



**instituto de astrofísica  
e ciências do espaço**

**Institute of Astrophysics  
and Space Sciences  
2023 Activity Report**

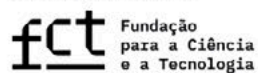




# Institute of Astrophysics and Space Sciences 2023 Activity Report



COFINANCIAMENTO / COFINANCING





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## Unit Overview

The **Instituto de Astrofísica e Ciências do Espaço (IA)** is a research infrastructure with a national dimension, embodying a bold vision for the development of Astronomy, Astrophysics and Space Sciences in Portugal. It is the largest research unit of this area in the country, being responsible for the majority of the national productivity in international ISI journals in the area of Space Sciences — one of the scientific areas with the highest relative impact factor and highest average number of citations per article for Portugal. IA has a demonstrated ability to drive major astronomical projects, at all development levels: scientific and technical definition, instrument concept and design, construction and commissioning, and scientific exploitation.

The mission of IA is to foster research with the highest impact in the field of astrophysics and space sciences and to support teaching and training of young researchers and students in close collaboration with the Universities of Lisbon and Porto, and from June 2021, in Coimbra. Indeed, IA has now grown with the creation of a new pole at the University of Coimbra, with headquarters at the Observatório Geofísico e Astronómico of the University of Coimbra (OGAUC), of the Science and Technology Faculty of the University of Coimbra (FCTUC), which reveals the national impact of the IA. It also aims to promote wide-ranging science communication activities that enhance public understanding of the Universe and our place in it, as well as awareness of the importance of research in this field.

Our vision is to achieve international leadership in key areas of astrophysics and space sciences, taking full advantage and realising the potential created by the national membership of the European Space Agency (ESA) and the European Southern Observatory (ESO) and the Square Kilometre Array Observatory (SKAO). This is done through state-of-the-art research, enabled by our leading participation in strategic international ground and space-based projects and missions.

In 2023, the IA resumed in-person activities following the easing of the COVID-19 restrictions. The IA team continued to engage in cutting-edge research, maintaining a leading role in international ground- and space-based projects and missions. Despite the pandemic's impact, the scientific output remained strong in both volume and impact, positioning IA for long-term growth. Efforts were focused on strengthening synergies across its three nodes, enhancing IA's international presence. The team remained cohesive during the preparations of the Research Unit evaluation, and the recent establishment of the Diversity and Inclusion Group continued to support the growing team at IA.

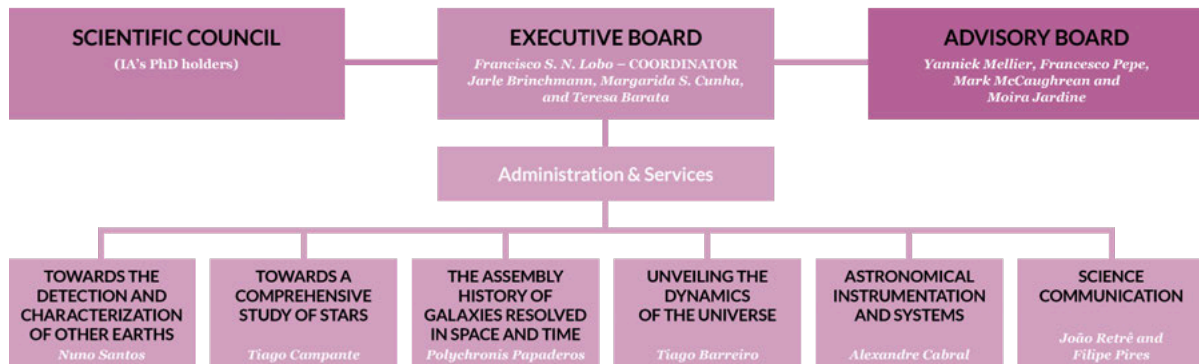
The upcoming pages offer a detailed summary of IA's activities in 2023, highlighting IA's involvement in ESA and ESO projects. These initiatives, initially driven by targeted scientific objectives, have fostered stronger inter-group collaboration and the creation of new synergies within IA. We would like to express our deep appreciation for the commitment of our researchers, students, and support staff, whose efforts sustained IA through the challenges of the COVID-19 pandemic and during the preparations for the Research Unit evaluation. We also pay tribute to the resilience shown by the entire team in face of these particularly difficult circumstances.

Francisco S.N. Lobo, Jarle Brinchmann, Margarida S. Cunha, Teresa Barata  
IA Executive Board

## IA Management

The Executive Board is composed of 2 members from the Porto node (Jarle Brinchmann and Margarida S. Cunha), 1 member from the Lisbon node (Francisco S.N. Lobo) and 1 member of the Coimbra node (Teresa Barata), with Francisco S.N. Lobo as the coordinator of the research unit.

### IA SCIENTIFIC MANAGEMENT STRUCTURE



During 2023, the EB continued having regular weekly meetings to coordinate the scientific and management activities of the IA strategic plan. Every other week these meetings also include group leaders, including the Science Communication Group. Contacts with the management institutions were also done whenever necessary.



## IA-ON 10

The IA-ON meetings continue to be a fundamental annual event enhancing scientific discussion between the whole IA team on outreach, management issues and strategic lines of the Institute. The 10th Internal workshop (IA-On 10) took place in Fátima, during the 26th and 27th of January, at the **Domus Pacis Fátima Hotel**.

The **IA-On 10** assembled most of the team, with an attendance of approximately 75 participants among researchers, students, and support personnel. The highlights of the year were shared and discussed with the whole team. In 2023, the focus was given to the preparations of the external Advisory Board visit and the pending FCT evaluation of the Research Units.



## The IA team (2023)

### Towards the detection and characterization of other Earths (Planets Group)

#### Researchers (PhDs)

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Alberto Negrão
Ângela R. G. Santos *
Clara Sousa Silva <small>(joined 01 June)</small>
Elisa Delgado Mena *
João N. T. Gomes da Silva *
João P. Faria <small>(left 31 July)</small>
Jorge H. C. Martins
Koraljka Mužic *
L. Filipe Pereira *
Nuno Peixinho *
Nuno C. Santos *
Olivier D. S. Demangeon
Pedro Machado
Pedro Pina * <small>(left 30 September)</small>
Pedro Figueira
Pedro B. Lacerda
Pedro T. P. Viana
Sérgio A. G. Sousa *
Susana C. C. Barros
Tiago J. L. C. E. Campante *
Vardan Zh. Adibekyan *

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#### Others

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Alba Barka <small>(joined 04 October)</small>
Alexandros Antoniadis Karnavas *
Ana Rita Costa Silva
André Miguel A. C. V. Silva *
Bárbara M. T. B. Soares
Carmen San Nicolás Martínéz <small>(joined 15 September)</small>
Daniela C. Espadinha
Diogo Quirino <small>(joined 01 October)</small>
Eduardo A. S. Cristo
Francisco Brasil
Jennifer Peralta Lucero <small>(joined 06 November)</small>
João André B. Dias
José Rodrigues *
José Luís F. Ribeiro
Nuno M. Rosário
Tomás de Azevedo Silva

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### Towards a comprehensive study of stars (Stars Group)

#### Researchers (PhDs)

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Ângela R. G. Santos *
Anna Morozova
Bruno Arsoli * <small>(joined 01 January)</small>
Daniel F. M. Folha
Diego Bossini <small>(left 31 December)</small>
Elisa Delgado Mena *
João J. G. Lima
João L. Yun
João N. T. Gomes da Silva *
Jorge Filipe Gameiro
Koraljka Mužic *
L. Filipe Pereira *
Mário J. P. F. G. Monteiro

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#### Others

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Afonso M. R. Vale <small>(joined 01 September)</small>
Alexandros Antoniadis Karnavas *
Ana F. S. Barros <small>(joined 03 May)</small>
Andreas W. Neitzel
Grégoire Francisco
Miguel T. Clara
Nuno A. M. Moedas
Paulina M. Zaworska
Slava L. L. Bourgeois
Thibault Boulet

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Margarida S. Cunha

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Maria Teresa Barata

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Maria Teresa V. T. Lago

---

Nuno C. Santos \*

---

Nuno Peixinho \*

---

Pedro Pina \* (left 30 September)

---

Pedro P. Avelino \*

---

Ricardo Jorge Gafeira

---

Rui Agostinho \*

---

Sérgio A. G. Sousa \*

---

Sara J. Carvalho

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## The assembly history of galaxies resolved in space and time (Galaxies Group)

### Researchers (PhDs)

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Ana S. Paulino Afonso

Bruno Arsioli \*

Catarina Lobo

Cirino Pappalardo

Claudio Llinares (left 15 December)

Israel Matute

Jarle Brinchmann

Jean Michel Gomes

José Afonso

Patricio Lagos

Polychronis Papaderos

Rui Agostinho \*

Tom C. Scott

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### Others

---

Abhishek Chougule

Daniel A. D. Vaz

Davi D. Barbosa

Eleanor L. Worrell

Henrique B. Miranda

Mara Jacinto (left 23 May)

Maya Shemesh (joined 06 December)

Pedro Alexandre C. Cunha

Pedro M. Martins

Rodrigo A. Carvajal Pizarro

Sandy G. Morais

---

## Unveiling the dynamics of the Universe (Cosmology Group)

### Researchers (PhDs)

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Andrew R. Liddle

António C. da Silva

Bruno J. Barros

Carlos J. A. P. Martins

Claudio Llinares (left 15 December)

Francisco S. N. Lobo

Giuseppe Fanizza (left 01 November)

Ismael Tereno

José Carlos Fonseca

José Pedro Mimoso

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### Others

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Ana Sofia Carvalho

Catarina M. J. Marques

Clara Marie Winckler (joined 01 December)

David Grüber

David M. Oliveira

Diogo M. L. Castelão

Inês S. Albuquerque

João D. F. Dias

Luís Atayde

Miguel A. S. Pinto (joined 11 May)

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Lara G. Sousa

---

Marina Cortês

---

Nelson J. Nunes

---

Nuno Barros e Sá (joined 13 January)

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Paulo Crawford

---

Paulo M. Sá

---

Paulo Maurício de Carvalho

---

Pedro P. Avelino \*

---

Tiago Barreiro

---

---

Miguel J. P. C. Conceição

---

Ricarda Heilemann (joined 01 October)

---

Sergei Mukovnikov

---

Tiago Barreiro Gonçalves

---

Vitor da Fonseca

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## Astronomical Instrumentation and Systems (Instrumentation Group)

### Researchers (PhDs)

---

---

Alexandre Cabral

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Bachar Wehbe

---

David Castro Alves

---

Elena Duarte

---

João Coelho

---

João Dinis

---

José M. Rebordão

---

Manuel Abreu

---

Nuno Peixinho \*

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Sérgio A. G. Sousa \*

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### Others

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André Miguel A. C. V. Silva \*

---

Cédric P. Pereira

---

Inês Meira Leite

---

Joel Filho

---

Nuno Miguel Gonçalves

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## Science Communication Group

### Staff

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Adriana Silva

Catarina Leote (left 29 December)

Elsa M. P. S. Moreira

Filipe A. L. Pires

Francisco Miguel Gonçalves (joined 26 September)

Ilídio André P. M. Costa \*

João Retrê

José Manuel C. Dantas

Paulo J. T. Pereira

Ricardo S. S. C. Reis

Sérgio Pereira

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### Researchers (PhDs)

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Ilídio André P. M. Costa \*

Joana Marques (joined 15 March)

Nuno Peixinho \*

Raul Cerveira Lima

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## Interface to Science (Support to Science Activities)

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Argentina Pereira

Carlos Santos

Elsa Marta Silva

Joana Bateira

Sandra Homem

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Researchers that work in more than one group are marked with (\*).



## Research Projects/Programmes

During 2023, a number of funded projects were on-going at IA, providing most of the funds available for research, including outreach activities.

### Projects focused on scientific activities

The research projects that in 2023 were supported by national and European funds are:

#### (i) Projects funded by the European Commission (EC):

- Revealing the Milky Way with Gaia (MW-GAIA) (COST ACTION CA18104)  
PI: Vardan Adibekyan & Nuno Santos  
[start date: 14 March 2019 – end date: 13 March 2023]
- Space Weather Awareness Training Network (SWATNet) (H2020-MSCA-ITN-955620)  
PI: Teresa Barata  
[start date: 1 March 2021 – end date: 28 Agosto 2025]
- Multifrequency and Machine Learning methods to Search for Early Super Massive Black Holes (ML-SMBH) (HORIZON-MSCA-2021-PF-01-101066981)  
PI: Bruno Arsioli  
[start date: 1 December 2022 – end date: 30 November 2024]
- Finding ExoeaRths: tackling the ChallengEs of stellar activity (FIERCE) (GAP-101052347, ERC-2021-ADG)  
PI: Nuno Santos  
[start date: 1 October 2022 – end date: 30 September 2027]

#### (ii) Research projects funded by Fundação para a Ciência e a Tecnologia (FCT):

- Modified Gravity impact on Cosmology and Astroparticles (MGiCAP) (CERN/FIS-PAR/0037/2019)  
PI: Francisco Lobo  
[start date: 1 September 2020 – end date: 31 August 2023]
- Dark matter and metals in galaxies (DarkMAGE) (PTDC/FIS-AST/4862/2020)  
PI: Jarle Brinchmann  
[start date: 1 September 2021 – end date: 31 August 2025]
- BEYond Lambda (BEYLA) (PTDC/FIS-AST/0054/2021)  
PI: Noemia Frusciante  
[start date: 1 January – end date: 31 December 2024]

- Stellar Activity Modelling for exoplanet detection (SAM) (EXPL/FIS-AST/0615/2021)  
PI: João Faria  
[start date: 1 January 2022 – end date: 31 December 2023]
- Finding Lyman-alpha emitters through machine learning (FLAEMING) (EXPL/FIS-AST/1085/2021)  
PI: Ana Paulino-Afonso  
[start date: 1 January 2022 – end date: 31 December 2023]
- Phi in the Sky: Astrophysical probes of fundamental physics (PTDC/FIS-AST/4862/2020)  
PI: Carlos Martins  
[start date: 1 January 2023 – end date: 31 December 2025]
- Star-exoplanet compositional link: towards realistic characterization of terrestrial planets (2022.06962.PTDC)  
PI: Vardan Adibekyan  
[start date: 1 January 2023 – end date: 31 December 2024]
- Cool Stars in the near-Infrared (2022.04416.PTDC)  
PI: Elisa Delgado Mena  
[start date: 1 January 2023 – end date: 31 December 2024]
- Uncovering the nature of cosmic strings (2022.03495.PTDC)  
PI: Lara Sousa  
[start date: 1 January 2023 – end date: 30 June 2024]
- Using Ap stars as LABORatories for probing chemical transport mechanisms, with ultra-precise space- based photometry (2022.03993..PTDC)  
PI: Margarida Cunha  
[start date: 10 March 2023 – end date: 9 March 2025]
- Portuguese Regional Ionosphere Model (PRIME) (EXPL/CTA-MET/0677/2021)  
PI: Anna Morozova  
[start date: 1 January 2022 – end date: 31 November 2023]
- Abordagens de aprendizagem automática para a cosmologia com enxames de galáxias a partir da missão Euclid (ML\_Clusters) (EXPL/FIS-AST/1368/2021)  
PI: António da Silva  
[start date: 1 January 2022 – end date: 30 December 2023]
- Bioscosmologia: O nascimento de uma nova ciência (Biocosm) (EXPL/FIS-AST/1418/2021)  
PI: Andrew Liddle  
[start date: 1 January 2022 – end date: 30 June 2023]

**(iii) Infrastructure funded projects (FCT):**

- R&D Unit Financing: Instituto de Astrofísica e Ciências do Espaço (UIDB/04434/2020 & UIDP/04434/2020)  
PI: Francisco Lobo  
[start date: 1 January 2020 – end date: 31 December 2024]

**(vi) Other projects**

- Participation to CHEOPS Science Operations Centre (SOC)  
PI: Nuno Santos  
[start date: 31 October 2013 – end date: 31 October 2023]
- PLATO OGSE and PDC Phase B (ESA Contract No. 4000133026)  
PI: Nuno Santos  
[start date: 1 January 2018 – end date: 31 December 2025]
- e-CHEOPS: Extending the CHEOPS mission (ESA Contract No. 4000142255)  
PI: Sérgio Sousa  
[start date: 1 October 2023 – end date: 31 December 2025]
- ANDES@ELT (ESA Contract No. 4000143136)  
PI: Nuno Santos  
[start date: 1 January 2023 – end date: 31 December 2025]
- MWWW: Mars Wind Wave Mapping (ESA RFP/3-17570/22/ES/CM)  
PI: Pedro Machado  
[start date: 6 June 2022 – end date: 5 June 2023]
- Moons AIT: Partnership for the MOONS Consortium for the Construction of a Multi-Object Optical and Near-infrared Spectrometer for the VLT (ESO-VLT-MOU-MON-14620-0001)  
PI: Alexandre Cabral  
[start date: 27 November 2020 – end date: 26 May 2023]
- Space Weather (SWE) Products for Southern Europe - Phase 1 (PROSE) (ESA)  
PI: Anna Morozova  
[start date: 23 June 2022 – end date: 30 June 2024]
- ERAACA: Elaboração da Estratégia Regional de Adaptação às Alterações Climáticas do Alentejo (CPS02/2022)  
PI: Pedro Machado  
[start date: 16 March 2022 – end date: 15 June 2023]

## Projects focused on communication and outreach

During 2023 there were several funded projects in IA:

- AstroCamp 2023  
PI: Carlos Martins  
[start date: 1 January 2023 – end date: 1 December 2023]
- Ocupação Científica dos Jovens nas Férias 2023  
PI: Carlos Martins  
[start date: 1 January 2023 – end date: 31 December 2023]
- Formação ESERO  
PI: Filipe Pires/Ilídio Costa  
[start date: 1 January 2023 – end date: 31 December 2023]
- Renewing the solar system exhibition – Europlanet Society  
PI: João Retré  
[start date: 1 January 2020 – end date: 31 December 2023]
- Capacitação dos Centros de Ciência Viva (NORTE-09-5864-FSE-000027)  
PI: Filipe Pires  
[start date: 1 April 2021 – end date: 31 March 2023]
- Rede de Escolas Ciência Viva (RE-C06-i04.02 – Impulso Jovem Steam)  
PI: Filipe Pires  
[start date: 1 March 2023 – end date: 30 March 2025]
- Abordagem STEM e a sua influência nas aprendizagens de Física, interesse e motivação (GoSTEM) (PTDC/CED-EDG/31480/2017)  
PI: Rui Agostinho  
[start date: 1 March 2019 – end date: 28 February 2023]

## Scientific Output and Activities

The overall output of IA in **2023** was (see appendix **Scientific Output** for details)

219

Papers in refereed journals

28

Papers in books and proceedings

144

Communications in international meetings

57

Communications in national meetings

45

Seminars in other institutions

36

Seminars organized at IA

261

Public outreach talks

17

MSc thesis completed

0

PhD thesis completed

22

Observing runs

15

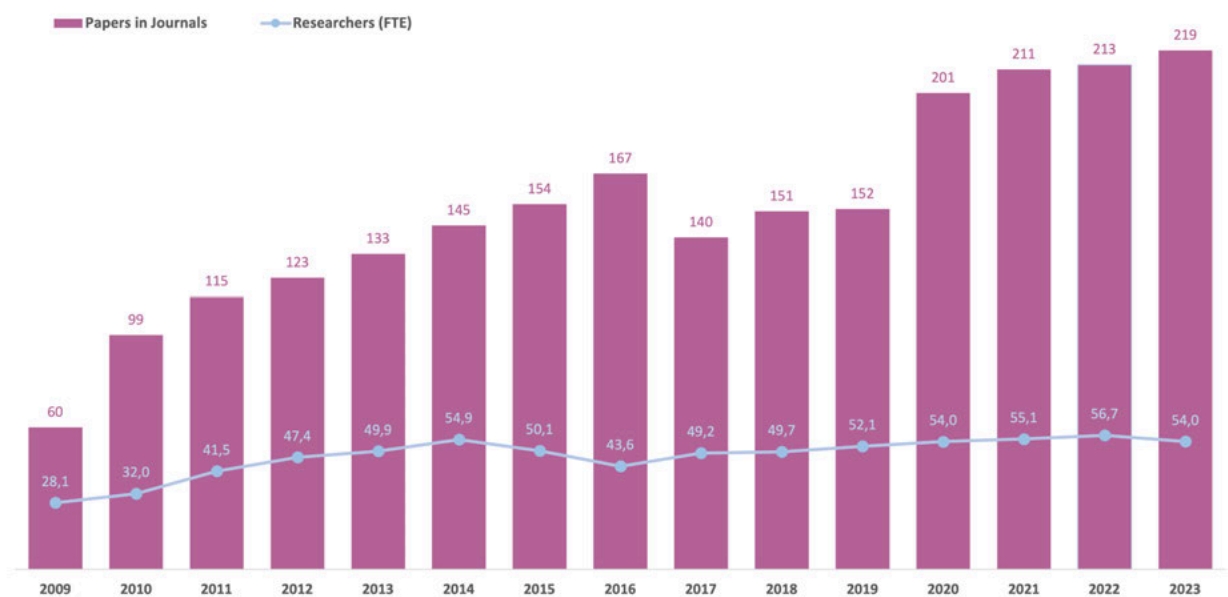
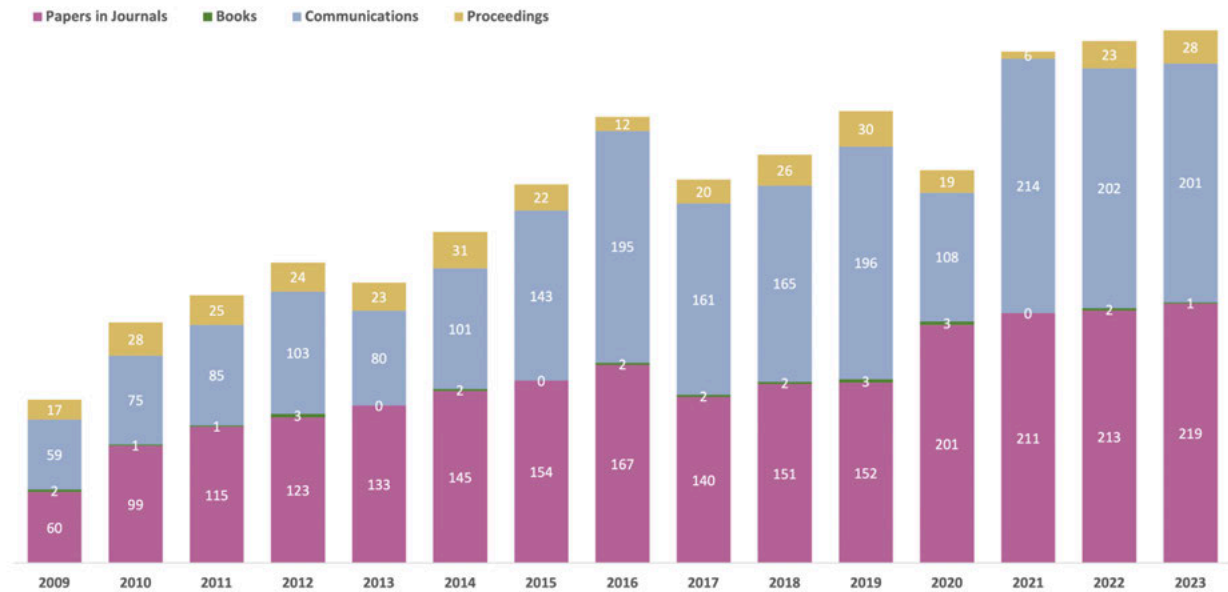
Organization of conferences

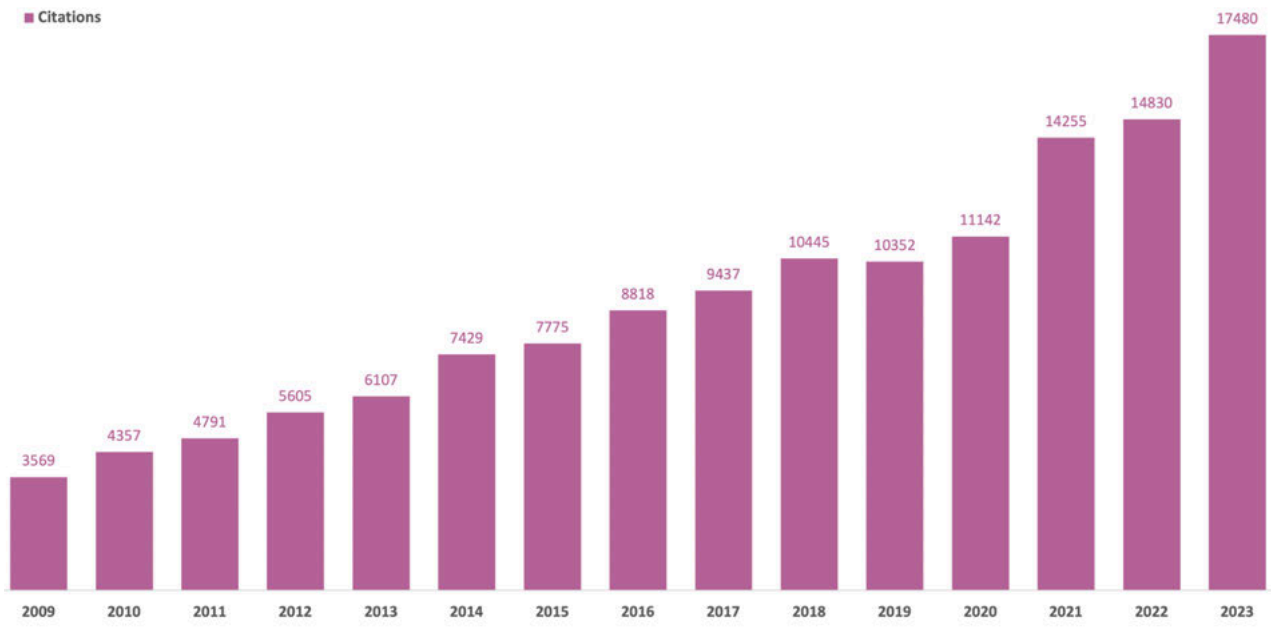
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Reports

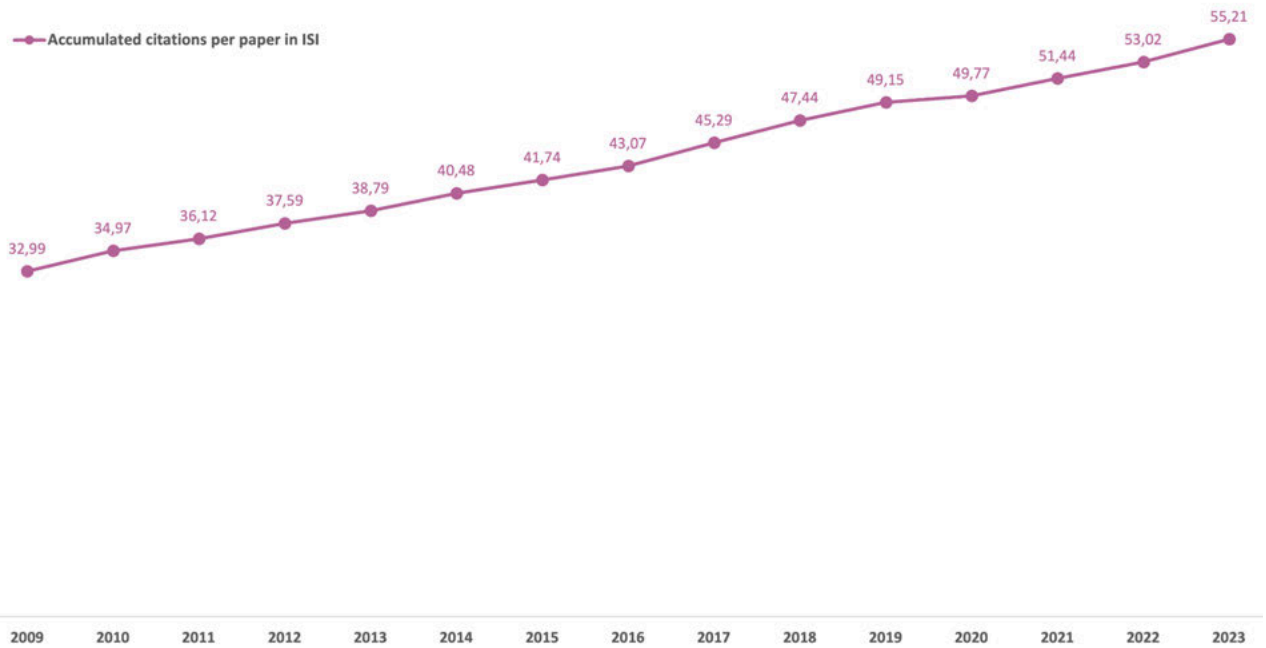


The figures below illustrate the institute’s productivity during the past year. There is a clear and natural relation between the number of researchers and the number of papers in journals subject, understandably, with a small shift in time. The figures show a continuation of the increase in the number of publications and communications, which is a strong indication for the strong activity of the Institute. The number of citations also maintains an increasing trend which is not simply justified by an increase in the numbers or articles. Indeed, the figures show that the accumulated impact continues to grow.





The number of citations obtained in a given year for all the IA articles published since 1990 up to that year.



The accumulated impact in a given year is measured as the ratio between the sum of the number of citations up to that year since 1990 and the number of articles in the same period.

## Report from the Thematic Line

### Towards the detection and characterisation of other Earths

Activities of the team were centred around i) the detection, detailed characterization, and study of exoplanet systems and their host stars, and ii) the study of Solar System bodies (with a focus on their atmospheres), seen also as a stepping-stone towards the understanding of exoplanet atmospheres. Exoplanet research has been mostly centred in the Porto node of IA, while Solar System research is divided in planet atmospheres (centred in Lisbon) and the study of minor bodies (centred in Coimbra). Active collaborations exist between the three nodes, namely in the study of planetary atmospheres (Porto-Lisbon) and the study of solar system exospheres (Lisbon-Coimbra).

In this context, the team focused on tackling high impact questions such as: How diverse are planetary systems in the Galaxy? How frequent are rocky, temperate planets orbiting other Suns? Are there other habitable planets?

To answer these questions, the team concentrated its activities on:

- 1) the search and detailed characterization of exoplanets, including the study of their atmospheres, using state-of-the-art high-resolution spectroscopy and space-based photometric data;
- 2) the study of astrophysical sources of "noise" that hinder the detection and characterization of planets, as well as developing methods to correct/model them, keeping in mind the end goal of detecting and characterising rocky planets orbiting other suns
- 3) the study of the star-planet connection as a way to better characterise planetary systems, their properties and formation processes.
- 4) the exploration of new avenues in the study of Solar System atmospheres (focused on Venus, Mars, and Jupiter), namely to understand their dynamics and chemistry.

A significant part of this research is based in our top-level (leading) scientific participation in different international consortia. From the ongoing projects, we highlight ESO's ESPRESSO and ESA's CHEOPS mission (now starting its first extension until 2026), the NIRPS spectrograph (@ESO's 3.6m), as well as the soon-to-be-commissioned (2025) PoET telescope (entirely led by IA and funded through an ERC grant). All these projects serve as stepping-stones for the science opportunities raised by future projects and missions such as ESA's PLATO (2026), as well as (further ahead) projects such as ANDES@ESO's ELT (2031) and ESA's ARIEL (2029), and EnVision (2031) missions. Our high-level participation in all these projects assures continuity, reinforces the existing strategy, and allows the team to be in the forefront of exoplanet detection and characterization for the next decade and beyond.

## Scientific Highlights for 2023

In 2023, a total of 9 Press-releases were published by IA announcing scientific results or other major activities (e.g. issuing from ongoing instrumentation projects) with a leading scientific participation of the team. Below we highlight 3 of these.

### **Discovering planets around giant stars: understanding the fate of our Solar System**

In 2023, the IA team made significant progress in the understanding of exoplanet populations around giant stars. In two recently published articles led by Elisa Delgado-Mena and Filipe Pereira, the discoveries of two “Jupiters” and two “hot Jupiters” around stars of this type were announced.

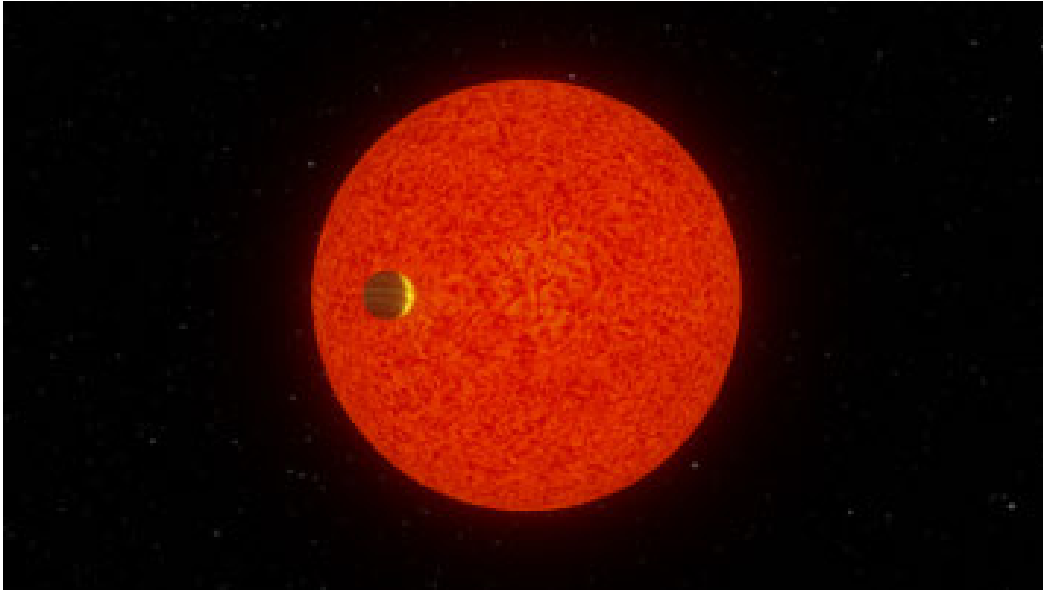
Giant exoplanets, similar to Jupiter, are common in the Universe. But in intermediate mass stars and closer to the end of their life, the frequency of this type of planets decreases considerably – currently, less than 5% of known planets orbit stars with masses greater than 1.6 times the mass of the Sun.

Elisa Delgado Mena (IA & Universidade do Porto) explains that “the abrupt decrease in the frequency of detection of giant planets around stars with masses greater than twice the mass of the Sun led us to observe young open clusters, as they contain many intermediate-mass stars in the giant phase. It is easier to detect planets at this stage, when the stars have cooled down and have a slower rotation, which allows us to measure radial velocities from their spectrum.”

Due to this difficulty, the team began a systematic survey, which has been ongoing for 17 years, with the HARPS spectrograph, mounted on ESO's 3.6-meter Telescope. As a result of this long term effort, they detected two new giant planets in long period orbits (between 744 and 1155 days) around stars from open clusters IC4651 and NGC3680. But the most surprising data was found by looking at 4 other stars that show stable periodic signals for more than 15 years, which despite appearing to be caused by planets, in reality have stellar origins. “It is a mystery how these stellar signals can last so long and whether they are caused by magnetic fields or other types of stellar phenomena. Our work shows that there may be several “planetary impostors”, which we can only unravel after long-term observations”, added Elisa Delgado Mena.

In the article led by Filipe Pereira, the team used transit photometry data, obtained with the TESS space observatory (NASA), to detect two hot Jupiters, around red giant stars. These observations were later confirmed with measurements of radial velocities obtained with different telescopes. Around the star TOI-4377, the team detected an exoplanet with 0.96 times the diameter and 1.35 times the mass of Jupiter, orbiting in just 4.38 days, at a distance of just 0.058 astronomical units from the star. Around the star TOI-4551, the team detected an exoplanet with about 1.06 times the diameter and 1.5 times the mass of Jupiter, which orbits its star in just under 10 days and at a distance of 0.1 astronomical units.

These are two rare examples of “hot Jupiters” orbiting red giant stars. Systematic surveys using radial velocities initially suggested that these planets would be destroyed by their star, which would explain the small number of these types of exoplanets detected. However, more recent results, based on TESS data, appear to suggest that this destruction process occurs later than initially estimated.



Artist's image of a “hot Jupiter” orbiting a red giant star.

(Credit: Tania Cunha (Planetário do Porto – Centro Ciência Viva & Institute of Astrophysics and Space Sciences))

### **Three-dimensional atmosphere of Venus prepares future observations of rocky exoplanets**

The atmosphere of Venus can be used as a natural laboratory to understand the evolution of Earth-like planets, according to a study led by the Institute of Astrophysics and Space Sciences (IA).

Venus and Earth are in almost the same region of the Solar System and have similar sizes and densities, but their atmospheres and surface conditions are radically different. If they were observed from a distance of 100 light years, how could we tell them apart?

