Book of Abstracts

XXXVI Encontro Nacional de Astronomia e Astrofísica

Contents

Stars, Stellar Remnants, Compact Objects and Space Weather

INVITED TALK

Probing the low-mass end of star formation with JWST

Presenter: Koraljka Mužić
IA/FCUL

ABSTRACT

The initial mass function (IMF) is a cornerstone of astrophysics, linking the process of star formation to the properties of stellar populations. Yet fundamental questions remain regarding its origin, the role of the environment, and the nature of its lowest-mass constituents - brown dwarfs and free-floating planetary-mass objects. In this talk, I will review recent observational advances in our understanding of the low-mass end of the IMF, highlighting results from deep imaging and spectroscopic surveys of nearby star-forming regions and massive young clusters. I will discuss how the unprecedented capabilities of JWST are transforming the field, enabling both new tests of the IMF across a wide range of star-forming environments and detailed studies of young substellar objects, including their atmospheres, disks, and accretion. Finally, I will outline the key challenges and exciting prospects for understanding the origin and early evolution of substellar populations in the era of JWST and the next generation of astronomical facilities.

Stars, Stellar Remnants, Compact Objects and Space Weather

INVITED TALK

Recent developments and future perspectives on Space Weather research within the National Space Ecosystem

Presenter: Ricardo Gafeira
OGAUC and IA

ABSTRACT

As modern society becomes increasingly dependent on satellite networks, global navigation systems, and interconnected ground infrastructures, understanding and mitigating the impacts of Space Weather has transitioned from a purely academic concern to a critical global security necessity. This presentation highlights recent breakthroughs and future developments in Space Weather research in Portugal. Utilizing state-of-the-art capabilities in continuous solar and ionospheric monitoring, along with advanced data analysis techniques, I will summarize how national research centers have successfully consolidated expertise in operational space weather forecasting and space situational awareness. Special attention will be given to recent strategic milestones, particularly the significant integration of Portuguese research teams into the European Space Agency's (ESA) Space Weather Service Experts Group. Finally, we will outline future perspectives for collaborative space hubs, demonstrating how cutting-edge solar-terrestrial physics is being transformed into operational technological solutions, establishing Portugal as a vital player in the European space ecosystem.

Stars, Stellar Remnants, Compact Objects and Space Weather

CONTRIBUTED TALK

The JWST view of proplyd HST10: gas, dust and PAHs

Presenter: Sílvia Vicente

Instituto de Astrofísica e Ciências do Espaço (IA) - FCUL

ABSTRACT

What is the composition, and hence reservoir, in dust, gas and polycyclic aromatic hydrocarbon molecules (PAHs) in a typical externally illuminated disk (proplyd)? What is the thermo-chemical structure of a proplyd Photodissociation Region (PDR)? How does external irradiation affect the process of planet formation in these disks? And how their properties differ from those of disks found in more quiescent environments, such as Taurus-Auriga? These questions are addressed in our Cycle2 program GO 4332 (PI: S. Vicente) consisting in a JWST deep observational study of an EUV+FUV externally illuminated protoplanetary disk (proplyd) found in the Orion Nebula Cluster (ONC) using the IFU mode of NIRSpec and MIRI-MRS. The JWST observations spatially resolve the disk, neutral cocoon and ionization front simultaneously over the 0.9 - 11.7 micron spectral range, providing key line, continuum and PAHs diagnostics to trace the physical conditions, the chemical composition and abundances under the effect of the external FUV-radiation. It is the FUV radiation that changes the thermo-chemical structure of the disk, creates the PDR and sets the mass-loss rate through photoevaporation. By comparing our results to those of protoplanetary disks (TTauris) found in nearby low-mass star forming regions, one can start to assess the real effects of a FUV-dominant environment on protoplanetary disk evolution and planet formation. In this talk I will introduce the program GO2 4332 and I will show the observational results of the JWST MIRI and NIRSpec data in gas, dust and PAHs. I will also present the results of our preliminary analysis using 2D modelling.

Stars, Stellar Remnants, Compact Objects and Space Weather

CONTRIBUTED TALK

Formation of stars and brown dwarfs in the Rosette Nebula

Presenter: Daniel Capela
University of St Andrews

ABSTRACT

The Rosette Nebula is an emblematic star-forming region, hosting a rich population of young stars, including the ~2 Myr old cluster NGC 2244 at its centre, located at a distance of 1.5 kpc. In this talk, I will present a deep multi-band survey of the Rosette region combining newly stacked Spitzer/IRAC mid-infrared images from archival data, along with new JWST/NIRCam observations. Using colour criteria, we select objects spanning 4 orders of magnitude in mass: young stars, embedded sources, and very low mass objects down to planetary masses, allowing us to reconstruct the star formation chronology throughout the molecular cloud. Our analysis reveals a complex star formation history across the region. While some stellar groups show evidence for star formation triggered by the expanding HII bubble driven by NGC 2244, the presence of a young stellar population beyond this bubble points to a more intricate and dynamic evolution of the entire cloud. Finally, we uncover a free-floating planetary-mass object population in the heart of the Rosette Nebula, with masses reaching down to ~3 Jupiter masses.

Stars, Stellar Remnants, Compact Objects and Space Weather

CONTRIBUTED TALK

Substellar population of the young massive cluster RCW 36 in Vela

Presenter: Afonso Brito do Vale

Instituto de Astrofísica e Ciências do Espaço / Laboratoire d'Astrophysique de Bordeaux

ABSTRACT

The exact shape of the initial mass function (IMF) down to the brown dwarf regime remains a fundamental yet contentious topic in the study of stellar formation and evolution. Understanding how different environments affect the formation of stars and brown dwarfs (BDs) is essential. RCW 36 is an embedded, young, massive cluster in the Vela Molecular Ridge (~1 kpc), with a stellar surface density comparable to the Orion Nebula Cluster, and is therefore well suited for testing the impact of such environmental effects on the IMF. We used deep HAWK-I/VLT near-infrared observations with ground-layer adaptive optics, complemented by 2MASS, SOFI/NTT, and Gaia DR3 kinematics to obtain the deepest census of the stellar and substellar populations in RCW 36 yet. Nebular emission was removed using the deep-learning algorithm DeNeb, improving source extraction and increasing the 50% completeness limit down to 0.03 Msun. Membership weights were assigned through statistical comparisons of color-magnitude diagrams between RCW 36 and a control field, and individual masses were estimated from model isochrones. Employing the membership weights, we found a median of 426 members of RCW 36, including approximately 70-90 brown dwarfs. We determine the dN/dM IMF down to 0.03 Msun, described by a broken power law with a slope that is shallower than the Salpeter slope in the high-mass regime and a flatter slope of 0.46+-0.14 between 0.03 Msun - 0.20 Msun. The resulting star-BD ratio of 2--5 is consistent with those measured in other young Galactic clusters. Lastly, we also detect signs of possible primordial mass segregation.

Stars, Stellar Remnants, Compact Objects and Space Weather

CONTRIBUTED TALK

Visible Versus Near-Infrared Solar-type Activity Patterns

Presenter: Khaled Al Moulla
Instituto de Astrofísica e Ciências do Espaço

ABSTRACT

In 2023, the near-infrared (NIR) NIRPS spectrograph began its symbiotic operations with the visible (VIS) HARPS spectrograph at the ESO 3.6m Telescope (La Silla Observatory, Chile). Additionally, both instruments are connected to the HELIOS solar telescope, which delivers high-S/N, disk-integrated observations at a 1-minute cadence. While there exists other solar facilitates at various high-resolution spectrographs, primarily in the VIS, the NIRPS dataset is the first of its kind to achieve long-term instrumental precision at NIR wavelengths with substantial baseline to cover astrophysical signals at multiple timescales. We present an overview of the NIRPS solar data, specifically the radial velocity (RV) measurements which are able to achieve a median intra-day dispersion of 1.5 m/s. Furthermore, we compare the astrophysical signals present in the RV time series with their VIS counterparts. In particular, we demonstrate how the pressure modes appear unchanged, how the granulation phenomena exhibit shorter timescales and increased scatter in the NIR, and how the unsigned magnetic flux can be extracted with high confidence in both the VIS and NIR. These findings can help us better understand the chromatic nature of solar-type activity, which we can use to inform our stellar activity models in the search for low-mass exoplanets.

Stars, Stellar Remnants, Compact Objects and Space Weather

CONTRIBUTED TALK

BepiColombo SEP catalogue: Events measured with BERM, SIXS and SPM

Presenter: António Gomes

LIP, Laboratório de Instrumentação e Física Experimental de Partículas

ABSTRACT

We present a catalogue of Solar Energetic Particle (SEP) events observed by the BepiColombo spacecraft during its cruise phase between 2020 and 2026, covering the rising phase and maximum of Solar Cycle 25. The catalogue is based on proton measurements from three complementary particle instruments: the BepiColombo Environment Radiation Monitor (BERM) and the Solar Intensity X-ray and Particle Spectrometer particle detector (SIXS-P), both onboard the Mercury Planetary Orbiter (MPO), together with the Solar Particle Monitor (SPM) onboard the Mercury Magnetospheric Orbiter (Mio). Combined, these instruments provide continuous proton measurements over an energy range of approximately 1–230 MeV while BepiColombo traversed the inner heliosphere between approximately 0.3 and 1.2 AU. SEP events were identified from flux enhancements in the lowest-energy channels of BERM and SIXS-P, resulting in a list of 76 SEP events. For each event includes, the onset and peak times, peak proton flux, fluence, maximum proton energy measured, and proton energy spectra. Using this catalogue, we investigate the temporal evolution of SEP occurrence throughout Solar Cycle 25. The annual event rate increases rapidly from 2021, reaches a maximum during 2023–2024, and subsequently declines, closely following the evolution of solar activity. We further examine the spatial distribution of the detected events along the BepiColombo trajectory, demonstrating that most events were observed at heliocentric distances below 0.6 AU, reflecting the combined effects of the spacecraft orbit and the evolution of Solar Cycle 25. Finally, we investigate the statistical correlation between the SEP peak flux and fluence. A strong positive correlation is found between both quantities over the analysed energy range, consistent with a power-law scaling. We also characterise the event energy spectra across the full proton energy range, providing a comprehensive description of SEP spectral properties in the inner heliosphere. This catalogue represents a comprehensive in-situ SEP datasets obtained during Solar Cycle 25 over a wide range of heliocentric distances and provides a valuable resource for future studies of SEP acceleration, interplanetary transport, and space weather throughout the inner Solar System.

Stars, Stellar Remnants, Compact Objects and Space Weather

CONTRIBUTED TALK

Modelling the Radiation Environment of Weakly Magnetised Bodies

Presenter: Bruna Lima

LIP - Laboratório de Instrumentação e Física Experimental de Partículas

ABSTRACT

Modelling the space radiation environment and its effects is critical for future space exploration, especially for the Moon and Mars. This problem is enhanced by the absence of a global magnetic field and a sufficiently dense atmosphere on these bodies, both of which limit natural radiation shielding. To address this, the combined detailed Mars Energetic Radiation Environment Model and LUNAr Ionising Radiation Environment tool (dMEREM–LUNAIRE) is presented, extending the existing dMEREM model to the lunar environment and supporting the study and analysis of past events as well as future mission planning. This Geant4-based model simulates secondary particle generation and calculates particle flux, dose, and LET spectra at the surface and underground, among other radiologically relevant quantities. Developed by LIP (Laboratory of Instrumentation and Experimental Particle Physics) for ESA (European Space Agency), the models include location-dependent surface and atmospheric composition (when present, as in the martian case), along with user-defined particle spectra as inputs. The lunar model is validated against in situ data from the Cosmic Ray Telescope for the Effects of Radiation (CRaTER) aboard the Lunar Reconnaissance Orbiter (LRO), and the Lunar Lander Neutrons and Dosimetry (LND) instrument aboard the Chang'E-4 mission to the lunar far side. The Martian model is validated against Radiation Assessment Detector (RAD) data from the Mars Science Laboratory (MSL) Curiosity rover at Gale crater. Realistic exploration scenarios, such as in situ shelters, are further explored under relevant radiation conditions, with the goal of supporting exploration- and mission-related decision-making. For this study, Galactic Cosmic Rays (GCR) are the main scenario explored, owing to their continuous contribution to radiation exposure. Results highlight the relative radiation exposure at the lunar and martian surfaces and underground, providing a scientific basis for shielding and mission-planning decisions in future exploration.

Stars, Stellar Remnants, Compact Objects and Space Weather

POSTER

General-relativistic radiation reaction cooling in neutron star magnetospheres

Presenter: João Joaquim

GoLP/IPFN, Instituto Superior Técnico (IST), Universidade de Lisboa

ABSTRACT

Electromagnetic radiation reaction plays an important role in describing the extreme plasma conditions found in the magnetospheres of astrophysical compact objects. This recoil force that relativistic charged particles experience during radiation emission is known to trigger the formation of anisotropic ring-shaped momentum distribution functions with inverted Landau populations. Inverted distributions are a natural source of free energy for kinetic plasma instabilities such as the electron cyclotron maser instability, a leading candidate mechanism to explain coherent radio emission in pulsars and fast radio bursts. We present the first systematic investigation of this mechanism under realistic astrophysical conditions, by extending the radiative Vlasov formalism to curved spacetime and dipolar fields. Analytically, we show that drift velocities deform the ring distributions into spiral structures that still support population inversion. Using general-relativistic test-particle simulations, we find that the stellar compactness increases the momentum-space gradient that supports the instability, while the stellar rotation prolongs the lifetime of the inverted structure via frame-dragging. These results show that realistic magnetospheric conditions preserve and enhance the conditions necessary for radiation-reaction-powered emission of coherent radiation to occur in these environments.

Stars, Stellar Remnants, Compact Objects and Space Weather

POSTER

Solving the Spectropolarimetric 180° Transverse Magnetic Field Ambiguity with a Physics-Informed Neural Network

Presenter: Carlos António

Instituto de Astrofísica e Ciências do Espaço, Universidade de Coimbra, Faculdade de Ciências e Tecnologia

ABSTRACT

Astrophysical magnetic fields are generally measured using Zeeman spectropolarimetry. However, these measurements are intrinsically affected by the well-known 180° azimuth ambiguity problem. This ambiguity arises because the polarization produced by the Zeeman effect cannot distinguish between two transverse magnetic field directions separated by 180°. In other words, the linear polarization signals are symmetric under 180° rotations. Although particularly important in solar physics, this problem is common to spectropolarimetric measurements in many astrophysical contexts. Resolving this ambiguity is essential for obtaining physically meaningful solar vector magnetic fields, yet it remains a challenging problem. One of the best-performing approaches is the classical Minimum Energy method, which assumes that an incorrect azimuth introduces unrealistic magnetic divergence and vertical electric currents, and therefore searches for the configuration that minimizes these quantities. Owing to its accuracy, it is used, for example, in SDO/HMI data products. However, it is computationally expensive and does not account for atmospheric stratification, meaning that it is typically combined with other methods. We present the first version of PACMEN-D (Potential-Assisted Computation for Minimal-Energy Neural Disambiguation), a novel physics-informed neural network (PINN) framework for magnetic field disambiguation. PINNs are neural networks originally developed as solvers for partial differential equations (PDEs), where physical laws are enforced through the loss function. Here, we reformulate the ambiguity-resolution problem so that the network learns a single continuous angular variable, θ, which naturally converges toward either 0° or 180° in regions where the physical constraints strongly favor one of the two solutions. This provides both the disambiguated magnetic field and a quantitative measure of confidence. Unlike conventional methods, PACMEN-D operates volumetrically, incorporating atmospheric stratification information when computing magnetic divergence and vertical electric currents. Consequently, it naturally supports disambiguation directly on corrugated, constant optical-depth surfaces, rather than being restricted to planar boundaries. The proposed approach resolves the transverse-field ambiguity in only a few seconds (including training) to a few minutes while preserving the physical constraints that underpin minimum-energy methods, offering a fast and flexible alternative for next-generation spectropolarimetric inversions.

