

Curriculum: MECHANICS

Research topic: Advance mechanical system based on Shape Memory Alloy for cryogenic applications.

Abstract: Infrared spectrographs are used in space to gather information about Earth like Climate Monitoring and Climate Change Research, Ocean Observation, Weather Forecasting Agriculture and Food Security. To mitigate the temperature fluctuations in space, these devices typically have advanced thermal management systems, such as insulation and active cooling systems like cryo-coolers for detectors that need low working temperatures. The criticalities that arise from the harsh cold environment such as those ascribed to the materials, for example embrittlement, thermal expansion mismatches or tribology issues, cause a malfunctioning of moving parts and a subsequent impairment of the measurements and the introduction of stresses inside the optical components. Shape Memory Alloys (SMAs) are recognized for their ability to recover a specific shape in response to thermal changes (shape memory effect, SME) or applied load (pseudo-elasticity, PE) due to a reversible solid-to-solid thermos-elastic phase transition.

Location: INAF – Osservatorio Astronomico di Brera, Sede di Merate (Lecco).

Supervisor: Edoardo Maria Alberto Redaelli

Curriculum: MECHANICS

Research topic: Thermal behavior and turbulence validation of astronomical instrumentation in the ELT era.

Abstract: This thesis is dedicated to analyzing temperature changes and their impact on the optical performance of astronomical instrumentation, with a particular focus on the Extremely Large Telescope. The study aims to understand how variations in ambient temperature and internal heat sources influence optical performance. To achieve this, thermal models will be developed to simulate temperature distributions in both the air and opto-mechanical components. To validate these Finite Element Method (FEM) and Computational Fluid Dynamics (CFD) simulations, various techniques will be evaluated, including interferometric measurements, Background-Oriented Schlieren (BOS) cameras, Schlieren systems, Laser-Induced Fluorescence (LIF), and sensor matrices. The ultimate goal is to build confidence in and enhance the robustness of CFD analyses to assess temperature effects and develop strategies to mitigate adverse opto-thermal impacts. This research will improve the optical performance of astronomical instruments, offering valuable insights for future designs.

Location: INAF – Osservatorio Astronomico di Brera, Sede di Merate (Lecco).

Supervisor: Matteo Aliverti

Curriculum: ELECTRONICS

Research topic: Design and development of control and readout electronics for VL and NIR detectors for scientific instrumentation on board future space missions.

Abstract: Design and development of control and readout electronics for VL and NIR/hybrid detectors intended for scientific instrumentation on board future space missions, aimed at the discovery of exoplanets and the characterization of their atmospheres, with particular emphasis on large missions such as HWO, LIFE, and ultra-high precision (sub- μ s) medium/small/mini-class spectroscopic/astrometric surveys. Optimization of the S/N ratio both pre- and post- analog-to-digital conversion, including broad-band electromagnetic compatibility and performance, end-to-end (including cabling).

Location: INAF – Osservatorio Astrofisico di Arcetri (Firenze).

Supervisor: Mauro Focardi

Curriculum: ELECTRONICS

Research topic: Electromagnetic analysis for radio astronomy applications.

Abstract: Modern radio astronomy antenna systems rely at every stage of development (design, optimization, mechanical model verification, characterization, etc.) on sophisticated electromagnetic models. These models are analyzed using full-wave techniques for solving Maxwell's equations, implemented by specialized commercial software (CST Microwave Studio, FEKO, GRASP, HFSS, etc.). In recent years, numerous radio astronomy projects have benefited from accurate and fast numerical analyses capable of converging on optimized solutions — for

example, the SKALA4.1 antenna selected for the SKA-LOW radio telescope, the new focal line of the East-West arm of the Northern Cross in Medicina, and the illuminator operating between 300 and 420 MHz for the Noto radio telescope. The optimization of these antennas — for instance, refining EM models to more realistically reproduce the operational conditions of SKA-LOW — as well as the development of next generation radio astronomy instruments, would greatly benefit from expertise in numerical electromagnetism applied to radio astronomy.

