme CME events, quantifying the probability of >10 MeV proton radiation lethal to astronauts and damaging to extraterrestrial infrastructure. The project links CME simulations with turbulence models for SEP forecasting, producing operational risk maps directly usable by ASI and ESA for mission planning and crew safety, and will benefit from research periods at KU Leuven and other research centers.

Positions reserved for candidates of Kenyan nationality

- (2KA) Generative AI for Space Weather Nowcasting (CUP F63C26000230005)

Funding institution: Italian Space Agency - ASI
Doctoral site: Fondazione Bruno Kessler - FBK
Contact: Marco Cristoforetti [mcristofo@fbk.eu]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

Solar activity can severely disrupt GNSS positioning, aviation communications, and power grids by perturbing the Earth's ionosphere. Forecasting these disturbances at short lead times is an open and practically relevant problem: physics-based models are hard to adopt for responding during rapidly evolving geomagnetic storms, and simple data extrapolation breaks down exactly when it matters most.

Approaches based on AI, developed for precipitation nowcasting, have strong potential for adaptation, e.g., to ionospheric Total Electron Content maps, available as globally gridded products updated every 15 minutes. The core challenge is that ionospheric dynamics are driven by external solar forcing with no meteorological analog, requiring the model to integrate multimodal inputs to anticipate the onset and spatial evolution of ionospheric storms.

The successful candidate will work at the intersection of deep learning and space physics, in close collaboration with FBK researchers.

Curriculum 3 - Planetary Sciences

- (3A) Integrated Laboratory Characterization of Lunar Analogues and Development of Simulation Systems for Lunar Resource Exploration Sensors (CUP C53C24001850005)

Funding institution: Istituto Nazionale di Astrofisica - INAF
Doctoral site: Istituto Nazionale di Astrofisica - INAF, Osservatorio Astronomico di Capodimonte (Napoli)
Contact: Francesca Esposito [francesca.esposito@inaf.it]
Funds: Project Funds
Mobility abroad: compulsory, minimum 6 months.
Periods in companies/research centres/public administrations: optional

INAF is developing space instrumentation for the exploration and mapping of lunar resources and for the investigation of the Moon's environment, with particular emphasis on dust–plasma–surface interactions.

The research activity focuses on the detailed laboratory characterization of lunar analogue materials required for the calibration and validation of sensors currently under development for resource detection and environmental measurements on the Moon. In parallel, the work includes the design and testing of technological solutions aimed at upgrading the INAF lunar simulation facility, enhancing its capability to reproduce representative lunar environmental conditions.

The student will be integrated into ongoing national-level projects within INAF and will have the opportunity to collaborate with researchers from multiple institutes (Naples, Padua, Rome, Trieste, Bologna), within a stimulating and multidisciplinary research environment.

Curriculum 4 - Astrobiology, Life Sciences and Space Medicine

- (4A) Bioengineering approaches to neurophysiology in the space environment (CUP E84I19001220005)

Funding institution: University of Rome Tor Vergata
Doctoral site: University of Rome Tor Vergata
Contact: Myrka Zago [myrka.zago@uniroma2.it]
Funds: Project Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

Future human space exploration programs represent extraordinary milestones for the sustainable development of our civilization, contributing to our social and economic well-being. However, these programs also pose significant challenges to human health. The main objective of the research is to study the physiological and biological bases of space adaptations, sensory deconditioning, and the internal model of gravity.

Understanding these aspects is crucial for developing effective countermeasures to protect astronauts' health during long-duration space missions. This research will provide insights into how the human body adapts to the microgravity environment of space and the implications for long-term human presence beyond Earth. The PhD position in Space Sciences and Technology, offered by the University of Rome Tor Vergata, focuses on Human Life Science and Space Medicine. This program specifically addresses the physiological and biological bases of space adaptations, aiming to equip researchers with the knowledge and skills needed to tackle these complex challenges and contribute to the future of human space exploration.

- (4B) Bioengineering approaches to neurophysiology in the space environment (CUP E84I19001220005 e E53C23002510002)

Funding institution: University of Rome Tor Vergata
Doctoral site: University of Rome Tor Vergata
Contact: Myrka Zago [myrka.zago@uniroma2.it]
Funds: Project Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

Future human space exploration programs represent extraordinary milestones for the sustainable development of our civilization, contributing to our social and economic well-being. However, these programs also pose significant challenges to human health. The main objective of the research is to study the physiological and biological bases of space adaptations, sensory deconditioning, and the internal model of gravity.