In a paper led by Diogo Quirino, from the Institute of Astrophysics and Space Sciences (IA), and by Gabriella Gilli, IA collaborator and researcher at the Institute of Astrophysics of Andalusia (IAA –CSIC), a team of researchers chose a planet 106 light years away, with 1.37 times the diameter of Earth, to present the first three-dimensional simulation of the climate of a rocky planet with the characteristics we currently know in Venus. The planet, named LP 890-9 c, orbits its star at a distance that places it in the habitability zone, but very close to the limit of uncontrolled greenhouse effect that we see on Venus.

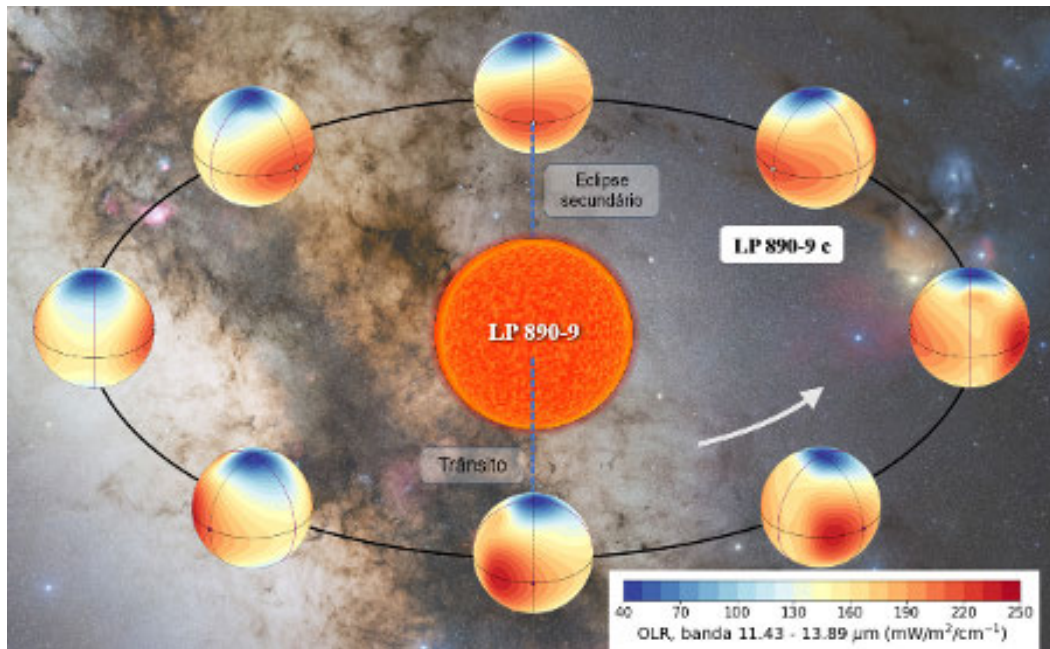
This planet's potential to be similar to Venus makes it an ideal target for studies that seek to understand the evolution of the atmosphere on terrestrial-type planets and explain the climate divergence we observe today between Earth and Venus. This simulation will help prepare observations of this and other rocky planets with the instruments of the current James Webb Space Telescope (JWST), or the future Extremely Large Telescope (ELT), of the European Southern Observatory (ESO), among others.

Based on the hypothesis that the climate of LP 890-9 c evolved into a modern Venus-type atmosphere, the authors simulated it with a surface pressure 92 times greater than that of Earth, a chemical composition dominated by 96.5% carbon dioxide and a global blanket of sulfuric acid clouds. Previous



studies indicate that, in fact, the accumulation of carbon dioxide in the atmosphere is one of the likely scenarios for evolution in terrestrial-type planets orbiting red dwarf stars. The team thus offers predictions for the temperature and intensity of winds at the top of the clouds, as well as the number of observations that will be necessary to carry out the atmospheric characterization of this planet.

It is not yet known whether exo-Venuses exist, but three-dimensional models and simulations, informed by the knowledge we have about the Solar System, are essential so that scientists can have useful and operational tools when discovering extrasolar planets.



Schematic representation of the orbit of the exoplanet LP 890-9 c and the radiation emitted by the planet in a specific band of the spectrum. This information obtained with the three-dimensional atmospheric model is used to calculate the variation in radiation received by an observer on Earth throughout the planet's orbit. The planet and the star are not to scale. Courtesy Diogo Quirino/ESO.

### Jupiter as seen by an exoplanet hunter

For the first time, an instrument to find planets light years away was used on an object in the Solar System, in a study on Jupiter's winds carried out by the Institute of Astrophysics and Space Sciences (IA).

We find ourselves at a time when it has become almost commonplace to discover planets orbiting another star, with more than 5,000 already registered. The first distant worlds to incorporate this list were mainly giant planets, similar to but also very different in many ways from Jupiter and Saturn.

Astrophysicists have already begun to obtain data on the atmospheres of exoplanets, but fundamental questions about the atmosphere of the largest planet in the Solar System are yet to be answered.

To understand what happens in Jupiter's clouds and air layers, it is necessary to study it over time, in continuous observations. Now, for the first time, an instrument developed to find and analyse worlds light years away, exoplanets, has been pointed at a target in the Solar System, 43 light minutes away from Earth: the planet Jupiter.

The ESPRESSO spectrograph, installed on the European Southern Observatory's (ESO) VLT telescope, was used by a team from the Institute of Astrophysics and Space Sciences (IA) to measure wind speeds on Jupiter. The method used with ESPRESSO was developed by the IA Planetary Systems group with other spectrographs to study the atmosphere of Venus. The IA group has been measuring the winds of this neighbouring planet and has been contributing to the modelling of its general atmosphere system for several years.

Now, the exploratory application of this method with a state-of-the-art instrument such as ESPRESSO has resulted in a success that opens new horizons to the knowledge of our cosmic neighbourhood. This work affirms the feasibility of systematically monitoring the most distant atmospheres on gaseous planets.

With ESPRESSO, the team was able to measure winds on Jupiter from 60 to 428 km/h with an uncertainty of less than 36 km/h. To verify the effectiveness of Doppler velocimetry from telescopes on Earth in measuring winds on Jupiter, the team also gathered measurements obtained in the past in order to compare the results. Most of the existing data was collected by instruments in space and used a different method, which consists of obtaining average values of wind speed by following cloud patterns in images captured at nearby times.

The consistency between this history and the values measured in this now published study confirms the feasibility of implementing Doppler velocimetry in a program for monitoring Jupiter's winds from Earth. The monitoring will allow us to collect data on how winds change over time and will be essential for developing a reliable model of the global circulation of Jupiter's atmosphere. This computational model should reproduce the differences in winds depending on latitude, as well as Jupiter's storms, to help understand the causes of the atmospheric phenomena we observe on this planet.

The success of these observations with ESPRESSO proves to be important at a time when its successor, ANDES (on which the IA team is deeply involved), is being designed for the future Extremely Large Telescope (ELT), also from ESO and currently under construction in Chile, but also the future JUICE mission, from the European Space Agency (ESA), dedicated to Jupiter and which will provide additional data.

## Thematic line meetings, Journal Clubs and other activities

In 2023, as for the previous years, the IA-planet line maintained a regular journal club and team meeting agenda. Team meetings and journal clubs are organised every two weeks. Meetings include a presentation of “general information”, as well as a short presentation of the work being carried out by one PhD student and one researcher, followed by discussion. This format helps the whole team to be acquainted with the research that is being carried out and helps the students to develop presentation skills and identify potential problems and solutions in their research project. Journal clubs include the presentation of recent research papers, followed by discussions.

All this information is kept up-to-date in the new team web pages (<http://planetas.iastro.pt>).

All regular team meetings and journal clubs were performed remotely via Zoom, to assure a smooth participation from team members in all 3 nodes (Porto, Coimbra, and Lisboa).

We also organised our annual team meeting (called "2-DEMOC"), where the team strategy and plans (both scientific and organisational) were discussed. This year's event took place in Santarem.

Among the participation in several Scientific Organizing Committees of international conferences, the team organised an international conference in Porto (Towards Other Earths III) also started the organisation of one large international conference (Extreme Precision Radial Velocities 6) that will take place in 2025. Finally, the 1st PoET workshop was organised in February.

Team members actively participated in different public outreach activities, including public talks and debates in schools and online, as well as other outreach events. In this context, the team has also kept updating a public outreach page on Planetary Systems (<https://outrosmundos.iaastro.pt>), where information in Portuguese is provided about planetary system's science as well as the discoveries where the team is involved.

In 2023, 8 MSc thesis were successfully finished (several other PhD and MSc are ongoing):

- “Estimativa de dose efetiva num corpo humano submetido a um campo de partículas semelhante ao encontrado na superfície de Marte”, Dr. Miguel Correia Ralha (MSc)
- “Looking at the Sun, finding other Earths: identification of solar regions”, Dr. José Lino (MSc)
- “Fungal melanins as possible biosignatures in exoplanetary conditions”, Afonso Mota (MSc)
- “SAR Tomography To Image Asteroid Interior: preparation of the JuRa/HERA data inversion”, Miguel José Tavares Gomes (MSc)
- “Collisional Evolution of Jupiter Trojans”, Vasco Serra Cardoso (MSc)
- “Stellar flare spectroscopy with ESPRESSO: detecting planets around flaring stars”, José Manuel Leiria Amoreira (MSc)
- “Where in the Milky Way do exoplanets preferentially form?”, Joana Raquel Aguiar Teixeira (MSc)
- “A Machine Learning approach to determine Stellar Atmospheric Parameters using Spectral Data”, Joana Catarina Santos Leite (MSc)

A number of undergraduate students also worked with the IA team in different projects:

- “Development of a tool for the normalization of stellar spectra - application to ESPRESSO data”, Diogo Marques
- “Determining the rotational velocity of stars with exoplanets”, Bárbara Oliveira
- “Determining the rotational velocity of stars with exoplanets”, Pedro Branco
- “A new activity proxy for finding other Earths”, Pedro Afonso – A new activity proxy for finding other Earths

In 2023, team funding comes mostly from IA “strategic funding” as well as from 2 running FCT (PEX) projects and one ERC Advanced Grant. The preparation for the response to the FCT 2023 call (deadline in March 2024) was also part of our activities.

Furthermore, funding for our participation in the CHEOPS, PLATO, ARIEL, and ANDES projects was secured through PRODEX. We note, however, the PRODEX funding covers only the "project level activities".

We would further like to highlight the strong collaborative work done in 2023 to foster collaborations of IA-Planet team members with other groups in the institute. This particularly concerns collaborations with the Stellar and Instrumentation groups. Collaborations with the stellar group include the characterisation of planet host stars, stellar spectroscopy, and asteroseismology, the study of solar and stellar activity, and Galactic chemical evolution. Instrumentation group collaborations touches several aspects related with the development of new instruments and related software, such as PoET, NIRPS, CHEOPS, PLATO, and ANDES. Collaborations with other groups, namely cosmology and science communication, has also been done, respectively, through common instrumentation interests and through the communication of science results.

Nuno Santos

Group Leader

## Report from the Group

### Towards a comprehensive study of stars

Our activity during 2023 was distributed across three main research lines: Sun and Heliosphere, Stellar Physics, and Stellar Populations.

**Sun and Heliosphere research line.** We continued to participate and collaborate in several national and international projects. Group members lead the Portuguese participation in the SWATNet MSCA Innovative Training Network, are actively contributing to the European Solar Telescope (EST) project, developed the first detailed regional model of the ionosphere, and recently started a partnership with MIT to develop a coupled thermosphere-ionosphere model for the Atlantic mid-latitude regions. Our participation in EST is of particular strategic importance. The Portuguese contribution to the project focuses on developing the Integral Field Spectropolarimeter, of which one of the group members is Co-PI.

**Stellar Physics research line.** The exploitation of asteroseismic data from TESS (NASA) is being carried out in the context of the TESS Asteroseismic Science Consortium (TASC), in which our team is strongly involved, with representation on the Steering Committee and co-leadership of one of its working groups. Furthermore, our team continues to be strongly involved in the preparation of the stellar science component of PLATO (ESA), with responsibilities in the design, implementation, and validation of sections of the Stellar Analysis System (SAS) pipeline, leading work packages in the framework of both the PLATO Science Management (PSM) and the PLATO Data Center (PDC). The team also continued to actively contribute to the Ariel (ESA) consortium, in the context of which we coordinate working groups responsible for determining the surface chemical abundances as well as the fundamental properties of the mission's target stars.

The team continued to engage in the characterization of pre-main-sequence stars and their environments, in particular of T Tauri stars. Our research also included studies of low-mass stellar and substellar populations in young clusters and star-forming regions in the Milky Way. The team's involvement in SPIRou@CFHT is of particular importance in this respect, with one of its members being part of the consortium's Steering Committee.

**Stellar Populations research line.** We continued to be actively engaged in several international consortia, including ANDES@ELT, the Maunakea Spectroscopic Explorer (MSE), ESPRESSO@VLT, and NIRPS@ESO 3.6-m Telescope. We highlight the team's involvement in ANDES@ELT, where we play a role in the development of the scientific priorities and the definition of top level requirements for the instrumentation.

### Scientific highlights for 2023

#### A deeper understanding of solar physics with the help of machine learning

The use of machine learning techniques within the field of solar physics holds promise for advancing our comprehension of the intricate phenomena occurring in the Sun's atmosphere. In Asensio Ramos, Cheung, Chifu & Gafeira (2023, Living Reviews in Solar Physics, 20, 4), the authors provide a



comprehensive review on the topic of machine learning applied to solar physics. Through methodologies like deep learning, it should be possible to sift through vast data sets derived from modern-day solar observations, thus uncovering patterns and trends previously elusive via conventional methods. For instance, this will greatly aid in elucidating phenomena such as solar flares, which have significant influence over Earth's environment. Moreover, machine learning allows delving deeper into solar data, accelerating the development of more intricate models to unravel the Sun's inner mechanisms. Additionally, its application streamlines the analysis process, decreasing the reliance on manual labor and amplifying research efficiency within this domain. A research note was issued by IA accompanying the publication of this review article.

### Towards a regional ionosphere model

The ionospheric response at middle latitudes to geomagnetic storms is not yet very well understood. In Barata et al. (2023, *Atmosphere*, 14, 949), the authors attempt to fill this gap by studying variations in the total electron content (TEC) associated with eight strong geomagnetic storms (which occurred between 2015 and 2022; see Figure below) obtained from GNSS receivers in the eastern area of the North Atlantic (Portuguese continental and insular territory). They found that there is no clear dependence between the strength of a geomagnetic storm and the strength and type of an ensuing ionospheric storm, as well as the appearance of different types of discontinuities in the work of GNSS systems. Even though six out of the eight studied storms were accompanied by reports of different kinds of failure in one or many of the operational GNSS systems, some of the storms were nevertheless completely “invisible” from a GNSS point of view. The authors believe that this ambiguity is due to the lack of systematic and uniform collection and analysis of data on the GNSS system failures. This study is a direct contribution to the group-led PRIME FCT R&D project, which aims at developing a regional ionosphere model. Such a model will likely play an important role in supporting the air navigation sector (Portugal is located on the border of the EGNOS system, a satellite-based augmentation system for Galileo).

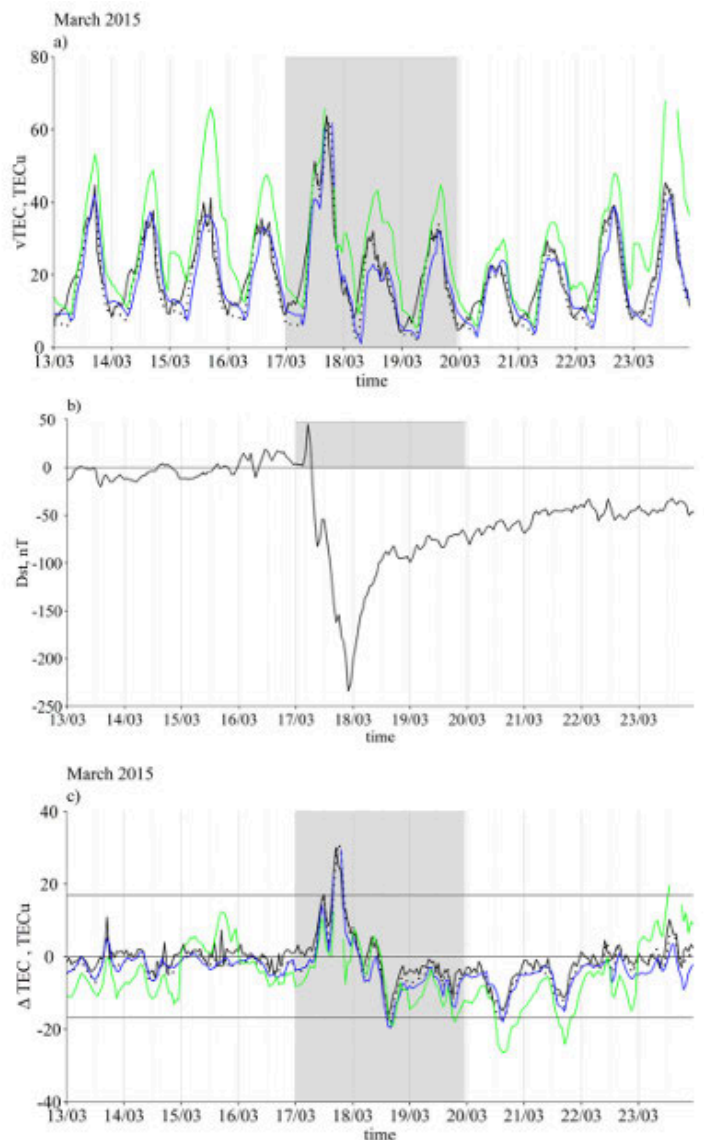


Figure 1: Variations of the TEC and Dst geomagnetic index at three different locations during March 2015. From Barata et al. (2023).

## Does the Sun behave like other “Sun-like” stars?

Photometric time series of solar-like stars may exhibit rotational modulation, i.e., brightness variations due to active regions co-rotating with the stellar surface. These signatures allow one to constrain properties of stellar rotation and magnetic activity. In Santos et al. (2023, *Astronomy & Astrophysics*, 672, A56), the authors investigate the behaviour of the photometric magnetic activity of Kepler solar-like stars and compare it with that of the Sun. The photometric magnetic activity proxy,  $S_{ph}$ , is adopted for this purpose. Sun-like stars were selected from a very narrow parameter space around the solar properties. The authors also paid special attention to KIC 8006161, a very active metal-rich G dwarf, having compared its magnetic activity to that of stars with similar stellar fundamental parameters. They found that the amplitude of  $S_{ph}$  variability is strongly correlated with its mean value regardless of spectral type (see figure), similar to a relationship previously found for ground-based observations of chromospheric activity emission. While, depending on the phase of its activity cycle, the Sun is among the less active stars in the sample, the authors found that the  $S_{ph,\odot}$  properties are consistent with those observed for Kepler Sun-like stars. KIC 8006161 is, on the other hand, among the most active stars, which also tend to be metal-rich. This supports the interpretation that the strong activity of KIC 8006161 is a consequence of its high metallicity, which in turn affects the depth of the convection zone and, consequently, the efficiency of the underlying dynamo mechanism. A press release was issued by IA accompanying the publication of this article.

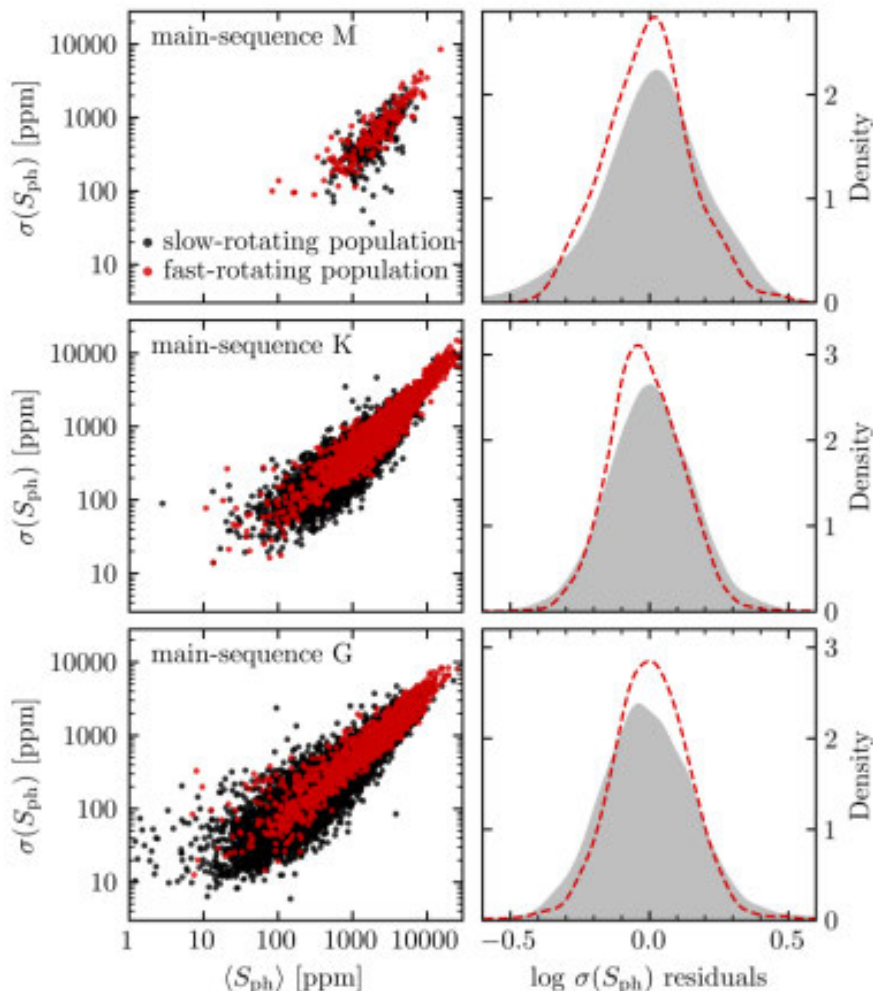


Figure 2: Relation between  $\sigma(S_{ph})$  and  $\langle S_{ph} \rangle$  for main-sequence GKM stars. From Santos et al. (2023).

## Detailed seismic modelling of evolved RGB stars

Asteroseismology is playing an increasingly important role in the characterization of red giant host stars and their planetary systems. In Campante et al. (2023, *The Astronomical Journal*, 165, 214), the authors conduct detailed asteroseismic modelling of the evolved red giant branch (RGB) hosts KOI-3886 and Draconis, making use of end-of-mission Kepler (KOI-3886) and multisector TESS (Draconis) time-series photometry. They also model the benchmark star KIC 8410637, a member of an eclipsing binary, thus providing a direct test to the seismic determination. The authors aimed at testing the impact of adopting different sets of observed modes as seismic constraints. Given the very small spacing of adjacent dipole mixed modes in evolved RGB stars, the sparse set of observed g-dominated modes was not able to provide extra constraints,

further leading to highly multimodal posteriors (see figure below). Furthermore, they tested the impact of varying the atmospheric boundary condition in their stellar models. They found the mass and radius estimates to be insensitive to the description of the near-surface layers, at the expense of substantially changing both the near-surface structure of the best-fitting models and the values of associated parameters like the initial helium abundance,  $Y_i$ . Attempts to measure  $Y_i$  from seismic modelling of red giants may thus be systematically dependent on the choice of atmospheric physics.

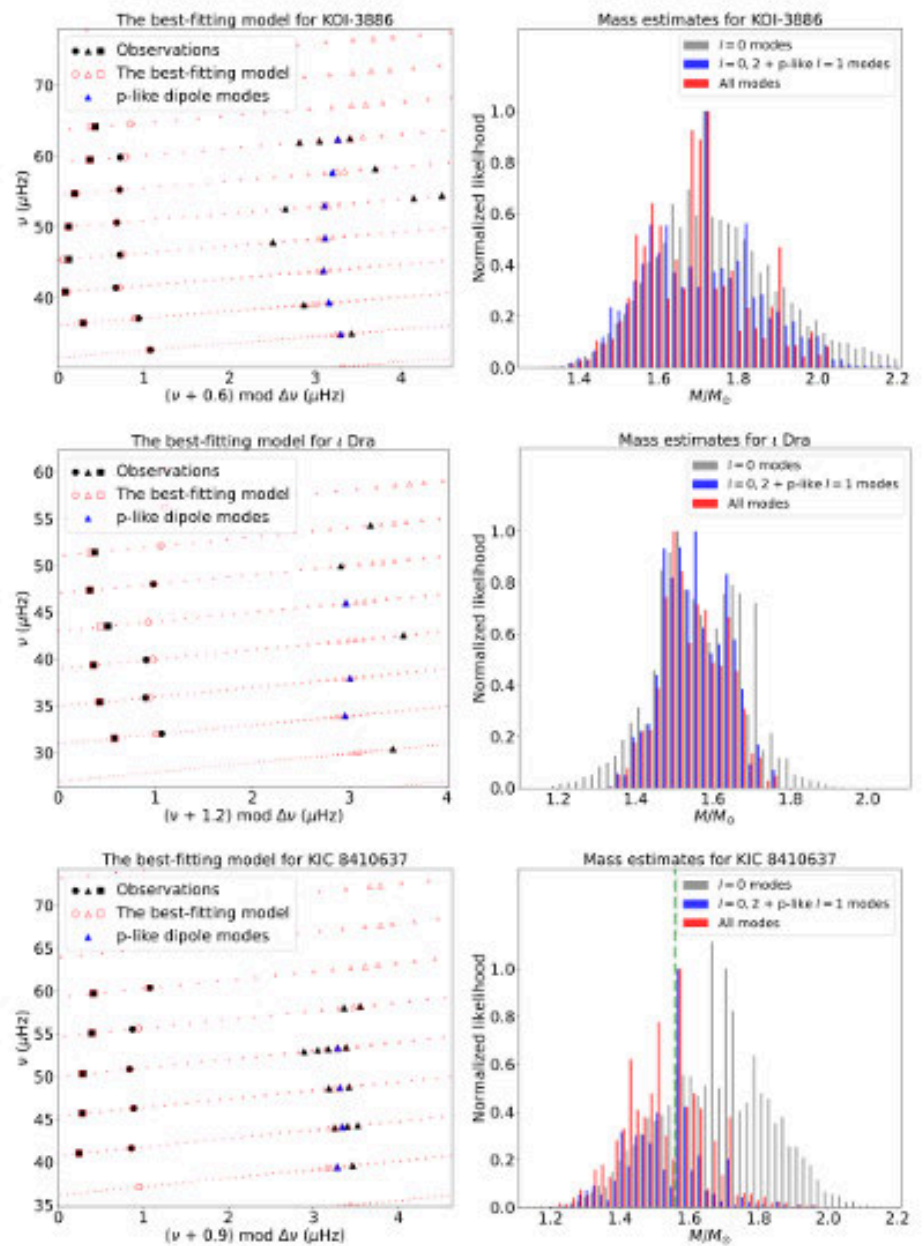


Figure 3: Left column: Échelle diagrams of the best-fitting models for (from top to bottom) KOI-3886, Dra, and KIC 8410637 constrained by all the observed mode frequencies (method “A”). Right column: Probability distributions for the stellar mass estimated using each of the three optimization methods (“0” in gray, “P” in blue, and “A” in red). The vertical dashed line in the bottom panel represents the dynamical mass of KIC 8410637. From Campante et al. (2023).

### **e-book: Challenges of asteroseismology in the era of space missions**

New insights into the physics of stellar interiors and evolution are being made possible by asteroseismology. Moreover, asteroseismology is being increasingly applied to studies of Galactic archaeology, exoplanetary systems, and even tests of fundamental physics. Nevertheless, more data does not necessarily mean a better understanding, and there are long-standing problems that remain unresolved and others that have emerged as a result of the unprecedented quality of the data collected by space missions like CNES/ESA's CoRoT, and NASA's Kepler/K2 and TESS. In the e-book "Challenges of asteroseismology in the era of space missions" (Pascual Granado, Campante, García Hernández & Guo, Eds., 2023, *Frontiers in Astronomy and Space Sciences*), the editors aimed at providing contributing authors with an opportunity to publish studies that tackle unresolved problems in asteroseismology, doing so from an original perspective, be it of a theoretical or observational nature. The eleven articles published therein fulfil that role, making use of a diverse set of techniques while addressing a heterogeneous mix of subfields.

### **Other activities**

We start by providing an overview of the group's internal procedures and meetings. Next, we highlight a number of indicators for the year 2023, namely, funded projects, completed theses, organisation of conferences and workshops, visiting scientists, and outreach activities.

### **Regular meetings and activities**

We hold biweekly group meetings, a forum for discussing group-related issues and strategy. These are held together with the Journal Club. Moreover, we hold science meetings on a biweekly basis (alternating them with the group meetings), a forum for presenting and discussing ongoing work conducted by group members. In 2023, we had two more instalments of Stars Day (one in May and the other in December), a biannual in-person meeting with a strong social component. Stars Day events are fully organised by our students.

### **Communication**

The group website is regularly updated, containing the latest group-related news as well as information on our research and other activities.

### **Funded projects (starting, finishing, or ongoing in 2023)**

#### **FCT R&D projects:**

- 4 exploratory projects.

#### **Cooperation projects:**

- Space Weather Modeling: A Coupled Ionosphere-Thermosphere Physics-Based Approach — MIT Portugal Partnership 2030 (MPP2030).

#### **Regional funding:**

- AM Radio Signal Datalogger (AMANDA) — INOVC+.

#### European funding:

- Revealing the Milky Way with Gaia (MW-GAIA) — COST Action.
- Space Weather Awareness Training Network (SWATNet) — MSCA Innovative Training Network.
- SSA P3-SWE-XXXVII SWE Products for Southern Europe — Phase 1 (PROSE).

#### Completed theses

##### MSc:

- Anselmo Falorca. Title: Numerical simulations (HD and MHD) of planetary winds in the vicinity of stellar winds emanating from their host stars. Supervisors: João Lima and Adam Frank.
- Inês Rolo. Title: Application of realistic magnetic-cycle reconstruction to Sun-as-a-star observations. Supervisors: João Faria, Margarida Cunha, and Ângela Santos.
- Maria Ferreira. Title: Small separations in red-giant stars: quest for late evolution signatures using asteroseismology. Supervisors: Diego Bossini and Nuno Peixinho.
- Joana Pereira. Title: Variations of the ionospheric total electron content over continental Portugal and islands. Supervisors: Anna Morozova.
- Eva Silva. Title: Atividade cromosférica em estrelas evoluídas. Supervisors: Elisa Delgado Mena, João Gomes da Silva, and Ricardo Gafeira.
- Gabriela Lapa. Title: Impact of stellar activity on planetary habitability. Supervisors: Ângela Santos and João Fernandes.

#### Organization of conferences/meetings/workshops

- Space weather influence on the ionosphere and its potential threats to GNSS services — Online Workshop.
- NLTE Workshop 2023.
- 3rd Iberian Space Science Summer School (i4s).

#### Visiting scientists

- November 29-30. Paul Beck (Instituto de Astrofísica de Canarias, Spain).
- November 13-17. Morgan Deal (Université de Montpellier, France).
- September 25-28. Adam Frank (University of Rochester, USA).
- June 20-22. Mathieu Vrad (Observatoire de la Côte d'Azur, France).
- June 6-7. Evelyne Alecian (Université Grenoble Alpes, France).
- April 26-May 5. Joergen Christensen-Dalsgaard (Aarhus University, Denmark).
- March 20-24. Savita Mathur (Instituto de Astrofísica de Canarias, Spain).
- March 20-24. Rafael García (Université Paris-Saclay, France).
- January 23-27. Benard Nsamba (Max Planck Institute for Astrophysics, Germany; Kyambogo University, Uganda).
- January 9-12. Jose Carlos del Toro Iniesta (Instituto de Astrofísica de Andalucía, Spain).

### **Outreach (selected)**

- 5 group-related press releases/news articles issued by the Science Communication Group at IA.
- Partnership with National Geographic Portugal: 1 article published by group members.

Tiago Campante

Group Leader



## Report from the Group

### The assembly history of galaxies resolved in space and time

In 2023, the Group continued to successfully implement its scientific strategy, making significant progress in investigating the formation history of galaxies and their structural components, the genesis and growth of supermassive black holes (SMBHs) in galactic nuclei and their influence on the assembly history of galaxies, the origin and implications of starburst activity and the influence of the environment on galaxy evolution.

These scientific objectives, pursued by a team of 12 researchers, 13 collaborators and 10 students, are served by the IA participation with leadership roles in the ESO instrument consortia of MOONS@VLT, BlueMUSE@VLT, MOSAIC@ELT of ESO, and ESA missions with key importance for the Group's strategy (Euclid, Athena), as well as by the parallel development of highly optimised computational tools for the scientific exploitation of multi-wavelength data for galaxies near and far.

The growth of SMBHs and their observational manifestations as Active Galactic Nuclei (AGN) is being investigated by the Group both at highest redshifts and in the nearby universe. The emergence of the very first powerful AGN in the Universe, and how they shaped the earliest galaxy evolution is being studied through sub-mm observations with IRAM and the revolutionary ALMA, and by post-processing cosmological simulations to obtain quantitative predictions on the number and detectability of early SMBHs at X-rays and radio wavelengths. Building upon its expertise on the analysis and interpretation of multi-wavelength data, and as part of a coherent strategic roadmap, the Group is developing new observational discriminators for the detection of proto-AGN at the Epoch of Reionization (EoR). It also acts as a strong driver in the development of ASKAP's Evolutionary Map of the Universe survey, through the IA-lead Key Science Project "Radio AGN in the EoR" and is represented at the Board and Science team level in ESA's future X-ray mission, Athena.

At low and intermediate redshift ( $z$ ), the AGN phenomenon is being studied using the currently most powerful telescopes and instruments, most notably the Multi Unit Spectroscopic Explorer (MUSE) at ESO-VLT. Special emphasis is being laid on the study of quasars surrounded by gigantic Lyman- $\alpha$  halos and the definition of new diagnostics for constraining the physical conditions and excitation mechanisms in the nebular component of these extreme environments. This line of research is further supported by a comparative analysis of gas kinematics and excitation properties obtained from integral field spectroscopy (IFS) with predictions from cosmological simulations incorporating AGN feedback, and through IA's spectral synthesis code FADO. The latter, together with other IA-developed tools, are being used to prepare the scientific exploitation of MOONS (the Multi Object Optical and Near-infrared Spectrograph for the VLT), an instrument the IA co-leads and which is expected to start its operation at the end of 2024. During 2023, the team continued having a key involvement in the preparation of guaranteed time observations with MOONS and in the definition of strategies for the reduction and analysis of data from it. IA researchers assume major roles in several MOONS Science and Technical Working Groups (WGs), including the co-leadership of the AGN WG and the technical WG-1, and have an active role in the scientific WGs on Physics of the ISM, Passive galaxies and stellar continuum, Galaxy environment, Large-Scale Structures, High- $z$  Universe and the EoR, Clusters/Protoclusters, and in the technical WGs on Mock Catalogues from Simulations, Determination of Redshift and Physical Parameters from Spectra, and on the Determination of Environmental Parameters.

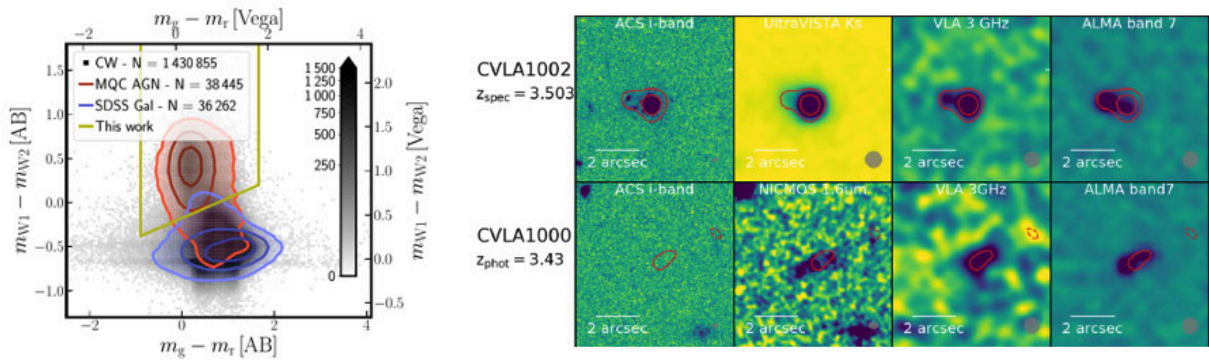
Another important field of the activities of the Group centres on spatially resolved investigations of galaxies with IFS and deep multi-band photometry. Using MUSE and the CALIFA and MaNGA IFS galaxy surveys, as well as data from the Hubble Space Telescope (HST) and the James Webb Space Telescope (JWST), team members are investigating a wide range of fundamental issues in extragalactic research, including the build-up history of galaxy bulges and the physical drivers of their inside-out star formation quenching, the spatial and temporal progression of starburst activity and starburst-driven feedback processes in galaxies, the mechanisms facilitating and regulating the escape of Lyman- $\alpha$  and Lyman-continuum radiation from galaxies, age and metallicity patterns in spiral and elliptical galaxies, cooling flows and ram pressure stripping effects in galaxy clusters, and the nature of ultra-faint galaxies. The activities of the team also encompass the development of Machine Learning tools for the identification of high- $z$  AGN and the characterization of galaxies from the Euclid Galaxy Legacy Survey, which is co-led by IA.

