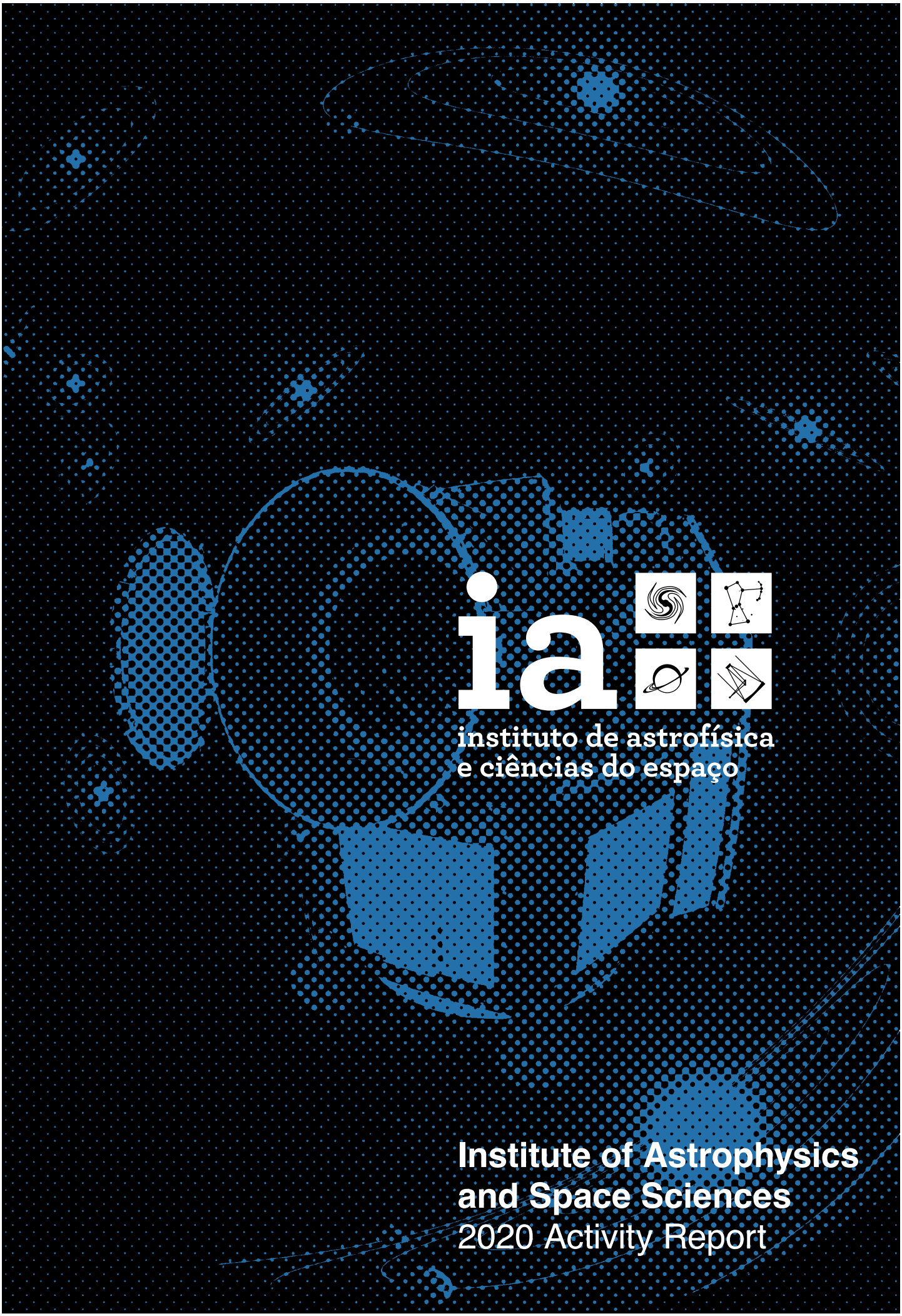


instituto de astrofísica
e ciências do espaço

Institute of Astrophysics and Space Sciences

2020 Activity Report

Institute of Astrophysics and Space Sciences
2020 Activity Report

instituto de astrofísica
e ciências do espaço

U.PORTO

Ciências ULisboa

COFINANCIAMENTO

FCT Fundação para a Ciência e a Tecnologia

COMPETE 2020

PORTUGAL 2020

UNIÃO EUROPEIA
Fundo Europeu de Desenvolvimento Regional

Index

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.