Understanding these aspects is crucial for developing effective countermeasures to protect astronauts' health during long-duration space missions. This research will provide insights into how the human body adapts to the microgravity environment of space and the implications for long-term human presence beyond Earth. The PhD position in Space Sciences and Technology, offered by the University of Rome Tor Vergata, focuses on Human Life Science and Space Medicine. This program specifically addresses the physiological and biological bases of space adaptations, aiming to equip researchers with the knowledge and skills needed to tackle these complex challenges and contribute to the future of human space exploration.

Applicants must demonstrate prior participation in space research projects funded by national and/or international space agencies. Such experience can be proved with appropriate documentation, including contracts, appointment letters, or official project deliverables.

- (4C) Space Nutrition: Optimizing Protein and Energy Intake to Preserve Skeletal Muscle and Cardiovascular Health (CUP F63C26000380001)

Funding institution: Italian Space Agency - ASI
Doctoral site: University of Trieste - UNITS
Contact: Gianni Biolo [biolo@units.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 12 months
Periods in companies/research centres/public administrations: optional

Space nutrition is a strategic field for human exploration, as prolonged exposure to microgravity induces skeletal muscle loss, anabolic and insulin resistance, redox imbalance, lipid remodeling and increased cardiovascular vulnerability. This PhD project, within the National PhD Programme in Space Science and Technology at the University of Trieste, aims to define optimized protein and energy strategies to preserve muscle and cardiometabolic health during simulated and real spaceflight. The doctoral research will be embedded in an active space biomedicine programme coordinated by the "Clinica Medica" Unit of the Department of Medical Surgical and Health Sciences of the University of Trieste, building on ongoing ASI and ESA projects, including HDT bed-rest, dry-immersion, nutritional countermeasure studies and the ASI-ESA NUTRISS project on energy balance aboard the International Space Station. Using head-down tilt bed rest and dry immersion as terrestrial microgravity analogues, the project will investigate the interaction between muscle protein turnover, insulin sensitivity, lipid metabolism, redox regulation, endocrine pathways including the renin–angiotensin–aldosterone system, and sex-specific responses. Methods will include stable isotope tracers, DEXA and MRI, metabolomics, lipidomics, endocrine biomarkers, and omics-based pathway analyses. The expected outcome is the identification of integrated biomarkers and personalized countermeasures combining nutrition, exercise and potentially pharmacological approaches. The project will generate translational knowledge relevant to spaceflight, ageing, immobilization, sarcopenia and chronic disease.

Curriculum 5 - Space sensing and instrumentation

- (5A) Detection of space debris by networks of distributed radars (CUP -)

Funding institution: Consorzio nazionale interuniversitario per le telecomunicazioni - CNIT
Doctoral site: Laboratorio Nazionale di Reti e Tecnologie Fotoniche con sede a PISA - Consorzio nazionale interuniversitario per le telecomunicazioni
Contact: Paolo Ghelfi [paolo.ghelfi@cnit.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

As satellites are filling up the lowest orbits with mega constellation, the problem of detecting and tracking small debris is becoming urgent. This project proposes to study a solution based on a network of distributed radars at high frequency, significantly improving the resolution of the detection to about 1cm by exploiting the coherent observation from multiple viewpoints.

- (5B) Design and prototype characterization of innovative high energy particle detectors for space application (CUP -)

Funding institution: National Institute for Nuclear Physics - INFN
Doctoral site: National Institute for Nuclear Physics – INFN, Bari or Rome section
Contact: Fabio Gargano [fabio.gargano@ba.infn.it]; Roberta Sparvoli [roberta.sparvoli@roma2.infn.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The design and characterization of innovative high-energy particle detectors for space applications is a critical area of research that seeks to develop advanced technology capable of detecting and measuring high-energy particles in space. These detectors are essential for studying the space environment, such as the radiation levels in space, the properties of cosmic rays, and the behavior of high-energy particles. The design process involves the development of advanced prototypes, which are then characterized using a range of techniques to evaluate their performance and suitability for use in space missions. Ultimately, this research aims to improve our understanding of the space environment and support the development of space-based technologies.

- (5C) Development of 3D-Integrated Trench-Isolated LGADs For Detecting Low-Energy X-Rays in Space Experiments (CUP C63C23001090006)

Funding institution: Fondazione Bruno Kessler - FBK
Doctoral site: Fondazione Bruno Kessler - FBK
Contact: Ashish Bisht [abisht@fbk.eu]
Funds: Project Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

Low Gain Avalanche Diodes (LGADs) are silicon detectors that utilize the impact ionization process to achieve gain values of ~10. While LGADs have been optimized for high precision timing (σt~30 ps) in charged particle detection, standard gain-layer segmentation typically limits the fill factor due to significant “dead area” between pixels.