Location: INAF – Osservatorio Astrofisico di Arcetri (Firenze).

Supervisor: Pietro Bolli

Curriculum: ELECTRONICS

Research topic: Development of new electronic boards for radio astronomy receivers.

Abstract: The proposal is part of the research and development activities on radio astronomy receivers carried out at the INAF Astronomical Observatory of Cagliari. These receivers are highly sensitive instruments for measuring microwave electromagnetic radiation, operating at cryogenic temperatures and installed at the focal positions of radio telescopes. Receiver electronics are continuously evolving to enable fully remote-controlled systems with wide frequency bandwidths and an increased number of channels, thereby expanding the radio telescope's field of view. One of the major electronic advancements is the digitization of the RF signal. Thanks to the availability of increasingly powerful and fast ADCs on the market, the goal is to sample the received signal as close as possible to the beginning of the receiver chain. The proposal involves the candidate studying and developing new electronic boards for controlling, sampling, and conditioning receiver signals, gaining new skills in electronic design—both analog and digital—at low and high frequencies.

Location: INAF – Osservatorio Astronomico di Cagliari.

Supervisor: Tonino Pisanu

Curriculum: IT AND COMPUTING

Research topic: Development of Synthetic Tracking algorithms for the rapid detection of Near-Earth Objects (NEOs) using GPU acceleration and Deep Learning techniques.

Abstract: The project is part of the research and development activities related to the STILES and CN HPC projects, funded by the PNRR, aimed at installing and testing a robotic wide-field imaging observatory at the INAF site in Serra La Nave (STILES) and an HPC infrastructure for research and development of Artificial Intelligence techniques (CN HPC). The goal is to develop innovative algorithms for the synthetic tracking technique, enabling the efficient detection of Near-Earth Objects (NEOs) using high frame rate imaging. Deep Learning techniques will be employed to improve: sensitivity, reliability, automatic classification, and to reduce false positives through convolutional neural networks (CNNs) and advanced transformer-based vision model architectures, all implemented in a GPU computing environment. The development of these algorithms will have a significant impact on sky survey capabilities, enhancing the identification of NEOs and astrophysical transients.

Location: INAF – Osservatorio Astrofisico di Catania.

Supervisor: Giuseppe Leto

Curriculum: IT AND COMPUTING

Research topic: Optimizing Machine Learning Algorithms for High-Precision Photometry and Anomaly Detection in Variable Stars' Light Curves.

Abstract: Machine Learning (ML) techniques have demonstrated considerable success in both classification and regression tasks involving astrophysical light curves. However, the specific challenge of detecting anomalous behavior in regular, semi-regular, or irregular variable stars remains underexplored. This project aims to develop and optimize advanced ML algorithms tailored for high-precision photometry and anomaly detection in stellar variability data. The selected candidate will focus on the study of pre-supernova outbursts in low-mass red supergiants. Detecting subtle deviations from their long-term variability could offer unprecedented insights into the terminal evolutionary stages of massive stars, potentially enabling the first-ever real-time prediction of

supernova events. The research will involve the design, training, and refinement of ML models adapted to homogeneous, multi-band, short-cadence light curves obtained from long-term monitoring programs. Emphasis will be placed on developing robust anomaly detection pipelines, implementing advanced preprocessing strategies, and validating models with astrophysical interpretability in mind. This project lies at the intersection of computational astrophysics, data science, and stellar evolution, and is ideal for candidates with a strong interest in artificial intelligence applications in time-domain astronomy.

Location: INAF – Osservatorio Astronomico di Palermo.

Supervisor: Fabrizio Bocchino

Curriculum: IT AND COMPUTING

Research topic: QUBRICS: Machine Learning for Cosmology.