## Scientific Highlights for 2023

### **AGN and the growth of SMBHs since the Epoch of the Reionization**

Over the past few years, the team has focused on the search for the earliest radio-powerful SMBHs. Extending work by Amantidis et al. (2019), based on state-of-the-art galaxy formation models, and implementing prescriptions for the radio emission from SMBHs, has developed new radio multiwavelength selection and classification techniques and explored new samples of high- $z$  radio galaxy candidates, using ALMA and HST observations to confirm some of the earliest radio-powerful galaxies currently known. The expertise gained showed us how to explore the highest redshifts and find some of the earliest AGN in the Universe, and we are now able to continue our efforts into the next generation of radio observations in the SKA-era.

A breakthrough development by our team in the selection of very high- $z$  SMBHs was achieved by Carvajal et al. (2023). There, we developed a machine learning (ML) model capable of predicting which sources, detected at infrared wavelengths, are likely to be AGN and be detected in deep radio surveys. Quite importantly, this work led to a "machine-learning-assisted" definition of an optimal 4-band diagnostic for the identification of AGN (Fig. 1). We showed that the algorithm can also efficiently estimate redshift values for predicted radio AGNs, at the same level of accuracy as traditional photometric redshift techniques. Interestingly, the highest impact of this work is not only the prediction of radio-bright SMBHs, but also obtaining insight into the currently less known physical interplays between the properties of radio AGNs (e.g. mass of black hole, accretion rate, infrared and radio luminosities). This approach reflects our efforts in going beyond the usual blind application of ML algorithms, using them as guidance to better understand the physical processes at play in the phenomena being studied. We note that the criteria by Carvajal et al. are now used in the Evolutionary Map of the Universe Survey (EMU) Pilot Observations, and have already led to serendipitous discoveries.



Left: Separation of AGN from normal galaxies on a two-color diagram, constructed using ML tools (from Carvajal et al. 2023). This two-color diagnostic has been adopted by the EMU collaboration for the search of high- $z$  active SMBHs and has already led to a number of serendipitous detections of such sources. right: Examples of the multi-wavelength analysis of  $z > 3$  galaxies containing obscured star formation. The overlaid contours show the radio emission from VLA (from Amaratidis et al. 2023).

Recently, one of our PhD students (Barbosa et al. 2024, in preparation) showed that some radio-only techniques cannot be used effectively at the depth of EMU, as low- $z$  star-forming galaxies appear to mimic the radio emission previously expected only from very distant AGN. This has led to an optimization of our AGN search strategies exploiting different combinations of available multiwavelength data. In Amaratidis et al. (2023) we explored a mixed far-infrared - radio technique to reveal a dusty galaxy population apparently growing quickly and hosting both an active SMBH and intense star formation. The team has been further working on a logical optimization of the AGN selection criteria by Amaratidis et al. (2023) to the highest-redshift regime, with the exploration of ALMA observations, a capability we have already built-up between 2014 and 2020 through the establishment and management of the Portuguese ALMA Regional Center. Finally, a parallel project (Matute et al., in prep.) uses unsupervised ML, specifically, Self-Organizing Maps (SOMs) to unlock hidden patterns in massive astronomical data sets and gain insights into the processes that drive accretion-powered nuclear activity from the earliest galaxies, now being detected by the JWST.

## Physical characterization of high-redshift galaxies in the era of Euclid and JWST

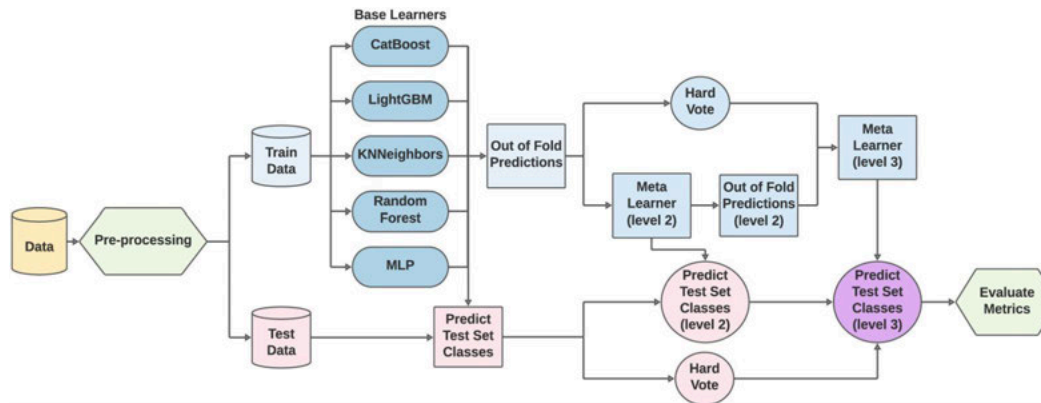
The advent of Euclid and JWST, and the availability of large multi-wavelength data sets for galaxies near and far have intensified activities by our team toward the physical characterization of high- $z$  galaxies.

### Galaxy characterization using Machine Learning algorithms

Several parallel efforts by our team have focused on the development of ML tools for the unambiguous identification of high- $z$  AGN (Sect. 1) and the automated characterization of galaxies on the basis of their spectral energy distribution (SED) and morphology.

Building upon ML techniques for the classification of astronomical sources in Humphrey et al. 2022 and Cunha & Humphrey 2022, Humphrey et al. (2023) have developed a novel ML-based pipeline (ARIADNE)

for the selection of quiescent (non-star-forming) galaxies from Euclid broadband imaging data in combination with multi-wavelength photometry from other large surveys (e.g. the Rubin LSST). ARIADNE combines meta-learning to fuse decision-tree ensembles, nearest-neighbors, and deep-learning methods into a single classifier that yields significantly higher accuracy than any of the individual learning methods separately, and offers a powerful new tool for galaxy characterization.



Flow chart illustrating the overall learning algorithm used for the ARIADNE galaxy classification pipeline (from Humphrey et al. 2023).

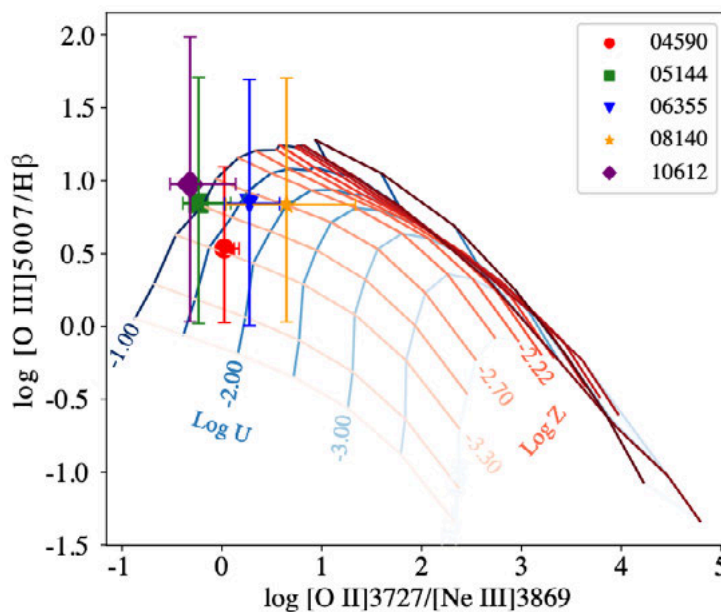
Another line of ML-supported research by the IA-Galaxies team centres on Lyman- $\alpha$ -emitting (LAE) galaxies. Paulino-Afonso, in the framework of the FLAEMING project that she initiated in 2022, has trained ML algorithms on multi-band galaxy surveys like COSMOS towards the identification of high- $z$  LAE candidates. This project turned out to be particularly successful, as it permits LAE classification with approximately 90% accuracy using only optical and near-infrared fluxes. An application of this model to the COSMOS field has permitted the prediction of the existence of  $\sim 3500$  new LAE candidates not detected by the SC4K survey, effectively doubling the existing sample of such sources. Two parallel projects, developed within MSc projects, used a) gradient-boosting algorithms trained from COSMOS2020 and SC4K to improve LAE identification, and b) Convolutional Neural Networks for the search of LAEs from broadband image data. These research activities strongly benefit from GPUs awarded to Paulino-Afonso through the NVIDIA Academic Hardware Grant Program.

In addition, it is worth noting the following spin-off projects inspired by the Group's research activities and consolidated expertise in ML: i) Paulino-Afonso is co-supervisor of an FCT-funded PhD thesis entitled "Precision Therapy using Cannabidiol and Terpenes in SARS-CoV-2" where the aim is to develop a ML/artificial intelligence model to support medicine strategies concerning therapeutic choice and follow-up; ii) Paulino-Afonso and Cunha submitted a successful application to the Artificial Intelligence in Cloud (2nd Edition) call with the title "AstroLingua: Empowering Inclusive Astronomy through AI" that was awarded a GPU-time-equivalent value of  $\sim 60$  k€; This project, having its main focus on automated image captioning of galaxy images in Portuguese, will start early in 2024; iii) B. Arsioli applied statistical methods and ML tools developed in the context of his research on high- $z$  blazars and AGN to a time-resolved morphological analysis of  $\gamma$ -ray emission from the Sun over the past 14 years. This led to the surprising discovery of an unexpected asymmetry in solar GeV emission with a surplus localised in the solar southern pole (Arsioli & Orlando 2023, submitted; further information is available here). This discovery has attracted considerable interest from the national and international astronomical

community, inter alia because the solar maximum in 2024 and the inversion of the Sun's magnetic poles will provide an important opportunity to study the evolution of the Sun's GeV asymmetry. It is worth noting that Arsioli's results have motivated a collaborative project between the extragalactic and stellar groups of IA.

### Gas excitation mechanisms in high-z galaxies

Brinchmann (2023) has carried out a critical examination of galaxies with available JWST NIRSpec data at  $1.2 < z < 8.5$ . He devised a modification of the direct abundance determination method that reduces the dependence of metallicity estimates on flux calibration uncertainties by a factor  $\sim 3$ . Two of the most important results from this study were that shocks provide a substantial contribution to the gas excitation in galaxies at  $z < 3$ . This study additionally demonstrated that studies of the mass-metallicity relation at higher  $z$  based on galaxy samples with detected auroral [OIII]4363 line emission can introduce serious biases, given that such galaxies form a special subclass of low-metallicity, high-excitation sources. This study has shown instead that Bayesian photoionization modelling of strong lines is preferable to using temperature-sensitive emission lines.



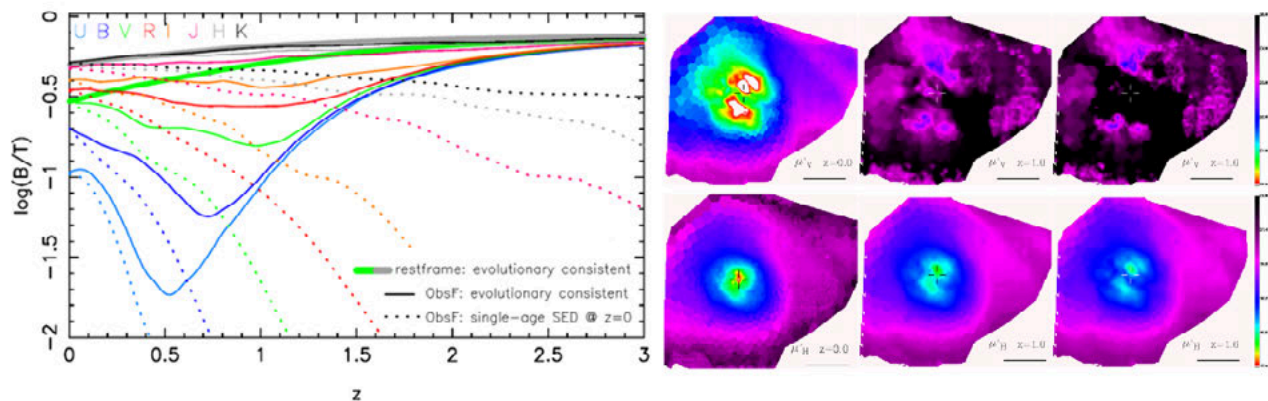
Comparison of the determined line ratios for the high- $z$  galaxies studied by Brinchmann (2023) with photoionization models from Gutkin et al. (2016). The grid (reddish) lines correspond to the ionisation parameter  $U$  (metallicity  $Z$ ).

### Morphology, structural properties and color gradients of high-redshift galaxies: the chromatic surface brightness modulation (CMOD) effect

Papaderos, Östlin & Breda (2023) have investigated the connection between rest-frame and observer's frame (ObsF) morphological and structural properties of high- $z$  galaxies using i) mock galaxy images computed with evolutionary synthesis models, and ii) a novel technique that predicts the rest-frame SED of galaxies in the UV on the basis of their spatially resolved star formation history (SFH), dust attenuation and nebular characteristics. The starting point of this project was that the shift of the rest-frame UV into the ObsF optical and near-infrared leads to a surface brightness enhancement (dimming) of the UV-bright (UV-faint) disk (bulge). This differential effect, dubbed chromatic surface brightness modulation (CMOD) by these researchers, results in a global change in the morphology, structural properties and



color patterns of high- $z$  galaxies. For example, one implication of it is that old (UV-faint) bulges at  $z \sim 1$  almost disappear in the optical ObsF, potentially leading to the erroneous conclusion that spiral galaxies in this cosmic epoch have been pure disks, and bulge formation begun only  $\sim 8$  Gyr ago. This misconception could then strongly bias our understanding of the co-evolution of bulges and SMBHs. This study also showed that “HST-dark” galaxies is a natural expectation from CMOD since even a low level of dust obscuration could lead to the virtual disappearance of the central part of a high- $z$  galaxy.



left: Logarithm of the bulge-to-total (B/T) luminosity ratio vs. redshift  $z$  in different filters, as obtained from structural decomposition of synthetic galaxy images that take into account CMOD effects. Thin solid and dotted curves show the predicted ObsF B/T ratio from models assuming, respectively, a time-evolving and time-invariant SED, and thick curves the true (rest-frame) value in the V and H filter (green and gray, respectively). It can be seen that the B/T ratio of a spiral galaxy is strongly underestimated at  $z \sim 1$ . right: Simulated V and H images (upper and lower panel, respectively) of the ultraluminous infrared galaxy Arp 220 at  $z=0$ , 1 and 1.6 (from left to right). The (achromatic) effect of cosmological dimming is not taken into account for the sake of better visualisation: the central part of the galaxy where dust obscuration is significant entirely evades detection in the optical at  $z > 1$  (from Papaderos, Östlin & Breda 2023).

In a subsequent study, Papaderos & Östlin (2023, A&A submitted) have studied CMOD effects for starburst galaxies, i.e., systems with very high SF surface density and strong nebular emission. This study showed that color maps of high- $z$  starburst galaxies are drastically affected by CMOD, in particular because of the luminosity contribution of strong emission lines moving in and out of filter transmission curves, depending on  $z$ . In the light of this study, the understanding and rectification of CMOD effects is a key prerequisite for fully unleashing the potential of JWST and Euclid for elucidating the starburst phenomenon and its role in the cosmic scenery.

### Fundamental scaling relations and the physical drivers of star formation quenching in galaxies

In preparation for the spectroscopic investigation of evolutionary and chemical properties of galaxies in the critical cosmic epoch around  $z \sim 1$  with the upcoming MOONS@VLT, the team has deepened its expertise in spectral modelling and studied in great detail fundamental scaling relations of galaxies in the low- $z$  universe. Miranda et al. (2023) applied the IA-developed spectral synthesis code FADO (Gomes & Papaderos 2017) to study the slope and scatter of the “star formation main sequence”, placing particular attention to the self-consistent treatment of nebular emission as a prerequisite for the accurate determination of the star formation history (SFH) and stellar mass of star-forming galaxies through spectral modelling.

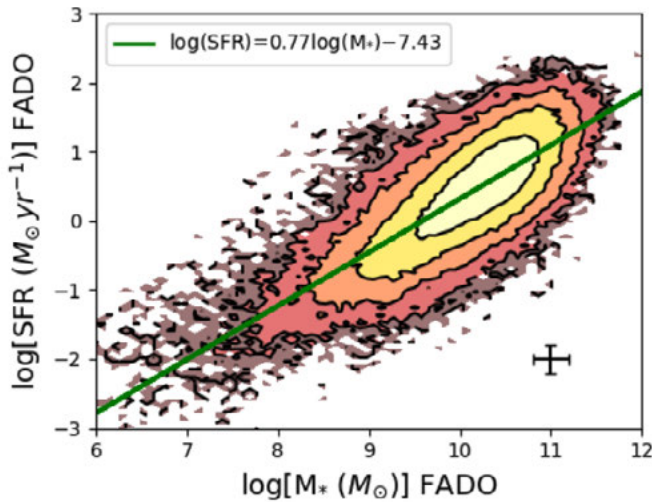


Figure: Star formation main sequence in the nearby universe ( $\langle z \rangle = 0.07$ ) as derived from spectral modelling of  $\sim 0.2$  million galaxies from SDSS with FADO. The cross at the bottom-right corner depicts a median error, and contours delineate areas encompassing 20, 40, 60, 80, and 100% of the sample. A linear fit (equation in the upper-left corner) is shown with the green line (from Miranda et al. 2023).

A parallel project (Santos et al. 2023, A&A, submitted) addressed the influence of the nebular continuum on emission-line diagnostics and proposed a new spectroscopic classification scheme involving the  $H\beta$  equivalent width vs. the  $[OIII]5007/H\beta$  ratio, i.e., diagnostics better suited for studies of high- $z$  galaxies where the  $H\alpha$  and  $[NII]6584$  line are inaccessible in the optical spectral range.

In addition, a slightly modified version of FADO in which a power-law component is self-consistently included in the spectral fit to approximate the featureless AGN continuum was tested on both synthetic and observed spectra of Seyfert 2 galaxies. A series of extensive tests has shown that this concept permits adequate first-order estimates of the spectral index of the AGN and its monochromatic luminosity contribution at  $4020 \text{ \AA}$  (Chougule, PhD thesis, in prep.).

Finally, in anticipation of studies with MOONS of the physical mechanisms behind the gradual cessation (“quenching”) of star formation (SF) activity since  $z \sim 1$ , Breda & Papaderos (2023) investigated the dependence of the SF quenching timescale ( $\tau$ ) on the stellar surface density and galactocentric radius of galaxies. Observational constraints in this respect are crucial for disentangling rapid ( $< 0.5$  Gyr) SF shut-off caused by negative AGN feedback from a gentle SF decline over several Gyr that likely reflects a gradual consumption of the available gas reservoir.

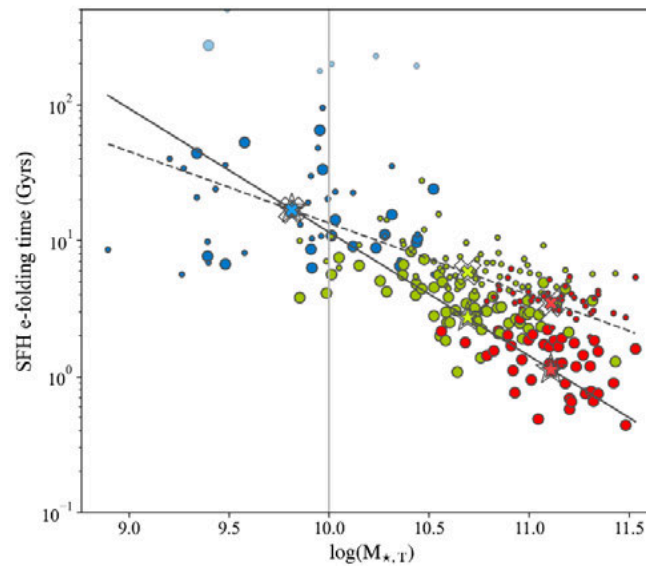


Fig. 7: e-folding time  $\tau$  (Gyr) quantifying the duration of SF quenching in the bulge and disk component (large and small dots, respectively) of local spiral galaxies vs. logarithm of their present-day stellar mass  $M_*$ . Linear relations for both components are over-plotted (solid and dashed line, respectively). It can be appreciated from this diagram that the SF quenching timescale of galaxies is inversely related to  $M_*$  (from Breda & Papaderos 2023).

Finally, in anticipation of studies with MOONS of the physical mechanisms behind the gradual cessation (“quenching”) of star formation (SF) activity since  $z \sim 1$ , Breda & Papaderos (2023) investigated the dependence of the SF quenching timescale ( $\tau$ ) on the stellar surface density and galactocentric radius of galaxies. Observational constraints in this respect are crucial for disentangling rapid ( $< 0.5$  Gyr) SF



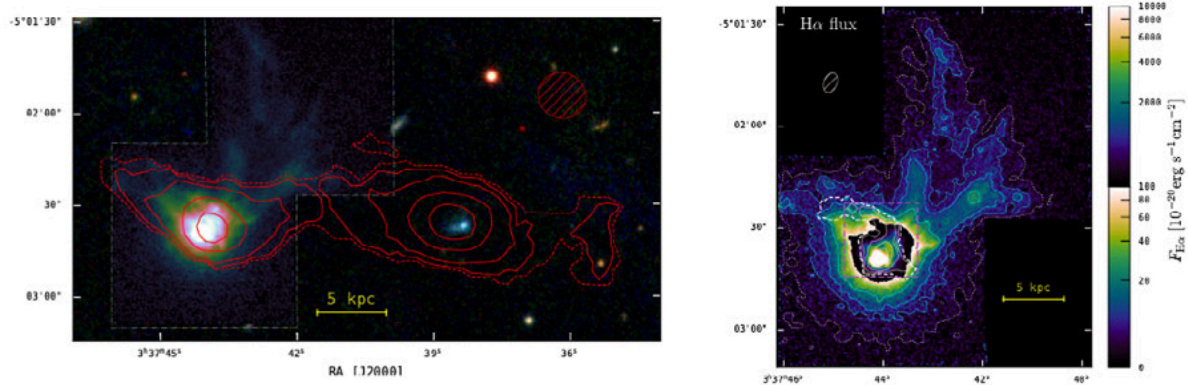
shut-off caused by negative AGN feedback from a gentle SF decline over several Gyr that likely reflects a gradual consumption of the available gas reservoir. This work, based on spectral modelling of nearly one million individual spaxels in 135 local galaxies from the CALIFA IFS survey, has allowed for the first time to define a semi-empirical parameterization of  $\tau$  for both the bulge and the disk component of galaxies as a function of their total stellar mass.

### **Starburst activity and starburst-driven galactic outflows**

Starburst activity, prevalent at high redshift, is a fundamental driver of the stellar mass growth and chemical enrichment of galaxies and likely the main driver of the escape of ionizing Lyman continuum (LyC) radiation that led to the reionization of the Universe. Hence, understanding the spatial and temporal progression of this phenomenon and its role in galaxy evolution is of utmost importance.

Starburst-driven galactic outflows are believed to play a critical role in the evolution of galaxies by regulating their mass build-up and star formation history. Theoretical models assume bipolar shapes for the outflows that extend well into the circumgalactic medium, up to tens of kiloparsecs (kpc) perpendicular to the galaxies. They have been directly observed in several local galaxies, however remained elusive in the high- $z$  Universe. Recently, Guo ... Brinchmann et al. (2023, Nature) detected for the first time extended Mg II emission surrounding a sample of galaxies at  $z \approx 1$  through ultra-deep IFS observations with MUSE@VLT. This discovery strongly suggests the presence of galactic winds reaching out to more than 10 kpc. Quite importantly, it revealed a strong dependence of the detected winds on galaxy orientation, with edge-on galaxies clearly showing enhanced Mg II emission along the minor axis, whereas face-on galaxies show much weaker and more isotropic emission. This is an important observational proof that bipolar gas outflows develop perpendicular to galactic disks and are prevalent among young galaxies with very active star formation in the early Universe.

Low-mass starburst galaxies in the nearby Universe (see recent review by the team member P. Lagos in National Geographic Portugal) offer the possibility to study such galactic outflows at a much better spatial resolution than possible at high redshift. One such example is the extremely metal-poor blue compact dwarf (BCD) galaxy SBS 0335-052E in which very deep MUSE@VLT observations allowed the detection of a spectacular 15 kpc outflow by Herenz ... Papaderos et al. (2023). A combined interpretation of IFS data with HI interferometric data from the VLA suggests that LyC radiation produced by massive young stellar clusters in this BCD is escaping anisotropically. Anisotropic LyC photon escape, if common at high  $z$ , may have major implications for our understanding of the role of low-mass starburst galaxies on the reionization of the Universe.



left: HI VLA map of SBS 0335-052E and its faint western companion (from Herenz ... Papaderos et al. 2023). right: Continuum-subtracted H $\alpha$  narrowband image of SBS 0335-052E revealing a spectacular starburst-driven outflow protruding out to 15 kpc from the galaxy.

Within the CLASSY project, a series of detailed studies dedicated to the mechanisms that facilitate the escape of LyC and Ly $\alpha$  radiation from starburst galaxies were carried out. In particular, Hu ... Brinchmann et al. (2023) found an inverse relation between Ly $\alpha$ -peak separation and the [OIII]/[OII] flux ratio, confirming that the covering fraction of LyC-thin sightlines increases as the Ly $\alpha$  peak separation decreases. This study has also devised a new diagnostic for LyC-leaking galaxies that combines the Ly $\alpha$  peak separation and the Ly $\alpha$  red-peak asymmetry. These studies were supplemented by the search for extreme emission-line galaxies at high  $z$  as probable sources of Lyman photon escape. Maseda ... Brinchmann et al. (2023) have detected with MUSE and JWST/NIRSpec a population of low-mass galaxies ( $MUV \approx -15$ ;  $0.01 L_{\odot}$ ) at  $2.9 < z < 6.7$  with very strong Ly $\alpha$  emission and no detectable continuum. The Ly $\alpha$  equivalent widths (EWs) of these LAEs can exceed 100–200 Å, implying strong starburst activity and a very low level of metal enrichment.

Further studies of galaxies with intense SF were dedicated to the cometary BCD NGC 4861 (Roche ... Papaderos et al. 2023), jellyfish galaxies (Azevedo ... Gomes et al. 2023), and the extremely metal-deficient BCD CGCG007-025. SF feedback and its connection with nebular kinematics were studied in this system by Valle-Espinosa ... Papaderos (2023) with MUSE and involved kinematical decomposition of strong emission lines. This analysis revealed complex kinematics in the ionized gas and the presence of a highly turbulent medium with a velocity dispersion of up to 1000 km/s, witnessing the release of energy and momentum by stellar winds and SNe. It also documented a spatial anti-correlation between SF surface density and gas-phase metallicity, which is consistent with accretion of metal-poor gas from the cosmic web as a possible triggering mechanism for the ongoing starburst episode. Further insights into the nebular properties of CGCG 007-025 were gained in Fernández ... Papaderos (2023). This study used deep optical spectra with the 10.4m GTC, in conjunction with FADO and a novel neural network sampler to explore the SFH and derive spatially resolved maps of the metallicity and the ionisation parameter.

Finally, the team's recent studies on star-forming dwarf galaxies include a new catalogue of relatively isolated metal-rich blue dwarf galaxies from SDSS that addresses the environmental properties of the sample galaxies and their position on the mass-metallicity relation (Guo ... Scott, Lagos et al. 2023a). This study suggests that the chemical self-enrichment of these systems is internally driven by episodic mild episodes of SF rather than external interactions. Further support for this conclusion came from an

in-depth optical and HI study of one isolated near-solar metallicity dwarf galaxy from this sample (Guo ... Scott, Lagos et al. 2023b) which ruled out the hypothesis that this system is a tidal dwarf galaxy.

### **The least massive dwarf galaxies as laboratories of galaxy formation**

Vaz, Brinchmann et al. (2023) have studied with MUSE Leo T ( $M_V = -8.0$  mag), a peculiar dwarf galaxy that stands out for being both the faintest and the least massive galaxy known to contain neutral gas and to display signs of recent SF. It is also extremely dark matter-dominated. As a result, Leo T presents an invaluable opportunity to study the processes of gas and star formation at the limit where galaxies are found to have rejuvenating episodes of SF.

A surprising result from this study was that the galaxy consists of two stellar populations, a young ( $<500$  Myr) and old (5-10 Gyr) stellar component, with the latter characterised by a factor of  $\sim 4$  higher velocity dispersion. This observational insight holds important clues to the star formation history and dynamical evolution of the least massive galaxies in the local universe.

Júlio, Brinchmann et al. (2023) have studied with MUSE stellar line-of-sight velocities in the faint dwarf galaxy Antlia B with the aim to derive constraints on the fundamental properties of scalar field dark matter (SFDM), which was originally proposed to solve the small-scale problems faced by cold dark matter models. Based on measurements of 127 individual stars with MUSE, they modelled the dark matter density profile of the galaxy and found that the scale for repulsive self-interaction of the SFDM model is  $\lesssim 180$  pc, which is inconsistent with the value required to match observations of dwarf galaxies in the Local Group. This implies that the central cores in the dark matter profile of these systems are not caused by SFDM.

### **Group meetings, Journal Clubs and other activities**

In 2023, the team significantly increased its productivity, further strengthened internal synergies, and established new collaborations. Throughout this year the team maintained a busy schedule of weekly briefings to discuss its scientific work. In addition, regular weekly journal clubs continued, where the latest scientific results, mostly non-IA, were discussed. In addition, the team organized two internal workshops (in Porto and Coimbra, respectively, in June and September) to discuss current research and key objectives for the coming years.

The dynamism of the team is also reflected in the continuous development and intensive scientific exploitation of machine learning tools that will strongly support its scientific activities within Euclid, JWST, MOONS@VLT, MOSAIC@ELT and BlueMUSE@VLT, as well as in the co-organization of the conferences “Escape of Lyman radiation from galactic labyrinths” (Crete, April 2023), and the upcoming “Science with the Hubble and James Webb Space Telescopes VII: Stars, Gas & Dust in the Universe” and “Beyond the Edge of the Universe: Latest results from the deepest astronomical surveys” (to be held in Porto and Sintra, respectively, in spring and autumn 2024).

Polychronis Papaderos

Group Leader

## Report from the Group

### Unveiling the dynamics of the Universe

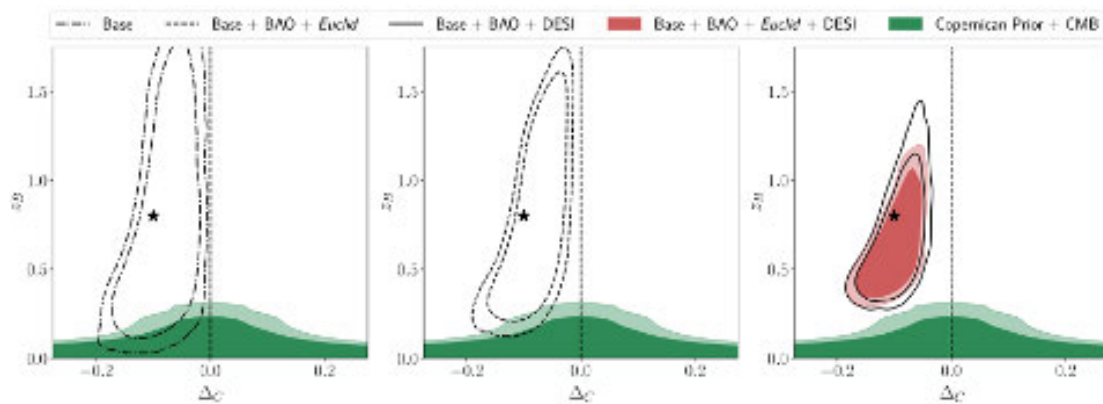
The activity of the cosmology group was focused on testing the validity of the current standard cosmological model, looking to answer the question: Do we need new physics to understand the Universe? Specifically, does Einstein's general relativity accurately describe gravitation? Is a cosmological constant the correct explanation for the currently observed accelerated expansion of the Universe? Is the Standard Model of particle physics all we need to adequately describe the early Universe? We do this by exploring tests to Einstein's general relativity, delving into the detailed structure of the dark sector and investigating observational signatures of topological defects networks. Our contributions involve our continuing participation in various international consortia. ESA's Euclid mission (in operation), LISA (2035 launch), ESO's ESPRESSO (in operation) and ANDES (2028). This year the team centred its activities on:

1. Euclid is a mission dedicated to the exploration of the dark universe through the measurement of the properties of the cosmological large-scale structure. IA is strongly involved in this mission, participating in the consortium board, in various Science Working Groups and in the Survey Design. Our participation in the consortium last year was focused on producing Euclid forecasts. Our team was involved in testing the Copernican principle, the use of higher order weak lensing statistics and constraints on modified gravity models.
2. Putting the present standard cosmological constant model to the test is one of the strongest objectives of our group. Towards this goal, we explored extensions to Einstein's general relativity and their observational signatures and worked on observational signatures of dynamical dark energy models with couplings to the dark matter, or to neutrinos. Most of this work is aligned with the goals of the BEYLA FCT project.
3. The first detection of gravitational waves in 2015 opened a new era for astronomical observations. Several of our members have dedicated their time to studying the stochastic gravitational wave background that can be generated from topological defects, namely cosmic strings and domain wall networks. This background can possibly be detected by the LISA space telescope and building a database of cosmic string signals is crucial towards this goal.
4. The observational measurement of the fine structure constant at different redshifts presents a direct form of testing the validity of its constancy. This is something that the ESPRESSO spectrograph is particularly suited to doing and will be significantly improved with ANDES. With ANDES there is also the possibility of a direct measurement of the expansion rate of the Universe from observing the redshift drift. Several of our members have been directly involved in exploring these possibilities.

## Scientific highlights for 2023

### Euclid: Testing the Copernican principle with next-generation surveys

The Copernican principle, the notion that we are not at a special location in the Universe, is one of the cornerstones of modern cosmology. Its violation would invalidate the Friedmann-Lemaître-Robertson-Walker metric, causing a major change in our understanding of the Universe. In the publication “Euclid: Testing the Copernican principle with next-generation surveys”, Camarena et al. (2023, A&A 671, A68) constraints on an inhomogeneous Lemaître-Tolman-Bondi model with a cosmological constant were forecast for combinations of present data with simulated Euclid data. It was shown that for a  $\Lambda$ CDM fiducial model Euclid data will improve present constraints by around 30%, with some variation dependent on the observables and scales considered.



A comparison between present and mock datasets constraints on the two parameters  $z_B$  and  $\Delta_C$  that classify the profile of the inhomogeneity in a specific ALTB model. The star depicts the fiducial model at  $\Delta_C = -0.1$  and  $z_B = 0.8$ .

### Fundamental cosmology from ANDES precision spectroscopy

Fundamental cosmology observations, such as the detection of the redshift drift and tests of the universality of physical laws, are key science and design drivers of the Armazones high Dispersion Echelle Spectrograph (ANDES), an Extremely Large Telescope instrument.

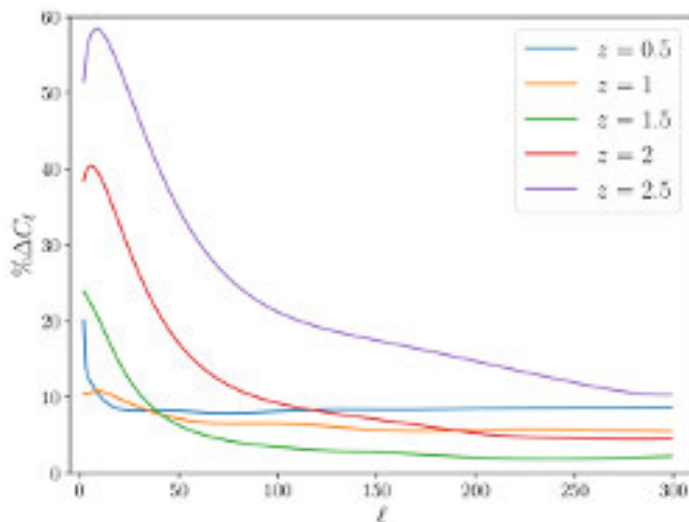
In the work “Fundamental cosmology from ANDES precision spectroscopy”, Marques et al., (2023, MNRAS, 522, 4, 5937), Fisher matrix forecast tools combining both observables were developed. This demonstrates a possible synergy between the two ANDES datasets, quantifying the improvements in the constraints and working towards optimizing ANDES observation strategy.

### Cosmology with the Laser Interferometer Space Antenna

The Laser Interferometer Space Antenna (LISA) has two primary cosmological goals: to probe the expansion rate of the universe and to understand stochastic gravitational-wave backgrounds and their implication to our knowledge of the early universe and its relation to particle physics. This white paper publication from the Cosmology working group in LISA, Auclair et al., Living Reviews in Rel. (2023) 26, 1, 5 presents a summary of the state of the art in LISA cosmology. Our group was particularly involved in the work on the topological defects background and on the use of standard sirens to probe the dark sector.