IA's mission 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. 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.

The year of 2020 was unique, with the entire planet struggling with the effects of the covid-19 pandemic. The toll on individuals and institutions was unprecedented (at least in modern, post-war society), and any words about how IA managed to keep research and projects on-going would be disrespectful to the personal struggles endured during this year. Observatories shut down, international projects were put on hold, new contracts were not started, researchers and students left their work environments and attempted to balance family and professional life in a weird separated-together world. "Normal" was a frequently used word, as no "normal" existed anymore. At IA, research became also an anchor, an opportunity to keep many of us reminded we are not completely alone – specially for those that were already away from family and friends. IA teams kept meeting throughout this period, often not focusing on work itself, but on offering some guidance and brief haven from the isolation and desolation that covid ensued. That was also a focus of our Science Communication group, with activities becoming fully on-line, aiming to keep highlighting the wonders of the Universe beyond our corner of the Cosmos.

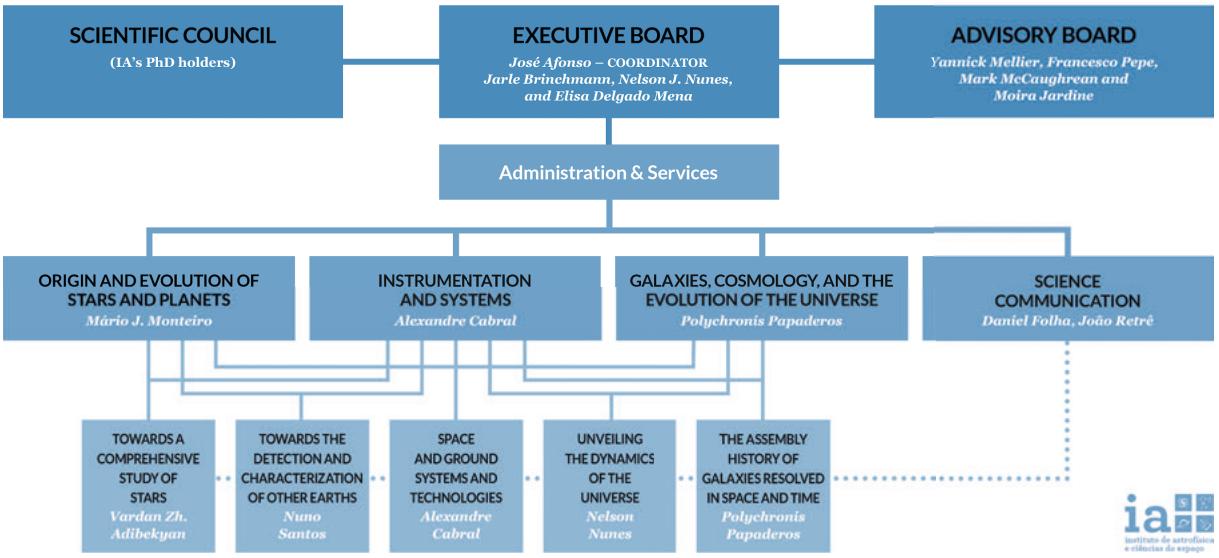
As usual, you will find in the following pages an overview of IA's activities during 2020. Take a moment to also read between the lines and appreciate the personal efforts from researchers, students and support personnel that kept IA going during this year. We certainly do, and pay our homage to our team for their resilience in the face of specially hard, and hopefully soon-to-be-over, conditions.

José Afonso, Jarle Brinchmann, Elisa Delgado Mena, Nelson Nunes
IA Executive Board

IA Management

The Executive Board (EB, elected in April 2018) is composed of 2 members from the Porto node (Jarle Brinchmann and Elisa Delgado Mena) and 2 members from the Lisbon node (José Afonso and Nelson Nunes), with José Afonso as the coordinator of the research unit.