Abstract: The QUBRICS project applies state-of-the-art machine learning (ML) techniques to the discovery of luminous, high- z QSOs, using extensive photometric databases. Astronomical surveys such as Euclid and the Rubin-LSST usher in a new era of massive data acquisition, requiring advanced computational methodologies to analyze these vast datasets. This PhD fellowship provides an opportunity to contribute to the technological evolution of ML-driven astrophysics, developing and implementing novel data-mining algorithms while utilizing HPC resources to optimize QSO identification pipelines. The selected PhD candidate will acquire expertise in cutting-edge data science applications within astrophysics, including: database management; candidate selection; implementation of probabilistic classification models (PRF, XGBoost, Deep Learning); photometric redshift estimation; target prioritization strategies; proposal writing; observational execution; scientific analysis and paper preparation.

Location: INAF – Osservatorio Astronomico di Padova.

Supervisor: Andrea Grazian

Curriculum: IT AND COMPUTING

Research topic: New accelerated and AI-powered transient search pipeline for Current and New Generation Radio Telescopes.

Abstract: The study of astrophysical transient phenomena (e.g. FRBs, Pulsars) represents one of the key science topics of astronomical research. Due to the large data volumes generated by the search of these events, especially in planned surveys for current and future radio telescopes, data processing and analysis have to be conducted in real-time. Modern technologies, like parallel computing architectures, and the emerging machine and deep learning based algorithms offer the suitable tools to tackle this challenge. It is of primary importance the development of innovative search techniques and real-time pipelines able to leverage these resources and maximize the scientific return. The aim of this Ph.D. project is to design and implement a new scalable, flexible, GPU-based, real-time transient search pipeline composed of several processing stages, including RFI flagging and mitigation, dedispersion, event detection and classification, as well as data quantization and persistence. To achieve this target, the candidate will work with the upgraded Northern Cross Radio telescope equipped with a state-of-the-art HPC cluster. A long standing and fruitful collaboration with the University of Malta, the Astronomical Observatory of Cagliari and the University of Bologna, as well as the recent partnership with Chord Collaboration, will constitute the fertile background for the development of this activity.

Location: INAF – Istituto di Radioastronomia, Sede di Bologna.

Supervisor: Giovanni Naldi

Curriculum: IT AND COMPUTING

Research topic: New computational techniques for ultra-high-precision astrometry and their implementation for the characterization of weak signals, with particular reference to gravitational waves.

Abstract: The candidate will study and implement state-of-the-art computational techniques in the field of astrometry (using both real and simulated data). Modern methods such as Neural Networks and Machine Learning have never been comprehensively applied to major astrometric missions (like Gaia), since these

missions were developed prior to the recent AI revolution. The candidate will therefore assess the actual scientific contribution of these methods across a diverse range of applications, from algorithm optimization to the study of systematics and image processing, with a strong focus on gravitational wave research. In particular, the candidate may investigate new methods of cross-correlation between astrometric data and other low-frequency experiments (PTA, SKAO, LSST, etc.) through the training of dedicated neural networks.

Location: INAF – Osservatorio Astrofisico di Torino.

Supervisor: Mariateresa Crosta

Curriculum: IT AND COMPUTING

Research topic: Artificial Intelligence for gamma-ray data analysis: the NASA COSI mission.

Abstract: The observation of the Universe in the MeV band is particularly challenging because of the high background, the low efficiency of the dominant physics processes (Compton scattering and pair production), the complexity of the signal reconstruction and the need for space-based technologies. For this reason, the MeV region is still fairly unexplored, with no significant progress for more than 20 years. INAF, with the support of the Italian Space Agency (ASI), is involved in the next generation of gamma-ray missions such as the NASA Compton Spectrometer and Imager (COSI), a Compton space telescope that will observe in the 0.2 - 5 MeV band, to be launched in 2027. Future MeV missions will increase the sensitivity in the MeV band by more than 10 times what achieved in the past, opening the possibilities to new discoveries (e.g. GRBs, blazars, magnetars) thanks to new and advanced artificial intelligence models for the signal reconstruction and event detection. The INAF OAS team has a huge heritage in high-energy space missions and artificial intelligence, actively contributing to the simulation and analysis software for the COSI mission, the Compton-pair new-ASTROGAM ESA mission proposal, and the ASI AGILE space mission, launched in 2007 and terminated in 2024. This PhD project activity foresees: i) high energy mission simulations using Geant4 to evaluate the scientific performance and prepare datasets for the training of machine learning models; ii) exploration of innovative artificial intelligence architectures (e.g. physics informed neural networks) to classify and reconstruct the astrophysical signal iii) development of new tools for the scientific analysis, based on classical or machine learning techniques; iv) evaluation of developed tools with real data acquired by COSI after the launch. The student will be integrated into the space mission team to maintain direct and continuous collaboration with other members with the possibility of spending periods abroad to learn specific analysis techniques and acquire the necessary skills.