## The observed number counts in luminosity distance

Next generation surveys will give us unprecedented detections of supernovae Type Ia and gravitational wave merger events. Cross-correlations of such objects offer novel and powerful insights into the large-scale distribution of matter in the universe. Both sources carry information on their luminosity distance but remain uninformative about their redshifts; hence their clustering analyses and cross-correlations must be done in luminosity distance space, as opposed to redshift space. In the paper “The observed number counts in luminosity distance”, Fonseca et al. (2023, JCAP 08, 050), the full expression for the number count fluctuation in terms of a perturbation to the observed luminosity distance was calculated. The expression was found to differ significantly from the one commonly used in redshift space. Furthermore, a comparison of the number count angular power spectra between luminosity distance and redshift spaces was presented. We see a wide divergence between the two at large scales, and lensing seems to be the main contribution to such differences. On such scales and at higher redshifts the difference between the angular power spectra in luminosity distance and redshift spaces can be roughly 50%. The conclusion is that in a cosmic variance limited survey, the relativistic corrections to the density-only term ought to be included.



Percentage difference between the angular power spectrum in luminosity distance space and redshift space for a  $\sigma = 0.2$  binning. At high redshift lower  $l$  can differ substantially. Smaller scales with higher values of  $l$  exhibit a milder effect. This difference is also impacted by the binning used, improving for smaller bin size.

## Group meetings, Journal Clubs and other activities

The group has regular weekly journal club meetings, our “Cosmoclub”. These are in person in both nodes with an online zoom connection. Every week we have a general discussion, and a different team member brings one paper (or more) for discussion. Details can be found in <http://ia-cosmoclub.wikidot.com/>.

We participated in the international Cosmoverse meeting that took place at FCUL in Lisbon, on 30 May to 1 June 2023. This was a meeting within the framework of the Cosmoverse e-COST action from the EU.

The cosmology group also organised COSMONATA, the annual meeting in late December bringing together Portuguese researchers working abroad with researchers in Portugal.

Team members were also actively engaged throughout 2022 in several outreach activities, including talks given in schools. Most of these activities are developed with the Science Communication Team.

Tiago Barreiro

Group Leader



## Report from the Group

# Astronomical Instrumentation and Systems

The year 2023 was a very intense period for the group, with some projects reaching their final stages and others beginning the detailed design phases, which usually involve additional effort and dedication.

As seen in this report, there was significant progress during this year, achieving some important milestones in several projects and starting promising future ones.

During 2023, the following instruments had engineering and implementation activities at IA:

- For the European Southern Observatory (ESO): MOONS, ANDES, BlueMUSE and PoET.
- For the European Space Agency (ESA): EUCLID, CHEOPS, PLATO, ARIEL and ATHENA.

Currently the AISG participates in a considerable number of projects, involving all its human resources. This includes not only the technical design of the instruments themselves but also the respective science exploration of the collected data through big collaboration projects such as consortiums and surveys. Its importance stems from the need to secure privileged access to existing and future facilities of the European Organization for Astronomical Research in the Southern Hemisphere (ESO) and of the European Space Agency (ESA) and to contribute to the long-term development of Astronomy in Portugal.

In terms of Human Resources, the group currently has a handicap on the Mechanical Engineering side, a problem to be solved in the start of 2024 with the opening of a technical position in this area. On the software side, a new member has reinforced the team.

The current composition of the AISG is:

### Researchers (PhDs)

- Alexandre Cabral
- Bachar Wehbe
- David Alves
- Elena Duarte
- João Dinis
- João Coelho
- Jorge Gameiro
- José M. Rebordão
- Manuel Abreu
- Sérgio A. G. Sousa \*
- Nuno Peixinho \*

### Others

- António Joaquim Marques de Oliveira
- Manuel Monteiro

### PhD Students

- André Miguel Silva \* (PhD student since 01/10/2019)
- Cédric Pereira (PhD student since 01/10/2019)
- Inês Leite (PhD student since 01/10/2021)
- Nuno Gonçalves (PhD student since 01/10/2021)
- Joel Filho \* (PhD student since 01/09/2022)

*Researchers that work in more than one group are marked with (\*).*

In terms of new themes of research, somehow supported by background expertise in Astronomy Instruments / Space missions and consolidated by the work PhD students supervised by AISG researchers, the team is exploring:

- a) Stabilisation of calibration light sources for High Accuracy Photometry Instruments resulting from research and develop a device that senses the light source fluctuations and modulates the beam, both in flux and in spectra, to produce a sufficiently stable source, a truly impressive challenge when stabilisation levels of few ppm are required over long periods of observation.
- b) Discovery and characterization of temperate Earth-like worlds with ESPRESSO, with a main goal to improve the radial velocity extraction from the ESPRESSO science data. This is a module to be attached to the Data reduction pipeline of ESPRESSO. This thesis is more focused on the analysis of M stars which are trickier to get precise and stable radial velocities for the detection of exoplanets, but at the same time are the more promising targets to find earth-like in the habitable zone.
- c) Development of a solar telescope that will allow the detailed study of the Sun (using it as a proxy to understand the sources of noise that affect the observations of other stars). For that, it is fundamental to be able to obtain disk-resolved, HR spectra, opening a whole new path for the detection and characterization of Earth-like planets orbiting other Suns.
- d) Development of miniaturised Cross dispersed echelle spectrographs operating in the VIS and UV with the Size Weight and Power (SWaP) requirements for a SmallSat solution and the required spectral resolution to allow the study of this less explored spectral range.
- e) Study of space debris detection algorithms in a standalone platform, with the goal to implement and test a star tracker that can be used for space debris detection. The methodological approach consists of selecting the most appropriate debris detection algorithms, adding automatic photometry measurements, developing a standalone platform, implementing the algorithms in the platform, selecting the low-cost materials capable of withstanding the harsh space environment, and optimizing the algorithms to work in different scenarios.

In the following we list the detailed activity in each of the running projects.

## Summary of instrumentation projects

### **MOONS (ESO)**

The Multi-Object Optical and Near-infrared Spectrograph (MOONS) is a future third-generation instrument for the Very Large Telescope (VLT) to have first light by 2023. It matches an enormous multiplexing capability, reaching up to 1000 positions being spectroscopically observed at the same time over a single telescope pointing, to the grasp of the 8.2m VLT, making it a unique instrument for deep galaxy surveys.

The subsystems under IA responsibility are the MOONS Rotating Front End (RFE) and the Field Corrector (1 m diameter set of two lenses).

In 2023, after the RFE was delivered to UKATC in Scotland in the end of 2022, the IA team did 4 missions in UKATC to integrate all the sub-systems that the RFE will support and to perform all the performance tests. All the 4 mission were very successful, ending in November with the integration of the Focal Plate Module, the critical core of the front end with its 1000 robot fibre positioners (under the responsibility of UKATC) into the RFE structure.

The first semester of 2024 will see the conclusion of the MOONS integrations and tests towards the Preliminary Acceptance in Europe, before the shipping to Paranal in the second semester.

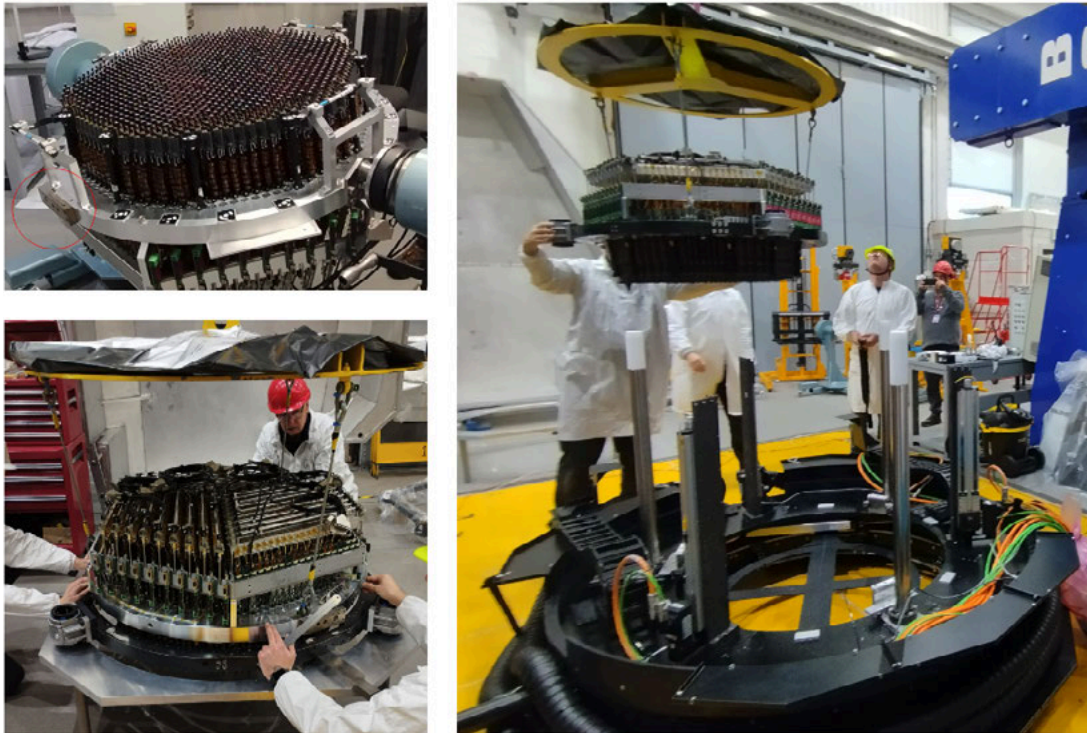


Figure: The MOONS (ESO) RFE during the integration for the Focal Plane Module.

## ANDES (ESO)

ANDES, formerly known as HIRES, is the project for a high resolution spectrograph to be installed at the ESO E-ELT telescope. The concept of ANDES is being developed by a consortium that comprises several institutes in different European countries, as well as USA, Canada, Brazil and Chile. The Portuguese participation in this consortium is done through IA that is leading the “front end” work package component of the instrument, the data reduction and analysis software, the software system architecture, and the science drivers for the project. The group also participates in the management of the consortium, having several key persons.

2023 was a very busy successful year for ANDES. The team participated in the preparation of all the documentation package that was sent to ESO regarding the System Architecture Review (SAR). The review was held in ESO's headquarters in Germany on October 17-18, 2023, with the participation of the IA instrumentation team.

On November 15, 2023, ANDES received the certificate of provisional acceptance (PVA) of the SAR, which officially closes the Phase B1 contract with ESO. ESO has granted the PVA without reservation and offered the consortium one night of Guaranteed Time Observation (GTO) on one of the instruments at the ELT telescope in return for the consortium's contribution to the System Architecture Review.

Another milestone, with high importance for the FE, was achieved. The team submitted a change request to ESO to change the architecture of the FE structure. Since we will no longer need the possibility to observe two targets simultaneously, that led to huge simplification to the FE. We no

longer need the rotating structure, and we will now adapt the fixed structure architecture. The change request was recently approved by ESO.

On top of these two milestones, the FE team organised and participated in several working meetings (in Italy, and in Portugal). The team is also preparing the documentation package for the subsystems preliminary design review that will be held in October 2024.

### **PoET (ESO)**

The detection and characterisation of other Earths, planets with the physical conditions to hold liquid water and thus potential life-sustaining environments, is a bold objective of present-day astrophysics. This quest is however severely challenged by astrophysical “noise” from the host stars. To approach this problem, we started in 2022 a new project to build a dedicated facility, the Paranal solar Espresso Telescope (PoET). This telescope will be linked to the ESPRESSO spectrograph (ESO) and allow simultaneous acquisition of disk-integrated (sun-as-a-star) and arcsecond level disk-resolved observations of the Sun at a spectral resolution  $R \sim 200000$ . The project is funded by the European Union (ERC, FIERCE, 101052347). And it is a Portuguese project.

During 2023, the project had its first full year of work, ending with the delivery of the “PoET Design and Interface Report” that will be reviewed by ESO in the beginning of 2024, followed by the final design and construction phase.

### **BlueMUSE (ESO)**

IA has been invited to participate in the ESO-BLueMUSE instrument, which is a blue-optimised, medium spectral resolution, panoramic integral field spectrograph based on the MUSE instrument, proposed for the Very Large Telescope (installed at Nasmyth platform level). Phase A of this project is scheduled for the beginning of 2024, but preparatory works already took place during 2023.

With an optimised transmission down to 350 nm, BlueMUSE builds upon the heritage of MUSE but includes both obvious and novel improvements (e.g., improved stability with better temperature control and automated alignment processes). Along with all the core subsystems supporting the increased performance of BlueMUSE, the instrument shall be managed at hardware and software level according to the new standards currently in use at the VLT.

The Instrumentation team of IA will be responsible for the Instrument Control Electronics and for the Instrument Control Software of the full instrument.

### **Euclid (ESA)**

Euclid is ESA's mission dedicated to the exploration of the dark universe through the measurement of the properties of the cosmological large-scale structure. IA is strongly involved in this mission, participating in the consortium board, in the consortium coordination group, in various science working groups, and leading the Survey operations support team.

In 2023, IA's Instrumentation and Systems Group continued its long-standing participation in the preparation of the Survey Design, focusing on the development of the ECTile software. This software computes the mission's Reference Survey, i.e., it produces schedules of the Euclid Deep and Wide



surveys, including implementation of all calibrations, that are compliant with all constraints and requirements. The IA-computed reference survey is the basis of the operational survey to be executed by the Euclid satellite during the nominal science observations phase (NSOP).

During the first half of the year, we further consolidated ECTile as an operational tool. This included the incorporation of precise on-target times specified in the observation configuration files, the usage of proper motion of blinding stars when tessellating the sky, updating to new calibration specifications, implementation of a refined region-of-interest, new computation of the Euclid common FoV. In addition a new tool was developed to schedule some of the observations of the performance verification phase (PV). These activities led to the generation of two surveys RSD2023A and B. A workshop on ECTile usage and RSD generation was organized in FCUL (May 2023) to Euclid consortium and ESA users.

On July 1st, Euclid was successfully launched. The launch was followed by commissioning, then the PV phase and finally the Wave Front Error campaign (WFE), prior to the NSOP scheduled to start on February 2024. Measurements in these early observing phases led to changes in some of the operational specifications. In particular, the telescope orientation was strongly restricted which invalidated the usage of RSD2023A and B in the NSOP. The second half of the year was dedicated to modifying ECTile to cope with the new unforeseen requirements. This included adding the capability of placing tilted FoVs and adapting the algorithms to cope with them. In addition, ECTile was adapted to consider a specific orbit file in its computations. A test survey, RSD2023C, was generated with the modified ECTile. The final month of the year was dedicated to the computation of RSD2024A, the first RSD version to be used for NSOP.

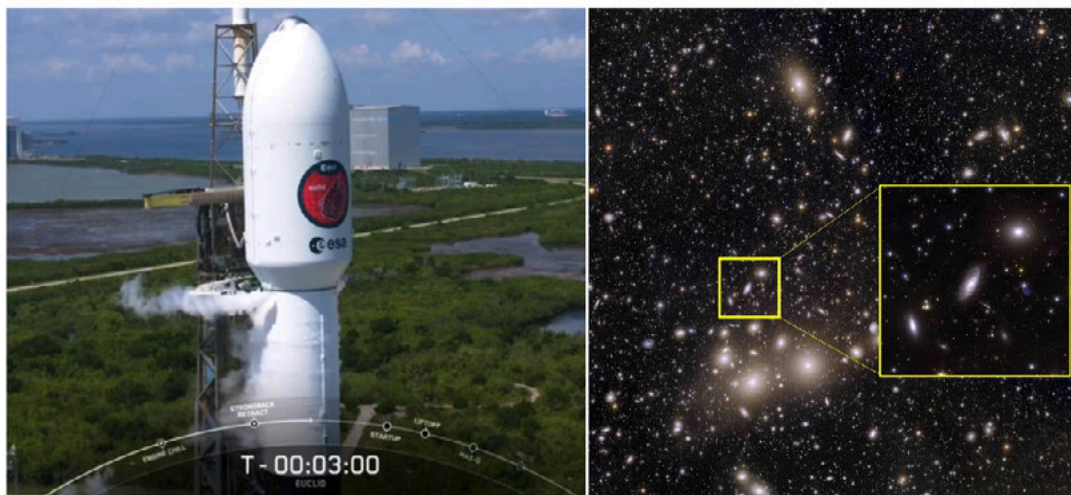


Figure: (Left) (Launch: July 1st 2023, Euclid launch countdown. The nose cone enclosing the Euclid spacecraft sits on top of the Falcon 9 rocket on platform 40 of the Kennedy Space Center, 3 seconds to launch. (Right) Perseus: The first Euclid science images were released on November 7th 2023. This image of the Perseus Cluster shows 1000 galaxies belonging to the cluster, and more than 100 000 additional galaxies further away in the background. The full cluster is contained in the Euclid wide field-of-view, and the whole area is imaged with high resolution as shown in the cut-out. This image showcases the power of Euclid: to obtain extremely sharp images of the distant Universe over a large region of the sky in one single pointing.

## **CHEOPS (ESA)**

The Characterising Exoplanet Satellite (CHEOPS) is the first mission dedicated to search for transits of exoplanets by means of ultrahigh precision photometry on bright stars already known to host planets. It will provide the unique capability of determining accurate radii for a subset of those planets for which the mass has already been estimated from ground-based spectroscopic surveys. CHEOPS will also provide prime targets for future instruments suited to the spectroscopic characterization of exoplanetary atmospheres. IA is strongly contributing for this mission participating both in the board and the core science team of the mission. This work is also closely related with the science data archive which is being developed by our industry partners (DEIMOS), contributing to the development of stronger relations with the Portuguese industry in the area of scientific related software.

Moreover there is a contribution for the mission science operation centre, more specifically for the CHEOPS data reduction pipeline where we were responsible for the calibration of the pipeline until the end of the nominal mission.

In 2023, CHEOPS continued to run well within specifications and continues to get scientific observations of high precision. IA continued to give maintenance support to the data reduction pipeline during the CHEOPS nominal mission until September 2023. With the end of the nominal mission and the start of the extension of the mission we took the responsibility for the maintenance of the full data reduction software where we will need to deal with the ageing of the instrument. During this year we also signed the contract for the funding of this task through Prodex. The proposal will allow hiring a dedicated person to this task for which a call was already issued in December 2023. It is expected that the hired person will start working on this in the beginning of the next year.

## **PLATO (ESA)**

The PLATO mission, whose main scientific focus is the detection and characterization of extra-solar planets orbiting nearby, bright stars, using the transit method, as well as the detailed characterization of their host stars through asteroseismology, was adopted by ESA in June 2017. The instrumentation team has leadership of several work packages for the development of software for the Plato Data Center (PDC) as well as in the development of the Optical Ground Segment (OGSE) component to test and calibrate the PLATO cameras on ground.

Regarding the activity for the OGSE work package, two units were already delivered and commissioned to the Centre Spatiale de Liège (CSL), and during the year of 2023, the team has as main activity the support and maintenance of the two units that are now fully integrated in the PLATO cameras integration and testing work path. In this scope, the IA team assured remote assistance and support to the CSL team, analysing log data generated by housekeeping processes running in our unit. During the past year, the main problem encountered was associated with a broken optical fibre which was promptly replaced by a spare item.

As referred to in the previous report, ESA contracted us to produce a 3rd unit of the collimator, which was adapted to different light sources, and whose objective was to provide ESA with extra camera testing capability, reinforcing the different test houses resources.

This collimator was commissioned in August 2023 and successfully tested with a PLATO EM camera.

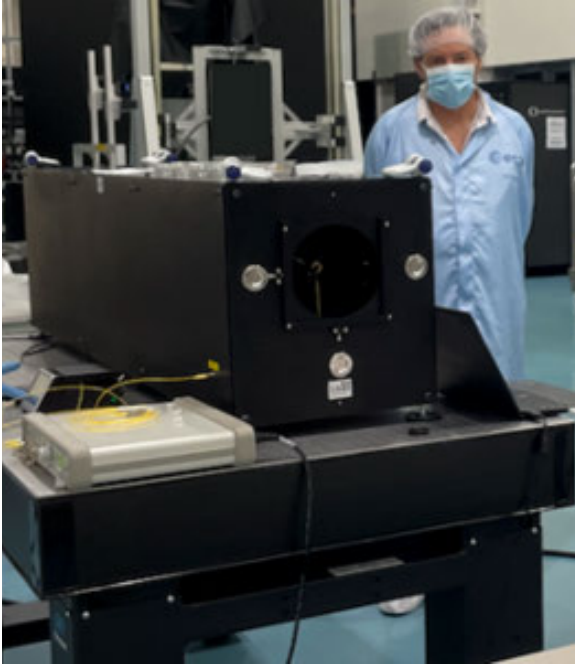


Figure: Plato OGSE in test before installation at ESA.

## **ARIEL (ESA)**

ARIEL (Atmospheric Remote-sensing Exoplanet Large-survey) was one of the three candidate missions selected by the European Space Agency (ESA) for its next medium-class science mission due for launch in 2028. The goal of the ARIEL mission is to investigate the atmospheres of several hundred planets orbiting distant stars in order to address the fundamental questions on how planetary systems form and evolve.

The main activities Instrumentation group in ARIEL, and together with the OGSE team led by Oxford University, were associated to the design of part of OGSE system, associated to the illumination module and reference detector subsystem working in the Visible /Near Infrared part of the spectrum. The reference detector function is to monitor the light source fluctuations and to provide source stability data required to detrend the results from the ARIEL instruments during calibration and verification procedure.

The work performed during the period of this activity reporting refers to all the tasks regarding the preparation of the CDR, which should have happened during 2023 but, for reasons external to the OGSE team, is being scheduled for the end of the 1st semester of 2024.

During this last year the OGSE team adapted the previous design to current OGSE configuration, namely with the substitution of the “target projector unit” with the “periscope unit”. This is the subsystem that interfaces the OGSE with the Ariel M1 mirror.

A considerable effort was also focused on the interface of the ambient optical bench (where all the illumination sources sit) with the Integrating Sphere (vacuum and cryo conditions), mainly due to the need to cope with significant thermoelastic deformations arising during the cool-down process.

In terms of the development of hardware, the PCB circuits for the reference detectors pre-amplifiers were designed and tested in real operating conditions (vacuum and 70 K temperature ambient) to be



able to evaluate its noise characteristics. The best amplifier / reference detector pair was chosen based on its performance in these working conditions.

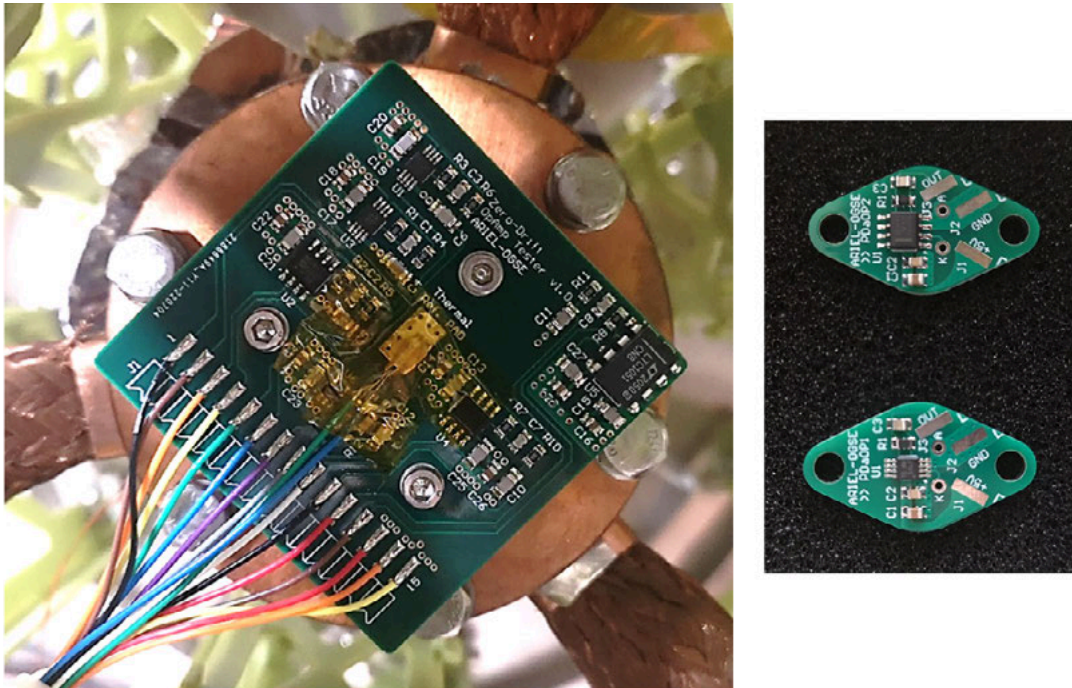


Figure: Electronic circuits for reference detector and pre-amplifier testing at cryo conditions (70K).

## ATHENA (ESA)

The group of Instrumentation of IA is leading the international consortium for the development of the Athena mission on-board metrology system, in the sequence of the approval of activity proposal to the ESA tender, which had the kick-off in June 2020.

The function of the system being developed by the IA team is measuring the exact pointing of the Athena mirror during the process of switching focus between the X-IFU and WFI Athena instruments. The level of accuracy required for this task is at the level of a fraction of an arcsecond.

Most of the work done during 2023 was related to the development of the optical test setup in our labs. This testbed will be used to verify all the metrological and operational requirements defined for the EM version of the On-board Metrology system developed by our group.

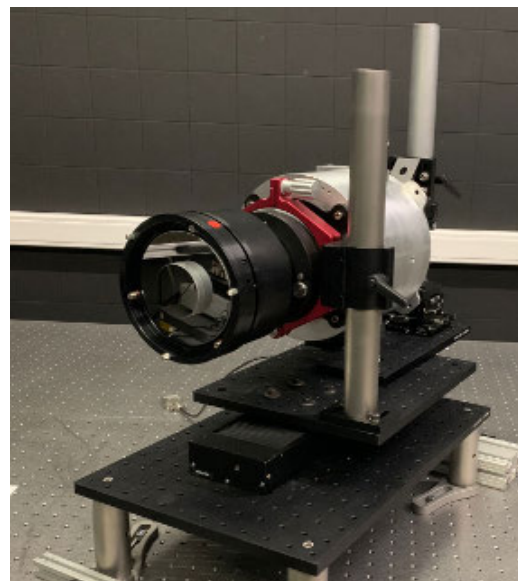


Figure: OBM camera being prepared for verification testing

At the moment of writing, the OBM hardware and camera are being integrated for the testing phase. The consortium led by IA has already partially achieved the TRR milestone (test readiness review),

which assures the group readiness for the initiation of the verification and compliance testing. Full readiness is however being delayed by some problems associated to the image sensor operation, which are being actively pursued and debugged by the team with the support of the sensor manufacturer (Teledyne).

## Highlights for 2023

- In November 2023, the integration of the MOONS Focal Plane Unit with its 1000 fibre positioner robots, developed by UKATC, into the Rotating Front End developed by IA, was successfully concluded, finishing one of the last and critical phases of the MOONS instrument.
- ANDES received in November 2023 the certificate of provisional acceptance (PVA) of the SAR, which officially closes the Phase B1 contract with ESO. ESO has granted the PVA without reservation and offered the consortium one night of Guaranteed Time Observation (GTO) on one of the instruments at the ELT telescope in return for the consortium's contribution to the System Architecture Review.
- Sixteen years after the first proposal in 2007, and with IA's participation since 2012, the Euclid mission was successfully launched this year, on July 1st. Euclid is a cosmology survey mission, designed to determine the properties of dark energy and dark matter on cosmological scales. It is unique in combining a wide field with high resolution and far reaching, and it will build a large archive, unprecedented for a space-based mission. Observations have started and the first images were released on November 7th. IA has a leading role in some aspects of the mission: developing the survey planning software, leading the survey operations support team, and coordinating the astrophysics (non-cosmology) program of the mission.
- In the scope of the PLATO project, as result of direct contract from ESA, a 3rd unit of the OGSE collimator was produced and commissioned @ ESA premises at ESTEC.
- The work on the Athena OBM led by IA achieved the TRR milestone, which determines the start of the testing and compliance verification of the prototype developed by the consortium.

Alexandre Cabral

Group Leader

## Report from the Group

### Science Communication

Throughout 2023 many initiatives of the Science Communication group were still marked by the past COVID-19 Pandemic. This continued to have an impact on the IA Science Communication Group (SCG) activity.

During 2023 the SCG organised and participated in several public Science Communication initiatives which reached a total of about 93 188 people (76 000 in 2022) people.

Public activities directly organised by IA reached about 66,183 people. These activities include, among others, planetarium shows, monthly periodic outreach sessions, exhibitions, showcases, hands-on laboratories and special public events and talks. The SCG team has also participated in several initiatives promoted by other institutions, such as Ciência Viva, the Museums of the University of Lisbon and many schools, contributing also with talks, observations of the night sky, planetarium shows, exhibitions, showcases, workshops and short courses, reaching about 27,005 people.

IA maintains its strong presence in social media, with 9800 followers on Facebook, 829 on Twitter, 1556 on Instagram and 2348 on Youtube. The group has produced 259 publications on Facebook, 215 on Twitter and 4 on Youtube. These numbers of (unpaid) publications resulted in a total reach of more than 286,754 people (unique users).

IA now has 4694 subscribers of the monthly IAstro Newsletter, a 6.8% increase over the number of subscribers in 2022. In total, IA sent 17 newsletters in 2023.

The SCG produced 6 articles (written for the public) for National Geographic Portugal and SAPO Tek websites. This increases the visibility of IA since, for example, SAPO Tek reaches about 2 million people. In 2023 the SCG also created several media contents, such as Youtube videos, and contents for its official webpage.

The SCG team produced and made available to the media 14 press releases (3 international) related to the science produced by IA or to its outreach activities. We also made available through our webpage and partners, 2 news releases.



#### Atividades



#### Star Party - Luar de Outono

Sábado, 28 Outubro, 18h00 - 00h00

Observatório Astronómico da Ajuda

Em noite de eclipse lunar parcial, o Instituto de Astrofísica e Ciências do Espaço (IA) lança o convite para uma Star Party no Observatório Astronómico da Ajuda. Esta edição inclui visitas guiadas ao Observatório, observação do céu noturno com telescópios, *speed-dating* com astrónomos, a história de um rato que foi à Lua e outras atividades.

Várias atividades sujeitas a inscrição no local. As observações astronómicas estão dependentes de condições meteorológicas favoráveis.

Créditos da imagem: [Miguel Claro](#)

Entrada livre

MAIS INFORMAÇÕES EM BREVE NO NOSSO WEBSITE



#### Ignite IAstro – Marco de Canaveses

Sábado, 11 Novembro, 21h00

Emergente - Centro Cultural, Marco de Canaveses

Vamos viajar do Sistema Solar às estrelas e às galáxias, e falar dos instrumentos que nos permitem chegar tão longe. O formato dos eventos [Ignite IAstro](#) permite expor, de modo divertido e acessível, cerca de uma dezena de temas da investigação em ciências do espaço feita em Portugal.

Em cada evento da *Digressão Ignite IAstro*, entre oito e dez investigadores do Instituto de Astrofísica e Ciências do Espaço apresentam a sua



IA has been mentioned by international news media, for example: Quanta Magazine, Universe Today, Phys.org, and Space.com.

The science communication and education work at IA has been presented in national and international conferences with invited and contributed talks – 5 invited talks and 7 contributed talks. The conferences include, among others, the National Conference Scientix, the 5th Shaw-IAU Workshop on Astronomy for Education and the XXXIII Encontro Nacional de Astronomia e Astrofísica – ENAA. The team is responsible for several articles for monthly columns.

The SCG has supervised about 100 bachelor and master students from several faculties and universities, including Faculdade de Ciências Sociais e Humanas da Universidade Nova de Lisboa, Faculdade de Belas Artes da Universidade do Porto, Universidade Lusófona, Faculdade de Ciências da Universidade do Porto and Politécnico do Porto – Escola Superior de Educação.

The IAstro Summer Internships are a three-week IA program to give university students a first contact with the research done at IA, as well as training in science communication. The 2023 edition offered a total of 17 projects and two science communication workshops, involving 26 researchers. 161 applications were received and 69 students participated in the training, from around 62 different universities from Portugal, Brazil, United Kingdom, Spain, Italy, Germany, The Netherlands, India, Pakistan, Bolivia, Chile, among other countries.

During 2023, the SCG has conducted several training sessions for teachers, science communication officers, students and the non-specialist public.

The SCG is responsible for the creation and development of several national projects like, the Rewrite the Stars, Ignite IAstro Tour and CoAstro:@n Astronomy Condo. IA also participated in the Cientificamente Provável

programme, a partnership by the Portuguese Government, implemented through the network of school libraries, and in the Clubes Ciência Viva na Escola, a Ciência Viva project, partnering with 112 schools.



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ia instituto de astrofísica e ciências do espaço

Marco de Canaveses  
Emergente Centro Cultural  
Sábado, 11 novembro, 2023 - 21:00  
Entrada gratuita

numa digressão por Portugal.

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IA provides the scientific management of the Planetário do Porto CCV activities, all of which are developed, organised and implemented by members of IA's SCG, having reached in 2023 64,715 people through fixed domed and portable planetarium sessions, hands-on laboratories, online activities and special initiatives.

Following the memorandum between IA and the Office for Astronomy Outreach of the International Astronomical Union (IAU-OAO), the largest international organisation in astronomy, IA continued to expand the production of contents and tools for the communication and teaching of astronomy. One of the components of this collaboration is the involvement of IA at the editorial level in IAU’s international peer-reviewed journal of astronomy communication, *Communicating Astronomy with the Public* (CAPIournal), in which IA will figure as official partner.



IA co-leads, together with the Leiden Observatory/University of Leiden, the development of an international Astronomy Literacy Project, which aims to define global astronomy education goals to be applied in worldwide school curricula. The SCG has been working towards following what it has committed to – prepare the third version of the “Big Ideas in Astronomy” booklet, the first deliverable from this project which is hosted by the International Astronomical Union’s Office of Astronomy Education (OAE). This is being done by conducting a Delphi Study which will guarantee that the document is an “Expert Document”, after several iterations with more specialists in the areas covered by the booklet.

IA continues with a strong involvement with the “Portuguese Language Expertise Centre for the Office of Astronomy for Development (of the International Astronomical Union)” – PLOAD. It is hosted by Núcleo Interativo de Astronomia (NUCLIO), in collaboration with IA. The PLOAD’s main objectives are to establish a strong collaborative network between Portuguese speaking countries and communities and empower these countries and communities with the necessary tools to build their own local support structures and strategy development in Astronomy and Space Sciences.

For the future, the SCG will continue to enhance the public understanding of the Universe, improve scientific literacy, and foster links between society and research. This is achieved through a diversity of actions aligned along four strategic pillars:

- Museums & Science Centres
- Society Engagement
- Inclusion & Equity
- Internationalisation

In the period 2024-2029 the group will reinforce its presence in all these domains, pursuing the following objectives:

- i) Schools and the wider public: through the Porto Planetarium-CCV – the only *Ciência Viva* centre managed by a research institute – and activities at the Astronomical Observatory of Lisbon and GAOUC’s planetarium and museum collection, we aim at surpassing 500k in-person visitors. We will focus on producing, and distributing nationwide, our own content adapted to school programs. Additionally, we will also reinforce the activities of the PRR-funded *Ciência Viva* School, using research-based teaching methods, in articulation with the municipal council.

- ii) Extending key partnerships: with Turismo de Portugal, we will train night sky guides for a programme on dark sky awareness and sustainable regional tourism. We will also strengthen synergies with the Portuguese Republic's Presidency and the Parliament to reach policy makers through regular and diverse initiatives at these institutions' official premises.
- iii) Contributing to global society: with Leiden University and IAU-OAE, we will publish the 3rd version of the first global Astronomy Literacy document, Big Ideas in Astronomy. Moreover, we will reinforce, at the editorial level, the only Communication in Astronomy peer-reviewed journal - IAU's CAPJournal.
- iv) Social responsibility: the project Rewrite the Stars (see group's highlights), will be extended nationally and, potentially, internationally. The next steps include seeking financial support and strengthening the partnerships with important institutions like the Portuguese Institute for Cancer and Casa Pia Lisboa.