Stars, Stellar Remnants, Compact Objects and Space Weather

POSTER

The Nature of the Newly Proposed Substellar Class in IC 348

Presenter: Pedro Azóia
Instituto de Astrofísica e Ciências do Espaço

ABSTRACT

Constraining the Initial Mass Function down to planetary-mass objects is fundamental to understanding star formation. The debate centers on whether these objects, which are found freely floating in young clusters with masses below the deuterium-burning limit at ~13 MJup, form like stars via cloud fragmentation or represent ejected giant planets. Because substellar objects cool and grow fainter over time, young clusters serve as ideal laboratories for their study. Their known ages break the mass-luminosity-age degeneracy, while their youth makes these faint populations significantly easier to detect. Recent observations of the young cluster IC 348 by the James Webb Space Telescope (JWST) revealed a population of substellar objects exhibiting a previously unobserved 3.4 µm absorption feature of unknown origin. While their near-infrared spectra resemble typical young M- and L-type dwarfs, they present luminosities significantly lower than expected, suggesting ultra-low masses. Driven by this combination of anomalous absorption and unexpectedly low luminosities, these objects have been proposed as a new spectral class, the "H-dwarfs". We present an independent and systematic re-analysis of the complete JWST spectroscopic sample in IC 348 to evaluate the validity of this proposed spectral class. We start with an objective verification of the presence of the 3.4 µm feature across the sample. To assess whether these candidates are genuine cluster members or field contaminants, we investigate their spatial distribution and apply gravity-sensitive spectral indices. Finally, we utilize synthetic photometry combined with evolutionary models to derive their physical parameters, yielding masses as low as 4 MJup. We find that there is a significant tension between the atmospheric and evolutionary analyses in this ultra-low-mass regime, demonstrating how extinction determinations and model choice heavily impact the results and, therefore, our understanding of the boundary between stars and planets.

Stars, Stellar Remnants, Compact Objects and Space Weather

POSTER

Characterizing brown dwarfs in the Epsilon Indi and Gliese 570 systems

Presenter: Matilde Tam

Instituto de Astrofísica e Ciências do Espaço

ABSTRACT

In contrast to main-sequence stars, brown dwarfs follow a complex age-mass-luminosity relation that requires evolutionary and atmosphere models for their characterisation. This process depends critically on age, which is difficult to constrain for isolated brown dwarfs but can be inferred for companions from the properties of their primary stars. In this work, we study in detail the brown dwarfs of the Epsilon Indi system, the GJ570 system, and the planet Epsilon Indi Ab, using age determinations for their primary stars. We adopt asteroseismic ages from previous studies and derive new age estimates from age-activity and gyrochronology relations. Masses for the three brown dwarfs (Epsilon Indi Ba, Bb and GJ570D) and the exoplanet are obtained by interpolation in the age-photometry space, using BT-Settl, Sonora-Bobcat and Chabrier-ATMO evolutionary tracks. Effective temperatures are derived both from evolutionary models and from chi^2 fitting of atmosphere models to the spectral energy distributions, using VO SED Analyzer (VOSA). Finally, we discuss the impact of different age inputs and model choices on the derived properties, and compare the derived masses with model-independent dynamical mass measurements. These results contribute to the calibration of substellar evolutionary and atmospheric models, enabling more reliable characterization of brown dwarfs.

Stars, Stellar Remnants, Compact Objects and Space Weather

POSTER

JANUS: a machine-learning-based chemistry catalogue for the full TESS asteroseismic red-giant sample from Gaia XP spectra

Presenter: Andreas Neitzel
Instituto de Astrofísica e Ciências do Espaço

ABSTRACT

Tracing the assembly history of the Milky Way requires precise estimates of the ages, chemical abundances, and kinematic properties of the stars that constitute the Galaxy's various stellar populations. Asteroseismic surveys of red giants provide the most precise and accurate ages currently available. NASA's Transiting Exoplanet Survey Satellite (TESS) has extended that capability from the small Kepler field to nearly the full sky, resulting in a catalogue of approximately 158,000 oscillating red giants. Using this sample to characterise the Milky Way's stellar populations requires star-by-star photospheric chemistry, but the highest-fidelity large-scale spectroscopic survey currently available, APOGEE DR19, covers only about 12% of these stars. We present JANUS, a neural network that maps Gaia DR3 XP low-resolution prism spectra to APOGEE-consistent Teff, log(g), [Fe/H], and [α/M]. For each star, JANUS returns uncertainty covariances calibrated against the empirical residual distribution and an out-of-distribution flag relative to the trained feature space. On an APOGEE-DR19 hold-out (n = 23,024), JANUS reaches per-star precisions of 39 K in Teff, 0.08 dex in log(g), 0.06 dex in [Fe/H], and 0.03 dex in [α/M] (NMAD residuals against APOGEE labels), with biases below 5 K and 0.005 dex. Applied to the full TESS asteroseismic red-giant sample, JANUS delivers uncertainty-calibrated chemistry for 89,372 stars, a 4.85-fold expansion over the APOGEE-observed crossmatch. The catalogue is validated against three physics-grounded requirements: chemical homogeneity within fifteen open clusters spanning the disc metallicity range (0.10 dex scatter across cluster-median [Fe/H] around a -0.03 dex mean offset from literature values); differential agreement across 375 wide binary red-giant pairs (pair-z standard deviations of 0.53 in [Fe/H] and 0.45 in [α/M]); and unit-consistency of the pull distribution on the APOGEE-DR19 hold-out. Combining the chemistry with ESA Gaia astrometry and radial velocities places 87,903 of these stars in dynamical space, where the low-α and high-α discs separate as expected in the Toomre, energy-angular-momentum, and action planes. The catalogue provides a substrate for Galactic-archaeology programmes previously constrained by the APOGEE footprint, including the ongoing FCT-funded ArqueoGal Exploratory Project.

Stars, Stellar Remnants, Compact Objects and Space Weather

POSTER

Utilizing opacity-enhanced models to mitigate the radius discrepancy of asteroseismic K-dwarfs

Presenter: Rúben Costa

Instituto de Astrofísica e Ciências do Espaço

ABSTRACT

Recent helioseismic studies have suggested the need for an increase in the opacity at the bottom of the convective envelope of the Sun, while experimental studies suggest the need for an increase in the stellar opacity of specific elements, such as Iron and Oxygen. Properly calibrating the stellar opacity profile is important, as improper values can lead to bias and errors in the determination of global stellar parameters like the radius and age. In this presentation we will showcase our results for the impact of opacity-enhanced models in attempting to diminish the radius discrepancy in K-type stars, a systematic discrepancy that exists between the values for the modelled and interferometric radii in M and K-type stars. We will show the impact of applying an increase in the opacity at the bottom of convective envelope, along with that of utilizing the most recently available stellar opacity tables. We will also do a small review of the current state of asteroseismology in K-type stars, as in our sample of stars we have included all of the K-type stars with available asteroseismic data. The availability of asteroseismic data for K-type stars is a recent development, and it allows us to study components of the input physics of stellar models with a higher degree of precision, such as the opacity.

Stars, Stellar Remnants, Compact Objects and Space Weather

POSTER

Mapping Granulation Signatures Across Spectral Lines with Disk-Resolved Solar Observations

Presenter: Carmen San Nicolas

Instituto de Astrofísica e Ciências do Espaço; Universidade do Porto

ABSTRACT

Stellar surface inhomogeneities remain a fundamental limitation to extreme-precision radial velocity (RV) measurements, with granulation driving variability on short timescales that is not yet fully captured by current mitigation strategies. Achieving cm/s precision for Earth-analog detection requires a detailed understanding of how these processes manifest across spectral lines and evolve in time. In this work, I present results from disk-resolved solar observations obtained with the PoET telescope (Santos et al. 2025) that provide a direct view of granulation-driven photospheric variability and its spectroscopic signatures. The analysis is performed with TILARA (San Nicolas et al. 2026), a line-by-line RV extraction framework based on iterative multi-Gaussian modelling of individual absorption lines. This approach allows the characterization of the differential response of spectral lines to stellar surface variability. I will present a classification of absorption lines according to their sensitivity to granulation-driven RV variations, identifying both stable lines and those strongly affected by short-term variability. Furthermore, I will explore how these RV signatures correlate with key line properties, including line strength, wavelength, atomic species, and excitation potential, providing insight into how granulation effects are encoded across spectral features formed under different physical conditions. These results demonstrate the value of disk-resolved solar observations as a benchmark for understanding stellar activity. Identifying spectral lines that are less sensitive to granulation variability opens new possibilities for future mitigation techniques based on selective line weighting and optimized spectral masks for extreme-precision RV studies.

Stars, Stellar Remnants, Compact Objects and Space Weather

POSTER

Statistical analysis of the ionospheric response to geomagnetic storms at Lisbon, Azores and Madeira.

Presenter: Shedrach Chiaha
CAUP/IA

ABSTRACT

During geomagnetic storms, ionization and recombination processes in the ionosphere are either enhanced or diminished. These two processes give rise to positive and negative storms respectively. Also, there are combination of both responses to geomagnetic storms (e.g., positive-negative, negative-positive and so on). Variations in these responses, depends on several factors. They include; strength of a storm, commencement type, type of the solar origin of a geomagnetic storm (e.g., coronal mass ejections or high-speed solar wind streams) and location of geomagnetic stations. In this work, we carried out a statistical analysis of eighty-one moderate to major geomagnetic storms during the declining phase of the 24th solar cycle, from 2015 to 2019. The analysis was carried out using total electron content (TEC) data obtained from three geodetic receivers in Portugal; Lisbon (Continental Portugal) 38.7oN 9.14oW, Furnas (Azores) 37.8oN 25.4oW and Funchal (Madeira) 32.7oN 16.9oW. Results from this work, show patterns in the ionospheric to storms with different characteristics. Attention was also given to the Latitudinal and longitudinal (dis) similarities in the ionospheric variations observed at the studied locations.

Stars, Stellar Remnants, Compact Objects and Space Weather

POSTER

Space Weather monitoring with BepiColombo and JUICE

Presenter: Marco Pinto

LIP

ABSTRACT

The space environment is highly dynamic and varies significantly with solar activity. I is populated by highly energetic particles including Galactic Cosmic Rays, Solar Energetic Particles, and trapped particles within planetary magnetospheres. These particles cause a plethora of effects and represent one of the main hazards to spacecraft, human exploration, and planetary environments. Understanding their origin, transport, and evolution is therefore essential for forecasting adverse conditions throughout the Solar System. Monitoring interplanetary Space Weather requires knowledge of solar and solar-wind conditions, local planetary environments, solar wind–magnetosphere–ionosphere coupling, and the interaction of each spacecraft with its surroundings. Despite the growing number of missions dedicated to studying heliophysical phenomena, spatial coverage remains extremely limited. ESA's BepiColombo and JUICE missions, travelling to Mercury and the Jovian system, respectively, provide a unique opportunity to investigate energetic particles during their long cruise phases. During cruise, BepiColombo regularly operates several instruments dedicated to plasma, radiation, and magnetic-field measurements, including SIXS, BERM, SPM, and MPO-MAG. On JUICE, RADEM operates continuously, with additional instruments expected to contribute during the later stages of the cruise. Their measurements enable coordinated studies with heliophysics missions such as Parker Solar Probe and Solar Orbiter, and depending on their location, act as upstream solar-wind monitors for planets including Venus and Mars. In this work, we report the scientific contributions of both missions to date and discuss the importance of cruise-phase observations for characterizing energetic-particle dynamics and Space Weather conditions in the inner Solar System.

Stars, Stellar Remnants, Compact Objects and Space Weather

POSTER

Time-Skipping Stellar Evolution at the Millisecond Scale: Autoregressive Deep Learning Emulation of RGB Tracks

Presenter: João Santos
CENTRA

ABSTRACT

Abstract not provided.

Planets, Exoplanets and Astrobiology

INVITED TALK

PoET - A Portuguese solar telescope in the Atacama Desert

Presenter: André Silva

Instituto de Astrofísica e Ciências do Espaço (IA-CAUP)

ABSTRACT

The detection and characterisation of Earth-like planets—those with physical conditions suitable for liquid water and potentially life-sustaining environments—is a major goal of modern astrophysics. Nowadays, the roadblock lies in astrophysical "noise" from host stars, distorting the spectra used to detect and analyse such planets. Existing mitigation techniques have yet to reach the precision required to detect the minute radial-velocity signals induced by Earth analogues, motivating a growing focus on solar observations to better understand stellar variability. The Paranal solar Espresso Telescope (PoET) aims to offer a novel approach to understanding stellar "noise". With its first light achieved in April 2026, PoET is connected to the ESPRESSO spectrograph on the ESO-VLT. This telescope was fully built by a Portuguese team from the Instituto de Astrofísica e Ciências do Espaço, spread between Porto, Lisbon, and Coimbra. It provides both disk-resolved and disk-integrated ("Sun-as-a-star") high-resolution (R > 200,000) observations of the Sun covering the full optional domain (380–780 nm) in a single shot. PoET allows for a detailed mapping of our host star, enabling an unprecedented understanding of how different solar features evolve over the wavelength and temporal domains across the solar disk. Furthermore, by using the Sun as a proxy for other Sun-like stars, these results will inform improved strategies to mitigate stellar noise in exoplanet research. In this talk, I will present the scientific objectives of PoET together with some of the first results from resolved regions of the solar disk, highlighting the instrument's potential to advance both solar and exoplanet science.

Planets, Exoplanets and Astrobiology

CONTRIBUTED TALK

The Fear of Missing Out in Atmospheric Studies: Exploring the Role of Molecular Opacities in Interpreting Exoplanet Spectra

Presenter: Alexandre Branco

Instituto de Astrofísica e Ciências do Espaço, U. Porto, Bard College

ABSTRACT

Understanding the atmospheric diversity of exoplanets in the terrestrial and sub-Neptune regime requires not only high-quality observational data but also robust photochemical models. However, many molecules still lack measured UV–Visible absorption cross-sections, which are crucial for modelling photolysis and build complex reaction networks for exoplanet atmospheres. In their absence, models often rely on proxy species, introducing uncertainties that can affect both observation planning and data interpretation. In this work, we explore how the lack of molecular opacity data can influence atmospheric characterization studies of small exoplanets. Using the Atmos photochemical model (Kasting et al. 1979), we assess the sensitivity of simulated spectra to educated UV–Visible cross-section assumptions for the unconstrained species HSO – a key intermediates in sulphur chemistry (Hu et al. 2013, Harman et al. 2018, Ranjan et al. 2019). This study has been accepted for publication in The Astrophysical Journal (Branco et al. 2026) and demonstrates how sensitivity analyses can identify molecules that should be prioritised for future laboratory and/or theoretical characterisation. Motivated by the challenge of how uncertain molecular cross-sections influence data interpretation, we are extending this framework towards low-resolution, JWST transit observations. This effort aims to quantify how these uncertainties propagate into retrieval analyses and to outline strategies for mitigating ambiguities in exoplanet atmospheric characterization.