Location: INAF – Osservatorio di Astrofisica e Scienza dello Spazio di Bologna.

Supervisor: Valentina Fioretti

Curriculum: IT AND COMPUTING

Research topic: Edge Artificial Intelligence for Event-Level Discrimination in Scintillator Detectors on CubeSat Computing Platforms.

Abstract: The project aims to develop Edge Artificial Intelligence technologies for the real-time classification of gamma-ray events in scintillator detectors, optimized for computational platforms deployed onboard CubeSats and, prospectively, for lunar rovers. Both simulated data (Geant4) and data acquired from real scintillators will be used. The activities include designing experiments, training, and optimizing machine learning models (e.g., CNN and LSTM) on hardware platforms that meet the stringent requirements of space missions. The goal is to create intelligent systems capable of discriminating X-ray and gamma-ray events of interest from background noise directly onboard, thereby reducing the amount of data to be transmitted to Earth, cutting costs, and enhancing operational autonomy. The primary application is the observation of transient events (Terrestrial Gamma-ray Flashes, Gamma-ray Bursts) and the identification of spectral variations.

Location: INAF – Osservatorio di Astrofisica e Scienza dello Spazio di Bologna.

Supervisor: Andrea Bulgarelli

Curriculum: IT AND COMPUTING

Research topic: Accelerating Cosmic Ray Spectral Evolution in Cosmological Simulations via Physics-Informed AI.

Abstract: Particle acceleration by turbulence is key in astrophysical plasmas, transferring energy from bulk motions to cosmic rays (CRs) via stochastic processes. CRs emit synchrotron radiation observable in radio bands. Their complex spectral evolution is governed by the Fokker-Planck equation, typically solved numerically. In simulations, CRs are tracked using tracer particles carrying momentum spectra evolved independently. Due to the high tracer count required for accurate radio predictions, full integration into MHD simulations is currently unfeasible. A promising alternative is using physics-informed neural networks (PINNs) to replace traditional solvers, shifting the computational cost to training. Once trained, the network can rapidly infer CR spectra during simulations. The PhD plan includes familiarize with the specific problem and with the concepts and solutions related to physics informed ML methodologies (M1–M6), developing the PINN (M7–M18), validating it on snapshot data (M19–M24), integrating into a simulation code (M25–M30), and concluding with thesis writing (M31–M36). Two or three journal papers are expected to be published during the thesis (methodology, application to snapshot, simulations).

Location: INAF – Istituto di Radioastronomia, Sede di Bologna.

Supervisor: Claudio Gheller

Curriculum: IT AND COMPUTING

Research topic: Multimodal Generative AI for Scientific Discovery in LOFAR Radio Astronomy.

Abstract: Multimodal Generative AI provides powerful tools for scientific discovery in large datasets from modern astronomical instruments. By combining information from diverse sources—text, images, time-series, metadata—AI enables both descriptive and advanced quantitative tasks, including feature extraction, semantic segmentation, and multi-parametric regression. This PhD project focuses on developing a tailored AI solution for LOFAR radio telescope data, offering intuitive access to complex operations through Large Language Models and enhanced by cutting-edge methods like multimodal foundation models, Retrieval-Augmented Generation, and fine-tuning. The plan includes familiarization with LOFAR data and generative AI (M1–M6), design and selection of the architecture and methods (M7–M12), implementation and testing on a representative dataset (M13–M24), deployment of core functionalities (M25–M30), and thesis writing (M31–M36). Two to three journal publications are expected during the PhD.