João Retrê and Filipe Pires

Group Lead

## Scientific Output

### Books <sup>[1]</sup>

1. **A. L. Morozova**, T. Barlyaeva, 2023; *Space weather influence on the ionosphere and its potential threats to GNSS services: focus on the Portuguese territories*; Instituto de Astrofísica e Ciências do Espaço, University of Coimbra

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1. **H. Miranda, C. Pappalardo, P. Papaderos, J. Afonso, I. Matute, C. Lobo, A. Paulino-Afonso, R. Carvajal, S. Lorenzoni, D. M. Santos**, 2023; *An investigation of the star-forming main sequence considering the nebular continuum emission at low-z*; *Astronomy & Astrophysics*, 669, A16, 13
2. O. Balsalobre-Ruza, J. Lillo-Box, A. Berihuete, **A. M. Silva, N. C. Santos**, A. Castro-González, **J. P. Faria**, N. Huélamo, D. Barrado, **O. Demangeon** et al. (including: **S. C. C. Barros**), 2023; *KOBESim: A Bayesian observing strategy algorithm for planet detection in radial velocity blind-search surveys*; *Astronomy & Astrophysics*, 669, A18, 14
3. D. Farrah, A. Efstathiou, **J. Afonso**, D. L. Clements, K. Croker, E. Hatziminaoglou, M. Joyce, V. Lebouteiller, A. Lee, C. Lonsdale, 2023; *Molecular Gas Heating, Star Formation Rate Relations, and AGN Feedback in Infrared-Luminous Galaxy Mergers*; *Universe*, 9, 1
4. J. Harrell, A. M. S. Smith, **S. C. C. Barros**, G. Boué, S. Csizmadia, D. Ehrenreich, H. -G. Florén, A. Fortier, P. F. L. Maxted, M. J. Hooton et al. (including: **B. Akinsanmi, N. M. Rosário, V. Zh. Adibekyan, O. D. S. Demangeon, N. C. Santos, S. G. Sousa**), 2023; *Examining the orbital decay targets KELT-9 b, KELT-16 b, and WASP-4b, and the transit-timing variations of HD 97658 b*; *Astronomy & Astrophysics*, 669, A124, 17
5. J. Lillo-Box, D. Gandolfi, D. J. Armstrong, K. A. Collins, L. D. Nielsen, R. Luque, J. Korth, **S. G. Sousa**, S. N. Quinn, L. Acuña et al. (including: **V. Zh. Adibekyan, T. de Azevedo Silva, N. C. Santos, S. C. C. Barros, O. D. S. Demangeon**), 2023; *TOI-969: a late-K dwarf with a hot mini-Neptune in the desert and an eccentric cold Jupiter*; *Astronomy & Astrophysics*, 669, A109, 23
6. B.-O. Demory, S. Sulis, E. Meier Valdés, L. Delrez, A. Brandeker, N. Billot, A. Fortier, S. Hoyer, **S. G. Sousa**, K. Heng et al. (including: **S. C. C. Barros, O. D. S. Demangeon, N. C. Santos**), 2023; *55 Cancri e's occultation captured with CHEOPS*; *Astronomy & Astrophysics*, 669, A64, 10
7. K. Al Moulla, X. Dumusque, **P. Figueira**, G. Lo Curto, **N. C. Santos**, F. Wildi, 2023; *Stellar signal components seen in HARPS and HARPS-N solar radial velocities*; *Astronomy & Astrophysics*, 669, A39, 13
8. D. S. Aguado, E. Caffau, P. Molaro, C. Allende Prieto, P. Bonifacio, J. I. González Hernández, R. Rebolo, S. Salvadori, M. R. Zapatero Osorio, S. Cristiani et al. (including: **N. C. Santos, N. J. Nunes, C. J. A. P. Martins, J. Rodrigues**), 2023; *The pristine nature of SMSS 1605–1443 revealed by ESPRESSO*; *Astronomy & Astrophysics*, 669, L4, 8
9. **B. A. R. Rocha, C. J. A. P. Martins**, 2023; *Redshift drift cosmography with ELT and SKAO measurement*; *Monthly Notices of the Royal Astronomical Society*, 518, 2, 16
10. I. P. Breda, **P. Papaderos**, 2023; *Exploring the genesis of spiral galaxies. Classical and pseudo bulges as extremities of a continuous sequence*; *Astronomy & Astrophysics*, 669, A70, 10
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12. B. J. Barros, **D. M. L. Castelão, V. da Fonseca, T. Barreiro, N. J. Nunes, I. Tereno**, 2023; *Is there evidence for CIDER in the Universe?*; *Journal of Cosmology and Astroparticle Physics*, 2023
13. **A. L. Morozova**, R. Rebbah, 2023; *Principal component analysis as a tool to extract Sq variation from the geomagnetic field observations: Conditions of applicability*; *MethodsX*, 10
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  17. **C. J. A. P. Martins, C. S. Alves, J. Esteves, A. Lapel, B. G. Pereira**; 2023; *Closing the cosmological loop with the redshift drift*; Proceedings of the MG16 Meeting on General Relativity; (Eds.)Remo Ruffini; Gregory Vereshchagin, World Scientific Publishing Co Pte Ltd, 2890
  18. **C. J. A. P. Martins**; 2023; *Varying fundamental constants and dark energy in the ESPRESSO era*; Proceedings of the MG16 Meeting on General Relativity; (Eds.)Remo Ruffini; Gregory Vereshchagin, World Scientific Publishing Co Pte Ltd, 3963
  19. I. Millán-Irigoyen, M. G. del Valle-Espinosa, R. Fernández-Aranda, L. Galbany, **J. M. Gomes**, M. Mollá; 2023; *Stellar Populations in type Ia supernova host galaxies at intermediate-high redshift: Star formation and metallicity enrichment histories*; Highlights of Spanish Astrophysics XI; (Eds.)M. Manteiga; L. Bellot; P. Benavidez; A. de Lorenzo-Cáceres; M. A. Fuente; M. J. Martínez; M. Vázquez Acosta; C. Dafonte, SEA, 75
  20. **J. P. Mimoso**, A. Maciel, M. Le Delliou; 2023; *Tolman-Oppenheimer-Volkov conditions beyond spherical symmetry*; Proceedings of the MG16 Meeting on General Relativity; (Eds.)Remo Ruffini; Gregory Vereshchagin, World Scientific Publishing Co. Pte. Ltd., 2479
  21. **A. L. Morozova, T. Barata, I. Oliveira, J. P. M. F. Pereira, T. Barlyaeva**; 2023; *Ionospheric parameters over Portugal during quiet and disturbed periods*; Proceedings of the 10th Spanish-Portuguese Assembly of Geodesy and Geophysics, O.A. Centro Nacional de Información Geográfica, 564
  22. **A. L. Morozova, J. P. M. F. Pereira**; 2023; *EC variations for different locations (Continent and Islands)*; Space weather influence on the ionosphere and its potential threats to GNSS services: focus on the Portuguese territories; (Eds.)A. Morozova; T. Barlyaeva, Instituto de Astrofísica e Ciências do Espaço, University of Coimbra
  23. **A. L. Morozova, R. Gafeira**; 2023; *Regional TEC models for Portugal*; Space weather influence on the ionosphere and its potential threats to GNSS services: focus on the Portuguese territories; (Eds.)A. Morozova; T. Barlyaeva, Instituto de Astrofísica e Ciências do Espaço, University of Coimbra
  24. **A. L. Morozova**; 2023; *Ionosphere scintillations*; Space weather influence on the ionosphere and its potential threats to GNSS services: focus on the Portuguese territories; (Eds.)A. Morozova; T. Barlyaeva, Instituto de Astrofísica e Ciências do Espaço, University of Coimbra
  25. **M. Pinto**, T. Harko, **F. S. N. Lobo**; 2023; *Challenging  $\Lambda$ CDM with Scalar-tensor  $f(R, T)$  Gravity and Thermodynamics of Irreversible Matter Creation*; Acta Physica Polonica B Proceedings Supplement; (Eds.)Przemysław Malkiewicz; Jan Jakub Ostrowski, Jagiellonian University, 16, 4
  26. **A. R. Ribeiro**, D. Vernieri, **F. S. N. Lobo**; 2023; *Effective  $f(R)$  actions for modified loop quantum cosmologies*; Proceedings of the MG16 Meeting on General Relativity; (Eds.)Remo Ruffini; Gregory Vereshchagin, World Scientific Publishing Co. Pte. Ltd., 517
  27. A. Sousa, **R. Pinto**, B. Couto, B. Nadal, H. Onderwater, P. Gordo, **M. Abreu**, R. Melicio, P. Michel; 2023; *Breadboard of Microchip and Avalanche Photodiode in*

*Linear and Geiger Mode for LiDAR Applications*; Journal of Physics: Conference Series, IOP Science, 2526

28. **L. Sousa**; 2023; *Probing the Nature of Cosmic Strings with Gravitational Waves*; Book cover Gravity, Cosmology, and Astrophysics; (Eds.)Betti Hartmann; Jutta Kunz, Springer Cham, Lecture Notes in Physics, 1022

## International Scientific Communications <sup>[144]</sup>

1. **V. Zh. Adibekyan**; 2023; *PoET: Mapping the Sun in space and time*; IAU Symposium 365 - Dynamics of Solar and Stellar Convection Zones and Atmospheres, Yerevan, Armenia
2. **J. Afonso**; 2023; *The Quest for Radio Powerful AGN in the EoR*; Shedding new light on the first billion years of the Universe International Meeting — 16th edition of the GECO team conference cycle, Marseille, France
3. **I. S. Albuquerque**; 2023; *Spherical collapse in shift symmetric Galileon theory*; COSMO'23, Instituto de Física Teórica (IFT UAM-CSIC), Madrid, Spain
4. **I. S. Albuquerque**, N. Frusciante; 2023; *A designer approach to  $f(Q)$  gravity and cosmological implications*; DarkCosmoGrav: New Frontiers in Particle Physics, Gravity, and Cosmology, University of Pisa, Italy
5. **T. Barata, A. L. Morozova**, T. Barlyaeva; 2023; *Assessment of spatial TEC gradients during geomagnetically quiet and disturbed days for Iberian Peninsula and Portuguese archipelagos*; 19th European Space-Weather Week (ESWW2023), Toulouse, France
6. **T. Barata, A. L. Morozova**, T. Barlyaeva; 2023; *Assessment of spatial TEC gradients during geomagnetically quiet and disturbed days for Iberian Peninsula and Portuguese Archipelagos*; 19th European Space-Weather Week (ESWW2023), Toulouse, France
7. **D. D. Barbosa**; 2023; *A Complete Characterisation of Ultra Steep Spectrum Sources in the COSMOS Field*; Towards the SKAO: Partnerships and Africa's role in the next generation of global radio astronomy, University of Bristol, Bristol, UK
8. **B. J. Barros**; 2023; *Wormholes with matter haunted by ghosts*; IberiCos 2023 - 17th Iberian Cosmology Meeting, Ponte de Lima, Portugal
9. **S. C. C. Barros**; 2023; *Detecting tidal deformation and tidal decay*; Towards Other Earths III: The Planet-Star connection, Porto, Portugal
10. **S. C. C. Barros**; 2023; *Review of the WG5 Feature characterise results*; CHEOPS Science Team Meeting #29, Center of Space and Habitability, University of Bern, Switzerland
11. **S. L. L. Bourgeois, T. Barata**, R. Erdelyi, **R. Gafeira**, O. Oliveira; 2023; *Machine Learning/Mathematical Morphology coupling for solar features detection*; International Workshop On Machine Learning And Computer Vision In Heliophysics, Sofia, Bulgaria
12. **S. L. L. Bourgeois, T. Barata**, R. Erdelyi, **R. Gafeira**, O. Oliveira; 2023; *Getting solar feature contouring with Mathematical Morphology image processing*; 19th European Space-Weather Week (ESWW2023), Toulouse, France
13. **S. L. L. Bourgeois**, A. Wagner, **T. Barata**, R. Erdelyi, O. Oliveira; 2023; *Mathematical Morphology applied to solar features detection*; EGU23 General Assembly, Vienna, Austria
14. **S. L. L. Bourgeois, T. Barata**, R. Erdelyi, O. Oliveira; 2023; *Applying Mathematical Morphology to solar feature detection*; Science Showcase, University of Sheffield, UK
15. **F. Brasil, P. Machado**, G. Gilli, **D. C. Espadinha, J. Ribeiro, J. A. Dias, R. Rianço Silva, F. Rodrigues, C. T. Freire**, P. M. H. Branco; 2023; *Planetary Systems Group - Study of Planetary Atmospheres*; STARLab - CMS Meeting, Shanghai Astronomical Observatory, Chinese Academy of Sciences, Shanghai, China
16. **F. Brasil, P. Machado**, G. Gilli, A. Cardesin-Moinelo, **J. E. O. Silva, D. C. Espadinha**, L. Riu, J. Carter, D. Tirsch, T. Roatsch, C. Wilson; 2023; *Detecting and Characterising atmospheric gravity waves on Mars' atmosphere - Final results using data from OMEGA/Mars Express*; 55th Annual Division for Planetary Sciences (DPS) meeting joint with the Europlanet Science Congress (EPSC), San Antonio, Texas, USA
17. **F. Brasil, P. Machado**, G. Gilli, **J. E. O. Silva, D. C. Espadinha, R. Rianço Silva**; 2023; *Probing Atmospheric Gravity Waves on Mars' Atmosphere Using Mars Express Omega Data*; China - ESA Advanced Mars School, Huairou, Beijing, China
18. **F. Brasil, P. Machado**, G. Gilli, A. Cardesin-Moinelo, **J. E. O. Silva, D. C. Espadinha**, L. Riu, J. Carter, D. Tirsch, T. Roatsch, C. Wilson; 2023; *Detecting and Characterising atmospheric gravity waves on Mars' atmosphere - Final results using data from OMEGA/Mars Express*; 55th Annual Division for Planetary Sciences (DPS) meeting joint with the Europlanet Science Congress (EPSC), San Antonio, Texas, USA
19. **F. Brasil, P. Machado**, G. Gilli, **J. E. O. Silva, D. C. Espadinha**; 2023; *From Detection to Characterisation: A systematic approach in the identification and quantification of oscillatory patterns in the atmosphere*; Japan and Portugal Collaboration on Venus' Atmosphere Research in the framework of Akatsuki space mission, Lisboa, Portugal
20. **J. Brinchmann**; 2023; *Euclid for MOONS*; MOONS consortium meeting,, Online
21. **J. Brinchmann**; 2023; *MuseFaint - an overview*; MUSE Busy week, Aussois, France
22. **J. Brinchmann**; 2023; *Galaxy & AGN SWG - Updates & Key Projects for Q1/DR1*; Euclid Consortium Meeting, Copenhagen, Denmark
23. **J. Brinchmann**, R. S. Ellis; 2023; *Extragalactic Science with WST*; European Astronomical Society Annual Meeting, Kraków, Poland
24. **J. Brinchmann**, R. S. Ellis; 2023; *Extra-galactic working group*; Science with the future WideField Spectroscopic Telescope, Vienna, Austria
25. **J. Brinchmann**, R. S. Ellis; 2023; *Extragalactic Science Cases for WST*; WST Busy Week, Varenna, Italy
26. **J. Brinchmann**; 2023; *Studying ultra-faint dwarfs with MUSE - lessons for WST*; Science with the future WideField Spectroscopic Telescope, Vienna, Austria
27. **T. L. Campante**; 2023; *Pushing the boundaries of cool-dwarf asteroseismology with ESPRESSO*; TASC7/KASC14 workshop, Honolulu, USA
28. **R. Carvajal, I. Matute, J. Afonso**, R. P. Norris, K. J. Luken, P. Sánchez-Sáez, **P. A. C. Cunha**, A. Humphrey, H. Messias, S. Amarantidis, **D. D. Barbosa**, H. A. Cruz, **H. Miranda, C. Pappalardo**, A. Paulino-Afonso; 2023; *Extracting physical rules from ensemble machine learning for the selection of radio AGN*; Debating the potential of Machine Learning in astronomical surveys #2, IAP, Paris / Flatiron Institute, New York, France / USA
29. **R. Carvajal, I. Matute, J. Afonso**, R. P. Norris, K. J. Luken, P. Sánchez-Sáez, **P. A. C. Cunha**, A. Humphrey,



- H. Messias, S. Amarantidis, **D. D. Barbosa**, H. A. Cruz, **H. Miranda**, **A. Paulino-Afonso**, **C. Pappalardo**; 2023; *Radio Galaxy prediction with multi-survey data and ensemble Machine Learning*; Coordinated Surveys of the Southern Sky (CSSS), ESO Garching, Germany
30. **R. Carvajal**, **I. Matute**, **J. Afonso**, R. P. Norris, K. J. Luken, P. Sánchez-Sáez, **P. A. C. Cunha**, A. Humphrey, H. Messias, S. Amarantidis, **D. D. Barbosa**, H. A. Cruz, **H. Miranda**, **A. Paulino-Afonso**, **C. Pappalardo**; 2023; *Ensemble Machine Learning for the prediction of Radio AGN in multi-survey data*; VIII Encontro Internacional da Casa das Ciências, Aveiro, Portugal
31. **M. T. Clara**; 2023; *Towards a Comprehensive Characterization of Grid Interpolation in the context of Grid-based Modelling*; PLATO Stellar Science Conference 2023, Milazzo, Italy
32. **M. T. Clara**, **M. S. Cunha**, **P. P. Avelino**, **T. L. Campante**, S. Deheuvels, D. R. Reese; 2023; *Towards a Comprehensive Characterization of Grid Interpolation in the Context of Grid-Based Modelling*; TASC7/KASC14 workshop, Honolulu, USA
33. **M. J. Conceição**; 2023; *Emulating Hydrodynamical Density Fields with Machine Learning*; COSMO'23, Instituto de Física Teórica (IFT UAM-CSIC), Madrid, Spain
34. **M. J. Conceição**, **A. C. da Silva**, A. Krone-Martins; 2023; *Emulating Hydrodynamics from Dark Matter 3D Density Fields*; IEEE eScience 2023, Limassol, Cyprus
35. **M. Cortês**; 2023; *Biocosmology: Lessons from biology on physics of the continuum*; At Varieties of Indeterminism, Les Diabrelets, Switzerland
36. **M. Cortês**; 2023; *There will be no absolute truths left in the study of reality*; Open Historicity of Life. Theory, epistemology, practice, Salle Dussane, École Normale Supérieure, Paris, France
37. **A. R. Costa Silva**, **O. Demangeon**; 2023; *Exoplanet atmospheric studies: Emission and reflection spectroscopy*; ESPRESSO Science Team Meeting 2023, Lanzarote, Spain
38. **A. R. Costa Silva**, **O. Demangeon**, **N. C. Santos**; 2023; *Neutral iron detection in dayside emission spectra of WASP-76 b*; 4th Astrophysical School on Exoplanetary Sciences, Vietri Sul Mare, Salerno, Italy
39. **A. R. Costa Silva**, **O. Demangeon**, **N. C. Santos**; 2023; *Neutral iron detection in dayside emission spectra of WASP-76 b*; Towards Other Earths III: the planet-star connection, Porto, Portugal
40. **I. A. Costa**; 2023; *From science communication to science educations: the educational assessment of an outreach oriented science center*; 7th International Technology, Education and Development Conference (INTED 2023), Valencia, Spain
41. **I. A. Costa**; 2023; *CoAstro: um Condomínio de Astronomi@*; VIII Encontro Internacional da Casa das Ciências, Aveiro, Portugal
42. S. Cristiani, M. Porru, F. Guarneri, G. Calderone, K. Boutsia, A. Grazian, G. Cupani, V. D'Odorico, F. Fontanot, **C. J. A. P. Martins**, **C. M. J. Marques**, C. Maitra; 2023; *The Golden Sample for the cosmological redshift drift test*; Spectral Fidelity, Florence, Italy
43. **E. A. S. Cristo**, **N. C. Santos**, **O. Demangeon**; 2023; *Unveiling the atmosphere of HD 189733b with ESPRESSO*; The Extreme Precision Radial Velocity 5, Santa Barbara, California, USA
44. **E. A. S. Cristo**; 2023; *Prospects of modeling stellar activity and planetary transits with SOAP*; PoET workshop, Porto, Portugal
45. **E. A. S. Cristo**, **N. C. Santos**, **O. Demangeon**; 2023; *Unveiling the atmosphere of HD 189733b with ESPRESSO*; Towards Other Earths III: The Planet-Star connection, Porto, Portugal
46. **P. A. C. Cunha**, A. Humphrey, **J. Brinchmann**; 2023; *SpecSound: a sonification approach to astronomical spectroscopic analysis using machine learning*; ICAD 2023 Sonification for the Masses: Student ThinkTank, Linköping University, Norrköping, Sweden
47. **P. A. C. Cunha**, A. Humphrey, **J. Brinchmann**; 2023; *Few-shot learning photometric classification for the identification of Type II Quasars at intermediate and high-redshift*; European Astronomical Society Annual Meeting, Kraków, Poland
48. **P. A. C. Cunha**, A. Humphrey, **J. Brinchmann**; 2023; *SpecSound: a sonification approach to astronomical spectroscopic analysis using machine learning*; ICAD 2023 Sonification for the Masses: Student ThinkTank, Linköping University, Norrköping, Sweden
49. **P. A. C. Cunha**, A. Humphrey, **J. Brinchmann**; 2023; *Unveiling the Physical Properties of Type II Quasars Candidates in the Redshift Desert*; Euclid Consortium Meeting, Copenhagen, Denmark
50. **P. A. C. Cunha**, A. Humphrey, **J. Brinchmann**; 2023; *Unveiling the Physical Properties of Type II Quasars Candidates in the Redshift Desert*; European Astronomical Society Annual Meeting, Kraków, Poland
51. **V. da Fonseca**; 2023; *A new form for the interaction between quintessence and the electromagnetic fields*; IberiCos 2023 - 17th Iberian Cosmology Meeting, Ponte de Lima, Portugal
52. **V. da Fonseca**; 2023; *Varying alpha through the dynamics of dark energy*; CosmoVerse@Lisbon, Ciências ULisboa, Portugal
53. **T. de Azevedo Silva**; 2023; *Detection of Barium in the atmospheres of the ultra-hot gas giants WASP-76b and WASP-121b*; PLANET-ESLAB-2023: Understanding planets in the solar system and beyond, ESTEC, The Netherlands
54. **E. Delgado Mena**; 2023; *NIRPS - Other Science Programs (online)*; NIRPS Science meeting, Montreal, Canada
55. **E. Delgado Mena**; 2023; *Long period RV signals in intermediate mass evolved stars: planets, oscillations or stellar activity?*; Towards Other Earths III: The Planet-Star connection, Porto, Portugal
56. **J. A. Dias**, **P. Machado**, S. Robert, **F. Brasil**; 2023; *Detecting Volcanic Plumes and Ice Using High-Resolution Spectroscopy on Venus and Mars*; 55th Annual Division for Planetary Sciences (DPS) meeting joint with the Europlanet Science Congress (EPSC), San Antonio, Texas, USA
57. **J. A. Dias**, **P. Machado**, S. Robert, **F. Brasil**; 2023; *Detecting Volcanic Plumes and Ice Using High-Resolution Spectroscopy on Venus and Mars*; 55th Annual Division for Planetary Sciences (DPS) meeting joint with the Europlanet Science Congress (EPSC), San Antonio, Texas, USA
58. **J. A. Dias**, **P. Machado**, S. Robert, C. T. Freire; 2023; *On the effect of volcanic plumes on the near-infrared spectra of Venus*; Japan and Portugal Collaboration on Venus' Atmosphere Research in the framework of Akatsuki space mission, Lisboa, Portugal
59. **J. D. F. Dias**; 2023; *Constraints on extended Bekenstein models from cosmological, astrophysical, and local data*; IberiCos 2023 - 17th Iberian Cosmology Meeting, Ponte de Lima, Portugal
60. P. Fanha, **M. S. Cunha**, **D. Bossini**, **M. I. M. F. S. Ferreira**, M. Deal; 2023; *Testing a new tool to distinguish the stage of evolution of red-giant stars*; PLATO Stellar Science Conference 2023, Milazzo, Italy

61. **D. C. Espadinha, P. Machado, J. Peralta, J. E. O. Silva, F. Brasil;** 2023; *Studying Venus' atmosphere gravity waves using Akatsuki UVI data*; Japan and Portugal Collaboration on Venus' Atmosphere Research in the framework of Akatsuki space mission, Lisboa, Portugal
62. **D. C. Espadinha, P. Machado, T. Widemann, J. Peralta, J. E. O. Silva, F. Brasil;** 2023; *Venus atmospheric dynamics: Akatsuki and TNG HARPS-N observations*; Japan and Portugal Collaboration on Venus' Atmosphere Research in the framework of Akatsuki space mission, Lisboa, Portugal
63. **J. Ferreira, T. Barreiro, J. P. Mimoso, N. J. Nunes;** 2023; *Testing Lambdafree  $f(Q)$  Cosmology*; Dark Matter and Stars: Multi-Messenger Probes of Dark Matter and Modified Gravity, Center for Astrophysics and Gravitation, Instituto Superior Técnico, Portugal
64. **J. Ferreira, T. Barreiro, J. P. Mimoso, N. J. Nunes;** 2023; *Testing Lambdafree  $f(Q)$  Cosmology*; CosmoVerse@Lisbon, Ciências ULisboa, Portugal
65. **J. C. Fonseca;** 2023; *The observed number counts in luminosity distance space*; 26th International Conference on Particle Physics and Cosmology (COSMO23), Madrid, Spain
66. **G. Francisco, D. Del Moro, T. Barata, J. M. Fernandes, S. Guastavino, M. Piana;** 2023; *Insight on Solar Flare Forecast with Explainable Deep Learning*; International Workshop On Machine Learning And Computer Vision In Heliophysics, Sofia, Bulgaria
67. **R. Gafeira, A. L. Morozova, T. Barata, T. Barlyaeva;** 2023; *PCA-NN model for TEC with space weather parameters as predictors: tuning of NN algorithms and input parameters*; International Workshop On Machine Learning And Computer Vision In Heliophysics, Sofia, Bulgaria
68. **R. Gafeira;** 2023; *Diagnostic capabilities of PoET observation on solar lower atmospheric studies*; PoET workshop, Porto, Portugal
69. G. Gilli, **P. Machado, P. Drossart, T. Encrenaz, M. Rengel, D. Quirino, C. Gapp, M. Lopez-Puertas, E. Marcq, K. Molaverdikhani, J. Leconte, S. Robert, F. Oliva, A. Piccialli, A. Sánchez-López, M. Lefèvre, A. Spiga, P. Wolkenberg, A. Coustenis, A. Migliorini, L. M. Lara, F. Brasil, J. A. Dias, J. E. O. Silva, D. Turrini, A. C. Vandaele;** 2023; *The Solar System planets as testing ground for exoplanets: a contribution from the Ariel Consortium Working Group*; PLANET-ESLAB-2023: Understanding planets in the solar system and beyond, ESTEC, The Netherlands
70. G. Gilli, **P. Machado, P. Drossart, T. Encrenaz, M. Rengel, D. Quirino, C. Gapp, M. Lopez-Puertas, E. Marcq, K. Molaverdikhani, J. Leconte, S. Robert, F. Oliva, A. Piccialli, A. Sánchez-López, M. Lefèvre, A. Spiga, P. Wolkenberg, A. Coustenis, A. Migliorini, L. M. Lara, F. Brasil, J. A. Dias, J. E. O. Silva, D. Turrini, A. C. Vandaele;** 2023; *The Solar System planets as testing ground for exoplanets: a contribution from the Ariel Consortium Working Group*; PLANET-ESLAB-2023: Understanding planets in the solar system and beyond, ESTEC, The Netherlands
71. G. Gilli, **D. Quirino, T. Navarro, M. Turbet, L. Kaltenecker, T. J. Faucher, J. Leconte, S. Lebonnois, L. M. Lara;** 2023; *Venus as a natural laboratory to infer observational prospects of close-in-orbit rocky exoplanets with a 3D model*; EGU23 General Assembly, Vienna, Austria
72. **J. M. Gomes;** 2023; *Nebular Emission in Early-Type Galaxies*; S-PLUS meeting,, Brazil
73. **N. M. Gonçalves, A. Cabral, M. Abreu;** 2023; *Trade-off analysis of a high resolution cross dispersed echelle spectrograph with a Cassegrain collimator*; NYRIA Workshop, Marseille, France
74. **T. B. Gonçalves;** 2023; *When will gravity be revolutionised?*; 7th Winter Workshop @Valencia, Faculty of Physics of the University of Valencia, Spain
75. **T. B. Gonçalves, L. Atayde, N. Frusciante;** 2023;  *$f(Q)$  gravity: DGP-like model background & perturbations*; Dark Matter and Stars: Multi-Messenger Probes of Dark Matter and Modified Gravity, Center for Astrophysics and Gravitation, Instituto Superior Técnico, Portugal
76. **T. B. Gonçalves, L. Atayde, N. Frusciante;** 2023;  *$f(Q)$  gravity: DGP-like model background & perturbations*; CosmoVerse@Lisbon, Ciências ULisboa, Portugal
77. E. K. J. Kilpua, **T. Barata,** and the SWATNet team; 2023; *Training program for PhD students in the field of heliophysics*; EGU23 General Assembly, Vienna, Austria
78. **F. S. N. Lobo;** 2023; *Beyond Einstein's General Relativity: Hybrid metric-Palatini gravity*; XV International Conference on Gravitation, Astrophysics and Cosmology, Gyeongju, Korea
79. **F. S. N. Lobo;** 2023; *Modified-gravity wormholes without exotic matter*; XV International Conference on Gravitation, Astrophysics and Cosmology, Gyeongju, Korea
80. **P. Machado;** 2023; *Atmospheres - A Planetary Research Roadmap on the Solar System and beyond...*; 7th edition of the Meeting on Planetary Sciences and Exploration of the Solar System (CPSS-7), Palacio de Congresos Conde Ansúrez, Valladolid, Spain
81. **P. Machado, F. Brasil;** 2023; *MWWM - Mars Wind & Wave Mapping*; Mars Express - Trace Gas Orbiter Science Working Team Meeting and Science Workshop, ESAC-ESA, Madrid, Spain
82. **P. Machado, F. Brasil, J. A. Dias;** 2023; *MWWM - Mars Wind & Wave Mapping*; Mars Express Science Working Team Meeting and Science Workshop, ESOC-ESA, Darmstadt, Germany
83. **P. Machado, T. de Azevedo Silva, A. Branco, S. Jaeggli, P. Tanga, T. Widemann;** 2023; *Transmission spectroscopy along the transit of Venus used for probing the atmosphere's upper layers and as a proxy for exoplanets atmosphere characterization*; 55th Annual Division for Planetary Sciences (DPS) meeting joint with the Europlanet Science Congress (EPSC), San Antonio, Texas, USA
84. **C. M. J. Marques, C. J. A. P. Martins, C. S. Alves;** 2023; *Fundamental cosmology from ANDES precision spectroscopy*; IberiCos 2023 - 17th Iberian Cosmology Meeting, Ponte de Lima, Portugal
85. **J. Marques Oliveira, J. Retrê;** 2023; *Night sky observations with the public: contributions from research and practice to the training of guides*; GHOU - Global Hands-On Universe Conference, Kagoshima (hybrid event), Japan
86. **J. B. V. Marques;** 2023; *Observações do céu enquanto práticas potenciadoras de aprendizagens*; I Congresso Internacional de Ensino em Astronomia, Imperatriz do Maranhão, Brazil
87. **J. B. V. Marques, I. A. Costa, M. Gomes;** 2023; *What do people really talk about inside the dome? A detailed look at planetarium communication topics*; 5th Shaw-IAU Workshop on Astronomy for Education,, Online
88. **J. B. V. Marques, A. P. Carlin, M. Gomes;** 2023; *Wonder and Awe observing the sky*; ASTROEDU 2023, Toronto (hybrid event), Canada
89. **C. J. A. P. Martins;** 2023; *Reaching new heights in fundamental cosmology with the redshift drift*; StEm65, Sexten, Bozen, Italy
90. **C. J. A. P. Martins;** 2023; *Testing the standard model with QSO absorption lines*; Spectral Fidelity, Florence, Italy

91. **C. J. A. P. Martins**; 2023; *To scale, or not to scale*; VII Olentzero Workshop, Bilbao, Spain
92. **C. J. A. P. Martins**; 2023; *The ESPRESSO Redshift Drift Experiment*; ESPRESSO Science Team Meeting 2023, Lanzarote, Spain
93. **C. J. A. P. Martins**; 2023; *The ESPRESSO I2 Cell Experiment*; ESPRESSO Science Team Meeting 2023, Lanzarote, Spain
94. **C. J. A. P. Martins**; 2023; *The ESPRESSO I2 Cell Experiment*; ANDES System Architecture Meeting 2023, La Laguna, Tenerife, Spain
95. **I. Matute, R. Carvajal, J. Afonso**; 2023; *Charting the Cosmos: Self-Organized Insights from Large-Scale Surveys*; Machine learning meets galaxy classification: Addressing paradigms of galaxy evolution and their environment, ESAC, Madrid, Spain
96. **N. A. M. Moedas**; 2023; *Radiative accelerations in solar-like stars: a more efficient way to compute them in MESA*; 10th Iberian Meeting on Asteroseismology, Lanzarote, Spain
97. **N. A. M. Moedas, D. Bossini, M. Deal**; 2023; *An efficient way to compute dense and accurate grids of stellar models including the effect of radiative accelerations*; PLATO Stellar Science Conference 2023, Milazzo, Italy
98. **N. A. M. Moedas, D. Bossini, M. Deal**; 2023; *Accurate Characterisation of FG-type Stars with Improved Chemical Transport Mechanisms*; TASC7/KASC14 workshop, Honolulu, USA
99. **A. L. Morozova, T. Barata, J. P. M. F. Pereira**; 2023; *Variations of ionospheric parameters for Lisbon region during quiet and disturbed days*; XXVIII General Assembly of the International Union of Geodesy and Geophysics (IUGG), Berlin, Germany
100. **A. L. Morozova**; 2023; *Portuguese regional ionosphere maps*; Online PITHIA-NRF TNA User Meeting, online
101. **A. L. Morozova, R. Gafeira, T. Barata, T. Barlyaeva**; 2023; *Different types of PCA-NN model for TEC with space weather parameters as predictors: advantages and disadvantages of different NN algorithms*; EGU23 General Assembly, Vienna, Austria
102. **A. L. Morozova, L. Spogli**; 2023; *Assessment of the ionospheric scintillation on L-band signals over Portugal*; 19th European Space-Weather Week (ESWW2023), Toulouse, France
103. **A. L. Morozova, J. P. M. F. Pereira, T. Barata, M. Hernandez-Pajares, T. Barlyaeva**; 2023; *Ionosphere over Eastern North Atlantic mid-latitude zone during geomagnetic storms*; 19th European Space-Weather Week (ESWW2023), Toulouse, France
104. **A. L. Morozova**; 2023; *Total electron content (TEC) variations for different locations: Continent & islands*; Space weather influence on the ionosphere and its potential threats to GNSS services: focus on the Portuguese territories, Online
105. **A. L. Morozova**; 2023; *Ionospheric scintillations*; Space weather influence on the ionosphere and its potential threats to GNSS services: focus on the Portuguese territories, online
106. **N. J. Nunes**; 2023; *Current and future constraints on  $f(Q)$  cosmology with  $\Lambda$ CDM background*; DArk Energy: from Fundamental Theories to Observations (and back), INFN - Laboratori Nazionali di Frascati, Italy
107. **N. J. Nunes**; 2023; *Current and future constraints on  $f(Q)$  cosmology with  $\Lambda$ CDM background*; Spanish and Portuguese Relativity Meeting (EREP 2023), Bizkaia Areatoa, Spain
108. **C. Pappalardo**; 2023; *Outcomes from the collaboration between the Universities of Dodoma and Lisbon*; European Astronomical Society Annual Meeting, Kraków, Poland
109. **C. Pappalardo, E. Blucher**; 2023; *The importance of being nebular*; European Astronomical Society Annual Meeting, Kraków, Poland
110. **A. Paulino-Afonso**; 2023; *FLAEMING: are we able to find SC4K-like LAEs using AI?*; Escape of Lyman radiation from galactic labyrinths, Kolymbari, Crete, Greece
111. **A. Paulino-Afonso**; 2023; *Identifying more than 7K new LAEs in the COSMOS field: implications for the Ly $\alpha$  luminosity function*; Shedding new light on the first billion years of the Universe 16th edition of the GECO team conference cycle, Marseille, France
112. **A. Paulino-Afonso**; 2023; *How to find LAEs in a galaxy haystack?*; European Astronomical Society Annual Meeting, Kraków, Poland
113. **J. P. M. F. Pereira, A. L. Morozova, T. Barata, T. Barlyaeva**; 2023; *Variations of the ionospheric total electron content over Portugal Continental and Azores*; EGU23 General Assembly, Vienna, Austria
114. **M. Pinto**; 2023; *Non-minimal geometry-matter couplings and their implications*; 7th Winter Workshop @Valencia, Faculty of Physics of the University of Valencia, Spain
115. **M. Pinto**; 2023; *Gravitationally induced particle production in modified gravity*; IberiCos 2023 - 17th Iberian Cosmology Meeting, Ponte de Lima, Portugal
116. **D. Quirino, P. Machado, J. Peralta, F. Gonzalez-Galindo, E. Blucher**; 2023; *3D Climate modelling of rocky exoplanets with a Venus-like atmosphere: LP 890-9 b-c and TRAPPIST-1 c-d*; Generic-PCM days conference, Laboratoire de Météorologie Dynamique (virtual attendance), France
117. **D. Quirino, G. Gilli, T. Navarro, L. Kaltenecker, M. Turbet, T. J. Faucher, J. Leconte, S. Lebonnois, P. Machado, J. Peralta, F. Gonzalez-Galindo**; 2023; *3D Climate modelling of modern Venus-like atmospheres in the solar neighbourhood: LP 890-9 c and TRAPPIST-1 c*; Japan and Portugal Collaboration on Venus' Atmosphere Research in the framework of Akatsuki space mission, Lisboa, Portugal
118. **R. Rianço Silva, P. Machado, Z. Martins**; 2023; *High resolution visible spectroscopy of planetary atmospheres: Empirical line characterisation and minor compound detection*; Japan and Portugal Collaboration on Venus' Atmosphere Research in the framework of Akatsuki space mission, Lisboa, Portugal
119. **N. M. Rosário**; 2023; *Constraining the structure and composition of two short-period rocky planets spanning the radius valley*; European Astronomical Society Annual Meeting, Kraków, Poland
120. **N. M. Rosário**; 2023; *Constraining the structure and composition of two short-period rocky planets spanning the radius valley*; Towards Other Earths III: the planet-star connection, Porto, Portugal
121. **P. M. Sá**; 2023; *Inflationary cosmology and the swampland conjectures in string theory*; IberiCos 2023 - 17th Iberian Cosmology Meeting, Ponte de Lima, Portugal
122. **A. R. G. Santos**; 2023; *Measuring stellar rotation and magnetic activity from photometric time-series*; PLATO Stellar Science Conference 2023, Milazzo, Italy
123. **A. R. G. Santos**; 2023; *Stellar Physics @ Institute of Astrophysics and Space Sciences*; 10th Iberian Meeting on Asteroseismology, Lanzarote, Spain
124. **N. C. Santos**; 2023; *PoET, the Paranal solar ESPRESSO Telescope*; Spectral Fidelity, Florence, Italy