Trench-Isolated Low Gain Avalanche Diodes (TI-LGADs) is an alternative technological approach to achieve fine segmentation in LGADs. Developed by FBK, this technology replaces traditional junction termination extension (JTE) and p-stop with sub-micron trenches (<1 μm) filled with dielectric material (SiO2). This innovation reduces the nominal inter-pixel no-gain width from the standard 30–80 μm to less than 3 μm, enabling a fill-factor of nearly 80% for a 50 μm pitch sensor. Furthermore, TI-LGAD sensors manufactured with a double-sided process hold promise for soft X-ray detection. They can provide a reasonably high fill factor, small pixels down to 25 μm, and simultaneously offer the possibility to integrate an entrance window on the sensor backside.

Next-generation X-ray telescopes require significantly higher quantum efficiency across the soft X-ray band to observe faint celestial objects—capabilities that current CCD or SDD-based detectors struggle to meet. By coupling TI-LGADs with the custom XPOL-III readout ASIC, this integrated system can achieve microsecond timing resolution and extend sensitivity to low-energy photons (~1 keV). The result is a comprehensive 5D resolution solution for the next generation of space-based ionizing radiation detection.

The successful candidate will be involved in the development and characterization of the TI-LGADs with an optimized entrance window on the sensor backside. The main activities of this position will be focused on:

· the characterization of sensors using infrared/visible, x-ray and gamma radiation, as well as charged particles; these tasks will be mainly performed in the laboratories of FBK;

· development and optimization of new characterization setups.

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- (5D) Integration and calibration of the hyperspectral stereo camera (SHY-4D) for a lunar rover (CUP C53C24001850005)

Funding institution: Istituto Nazionale di Astrofisica - INAF
Doctoral site: Istituto Nazionale di Astrofisica - INAF, Osservatorio Astronomico di Padova
Contact: Gabriele Cremonese [gabriele.cremonese@inaf.it]
Funds: Project Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

SHY-4D is a hyperspectral stereo camera that we are realizing for a lunar rover within the strategic project INAF-CNR HARLOCK. The instrument consists of two hyperspectral cameras, working in the visible spectral range. The two cameras will rotate by 360 degrees collecting stereo pairs for each

spectral band; in so doing we can generate hyperspectral Digital Terrain Model. It means we provide for each pixel of the 3D image the spectral information. The camera is a new design based on lenses plus a linear variable filter deposited on top the detector. The PhD student will support the final design of the camera, the integration of the optical elements and the detector, and the calibration on the optical bench.

- (5E) Multimessenger observation of UHE neutral messengers (CUP -)

Funding institution: University of Palermo - UNIPA
Doctoral site: University of Palermo - UNIPA
Contact: Giovanni Marsella [giovanni.marsella@unipa.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

We propose to investigate the possibilities of searches for ultra-high energy photons and neutrinos as counterparts of transient astronomical events (merging of compact objects, explosions of massive stars, jets from supermassive black holes hosted by active galaxies).

The development of synergies between ground-based and space-based observatories will have a key role in this scenario.

Satellites and large field of view ground-based observatories are important in order to provide external triggers to telescopes for a complete multimessenger follow-up.

This work aims at investigating this research area with both simulations and real data and will be carried out within one or more experiments currently operating, like the Pierre Auger Observatory, Km3NET, the Cherenkov Telescope Array Observatory, FERMI, Dampe,…

- (5F) Development of Bent-Crystal Optics for X-ray Spectrometry and Imaging (CUP -)

Funding institution: University of Ferrara - UNIFE
Doctoral site: University of Ferrara - UNIFE
Contact: Andrea Mazzolari [mazzolari@fe.infn.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The PhD project is devoted to the development of advanced optics for X-ray sources, with the aim of improving the precision and efficiency of spectroscopic, diffraction, and imaging measurements through the investigation of innovative materials. The research will focus on X-ray diffraction in bent crystals and its applications to high-resolution spectrometry and imaging, as well as on the development and testing of hardware for future X-ray missions. The programme includes modelling, simulation, and experimental characterization activities, to be carried out both in the laboratory and at synchrotron light facilities. A further objective is the development of Laue lenses for the focusing of X-ray and gamma-ray radiation, with potential applications in future satellite-based observations and advanced scientific instrumentation.

- (5G) Experimental Astroparticle Physics for Space Applications (CUP E53D23002110006)

Funding institution: University of Trento- UNITN
Doctoral site: University of Trento- UNITN
Contact: Roberto Iuppa [roberto.iuppa@unitn.it]
Funds: Institutional Funds / Project Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The PhD project will focus on the development and scientific exploitation of next-generation particle detectors for space missions, with applications to cosmic-ray physics, space weather, transient phenomena, and direct measurements of charged particles in low-Earth orbit.