Location: INAF – Istituto di Radioastronomia, Sede di Bologna.

Supervisor: Andrea Botteon

Curriculum: IT AND COMPUTING

Research topic: Data Acquisition and Processing System for the MezzoCielo Telescope.

Abstract: MezzoCielo is a concept for a new class of very wide field telescopes, capable of imaging a large fraction of the sky (~10000 square degrees) simultaneously. It addresses a vast range of Science use cases, from transients' detection, variability monitoring and multi-messenger Astrophysics, to space debris and NEOs observations. A MezzoCielo telescope employs thousands of cameras composed of corrective optics and large format CMOS detectors, because of their lower cost and faster readout speed compared to, e.g., CCDs. The expected data flow and volume from such system is challenging. The aim of this project is to devise a conceptual design of the MezzoCielo data acquisition and processing system in the framework of a reduced-scale demonstrator to be deployed at Sos Enattos, the Italian candidate site for the Einstein Telescope. The PhD candidate will collaborate in translating science requirements into an implementation for the demonstrator that will serve as a proof-of-concept and, at the same time, address real science cases.

Location: INAF – Osservatorio Astronomico di Padova.

Supervisor: Andrea Baruffolo

Curriculum: IT AND COMPUTING

Research topic: Deep Learning to predict the distribution and evolution of the Cosmic Web (galaxies, galaxy clusters, cosmic voids and filaments) in the presence of dark energy and massive neutrinos.

Abstract: This project will leverage state-of-the-art deep learning algorithms to exploit proprietary cosmological simulations (e.g. the DEMNUni simulations) with the aim of predicting the formation and evolution of galaxies, cosmic voids, galaxy clusters, and filaments in the presence of massive neutrinos and dynamical dark energy. The candidate will develop predictive models and validate them against simulated and observed data. In particular, for void and filaments such models are still inaccurate or even missing in the literature. Nonetheless, these structures can bring valuable information about the universe and its underlying cosmological model.

Location: INAF – Istituto di Astrofisica Spaziale e Fisica Cosmica di Milano.

Supervisor: Carmelita Carbone

Curriculum: IT AND COMPUTING

Research topic: Real-time pipeline for Innovative Wavefront Sensors.

Abstract: Extremely large telescopes, currently under construction, will employ Sodium Laser Guide Stars (LGSs) to increase sky coverage in observations taking advantage of Adaptive Optics corrections. These LGSs, as seen by the Wavefront Sensor (WFS), appear elongated rather than point-like. "Traditional" WFSs (e.g., Shack-Hartmann) are designed to work with point-like sources: the LGS elongation introduces biases in the measurements. New wavefront sensor concepts, like the Ingot WFS, are being explored to overcome the shortcomings of "traditional" sensors. The Ingot is based on the idea of matching the elongated source with the optical surface used to sense it. The PhD candidate will work in the group currently studying the performance of the Ingot and compare it to other WFSs. [S]he will collaborate to the laboratory activities and to the setup, configuration, and optimization of a laboratory Real-Time Computer (RTC) designed to provide closed loop operations with S-H, Pyramid, and Ingot WFSs.

Location: INAF – Osservatorio Astronomico di Padova.

Supervisor: Andrea Baruffolo

Curriculum: DETECTORS, LASERS AND OPTICS

Research topic: Photogrammetric and Image Analysis Techniques for the Hyperhemispheric PANCAM for Lunar Cave Exploration.