125. **N. C. Santos**; 2023; *Science, Technoly, and Industry: The virtuous circle of space sciences*; 6th New Space Atlantic Summit: a global effort for space sustainability, European Maritime, Lisboa, Portugal
126. **N. C. Santos**; 2023; *Looking at the Sun, finding other Earths: the Paranal solar ESPRESSO Telescope*; Towards Other Earths III: the planet-star connection, Porto, Portugal
127. **N. C. Santos**; 2023; *The Paranal Solar ESPRESSO Telescope*; PoET workshop, Porto, Portugal
128. **A. M. Silva**; 2023; *Towards a fully Bayesian RV extraction model*; The Extreme Precision Radial Velocity 5, Santa Barbara, California, USA
129. **A. M. Silva**; 2023; *Approaches for RV extraction: s-BART and the first steps towards a fully Bayesian model*; Towards Other Earths III: The Planet-Star connection, Porto, Portugal
130. **A. M. Silva**; 2023; *sBART application to the ESPRESSO WG1 targets*; ESPRESSO Science Team Meeting 2023, Lanzarote, Spain
131. **J. E. O. Silva**, Y. J. Lee, **J. Peralta**, **D. C. Espadinha**; 2023; *Observing Waves on Venus Dayside Upper Cloud with Virtis*; 20th Annual Meeting of the Asia Oceania Geosciences Society (AOGS2023), SUNTEC, Singapore
132. **B. Soares**, **V. Zh. Adibekyan**, C. Mordasini, **E. Delgado Mena**, **S. G. Sousa**, **N. C. Santos**; 2023; *Assessing the processes behind planet engulfment and its imprints*; Towards Other Earths III: The Planet-Star connection, Porto, Portugal
133. **L. Sousa**; 2023; *Update on the cosmic strings parameter estimation project*; 10th LISA Cosmology Working Group Workshop, University of Stavanger, Norway
134. **L. Sousa**; 2023; *Emission of gravitational waves by superconducting cosmic strings*; Spanish and Portuguese Relativity Meeting, University of the Basque Country, Bilbao, Spain
135. **L. Sousa**; 2023; *Emission of gravitational waves by superconducting cosmic strings*; IberiCos 2023 - 17th Iberian Cosmology Meeting, Ponte de Lima, Portugal
136. **S. G. Sousa**; 2023; *Challenges in inferring fundamental stellar parameters*; PLATO Stellar Science Conference 2023, Milazzo, Italy
137. **S. G. Sousa**; 2023; *CHEOPS TS3 report*; CHEOPS Science Team Meeting #28, Online
138. **S. G. Sousa**; 2023; *SWEET-Cat: The Cat is still SWEETer*; Towards Other Earths III: The Planet-Star connection, Porto, Portugal
139. L. Spogli, S. Poedts, **A. L. Morozova**, A. Guerrero, R. Van der Linden, S. Chabanski; 2023; *Sustaining the European Space Weather and SpaceClimate community on the long term through E-SWAN*; Heliophysics in Europe, ESTEC, Netherlands
140. **I. Tereno**; 2023; *Survey products for the Euclid community*; Euclid implementation meeting, Marriott Coca Beach, USA
141. **I. Tereno**; 2023; *The light deflection measurements of 1919: the data analyses in a nutshell*; 1st workshop E3Global, FCUL, Lisboa, Portugal
142. **D. A. D. Vaz**, **J. Brinchmann**; 2023; *Leo T Dissected with the MUSE-Faint Survey*; IAU Symposium 379: Dynamical Masses of Local Group Galaxies, Potsdam, Germany
143. **D. A. D. Vaz**, **J. Brinchmann**, S. L. Zoutendijk; 2023; *A Window Through Cosmic Time: Unlocking the Properties of the First Galaxies with Observations of Nearby Relics*; European Astronomical Society Annual Meeting, Kraków, Poland
144. J. Vila-Perez, N. C. Nguyen, J. Peraire, **A. L. Morozova**, **T. Barata**; 2023; *A High-Order Discontinuous Galerkin Approach for Physics-Based Thermospheric Modeling*; MIT Portugal Program (MPP) Annual Conference, Altice Forum Braga, Portugal

## National Scientific Communications <sup>[57]</sup>

- I. S. Albuquerque**; 2023; *Spherical collapse in shift symmetric Galileon theory*; Jornadas Doutorais do Departamento de Física, Ciências ULisboa, Portugal
- B. Arsioli**; 2023; *Yet Another Sunshine Mystery*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
- D. D. Barbosa**, **J. Afonso**, **I. Matute**; 2023; *A complete characterization of ultra steep spectrum sources in the cosmos field*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
- D. D. Barbosa**; 2023; *Podcasts como ferramenta de divulgação em astronomia*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
- D. D. Barbosa**; 2023; *A complete characterization of ultra steep spectrum sources in the cosmos field*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
- D. D. Barbosa**, **J. Afonso**, **I. Matute**, **R. Carvajal**, **C. Pappalardo**, I. H. Whittam, I. Heywood; 2023; *A Complete Characterization of Ultra Steep Spectrum Sources in the COSMOS Field*; Encontro Ciência 2023, Aveiro, Portugal
- T. Boulet**; 2023; *Advancing our Understanding of the Milky Way's Formation: Machine Learning-Based Stellar Age Predictions and Age Mapping*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
- F. Brasil**, **P. Machado**, G. Gilli, **J. E. O. Silva**, **D. C. Espadinha**; 2023; *Detecting and characterising atmospheric gravity waves on Mars' atmosphere - Final results from the nominal mission of OMEGA/Mars E*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
- J. Brinchmann**; 2023; *Euclid - a brief summary and outlook*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
- A. Cabral**; 2023; *Telescópios e Instrumentação*; 3 Day Mission: Space Exploration, FCUL, Portugal
- T. L. Campante; 2023; *Homogeneous ages and masses for stars in the Ariel Reference Sample*; 3rd Planetary Systems Day @IA, Porto, Portugal
- R. Carvajal**, **I. Matute**, **J. Afonso**, R. P. Norris, K. J. Luken, P. Sánchez-Sáez, **P. A. C. Cunha**, A. Humphrey, H. Messias, S. Amarantidis, **D. D. Barbosa**, H. A. Cruz, **H. Miranda**, **A. Paulino-Afonso**, **C. Pappalardo**; 2023; *Ensemble Machine Learning for the selection of radio AGN in multi-survey data*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
- M. M. C. D. Carvalho**, **C. J. A. P. Martins**; 2023; *Observational consequences of string theory inspired scalar fields*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
- A. Chougule**; 2023; *Spectral Synthesis of Seyfert 2 Galaxies Uning FADO*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
- M. T. Clara**; 2023; *Characterizing Grid Interpolation in the Context of Grid-Based Modelling of Subgiant Stars*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal

16. **A. R. Costa Silva, O. Demangeon, N. C. Santos;** 2023; *Neutral iron detection in dayside emission spectra of WASP-76 b*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
17. **I. A. Costa;** 2023; *O Ensino da Astronomia na Escolaridade Obrigatória: um Olhar Sobre as Aprendizagens Essenciais*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
18. **I. A. Costa;** 2023; *CoAstro: um Condomínio de Astronomi@*; Conferência Nacional Scientix - Novos Desafios da Educação em Ciência, Online, Portugal
19. **I. A. Costa;** 2023; *CoAstro: um Condomínio de Astronomi@*; Conferência Nacional Scientix - Novos Desafios da Educação em Ciência, Online, Portugal
20. **P. A. C. Cunha, A. Humphrey, J. Brinchmann;** 2023; *Unveiling the Physical Properties of Type II Quasars Candidates in the Redshift Desert*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
21. **J. A. Dias, P. Machado, S. Robert, F. Brasil;** 2023; *Detection of Ice and Volcanic Plumes using High-Resolution Spectroscopy in the Solar System*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
22. **J. A. Dias;** 2023; *Dry Volcanos to Icy Deserts using High-Resolution Spectroscopy in the Solar System*; Ciências Research & Innovation Day 2023, Ciências ULisboa, Portugal
23. **J. A. Dias, P. Machado, S. Robert, F. Brasil;** 2023; *Detection of Ice and Volcanic Plumes using High-Resolution Spectroscopy in the Solar System*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
24. **J. A. Dias, P. Machado, S. Robert, C. T. Freire;** 2023; *On the effect of volcanic plumes on the nightside near-infrared spectrum of Venus*; Jornadas Doutorais do Departamento de Física, Ciências ULisboa, Portugal
25. **J. D. F. Dias;** 2023; *Runaway dilaton models: Improved constraints from the full cosmological evolution*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
26. **J. D. F. Dias;** 2023; *Astrophysical and Local Tests of the Einstein Equivalence Principle*; MAP-Fis Research Conference, Online, Portugal
27. **D. C. Espadinha, P. Machado, T. Widemann, J. Peralta, J. E. O. Silva, F. Brasil;** 2023; *Atmospheric gravity waves with UVI instrument*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
28. **N. M. Gonçalves, A. Cabral, M. Abreu;** 2023; *Trade-off analysis of a high resolution cross dispersed echelle spectrograph with a Cassegrain collimator*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
29. **N. M. Gonçalves, A. Cabral, M. Abreu;** 2023; *Optical design for a prototype of a cross dispersed echelle spectrograph*; Jornadas Doutorais do Departamento de Física, Ciências ULisboa, Portugal
30. **T. B. Gonçalves, J. L. Rosa, F. S. N. Lobo;** 2023; *Accelerating without Dark Energy*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
31. **T. B. Gonçalves, J. L. Rosa, F. S. N. Lobo;** 2023; *Dynamic Systems in  $f(R, T)$  gravity*; Jornadas Doutorais do Departamento de Física, Ciências ULisboa, Portugal
32. **I. M. Leite, A. Cabral, N. C. Santos;** 2023; *Paranal Solar ESPRESSO Telescope: instrument concept and radiometric budget*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
33. **C. Leote;** 2023; *Comunicação de ciência: o quê, como e porquê?*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
34. **P. Machado;** 2023; *Ariel Portuguese Consortium contribution to Ariel Space mission*; 3rd Planetary Systems Day @IA, Porto, Portugal
35. **C. M. J. Marques, C. J. A. P. Martins, C. S. Alves;** 2023; *Fundamental cosmology from ANDES precision spectroscopy*; IJUP 2023, Porto, Portugal
36. **J. B. V. Marques;** 2023; *Enthusiasm or disappointment? Management of emotions in observations of the sky*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
37. **P. M. N. M. G. Martins, J. Afonso, I. Matute, V. Cuambe;** 2023; *On the selection and exploration of radio powerful Active Galactic Nuclei*; Jornadas Doutorais do Departamento de Física, Ciências ULisboa, Portugal
38. **P. M. N. M. G. Martins, J. Afonso, V. Cuambe, I. Matute;** 2023; *On the selection and exploration of radio powerful Active Galactic Nuclei*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
39. **P. M. N. M. G. Martins, J. Afonso, I. Matute, V. Cuambe;** 2023; *On the selection and exploration of radio powerful Active Galactic Nuclei*; Encontro Ciência 2023, Aveiro, Portugal
40. **P. M. N. M. G. Martins, J. Afonso, I. Matute, V. Cuambe;** 2023; *On the selection and exploration of radio powerful Active Galactic Nuclei*; Ciências Research & Innovation Day 2023, Ciências ULisboa, Portugal
41. **I. Matute, R. Carvajal, J. Afonso;** 2023; *Deciphering the cosmic tapestry: selforganized analysis of large-scale surveys and future prospects for skao*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
42. **H. Miranda, C. Pappalardo, J. Afonso;** 2023; *The Evolution of Ionised Gas in Galaxies*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
43. **H. Miranda, C. Pappalardo, J. Afonso;** 2023; *The Birth of the Galaxy Main Sequence in the Young Universe*; Ciências Research & Innovation Day 2023, Ciências ULisboa, Portugal
44. **H. Miranda, C. Pappalardo, J. Afonso;** 2023; *The Birth of the Galaxy Main Sequence in the Young Universe*; Encontro Ciência 2023, Aveiro, Portugal
45. **N. A. M. Moedas;** 2023; *Study of Planet Host FG-Type Stars With Improved Chemical Transport Mechanisms*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
46. **N. A. M. Moedas;** 2023; *Precise Characterisation of HD15337 with CHEOPS*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
47. **K. Muzic, A. Paulino-Afonso, J. M. C. Grave, P. N. M. B. Gual, B. Ribeiro;** 2023; *Olimpíadas de Astronomia: Envolvendo futuras gerações de cientistas*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
48. **A. W. Neitzel;** 2023; *Machine Learning Applied to Galactic Archaeology*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
49. **P. Papaderos;** 2023; *Bulgeless Disks And Other Expected Phenomena At High Z*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
50. **A. Paulino-Afonso;** 2023; *Illuminating the secrets of the Universe with over 7,000 newly discovered Lyman- $\alpha$*

- emitters and their impact on the Lya luminosity function*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
51. **C. P. Pereira**; 2023; *A Calibration System for the ARIEL Space Mission*; 3 Day Mission: SP4C3 EXPLORATION, FCUL, Portugal
  52. **C. P. Pereira**; 2023; *Optical Sub-System to characterize the future ARIEL Space Mission*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
  53. **C. P. Pereira**; 2023; *VIS/NIR Illumination System for the OGSE of ARIEL Space Mission*; Jornadas Doutorais do Departamento de Física, Ciências ULisboa, Portugal
  54. **D. Quirino**, G. Gilli, T. Navarro, L. Kaltenegger, M. Turbet, T. J. Fauchez, J. Leconte, S. Lebonnois, **P. Machado**, J. Peralta, F. Gonzalez-Galindo; 2023; *3D Climate modelling of rocky exoplanets with a Venus-like atmosphere: LP 890-9 c and TRAPPIST-1 c*; 3rd Planetary Systems Day @IA, Porto, Portugal
  55. **R. Rianço Silva**, **P. Machado**, Z. Martins, E. Lellouch, J. Loison, M. Dobrijević, **J. A. Dias**, **J. Ribeiro**; 2023; *A study of very high resolution visible spectra of Titan: Line characterisation in visible CH<sub>4</sub> bands and the search for C<sub>3</sub>*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
  56. **J. Ribeiro**, **P. Machado**, S. Perez-Hoyos, **J. A. Dias**, P. G. J. Irwin; 2023; *Reanalyzing Jupiter ISO/SWS data through a more recent atmospheric model*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
  57. **N. C. Santos**; 2023; *Invited Panel Member*; Desafios da Ciência no Ensino Superior em Portugal, Faculdade de Psicologia e de Ciências da Educação da Universidade do Porto, Portugal
  14. James, B. L.; 2023; *Exploring ISM Properties in Pristine Environments Throughout the Universe*
  15. Jun, S.-W.; 2023; *FarSlayer: Turnkey Acceleration of Legacy Software on Commodity FPGA Cards and application to cosmological software*
  16. Kauffman, S. A.; 2023; *Is There a 4th Law for Nonergodic Systems that Construct Their Expanding Phase Space?*
  17. Mathur, S.; 2023; *Evolution of magnetic activity of solar-like stars with age*
  18. Mendes de Oliveira, C.; 2023; *The Southern Photometric Local Universe Survey*
  19. Messias, H.; 2023; *Neutral gas content in the ISM at the cosmic noon: a millimeter-based assessment*
  20. Mota, A.; 2023; *Astrobiology and Exoplanet Habitability: a Holistic Approach Joining Biology and Astrophysics*
  21. Neyrinck, M.; 2023; *Swirls, Information and Eddies, Cosmic and Chaotic*
  22. Nsamba, B.; 2023; *Progress of astronomy research at Kyambogo University*
  23. Palumbo, M. L.; 2023; *Finding other Earths by observing the Sun: physical insights from ground- and space-based solar observations*
  24. Parmentier, V.; 2023; *Exoplanets atmospheres in the 2020s: from the JWST to the E-ELTs*
  25. Pietrow, A.; 2023; *Bridging the gap: Translating high-resolution solar observations to the stellar regime*
  26. Riffel, R.; 2023; *The star formation history of nearby active galactic nuclei*
  27. Samanta, R.; 2023; *A new parametric window for QCD axion dark matter*
  28. Santiago, J.; 2023; *Multipoles in the Hubble and deceleration parameters: what does the theory has to say about it?*
  29. Seidel, J. V.; 2023; *Exoplanet atmospheric dynamics - Observations in high spectral resolution*
  30. Seymour, N.; 2023; *The GLEAMing of the First Black Holes*
  31. Tamayo Ramirez, D. A.; 2023; *Some applications of thermodynamics to explore dark energy and inflation*
  32. Teixeira, E. M.; 2023; *Coupled Quintessence in Flat and Closed Geometries*
  33. Tojeiro, R.; 2023; *Teacher-researcher collaborations: bridging the gap between contemporary science and the classroom and the impact on teacher identity, self-efficacy and wellbeing*
  34. Ulmer-Moll, S.; 2023; *Detection and modeling of cool giants*
  35. Vvard, M.; 2023; *First characterization of the precise structure of red-giant star cores*
  36. Zilhão, M.; 2023; *Dynamics of black holes and scalar fields*

## Seminars at IA <sup>[36]</sup>

1. Alecian, E.; 2023; *Stellar magnetic field origin and impact during the stellar formation*
2. Allart, R.; 2023; *Exoplanet atmospheres at high spectral resolution: toward statistical surveys*
3. Baptista, J.; 2023; *Internal symmetries in Kaluza-Klein models*
4. Barros, B. J.; 2023; *An expedition to the dark universe*
5. Beck, P. G.; 2023; *Constraining stellar and orbital co-evolution from the oscillating red-giant binaries revealed by Gaia DR3*
6. Christensen-Dalsgaard, J.; 2023; *Asteroseismic inferences of red-giant internal magnetic fields*
7. del Toro Iniesta, J. C.; 2023; *Solar spectropolarimetry: A personal view*
8. Duque-Arribas, C.; 2023; *Chemical composition of M-type dwarf stars*
9. Ellison, S. L.; 2023; *Gas and star formation in the nearby universe with the ALMA-MaNGA QUENching and STar formation (ALMaQUEST) survey*
10. Frank, A.; 2023; *Biosignatures and Technosignatures. The Telescopic Search for Life Across Interstellar Distances.*
11. Garcia, R. A.; 2023; *Architecture of Kepler single exoplanet systems compared to star-planet evolution models*
12. Heinesen, A.; 2023; *Dimming of light in general relativity: On the possibility of explaining cosmological observations without dark energy*
13. Humphrey, A.; 2023; *Exploring Machine Learning for the Euclid and Rubin/LSST Era*
51. **C. P. Pereira**; 2023; *A Calibration System for the ARIEL Space Mission*; 3 Day Mission: SP4C3 EXPLORATION, FCUL, Portugal
52. **C. P. Pereira**; 2023; *Optical Sub-System to characterize the future ARIEL Space Mission*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
53. **C. P. Pereira**; 2023; *VIS/NIR Illumination System for the OGSE of ARIEL Space Mission*; Jornadas Doutorais do Departamento de Física, Ciências ULisboa, Portugal
54. **D. Quirino**, G. Gilli, T. Navarro, L. Kaltenegger, M. Turbet, T. J. Fauchez, J. Leconte, S. Lebonnois, **P. Machado**, J. Peralta, F. Gonzalez-Galindo; 2023; *3D Climate modelling of rocky exoplanets with a Venus-like atmosphere: LP 890-9 c and TRAPPIST-1 c*; 3rd Planetary Systems Day @IA, Porto, Portugal
55. **R. Rianço Silva**, **P. Machado**, Z. Martins, E. Lellouch, J. Loison, M. Dobrijević, **J. A. Dias**, **J. Ribeiro**; 2023; *A study of very high resolution visible spectra of Titan: Line characterisation in visible CH<sub>4</sub> bands and the search for C<sub>3</sub>*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
56. **J. Ribeiro**, **P. Machado**, S. Perez-Hoyos, **J. A. Dias**, P. G. J. Irwin; 2023; *Reanalyzing Jupiter ISO/SWS data through a more recent atmospheric model*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra, Portugal
57. **N. C. Santos**; 2023; *Invited Panel Member*; Desafios da Ciência no Ensino Superior em Portugal, Faculdade de Psicologia e de Ciências da Educação da Universidade do Porto, Portugal

## Organization of Conferences <sup>[15]</sup>

1. *3rd Planetary Systems Day @IA*; 13 January 2023; Porto/Online, Portugal
2. *IA-ON10; Instituto de Astrofísica e Ciências do Espaço 10<sup>th</sup> internal workshop*; 26 to 27 January 2023; Fátima, Portugal
3. *Homenagem ao Prof. Paulo Crawford*; 10 February 2023; Lisboa, Portugal
4. *PoET Workshop*; 23 to 24 February 2023; Porto, Portugal



5. *IberiCos 2023; 17th Iberian Cosmology Meeting; 3 to 5 April 2023; Ponte de Lima, Portugal*
6. *Escape of Lyman radiation from galactic labyrinths; 18 to 21 April 2023; OAC, Kolybari, Crete*
7. *Stars Day 2.5; 24 May 2023; Observatório Geofísico e Astronómico da Universidade de Coimbra, Portugal*
8. *CosmoVerse@Lisbon; 30 May to 1 June 2023; Lisboa, Portugal*
9. *3rd Galaxies Day @IA; 14 to 16 June 2023; Porto, Portugal*
10. *Towards Other Earths III: The Planet-Star connection; 17 to 21 July 2023; Porto, Portugal*
11. *NLTE Workshop 2023; 4 to 6 September 2023; Porto, Portugal*
12. *33rd National Meeting of Astronomy and Astrophysics (ENAA 2023); 7 to 9 September 2023; Coimbra, Portugal*
13. *Space weather influence on the ionosphere and its potential threats to GNSS services: focus on the Portuguese territories; 11 October 2023; Coimbra (online), Portugal*
14. *Stars Day 2023; 4 December 2023; Porto, Portugal*
15. *COSMONATA 2023; 21 December 2023; Porto/Lisboa/Online, Portugal*

## Observing runs <sup>[22]</sup>

1. **Azaymi Siu Tapia, Ricardo Gafeira;** *Magnetic field properties on Sunspots at different mu angle; Observation on the Swedish Solar Telescope (CRISP and CHROMIS), 9-20 August 2023*
2. **Bárbara Soares (PI), Vardan Adibekyan, Nuno Santos, Sergio Sousa, Elisa Delgado Mena, Diego Bossini, Pedro Figueira,** Garik Israelian, Artur Hakobyan, Bertram Bitsch, Caroline Dorn, Christoph Mordasini, **Susana Barros, Olivier Demangeon,** K.G. Strassmeier, **João Pedro Sousa Faria;** *UPFRONT: Ultra-high Precision spectroscopy of ROcky plaNet hosts; 112.25T4, ESPRESSO@VLT 1UT; 01 Oct 2023 to 31 Mar 2024*
3. **Bruno Arsioli;** *Fermi Large Area Telescope (LAT); MeV-GeV mission. Project: Localization of GeV photons from the solar-disk; In collaboration with Solar Group; University of Trieste & INFN, Italy*
4. C. Danielski et al. (including, **Elisa Delgado Mena**); *Building a public catalogue of homogeneously characterised Ariel exoplanet-host stars; 110.24BU-111.2542; UVES/VLT; period 110-111 service mode*
5. **Carlos Martins,** Stefano Cristiani, Valentina D'Odorico, Paolo Molaro, Francesco Guarneri, Michael Murphy, Tobias Schmidt, Dinko Milakovic, L. Pasquini, Gaspare Lo Curto, **Catarina Marques,** Ricardo Genova-Santos, Guido Cupani, Carlos Allende Prieto, David Ehrenreich, **Pedro Figueira,** Jonay I. Gonzalez Hernandez, Christophe Lovis, Andrea Mehner, **Nelson Nunes,** Francesco Pepe, Rafael Rebolo, **Sergio Sousa,** Alessandro Sozzetti, S. Udry, Alejandro Suárez Mascareño, María Rosa Zapatero Osorio, **N.C. Santos,** Ennio Poretti, Giorgio Calderone, Andrea Grazian, Andrea Trost; *An ESPRESSO Redshift Drift Experiment, Part Ia; 110.247Q; ESPRESSO - VLT; P110 (GTO)*
6. **Carlos Martins,** Stefano Cristiani, Valentina D'Odorico, Paolo Molaro, Francesco Guarneri, Michael Murphy, Tobias Schmidt, Dinko Milakovic, L. Pasquini, Gaspare Lo Curto, **Catarina Marques,** Ricardo Genova-Santos, Guido Cupani, Carlos Allende Prieto, David Ehrenreich, **Pedro Figueira,** Jonay I. Gonzalez Hernandez, Christophe Lovis, Andrea Mehner, **Nelson Nunes,** Francesco Pepe, Rafael Rebolo, **Sergio Sousa,** Alessandro Sozzetti, S. Udry, Alejandro Suárez Mascareño, María Rosa Zapatero Osorio, **Nuno Santos,** Ennio Poretti, Giorgio Calderone, Andrea Grazian, Andrea Trost; *An ESPRESSO Redshift Drift Experiment, Part Ib; 111.251D; ESPRESSO - VLT; P111 (GTO)*
7. **Carlos Martins,** Stefano Cristiani, Valentina D'Odorico, Paolo Molaro, Francesco Guarneri, Michael Murphy, Tobias Schmidt, Dinko Milakovic, L. Pasquini, Gaspare Lo Curto, **Catarina Marques,** Ricardo Genova-Santos, Guido Cupani, Carlos Allende Prieto, David Ehrenreich, **Pedro Figueira,** Jonay I. Gonzalez Hernandez, Christophe Lovis, Andrea Mehner, **Nelson Nunes,** Francesco Pepe, Rafael Rebolo, **Sergio Sousa,** Alessandro Sozzetti, S. Udry, Alejandro Suárez Mascareño, María Rosa Zapatero Osorio, **Nuno Santos,** Ennio Poretti, Giorgio Calderone, Andrea Grazian, Andrea Trost; *An ESPRESSO Redshift Drift Experiment, Part IIa; 112.25K7; ESPRESSO - VLT; P112 (GTO)*
8. **Ana Rita Costa Silva,** Allart, R., **Olivier Demangeon,** Borsa, F., Palle, E., Lillo-Box, J., Herrero-Cisneros, E., Zapatero-Osorio, M. R., Lovis, C., Taberner, H., **Nuno Santos,** Vardan Adibekyan, Ehrenreich, D., Steiner, M., **Tomás Azevedo Silva,** Pepe, F.; *Emission spectroscopy survey of ultra hot Jupiters; 112.25UT; ESPRESSO, Very Large Telescope (European Southern Observatory); 2023 Oct 09, 2023 Nov 04, 2023 Dec 04, 2023 Dec 17, 2023 Dec 20, 2.21 nights (out of 3.55 nights in ESO P112, Oct 2023 - Mar 2024)*
9. D. Hodsworth et al. (including **Margarida Cunha**); *Defining a new chemically peculiar star catalogue; 2023-2-SCI-006, ID 12394, HRS/SALT; start: November 2023 (1 semester)*
10. **Davi Barbosa;** *Two days of radio observations of molecular clouds and Masers; with a single dish of 13.2m diameter - RAEGE, Açores, Portugal*
11. **Elisa Delgado Mena** et al. (as part of the NIRPS GTO Other Science proposals); *NIRPS GTO - Other Science 1: Improving metallicity determination of M dwarfs with FGK binaries; NIRPS-ESO-3.6m; ESO period 111 and 112*
12. **Elisa Delgado Mena** et al. (as part of the NIRPS GTO Other Science proposals); *NIRPS GTO - Other Science 2: Radial-velocity variations in cool giants: exoplanets or stellar activity?; NIRPS-ESO-3.6m; ESO period 111 and 112*
13. **Eduardo A. S. Cristo;** *ESPRESSO GTO; GTO mixed program targets; ESPRESSO@VLT; 2 January 2023*
14. **Eduardo A. S. Cristo;** *NIRPS commissioning; GTO mixed program targets for the commissioning; HARPS&NIRPS@3.6m La Silla; 1 - 12 February 2023*
15. **Eduardo A. S. Cristo;** *NIRPS GTO; GTO mixed program targets; HARPS&NIRPS@3.6m La Silla; 31 May - 9 June 2023*
16. P. Jachym, M. Fumagalli, J. Palous, L. Cortese, W. Cramer, S. Sivanandam, E. Brinks, A. Kabatova, J. Kenney, **Tom Scott,** F. Combes; *ALMA JELLY - Survey of Nearby Jellyfish and Ram Pressure Stripped Galaxies; 2021.1.01616.L; ALMA Large program; 2023 - ongoing*
17. P. Jachym, C. Ge, M. Yagi, M. Sun, R. Luo, E. Brinks, A. Kabatova, J. Kenney, **Tom Scott,** F. Combes; *Non-star-forming molecular gas in intra-cluster multiphase orphan cloud; 2022.1.01626.S; 2023*
18. Jean-François Donati (PI), **Jorge Filipe Gameiro;** *SPICE: Consolidating & Enhancing the SPIRou Legacy Survey; 2023*
19. **Jorge Filipe Gameiro;** *CFHT/SPIRou; 174.28 nights (4 semesters (2022b-2024a)).*

20. Mousumi Das (PI); **Daniel Vaz**(Co-Is), S. Amrutha; *Imaging Star Formation in the Milky Way Satellite Dwarf Galaxy Leo T*; A13\_077; Astrosat-UVIT; Cycle A13
21. **Pedro Machado**; *Venus observations with IRTF*; iSHELL; 19-23 October 2023
22. **Sérgio Sousa**, Mortier, **Nuno Santos**, Rojas Ayala, **Vardan Adibekyan**, Israeliian, **Olivier Demangeon**, **Susana Barros**, **Alexandros Antoniadis Karnavas**, **Elisa Delgado Mena**, Tsantaki, **Bárbara Soares**; *Know The Star To Know The Planet: Improving Sweet-cat With Homogeneous Planet-host Parameters*; Uves, Vlt Ut2, Sm 110.23td.001; 111.24hz.001
19. André Silva; *À procura por outra Terra - deteção de planetas fora do sistema solar*; Espaço vai à Escola 2023, Agrupamento de Escolas Conde de Ourém (online), Ourém; 11 October 2023
20. André Silva; *À procura por outra Terra - deteção de planetas fora do sistema solar*; Espaço vai à Escola 2023, (online) Agrupamento de Escolas da Bemposta, Portimão; 11 October 2023
21. André Silva; *À procura por outra Terra - deteção de planetas fora do sistema solar*; Espaço vai à Escola 2023, Escola Secundária Gonçalves Zarco, Matosinhos; 16 October 2023
22. André Silva; *À procura por outra Terra - deteção de planetas fora do sistema solar*; Espaço vai à Escola 2023, Escola Básica e Secundária de Águas Santas, Maia; 26 October 2023

## Outreach talks <sup>[261]</sup>

1. Afonso Vale; *Blinking Lights in Taurus: long-term variability of Young Stars and Brown Dwarfs*; Planetário do Porto; 4 December 2023
2. Alberto Negrão; *Titã, uma lua de outro mundo*; Ignite IAstro, Ílhavo; 14 October 2023
3. Alexandre Cabral; *Há futuro na exploração Espacial?*; Mesa redonda 3 Day Mission SP4C3 EXPLORATION, FCUL – Lisboa; 15 October 2023
4. Alexandre Cabral; *A Magia da Luz e da Cor*; Palestra na Escola B+S Gama Barros, Cacém, Sintra; 10 February 2023
5. Alexandre Cabral; *A Magia da Luz e da Cor*; Escola B D. António de Ataíde, Castanheira do Ribatejo, Vila Franca de Xira; 25 March 2023
6. Alexandre Cabral; *Grandes telescópios, espectrógrafos e a luz em busca de planetas extra solares*; Escola Secundaria Leal da Camara - Rio de Mouro; 20 April 2023
7. Alexandre Cabral; *Astronomia XXL*; Ignite Astro, Auditório dos Paços do Concelho, Torres Vedras; 15 April 2023
8. Alexandre Cabral; *A Luz*; Centro Ciência Viva do Lousal; 16 February 2023
9. Alexandre Cabral; *Uma Aventura no Deserto de Atacama*; Centro Ciência Viva do Lousal; 24 November 2023
10. Ana Rita Costa Silva; *Astronomia 101*; Escola de Verão de Astronomia, Instituto Superior Técnico, Lisboa; 6 September 2023
11. Ana Rita Costa Silva; *Astronomia no Feminino*; Planetário do Porto, Porto; 11 February 2023
12. Ana Rita Costa Silva; *Exoplanetas e a procura por vida extraterrestre*; Astrofesta XXVIII, Centro de Ciência Viva de Constância; 26 August 2023
13. Ana Rita Costa Silva; *Exoplanetas*; Universidade Júnior do Porto, Centro de Astrofísica da Universidade do Porto; 11 & 18 July 2023
14. Ana Rita Costa Silva; *Instagram como ferramenta para comunicação de ciência e influência para a ciência*; Encontro Nacional de Astronomia e Astrofísica XXXIII, Coimbra; 9 September 2023
15. Ana Rita Costa Silva; *Outros mundos, outras atmosferas*; Ignite IAstro, Torres Vedras; 15 April 2023
16. Ana Rita Costa Silva; *Quando for grande, quero andar com a cabeça na Lua*; Escolas Secundárias e Observatório Astronómico de Santana, São Miguel, Açores; 11-12 May 2023
17. Ana Rita Costa Silva; *Ver estrelas através do Instagram*; INOVA+ Webinar series Ciência às Quartas; 13 September 2023
18. Ana Paulino Afonso; *Portugal at the International Astronomy Olympiad*; Coimbra; 9 September 2023
23. André Silva; *À procura por outra Terra - deteção de planetas fora do sistema solar*; Espaço vai à Escola 2023, (online); 26 October 2023
24. André Silva; *À procura por outra Terra - deteção de planetas fora do sistema solar*; Espaço vai à Escola 2023, Escola Secundária Aurélio de Sousa, Porto; 30 October 2023
25. André Silva; *À procura por outra Terra - deteção de planetas fora do sistema solar*; Espaço vai à Escola 2023, Agrupamento de Escolas Professor Paula Nogueira (online), Olhão; 2 November 2023
26. André Silva; *À procura por outra Terra - deteção de planetas fora do sistema solar*; Espaço vai à Escola 2023, Agrupamento de Escolas Professor Ruy Luís Gomes (online), Almada; 9 November 2023
27. André Silva; *À procura por outra Terra - deteção de planetas fora do sistema solar*; Espaço vai à Escola 2023, Escola Básica Sophia de Mello Breyner, Corvo; 24 November 2023
28. Ângela Santos; *O envelhecimento ativo das estrelas*; Ignite IAstro, Ílhavo; 14 September 2023
29. Ângela Santos; *O envelhecimento ativo das estrelas*; Ignite IAstro, Marco de Canaveses; 11 November 2023
30. Ângela Santos; *O envelhecimento ativo das estrelas*; Ignite IAstro, Torres Vedras; 15 April 2023
31. Ângela Santos; *O género da nossa estrela: a atividade das estrelas*; Online - Noite de observação: Apresentação às estrelas do Centro Ciência Viva do Algarve; 09 February 2023
32. Bárbara Soares; *How to swallow a planet: Processes and consequences of planet engulfment*; PlanetS@Fantasy Basel 2023, Basel, Switzerland; 18 May 2023
33. Bárbara Soares; *Dia das Mulheres e Raparigas na Astronomia 2023*; 11 February 2023
34. Bruno Arsioli; *On the solar very-high energy emission*; Ignite IAstro, Ílhavo; 14 October 2023
35. Carlos Martins; *A Física da Energia e do Aquecimento Global*; ES Fonseca Benevides, Lisboa; 9 October
36. Carlos Martins; *A Física da Energia e do Aquecimento Global*; ES José Macedo Fragateiro, Ovar; 17 October 2023
37. Carlos Martins; *A Física da Energia e do Aquecimento Global*; ES Josefa de Óbidos, Lisboa; 19 October 2023
38. Carlos Martins; *A Física da Energia e do Aquecimento Global*; ES Maria Amália Vaz de Carvalho, Lisboa; 25 October 2023
39. Carlos Martins; *A Física da Energia e do Aquecimento Global*; ES Emídio Navarro, Almada; 26 October 2023
40. Carlos Martins; *A Física da Energia e do Aquecimento Global*; ES de Vouzela; 8 November 2023