The research activity is expected to involve a combination of:

- detector development and characterization;
- Monte Carlo simulation of particle detectors;
- analysis of data from space-borne instruments;
- development of machine-learning methods for event reconstruction and classification;
- participation in large international collaborations in astroparticle physics and space science.

The position is particularly suitable for candidates with a solid background in experimental physics, detector instrumentation, electronics, scientific computing, or closely related disciplines.

Candidates primarily interested in theoretical physics, generic artificial intelligence applications, pure data science, or software engineering without a strong motivation towards experimental science and instrumentation may find the project misaligned with their interests.

Prior experience with one or more of the following topics will be considered advantageous:

- particle or radiation detectors;
- Monte Carlo methods;
- scientific programming (Python/C++);
- machine learning for scientific applications;
- space instrumentation;
- high-energy, nuclear, astroparticle, or space physics.

The project will involve interaction with international collaborations and may require occasional participation in detector tests, integration activities, beam campaigns, and collaboration meetings.

- (5H) A multidisciplinary approach to X-ray and gamma-ray spectroscopy of planetary surfaces: simulations, laboratory tests, Artificial Intelligence (CUP F63C26000380001)

Funding institution: Italian Space Agency - ASI
Doctoral site: National Institute for Astrophysics - INAF, Trieste Astronomical Observatory
Contact: Fabrizio Fiore [fabrizio.fiore@inaf.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

X-ray and gamma-ray spectroscopy enable detailed assessment of planetary surface composition, essential for understanding geological evolution and prospecting resources. This is particularly relevant for the Moon, where the terrain shows evidence of valuable materials. In-situ resources include water, oxygen, rocket propellants (hydrogen and oxygen), construction materials, and metals such as iron, titanium, and aluminum. Other high-value resources on Earth include KREEP components (Rare Earth Elements [REE], potassium [K], phosphorus [P]) and Platinum-Group Elements (PGEs: platinum, palladium, rhodium, ruthenium, iridium, osmium). Current data on their abundances remain insufficient for both scientific and economic needs. Knowledge derives from returned samples (Apollo and Chang'e missions) and remote sensing (e.g., Kaguya, Lunar prospector). Samples are limited to small, specific sites, while remote observations cover broader areas but at low resolution (~tens of kilometers). To bridge this gap and improve mapping of metals and REEs on the lunar surface, intermediate-scale investigations are needed. X-ray and gamma-ray spectroscopy instruments on AI-equipped rovers can enable autonomous soil exploration. A hierarchical in-situ strategy combines gamma-ray spectroscopy for initial geochemical surveys and proxy mapping, followed by close-range X-ray analysis of promising detections. Developing a single broadband instrument (≈1 keV to 5 MeV) is strategic. It would support gamma-ray spectroscopy of nuclear lines (K, Th, U) at moderate resolution (~6% at 600 keV) and X-ray fluorescence spectroscopy of atomic lines (Si to Ti, Fe, Ni, REEs, PGEs) at 150–200 eV resolution. An AI-enabled rover with this instrument could correlate detections and autonomously guide exploration. This approach advances knowledge and technologies for future lunar and planetary missions. It offers a highly innovative PhD opportunity. The spectrometer leverages prior in-orbit heritage (TRL 9) but requires redesign for lunar conditions (starting at TRL 5). Based on existing experience, this gap can be closed in a few years, potentially enabling a lunar demonstration during the PhD timeframe. The student would play a central role by:

- Defining the lunar surface environment
- Designing and testing the spectrometer's mechanical structure against environmental challenges
- Calibrating detection for lunar targets via simulations and lab tests
- Adapting spectrometer outputs for AI integration

The PhD requires familiarity with diverse fields and contents: lunar geology, X-ray and gamma-rayspectroscopy, mechanical design for lunar conditions, and AI interfaces. Methodologically, the student will gain skills in:

- Lunar terrain geology
- Mechanical design for extreme conditions (radiation, thermal cycling, regolith), including industry collaboration for manufacturing and testing at advanced space facilities
- High-energy spectroscopy through simulation, data analysis, and X-ray lab testing on lunar-analog samples
- AI application development

The PhD student will be required to face an intrinsically interdisciplinary approach: this will enable the student to explore different fields, whilst maintaining a strong focus on the development of knowledge and technology related to the lunar environment and planetary surfaces, which could potentially be applied in other mission contexts.