IA SCIENTIFIC MANAGEMENT STRUCTURE



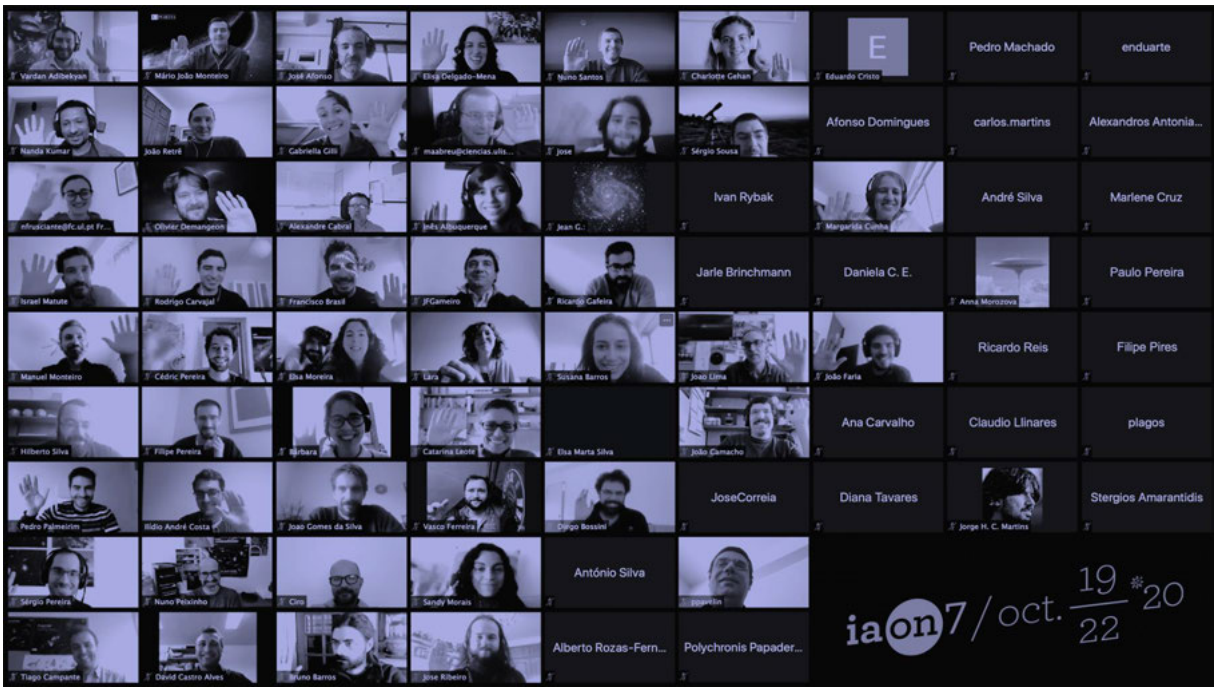
During 2020, the EB continued having regular weekly meetings to coordinate the scientific and management activities of the IA strategic plan. Every other week these meetings also include group leaders, including the Science Communication Group. Contacts with the two management institutions (CAUP and FCiências.ID) were also done whenever necessary.

IA-ON 7

Due to the pandemic restrictions the 7th Internal workshop (IA-ON 7) took place virtually from the 19th to the 22th of October.

The IA-ON 7 assembled most of the team, with an attendance of 109 researchers, students, and support personnel. The highlights of the year were shared and discussed with the whole team, with many presentations being given by younger researchers. In 2020 the focus was given to scientific discussions, pausing the customary SOAR and SWOT analyses. IA-ON 7 also included several practical workshops organised by the Science Communication Group, on topics of high interest to the team ("How to speak to different audiences", "How to prepare a scientific poster" and "Communicating science to the public and the media").

For the first time, external researchers (University of Coimbra), having manifested interest in IA's activities, were invited to attend some of the meeting's Sessions.



The IA team (2020)

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

Researchers (PhDs)
Alberto Negrão
Elisa Delgado-Mena *
Gabriella Gilli
Hugo M. Tabernero Guzmán
João N. T. Gomes da Silva
João P. S. Faria
Jorge H. C. Martins
Nuno C. Santos
Olivier Demangeon
Pedro Machado
Pedro Figueira
Pedro T. P. Viana
Sérgio A. G. Sousa*
Susana C. C. Barros
Tiago J. L. C. E. Campante *
Vardan Zh. Adibekyan *