41. Carlos Martins; *A Física da Gravidade e dos Satélites*; Colégio da Trofa, Portugal; 12 October 2023
42. Carlos Martins; *A Física da Gravidade e dos Satélites*; ES da Ribeira Grande, Azores; 11 October 2023
43. Carlos Martins; *A Física da Gravidade e dos Satélites*; ES de Pinhal de Rei, Marinha Grande; 13 October 2023
44. Carlos Martins; *A Física da Gravidade e dos Satélites*; ES da Maia; 20 October 2023
45. Carlos Martins; *A Física da Gravidade e dos Satélites*; ES da Bemposta, Portimão; 24 October 2023
46. Carlos Martins; *A Física da Gravidade e dos Satélites*; ES de Fajões, Oliveira de Azeméis; 10 November 2023
47. Carlos Martins; *A Física da Gravidade e dos Satélites*; Nobel International School Algarve, Lagoa; 24 October 2023
48. Carlos Martins; *A Física da Radioactividade e do Cancro*; ES de Castro Verde; 27 March 2023
49. Carlos Martins; *A Física da Radioactividade e do Cancro*; ES de S. Roque do Pico; 9 October 2023
50. Carlos Martins; *A Física da Radioactividade e do Cancro*; ES de Estarreja; 17 October 2023
51. Carlos Martins; *A Física da Radioactividade e do Cancro*; ES Filipa de Vilhena, Porto; 27 November 2023
52. Carlos Martins; *A Física da Relatividade*; ES Filipa de Vilhena, Porto; 20 October 2023
53. Carlos Martins; *A Física da Relatividade*; ES Latino Coelho, Lamego; 30 October 2023
54. Carlos Martins; *A Física da Relatividade*; ES Rocha Peixoto, Póvoa de Varzim; 9 November 2023
55. Carlos Martins; *A Física da Vida e dos Extraterrestres*; ES Aurélia de Sousa, Porto; 13 November 2023
56. Carlos Martins; *A Física do Big Bang*; ES Camilo Castelo Branco, Famalicão; 12 October 2023
57. Carlos Martins; *A Física do Big Bang*; ES Sebastião da Gama, Setúbal; 26 October 2023
58. Carlos Martins; *A Física do Big Bang*; IberiCos 2023 Public Talk, Ponte de Lima; 3 April 2023
59. Carlos Martins; *Euclid e o lado escuro do Universo*; CAUP Public Talk; 1 July 2023
60. Carlos Martins; *How to improve Portuguese secondary education*; CEIA-PPCB, Paredes de Coura; 18 August 2023
61. Carlos Martins; *The Phi in the Sky project*; CEIA-PPCB, Paredes de Coura; 21 August 2023
62. Catarina Lobo; *A nossa galáxia e as outras: uma viagem através do Universo*; Escola Secundária Gonçalves Zarco (Matosinhos); 24 November 2023
63. Catarina Lobo; *A nossa galáxia e as outras: uma viagem através do Universo*; Colégio Casa Mãe (Baltar); 12 December 2023
64. Catarina Lobo; *A Via Láctea e as outras galáxias*; Centro de Astrofísica da Universidade do Porto (Universidade Júnior UP); 11 July 2023
65. Catarina Lobo; *A Via Láctea e as outras galáxias*; Centro de Astrofísica da Universidade do Porto (Universidade Júnior UP); 18 July 2023
66. Catarina Lobo; *Dentro de um enxame... de galáxias!*; Ignite IAstro 2023, Vizela (Auditório Francisco Ferreira); 20 May 2023
67. Catarina Lobo; *Dentro de um enxame... de galáxias!*; Ignite IAstro, Marco de Canaveses; 11 November 2023
68. Catarina Marques; *Cosmologia Observacional: o caminho do ESPRESSO ao ANDES*; DFA – FCUP; 18 April 2023
69. Catarina Marques; *Os mistérios do nosso Universo: em busca das respostas*; Escola Secundária de São Pedro do Sul (online), Viseu; 23 October 2023
70. Catarina Marques; *Os mistérios do nosso Universo: em busca das respostas*; Escola Básica de Montenegro (online), Faro; 26 October 2023
71. Catarina Marques; *Os mistérios do nosso Universo: em busca das respostas*; Escola Secundária Inês de Castro, Vila Nova de Gaia; 10 November 2023
72. Catarina Marques; *Os mistérios do nosso Universo: em busca das respostas*; Escola Básica do Sudeste de Baião (online), Porto; 13 November 2023
73. Catarina Marques; *Os mistérios do nosso Universo: em busca das respostas*; Escola Secundária de São Pedro da Cova, Gondomar; 14 November 2023
74. Cédric Pereira; *Workshop sobre a Missão Espacial ARIEL, o projecto ExoClock e utilização de telescópios*; Semana Mundial do Espaço 2023, Açores; 9 October 2023
75. Cirino Pappalardo; *Portugal on the MOONS*; Ignite IAstro, Torres Vedras; 15 April 2023
76. Clara Sousa Silva; *Life and how to find it*; Hudson Canal Historical Society; 29 September 2023
77. Clara Sousa Silva; *Life and how to find it*; Lifelong Learning Institute; 6 October 2023
78. Clara Sousa Silva; *Space Talk*; Liberty Science Center; 16 November 2023
79. Daniel Folha; *The Wow Factor - Science communication for the general public*; Instituto Universitário de Ciências da Saúde - CESPUPhD Day; October 2023
80. Davi Barbosa; *Radiografia das Galáxias*; XXVIII Astrofestas, Constância; 26 August 2023
81. Davi Barbosa; *Do Micro ao Macro*; Espaço vai à escola – ESERO & Ciência Viva, Escola Primária João Franco, Fundão (online)
82. David Grüber; *A brief history of our universe*; "Astronomy on Tap", Catraio/Porto; 3 May 2023
83. Elisa Delgado Mena; *Del Big Bang a los exoplanetas: un viaje químico a través del espacio*; University of Valladolid, Spain; 5 October 2023
84. Francisco S. N. Lobo; *Odisseia no Espaço: 2023 e além...*; "3 Day Mission: SP4C3 EXPLORATION" - Congresso '23 da Physis; 14 October 2023
85. Ilídio André Costa; *Um dia muito especial*; Escola Básica Manoel de Oliveira, Porto; 09 October 2023
86. Ilídio André Costa; *Um dia muito especial*; Escola Básica dos Miosóti, Porto; 10 October 2023
87. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Santa Cruz da Trapa, São Pedro do Sul; 10 October 2023
88. Ilídio André Costa; *Um dia muito especial*; Escola Básica Júlio Dinis, Grijó, Vila Nova de Gaia; 10 October 2023
89. Ilídio André Costa; *Com a verdade me enganas*; Escola Secundária Jaime Moniz; 12 October 2023
90. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Ponte das Três Entradas, Oliveira do Hospital; 12 October 2023
91. Ilídio André Costa; *Um dia muito especial*; Jardim de Infância de Areias, Gondomar; 12 October 2023
92. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Casal do Malta, Marinha Grande; 16 October 2023



93. Ilídio André Costa; *Um dia muito especial*; Escola Básica n.º 1 de São Caetano, Gondomar; 16 October 2023
94. Ilídio André Costa; *Com a verdade me enganas*; Escola Básica do Castro, Alvarelhos, Trofa; 16 October 2023
95. Ilídio André Costa; *Com a verdade me enganas*; Escola Básica Soares dos Reis, Vila Nova de Gaia; 16 October 2023
96. Ilídio André Costa; *Um dia muito especial*; Ilha de Santa Maria- Açores; 17 October 2023
97. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Amareleja, Moura; 17 October 2023
98. Ilídio André Costa; *Um dia muito especial*; Jardim Escola João De Deus Tomar 1; 17 October 2023
99. Ilídio André Costa; *Um dia muito especial*; Escola Básica Manuel Augusto Papança, Reguengos de Monsaraz; 23 October 2023
100. Ilídio André Costa; *Um dia muito especial*; Escola Básica e Secundária de Mora; 24 October 2023
101. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Guetim, Espinho; 24 October 2023
102. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Azagães, Carregosa, Oliveira de Azeméis; 24 October 2023
103. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Azagães, Carregosa, Oliveira de Azeméis; 25 October 2023
104. Ilídio André Costa; *Um dia muito especial*; Escola Básica da Agrela e Vale do Leça, Santo Tirso; 25 October 2023
105. Ilídio André Costa; *Com a verdade me enganas*; Escola Básica D. Afonso Henriques, Creixomil, Guimarães; 25 October 2023
106. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Santa Marta do Pinhal, Corroios, Seixal; 26 October 2023
107. Ilídio André Costa; *Um dia muito especial*; Escola Básica Arquitecto Victor Palla, Lisboa; 27 October 2023
108. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Azagães, Carregosa, Oliveira de Azeméis; 30 October 2023
109. Ilídio André Costa; *Um dia muito especial*; Escola Básica de São João de Deus, Lisboa; 30 October 2023
110. Ilídio André Costa; *Um dia muito especial*; Escola Básica de São Paio, Canidelo, Vila Nova de Gaia; 30 October 2023
111. Ilídio André Costa; *Com a verdade me enganas*; Escola Secundária Filipa de Vilhena, Porto; 30 October 2023
112. Ilídio André Costa; *Com a verdade me enganas*; Escola Secundária Filipa de Vilhena, Porto; 30 October 2023
113. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Pedreira, Argivai, Póvoa de Varzim; 31 October 2023
114. Ilídio André Costa; *Com a verdade me enganas*; Escola Secundária de Molelos, Tondela; 31 October 2023
115. Ilídio André Costa; *Com a verdade me enganas*; Escola Básica da Agrela e Vale do Leça, Santo Tirso; 02 November 2023
116. Ilídio André Costa; *Com a verdade me enganas*; Escola Básica e Secundária D. João V, Damaia, Amadora; 02 November 2023
117. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Azagães, Carregosa, Oliveira de Azeméis; 03 November 2023
118. Ilídio André Costa; *Com a verdade me enganas*; Escola Básica e Secundária de Arrifana, Santa Maria da Feira; 06 November 2023
119. Ilídio André Costa; *Com a verdade me enganas*; Escola Básica e Secundária D. Martinho Vaz de Castelo Branco, Póvoa de Santa Iria, Vila Franca de Xira; 06 November 2023
120. Ilídio André Costa; *Um dia muito especial*; Jardim de Infância de Viladra, Vouzela; 07 November 2023
121. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Monte Abraão, Sintra; 08 November 2023
122. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Pindelo, Oliveira de Azeméis; 08 November 2023
123. Ilídio André Costa; *Com a verdade me enganas*; Escola Básica Sophia de Mello Breyner, Corvo, Vila Nova de Gaia; 08 November 2023
124. Ilídio André Costa; *Um dia muito especial*; Escola Básica e Secundária Padre Alberto Neto, Queluz, Sintra; 09 November 2023
125. Ilídio André Costa; *Um dia muito especial*; Escola Básica da Bobadela, Loures; 14 November 2023
126. Ilídio André Costa; *Um dia muito especial*; Escola Básica n.º 2 do Lavradio, Barreiro; 14 November 2023
127. Ilídio André Costa; *Com a verdade me enganas*; Pevidém; 14 November 2023
128. Ilídio André Costa; *Com a verdade me enganas*; Escola Secundária Dr. Joaquim Gomes Ferreira Alves, Valadares, Vila Nova de Gaia; 14 November 2023
129. Ilídio André Costa; *Um dia muito especial*; Escola Básica Álvaro Velho, Lavradio, Barreiro; 15 November 2023
130. Ilídio André Costa; *Um dia muito especial*; Escola Básica Engenheiro Duarte Pacheco, Lisboa; 15 November 2023
131. Ilídio André Costa; *Com a verdade me enganas*; Escola Secundária Aurélia de Sousa, Porto; 16 November 2023
132. Ilídio André Costa; *Com a verdade me enganas*; Escola Secundária Frei Heitor Pinto, Covilhã; 16 November 2023
133. Ilídio André Costa; *Um dia muito especial*; Escola Básica de Fidalguinhos, Barreiro; 17 November 2023
134. Ilídio André Costa; *Um dia muito especial*; Escola Básica do Bairro do Restelo, Lisboa; 17 November 2023
135. Ilídio André Costa; *Um dia muito especial*; Externato Ribadouro; 16 November 2023
136. Ilídio Costa; *Um dia muito especial*; online (para Timor-Leste); 18 April 2023
137. Inês Meira Leite; *Aventura nos telescópios do Chile*; Biblioteca Cinema Europa; 25 May 2023
138. Jarle Brinchmann; *De Dark Ages à Dark Matter - as questões escuras que iluminam a astronomia*; Romulo Coimbra; 23 March 2023
139. Jarle Brinchmann; *Euclid - e o Universo escuro*; Conferência de Professores Espaciais, Lisboa; 17 November 2023
140. Joana Marques; *Do Big Bang à Civilização: história do Universo e importância da Astronomia*; Escola Portuguesa de Moçambique and Instituto Educativo do Juncal (online); December 2023
141. João A. Dias, Rafael Silva, Constança Freire; *Navegando por Mares Nunca Dantes Navegados*; XXXIII Encontro Nacional de Astronomia e Astrofísica, Coimbra; 7-9 September 2023

142. João Lima; *Nem sempre o Sol está calmo*; Ignite IAstro, Torres Vedras; 15 April 2023
143. João L. Yun; *Impacto global no planeta Terra: Crise climática e crise ambiental*; III Encontro de Geografia; Escola Secundária Amélia Rey Colaço, Linda-a-Velha; 30 March 2023.
144. José Afonso; *A Astronomia da Próxima Geração*; Escola Ciência Viva, Pavilhão do Conhecimento; 18 January 2023
145. José Afonso; *O Lado Brilhante do Universo*; Ciclo Temas de Ciência do Ano 2023, Biblioteca Municipal de Beja; 20 January 2023
146. José Ribeiro; *Saturno*; Saturnália, Teatro Romano - Museu de Lisboa; 15 December 2023
147. Koraljka Mužic, K. Muzic, A. Afonso, J. Grave, P. Gual, B. Ribeiro, G. Rojas; *Olimpíadas de Astronomia: Envolvendo futuras gerações de cientistas*; XXXIII Astronomy and Astrophysics National Meeting (ENAA), Coimbra, Portugal; September 2023
148. Lara Sousa; *Ouvir o Universo*; Ignite IAstro, Marco Canaveses; 11 November 2023
149. Margarida Cunha; *A Música das Estrelas*; Ignite IAstro, Ílhavo; 14 October 2023
150. Maria Teresa Barata; *Tempestade em órbita e clima espacial*; Pint of Science, Liquidambar, Coimbra; 29 May 2023
151. Marina Cortês; *Biocosmology*; Pavilhão do Conhecimento, CiênciaViva; 29 September 2023.
152. Nelson J. Nunes; *Finding black holes*; Escola Básica e Secundária de São Sebastião, Mértola; 16 October 2023
153. Nelson J. Nunes; *Finding black holes*; Escola Secundária Francisco Franco, Funchal; 15 November 2023
154. Nelson J. Nunes; *Finding black holes*; Escola Profissional de Educação para o Desenvolvimento; 28 June 2023
155. Nelson J. Nunes; *How do we weight the Universe?*; Colégio Vasco da Gama; 6 November 2023
156. Nelson J. Nunes; *How do we weight the Universe?*; Escola Básica e Secundária Padre Alberto Neto, Queluz, Sintra; 25 October 2023
157. Nelson J. Nunes; *Surfing a gravitational wave*; Escola Padre Manuel Álvares, Ribeira Brava, Madeira; 13 November 2023
158. Nelson J. Nunes; *Surfing a gravitational wave*; Escola Secundária Stuart Carvalhais, Massamá, Sintra; 8 November 2023
159. Nelson J. Nunes; *Surfing a gravitational wave*; Escola Secundária do Arco-Íris, Portela, Loures; 3 November 2023
160. Nelson J. Nunes; *Surfing a gravitational wave*; Escola Secundária Fernando Lopes Graça, Parede, Cascais; 23 October 2023
161. Nelson J. Nunes; *Surfing a gravitational wave*; Escola Secundária José Saramago, Mafra; 11 October 2023
162. Nelson J. Nunes; *The sky tonight*; Centro de Educação e Desenvolvimento Nossa Senhora da Conceição (Casa Pia); 30 October 2023
163. Nelson J. Nunes; *The sky tonight*; Escola Básica e Secundária Dr. Ângelo Augusto da Silva, Funchal; 14 November 2023
164. Nelson J. Nunes; *The sky tonight*; Escola Básica Roque Gameiro, Reboleira, Amadora; 18 October 2023
165. Nelson J. Nunes; *The sky tonight*; Escola Padre Manuel Álvares, Ribeira Brava, Madeira; 13 November 2023
166. Nelson J. Nunes; *The sky tonight*; Escola Roque Gameiro, Amadora; 27 February 2023
167. Nelson J. Nunes; *The sky tonight*; Grémio de instrução liberal; 27 March 2023
168. Nuno Santos; *Palestra e debate "Noite Europeia dos Investigadores – Armamar"*; Armamar; 29 September 2023
169. Nuno Santos; *Participação na Mostra da Universidade do Porto, Pavilhão Multiusos de Gondomar - stand do DFA*; 20 April 2023
170. Nuno Gonçalves; *Astrofesta 2023, Constância*; 26 August 2023
171. Nuno Gonçalves; *Noite Internacional de Observação da Lua 2023, Colares*; 21 October 2023
172. Nuno Gonçalves; *O Espaço vai à Escola, Escola Secundária da Portela, Lisboa*; 9 November 2023
173. Patrício Lagos; *Anãs, azuis e compactas*; Ignite IAstro, Vizela; 20 May 2023
174. Paulo Maurício de Carvalho; *The "Phi in the Sky" project for secondary schools, Escola Secundária de Paredes, Paredes*; 12 January 2023
175. Paulo Maurício de Carvalho; *Um universo em expansão acelerada*; Escola Secundária de Latino Coelho, Lamego; 1 February 2023
176. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu (Online)*; Centro de Educação e Desenvolvimento D. Maria Pia (Casa Pia), Lisboa; 3 October 2023
177. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu (Presencial)*; Escola Jasmim, Valadares, Vila Nova de Gaia; 4 October 2023
178. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu (Presencial)*; Escola Básica Júlio Dinis, Grijó, Vila Nova de Gaia; 9 October 2023
179. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu (Presencial)*; Escola Secundária Cristina Torres, Figueira da Foz; 10 October 2023
180. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu (Presencial)*; Escola Básica Manoel de Oliveira, Aldoar, Porto; 11 October 2023
181. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz (Presencial)*, Escola Básica n.º 1 de São Caetano, S. Caetano, Gondomar; 12 October 2023
182. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz (Presencial)*, Colégio "Casa Mãe"; Baltar; 12 October 2023
183. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu (Presencial)*; Escola Básica de Argoncilhe, Sta. Maria da Feira; 13 October 2023
184. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu (Online)*; Escola EB1/JI de Aeroporto, Santa Maria, Açores; 16 October 2023
185. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz (Online)*; Escola Profissional do Pico, Açores; 16 October 2023
186. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu (Online)*; Escola Portuguesa de São Tomé e Príncipe, S. Tomé e Príncipe; 17 October 2023
187. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu (Online)*; Escola Básica e Secundária da Bemposta, Portimão; 18 October 2023
188. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu (Presencial)*; Escola Básica de Pedome, Vila Nova de Famalicão; 18 October 2023

189. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Online); Escola Básica D. Carlos I, Sintra; 19 October 2023
190. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Jardim Escola João De Deus, Salreu, Estarreja; 19 October 2023
191. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Online); Escola Secundária de Figueira de Castelo Rodrigo, Figueira de Castelo Rodrigo; 19 October 2023
192. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Secundária Filipa de Vilhena, Porto; 20 October 2023
193. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Online); Escola Secundária Viriato, Viseu; 23 October 2023
194. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Básica Professor Doutor Carlos Mota Pinto, Lajeosa do Dão, Tondela; 23 October 2023
195. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Jardim de Infância de São Caetano 2, Rio Tinto; 24 October 2023
196. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Online); Escola Básica de Alverca, Vila Franca de Xira; 24 October 2023
197. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Presencial); Escola Básica 2/3 de Pevidém, Guimaraães; 23 October 2023
198. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial), Escola Básica e Secundária de Águas Santas, Maia; 25 October 2023
199. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Presencial); Escola Básica de Outeiro, Gondomar; 26 October 2023
200. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Jardim de Infância n.º 1 de Portelinha, Fânzeres, Gondomar; 26 October 2023
201. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Básica Gualdim Pais, Pombal; 26 October 2023
202. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Básica de Fonte Nova, Pombal; 26 October 2023
203. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Presencial); Escola Básica de Vouzela, Vouzela; 27 October 2023
204. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Online); Escola Secundária do Arco-Iris, Portela, Loures; 30 October 2023
205. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Básica n.º 1 de Junqueira, Vila do Conde; 30 October 2023
206. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Presencial); Escola Secundária Filipa de Vilhena, Porto; 30 October 2023
207. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Online); Escola Básica Guilherme Stephens, Marinha Grande; 31 October 2023
208. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Online); Escola Secundária Rainha Dona Leonor, Lisboa; 2 November 2023
209. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Online); Escola Básica Engenheiro Duarte Pacheco, Lisboa; 2 November 2023
210. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Online); Escola Básica Engenheiro Duarte Pacheco, Lisboa; 2 November 2023
211. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Online); Escola Portuguesa de Cabo Verde, Cidade da Praia, Cabo Verde; 3 November 2023
212. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Básica de São João da Foz, Porto; 3 November 2023
213. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Presencial); Jardim Escola João De Deus; Salreu, Estarreja; 7 November 2023
214. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Secundária de São Pedro do Sul, S. Pedro do Sul; 9 November 2023
215. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Básica de Pombal, Pombal; 9 November 2023
216. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Secundária de Santa Comba Dão, Santa Comba Dão; 10 November 2023
217. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Básica e Secundária de Sever do Vouga, Sever do Vouga; 14 November 2023
218. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Presencial); Escola Básica de Ponte das Três Entradas, S. Sebastião da Feira, Oliveira do Hospital; 16 November 2023
219. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Presencial); Escola Básica de Ponte das Três Entradas, S. Sebastião da Feira, Oliveira do Hospital; 16 November 2023
220. Paulo Maurício de Carvalho; *Da Idade da Magia a Galileu* (Presencial); Escola Básica de Ponte das Três Entradas, S. Sebastião da Feira, Oliveira do Hospital; 16 November 2023
221. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Básica do Sudeste de Baião, St<sup>a</sup>. Marinha do Zêzere, Baião; 17 November 2023
222. Paulo Maurício de Carvalho; *Um Universo de Informação - A Luz* (Presencial); Escola Básica e Secundária de Fajões, Fajões, Oliveira de Azeméis; 28 November 2023
223. Paulo M. Sá; *Últimas Notícias do Universo*; O Espaço vai à Escola 2023 – ESERO & Ciência Viva, Escola Secundária Júlio Dantas, Lagos; 26 October 2023
224. Paulo M. Sá; *Últimas Notícias do Universo*; O Espaço vai à Escola 2023 – ESERO & Ciência Viva, Escola Secundária de Loulé, Loulé; 06 November 2023
225. Paulo M. Sá; *Últimas Notícias do Universo*; O Espaço vai à Escola 2023 – ESERO & Ciência Viva, Escola Secundária de Tomás Cabreira, Faro; 07 November 2023
226. Paulo M. Sá; *Últimas Notícias do Universo*; O Espaço vai à Escola 2023 – ESERO & Ciência Viva, Escola Básica e Secundária de Albufeira, Albufeira; 09 November 2023
227. Paulo M. Sá; *Últimas Notícias do Universo*; O Espaço vai à Escola 2023 – ESERO & Ciência Viva, Escola Básica e Secundária da Bemposta, Portimão; 13 November 2023
228. Pedro Machado; *Atmosferas Planetárias do Sistema Solar aos Exoplanetas*; Universidade dos Açores; 1 March 2023



229. Pedro Machado; *À conversa com os alunos do CanSat Júnior Açores*; Escola Secundária da Lagoa, Açores; 23 February 2023
230. Pedro Machado; *Espaço, a Próxima Fronteira...e a Lua e Marte aqui tão perto*; Salão Nobre da Camara Municipal de Ponta Delgada, Açores; 23 February 2023
231. Pedro Machado; *Exploração Espacial: com os olhos no Céu e os pés na Terra!*; Colégio do Castanheiro, Açores; 23 February 2023
232. Pedro Machado; *Vénus*; Centro Ciência Viva de Faro; 12 May 2023
233. Pedro Machado; *Do Sistema Solar aos Exoplanetas*; Escola Secundária Pedro Nunes, Lisboa; 30 March 2023
234. Pedro Machado; *Exploração Espacial: com os pés na Terra e a cabeça nas estrelas*; Escolas de Timor (Dili café), Online; 9 July 2023
235. Pedro Machado; *Do Sistema Solar aos Exoplanetas*; Espaço Vai à Escola ESERO - Ciência Viva, Escola Casa Pia; 3 November 2023
236. Pedro Machado; *Do Sistema Solar aos Exoplanetas*; Espaço Vai à Escola ESERO - Ciência Viva, Escola Luísa Todi, Setúbal; 10 November 2023
237. Pedro Machado; *Do Sistema Solar aos Exoplanetas*; Espaço Vai à Escola ESERO - Ciência Viva, Escola da Ramada; 10 November 2023
238. Pedro Machado; *Do Sistema Solar aos Exoplanetas*; Espaço Vai à Escola ESERO - Ciência Viva, Escola de Nelas; 13 November 2023
239. Pedro Machado; *Do Sistema Solar aos Exoplanetas*; Espaço Vai à Escola ESERO - Ciência Viva, Escola de Colares-Sintra, 13 November 2023
240. Pedro Machado; *Do Sistema Solar aos Exoplanetas*; Espaço Vai à Escola ESERO - Ciência Viva, Escola Algueirão-Mem Martins; 28 November 2023
241. Pedro Machado; *Espaço, a Próxima Fronteira...e a Lua e Marte aqui tão perto*; Escola Básica e Integrada Roberto Ivens; 24 February 2023
242. Pedro Machado; *Atmosferas planetárias*; Ignite IAstro, Vizela; 20 May 2023
243. Pedro Machado; *Outros Mundos: a Nova Grande Aventura*, OASA – Observatório Astronómico de Santana; 24 February 2023
244. Pedro Machado; *Encontro com o Cientista*; Pavilhão do Conhecimento – Centro Ciência Viva; 8 February 2023
245. Ricardo Reis; *Como produzir uma sessão de planetário?*; Planetários/PT 2023 - 2º Encontro nacional de Planetários; 20 February 2023
246. Rodrigo A. Carvajal Pizarro; *Looking for galaxies in a Universe of data*; IX Ecuadorian School of Astronomy and Astrophysics, Quito, Ecuador; 1 August 2023
247. Sérgio Sousa; *À descoberta de Exoplanetas com o CHEOPS e o ESPRESSO*; Escola Básica Dr. Carlos Pinto Ferreira, Junqueira, Vila do Conde; 11 October 2023
248. Sérgio Sousa; *À descoberta de Exoplanetas com o CHEOPS e o ESPRESSO*; Escola Secundária Filipa de Vilhena, Porto; 17 October 2023
249. Sérgio Sousa; *À descoberta de Exoplanetas com o CHEOPS e o ESPRESSO*; Escola Secundária Aurélia de Sousa, Porto; 30 October 2023
250. Sérgio Sousa; *À descoberta de Exoplanetas com o CHEOPS e o ESPRESSO*; Escola Básica de Milheirós de Poiares, Santa Maria da Feira; 31 October 2023
251. Sérgio Sousa; *À descoberta de Exoplanetas com o CHEOPS e o ESPRESSO*; Colégio da Trofa; 08 November 2023
252. Sérgio Sousa; *Tirar as medidas a exoplanetas*; Ignite IAstro, Vizela; 30 May 2023
253. Sérgio Sousa; *Tirar as medidas a exoplanetas*; Ignite IAstro, Marco de Canaveses; 11 November 2023
254. Slava L. L. Bourgeois; *Forecasting solar activity through mathematical morphology image processing*; Tipton Secondary School, Sheffield, UK; 6 December 2023
255. Susana C. C. Barros; *HD110067 sistema com 6 planetas*; Entrevista para a Antena 1 noticiário; 30 November 2023
256. Tiago Barreiro Gonçalves; *Os invisíveis e imparáveis neutrinos*; Ignite IAstro, Ílhavo; 14 October 2023
257. Tiago Barreiro Gonçalves; *Os invisíveis e imparáveis neutrinos*; Ignite IAstro, Marco de Canaveses; 11 November 2023
258. Tomás de Azevedo Silva; *Unveiling the atmospheres of distant planets*; Astronomy On Tap; 03 May 2023
259. Tomás de Azevedo Silva; *Em busca de planetas distantes, e como desvendar suas atmosferas!*; Espaço vai à Escola, Total of >20 talks; 2023
260. Tomás de Azevedo Silva; *Desvendar as atmosferas de planetas distantes*; Ignite IAstro, Marco de Canaveses; 11 November 2023
261. Tomás de Azevedo Silva; *Desvendar as atmosferas de planetas distantes*; Ignite IAstro, Vizela; 20 May 2023

## Reports <sup>[3]</sup>

1. **E. Duarte**; PLATO-UOL-PDC-DD-0004, *On-ground estimation ATBD*, issue 1.6, 2023
2. **E. Duarte**; PLATO-UOL-PDC-DD-0005, *Star CCD position calculation ATBD*, issue 1.3, 2023
3. **E. Duarte**; PLATO-UOL-PDC-DD-0007, *On-ground COB to Sky position ATBD*, issue 1.8, 2023

## External seminars by IA researchers <sup>[45]</sup>

1. **Ana Paulino Afonso**; *Exploring LAEs across cosmic time: numbers and insights powered by Machine Learning*; Ciências ULisboa, Portugal; 13 December 2023
2. **Andrew R. Liddle**; *Biocosmology: birth of a new science*; International Quantum Gravity and All That discussion group; online (hosted in Tokyo); 12 January 2023
3. **Andrew R. Liddle, Marina Cortês**; *Physics in Artificial Intelligence*; Online seminar; 26 November 2023
4. **Bruno Arsioli**; *Supermassive Black Holes and Blazars: Exploring the Multifrequency and Multimessenger Universe*; Ciências ULisboa, Portugal; 3 May 2023
5. **Bruno J. Barros**; *An expedition to the dark universe*; Departamento de Física, Ciências ULisboa, Portugal; 29 March 2023
6. **Bruno J. Barros**; *Delving into quintessence interactions*; Universidad de Salamanca, Spain; 22 March 2023
7. **Carlos J. A. P. Martins**; *Phi in the Sky: Astrophysical probes of fundamental physics*; ICCUB Seminar, Barcelona, Spain; 13 February 2023
8. **Carlos J. A. P. Martins**; *The ANDES Calibration Validation Strategy*, CAUP; 9 January 2023

9. **Cirino Pappalardo**; *The Importance of Being Nebular*; Ciências ULisboa; 15 March 2023
10. **Cirino Pappalardo**; *The Importance of Being Nebular*; Ciências ULisboa; 26 October 2023
11. **Clara Sousa Silva**; *Quantum Astrochemistry*; PSI, Switzerland; 1 June 2023
12. **Daniel Vaz**; *The MUSE-Faint Survey*; University of Surrey, UK; 8 June 2023
13. **Elisa Delgado Mena**; *The impact of stellar composition: from Galactic chemical evolution to planet formation*; IAA (online), Granada, Spain; 1 June 2023
14. **Jarle Brinchmann**; *MUSE-Faint - Dissecting the faintest galaxies with MUSE*; University of Surrey, United Kingdom; 27 June 2023
15. **Jarle Brinchmann**; *MUSE-Faint - Dissecting the faintest galaxies with MUSE*; Arcetri, Italy; 19 October 2023
16. **Jarle Brinchmann**; *MUSE-Faint - Dissecting the faintest galaxies with MUSE*; Milano Bicocca, Italy; 23 October 2023
17. **Jarle Brinchmann**; *MUSE-Faint - Dissecting the faintest galaxies with MUSE*; Instituto Superior Técnico, Portugal; 14 December 2023
18. **João A. Dias**; *A journey into Venus' Volcanoes: Is there Active Volcanism?*; Konkoly Thege Miklós Astronomical Institute, Budapest; 11 January 2023
19. **J. M. Gomes**; *Physical and Mathematical foundations of the FADO spectral synthesis code*, IATE (online), Argentina; 25 August 2023
20. **Jorge Martins**; *Um Nobel para a Astronomia: à descoberta de outros mundos*; Dias da Física - FCUP, Portugal; 30 March 2023
21. **José Afonso**; *Em busca de Buracos Negros Gigantes no início do Universo*; Coimbra, Portugal; 25 May 2023
22. **José Fonseca**; *Prospects for multi-probe Cosmology as gravity and inflation probes*; University of the Western Cape, Cape Town, South Africa; 5 March 2023
23. **José Fonseca**; *Prospects for multi-probe Cosmology as gravity and inflation probes*, Universidade de Aveiro, Aveiro, Portugal; 17 May 2023
24. **José Fonseca**; *Prospects for multi-probe Cosmology as gravity and inflation probes*, Oskar Klein Centre, Stockholm, Sweden; 1 December 2023
25. **Lara Sousa**; *Cosmic Microwave Background Anisotropies generated by Domain Walls and Cosmic Strings*, IFAE Institut de Física d'Altes Energies, Universitat Autònoma de Barcelona, Spain; 19 January 2023
26. **Lara Sousa**; *Radiação gravitacional de fundo gerada por cordas cósmicas*; Universidade do Maranhão, Brazil; 21 November 2023
27. **Margarida Cunha**; *Asteroseismology and Interferometry*; Cherenkov Telescope Array (online), Germany; 11 January 2023
28. **Marina Cortês**; *Biocosmology: the birth of a new science*; Oxford Philosophy of Physics seminar, Oxford; 17 April 2023
29. **Nelson J. Nunes**; *Current and future constraints on  $f(Q)$  cosmology with  $\Lambda$ CDM background*; Queen Mary University of London; 25 January 2023
30. **Nelson J. Nunes**; *Current and future constraints on  $f(Q)$  cosmology with  $\Lambda$ CDM background*; University of Pisanulok, Thailand; 24 February 2023
31. **Nuno Moedas**; *Analyzing the effect of turbulent mixing in F-type stars*; Montpellier, France; 26 April 2023
32. **Nuno Santos**; *Detection and characterization of Earth-like planets using high resolution spectroscopy*; European Space Sciences Committee, Lisboa; 5 June 2023
33. **Nuno Santos**; *Towards the detection and characterisation of Earth like planets*; Instituto Superior Técnico; 2 October 2023
34. **Pedro Machado**; *Atmospheres - A Planetary Roadmap of Ciências' research on the Solar System and beyond...*; Physics Seminar, Ciências ULisboa; 26 April 2023
35. **Pedro Machado**; *Planetary atmospheres – A roadmap to planets that lost their habitability*; Centro de Astrobiología (CAB), Spain; 10 February 2023
36. **Pedro Machado**; Universidade dos Açores; 1 March 2023
37. **Pedro Machado**; *O Asteroid PedroMachado*; Instituto Pedro Nunes, Portugal; 5 September 2023
38. **Raul Cerveira Lima**; *Aldeias estreladas: trazer as estrelas de volta*; Campo do Gerês, Terras de Bouro, Portugal; 24 May 2023
39. **Ricardo Gafeira**; *Long-term variation of quiet sun Mg II h&k lines and its relation with the solar cycle*; ESPOS seminars
40. **Rodrigo Carvajal**; *Selection of radio-detected AGN with ensemble machine learning*; Machine Learning in Australian Astronomy Group, Australia; 21 November 2023
41. **Sergei Mukovnikov**; *Synchrotron radiation from cosmic string wakes*; Porto, Portugal; 5 October 2023
42. **Slava L. L. Bourgeois**; *Solar feature contouring with Mathematical Morphology/Machine Learning techniques*; University of Sheffield, Sheffield; 23 June 2023
43. **Tiago Campante**; *Asteroseismology: probing the interiors of stars*; Ciências ULisboa, Lisbon, Portugal; 17 May 2023
44. **Tiago Campante**; *Expanding the frontiers of cool-dwarf asteroseismology with next-generation spectrographs*; Department of Physics and Astronomy, Aarhus University, Denmark, 12 October 2023
45. **Vitor da Fonseca**; *An odyssey in the dark side of the Universe*; Institute of Theoretical Physics and Astronomy Faculty of Physics, Vilnius University, Lithuania; 7 December 2023