Abstract: Hyper-hemispherical lenses are optical systems distinguished by their ultra-wide field of view. This extreme field of view introduces significant challenges for geometric calibration. While several methods have been developed to facilitate calibration—typically in short-range scenarios and controlled environments such as clean rooms, often employing simple calibration checkerboards—they may not be directly applicable to planetary applications. The lens examined in this study (PANCAM) is designed as a planetary payload for an ESA mission with photogrammetric objectives. As such, the current state-of-the-art in geometric calibration for hyper-hemispherical lenses has been reviewed and extended. The goal is to improve the projection model for this class of optics and enable their effective use in planetary imaging tasks, including lunar cave exploration.

Location: INAF – Osservatorio Astronomico di Padova.

Supervisor: Emanuele Simioni

Curriculum: DETECTORS, LASERS AND OPTICS

Research topic: Laue lenses: from the early stages to adjustable soft gamma-ray optics.

Abstract: Hard X-rays (>100 keV) cannot be focused using glass lenses or mirrors as in soft X-ray astronomy. The only way to focus hard X/soft gamma rays is through Bragg diffraction from atomic planes in crystals. This technique, still in its early stages, is called Laue lens and involves crystal tiles oriented to focus radiation into a single focal spot. In the PhD program we will study pros and cons of types of crystals in terms of diffraction efficiency and quality of diffraction both with simulations and experiments. The student will also help in the design, development and test of a prototype of a fraction of Laue lens. The accuracy required for crystal alignment is outstanding. This has posed, till now, limitation in the realization of prototypes. The commonly used method to fix the position of these crystals is through space-qualified adhesives which have the drawback of inducing micro-movements of the crystals due to the glue curing process. One of the methods under evaluation

is the use of adjustable systems based on piezoelectric actuators. This feature will open new, unexplored possibilities, such as gamma-ray adjustable optics.

Location: INAF – Osservatorio di Astrofisica e Scienza dello Spazio di Bologna.

Supervisor: Enrico Virgilli

Curriculum: DETECTORS, LASERS AND OPTICS

Research topic: MATTO - Integration and optimization of a Multi-Conjugate Adaptive Optics facility.

Abstract: This PhD project will focus on the integration, alignment and optimization of MATTO, a Multi-Conjugate Adaptive Optics (MCAO) facility, to be developed at INAF-OAPD premises. MCAO systems are in use, planned or evaluated for most of the current and future largest ground telescopes; MATTO will serve as a test bench for feasibility study, validation and comparison of next generation MCAO techniques. The bench is modular and includes both point-like (natural sources like) and elongated (laser like) reference sources, together with 3 Deformable mirrors, which can allow a variety of control scheme implementations. The candidate will be involved in the: 1) integration of the bench: optical alignment of the components and verification of the configurations; 2) implementation of the control scheme and real-time computing system; 3) optimization of the full system. The project will make full use of the wide range of opto-mechanical resources provided by the PNRR STILES project, enabling the implementation of a system that currently has no competitors in the European landscape. Such laboratorial setup will provide the candidate with the opportunity of facing all the different aspects behind the assembly and operation of a complex Adaptive Optics instrument, as well as the challenges for reaching the highest instrument performance for different scientific goals.

Location: INAF – Osservatorio Astronomico di Padova.

Supervisor: Luca Marafatto

Curriculum: DETECTORS, LASERS AND OPTICS

Research topic: Development and characterization of a biomolecule detector based on lab-on-chip technology for space applications.

Abstract: During the PhD project, the candidate will design a lab-on-chip microfluidic device capable of handling and detecting organic molecules extracted from various types of inorganic material using solvents, and simulating Martian soil and the moons Europa and Enceladus. Detection will be performed via laser illumination and fluorescence emission. The candidate will need to design the lab-on-chip device as an integrated microfluidic and detection system that meets the requirements for robustness and reliability. The chip should be compact and lightweight with monolithic integration of sensors and detection sites, and have high photon collection efficiency and mechanical stability. It must also ensure an optimal signal-to-noise ratio and limited data usage to enable faster processing and reduce the bandwidth required for communication with Earth.