The student will join a synergistic team in an active space research environment, the Italian PRORIS HARLOCK project (High-resolution Autonomous Resource Lunar Observation & Characterization Kit), which develops science-driven instrumentation for lunar resources. Within this context, the PhD student will work with the PROGReX group at INAF – Osservatorio Astronomico di Trieste and its national and international partners; in addition to the team's expertise, there will be the chance to attend specialised schools and conferences (the Space Resources Week in Luxembourg, ELS - European Lunar Symposium, SPIE - society for optics and photonics).

- (5I) Ab Initio-Guided Design of Radiation-Tolerant High-Entropy Alloys for Space Technologies and ADvanced Nuclear Energy Systems in Space (A-GRADES) (CUP F63C26000380001)

Funding institution: Italian Space Agency - ASI
Doctoral site: European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT), Fondazione Bruno Kessler - FBK
Contact: Simone Taioli [taioli@ectstar.eu]; Giovanni Garberoglio [garberoglio@ectstar.eu]; Maurizio Dapor [dapor@ectstar.eu]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

Future lunar, Martian, and deep-space missions will require advanced materials capable of withstanding extreme conditions over long-duration missions, including intense radiation, large temperature variations, and prolonged exposure to harsh environments. This PhD project aims to design and discover next-generation High-Entropy Alloys (HEAs) with enhanced radiation resistance and thermal stability for space technologies, contributing to the understanding and development of novel materials for extreme environments.

The research will combine state-of-the-art computational materials science, artificial intelligence, and multiscale modelling to investigate how cosmic rays, solar particles, and radiation environments affect the structural and electronic properties of complex materials. Using first-principles simulations, machine learning techniques, and advanced Monte Carlo methods, the student will develop predictive tools for designing materials for satellites, radiation detectors, and future space nuclear energy systems.

The project offers a unique interdisciplinary environment at the interface of condensed matter physics, materials science, nuclear physics, and space technology, with international collaborations and research stays at leading European institutions. The outcomes will contribute to the development of reliable, radiation-tolerant materials for the next generation of space exploration missions.

The ideal candidate should have a strong background in condensed matter physics, materials science, or a closely related field, with solid knowledge of quantum mechanics and statistical mechanics. Experience in computational physics and programming (e.g. Python, Fortran, C/C++ or similar), as well as familiarity with electronic structure methods such as density functional theory or many-body techniques, is highly desirable. The candidate should demonstrate strong analytical skills, motivation to work at the interface of materials modelling and nuclear theory, and the ability to work both independently and collaboratively in an international research environment.

Positions reserved for candidates of Kenyan nationality

- (5KA) Design, Fabrication and Characterization of Plasmonic Antennas for Infrared Detection in Space Applications (CUP F63C26000230005)

Funding institution: Italian Space Agency - ASI
Doctoral site: Fondazione Bruno Kessler - FBK
Contact: Giancarlo Pepponi [pepponi@fbk.eu]; Paolo Rocca [paolo.rocca@unitn.it]
Funds: Institutional Funds

Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

Infrared sensing plays a crucial role in modern space instrumentation, enabling the detection of weak thermal and spectroscopic signals in scientific payloads for astrophysics, planetary exploration, and satellite-based earth observation. Space missions such as ISO, Herschel, Webb, and SPHEREx demonstrate the continued strategic importance of infrared technologies across a broad range of wavelengths and scientific goals. In this context, plasmonic nanoantennas offer a promising route to enhance light–matter interaction at subwavelength scale and to support the development of compact, high-performance detectors. This PhD project proposes the design, simulation, fabrication, and characterization of plasmonic antennas for infrared detection in space applications. The activity will include numerical electromagnetic modelling, cleanroom fabrication, and optical/electrical characterization aimed at optimizing resonance control, absorption efficiency, and coupling to detector elements. The project is expected to provide new design strategies for antenna-assisted infrared detectors compatible with the constraints of future spaceborne instruments, including miniaturization, integration, and performance enhancement.

- (5KB) Artificial intelligence for the analysis of space remote sensing data (CUP F63C26000230005)

Funding institution: Italian Space Agency - ASI
Doctoral site: University of Trento
Contact: Lorenzo Bruzzone [lorenzo.bruzzone@unitn.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The research activities are focused on the development of methods based on artificial intelligence and/or deep learning for the analysis of data acquired by sensors on board satellite systems. This will include both radar data (e.g. Synthetic Aperture Radar images, radar sounder data) and images acquired by optical sensors (multispectral and hyperspectral images). Specific focus will be given to the methodologies for the integration of multisensor data for the classification and semantic segmentation of images as well as for change detection and the analysis of image time series. The methodologies will be applied to real scenarios either in the context of Earth observation or planetary exploration.