Others
Akinsanmi Babatunde (PhD student)
Alexandros Antoniadis Karnavas (PhD student) *
Ana Barboza
André Miguel A. C. V. Silva (PhD student) *
Bárbara M. T. B. Soares
Daniela C. Espadinha (PhD student) (joined 1 october)
Diogo Quirino (MSc student)
Eduardo Cristo (PhD student)
Henrique Legoinha (internship)
João André B. Dias (MSc student)
João D. R. Camacho (PhD student)
José Eduardo Oliveira Silva (PhD student)
José Luís F. Ribeiro (PhD student) (joined 1 october)
José Rodrigues (PhD student) (joined 13 october)
L. Filipe Pereira (PhD student) *
Luisa M. Serrano (PhD student) (finished 16 april)
Mariana I. C. Reis (MSc student)
Nuno A. R. Carvalho (MSc student)
Nuno M. Rosário (PhD student) (joined 15 october)
Pedro I. T. K. Sarmento (PhD student) (finished 12 june) *
Ruben Gonçalves (PhD student)
Saeed Hojjatpanah (PhD student)
Solène C. Ulmer-Moll (PhD student) (finished 15 may)
Tomás Silva (PhD student)
Vasco Silva (MSc student)

Towards a comprehensive study of stars (Stars Group)

Researchers (PhDs)
Charlotte Gehan
Daniel F. M. Folha
Diego Bossini
Doris Arzoumanian (left 14 july)

Others
Alexandros Antoniadis Karnavas (PhD student) *
Benard Nsamba (PhD student) (finished 16 january)
Gaëtan Devillers (internship)

Elisa Delgado Mena *
João J. G. Lima
João Lin Yun
Jorge Filipe S. Gameiro
Margarida S. Cunha
Maria Teresa V. T. Lago
Mário J. P. F. G. Monteiro
Morgan Deal
M. S. Nanda Kumar
Pedro M. Palmeirim
Pedro Pina Avelino *
Rui Agostinho *
Sérgio A. G. Sousa *
Tiago J. L. C. E. Campante *
Vardan Zh. Adibekyan *
Vítor M. M. Costa

Guilherme D. C. Teixeira (PhD student) (finished 10 january)
Hernán Cerviño Asorey (MSc student)
L. Filipe Pereira (PhD student) *
Miguel Clara (PhD student)
Nuno Moedas (PhD student) (joined 12 october)
Paulina M. Zaworska (PhD student)
Pedro I. T. K. Sarmento (PhD student) (finished 12 june)*
Pedro M. Martins (MSc student)
Raquel M. G. Albuquerque (PhD student) (finished 25 february)
Thibault Boulet (PhD Student)

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

Researchers (PhDs)
Andrew J. Humphrey
Catarina Lobo
Cirino Pappalardo
Fernando Buitrago (left 31 august)
Hugo Messias (left 8 january)
Iris P. Breda
Israel Matute
Jarle Brinchmann
Jean Michel Gomes
José Afonso
Patricio Lagos
Polychronis Papaderos
Rui Agostinho*
Tom C. Scott

Others
Abhishek Chougule (PhD Student)
Daniel A. D. Vaz (MSc student)
Davi D. Barbosa (PhD student) (joined 11 november)
Hugo m. G. Silva (MSc student)
Mariana P. Júlio (MSc student)
Nuno M. C. Morujão (internship)
Pedro Alexandre C. Cunha (MSc student)
Rodrigo A. Carvajal Pizarro (PhD student)
Sandra N. Reis (PhD student)
Sandy Gonçalves Morais (PhD student)
Stergios Amarantidis (PhD student)

Unveiling the dynamics of the Universe (Cosmology Group)

Researchers (PhDs)
Alberto Rozas-Fernández
Andrew R. Liddle
António C. da Silva
Carlos J. A. P. Martins
Claudio Llinares
Daniele Vernieri (left 26 february)
Francisco S. N. Lobo
Giuseppe Fanizza
Ismael Tereno
Ivan Rybak
José Pedro Mimoso
Lara G. Sousa
Marina Cortês
Nelson J. Nunes
Noemi Frusciante
Paulo Crawford
Paulo Maurício de Carvalho
Pedro Pina Avelino *
Ricardo Caldeira Costa (left 30 april)
Tiago Barreiro