## MSc Projects Completed <sup>[17]</sup>

1. A. M. B. Correia; 2023; *Activity-free radial velocities*; Master in Astronomy; Supervisor(s): **J. P. Faria**
2. A. T. F. Cipriano; 2023; *Study of Venus atmosphere's polar vortex using cloud tracking techniques and Venus Express (ESA) observations from VIRTIS image spectrometer*; Master in Physics; Supervisor: **P. Machado**
3. C. Freire; 2023; *Venus: Interaction Surface/Atmosphere in the framework of EnVision mission*; Master in Physics; Supervisor: **P. Machado**
4. E. L. Silva; 2023; *Actividade Cromosférica em Estrelas Evoluídas*; Master degree in Astrophysics and Instrumentation for Space; Supervisor(s): **E. Delgado Mena, J. Gomes da Silva, R. Gafeira**
5. Mariana Brum; 2023; *O Espectroheliógrafo do Observatório Geofísico e Astronómico da Universidade de Coimbra sob a ótica da museologia: Desafios e possibilidades*; Mestre em Património Cultural e Museologia; Supervisor(s): **R. Gafeira**

6. F. C. N. Q. Pimenta; 2023; *Analytical solutions for the evolution of current carrying cosmic strings*; Master in Astronomy; Supervisor(s): **C. J. A. P. Martins**
7. F. D. Rodrigues; 2023; *Identificação e interpretação de indícios morfológicos associados a ambientes fluviomarinhos em Marte*; Mestrado em Geografia Física e Ordenamento do Território; Supervisor(s): E. Reis, **P. Machado**
8. I. M. Rolo; 2023; *Application of realistic magnetic-cycle reconstruction to Sun-as-a-star observations*; Master in Astronomy; Supervisor(s): **J. P. Faria, A. R. G. Santos, M. S. Cunha**
9. J. Teixeira; 2023; *Where in the Milky Way do exoplanets preferentially form?*; Master in Astronomy; Supervisor(s): **V. Zh. Adibekyan, N. C. Santos**
10. M. M. C. D. Carvalho; 2023; *Is string theory falsifiable?*; Physics Master; Supervisor(s): **C. J. A. P. Martins**
11. A. J. G. Falorca; 2023; *Numerical simulations (HD and MHD) of planetary winds in the vicinity of stellar winds emanating from their host stars*; Physics Master; Supervisor(s): **J. J. G. Lima**
12. M. C. Ralha; 2023; *Effective dose equivalent estimation for humans on Mars*; Master in Medical Physics; Supervisor(s): P. Teles, **N. C. Santos**
13. J. Lino; 2023; *Looking at the Sun, finding other Earths: identification of solar regions*; Master in Engineering Physics; Supervisor(s): **N. C. Santos, A. M. Silva**
14. J. M. L. Amoreira; 2023; *Stellar flare spectroscopy with ESPRESSO: detecting planets around flaring stars*; Mestrado Bolonha em Engenharia Física Tecnológica; Supervisor(s): I. Lopes, **V. Zh. Adibekyan**
15. J. Pereira; 2023; *Variations of the ionospheric total electron content over continental Portugal and islands*; Physics Master; Supervisor(s): **A. Morozova**
16. D. M. Santos; 2023; *Who is Who? Fado and galaxy classification*; Supervisor(s): **C. Pappalardo**
17. M. A. S. Pinto; 2023; *Gravitational induced particle production in modified gravity*; Supervisor(s): **F. S. N. Lobo**
7. Devang Somawanshi; *IA Summer Internship: AMUSING ourselves with the secrets of galaxies using Integral Field Spectroscopy*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
8. Fernando Francisco da Silva Pereira e Caldas Ferreira; *Undergraduate Astrophysics Projects (FCUP): Galaxies or Clumps? Understanding the True Nature of LAEs during Cosmic Dawn*; Supervisor: Ana Paulino Afonso; September 2023 - December 2023
9. Gourav Kumawat; *IA Summer Internship: AMUSING ourselves with the secrets of galaxies using Integral Field Spectroscopy*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
10. Inês Nogueira Lello de Caldeilla; *Undergraduate Astrophysics Projects (FCUP): Unveiling Hidden Galaxy Populations through Unsupervised Machine Learning.*; Supervisor: Ana Paulino Afonso; September 2023 - January 2024
11. Irati Lizaso Berrueta; *IA Summer Internship: Exploring the COSMOS with Machine Learning: galaxies' physical properties*; Supervisor: Ana Paulino Afonso, July 2023 - July 2023
12. Ishan Jindal; *IA Summer Internship: Deep Learning for envisioning the evolution of bulge-to-total luminosity ratio*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
13. Joana Correia; *IA Summer Internship: Local Galaxies as time machines: navigating biases in studying cosmic evolution*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
14. Júlia Mestre; *IA Summer Internship; Counting and characterising galaxies in JWST deep field observations*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
15. Laxmi N. Ambuj; *IA Summer Internship: Local Galaxies as time machines: navigating biases in studying cosmic evolution*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
16. Margarida Fonseca; *IA Summer Internship: Exploring the COSMOS with Machine Learning: galaxies' physical properties*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
17. Meghna Varma; *IA Summer Internship: Local Galaxies as time machines: navigating biases in studying cosmic evolution*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
18. Pedro Ferreira; *IA Summer Internship : Exploring the COSMOS with Machine Learning: galaxies' physical properties*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
19. Rodrigo Cosme; *IA Summer Internship: AMUSING ourselves with the secrets of galaxies using Integral Field Spectroscopy*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
20. Rupam Kundu; *IA Summer Internship: AMUSING ourselves with the secrets of galaxies using Integral Field Spectroscopy*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
21. Sarah Aranibar; *IA Summer Internship: Exploring the COSMOS with Machine Learning: galaxies' physical properties*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
22. Shreyas Bhonjal; *IA Summer Internship: Counting and characterising galaxies in JWST deep field observations*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
23. Sudipta Mridha; *IA Summer Internship: AMUSING ourselves with the secrets of galaxies using Integral*

## BSc Traineeships / Projects completed <sup>[215]</sup>

(under the supervision of IA researchers)

1. Aman Kumar; *IA Summer Internship: Deep Learning for envisioning the evolution of bulge-to-total luminosity ratio*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
2. Anisha Khatri; *IA Summer Internship: Local Galaxies as time machines: navigating biases in studying cosmic evolution*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
3. Atul Samanta; *IA Summer Internship: Deep Learning for envisioning the evolution of bulge-to-total luminosity ratio*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
4. Beatriz Moura; *IA Summer Internship: Local Galaxies as time machines: navigating biases in studying cosmic evolution*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
5. Chaitanya Gaikwad; *IA Summer Internship: Counting and characterising galaxies in JWST deep field observations*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
6. Debarshi Mukherejee; *IA Summer Internship: Counting and characterising galaxies in JWST deep field*



- Field Spectroscopy*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
24. Suvam Tripathy; *IA Summer Internship: Local Galaxies as time machines: navigating biases in studying cosmic evolution*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
  25. Vishalika Sharma; *IA Summer Internship: AMUSING ourselves with the secrets of galaxies using Integral Field Spectroscopy*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
  26. Yichen Cao; *IA Summer Internship: Counting and characterising galaxies in JWST deep field observations*; Supervisor: Ana Paulino Afonso; July 2023 - July 2023
  27. Pedro Afonso; *Co-supervisor of undergraduate project: A new activity proxy for finding other Earths*; Supervisor: André Silva; November 2022 - February 2023
  28. Eduardo Campos Gonçalves; *Summer Internship: Degeneracy between starspot latitudes and stellar inclination angle in the integrated light of solar-like stars*; Supervisor: Ângela Santos; July 2023 - Sep 2023
  29. Fernando Francisco S. P. C. Ferreira; *PEEC: Spatial distribution of active regions over the solar magnetic cycle: I. Sunspot distribution*; Supervisor: Ângela Santos; February 2023 - July 2023
  30. Francisco P. S. Antunes Ferreira; *Continuation of the PEEC: Spatial distribution of active regions over the solar magnetic cycle: II. Photometric time-series*; Supervisor: Ângela Santos; October 2023 - December 2023
  31. Francisco P. S. Antunes Ferreira; *PEEC: Spatial distribution of active regions over the solar magnetic cycle: II. Photometric time-series*; Supervisor: Ângela R. G. Santos; February 2023 - July 2023
  32. Léana Jubert; *Internship: Metallicity of Kepler stars*; Supervisor: Ângela Santos; January 2023 - July 2023
  33. Victor Maraud; *Internship: Asteroseismology of chemically peculiar pulsators*; Supervisor: Ângela Santos; March 2023 - July 2023
  34. Akel Bernal Kede; *Escola de Verão 2023 (UC): Ionospheric response to atmospheric forcings*; Supervisor: A. Morozova; June 2023 - October 2023
  35. Miguel Nunes; *Estágio em Engenharia Física: Atmospheric seeing measurements on campus*; Supervisor: Bachar Wehbe; May 2023 - July 2023
  36. Rafael Salgado; *IA Summer Internship: Atmospheric seeing measurements in CAUP*; Supervisor: Bachar Wehbe; July 2023 - July 2023
  37. Alena Vanzurova (Masaryk U., Czechia); *Erasmus Traineeship: Constraining alternative cosmological models*; Supervisor: Carlos Martins
  38. Ana Alexandra Dias (Colégio INED, Porto); *OCJF internship: Watching the universe expand in real time*; Supervisor: Carlos Martins
  39. Bruno Parracho (FCUP); *PEEC: Tests of dynamical dark energy models*; Supervisor: Carlos Martins
  40. Cátia Silva (ES Inês de Castro, VN Gaia); *AstroCamp internship: Probing the nature of dark energy*; Supervisor: Carlos Martins
  41. Celia Clerfeuille (U. Strasbourg, France); *M2 internship: Varying Mu Cosmography*; Supervisor: Carlos Martins
  42. Chloé Barjou-Delayre (U. Toulouse III, France); *M2 internship: Varying Alpha in the Galaxy*; Supervisor: Carlos Martins
  43. Iuna Dreyer (IST, Portugal); *IST PIC: Loop solutions for wiggly and superconducting strings*; Supervisor: Carlos Martins
  44. Joana Costa (FCUP); *PEEC: Astrophysics, programming and statistics for secondary schools*; Supervisor: Carlos Martins
  45. José Ascensão (FCUP); *PEEC: Testing dark energy and modified gravity models*; Supervisor: Carlos Martins
  46. Josep Vaquer; *Joves i Ciència Program: Scaling solutions of defect networks*; Supervisor: Carlos Martins
  47. Magda Roçadas (ES Aurélio de Sousa, Porto); *OCJF internship: The physics of other universes*; Supervisor: Carlos Martins
  48. Mariana Melo e Sousa (FCUP); *PEEC: Constraining curvature with the redshift drift*; Supervisor: Carlos Martins
  49. Pedro Figueiredo (FCUP); *PEEC: Varying alpha cosmography*; Supervisor: Carlos J. A. P. Martins
  50. Samy Vinzl (U. Toulouse III, France); *Erasmus Traineeship: Measuring the CMB temperature with ESPRESSO*; Supervisor: Carlos Martins
  51. Sára Berger (E.S. Teleki Blanka, Szekesfehervar, Hungria); *AstroCamp internship: Probing the nature of dark energy*; Supervisor: Carlos Martins
  52. Sofia Fernandes (ES Ermesinde); *OCJF internship: Watching the universe expand in real time*; Supervisor: Carlos Martins
  53. Teresa Miranda (FCUP); *PEEC: Scientific literacy and numeracy in Portugal*; Supervisor: Carlos Martins
  54. Tomás Pinto (FCUP); *PEEC: Watching the universe expand in real time*; Supervisor: Carlos Martins
  55. Unai Canudas; *Joves i Ciència Program: Scaling solutions of defect networks*; Supervisor: Carlos Martins
  56. Mariana Lino; *IA Summer Internships: Discover the Universe*; Supervisor(es): Catarina Leote, Ricardo Reis; July 2023 - July 2023
  57. Rafia Waqar; *IA Summer Internships: Discover the Universe*; Supervisor(es): Catarina Leote, Ricardo Reis; July 2023 - July 2023
  58. Sónia Lucas; *MSc thesis in Science Communication from NOVA FCSH: Comunicação de Astronomia e Astrofísica em Portugal - a Abordagem do Instituto de Astrofísica e Ciências do Espaço*; Supervisor: Catarina Leote; September 2023 - November 2023
  59. Tiago Martins Sinde Lourenço; *1 semester project in the framework of the curricular unit Project in Astrophysics (FCUP BSc in Physics) "Exploring the physics of jellyfish galaxies"*; Supervisor: Catarina Lobo; February 2023 - May 2023.
  60. Victor Santos; *Project for Laboratório de Astrofísica: Passive but not Resigned*; Supervisor: Cirino Pappalardo; October 2022 - February 2023
  61. Daniel Matos; *Project for Laboratório de Astrofísica: Light my MOSFIRE*; Supervisor: Cirino Pappalardo; October 2022 - February 2023
  62. Caetano Ramos; *Black hole shadows and photon rings*; Supervisor: Francisco S. N. Lobo; April 2023 - July 2023
  63. Margarida Graça; *Traversable wormholes in modified gravity and their use for interstellar travel*; Supervisor: Francisco S. N. Lobo; April 2023 - July 2023
  64. Catarina Cristina; *Laboratory Astrophysics Projects - FCUL: Traversable wormholes in modified gravity and their use for interstellar travel1*; Supervisor: Francisco S. N. Lobo; 2022 - 2023
  65. André Roldan; *Laboratory Astrophysics Projects - FCUL: Black hole shadows and photon rings*; Supervisor: Francisco S. N. Lobo; 2022 - 2023

66. Ana Varo; *IA Summer Internship: Light my MOSFIRE*; Supervisor: Henrique B. Miranda, July 2023 - July 2023
67. Leonor Ferro; *IA Summer Internship: Light my MOSFIRE*; Supervisor: Henrique B. Miranda, July 2023 - July 2023
68. Maryam Ahsan; *IA Summer Internship: Light my MOSFIRE*; Supervisor: Henrique B. Miranda; July 2023 - July 2023
69. Suman Sahu; *IA Summer Internship: Light my MOSFIRE*; Supervisor: Henrique B. Miranda; July 2023 - July 2023
70. Adriana Maria Casanova Casais; *Licenciatura em Educação Básica, ESSE-Porto, IPP: Contextos e perfis da educação não formal, Iniciação às práticas profissionais*; Supervisor: Ilídio Costa; April 2023 - June 2023
71. Alunos das turmas do 7º ano do Conservatório de Música do Porto; *Astronomia de Bolso, Projeto SEI (Sociedade, Escola, Investigação)*; Supervisor: Ilídio Costa; October 2023 -ongoing.
72. Ana Rita Marques da Silva; *Licenciatura em Educação Básica - ESE-Porto - IPP: Contextos e perfis da educação não formal, Iniciação às práticas profissionais*; Supervisor: Ilídio Costa; April 2023 - June 2023
73. Ângela Machado; *Licenciatura em Educação Básica - ESE-Porto - IPP: Contextos e perfis da educação não formal, Iniciação às práticas*; Supervisor: Ilídio Costa; April 2023 - June 2023
74. Beatriz Graça Martins; *Licenciatura em Educação Básica - ESE-Porto - IPP: Contextos e perfis da educação não formal, Iniciação às práticas profissionais*; Supervisor: Ilídio Costa; April 2023 - June 2023
75. Beatriz Pereira Caldas; *Licenciatura em Educação Básica - ESE-Porto - IPP: Contextos e perfis da educação não formal, Iniciação às práticas profissionais*; Supervisor: Ilídio Costa; April 2023 - June 2023
76. Eduardo Arantes Magalhães; *PEEC: Contributos para a investigação em ensino e divulgação das ciências II - Conhecimentos em Astronomia*; Supervisor: Ilídio Costa; January 2023 - July 2023
77. Filipa Alexandra Ribeiro Azevedo; *Licenciatura em Educação Básica - ESE-Porto - IPP: Contextos e perfis da educação não formal, Iniciação às práticas profissionais*; Supervisor: Ilídio Costa; April 2023 - June 2023
78. Francisca Lage Rego; *Licenciatura em Educação Básica - ESE-Porto - IPP: Contextos e perfis da educação não formal, Iniciação às práticas profissionais*; Supervisor: Ilídio Costa; April 2023 - June 2023
79. Francisca Martins Esteves; *Licenciatura em Educação Básica - ESE-Porto - IPP: Contextos e perfis da educação não formal, Iniciação às práticas profissionais*; Supervisor: Ilídio Costa; April 2023 - June 2023
80. Fredson Jorge dos Santos Delgado; *PEEC: Contributos para a investigação em ensino e divulgação das ciências I - Avaliação da formação contínua de professores do PP-CCV*; Supervisor: Ilídio Costa; January 2023 - July 2023
81. Margarida Silva e Sousa; *Licenciatura em Educação Básica - ESE-Porto - IPP: Contextos e perfis da educação não formal, Iniciação às práticas profissionais*; Supervisor: Ilídio Costa; April 2023 - June 2023
82. Maria Vaz de Salvador; *PEEC: Contributos para a investigação em ensino e divulgação das ciências II - Atitudes e Crenças em relação à Astronomia*; Supervisor: Ilídio Costa; January 2023 - July 2023
83. Marta Branco da Silva; *Licenciatura em Educação Básica - ESE-Porto - IPP: Contextos e perfis da educação não formal, Iniciação às práticas profissionais*; Supervisor: Ilídio Costa; April 2023 - June 2023
84. Patrícia do Carmo Crispim Ribeiro; *Licenciatura em Educação Básica - ESE-Porto - IPP: Contextos e perfis da educação não formal, Iniciação às práticas*; Supervisor: Ilídio Costa; April 2023 - June 2023
85. Pedro dos Santos Ferreira Guimarães; *PEEC: Contributos para a investigação em ensino e divulgação das ciências II - Perceções dos astrónomos sobre a comunicação de ciência*; Supervisor: Ilídio Costa; January 2023 - July 2023
86. Prathmesh Jadhav; *IA Summer School: Contributos para a investigação em ensino e divulgação das ciências - Questionário de avaliação de literacia em astronomia*; Supervisor: Ilídio Costa; July 2023
87. Ranjini Murthy; *IA Summer School: Contributos para a investigação em ensino e divulgação das ciências - Questionário de avaliação de literacia em astronomia*; Supervisor: Ilídio Costa; July 2023
88. Joana Bagagem; *Short project: Connecting galaxies photometry with Supermassive Black Holes (SMBH) properties: A machine learning approach*; Supervisor: Israel Matute; October 2022 - February 2023
89. Leonor Ferro; *Short project: Secrets of the most massive supermassive black holes in the universe*; Supervisor: Israel Matute; October 2022 - February 2023
90. Maria Cravinho; *Short project: AGN demographics through Athena simulations*; Supervisor: Israel Matute; October 2022 - February 2023
91. Gorka Zubiri; *Laboratório de Astrofísica: Young stellar sources in the near-infrared: Processing and Analysis*; Supervisor: João L. Yun; October 2022 - February 2023
92. Maria Vitória Noronha Osório aguiar Branco; *PEEC: Determinação automática do excesso de emissão em estrelas jovens*; Supervisor: Jorge Gameiro; February 2023 - July 2023
93. Leonor Ferro; *Internship: Secrets of the most massive supermassive black holes in the universe*; Supervisor: José Afonso; October 2022 - January 2023
94. Luís Barroso; *Internship: Exploring the most active supermassive black holes in the first Gyr of the Universe*; Supervisor: José Afonso; October 2022 - January 2023
95. Peer Kuhlbrodt; *BSc thesis: Estimating the fraction of Active Galactic Nuclei hosting a black-hole binary with cosmological simulations*; Supervisor: José Afonso; April 2023 - December 2023
96. Pietro Malagoli; *Internship: Seeking serendipitous galaxies amongst JWST observations*; Supervisor: José Afonso; October 2022 - January 2023
97. José Henrique Rodrigues; *UC Project in Astrophysics: Line misidentification in future spectroscopic surveys*; Supervisor: José Fonseca; October 2022 - January 2023
98. Luciano dos Santos; *UC Project in Astrophysics: Using Gaia Quasars for Cosmology*; Supervisor: José Fonseca; October 2023 - January 2024
99. Luciano dos Santos; *PEEC: Testing the Dual Distance Relationship*; Supervisor: José Fonseca; February 2023 - June 2023
100. Daniel Bento; *Project - Laboratório de Astrofísica: Time Domain Astronomy: Redshift drift as a probe of*

- cosmology; Supervisor: José Pedro Mimoso; October 2022 - February 2023
101. Pedro Fanha; *Project in Astronomy, Curricular Unit of BSc in Physics UP: Testing a tool to probe the core of red-giant stars*; Supervisor: Margarida Cunha; September 2022 – January 2023
  102. Diogo Marques; *estágio sobre o tema “Development of a tool for the normalization of stellar spectra - application to ESPRESSO data”*; Supervisores - Nuno Santos, André Silva; March 2023 - June 2023
  103. Rodrigo Aarão; *IA Summer Internships: Characterisation of a transiting exoplanet using CHEOPS photometry*; Supervisor: Nuno Rosário; July 2023 - July 2023
  104. José Sousa; *IA Summer Internships: Characterisation of a transiting exoplanet using CHEOPS photometry*; Supervisor: Nuno Rosário; July 2023 - July 2023
  105. Madalena Silva Resende Ferreira Costa; *Planetário do Porto – Centro de Ciência +Acessível – projecto SPACE OUT*; Supervisors: Paulo J. T. Pereira, Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA) entre outros; February 2023 - June 2023
  106. Pedro Miguel Carvalho Soares; *Planetário do Porto – Centro de Ciência +Acessível – projecto SPACE OUT*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  107. Nuno Filipe Belo Soares Braga Chaves; *Planetário do Porto – Centro de Ciência +Acessível – projecto SPACE OUT*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  108. Aisha Silva Monteiro; *Planetário do Porto – Centro de Ciência +Acessível – projecto SPACE OUT*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  109. Ana Lúcia Lopes Cunha; *Planetário do Porto – Centro de Ciência +Acessível – projecto LOST IN SPACE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  110. Maria Inês Monteiro Figueiredo; *Planetário do Porto – Centro de Ciência +Acessível – projecto LOST IN SPACE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  111. Helena Isabel Tavares Carvalho; *Planetário do Porto – Centro de Ciência +Acessível – projecto LOST IN SPACE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  112. Inês Ferreira Martins; *Planetário do Porto – Centro de Ciência +Acessível – projecto LOST IN SPACE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  113. Renato Dias dos Santos Silva; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANETARY EXPEDITION*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  114. Maria Isabel de Oliveira Delgado; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANETARY EXPEDITION*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  115. Tomás Casals Namura Borges Pinto; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANETARY EXPEDITION*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  116. Ana Sofia Conde Nabais; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANETARY EXPEDITION*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  117. Diogo da Costa Guerra; *Planetário do Porto – Centro de Ciência +Acessível – projecto COSMO ZONE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  118. Rodrigo André Moreira Teixeira; *Planetário do Porto – Centro de Ciência +Acessível – projecto COSMO ZONE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
  119. João André Costa Jorge; *Planetário do Porto – Centro de Ciência +Acessível – projecto COSMO ZONE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário



- Vairinhos (UA), Carlos Santos (UA); February - June 2023
120. Francisco Miguel Fidalgo Padrela; *Planetário do Porto – Centro de Ciência +Acessível – projecto COSMO ZONE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
121. Beatriz Sofia da Costa Salazar; *Planetário do Porto – Centro de Ciência +Acessível – projecto CONSTELLATIONS*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
122. Anita Pereira Rodrigues; *Planetário do Porto – Centro de Ciência +Acessível – projecto CONSTELLATIONS*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
123. Miguel Ângelo Coelho da Rosa Tavares; *Planetário do Porto – Centro de Ciência +Acessível – projecto CONSTELLATIONS*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
124. Rafael Leonardo Rocha Matos; *Planetário do Porto – Centro de Ciência +Acessível – projecto CONSTELLATIONS*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
125. Stella Mosso Corrâ; *Planetário do Porto – Centro de Ciência +Acessível – projecto SPACE TRAVEL*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
126. António Mateus Marinho Almeida; *Planetário do Porto – Centro de Ciência +Acessível – projecto SPACE TRAVEL*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
127. Marta Catarina Barbosa Caetano; *Planetário do Porto – Centro de Ciência +Acessível – projecto SPACE TRAVEL*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
128. Hugo de Sousa Tavares; *Planetário do Porto – Centro de Ciência +Acessível – projecto LIFT OFF*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
129. Eva Filipa Martins Aguiar; *Planetário do Porto – Centro de Ciência +Acessível – projecto LIFT OFF*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
130. Luís Pedro da Rocha Pinto Costa; *Planetário do Porto – Centro de Ciência +Acessível – projecto LIFT OFF*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
131. Salvador Mendes Luís; *Planetário do Porto – Centro de Ciência +Acessível – projecto LIFT OFF*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
132. Antero Rodrigo Ferreira Rito; *Planetário do Porto – Centro de Ciência +Acessível – projecto APUS*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
133. Diogo Filipe Oliveira Mota; *Planetário do Porto – Centro de Ciência +Acessível – projecto APUS*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
134. Isadora Gonçalves de Andrade; *Planetário do Porto – Centro de Ciência +Acessível – projecto APUS*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
135. Luana Martinelli Moreira; *Planetário do Porto – Centro de Ciência +Acessível – projecto APUS*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
136. Lara Miguel Santos Lourenço; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANET QUEST*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário

- Vairinhos (UA), Carlos Santos (UA); February - June 2023
137. Gonçalo Correia Oliveira; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANET QUEST*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
138. Renato Silva Pires de Almeida; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANET QUEST*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
139. Tiago Costa Antunes Baptista; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANET QUEST*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
140. Margarida Teixeira de Freitas Bastos; *Planetário do Porto – Centro de Ciência +Acessível – projecto ASTRO DATA + ASTRO PRIZE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
141. Maria Rodrigues Monteiro; *Planetário do Porto – Centro de Ciência +Acessível – projecto ASTRO DATA + ASTRO PRIZE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
142. José Leandro Freitas Duarte; *Planetário do Porto – Centro de Ciência +Acessível – projecto ASTRO DATA + ASTRO PRIZE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
143. Artur Fernandes Ramos; *Planetário do Porto – Centro de Ciência +Acessível – projecto ASTRO DATA + ASTRO PRIZE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
144. Juliana Ferreira Vidal; *Planetário do Porto – Centro de Ciência +Acessível – projecto ALIENS ADVENTURES*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
145. Alberto Silva Bastos; *Planetário do Porto – Centro de Ciência +Acessível – projecto ALIENS ADVENTURES*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
146. Tiago Oliveira Reis; *Planetário do Porto – Centro de Ciência +Acessível – projecto ALIENS ADVENTURES*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
147. Pedro Felype Coelho Loyola; *Planetário do Porto – Centro de Ciência +Acessível – projecto ALIENS ADVENTURES*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
148. Pedro da Silva Henriques; *Planetário do Porto – Centro de Ciência +Acessível – projecto ALIENS ADVENTURES*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
149. David Rede Sena; *Planetário do Porto – Centro de Ciência +Acessível – projecto YOUNIVERSE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
150. Diogo José Gonçalves Ferreira; *Planetário do Porto – Centro de Ciência +Acessível – projecto YOUNIVERSE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
151. Isis Daniela Fangana Camacho Coutinho; *Planetário do Porto – Centro de Ciência +Acessível – projecto YOUNIVERSE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
152. Joana da Cunha Araújo; *Planetário do Porto – Centro de Ciência +Acessível – projecto YOUNIVERSE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
153. Filipa Martins Sequeira; *Planetário do Porto – Centro de Ciência +Acessível – projecto INVASÃO A MARTE*,



- licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
154. Ana Patrícia Gomes de Sousa; *Planetário do Porto – Centro de Ciência +Acessível – projecto INVASÃO A MARTE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
155. Júlia Köche Godinho; *Planetário do Porto – Centro de Ciência +Acessível – projecto INVASÃO A MARTE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
156. Sofia Ruge Martins; *Planetário do Porto – Centro de Ciência +Acessível – projecto INVASÃO A MARTE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
157. Ariana Ayumi Ferreira da Costa; *Planetário do Porto – Centro de Ciência +Acessível – projecto INVASÃO A MARTE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
158. António Duarte Coelho Alves de Sousa; *Planetário do Porto – Centro de Ciência +Acessível – projecto SPACE WISE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
159. Celina Isabel Almeida Cruz; *Planetário do Porto – Centro de Ciência +Acessível – projecto SPACE WISE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
160. Rafael Amaro de Almeida; *Planetário do Porto – Centro de Ciência +Acessível – projecto SPACE WISE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
161. António L. Pedro da Graça Vasconcelos; *Planetário do Porto – Centro de Ciência +Acessível – projecto SPACE WISE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
162. Tatiana Mateus Esteves; *Planetário do Porto – Centro de Ciência +Acessível – projecto ASTRO ADVENTURER*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
163. Rodrigo Martinho Dias; *Planetário do Porto – Centro de Ciência +Acessível – projecto ASTRO ADVENTURER*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
164. Marcela Laércia Homalom Insali; *Planetário do Porto – Centro de Ciência +Acessível – projecto ASTRO ADVENTURER*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
165. Filipa Lobão Dias; *Planetário do Porto – Centro de Ciência +Acessível – projecto ASTRO ADVENTURER*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
166. João de Castro Oliveira; *Planetário do Porto – Centro de Ciência +Acessível – projecto THE EVOLUTION OF LIFE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
167. Ana Cristina Ferraz Araújo; *Planetário do Porto – Centro de Ciência +Acessível – projecto THE EVOLUTION OF LIFE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
168. Tomás Rafael Cabral Sousa; *Planetário do Porto – Centro de Ciência +Acessível – projecto THE EVOLUTION OF LIFE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
169. Leonardo Castro Bastos; *Planetário do Porto – Centro de Ciência +Acessível – projecto THE EVOLUTION OF LIFE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João

- Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
170. Daniela Romão Santos; *Planetário do Porto – Centro de Ciência +Acessível – projecto INTERGALACTIC ADVENTURE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
171. Maria Miguel Martins Sousa; *Planetário do Porto – Centro de Ciência +Acessível – projecto INTERGALACTIC ADVENTURE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
172. Carolina Sofia Manteigas Duarte; *Planetário do Porto – Centro de Ciência +Acessível – projecto INTERGALACTIC ADVENTURE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
173. Mariana Silva Cabral; *Planetário do Porto – Centro de Ciência +Acessível – projecto INTERGALACTIC ADVENTURE*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
174. Pedro Miguel Valente de Sousa; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANETARIUM PURSUIT*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
175. Gabriel Martins Rosa; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANETARIUM PURSUIT*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
176. André dos Santos Francisco; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANETARIUM PURSUIT*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
177. Gonçalo Pereira Soares; *Planetário do Porto – Centro de Ciência +Acessível – projecto PLANETARIUM PURSUIT*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
178. Tiago Pinhão Paralta; *Planetário do Porto – Centro de Ciência +Acessível – projecto BOOKID*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
179. Bruna Campos Riba; *Planetário do Porto – Centro de Ciência +Acessível – projecto BOOKID*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
180. João António Pimenta Neves; *Planetário do Porto – Centro de Ciência +Acessível – projecto BOOKID*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
181. Flávio Daniel Bastos de Oliveira Brandão; *Planetário do Porto – Centro de Ciência +Acessível – projecto BOOKID*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
182. André Pais Rodrigues; *Planetário do Porto – Centro de Ciência +Acessível – projecto (sem título)*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
183. Pedro Henrique Pacheco Sousa; *Planetário do Porto – Centro de Ciência +Acessível – projecto (sem título)*, licenciatura em Multimédia e Tecnologias da Comunicação, da Departamento de Comunicação e Arte da Univ. de Aveiro; Supervisors: Paulo J. T. Pereira com os docentes Pedro Cardoso (UA), Maria João Lopes Antunes (UA), Oscar Mealha (UA), Mário Vairinhos (UA), Carlos Santos (UA); February - June 2023
184. Kevin da Silva Cunha; "*Calendário Cósmico*". Acolhimento e co-orientação do projecto de design e ilustração, com a docente Emília Dias da Costa, do estágio académico do 4º ano da licenciatura em Design de Comunicação da Faculdade de Belas Artes da Universidade do Porto; Planetário do Porto; Supervisor: Paulo Pereira; February - June 2023
185. Sofia Aragão Fonseca Maru Oliveira; "*Desenvolvimento de Personagens*". Acolhimento e co-orientação do projecto de design e animação, com a docente Emília Dias da Costa, do estágio académico do 4º ano da licenciatura em Design de Comunicação da Faculdade de Belas Artes da Universidade do Porto; Planetário do Porto; Supervisor: Paulo Pereira; February - June 2023
186. Kaustav Goswami; *Astro Summer Internships Program 2023: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Pedro M. Martins; July 2023 - July 2023
187. Prajna Mahakur; *Astro Summer Internships Program 2023: Multifrequency Analysis and Machine Learning for*

- the most powerful quasars in the Universe*; Supervisor: Pedro M. Martins; July 2023 - July 2023
188. Shashwat Sourav; *Astro Summer Internships Program 2023: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Pedro M. Martins; July 2023 - July 2023
189. Duarte Barreta; *Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe, Astro Summer Internships Program 2023*; Supervisor: Pedro M. Martins; 10-28 July 2023
190. Gustavo Monteiro; *Astro Summer Internships Program 2023: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Pedro M. Martins; July 2023 - July 2023
191. Sara Rijo; *Astro Summer Internships Program 2023: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Pedro M. Martins; July 2023 - July 2023
192. Tiago Melo; *Astro Summer Internships Program 2023: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Pedro M. Martins; July 2023 - July 2023
193. Leonardo Rodrigues; *Astro Summer Internships Program 2023: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Pedro M. Martins; July 2023 - July 2023
194. Jarno Sandrin; *Astro Summer Internships Program 2023: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Pedro M. Martins; July 2023 - July 2023
195. André Correia; *Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Pedro M. Martins; July 2023 - July 2023
196. Leonor Bernardo; *Gulbenkian projects: Martian fluvio-marine environments studies*; Supervisor: Pedro Machado; November 2023 – September 2024
197. Margarida Graça; *Gulbenkian projects: Exoplanets atmospheres - Transmission spectroscopy studies*; Supervisor: Pedro Machado; November 2023 – September 2024
198. Henrique Eira; *Spectral Endmember: spectral fingerprints of planetary contents*; Supervisor: Pedro Machado; 2023
199. Leonor Bernardo; *IA Summer Internships*; Supervisor: Pedro Machado; July 2023 - July 2023
200. Mariana Encarnação; *IA Summer Internships*; Supervisor: Pedro Machado; July 2023 - July 2023
201. João Simões; *On the cosmic relevance of a cosmological constant*; Astrophysics Project; Supervisor: Pedro P. Avelino; 2023
202. Ricardo Borges Vilhena; *Astrophysics Project: Cosmic domain walls*; Supervisor: Pedro P. Avelino; 2023
203. Daniela Teixeira; *ESS final project: Determinação dos efeitos na qualidade subjetiva do sono da mudança de horário Inverno-Verão em estudantes do ensino superior, estudo observacional*; Supervisor: Raul Cerveira Lima, Liliana Leite; 2023 - 2024
204. L. Rodrigues; *IA Summer Internship: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Rodrigo Carvajal; July 2023 - July 2023
205. G. Monteiro; *IA Summer Internship: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Rodrigo Carvajal; July 2023 - July 2023
206. A. Correia; *IA Summer Internship: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Rodrigo Carvajal; July 2023 - July 2023
207. D. Barreta; *IA Summer Internship: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Rodrigo Carvajal; July 2023 - July 2023
208. T. Melo; *IA Summer Internship: Multifrequency Analysis and Machine Learning for the most powerful quasars in the Universe*; Supervisor: Rodrigo Carvajal; July 2023 - July 2023
209. Bárbara Pavanito; *internship of bachelor students in Digital Animation of Lusófona University: Creation of educational short film animation in Astronomy Literacy*; Supervisor: Sérgio Pereira; November 2022 - January 2023
210. Beatriz Neto; *internship of bachelor students in Digital Animation of Lusófona University: Creation of educational short film animation in Astronomy Literacy*; Supervisor: Sérgio Pereira; October 2023 – ongoing
211. David Grenho; *internship of bachelor students in Digital Animation of Lusófona University: Creation of educational short film animation in Astronomy Literacy*; Supervisor: Sérgio Pereira; November 2022 - January 2023
212. Giovanni Martins; *internship of bachelor students in Digital Animation of Lusófona University: Creation of educational short film animation in Astronomy Literacy*; Supervisor: Sérgio Pereira; November 2022 - January 2023
213. Henrique Antunes; *internship of bachelor students in Digital Animation of Lusófona University: Creation of educational short film animation in Astronomy Literacy*; Supervisor: Sérgio Pereira; November 2022 - January 2023
214. Pedro Gamito; *Bolsa Gulbenkian, novos talentos: Testing Einstein's gravity with future missions*; Supervisor: Sérgio Pereira; October 2023 – June 2024
215. 8 high school students; *Ser Cientista (FCUL): À descoberta do Universo escuro com a missão Euclid*; Supervisor: Ismael Tereno; July 2023 - July 2023



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