Planets, Exoplanets and Astrobiology

CONTRIBUTED TALK

A Marauder's Map for stellar surfaces via transiting exoplanets

Presenter: Telmo Monteiro

IA/CAUP & FCUP

ABSTRACT

As the number of known exoplanets grows, the focus has shifted toward characterizing these worlds and their atmospheres. However, the detection of exoplanet atmospheres is challenged by our knowledge of stellar physics, including activity and center-to-limb variations (CLV), as the spectrum is not homogeneous across the apparent surface of the star. These inhomogeneities complicate transmission spectroscopy atmospheric retrievals, so understanding stellar surfaces is crucial for our success. To address this, we can use the "Doppler Shadow" technique, which uses the transiting planet as a probe to study local regions of the stellar surface, revealing how spectral lines vary with limb position and how this shapes distortions in transmission spectra. It remains the only method capable of extracting local spectra from stars other than the Sun, though its use has so far been limited to customized line-lists (CCFs). New-generation instruments like ESPRESSO, with their unprecedented spectral resolution and stability, now make it possible to revisit and extend this technique to a much broader range of planetary systems. In this contribution, we will present novel results regarding the application of the Doppler Shadow technique to ESPRESSO observations of HD 189733 and HD 209458. These results were enabled by HECATE, a fully documented and public analysis pipeline capable of extracting spectra occulted by transiting planets, introducing automation, significantly improving reproducibility and scalability.

CONTRIBUTED TALK

Spectral needs in Exoplanets/Necessidades espetrais em exoplanetas

Presenter: Clara Sousa-Silva
CAUP/Bard College

ABSTRACT

Exoplanet atmospheres, from gas giants to potential habitability targets, could plausibly contain hundreds of chemical species. Their resulting observational spectra is a complex signal that depends on many individual chemical contributions and their interaction with the environment, whether life is present or not. The spectroscopic properties of any potential biosignatures determine how they interact with the atmosphere, and the contextual species that allow for the analysis of abiotic scenarios have their own spectra and associated photochemical interactions. Without a complete picture of these complex spectral behaviours in the context of exoplanet atmospheres we restrict our interpretation of exoplanet atmospheres, and jeopardize our ability to interpret potential biosignatures. The understanding of planetary atmospheres, within and beyond the solar system, requires models that can interpret observations and simulate their environments. Whether we are aware of it or not, these models make spectroscopic choices that can impact their outputs and our ability to interpret them. How do we assess whether these choices were correctly made, and how do we choose differently if not? In this talk I present a few examples of recent work that aims to answer these questions, as well as efforts to obtain and test improved spectroscopic data from both reasonable (e.g., laboratory experiments) and extraordinary (e.g., space) sources. / As atmosferas de exoplanetas, desde gigantes gasosos a potenciais alvos de habitabilidade, podem plausivelmente conter centenas de espécies químicas. O espetro observacional resultante é um sinal complexo que depende de muitas contribuições químicas individuais e da sua interação com o ambiente, quer exista vida ou não. As propriedades espetroscópicas de quaisquer potenciais bioassinaturas determinam a forma como estas interagem com a atmosfera, e as espécies contextuais que permitem a análise de cenários abióticos têm os seus próprios espetros e interações fotoquímicas associadas. Sem uma visão completa destes comportamentos espetrais complexos no contexto das atmosferas de exoplanetas, restringimos a nossa interpretação dessas mesmas atmosferas e pomos em risco a nossa capacidade de interpretar potenciais bioassinaturas. A compreensão das atmosferas planetárias, dentro e fora do sistema solar, requer modelos que consigam interpretar observações e simular os seus ambientes. Quer tenhamos consciência disso ou não, estes modelos fazem escolhas espetroscópicas que podem impactar os seus resultados e a nossa capacidade de os interpretar. Como avaliamos se estas escolhas foram feitas corretamente e como podemos escolher de forma diferente se não tiverem sido? Nesta apresentação, dou alguns exemplos de trabalhos recentes que visam responder a estas questões, bem como esforços para obter e testar dados espetroscópicos melhorados a partir de fontes tanto razoáveis (por exemplo, experiências de laboratório) como extraordinárias (por exemplo, o espaço).

Planets, Exoplanets and Astrobiology

CONTRIBUTED TALK

Beating solar radial velocity jitter below 50cm/s with physics-based modeling

Presenter: Sophie Stucki

IEEC / ICE-CSIC

ABSTRACT

Stellar magnetic activity has become the dominant limitation for RV detection of Earth analogs, whose expected signal amplitude is of the order of 10 cm/s. The Sun provides a unique benchmark to test physics-based models and assess their ability to reproduce activity-driven RV variability at the sub-m/s level. I will present a stringent validation of the physics-based StarSim/SunSim framework using solar observations. SunSim combines SDO/HMI continuum intensity and LOS magnetogram images to derive the distribution of magnetic surface features and generate synthetic TSI and RV time series using spectra computed from 3D MHD MURaM simulations. Comparisons with HARPS-N observations show that SunSim reproduces solar activity from daily timescales to the solar cycle, reaching residual RV scatter of 49 cm/s over three years, consistent with the intrinsic deviation of HARPS-N and comparable to state-of-the-art data-driven approaches. Beyond reproducing solar variability, injection–recovery experiments demonstrate improved planetary signal recovery through physics-based modeling, extending detectability toward lower-mass exoplanets.

Planets, Exoplanets and Astrobiology

POSTER

Erasmus Mundus Joint Master in Planetary Geosciences (EMJM-Geoplanet) J. Fernandes, A. Pais and P. Pina

Presenter: João Fernandes
DM/CITEUC/FCTUC

ABSTRACT

The EMJM in Planetary Geosciences addresses the need to structure and internationalise teaching and training in Planetary Geosciences in the European Higher Education Area (EHEA). It aims to achieve excellence, to increase cooperation among universities and with industry and to train students to respond to the future challenges of space exploration in a multidisciplinary and multicultural environment. This programme brings together three partner universities: the University of Nantes (coordinator), the University of Gabriele d'Annunzio of Chieti-Pescara, and the University of Coimbra. In Portugal, the University of Porto is an associate partner. It also involves more than twenty other higher education and research institutions from the Geoplanet network, spread across the world. The EMJM-Geoplanet is funded by the European Commission under the Erasmus Mundus programme and started in the 2023/2024 academic year, with the last edition beginning in 2026/2027. In this poster, we aim to showcase this initiative and the results of its first three years.

Instrumentation

INVITED TALK

Instrumentação para astronomia, enquadrando desenvolvimentos recentes e perspectivas futuras.

Presenter: António Amorim

F. Ciências, U. Lisboa e LIP - Laboratório de Física Experimental e

ABSTRACT

Será apresentado um resumo dos esforços recentes da instrumentação em astrofísica em Portugal, passando pelos programas de instrumentação nos telescópios VLT, VLTI e ELT do ESO, bem como o programa inserido nos esforços SKA e satélites de observação da ESA no infravermelho e nos raios-x. Estes esforços passam essencialmente pelo desenvolvimento de sistemas mecânicos, óticos, ótica adaptativa e detectores para raios-X. Propõe-se discutir em detalhe as possibilidades de desenvolvimento futuro do domínio entre nós.

Instrumentation

CONTRIBUTED TALK

ANDES, the high resolution spectrograph for the ELT: The Front-End and its seeing limited arms

Presenter: Manuel Abreu

Instituto de Astrofísica e Ciências do Espaço - F.C.U.Lisboa

ABSTRACT

ANDES is a high-resolution spectrograph to be installed at one of the Nasmyth foci of the ESO Extremely Large Telescope (ELT) in Chile. The instrument will comprise four spectrographs, providing broad spectral coverage through dedicated UBV, RIZ, YJH and K channels. It will deliver a spectral resolution of approximately 100,000 with a simultaneous wavelength coverage from 0.35 µm to 2.4 µm. To stabilize and inject the telescope beam into the different spectrographs, a Front-End subsystem will be installed on the Nasmyth platform. This subsystem supports the various observing arms located at the telescope focal plane, enables the selection of the different observing modes, and manages the routing of fibre bundles and service cables. For the seeing-limited arms, the Front End also separates the spectral bands between the different channels, performs atmospheric dispersion correction, provides guiding and field stabilization, and injects calibration light into the science fibres. Following the successful Preliminary Design Review (PDR) of the Front-End subsystem, the full instrument Preliminary Design Review is scheduled for the last quarter of 2026. In this presentation, we will describe the preliminary design of the ANDES Front-End subsystem, with particular emphasis on the optical and opto-mechanical design of the seeing-limited arms. The main design drivers, engineering challenges, and expected performance will also be discussed.

Instrumentation

CONTRIBUTED TALK

MOONS: The next ESO VLT's Multi-Object Spectrograph

Presenter: Alexandre Cabral

Instituto de Astrofísica e Ciências do Espaço - F.C.U.Lisboa

ABSTRACT

MOONS, the Multi-Object Optical and Near-infrared Spectrograph, is ESO's next-generation multi-object spectrograph for the Very Large Telescope (VLT). It will be capable of simultaneously observing approximately 1,000 targets by feeding a set of optical fibres positioned at user-defined locations across the Nasmyth focal plane using individual robotic positioners. First light is expected in August 2026. The selected sub-fields are relayed through the fibres to two identical cryogenic spectrographs mounted on the Nasmyth platform of one of the ESO VLT 8-m telescopes. The instrument will provide both medium- and high-resolution spectroscopic observations over the wavelength range from 0.65 µm to 1.8 µm. This unique facility will enable a wide range of Galactic, extragalactic, and cosmological investigations, addressing some of the most important questions in modern astrophysics. In this talk, we will present the assembly, integration, testing, and commissioning of the complete instrument at the ESO Paranal Observatory. Particular emphasis will be given to the two subsystems that interface directly with the VLT telescope and were developed by the Institute of Astrophysics and Space Sciences (IA) in Portugal: the MOONS Field Corrector and the Rotating Front-End Assemblies. Their design, manufacturing, integration, and on-site commissioning will be described, together with the challenges encountered and the lessons learned during the successful deployment of the instrument.

Instrumentation

CONTRIBUTED TALK

THOR Mission Polarimetric Prospects

Presenter: Carolina Gouveia
Universidade de Coimbra

ABSTRACT

The Universe exhibits physical conditions that cannot be reproduced on Earth, such as natural particle acceleration mechanisms, intense gravitational fields, and extremely high magnetic fields. Because gamma rays are electrically neutral and are therefore not deflected by magnetic fields, they carry direct information about the processes that occur in these extreme environments. To explore the gamma ray domain, THOR-SR mission (TGF and High-energy astrophysics Observatory for gamma-Rays on-board Space Rider) was developed by the i-Astro group at LIP (Laboratório de Instrumentação e Física Experimental de Partículas) Coimbra to operate in Low Earth Orbit (LEO). The mission was designed to observe gamma rays in the energy range between 100 keV and 1 MeV using the Gamma Tracker Array, a Compton telescope composed of twelve pixelated cadmium telluride semiconductor detectors arranged in three planes of four detectors each. In this work, THOR mission polarimetric performance was estimated using the MEGAlib (Medium-Energy Gamma-ray Astronomy library) simulation toolkit. First, the detector response to monoenergetic sources was characterized through simulations to determine the effective area and modulation factor as a function of energy, and then the orbital background in LEO was estimated. By combining these results, the Minimum Detectable Polarization (MDP) for the Crab Nebula was calculated as a function of the observation time, for energies of 150 keV, 200 keV, 250 keV and 300 keV. Over an observation time of 40 days, corresponding to the expected cumulative exposure during the mission for observations of the Crab Nebula, the ideal MDP values were 37.82±2.20% and 37.52±2.03%, obtained at 150 keV and 200 keV, respectively. These results are comparable to the known polarization fraction of the source, indicating that the instrument can perform scientifically meaningful polarimetric measurements of the Crab Nebula.

Instrumentation

CONTRIBUTED TALK

An Improved, Satellite-Specific GNSS RFI Model for Single-Dish HI Intensity Mapping

Presenter: Vitória Branco

IA/CAUP

ABSTRACT

Hydrogen Intensity (HI) mapping in single-dish mode is a highly promising probe for large-scale structure and cosmology. However, these observations are severely hindered by Radio Frequency Interference (RFI), and one of the most disruptive sources are Global Navigation Satellite Systems (GNSS) as their allocated frequency bands overlap with cosmologically critical windows. Traditional RFI mitigation strategies often rely on aggressive frequency masking, which inherently leads to significant data loss and fails to adequately address out-of-band contamination. Recent efforts utilizing MeerKAT single-dish data have demonstrated the viability of modeling and subtracting observed satellite signals (Engelbrecht, 2024). In this work, we present a significantly improved and computationally optimized GNSS RFI model; while previous approaches assumed uniform signal characteristics across an entire satellite constellation, our pipeline performs signal fitting on an individual satellite-by-satellite basis, as well as reducing computational execution time from hours to minutes, thus enabling the efficient processing of large observational datasets. By calculating satellite trajectories and incorporating the MeerKAT beam response, we simulate individual satellite emissions and fit the signal amplitudes to observational data. We apply this pipeline to four MeerKAT L-band single-dish observation blocks, previously calibrated, focusing on the heavily GNSS-contaminated 1140–1310 MHz range. We evaluate the best-fit amplitude parameters across various masking strategies (with the purpose of excluding non-linear receiver responses); by isolating each satellite, we achieve a superior fit to the data, successfully reducing residuals by 5% to 30% (depending on the applied mask), while simultaneously characterizing individual satellite emission properties (Branco et al., in prep.). Finally, we aim to quantify the residual impact of GNSS RFI on cosmological measurements by estimating the HI auto- and cross-power spectra (following Cunnington et al., 2023). By comparing the power spectra of cleaned versus uncleaned data, we aim to explore the extent to which previously discarded, GNSS-contaminated data can be effectively salvaged for consequent robust cosmological analysis.

Instrumentation

POSTER

The Software of PoET

Presenter: Jorge H. C. Martins
Instituto de Astrofísica e Ciências do Espaço, Universidade do Porto

ABSTRACT

The Paranal solar ESPRESSO Telescope (PoET) is a 100% Portuguese solar telescope which has been installed at the European's Southern Observatory (ESO) Paranal Observatory. Coupled to the ESPRESSO spectrograph, it is able to simultaneously obtain high-resolution spectra of the integrated Sun and selected resolved regions of the solar surface. One of the key components of PoET is its control and observation software, which uses ESO's ELT (Extremetely Large Telescope) framework. PoET is the first instrument to use ESO's ELT framework, a software framework built to control the next generation of instruments to be installed at ESO's ELT. In this talk I will make an overview of PoET's control and observing software and present its key components. I will show how the control software links together the different components between them and to ESPRESSO.