Others
Ana C. O. Leite (PhD student)
Ana P. Rodrigues (MSc student)
Ana Rita R. Almeida (MSc student)
Ana Sofia Carvalho (PhD student) (joined 1 october)
Bernardo Manuel Dias (internship)
Bruno André R. Rocha
Bruno J. C. B. Barros (PhD student)
Carlos Bruno D. Fernandes (internship)
David Grüber (PhD student) (joined 1 october)
Diogo Castelão (PhD student)
Diogo S. V. B. Gomes (internship)
Francisco T. O. Cabral (PhD student)
Hilberto M. R. da Silva (MSc student) *
Inês Albuquerque (PhD student) (joined 1 october)
Ismael Ayuso (PhD student)
José G. B. Matos
José Ricardo Correia (PhD student)
Joshua Esteves (internship)
Luís Atayde (MSc student)
Mafalda Castro S. X. Matos (internship)
Manuel C. Rosa (MSc student)
Praveen Kumar (internship)
Rui P. L. Azevedo (PhD Student)
Sergei Mukovnikov (joined 5 november)
Siri A. Berge (internship)
Vasco Capela Tavares (internship)
Vasco M. C. Ferreira (PhD student)

Astronomical Instrumentation and Systems (Instrumentation Group)

Researchers (PhDs)	
Alexandre Cabral	João Dinis
David C. Alves (left 30 november)	José M. Rebordão
Elena Duarte	Manuel Abreu
João Coelho	Sérgio A. G. Sousa*

Others

Andreia Domingos (MSc student)

André Miguel A. C. V. Silva (PhD student) *

António Joaquim Marques de Oliveira

Bachar Wehbe (PhD student)

Cédric P. Pereira (PhD student)

Francisco Guerreiro (MSc student)

Guilherme Roque (MSc student)

Inês Leite

João Cachatra (MSc student)

Manuel Monteiro

Nuno Miguel Gonçalves (MSc student)

Pedro Manuel Fonseca Nunes dos Santos

Renato Alegria (MSc student)

Solène C. Ulmer-Moll (PhD student) (finished 15 may)

Tiago Magalhães (PhD student) (finished 8 may)

Science Communication Group

Catarina Leote

Elsa M. P. S. Moreira

Filipe A. L. Pires

Hilberto M. R. Silva *

Ilídio André P. M. Costa (finished PhD 20 july)

José Manuel C. Dantas (joined 1 september)

João Retrê

Lupércio B. Bezerra (PhD student) (finished 10 january)

Paulo J. T. Pereira

Ricardo S. S. C. Reis

Sérgio Pereira Ribeiro

Tânia F. S. Cunha

Interface to Science (Support to Science Activities)

Argentina Pereira

Carla Mendes (left 31 january)

Carlos Santos

Elsa Marta Silva

Marlene Cruz (joined 16 march)

Sandra Homem

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

Research Projects/Programmes

During 2020, 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 2020 were supported by national and European funds are:

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

- Detecting and characterization exoplanets around evolved stars with NASA's TESS mission (PULSATION) (MSCA-IF-EF-ST-792848)
  PI: Tiago Campante
  [start date: 1 November 2018 – end date: 31 October 2020]

- Hot Terrestrial Exo-planet Atmospheres: preparing new generation instrument observations with a global climate model (Hot-TEA) (MSCA-IF-EF-ST-796923)
  PI: Gabriella Gilli
  [start date: 1 September 2018 – end date: 31 August 2020]

- CANTATA – Cosmology and Astrophysics Network for Theoretical Advances and Training Actions (COST Association Cost Action CA-15117)
  PI: Ruth Lazkoz. Management Committee: José Pedro Mimoso
  [start date: 8 April 2016 – end date: 7 April 2020]

- 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]

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

- Characterizing the smallest planet hosts (IF/00849/2015/CP1276/CT0003)
  PI: Elisa Delgado Mena
  [start date: 1 January 2017 – end date: 31 December 2021]

- Zoom-In ON hIgh-mass Star forMation (ZIONISM) (IF/00956/2015/CP1273/CT0002)
  PI: Nanda Kumar
  [start date: 15 December 2016 – end date: 14 December 2021]

- Resolving galaxy evolution (IF/01654/2014/CP1215/CT003)
  PI: Jarle Brinchmann
  [start date: 30 June 2015 – end date: 29 June 2020]

- Gravitational Lensing in the Universe with Euclid (IF/01518/2014)
  PI: Ismael Tereno
  [start date: 30 June 2015 – end date: 29 June 2020]

- Towards characterization of Earth-like exoplanets (IF/00028/2014/CP1215/CT0002)
  PI: Sérgio Sousa
  [start date: 1 May 2015 – end date: 30 April 2020]