Research will be developed at the Remote Sensing Laboratory, Department of Information Engineering and Computer Science, University of Trento (https://rslab.disi.unitn.it/)

Curriculum 6 - Satellite Platforms: Engineering and Technologies

- (6A) AI-Driven Decision Support System for Smart Satellite Manufacturing and Supply Chain Optimization (CUP -)

Funding institution: Provincia Autonoma di Trento-Atto di indirizzo 2026-2028 & Thales Alenia Space S.p.A.
Doctoral site: University of Trento
Contact: Francesco Pilati [francesco.pilati@unitn.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months

Periods in companies/research centres/public administrations: optional

This PhD project aims to develop an advanced intelligent decision-support system for satellite production. By integrating heterogeneous data from Manufacturing Execution Systems (MES), sensors, testing systems, and digital twins, the research will build comprehensive event logs and dynamic representations of Assembly, Integration, and Testing (AIT) processes. Process mining techniques will be applied to reconstruct production flows, detect bottlenecks, and predict task durations. These models will feed a hybrid decision engine combining mathematical optimization, metaheuristics, and reinforcement learning to generate adaptive and robust production plans. The system will be validated through digital twin simulations and industrial use cases, enabling "what-if" analyses and KPI evaluation. Ultimately, the project aims to improve efficiency, flexibility, and responsiveness in satellite manufacturing, reducing lead times and enhancing throughput in complex industrial environments.

- (6B) Mechatronic systems for the LISA Gravitational Reference System (Accordo n.2024-36-HH.0, CUP F63C24000390001 "Attività per la fase B2/C della missione LISA")

Funding institution: OHB Italia SrL / Department of Physics, University of Trento
Doctoral site: University of Trento
Contact: Daniele Bortoluzzi [daniele.bortoluzzi@unitn.it]
Funds: Institutional Funds / Project Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The PhD project aims to investigate the evolution of space mechanism performance from Beginning of Life (BOL) to End of Life (EOL), with a focus on systems developed for the LISA mission. The research combines an experimental approach, in collaboration with OHB, with modeling activities to assess the effects of environmental conditions and operational cycles on performance and reliability.

The work includes supporting functional testing and qualification of mechanisms, interpreting experimental results (including tolerance effects and degradation phenomena), and correlating them with predictive models. The final goal is to contribute to the verification of design requirements and to develop guidelines for in-flight operations, improving robustness and performance predictability over the entire mission lifetime.

- (6C) Metallic additive manufacturing advancements for aerospace innovation in microsatellites (CUP -)

Funding institution: Provincia Autonoma di Trento-Atto di indirizzo 2026-2028 & Trentino Sviluppo S.p.A
Doctoral site: Trentino Sviluppo S.p.A. - ProM Facility & University of Trento
Contact: Nicola Pugno [nicola.pugno@unitn.it]; Paolo Gregori [paolo.gregori@trentinosviluppo.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The proposed doctoral scholarship, jointly promoted by the University of Trento and co-financed by ProM Facility of Trentino Sviluppo, focuses on advancing cutting-edge competencies in the field of metallic additive manufacturing applied to aerospace technologies. The successful candidate will have the unique opportunity to synergize generative design approaches and digital twin simulations available at the University of Trento with state-of-the-art machinery at ProM Facility. Key aspects of this PhD program include Generative Design Approach: The candidate will explore innovative design methodologies, leveraging generative algorithms to create optimised structures for additive manufacturing. Digital Twin Simulations: by harnessing digital twin technology, the candidate will simulate and validate the performance of additive-manufactured components ensuring their reliability and functionality. Advanced Manufacturing Technologies: ProM Facility offers cutting-edge resources, including 3D metal printers (for materials such as titanium, aluminium, and Inconel), X-ray tomography, reverse engineering capabilities, and integration of sensors and artificial intelligence. The research will specifically explore aerospace applications, with a specific focus on microsatellites, a frontier in future telecommunications. In summary, this industrial doctoral scholarship provides a unique blend of theoretical knowledge, practical skills, and hands-on experience, positioning the candidate at the forefront of metallic additive manufacturing advancements for aerospace innovation.