Instrumentation

POSTER

HRMOS: a High-Resolution Multi-Object Spectrograph for the ESO VLT – Instrument Overview and Key Science Drivers

Presenter: Sérgio Sousa
Instituto de Astrofísica e Ciências do Espaço

ABSTRACT

HRMOS (High-Resolution Multi-Object Spectrograph) is a new instrument concept currently being developed for the ESO Very Large Telescope (VLT) within the framework of the VLT2030 roadmap. Designed to provide a unique combination of very high spectral resolution, multi-object capability, and high radial-velocity precision, HRMOS aims to fill a critical gap in the future landscape of ground-based spectroscopic facilities. The current design foresees a resolving power of $R \approx 80{,}000$, simultaneous observations of 50–80 targets, wavelength coverage in three spectral windows between 385 and 675 nm, and radial-velocity precision reaching 5–10 m s^{-1}. These capabilities will enable transformative science that cannot be achieved by existing or planned survey instruments. This presentation will provide an overview of the current status of the HRMOS project, its main technical characteristics, and its role within the future ESO instrumentation programme. It will also highlight some of the flagship science cases that drive the instrument design, including the systematic search for exoplanets in dense stellar environments. HRMOS will further enable a broad range of investigations in stellar astrophysics, nucleosynthesis, star clusters, young stars and magnetic activity, while providing a powerful complement to forthcoming large spectroscopic surveys and space missions.

Instrumentation

POSTER

RISTRETTO: The new diffraction-limited instrument at the VLT

Presenter: Bachar Wehbe

Institute of Astrophysics and Space Sciences

ABSTRACT

High-resolution spectroscopy combined with high-contrast imaging is emerging as a powerful technique for the direct detection and characterization of exoplanets. RISTRETTO is a new high-resolution (R ≈ 140,000) integral-field spectrograph currently under construction for the Very Large Telescope (VLT), designed to exploit this approach. Coupled to an extreme adaptive optics system and a coronagraph, the instrument features a seven-spaxel integral-field unit optimized for high-contrast spectroscopy at small angular separations. RISTRETTO will enable the characterization of exoplanet atmospheres in reflected light while also providing access to key spectral diagnostics, such as Hα emission from young accreting planets. As a technological and scientific pathfinder for future Extremely Large Telescope instrumentation, including ELT/PCS and ELT/ANDES, RISTRETTO will demonstrate the capabilities of high-dispersion coronagraphy and help establish the observing strategies and data analysis techniques required for the next generation of exoplanet characterization. In this talk, I will present RISTRETTO and highlight the Portuguese instrumentation participation within the project.

Instrumentation

POSTER

Towards the miniaturization of cross-dispersed echelle spectrographs: Parametric modelling and trade-off analysis of three optical designs

Presenter: Nuno M. Gonçalves
Instituto de Astrofísica e Ciências do Espaço

ABSTRACT

High-resolution (HR) spectroscopy plays a fundamental role in modern astronomy. Cross-dispersed echelle spectrographs (CDES) are at the forefront of HR spectroscopy for both ground- and space-based observatories. Currently, a wide range of science cases—from exoplanet detection to solar characterization—require the capabilities of HR CDES. One constraint with this design typology is that the instruments are very bulky and complex. CDES come with a variety of optical designs, each tailored to specific scientific objectives and the observatory in which they are used. Based on their optical path, three major designs variations can be identified: the classic design, the double-pass, and the three-fold. The classic design is the original configuration; it was the first used in these instruments and remains the simplest to assemble. The double-pass design employs a single optical element as both the collimator and camera, enhancing the compactness of the system. Finally, the three-fold design—a white-pupil configuration that represents the current state of the art in ground-based observatories—uses a parabolic mirror to fold the beam three times. This approach enables a more compact design and allows for smaller aperture cross-dispersers and cameras, thanks to the white-pupil property. Each of these designs contributes differently in terms of area footprint, spectral power, and efficiency. However, no systematic analysis has been done to quantify the contributions of these characteristics across the different configurations. In this work, we propose a parametrization of the mathematical models for the three designs and propose a novel design configuration of CDES, the Cassegrain design. This approach allows us to quantify the impact of each design parameter on spectral power, area footprint, and efficiency and compare the three state of the art design with the Cassegrain. Ultimately, this parametrization enables a trade-off analysis between the designs using these criteria, helping to identify the optimal optical configuration for specific needs in terms of space, spectral power and efficiency to be applied in both space- and ground-based observatories.

Instrumentation

POSTER

PoET: a spatially resolved Sun in a high-resolution spectrograph

Presenter: Inês Leite

IA / FCUL

ABSTRACT

Among the billions of galaxies and stars in the universe, Earth remains the only known host of life. The continuing search for other inhabited worlds drives the development of increasingly advanced detection techniques. Although nearly 6000 exoplanets have been identified to date, an Earth analogue, a planet of comparable size orbiting a solar-type star at a similar distance, has yet to be confirmed. This limitation arises primarily from stellar “noise,” the intrinsic variability of stars such as our Sun. The combined effects of convective plasma motions, magnetic activity, dark spots, and photospheric granulation introduce complex spectroscopic signatures that can obscure or mimic planetary signals. To address this challenge, we developed the Paranal solar Espresso Telescope (PoET), an instrument based on a 60 cm solar telescope designed to characterize stellar noise using the Sun as a reference. PoET’s optical Front End couples sunlight into ESPRESSO (the Echelle SPectrograph for Rocky Exoplanets and Stable Spectroscopic Observations), one of the most stable and highest-resolution spectrographs currently available. This configuration enables simultaneous disk-integrated “Sun-as-a-star” spectra and spatially resolved observations over areas ranging from 1 to 60 arcseconds, at a spectral resolution of R ≈ 200 000. By combining solar observations at multiple spatial scales with ESPRESSO’s precision, PoET provides a unique framework to study the spectral impact of surface inhomogeneities and magnetic activity on radial velocity measurements. This work presents the optical and mechanical design of PoET, its integration and commissioning at the European Southern Observatory’s Paranal site in Chile, and initial performance results demonstrating its capability to support future exoplanet detection and stellar noise mitigation strategies.

Instrumentation

POSTER

Development of the OGSE Control and Monitoring Software for the Ariel Space Mission

Presenter: Cédric Pereira

Instituto de Astrofísica e Ciências do Espaço

ABSTRACT

The calibration and verification of the ARIEL payload require the operation of a complex Optical Ground Support Equipment (OGSE) infrastructure composed of multiple subsystems, including stabilized light sources, reference detectors, cryogenic systems, and mechanical actuators. The coordination of these heterogeneous subsystems demands a reliable software framework capable of providing centralized control, synchronized data acquisition, and long-term monitoring. This work presents the development of the ARIEL OGSE software platform, implemented in LabVIEW. The software acts as the central hub of the facility, providing instrument control, data acquisition, monitoring, alarm management, user access control, and database storage within a unified architecture. The system supports both manual and automated operation through a scripting engine, enabling the execution of complex calibration and characterization procedures. The software is currently supporting the integration and verification activities of the ARIEL payload and has become a key element in the operation, monitoring, and automation of the ARIEL OGSE infrastructure.

Instrumentation

POSTER

An Innovative High-Resolution Measurement System for Large-Scale Structures: Application to the WSS/METIS for the ESO/ELT

Presenter: João Canais
FCUL/LIP

ABSTRACT

This project presents a three-dimensional measurement system based on the intersection of vertical and horizontal laser curtains, designed for calibration and positioning applications with a resolution below 50 µm. The system offers an alternative to conventional techniques such as coordinate measuring machines (CMM) and laser trackers, providing high accuracy and portability for measurements on large-scale structures. The device architecture enables the automatic acquisition of spatial coordinates by detecting the intersection point of the laser beams with specific targets, thus eliminating the need for heavy instrumentation and accessibility constraints. This measurement system will be applied on the WSS/METIS for the ESO/ELT during assembly at the Portuguese integration facility.

Galaxies and the Milky Way

INVITED TALK

A Long Time Ago, in a Galaxy Far, Far Away...: Recent Advances in Galactic and Extragalactic Astronomy

Presenter: Fernando Buitrago
Universidad de Valladolid / Instituto de Astrofísica e Ciências do Espaço

ABSTRACT

Galactic and Extragalactic Astrophysics have undergone remarkable transformations in the last few years. Large-scale synoptic surveys, including Gaia for studies of the Milky Way and facilities such as DES, Euclid, the Vera C. Rubin Observatory, and the precursors of the SKA for the distant Universe, together with the unprecedented capabilities of JWST at the highest redshifts, have fundamentally reshaped our understanding of galaxy formation and evolution. At the same time, artificial intelligence and advanced data-analysis techniques have become integral components of virtually every stage of astronomical research. These ultradeep datasets also deliver an unprecedented view of low- and intermediate-redshift galaxies. This novel field, the so-called Low Surface Brightness realm, is forever changing our view of galaxy mass assembly by uncovering stellar structures that were previously inaccessible. I will present recent results in this rapidly evolving field and discuss ongoing and future initiatives (ARRAKIHS, Euclid LSB, etc.), highlighting potential interesting opportunities for the Portuguese community. Finally, drawing on my role as a member of the Executive Board of the Spanish Astronomical Society (SEA), I will outline several specific initiatives aimed at strengthening scientific collaboration between the Spanish and Portuguese astronomical communities, including activities related to Cultural Astronomy.

Galaxies and the Milky Way

CONTRIBUTED TALK

The Galactic Centre with GRAVITY+: tightening the net on Sgr A* and the discovery of a black-hole-spin-sensitive star

Presenter: Paulo Garcia
Universidade do Porto/CENTRA

ABSTRACT

Since our last report to this meeting in 2022 — when GRAVITY had just delivered a sub-percent mass and distance for Sgr A* and the tightest limits yet on an extended mass component (GRAVITY Collaboration 2022, A&A, 657, L12) — the upgraded GRAVITY+ instrument has continued its monitoring of the innermost stellar orbits at the Galactic Centre, turning this unique laboratory into an increasingly precise testbed for gravity in the strong-field regime. New results include refined limits on a putative intermediate-mass black hole companion to Sgr A* from the S2 orbit (GRAVITY Collaboration 2023, A&A, 672, A63); an independent, event-horizon-scale mass estimate from the polarimetry and astrometry of near-infrared flares (GRAVITY Collaboration 2023, A&A, 677, L10); tightened constraints on light scalar and vector "fifth-force" fields around the black hole from S2's motion (Foschi et al. 2023, MNRAS, 524, 1075; GRAVITY Collaboration 2024, MNRAS, 530, 3740; GRAVITY Collaboration 2025, A&A, 698, L15); and improved bounds on any diffuse mass distributed among the S-stars (GRAVITY Collaboration 2024, A&A, 692, A242). The GRAVITY+ upgrade itself reached a major milestone with the first light of its extreme adaptive optics system, boosting sensitivity and astrometric precision across the field (GRAVITY+ Collaboration 2026, A&A, 707, A115). Building on this improved performance, we report the discovery of S301, the faintest and most compact-orbit star yet found around Sgr A*: a main-sequence star on an 8.7-year, highly eccentric ($e \approx 0.98$) orbit whose pericenter passage brings it to about ten times closer to the black hole than S2, reaching roughly 8.5% of the speed of light. This extreme orbit makes S301 the first stellar probe practically sensitive to the spin of Sgr A* through the Lense–Thirring effect, opening a path toward a dynamical spin measurement within a decade. Its high eccentricity further points to a Hills-mechanism origin, as the surviving remnant of a compact binary disrupted by the black hole. This result, recently accepted for publication in Nature, marks a turning point for relativistic tests of stellar dynamics at the Galactic Centre.

Galaxies and the Milky Way

CONTRIBUTED TALK

The Importance of Being Nebular: From Cosmic Noon to the ELT Era

Presenter: Ciro Pappalardo

IA-FCUL

ABSTRACT

Astrophysics is undergoing a revolution driven by a new generation of facilities that are fundamentally altering our understanding of the Universe’s history. Our team, deeply integrated into the Portuguese astronomy community, is at the forefront of this transformation, focusing on the physical properties of the interstellar medium (ISM) and the mechanisms governing galaxy quenching over the last 10 billion years. This abstract provides an overview of our multi-faceted approach, combining cutting-edge spectral synthesis, high-redshift observations with the James Webb Space Telescope (JWST), and the development of future instrumentation for the Very Large Telescope (VLT) and Extremely Large Telescope (ELT). A central pillar of our research is investigating "nebular contamination" in spectral modelling. Historically, spectral synthesis codes have been "purely stellar," assuming nebular contributions to the continuum were negligible. However, our work with the in-house code FADO (Fitting Analysis using Differential Evolution Optimisation)—the first tool to self-consistently model both stellar and nebular components—has demonstrated that this assumption leads to significant biases. We have established that when the nebular contribution (X_neb) exceeds 8%, or the equivalent width of Halpha (EW(Halpha)) surpasses 500 Å, purely stellar codes can overestimate a galaxy's stellar mass by a factor of 3 to 10. Recent analysis of JWST data from the Blue Jay survey and the DAWN JWST Archive has confirmed that these scaling relations remain valid at high redshifts ($z \sim 1.7–3.9$), underscoring the necessity of accounting for the nebular continuum during the Cosmic Noon epoch. Complementing our modelling, we utilise large photometric datasets like COSMOS2020 to study the transition of galaxies from active star formation to quiescence. By analysing over 249,000 sources, our team has investigated the prevalence of post-starburst (PSB) galaxies—systems that experienced a recent burst of star formation followed by rapid quenching on timescales of tens of Myrs. Our findings indicate a clear redshift dependence in quenching mechanisms: at high redshifts ($z > 2$), quenching is dominated by fast processes, resulting in a higher fraction of PSB systems (~31% at $z \sim 2.5$). Conversely, at lower redshifts, quenching becomes more secular and gradual. The future of our team is anchored in the MOONS (Multi-Object Optical and Near-infrared Spectrograph) instrument for the VLT. Having held leadership roles in the MOONS consortium since 2010, we are preparing for the MOONRISE survey, which will observe half a million galaxies at $0.9 < z < 2.6$, providing the statistics needed to unveil the physical processes that shaped the "SDSS Universe". Our work with MOONS also serves as a vital technological stepping stone for the ELT, as expertise gained during the commissioning of the MOONS Rotator Front-End will directly inform the design of ANDES, ensuring Portugal remains at the heart of European instrumentation development.

Galaxies and the Milky Way

CONTRIBUTED TALK

The Extended Nebular Halo in Low-Mass Starburst Galaxies

Presenter: Bernardo Carneiro

FCUP/IA

ABSTRACT

Blue Compact Dwarf (BCD) galaxies are unique laboratories in extragalactic astronomy, widely regarded as the best local analogs of the first low-mass galaxies formed in the early Universe. This resemblance stems from their extremely low metallicity and intense starburst activity, manifested in the near-coeval formation of thousands of massive stars within young stellar clusters (YSCs). The copious ionizing radiation and mechanical energy released during such starburst episodes give rise to extended nebular emission, typically reaching kpc scales beyond the YSCs and forming an extended nebular halo. Characterizing the photometric and physical properties of this nebular halo, and its connection to the starburst's energy output, is essential not only for understanding the starburst cycle in BCDs themselves, but also for constraining the early assembly history of high-z galaxies more broadly, since starburst activity was ubiquitous at those redshifts and likely played a key role in the escape of ionizing radiation and the chemical enrichment of the intergalactic medium. I will present first results from an analysis of one hundred and six nearby BCDs, based on broad band B&R and narrow-band Hα imaging. I will show the diversity of radial Hα intensity profile shapes in these systems: while many galaxies exhibit a pure exponential decline on the galaxy outskirts, a substantial fraction show also plateaus right before this exponential decline, reflecting a more complex morphology of the gas than expected. Furthermore, using the different break radii defined by the photometric analysis (YSCs and extended Hα regions), I will quantify the fraction of extended Hα emission detected outside the YSCs, showing that on average ranges between 20% and 30%. I will also present first results from an in-depth analysis of five sample galaxies, based on spectral modeling of spatially resolved integral-field spectroscopy data obtained with MUSE@VLT to derive gas kinematics, emission-line ratios, and velocity-dispersion profiles within the halo. This way, a more direct link between the halo to the starburst-driven feedback can be explored and linked with the photometric sample of galaxies. This study reveals that a significant fraction (20-30%) of the total Hα emission in BCDs resides in a dynamic complex halo, possibly resulting from leakage of ionizing radiation and starburst-driven mechanical feedback. Therefore, this work provides critical, empirically derived constraints on the feedback efficiency in low-mass galaxies. Further studies of the nebular halo in low-mass starburst galaxies may provide crucial empirical constraints on starburst-driven feedback and the baryon cycle in the early Universe.