- Probing the Physics of the Dark Universe with Euclid (IF/01135/2015)
  PI: António da Silva
  [start date: 3 October 2016 – end date: 2 October 2021]

- Dark Couplings (IF/00852/2015)
  PI: Nelson Nunes
  [start date: 1 October 2016 – end date: 29 December 2020]

- Modified Gravitity impact on Cosmology and Astroparticles (MGiCAP)
  (CERN/FIS-PAR/0037/2019)
  PI: Francisco Lobo
  [start date: 1 September 2020 – end date: 31 August 2022]

- Probing cosmic strings and other topological defects with gravitational waves (Gwstrings)
  (POCI-01-0145-FEDER-031938 & PTDC/FIS-PAR/31938/2017)
  PI: Lara Sousa
  [start date: 15 October 2018 – end date: 14 October 2022]

- Planets – Towards Understanding their General circulation Atmospheres (P-TUGA)
  (PTDC/FIS-AST/29942/2017)
  PI: Pedro Machado
  [start date: 3 September 2018 – end date: 2 September 2021]

- Identify the Earliest Supermassive Black Holes with ALMA (IdEaS with ALMA)
  (PTDC/FIS-AST/29245)
  PI: José Afonso
  [start date: 3 September 2018 – end date: 2 September 2021]

- Spacetime ripples in the dark gravitational Universe (DarkRipple)
  (PTDC/FIS-OUT/29048/2017)
  PI: Francisco Lobo
  [start date: 1 September 2018 – end date: 31 August 2022]

- a Generation of Earth-ANalogs Exploration Spectrographs (G.EANES)
  (POCI-01-0145-FEDER-032113 & PTDC/FIS-AST/32113/2017

PI: Nuno Santos
[start date: 1 August 2018 – end date: 31 December 2021]

- Cosmology and Fundamental Physics with ESPRESSO (CosmoESPRESSO)
(POCI-01-0145-FEDER-028987 & PTDC/FIS-AST/28987/2017
PI: Carlos Martins
[start date: 1 June 2018 – end date: 31 May 2022]

- Exploring exoPlanets wIth CHEOPS (EPIC)
(POCI-01-0145-FEDER-028953 & PTDC/FIS-AST/28953/2017)
PI: Sérgio Sousa
[start date: 1 June 2018 – end date: 31 December 2021]

- Breaking through outstanding problems in stellar evolution with ultra-precise space-based photometry (BreakStarS) (POCI-01-0145-FEDER-030389 & PTDC/FIS-AST/30389/2017)
PI: Margarida Cunha
[start date: 1 May 2018 – end date: 30 April 2022]

(iii) Infrastructure funded projects (FCT):

- R&D Unit 2020-2023 Financing: Instituto de Astrofísica e Ciências do Espaço (UIDB/04434/2020 & (UIDP/04434/2020)
PI: José Afonso
[start date: 1 January 2020 – end date: 31 December 2023]

(iv) Doctoral programme (FCT):

- Doctoral Network in Space Sciences (PhD::SPACE) (PD/00040/2012)
PI: Mário João Monteiro
[start date: 1 October 2013 – end date: 31 December 2020]

(v) Cooperation projects funded by Gabinete de Relações Internacionais da Ciência e do Ensino Superior (FCT) and by Conselho de Reitores das Universidades Portuguesas

- Strategic partnership in astrophysics Portugal-Brazil: the connection between black holes and galaxies using powerful new instrumentation and theoretical insights (Cooperação Cientifica e Tecnológica FCT/CAPES – 2018/2019)
PI: Andrew Humphrey
[start date: 1 October 2013 – end date: 31 May 2021]

(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 2020]

- On-board Metrology for Athena (ESA Contract No. 4000131014/20/NL/HB/gg)
  PI: Manuel Abreu
  [start date: 19 June 2020 – end date: 1 October 2022]

Projects focused on communication and outreach

During 2020 there were several funded projects in IA:

- Ciência Viva no Verão em Rede 2020 (CV: 44-2020/446)
  PI: Filipe Pires
  [start date: 1st July 2020 – end date: 30th September 2020]

- Formação ESERO – Conhecer a Terra através do Espaço – 2a Edição
  PI: Filipe Pires
  [start date: 1st September 2019 – end date: 31th December 2020]

- Renovation of solar system exhibition – Europlanet Society
  PI: João Retré
  [start date: 1st January 2020 – end date: 31th December 2020]