- (6D) Cybersecure Data Sharing Framework for Distributed Smart Satellite Manufacturing Systems (CUP E53D23002100006, E53D23004090006)

Funding institution: Thales Alenia Space S.p.A. & University of Trento, Department of Physics
Doctoral site: University of Trento & Thales Alenia Space S.p.A.
Contact: Francesco Pilati [francesco.pilati@unitn.it]
Funds: Institutional Funds & Project Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

This PhD project aims to develop cybersecurity methods for resilient data exchange in distributed Smart Space Factory networks for satellite manufacturing. The research will focus on protecting real-time and offline industrial data flows among plants, suppliers and logistics partners against cyber threats affecting confidentiality, integrity, availability and trustworthiness of production information. The project will investigate zero-trust architectures, secure authentication and authorization mechanisms, encrypted industrial communication, tamper-evident data logging, integrity verification and cyber-resilient synchronization across heterogeneous OT/IT systems, including MES, traceability platforms, industrial sensing infrastructures, logistics systems and digital twins. Specific attention will be devoted to cyber- attack scenarios such as data manipulation, replay attacks, unauthorized access, disruption of data flows and compromised supplier nodes. The objective is to enable secure and trustworthy data flows supporting predictive analytics, scheduling, inventory management, supply chain optimization and production reconfiguration in distributed satellite manufacturing ecosystems.

- (6E) Hardware Architectures and Post-Quantum Protocols for Secure Communications and Operations in Advanced Space Systems (CUP F63C26000380001)

Funding institution: Italian Space Agency - ASI
Doctoral site: University of Pisa - UNIPI
Contact: Luca Fanucci [luca.fanucci@unipi.it]

Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The project aims to develop a "quantum-ready" cybersecurity framework for space systems, with a specific emphasis on the research and development of hardware solutions (root of trust, accelerators, and attestation mechanisms) for future Space Cloud and Space Edge computing architectures supporting exploration missions to the Moon and Mars. The adoption of post-quantum primitives (which are typically more computationally intensive than their classical counterparts) makes the availability of hardware acceleration crucial to mitigate latency and energy consumption, especially in resource-constrained platforms.

The evolution toward increasingly software-defined, interconnected, and autonomous payloads and platforms (satellites, landers, rovers, relays, and the ground segment) enables new paradigms for data handling and on-board decision-making optimization. However, it also expands the attack surface and makes the requirements of authenticity, integrity, confidentiality, and availability of data and commands critical.

In the space environment, these requirements must also be guaranteed in the presence of radiation and strict power/area/latency constraints: single-event effects (SEUs/SETs/SELs) can alter the internal state of systems, compromise the correctness of cryptographic operations, and generate conditions similar to fault-injection attacks, with impacts on both security and safety. Therefore, the project adopts a security-and-dependability co-design approach, in which fault robustness, hardening, and controlled degradation are an integral part of the cybersecurity requirements.

Scientific and Technological Objectives

- Define requirements, reference architectures, and threat models for Space Cloud/Space Edge and surface cyber-physical systems, including a realistic fault model for radiation (SEU/SET) and an analysis of how such faults can be exploited in fault-based attacks;
- Design and validate post-quantum cryptographic (PQC) primitives and protocols for communications and storage, including secure key management, strong authentication, secure boot, and remote attestation, with optimizations for intermittent links and high latency;
- Design, implement, and optimize PQC hardware accelerators and/or RISC-V ISA extensions (tightly/loosely-coupled) with measurable performance/energy/area targets, prioritizing reusable IPs; the technology will be prototyped and characterized on FPGA/SoC and, where appropriate, ported to "radiation-aware" standard-cell flows (RHBD) for feasibility and transferability analysis toward ASICs;
- Integrate countermeasures against side-channel and fault-injection attacks and, in parallel, rad-tolerance and reliability techniques (ECC, selective redundancy/TMR, scrubbing/refresh where applicable, hardened state elements, error monitors, and recovery), defining graceful degradation and fail-secure/fail-safe strategies;
- Demonstrate and measure results on a representative demonstrator platform (Space Cloud node + "flight-like" OBC + communication link) using reproducible metrics (throughput, latency, energy, leakage, fault coverage, availability) and requirement traceability.

Methodologies

The project will employ a comprehensive methodological framework including: threat & fault modeling (e.g., STRIDE/ATT&CK adapted for space + FTA/fault trees and SEU models), HW/SW co-design, RTL and micro-architectural design, firmware and middleware development, functional and security verification (vector testing, fuzzing, fault-injection/SEU emulation campaigns, side-

channel and robustness analysis), and experimental evaluation (performance/energy benchmarking, reliability and fault-sensitivity analysis).

An interdisciplinary approach will be adopted, combining cryptography, hardware security, embedded systems, space networks and protocols, reliability, and mission engineering. The PhD candidate will be embedded in an active research environment focused on space technologies and hardware security, with access to FPGA/embedded laboratories and collaborations with agencies and industry to validate real-world use cases (distributed data handling, command/telemetry protection, security of digital twins, and supply chains for critical components).