Galaxies and the Milky Way

CONTRIBUTED TALK

Chemical tagging in the Galactic thin disk using a graph attention autoencoder

Presenter: Cécilia Russo
Universidade de Coimbra

ABSTRACT

Understanding the formation and evolution of the Milky Way requires identifying stellar populations that share a common origin. While dynamical signatures are progressively blurred by phase mixing, stellar chemical abundances preserve information about a star's birth environment. Chemical tagging aims to use these abundance patterns to identify stars that formed together, even after they have dispersed throughout the Galaxy. In practice, however, the limited chemical contrast between disk stars and the uncertainties affecting spectroscopic measurements make this a challenging problem. In this work, we investigate graph-based machine-learning methods for chemical tagging in the Galactic thin disk using APOGEE DR17 abundances, Gaia DR3 astrometry, stellar ages, and orbital actions. Building on the graph-based chemical-tagging framework proposed by Spina et al. (2025), stars are represented as nodes described by their chemical abundances, while graph connections are defined from similarities in orbital actions and age. The model is trained to reconstruct the stellar chemical abundances, while the attention mechanism learns the relative importance of the graph connections during training. The analysis focuses on the reproducibility and robustness of this approach. We introduce a probabilistic thin-disk selection based on a Gaussian mixture model, replacing the manual cuts adopted in the original study, and use open clusters as reference populations to evaluate the reconstructed chemical-abundance space. We also investigate how methodological choices throughout the analysis affect the recovery of stellar groups. The results show that stars belonging to the same open cluster become more concentrated in the reconstructed chemical-abundance space, making their structure easier to identify than in the original abundance space. Overall, this work supports the potential of graph attention methods for chemical tagging and provides a basis for further methodological developments aimed at improving the identification of stellar populations in the Galactic disk.

Galaxies and the Milky Way

CONTRIBUTED TALK

A solution to the paradox of youth in the Galactic centre

Presenter: Rodrigo Silva
University of Coimbra

ABSTRACT

The supermassive black hole at the Galactic centre, Sgr A*, is surrounded by an S cluster of young stars. These stars are predominantly B-type stars, but their origin remains uncertain. Unlike massive stars in the Galactic field, which exhibit a binary fraction of about 70%, those in the S cluster show a significantly lower fraction. It is key to understand this discrepancy for constraining their formation. We show that the binary deficit arises naturally from dynamical interactions between stellar binaries and Sgr A* in an in situ formation scenario. Using K-amplitude data, we derived an observational binary fraction of f_obs = 0.43 ± 0.09 for the S-cluster stars. Our dynamical modelling predicts that interactions with Sgr A* cause 18% of the binaries to merge, 20% to be disrupted, and 62% to survive, yielding a theoretical binary fraction of f_theo = 0.38 ± 0.10. The predicted binary fraction with distance from Sgr A* is also consistent with independent observational constraints. These results show that the decline in binarity towards the Galactic centre is driven by stronger tidal forces, and they support an in situ origin of the S cluster in the same event that produced the Fermi bubbles.

Galaxies and the Milky Way

POSTER

Combining machine-learning galaxy size measurements in radio and optical/infrared wavelengths

Presenter: Rodrigo Carvajal
Universidad de Valladolid; IA-UL

ABSTRACT

A comprehensive study of galaxy size evolution across cosmic time is essential for understanding the formation history of galaxies and their environments. With the advent of deeper and wider surveys, new techniques have been developed to take advantage of increasingly high-quality data. One such method is the determination of galaxy edges, which are linked to the limit where efficient star formation can occur (Trujillo, Chamba, & Knappen, 2020). However, these newer edge-determination methods are highly involved and require significant human input. In the era of large-scale surveys, using machine-learning (ML) based approaches is crucial to efficiently obtain galaxy edges for millions of sources. Traditional classification and regression methods are applied to select sources according to their properties, while deep learning segmentation techniques can replace traditional radial-profile methods to determine galaxy edges. We present results obtained by applying these two complementary ML-based approaches to multi-wavelength photometric data. The segmentation method can isolate emission from galaxies, minimising environmental contamination (e.g. Vega-Ferrero et al. 2025). In parallel, the classification and photometric redshift models (Carvajal et al. 2023) further enable source selection and derivation of physical size estimates from photometric measurements. By comparing galaxy size determinations in several wavelengths, including optical/IR and radio, we assess potential discrepancies in size evolution, providing new constraints on the processes regulating galaxy growth throughout cosmic history.

Galaxies and the Milky Way

POSTER

Learning the continuum to uncover emission-line anomalies in Euclid NISP spectra

Presenter: Júlia Garetti
Instituto Superior Técnico

ABSTRACT

Euclid’s NISP instrument provides near-infrared slitless spectroscopy over wide areas, producing datasets that motivate scalable and complementary methods for identifying spectral features (cf. Euclid Collaboration: Jahnke et al. 2025; Copin et al. 2026). We investigate whether a Joint-Embedding Predictive Architecture (JEPA; e.g., LeCun 2022; Assran et al. 2023) can learn the normal behaviour of galaxy continua and use deviations from this behaviour to flag candidate emission lines. In this pilot study, we select approximately 5,000 high-quality, continuum-dominated spectra from the Euclid Deep Fields Q1 data release (cf. Euclid Collaboration: Aussel et al. 2026) to pre-train a one-dimensional JEPA. During training, wavelength intervals are masked, and the model predicts their latent representations from the surrounding spectral context. We then apply the trained model to spectra containing emission lines. The discrepancy between the predicted and observed latent representations provides a patch-level anomaly score, allowing unusual features to be detected and approximately localised in wavelength. We validate the method against robust emission-line measurements from the Euclid spectroscopic pipeline and assess its sensitivity and false-positive rate as a function of spectral quality and signal-to-noise ratio (cf. Euclid Collaboration: Le Brun et al. 2026). Finally, we investigate high-scoring features without robust pipeline identifications to determine whether they correspond to weak or unusual emission lines, contamination, or extraction artefacts. Developed within the IA Summer Program 2026, this pilot study explores JEPA as a complementary discovery and quality-control tool for Euclid spectroscopy.

POSTER

The nebular continuum emission of galaxies across cosmic time

Presenter: Henrique Miranda

Instituto de Astrofísica e Ciências do Espaço, Faculdade de Ciências da Universidade de Lisboa

ABSTRACT

The accurate determination of the physical and evolutionary properties of galaxies through spectral fitting depends on the proper treatment of the different galaxy components contributing to the overall observed spectrum. In this regard, the nebular continuum emission can significantly affect the interpretation of galaxy spectra, especially in systems undergoing intense star formation. However, in the past this component has often been neglected when interpreting the optical spectra of galaxies. In this talk, we will present the results from a series of works that studied the nebular continuum emission of galaxies, starting in the local Universe, based on SDSS data, and extending up to the Cosmic Noon, using JWST/NIRSpec. Through the fitting of the rest-frame optical spectra of galaxies using the self-consistent spectral synthesis code FADO, we have investigated how the modelling of the nebular continuum emission impacts the derivation of physical and evolutionary properties. Furthermore, we have correlated the strength of the nebular continuum with different tracers and derived empirical thresholds for when it cannot be neglected. Our results show that accounting for the nebular continuum emission becomes increasingly relevant as we trace a younger epoch of the history of the Universe. This is particularly relevant in the context of the scientific exploitation of MOONRISE, the extragalactic survey to be conducted with the MOONS spectrograph, currently being installed at the VLT, which will deliver unprecedented spectroscopic samples of galaxies at Cosmic Noon.

Galaxies and the Milky Way

POSTER

Structural Properties and Colors of Galaxies Since the Cosmic Noon

Presenter: José Sousa

FCUP/IA

ABSTRACT

Determining the morphological and structural properties of galaxies at intermediate to high redshift (z) is fundamental to advancing our understanding of galaxy formation and evolution. However, this task is far from straightforward. One challenge is that galaxies are composed of multiple spatially and evolutionarily distinct components, each characterized by its own spectral energy distribution. Early-type spiral galaxies, for example, typically consist of a red, older stellar bulge surrounded by a bluer, star-forming disk. When observing distant galaxies, a given photometric filter samples light from a bluer rest-frame wavelength. This results in differential dimming or enhancement of different galaxy components: UV-faint regions such as bulges become fainter, while UV-bright regions such as star-forming disks become more prominent. Consequently, the apparent morphology and structural parameters of galaxies — including light concentration, Sérsic index, effective radius, and bulge-to-disk luminosity ratio — change with redshift. For instance, an early-type spiral may show a prominent bulge in the V band at $z = 0$, whereas at $z \sim 1$ the same filter probes the near-UV rest frame, where the bulge appears faint, and the disk dominates, potentially causing the galaxy to appear "bulgeless." This effect, known as Chromatic Surface Brightness Modulation (CMOD), was first described by Papaderos et al. (2023, A&A, 673, A30). To date, CMOD simulations have been carried out for only a small number of galaxies, limiting our ability to understand and correct for the observational biases, this effect introduces — particularly in morphological classification and studies of galaxy evolution. Here, I present results from an MSc project that used simulations to investigate how CMOD alters the observed structural properties and colors of galaxies since $z \sim 3$, as seen through JWST and Euclid photometric filters. The analysis is based on spectral modeling of integral-field spectroscopy data from MUSE@VLT and the CALIFA survey, and spans the full morphological spectrum of present-day Hubble types, from ellipticals and lenticulars to late-type spirals. One key observational bias identified by this study is a CMOD-induced amplification of the color gradients of high-z galaxies.

Galaxies and the Milky Way

POSTER

When galaxy classifiers disagree: what drives machine-learning selection of Lyman-α emitters?

Presenter: José Henrique Sousa Rodrigues
IA/CAUP

ABSTRACT

Machine-learning searches for Lyman-α emitters (LAEs) from broad-band imaging rely on indirect information, since these images do not isolate the Lyα emission line. Here, we ask what drives LAE candidate selection when galaxy classifiers are trained on different imaging inputs. We train Convolutional Neural Network (CNN) architectures to distinguish SC4K-selected LAEs (Sobral et al. 2018) from COSMOS2020 CLASSIC sources (Weaver et al. 2022) not identified as LAEs by the SC4K narrow- and intermediate-band selection at 2<z<6. We use image cutouts from HST/ACS I-band, Euclid near-infrared Y, J and H bands, and a combined YJH image. The best separation is obtained with HST/ACS and the combined YJH image, while individual NIR bands perform more weakly. This suggests that single-band morphology and surface-brightness information are less discriminating than either higher-resolution optical structure or the continuum-shape information encoded by YJH. Applying the trained models to COSMOS2020 sources not used as SC4K-selected LAEs, and selecting high-confidence candidates from the median prediction across different class-balance assumptions, yields 3906 unique LAE candidates. Cross-matching with public spectroscopic catalogues (cf. Kohstovan et al. 2025) confirms 76 LAEs. However, only five confirmed LAEs are recovered by more than one imaging configuration. This low overlap is the central result since it suggests that different imaging inputs may emphasise different observational proxies for LAE selection, including compactness, surface brightness, rest-frame UV morphology, continuum shape, colour and contamination. By comparing where the models agree and disagree, this work uses LAEs as a test case for understanding how automated galaxy selections depend on the imaging data used, a necessary step towards robust machine-learning searches in future wide-field surveys (Rodrigues et al., in prep.).

Galaxies and the Milky Way

POSTER

Parsing Galactic Populations Using Advanced Machine Learning Techniques

Presenter: Ricardo Vaca

FCUP & CAUP

ABSTRACT

Understanding the Milky Way's formation requires disentangling its overlapping stellar populations, a task that becomes increasingly complex with the vast multidimensional data from Gaia and cosmological simulations. In this hands-on session, we will explore how manifold learning, such as UMAP, and clustering algorithms, like HDBSCAN, can reveal the structure of stellar populations in synthetic Gaia DR3-like datasets derived from the FIRE-2 simulations. Participants will interact with precomputed HDBSCAN embeddings through an intuitive visualization interface, examining how different regions correspond to physical Galactic components such as the thin disk, thick disk, or accreted halo. By comparing embeddings generated with varying hyperparameters, attendees will assess which configurations yield the most physically meaningful separations. The goal is to collect expert input on the interpretation of these representations, identify potential pitfalls, and discuss how such AI-driven tools can be integrated into future analyses of large stellar surveys.

Galaxies and the Milky Way

POSTER

From COSMOS to Euclid: interpretable and transferable LAE Classification

Presenter: Xoán Vilas Currás

CAUP

ABSTRACT

Lyman-α emitters (LAEs) are powerful tracers of star formation and the intergalactic medium at high redshift, but constructing large and reliable samples remains challenging. Within the PLATES project, and building on the broadband classification framework introduced by Vale et al. (2025), we are developing a reproducible machine-learning pipeline to distinguish LAEs from non-LAEs. We use LAEs selected by the SC4K survey (Sobral et al. 2018), together with multi-band photometry and associated uncertainties from COSMOS2020 (Weaver et al. 2022). To reduce biases related to redshift and brightness, we construct five independently matched non-LAE comparison samples and normalise each object's flux vector. This encourages the classifier to focus primarily on the shape of the spectral energy distribution rather than on absolute source brightness. We train an XGBoost classifier (Chen & Guestrin 2016), optimising its hyperparameters through grid search and five-fold cross-validation. Our preliminary models achieve a mean test F1-score of approximately 0.90 and an LAE recall of approximately 0.89. Using SHAP values (Lundberg & Lee 2017), we examine the contribution of individual filters and find that broadband information, particularly that associated with the g band, contributes strongly to the current classifications. We also propagate photometric uncertainties through Monte Carlo realisations, allowing us to quantify the stability of individual predictions and distinguish robust LAE candidates from uncertainty-sensitive cases. We are now extending this framework to heterogeneous photometric surveys. We are investigating transformer-based architectures that jointly encode fluxes, uncertainties, and filter information in a shared representation. We will test how effectively knowledge learned from COSMOS can be transferred to Euclid MER catalogue photometry (Euclid Collaboration: Romelli et al. 2026), including controlled experiments involving missing bands, different observational depths, and photometric perturbations. This work provides an interpretable classification baseline and a pathway towards transferable LAE identification in current and future wide-field surveys.