Location: INAF – Osservatorio Astrofisico di Arcetri (Firenze).

Supervisor: John Robert Brucato

Curriculum: DETECTORS, LASERS AND OPTICS

Research topic: EKARUS - Design optimization and implementation of an Adaptive Optics system for the Asiago Copernico telescope.

Abstract: This PhD project will focus on the design adaptation, optimization, and commissioning of the Adaptive Optics (AO) system Papyrus for integration with the coudé focal station of the Copernico Telescope at Cima Ekar, Asiago. Papyrus is an AO system based on a pyramid wavefront sensor, currently installed at the Observatoire de Haute-Provence. Due to ongoing maintenance and upgrades at its current site, there are plans to temporarily relocate the system to the Copernico Telescope, where it will be operated under the name EKARUS. This relocation presents a valuable opportunity for research and development in adaptive optics, as well as hands-on training for students and early-career researchers in advanced AO technologies. The main objectives of the project include: 1) Adapting and optimizing the Papyrus system for the Copernico telescope; 2) Carrying out its installation and on-site commissioning. The activity will provide the candidate with optical design skills, as well

as alignment and integration techniques. The position requires the availability to spend periodic shifts at the Cima Ekar Asiago Observatory. The project will be conducted in collaboration with the Laboratoire d'Astrophysique de Marseille (current owner of Papyrus), the University of Durham, and various INAF institutes in Italy.

Location: INAF – Osservatorio Astronomico di Padova.

Supervisor: Davide Greggio

Curriculum: DETECTORS, LASERS AND OPTICS

Research topic: Development of the Lunar Electromagnetic Monitor in X-rays (LEM-X).

Abstract: The Lunar Electromagnetic Monitor in X-rays (LEM-X) project aims at developing an X-ray (2-50 keV) all-sky monitor for the observation of Gamma-ray bursts and other X-ray transients from the Moon surface. With respect to in-flight and already flown wide-field X-ray monitors, the LEM-X modularity, detection plane technology and coded aperture design will allow for a continuous and simultaneous monitoring of the whole sky, enabling a complete and direct association of electromagnetic transients with multi-messenger events. The successful PhD candidate will join the LEM-X team and will be involved in the instrument development and optimization. During the three years, the candidate will participate to all the key activities of the LEM-X study, from the optimization of the coded-aperture imaging system to the measurement of the detector performance, from the study of the background components to the optimization of the LEM-X architecture and the definition of the mission profile. The following methods will be used to carry out the research activity: 1) Experimental science techniques and standards for space-borne instrumentation; 2) Scientific data analysis methods for solid-state X-ray detectors; 3) Numerical methods (e.g. analytical, MonteCarlo) for instrument performance simulation and assessment of the environmental conditions.

Location: INAF – Istituto di Astrofisica e Planetologia Spaziali di Roma.

Supervisor: Ettore Del Monte

Curriculum: DETECTORS, LASERS AND OPTICS

Research topic: Hyperspectral imaging systems through compressive sensing and compact spectrometers.

Abstract: This project focuses on the development of innovative hyperspectral imaging systems by combining state-of-the-art spectroscopy, multiband and hyperspectral imaging techniques, and single-pixel camera architectures. A key research direction is the application of compressive sensing to hyperspectral single-pixel cameras, optimizing both acquisition strategies and reconstruction algorithms to enhance efficiency and image quality. The main task involves the design and implementation of a prototype, including the telescope, focal plane modulator, dispersive system, and detector. Furthermore, the candidate will explore novel spectrograph designs leveraging holographic techniques to integrate the dispersive element with the imaging optics, aiming to miniaturize the system architecture while maintaining high spectral resolution. Applications in astronomy and Earth observation, from UV to NIR, will guide system requirements and performance evaluation. The final goal is to create a next-generation, integral-field-like spectrograph suitable for satellite and UAV platforms.

Location: INAF – Osservatorio Astronomico di Brera, Sede di Merate (Lecco).

Supervisor: Luca Oggioni