Positions reserved for candidates of Kenyan nationality

- (6KA) Formal Methods for Automated Reasoning and Reliability Analysis of Autonomous Space Systems (CUP F63C26000230005)

Funding institution: Italian Space Agency - ASI
Doctoral site: Fondazione Bruno Kessler - FBK
Contact: Stefano Tonetta [tonettas@fbk.eu]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

This research focuses on the application of formal methods and automated reasoning to ensure the reliability and safety of autonomous space systems. As satellite platforms transition toward higher levels of autonomy, there is a critical need for rigorous analysis techniques that can handle complex system behaviors. The research will investigate integrated frameworks for automated safety and reliability assessment, enabling the formal validation of system-level properties. Specifically, the project will leverage contract-based design to manage architectural complexity, automated generation of safety artifacts (such as Fault Trees and FMEA), and formal verification of FDIR strategies. Furthermore, the research will explore the use of formal monitors and safety cages to provide dependability guarantees for components using AI. By building on state-of-the-art tools like OCRA and xSAP, the goal is to develop a robust MBSE flow that supports the design and certification of next-generation autonomous missions.

- (6KB) Mechatronics systems and instruments for space applications (CUP F63C26000230005)

Funding institution: Italian Space Agency - ASI
Doctoral site: University of Trento
Contact: Daniele Bortoluzzi [daniele.bortoluzzi@unitn.it]
Funds: Institutional Funds
Mobility abroad: compulsory, minimum 6 months
Periods in companies/research centres/public administrations: optional

The PhD project aims to develop enabling technologies for mechatronic systems in the space sector, with a focus on Earth observation applications. The program combines advanced training in modeling, estimation, and control of mechatronic systems, along with hands-on experience in innovative manufacturing, sensors, and actuators. The research includes participation in prototype development, system qualification, and testing, in collaboration with academic and industrial partners. Inspired by major scientific missions, the project explores innovative solutions for space

applications in Earth orbit, particularly for geodetic instruments supporting water resource and cycle analysis. The main focus is on the mechatronic system design of satellite payloads, including sensing, actuation, and control, as well as their modeling, prototyping, and validation. Expected outcomes include scientific publications, conference participation, and the development of guidelines and requirements for future space missions.

Curriculum 8 – Gravity

- (8A) Experimental consolidation of design and free-fall performance for the LISA gravitational reference system (Accordo n.2024-36-HH.0, CUP F63C24000390001 “Attività per la fase B2/C della missione LISA”)

Funding institution: Provincia Autonoma di Trento-Atto di indirizzo 2026-2028 & Department of Physics, University of Trento

Doctoral site: University of Trento

Contact: William Joseph Weber [williamjoseph.weber@unitn.it]; Giacomo Ciani [giacomo.ciani@unitn.it]; Rita Dolesi [rita.dolesi@unitn.it]

Funds: Institutional Funds / Project Funds

Mobility abroad: compulsory, minimum 6 months

Periods in companies/research centres/public administrations: optional

The LISA observatory depends on the nearly perfect free-fall of a constellation of free-falling geodesic reference test masses, with stray accelerations limited to the femto-m/s2 level, to trace the gravitational wave tidal deformation from super massive black hole mergers and other signals from the milliHertz gravitational wave sky. This sets the low frequency sensitivity of the observatory and thus the LISA science return. LISA is now in the implementation phase, working towards launch in 2035, and these next several years represent the critical phase of experimental verification of the baseline design for the free-falling test mass system, known as the “Gravitational Reference System” (GRS), that is the Italian (ASI) contribution to the ESA LISA mission. The proposed doctoral research will contribute to this final phase of design optimization and laboratory testing before the flight hardware definition and production, with key analyses and experiments that can impact the last design choices, integration processes, experimental performance model, and in-orbit operations procedures. Specific measurement science objectives can include forces from molecular impacts, stray electrostatic fields, noise in electrostatic force actuation systems, gravitational balancing, photoelectric discharge, and other electromagnetic effects. Laboratory opportunities will include small force (sub-femto-Newton) measurement with torsion pendulums, low noise electronics tests, sub-femtoAmpere photocurrent measurement, and quantitative tests of both secularly decaying and transient desorption phenomena. Dedicated analysis campaigns will support the analysis and interpretation of the laboratory results, with electrostatic modelling, photoelectric charge transfer, molecular flow, and low noise circuitry. As part of the Trento GRS PI team, the doctoral student will have possibilities for intense collaboration with our industrial partner (OHB-Milano), the ESA LISA project team, and partner labs in Europe and in the US.