Galaxies and the Milky Way

POSTER

Spectral assessment of Lyman-alpha emitter candidates in the HETDEX database

Presenter: Gabriel Antunes

Instituto Superior Técnico

ABSTRACT

This project, conducted during a summer internship at the IA, aims to validate Lyman-alpha emitter candidates selected through machine-learning methods using spectroscopic data and classifications from HETDEX. Lyman-alpha emission is a valuable tracer of distant galaxies and provides information about star formation, circumgalactic gas, and galaxy evolution in the early Universe (Dijkstra, 2014; Ouchi, Ono, & Shibuya, 2020). The analysed candidates are located in the COSMOS field and are associated with photometric measurements and redshift estimates from COSMOS2020 (Weaver et al., 2022). For each candidate, the expected observed wavelength of Lyman-alpha and its uncertainty interval are calculated from the available redshift. The corresponding spectrum is extracted from a HETDEX integral-field spectroscopic datacube using a circular aperture centred on the candidate position, following the general HETDEX data structure and reduction methodology (Gebhardt et al., 2021). Validation is based on the presence and significance of an emission line near the predicted Lyman-alpha wavelength, while also considering its signal-to-noise ratio, flux, width, equivalent width, redshift reliability, and possible identification as another emission line, particularly [O II] (Leung et al., 2017; Davis et al., 2023). The resulting classifications are compared with the HETDEX Public Source Catalog (Mentuch Cooper et al., 2023) to assess the reliability of the machine-learning selection and identify the most robust Lyman-alpha emitter candidates.

Galaxies and the Milky Way

POSTER

Beyond the Fit: what GALFIT misses in MOONS targets?

Presenter: Artur Malheiro

Faculdade de Ciências da Universidade de Lisboa

ABSTRACT

Large spectroscopic surveys rely on automated image modelling, but formal convergence does not guarantee that a galaxy is adequately represented by the fitted model. As part of the technical preparation of extragalactic targets for MOONS, the multi-object optical and near-infrared spectrograph for the VLT (Cirasuolo et al. 2020), we examine blind, single-component GALFIT models of H-band imaging (Peng et al. 2002, 2010). The parent catalogues contain 1,511,929 sources in XMM-LSS and 1,224,229 in the Chandra Deep Field South, corresponding to 2,736,158 sources in total. After catalogue-quality cuts, source matching, and imaging-footprint checks, approximately 1.53 million sources remain for automated fitting. Only 737 sources are formally classified as GALFIT failures. However, apparently successful fits may still leave significant unmodelled light. Within the IA Summer Program 2026, we are carrying out a visual inspection of an initial sample of approximately 1,050 galaxies, with each of the seven students analysing around 150 objects. This sample will be expanded as the project progresses. For each galaxy, we compare the observed H-band image, the fitted model, and the corresponding residual image, classify the residual structures, and assign a quality flag to the fit. We identify features associated with neighbouring sources, blending, multiple components, asymmetric or extended emission, problematic masking, and fits converging on the wrong source. Where available, we compare the H-band results with independent K-band measurements or Euclid MER catalogue products (Euclid Collaboration: Romelli et al. 2026). Through this inspection, we distinguish well-modelled sources from apparently successful fits that require manual review or more complex modelling. We also identify residual patterns that may affect MOONS target preparation and future estimates of fibre-aperture losses, providing a targeted quality assessment of the automated fitting workflow.

Active Galactic Nuclei (AGN)

INVITED TALK

Gazing into the abyss: Exploring the depths of AGNs with very-long-baseline interferometry

Presenter: Héctor Sánchez
Universidade de Aveiro

ABSTRACT

Over the past decade, advances in very long baseline interferometry (VLBI) have enabled us to probe the hearts of active galactic nuclei at unprecedented angular resolution; in some cases, reaching spatial scales comparable to the event horizons of the supermassive black holes they host. In this talk, we will review some of the most important insights gained from the theoretical interpretation of these observations, highlighting their implications for our understanding of the astrophysics of these extreme environments, as well as for testing gravity in the strong-field regime. We will conclude by discussing some of the exciting scientific opportunities that the next generation of instruments is expected to unlock.

Active Galactic Nuclei (AGN)

CONTRIBUTED TALK

Binary and Offset AGN Through Gaia Astrometry and Multiwavelength Analysis

Presenter: Konstantinos Zafeiropoulos

University of Coimbra/MWGaiaDN

ABSTRACT

Active Galactic Nuclei (AGNs), powered by accreting supermassive black holes (SMBHs), play a central role in galaxy evolution. According to hierarchical galaxy formation models, galaxies and their SMBHs grow through mergers. During this process, binary SMBHs (BSMBHs) form as galaxies approach coalescence, and in some cases, post-merger SMBHs experience a recoil kick due to asymmetric gravitational wave emission, producing offset SMBHs (KSMBHs). Despite theoretical predictions, observational confirmation of both BSMBHs and KSMBHs remains scarce, with the number of detections significantly lower than simulations predict. We aim to address this observational gap by leveraging the microarcsecond-level astrometric accuracy of Gaia Data Release 3 (DR3) in combination with high-resolution sub-arcsecond radio data. By cross-matching Gaia DR3 sources with multi-wavelength datasets, we identify radio-loud AGN candidates that are offset from their host galaxy centers, as well as binary systems with sub-kiloparsec separations. Here, we present the most promising candidates discovered so far and highlight their key properties. When complete, the results of this study will provide critical constraints on SMBH merger timescales, improving our understanding of AGN dynamics and their role in galaxy evolution.

Active Galactic Nuclei (AGN)

CONTRIBUTED TALK

AGN demography with NewAthena's WFI

Presenter: Nuno Covas
Instituto de Astrofísica e Ciências do Espaço

ABSTRACT

Active galactic nuclei (AGN) provide a unique window into the growth of super massive black holes and their connection to galaxy evolution. A complete census of the AGN population across cosmic time, including obscured, low-luminosity systems, is essential for understanding the history of black hole accretion and the physical processes that regulate it. NewAthena's Wide Field Imager (WFI) has been designed to meet this challenge through its unique combination of large grasp, high angular resolution, excellent sensitivity, and spectroscopic capabilities. This talk will present the AGN demography science enabled by NewAthena, drawing on the science case and preliminary results of the ongoing NewAthena AGN Demography Special Issue paper. I will discuss how NewAthena's multi-tiered survey programme will deliver unprecedented AGN samples spanning a broad range of redshifts, luminosities, and obscuration, enabling precise measurements of the AGN luminosity function, the distribution and evolution of obscuration, and the growth of super massive black holes from the nearby Universe to the epoch of peak cosmic dawn. I will also highlight the complementarity of WFI observations with next-generation facilities. Together, these observations will establish the most complete picture yet of the cosmic AGN population and its evolution, illustrating the transformative role that NewAthena will play in studies of AGN in the 2030s.

Active Galactic Nuclei (AGN)

CONTRIBUTED TALK

Euclid’s dwarf galaxies – hunting for massive active black holes in the field-of-view of the Perseus Cluster

Presenter: Carolina Malheiro

FCUP/IA

ABSTRACT

Intermediate-mass black holes (IMBHs), with masses between stellar-mass and supermassive black holes, are expected to play a fundamental role in understanding the formation of the first black hole seeds and the subsequent growth of supermassive black holes. Dwarf galaxies are considered promising laboratories for the search for these objects, as their relatively quiet evolutionary histories may preserve signatures of early black hole formation. However, the identification of active galactic nuclei (AGN) in dwarf galaxies remains challenging because the AGN-associated emission can be weak, and easily diluted by emission from stars and/or star formation related processes in the host galaxy. In this work, we perform a multiwavelength search for AGN within the dwarf galaxy population recently identified in the Euclid Early Release Observations of the Perseus cluster. The parent sample consists of 1100 dwarf galaxy candidates. To identify possible AGN, these galaxies were cross-matched with surveys spanning the radio (NVSS, VLSSr), infrared (WISE, Spitzer, 2MASS), optical (SDSS), ultraviolet (GALEX), and X-ray (XMM-Newton, Chandra, and NuSTAR) wavelength regimes. Candidate AGN were selected using established infrared colour diagnostics, and X-ray and radio luminosity thresholds, while the global properties of the dwarf galaxy population were investigated through colour-based star formation classifications, stellar mass estimates, optical emission-line diagnostics, and spectral energy distribution (SED) fitting. A total of 52 AGN candidates were identified, corresponding to approximately 4.7% of the parent sample. The infrared colour selection based on WISE proved to be the most effective identification method. In contrast, only one source satisfied the adopted X-ray luminosity threshold. Although possible radio counterparts had initially been found, a posterior inspection of radio maps with higher resolution did not confirm any robust association. The dwarf galaxy population is found to be predominantly quiescent, with with the great majority of the sample having stellar masses below $\log(M^*/M_\odot) \lesssim 9.5$. A detailed analysis of one candidate, EDwC-0365, combining optical spectroscopy and SED fitting, revealed evidence consistent with a weak AGN whose emission is largely diluted by ongoing star formation. This case illustrates the intrinsic difficulty of identifying accreting BHs in dwarf galaxies. This work demonstrates the effectiveness of combining multiwavelength observations with the high-quality imaging provided by Euclid to identify promising AGN candidates in nearby dwarf galaxies. The resulting catalogue provides a valuable basis for future spectroscopic and high-resolution follow-up observations, necessary to confirm the nature of the identified candidates and estimate the occupation fraction of black holes in low-mass galaxies, improving our understanding of black hole seeding and galaxy evolution.

Active Galactic Nuclei (AGN)

CONTRIBUTED TALK

Looking for Hidden AGN Features in DESI

Presenter: Ana Martins
Faculdade de Ciências da Universidade de Lisboa

ABSTRACT

Active Galactic Nuclei (AGN) are thought to play a key role in galaxy evolution through feedback processes, but weak nuclear activity can remain hidden in galaxies whose optical spectra are dominated by star formation. Distinguishing between galaxies that host or do not host an AGN is therefore essential for obtaining a complete understanding of galaxy formation and evolution. In this work, we investigate whether star-forming galaxies may host hidden AGN features by searching for broad Hα emission in stacked spectra from the DESI DR1 survey. Galaxies were classified using the BPT diagram and divided into distance bins relative to the star-forming/AGN demarcation lines, allowing us to compare systems with different levels of proximity to the AGN regime. The spectra in each bin were stacked, and the Hα region was analyzed to test for the presence of a broad emission component. We find no statistically significant broad Hα component in the stacked spectra of star-forming galaxies, while all composite bins show clear evidence for a broad component. These results suggest that, on average, DESI star-forming galaxies do not host an optically detectable broad-line AGN, although weak or obscured activity in a fraction of individual systems cannot be ruled out. This work highlights the power of spectral stacking for probing faint AGN signatures in large spectroscopic surveys and contributes to building a more complete census of AGN prevalence in galaxies, which is essential for understanding the co-evolution of supermassive black holes and their hosts.

Active Galactic Nuclei (AGN)

CONTRIBUTED TALK

Characterising the AGN population at high redshift: insights from galaxy evolution models

Presenter: Pedro Martins

Instituto de Astrofísica e Ciências do Espaço, Faculdade de Ciências da Universidade de Lisboa

ABSTRACT

One of the fundamental questions in astronomy is how galaxies form and evolve through cosmic time. For the past few decades, various teams have been trying to answer this question through the construction of computational models for simulated galaxies. A key factor in understanding galaxy growth throughout the Universe's history is the existence of an actively accreting supermassive black hole (SMBH), revealing itself as an active galactic nucleus (AGN). With the next generation of telescopes currently developing survey strategies with a strong emphasis in exploring the early Universe (e.g. NewAthena in the X-ray and SKAO in the radio regime), it is of the utmost importance to explore the predictions from state-of-the-art galaxy formation and evolution models, in particular at the Epoch of Reionization (EoR). Recent works have showed that, while current models for SMBH and galaxy evolution (e.g. EAGLE, GALFORM, Millennium) compare well to the observational data, and are able to extrapolate into the high-redshift Universe ($z > 6$), those predictions are still limited, as the models still struggle to reproduce the most extreme SMBH masses already known to exist at very high redshifts. It is thus necessary to improve upon the physical prescriptions in the models. Here we explore the more recent galaxy evolution models Radio-SAGE and SIMBA. Radio-SAGE is a semi-analytic model with a built-in prescription of radio-jet physics, along with a cyclical model of AGN feedback. This provides a detailed description for radio emission with a strong physical motivation. The SIMBA hydrodynamic model employs a dual-mode (torque-limited, Bondi) accretion model for black hole growth, as well as a multi-mode feedback model governed by the instantaneous Eddington ratio of the black hole. We characterize the AGN population of the Radio-SAGE and SIMBA models, comparing it with observational data from the SDSS and DESI quasar catalogues.

Active Galactic Nuclei (AGN)

POSTER

Lines in the Sky - Physical Properties of QSOs from Euclid spectral fitting

Presenter: Joao Calhau

INAF - Osservatorio Astronomico di Capodimonte

ABSTRACT

Quasars (QSOs) are among the most luminous active galactic nuclei, and their spectra provide key insights into black hole growth and galaxy evolution. I will present the first spectroscopic characterization of QSOs from Euclid’s Q1 data release. Using QSFit program on visually confirmed Euclid Q1 QSOs and external catalogues such as DESI DR1, for QSO selection and redshift determination, we built a catalogue of >5000 QSOs with spectroscopic measurements enabling the study of QSO physical properties. We report line fluxes, FWHM values, and continuum slopes, and introduce criterion based on fitting statistics and signal-to-noise ratio to identify problematic spectra. Our sample spans 01 ≤ z ≤ 4.76 with an average continuum spectral index α_λ ∼ −1.17. We derive single-epoch black hole masses from Hα, Hβ, Mg II, HeI and Paβ lines, obtaining a mean log(MBH/Msolar)~8.7. These results provide a first demographic characterization of Euclid QSOs and show that, even though AGN studies are not Euclid’s primary goal, its spectroscopy can deliver results comparable to those from dedicated surveys.

Active Galactic Nuclei (AGN)

POSTER

Characterisation of Ultra Steep Spectrum radio sources in the COSMOS field

Presenter: Davi Barbosa

IA - Lisboa

ABSTRACT

Ultra Steep Spectrum (USS) radio sources are classical tracers used to select powerful high-redshift ($z > 2$) radio galaxies, assuming their emission is dominated by Active Galactic Nuclei (AGNs). While historically applied to bright surveys, new-generation Square Kilometre Array (SKA) pathfinders allow testing this selection in the sub-mJy regime. In this work, we evaluate the efficiency of the USS criterion at faint flux densities within the COSMOS field, leveraging deep radio observations from the MeerKAT MIGHTEE survey. We utilise the MIGHTEE L-band (1.22 GHz) and S-band (2.6 GHz) data, to perform a robust cross-matching with extensive multi-wavelength catalogues and redshift estimates. We identified USS sources, their physical properties closely mirror those of the broader sub-mJy population. A significant fraction consists of star-forming or composite galaxies with a redshift distribution peaking at $z < 1$, showing no statistical excess of high-redshift sources compared to non-USS counterparts. Our preliminary results demonstrate that the USS technique fails to isolate high-redshift radio galaxies in deep regimes. We conclude that as we transition into the SKA era, more robust multi-wavelength methods must complement traditional radio spectral index selections to successfully map the earliest radio AGNs.

Active Galactic Nuclei (AGN)

POSTER

Observing the radio spectral life cycle of quasar jets

Presenter: Luis Barroso
Faculdade de Ciências, Universidade de Lisboa

ABSTRACT

Active galactic nuclei launch relativistic jets whose radio spectra can be divided into steep-spectrum, flat-spectrum, gigahertz-peaked-spectrum (GPS), and inverted classes. Whether these are physically distinct populations or successive stages in the evolution of a single jet population remains unresolved. We address this by pairing a large observational sample with cosmological hydrodynamic simulations. Cross-matching the Million Quasar Catalogue with the LOFAR (150 MHz), RACS (887 MHz, 1.3 GHz), and VLASS (3 GHz) surveys yields a radio-selected quasar sample classified by spectral peak into 5,893 steep, 209 GPS, 7 flat, and 7 inverted sources. In parallel, we use the CosmoDRAGoN framework, relativistic-hydrodynamic jet simulations (PLUTO) with synchrotron emission synthesised in post-processing by PRAiSE, to track the radio SED of a single jet over its first million years, from z = 0.05 to z = 7. Tracing the full inverted→GPS→flat→steep sequence as the spectral peak migrates to lower frequency with age, the simulations show that these various radio populations can be interpreted as successive phases of a single youth-driven evolutionary sequence, in which compact young jets grow and age into extended sources.

Active Galactic Nuclei (AGN)

POSTER

Discovering High-Redshift Radio-Loud Quasars

Presenter: Gonçalo Ramos
Universidade de Coimbra, FCTUC, DF

ABSTRACT

A major open question in astrophysics is how supermassive black holes (SMBHs) reached masses of $\sim 10^9$ $M_\odot$ less than one billion years after the Big Bang, and whether relativistic jets played a role in this rapid growth. Observationally, relativistic jets are primarily identified through their radio emission. However, current studies of high-redshift radio-emitting quasars are limited by small, often highly heterogeneous samples. A complete census of radio-emitting high-redshift quasars is therefore essential to obtain an unbiased estimate of the frequency of relativistic jets during the epoch of early SMBH growth. This project aimed to construct a radio- and optical-flux-limited census of high-redshift jetted quasars at the sub-mJy level, using the Evolutionary Map of the Universe (EMU) survey, including moderately radio-emitting sources missed by previous studies. The wide sky coverage and high sensitivity of EMU make it an ideal starting point for assembling a large, statistically robust sample of radio-emitting quasars in the early Universe. Candidates were selected through the dropout method by cross-matching EMU radio sources with optical counterparts from DECam Local Volume Exploration (DELVE) DR2 survey. This study produced a well-defined, flux-limited sample of $z \geq 4$ quasar candidates, down to an optical magnitude of 21.5 mag in the band probing rest-frame wavelengths of approximately 1200−1400 Å. A complete spectroscopic follow-up is expected to substantially increase the known population of high-redshift radio-emitting quasars. In this talk, I will present the results of the candidate-selection process and the first findings from the spectroscopic observations, including the discovery of four new high-redshift radio-emitting quasars. These observations validate the candidate-selection method and indicate that the final sample could more than double the currently known population of high-redshift jetted quasars in this redshift range. Ongoing work will benefit from forthcoming optical and near-infrared surveys. In particular, the LSST survey is expected to improve the efficiency of the selection, especially at $z \geq 6$, while the Euclid mission will extend this validated methodology into the near-infrared, where the Lyα break shifts for quasars at $z \gtrsim 7$, enabling the discovery of sources at even earlier cosmic epochs.

Active Galactic Nuclei (AGN)

POSTER

Tracing the Nature of Gigahertz-Peaked-Spectrum Radio Sources through Multi-wavelength Radio and Infrared Observations

Presenter: João Tiago
Instituto de Astrofísica e Ciências do Espaço (IA) - FCUL

ABSTRACT

Peaked-spectrum radio sources are widely regarded as very young radio-powerful active galactic nuclei (AGN). Because radio-powerful AGN activity is thought to be short-lived, any such AGN observed at very high redshift must necessarily be caught in an early, young phase, making peaked-spectrum sources the natural beacons for identifying the high-redshift radio galaxy population. Their discovery and characterization are therefore fundamental to understanding the formation and early evolution of AGN and the growth of the first supermassive black holes (SMBH). We present a study of candidate peaked-spectrum sources selected by combining the multi-frequency Rapid ASKAP Continuum Survey (RACS) catalogues with the VLA Sky Survey (VLASS). The final sample comprises more than 84,000 radio sources, from which four subsamples are defined according to the frequency at which the radio spectrum peaks. These subsamples are cross-matched with spectroscopic quasar catalogues to investigate their redshift distribution and with the WISE infrared surveys to characterise their mid-infrared properties. Spectroscopic cross-matches show no clear dependence of redshift on peak frequency. In contrast, Kolmogorov–Smirnov tests reveal small but significant differences in WISE magnitudes across subsamples, pointing to a gradual evolution in infrared properties. Colour-colour diagnostics show the fraction of sources in the MIR-AGN selection region rising from ~19% to 44% with increasing peak frequency, suggesting that higher-frequency peakers are increasingly dominated by compact young AGN, while lower-frequency peakers retain a larger star-forming contribution. These results showcase the power of combining broadband radio and infrared surveys to constrain the nature of peaked-spectrum AGN. This knowledge will be fundamental in using GPS sources as beacons to identify very high-redshift, radio-powerful AGN, ultimately enabling the identification and study of the earliest examples of powerful radio activity in the Universe.

Cosmology and Large-Scale Structure

INVITED TALK

MeerKLASS: Cosmology with neutral hydrogen intensity mapping

Presenter: Mário Santos
University of the Western Cape

ABSTRACT

Mapping the large-scale structure of the Universe over cosmic time is one of the most powerful ways to probe dark energy, test gravity, and search for signatures of the early Universe. Neutral hydrogen intensity mapping offers a fast, complementary route: instead of detecting individual galaxies, it measures the combined 21 cm emission from all the hydrogen in large 3D volumes, turning a radio telescope into an efficient cosmological survey machine. I will introduce the technique and the main observational challenges — foregrounds thousands of times brighter than the signal, calibration, and radio-frequency interference — and show how they are being overcome. I will then present MeerKLASS, the largest survey on South Africa's MeerKAT and a precursor to the SKA, which has delivered the first single-dish 21 cm detections on cosmological scales, including a milestone HI auto-power measurement. Alongside the cosmology, MeerKLASS is producing a wide-area radio-continuum survey of millions of sources. I will close with the forecasts for the full survey and the path toward SKA-Mid.

Cosmology and Large-Scale Structure

CONTRIBUTED TALK

Lagrangian Identity and Mass Evolution of Particle-like Objects in Nonminimally Coupled Gravity

Presenter: Samuel Pinto

FCUP / CAUP

ABSTRACT

We show that the Lagrangian of a Nambu-Goto p-brane satisfies the identity $\mathcal{L}_{\rm [\it p \rm]}=T_{\rm [\it p \rm]}/(p+1)$, with $T_{\rm [\it p \rm]}$ denoting the trace of the corresponding energy-momentum tensor, independently of the properties of the gravitational field. While for $p=0$ this reduces to the standard $\mathcal{L}_{\rm [0]}=T_{\rm [0]}$ relation, which determines the on-shell Lagrangian of point particles and their fluids, more generally it depends explicitly on the p-brane dimensionality. We explore the implications of this Lagrangian identity for the dynamics of non-self-intersecting cosmic string loops in a homogeneous and isotropic universe within non-minimally coupled scalar-tensor gravity, showing that, unlike in general relativity, the proper mass of a cosmic string loop may change, regardless of its small size or tension. We then extend the analysis to the more general case of closed p-branes in $(N+1)$-dimensional Friedmann-Lemaître-Robertson-Walker spacetimes and discuss the implications of our results for describing fundamental particles as extended objects.

Cosmology and Large-Scale Structure

CONTRIBUTED TALK

Cosmic strings and domain walls: the impact of CMB B-mode data

Presenter: Clara Winckler

Instituto de Astrofísica e Ciências do Espaço (IA)/ Universidade do Porto (CAUP, FCUP)

ABSTRACT

Many particle physics scenarios predict the formation of networks of topological defects during symmetry-breaking phase transitions in the early Universe. Their presence may generate perturbations that could leave observable imprints on the cosmic microwave background. Here, we analyse such CMB constraints on stable networks of cosmic strings and domain walls using for the first time full Planck 2018 data together with BICEP/Keck 2018 B-mode measurements. The defect-induced anisotropies are computed using the Unconnected Segment Model for Nambu-Goto and Abelian-Higgs strings, as well as for stable domain walls, and included in a full Markov Chain Monte Carlo analysis jointly varying all ΛCDM parameters, the tensor-to-scalar ratio, and the string/domain wall tension. No statistically significant evidence for defects is found, although we observe a mild preference for non-zero cosmic string tension. Our results improve previous constraints on the cosmic string power spectrum and correct previous CMB analyses with domain walls that overestimated the constraints. We in particular highlight the importance of the B-mode polarisation for defect constraints, and present forecasts for the Simons Observatory and the LiteBIRD satellite.

Cosmology and Large-Scale Structure

CONTRIBUTED TALK

A New Window into Early-Universe Physics: Cosmic Strings with Friction

Presenter: Sergei Mukovnikov

The Instituto de Astrofísica e Ciências do Espaço

ABSTRACT

Cosmic strings can be produced during phase transitions in the very early universe. They are particularly interesting objects since they emit gravitational waves that contribute to the stochastic gravitational wave background (SGWB). This gives us the possibility to connect gravitational wave experiments to unknown physics scenarios of the very distant past. In the early stages of cosmic string network evolution, we expect frequent interactions of cosmic strings with particles of the surrounding plasma. Usually in the literature the contribution from this friction-dominated epoch to the SGWB is neglected. In our work, however, we show that, for a significant part of parameter space, the inclusion of friction leads to a prominent signature in the ultra-high frequency range of the spectrum. More than that, this signature should be sensitive to the particular underlying high energy physics scenarios, depending not only on the fields that constitute the string but also on other contents of the early universe.

Cosmology and Large-Scale Structure

CONTRIBUTED TALK

Improving constraints on magnification biases and tests of gravity through the Multi-tracer technique

Presenter: Tiago Sinde
CAUP

ABSTRACT

The observed large-scale structure of the Universe is not a direct measure of the underlying distribution of matter. These observations are subtly distorted by gravitational lensing effects, which leave imprints on the statistical distribution of galaxies and offer a powerful test of general relativity. In this work, we investigate whether HI intensity mapping from current and forthcoming surveys can improve constraints on magnification lensing obtained from photometric galaxy surveys by combining them through the multi-tracer technique. In particular, whether one can jointly constrain the magnification bias parameters and the amplitude of the Weyl potential, which we parametrise as β. We employ a Fisher matrix formalism in order to estimate future constrains on the magnification biases and β. We forecast constraints for three photometric surveys (DES-like, LSST-like, Euclid-like) individually and together with two HI intensity mapping surveys (MeerKLASS, SKAO). We apply the multi-tracer technique by combining each galaxy survey with each HI survey, exploiting the combined constraining in the overlapping sky area. The multi-tracer approach dramatically improves constraints on β by factors of 25 to 50, depending on the surveys considered. For , improvements can be marginal or by a factors of 2 to 8. We also verify that β and can be constrained simultaneously as the cross-correlations between tracers break the degeneracies among them We conclude that the multi-tracer combination of photometric galaxy surveys and HI intensity mapping surveys enables high-precision measurements of both and β. This opens an additional pathway to constrain Φ+Ψ and test the validity of general relativity on cosmological scales.

Cosmology and Large-Scale Structure

CONTRIBUTED TALK

Dynamics of Biased Domain Walls: The Rocket Effect

Presenter: Ricardo Vilhena
FCUP

ABSTRACT

We investigate the dynamics of domain walls in scalar field theories with degenerate vacua (i.e., vacua of equal energy density) in which the scalar field mass depends on the vacuum state. Using analytical arguments and numerical simulations, we show that this vacuum dependence of the scalar field mass renders the emission of scalar radiation from domain walls anisotropic, preferentially toward regions with smaller scalar field mass. We further show that the resulting recoil (rocket) effect biases the evolution of cosmological domain wall networks in favor of the lower-mass vacuum, thereby promoting network decay. We also demonstrate that the biased evolution of domain walls in theories with degenerate vacua, previously attributed to asymmetries of the potential barrier near the local maximum, is instead primarily controlled by the vacuum dependence of the scalar field mass. More generally, in theories with non-degenerate vacua, this recoil mechanism constitutes an additional source of dynamical bias that can either hasten or delay network decay relative to the standard expectation based solely on differences in vacuum energy density.

Cosmology and Large-Scale Structure

POSTER

Cosmological Consistency Tests in the Euclid Era

Presenter: Andreia Filipe
Affiliation not provided

ABSTRACT

Abstract not provided.

Cosmology and Large-Scale Structure

POSTER

Large-Scale Structure: Tessellation Statistics as a Probe of Cosmology

Presenter: André Rasgado Lopes

Faculdade de Ciências da Universidade de Lisboa

ABSTRACT

Large-scale structure provides a powerful observational window into the geometry, matter distribution, and dynamical evolution of the Universe. In this project, we developed and implemented a pipeline to apply Voronoi tessellation statistics to simulated cosmological galaxy catalogues, using the Euclid Flagship simulation as a baseline. We constructed redshift slices from the angular positions of galaxies, defined by right ascension and declination within selected redshift intervals, and applied Voronoi tessellation methods to each layer. From the resulting tessellations, we extracted statistical quantities such as the areas and perimeters of Voronoi cells and analysed their evolution with redshift. This pipeline provides the basis for a systematic comparison of tessellation statistics across different cosmological models. In future work, we will apply it to simulations of both homogeneous Friedmann-Lemaître-Robertson-Walker cosmologies and inhomogeneous Lemaître-Tolman-Bondi models, searching for model-dependent signatures in the Voronoi patterns of galaxy distributions. By studying how these statistics depend on redshift and on the assumptions defining each cosmological scenario, we aim to clarify their connection to the underlying cosmological parameters of the models under investigation. The extension of this approach to inhomogeneous cosmologies is particularly novel and may open a new route for testing departures from the standard cosmological framework using the geometry of the cosmic web. Authors: André Rasgado Lopes, Antonio da Silva, José Pedro Mimoso

Cosmology and Large-Scale Structure

POSTER

Hunting for the signal of cross-correlations between HI IM and photometric surveys

Presenter: José Silva

Universidade do Porto

ABSTRACT

HI Intensity Mapping (HI IM) is a novel way of probing the Large Scale Structure of the Universe. This method in particular relies on radio frequency surveys to map neutral Hydrogen, through it's 21cm hyperfine transition. Given that at low redshifts it is only located inside galaxies, it probes the distribution of matter. These surveys will be done by the SKAO (Square Kilometer Array Observatory), and it's predecessor MeerKAT. Other surveys are currently creating dense photometric galaxy catalogs. HI IM is not a straightforward task however, as the frequencies probed are quite polluted by sources of radiation orders of magnitude stronger, that must therefore be removed. In this project, we make use of simulations and statistical estimators, such as the Angular Power Spectrum and Angular Correlation Functions to determine what cross-correlation signal can be expected between the HI IM data, as obtained by the MeerKLASS project, and photometric galaxy catalogs, like DES.

Education and Communication

CONTRIBUTED TALK

A astronomia no ensino não superior: uma análise comparativa entre Portugal e Espanha

Presenter: Marco Freire

Agrupamento de Escolas de Santa Bárbara / Planetário do Porto - Centro Ciência Viva / Instituto de Astrofísica e Ciências do Espaço - Universidade do Porto / Faculdade de Ciências da Universidade do Porto

ABSTRACT

Autores: Ilídio André Costa; Marco Freire A astronomia, para além da sua importância científica, é o tema curricular mais apreciado pelos alunos, o que a torna central na promoção da literacia científica e na compreensão de fenómenos do quotidiano. O presente trabalho analisa a matriz curricular da escolaridade obrigatória de países europeus com línguas derivadas do latim (Espanha, França, Itália, Portugal e a Roménia). Tem como principal objetivo identificar semelhanças/diferenças na estrutura curricular e, como consequência fazer uma análise comparativa relativamente à importância atribuída aos conteúdos de astronomia, em dois desses países (Portugal e Espanha). De forma a ser possível a comparação entre os diferentes países foi utilizado o sistema ISCED (International Standard Classification of Education). A análise incidiu sobre os níveis ISCED 0 center-based (educação pré-escolar), ISCED 1-general (educação primária), ISCED 2-general (educação secundária inferior) e ISCED 3-general (educação secundária superior), que, dependendo do país em análise, correspondem total ou parcialmente à escolaridade obrigatória. Tendo em conta esta divisão de níveis de escolaridade foi realizada uma análise entre Portugal e Espanha, utilizando uma comparação quantitativa, ou seja, uma avaliação direta do número de temas relacionados com astronomia, lecionados em cada país. A essa análise adicionou-se uma comparação de natureza qualitativa, onde foram categorizados os diferentes conteúdos de astronomia. Os resultados evidenciam semelhanças ao nível da tipologia temática dos conteúdos de astronomia. Contudo, verificam-se, também, distinções significativas na abordagem e profundidade com que estes são tratados. No ISCED 1 verificamos que os programas se equivalem tanto no número de temas como na sua tipologia, com ênfase na orientação, na localização planetária e fenómenos relacionados com o Sol e a Lua. As diferenças começam a acentuar-se no ISCED 2, tanto a nível do número de temas, mas também, nos conteúdos apresentados. O currículo português aborda estas temáticas de forma mais superficial, quando comparado com o programa espanhol. Para o ISCED 3 registramos as maiores diferenças entre os dois países, de tal forma que Espanha inclui no programa conteúdos mais complexos para além de serem mais completos, enquanto no modelo curricular português a abordagem apresentada avança em torno da consolidação do que foi abordade em ciclos passados. Espanha apresenta um desenvolvimento curricular mais focado em conteúdos explicativos e abstratos. O programa de astronomia é abordado em diferentes disciplinas, existindo vários temas em disciplinas como História e Filosofia. De forma geral, Espanha apresenta os conteúdos de forma mais aprofundada, usando vários subtemas para obter uma descrição mais completa do fenómeno. Portugal, por outro lado, apresenta conteúdos relacionados com os fenómenos astronómicos observáveis e próximos da experiência quotidiana. A astronomia é apresentada com maior incidência em disciplinas das ciências como Física-Química e Ciências Naturais. Quando comparado com Espanha, Portugal apresenta os conteúdos de forma mais generalista, privilegiando a descrição direta dos fenómenos naturais. Este nosso trabalho permite, pois, verificar as variações dos perfis educacionais, relacionados com a astronomia, em Portugal e Espanha, demonstrando uma diversidade de abordagens e de importância para com esta área na escolaridade obrigatória. Tal possibilitará, a criação de diferentes estratégias para um aprofundamento da integração de astronomia na escolaridade obrigatória, em Portugal.

Education and Communication

CONTRIBUTED TALK

Beyond Dissemination: Building Educational Legacies from Scientific Research

Presenter: André Moitinho

FCUL / LIP

ABSTRACT

Publicly funded research projects increasingly devote substantial effort to dissemination, communication and societal impact. Yet, while these activities have become an integral part of research funding, relatively little attention has been given to how the knowledge, data, technologies and expertise generated by scientific projects can become part of lasting educational legacies. This contribution argues that research and education should not be viewed as successive stages of knowledge transfer, but as complementary ecosystems with distinct and mutually beneficial expertise. Research projects provide authentic scientific content, data, tools and methodologies that can enrich educational activities, while education projects contribute pedagogical expertise, learning communities and mechanisms for long-term adoption that can significantly extend the impact and legacy of scientific research. Rather than a one-way transfer of knowledge, this creates a genuine partnership in which both communities benefit. Using the collaboration between the Horizon Europe project SPACIOUS and the Erasmus+ project SPACEDIVE as a case study, this presentation will discuss how connecting research and STEAM education communities created opportunities that neither could have achieved independently. More broadly, it will invite discussion on how stronger links between research and education can transform dissemination into enduring educational legacies, maximising the long-term value of public investment in science and society.

Education and Communication

CONTRIBUTED TALK

Do Sol aos exoplanetas: uma proposta educativa em torno do telescópio PoET

Presenter: Juan Nolasco
Planetário do Porto

ABSTRACT

O PoET — Paranal solar ESPRESSO Telescope é um telescópio solar instalado no Observatório do Paranal e ligado, através de fibras óticas, ao espectrógrafo ESPRESSO. O sistema permite obter simultaneamente espectros de regiões específicas do disco solar e da luz integrada de toda a superfície visível do Sol. Esta capacidade possibilita relacionar fenómenos localizados na superfície solar com as alterações observadas no espectro do Sol quando este é analisado como uma estrela distante. Um dos principais objetivos científicos do PoET é melhorar a compreensão da variabilidade estelar que limita a deteção e a caracterização de exoplanetas através do método das velocidades radiais. Fenómenos como a atividade magnética, as manchas, as regiões brilhantes e os movimentos convectivos podem alterar os perfis das linhas espectrais, produzindo sinais que podem ser confundidos com os efeitos provocados por um planeta ou ocultar a sua presença. Esta comunicação apresenta uma proposta educativa inspirada no PoET, destinada a aproximar alunos e público não especializado de alguns dos principais desafios da investigação contemporânea em astrofísica. A atividade utiliza o Sol como estrela de referência para introduzir conceitos como espectroscopia, efeito Doppler, atividade estelar, velocidade radial e deteção de exoplanetas. A proposta combina explicação científica, análise de imagens e espectros solares, representação do movimento de uma estrela provocado pela presença de um planeta e simulação simplificada de medições de velocidade radial. Pretende-se que os participantes compreendam como os astrónomos inferem a presença de exoplanetas a partir de pequenas alterações no espectro de uma estrela e por que razão a variabilidade estelar dificulta essas medições. A atividade procura, assim, transformar investigação de fronteira desenvolvida no âmbito do PoET numa experiência educativa acessível, interdisciplinar e replicável em contextos escolares e de divulgação científica, estabelecendo uma ligação entre o estudo da nossa estrela e a procura de outros mundos.

Education and Communication

CONTRIBUTED TALK

"O Universo é o teu Recreio": da curiosidade infantil à aprendizagem em comunidade

Presenter: Ana Paulino-Afonso
IA-UPorto/CAUP

ABSTRACT

A comunicação de ciência no pré-escolar pode ir além da transmissão simplificada de conceitos científicos. Pode partir da curiosidade das crianças para criar relações entre o céu, o quotidiano e a comunidade. Concebido no âmbito da componente de comunicação de ciência do projeto PLATES (Powering the search of LAEs with transformers for large-scale extragalactic surveys) financiado pela Fundação para a Ciência e a Tecnologia (2024.05289.RESTART), "O Universo é o teu Recreio" explora esta possibilidade através de uma iniciativa continuada para crianças dos 3 aos 6 anos. Durante dois meses, realizaram-se sessões quinzenais baseadas no diálogo, na exploração sensorial e na aprendizagem pela ação. Histórias, projeções, imagens, modelos tridimensionais e materiais manipuláveis serviram de ponto de partida para conversar não só sobre a Lua, o Sol, os planetas, as constelações, as galáxias e os buracos negros, mas também sobre fenómenos próximos da experiência das crianças: as marés, a duração do dia, a proteção solar, os ciclos naturais e a relação entre o céu e práticas agrícolas conhecidas pelas suas famílias. Inspirada em princípios de aprendizagem ativa, lúdica e sensorial, a abordagem valorizou as perguntas das crianças, a manipulação de objetos e a continuidade dos temas nos projetos desenvolvidos com a equipa educativa. Estas opções são coerentes com a investigação que reconhece a capacidade das crianças pequenas de observar, raciocinar sobre fenómenos naturais e aprender através de experiências orientadas e concretas. A atividade culminou no Café com as Estrelas, um encontro que convidou as crianças a partilhar o seu percurso com as famílias e abriu espaço à participação criativa da comunidade. Deste modo, a ciência circulou entre a sala, a casa e a comunidade, integrando perguntas, histórias familiares, conhecimentos locais e novas formas de observar o quotidiano. A ideia desta comunicação é apresentar esta experiência como um modelo de intervenção adaptável a diferentes contextos: encontros continuados, ligação a fenómenos locais, materiais acessíveis, colaboração com educadores e envolvimento das famílias. Mais do que levar a astronomia ao pré-escolar, a iniciativa procurou mostrar como a comunicação científica pode criar espaços intergeracionais de curiosidade, participação e pertença, com potencial para aproximar e fortalecer comunidades com acesso limitado a equipamentos especializados.

Education and Communication

CONTRIBUTED TALK

Dia do Asteroide Portugal: da universidade para a sociedade

Presenter: Ana Rola

CITEUC - Centro de Investigação da Terra e do Espaço da Universidade de Coimbra

ABSTRACT

Abstract not provided.

Education and Communication

CONTRIBUTED TALK

Ideias de Astronomia prioritárias para a sociedade: Perspetivas de jovens participantes numa escola de verão.

Presenter: Jorge Fonte

IFIMUP / Instituto de Astrofísica e Ciências do Espaço - Universidade do Porto / Faculdade de Ciências da Universidade do Porto

ABSTRACT

A comunicação pública da astronomia enfrenta o desafio de selecionar, entre a vastidão de conceitos da área, aqueles que devem ser prioritariamente transmitidos à sociedade, de forma a promover uma literacia científica relevante e significativa para os cidadãos. Apesar de existirem propostas de referência sobre os conceitos essenciais em astronomia — como as Grandes Ideias em Astronomia elaboradas por Retrê e colaboradores, em 2011 — pouco se sabe sobre a perceção dos próprios jovens quanto à importância relativa desses conceitos, nomeadamente sobre que dimensões (científica, tecnológica, filosófica ou social) consideram mais significativas, e se essa valorização varia consoante o género. Este estudo procura, assim, identificar que conceitos de astronomia os jovens consideram mais relevantes para transmitir à sociedade, analisando as suas escolhas à luz das Grandes Ideias em Astronomia e explorando possíveis diferenças associadas ao género. Para tal, foi solicitado a 102 jovens participantes numa escola de verão de astronomia que selecionassem, de entre doze opções, as três ideias que consideravam essenciais para a literacia pública em astronomia. A análise das escolhas permitiu identificar tendências de valorização conceptual, evidenciando quais as dimensões — científica, tecnológica, filosófica ou social — foram mais valorizadas pelos jovens no contexto da comunicação pública da astronomia, bem como diferenças nas ideias privilegiadas em função do género. Os resultados contribuem para compreender como as novas gerações interpretam o papel da astronomia na sociedade contemporânea, oferecendo pistas para o desenvolvimento de estratégias educativas e de divulgação alinhadas com as suas prioridades e perceções. Realça-se, assim, a importância de um enquadramento adequado das atividades em astronomia, face à relação que os jovens estabelecem com esta área da ciência.

Education and Communication

CONTRIBUTED TALK

How Does Astronomy Reach the Public? Analysing IA's Institutional Communication Strategy

Presenter: Joana Januário

Faculdade de Ciências da Universidade de Lisboa

ABSTRACT

Nowadays research centers, universities and other scientific institutions communicate their science and results not just to their peers but also to the public. Press Releases and News Releases are an important part of this institutional communication. They are a way to reach the media and the public in a formal way, following the rules and structure of the journalist text, and the journalistic communication objectives. The Institute of Astrophysics and Space Sciences (IA), the largest research infrastructure dedicated to advancing Astronomy, Astrophysics, and Space Sciences in Portugal, produces releases regularly, that are distributed to the press and also published in the Institute's website. With the objective to study the institutional communication of IA, a research was conducted to analyse IA's press releases and news releases. This study was carried out by an international group of students and supervisors, during the IA Summer Program 2026, and aimed to evaluate how IA disseminates research results and to contribute to future studies on institutional science communication. The nearly 100 texts published in both Portuguese and English on the IA website, between 2021 and 2025, were examined, following criteria established during the analysis process. The press releases structure and objectives, and the characteristics of IA were central in choosing those analytical criteria, that include the content of the titles, the research topics, the use of audiovisual content, the research collaborations mentioned, among others. In this talk, the results of this study will be presented and discussed.

Education and Communication

POSTER

Dia do Asteroide Portugal: atividades práticas para a compreensão de conceitos abstratos

Presenter: Ana Rola

CITEUC - Centro de Investigação da Terra e do Espaço da Universidade de Coimbra

ABSTRACT

Este trabalho apresenta dois conjuntos de atividades práticas concebidos com o objetivo de tornar acessíveis conceitos relativamente abstratos, como asteroides, meteoros e meteoritos, a um público não especializado, no âmbito da comemoração do Dia Internacional do Asteroide, celebrado anualmente a 30 de junho. O Dia Internacional do Asteroide assinala o Evento de Tunguska, associado à explosão atmosférica de um pequeno corpo celeste, ocorrido em 1908, na Sibéria, Rússia. Esta efeméride foi proposta por Brian May, Rusty Schweickart, Grigorij Richters e Danica Remy, em 2014, e oficialmente reconhecida, em 2016, pela Assembleia Geral das Nações Unidas, com o objetivo de promover a sensibilização pública para os asteroides, os objetos próximos da Terra e a defesa planetária. Neste contexto, foram preparados os dois conjuntos de atividades práticas aqui apresentados, dirigidos sobretudo, mas não exclusivamente, ao público mais jovem, e testados nas duas últimas edições do Dia do Asteroide Portugal, em 2025 e 2026: a “Oficina dos impactos cósmicos” e “Odisseia no Espaço: da escala dos asteroides aos meteoritos”. As atividades, de caráter prático e participativo, foram concebidas para promover uma aprendizagem exploratória e participativa, recorrendo a materiais simples, analogias visuais e experiências demonstrativas. A “Oficina dos impactos cósmicos” permite simular a formação de crateras e discutir a influência de variáveis como o tamanho, a massa, a forma e a natureza do projétil. Já a atividade “Odisseia no Espaço: da escala dos asteroides aos meteoritos” explora a relação entre corpos menores do Sistema Solar e o risco de impacto cósmico através de modelos de escala. Em conjunto, estas propostas procuram transformar conceitos de difícil visualização em experiências concretas, acessíveis e cientificamente rigorosas, contribuindo para o envolvimento do público e para o reforço da literacia científica.

Education and Communication

POSTER

Harmonia das Esferas Apaixonadas: um projeto de Astronomia e Música

Presenter: João Fernandes
DM/CITEUC/FCTUC

ABSTRACT

Abstract not provided.