Scientific Output and Activities

The overall output of IA in **2020** was (see Appendix for details)

201

Papers in refereed journals

19

Papers in books and proceedings

49

Communications in international meetings

59

Communications in national meetings

13

Seminars in other institutions

26

Seminars organized at IA

118

Public outreach talks

6/9

MSc/PhD thesis completed

25

Observing runs

6

Organization of conferences

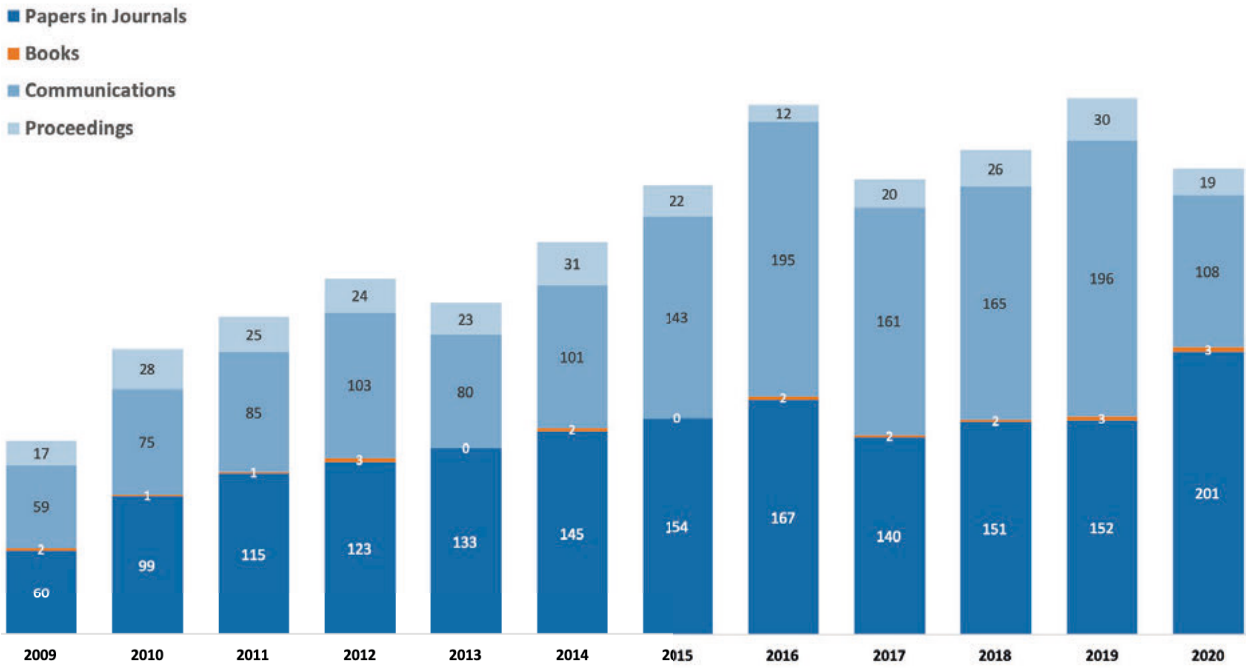
3

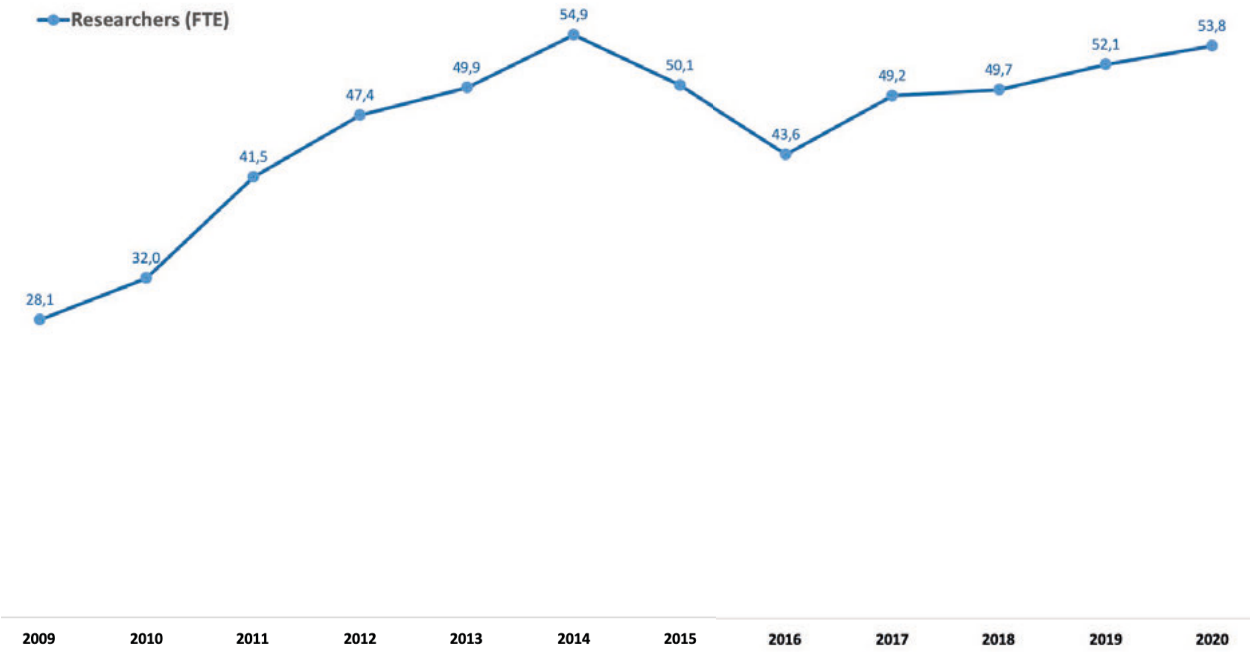
Books

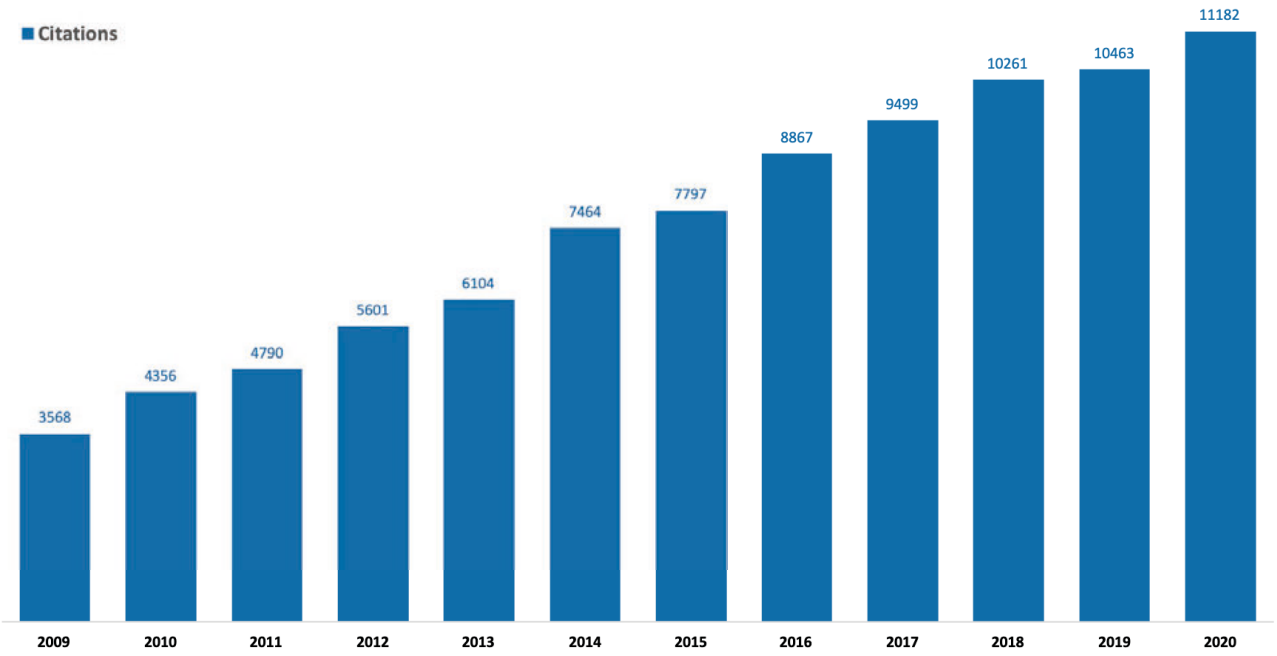
2

Reports

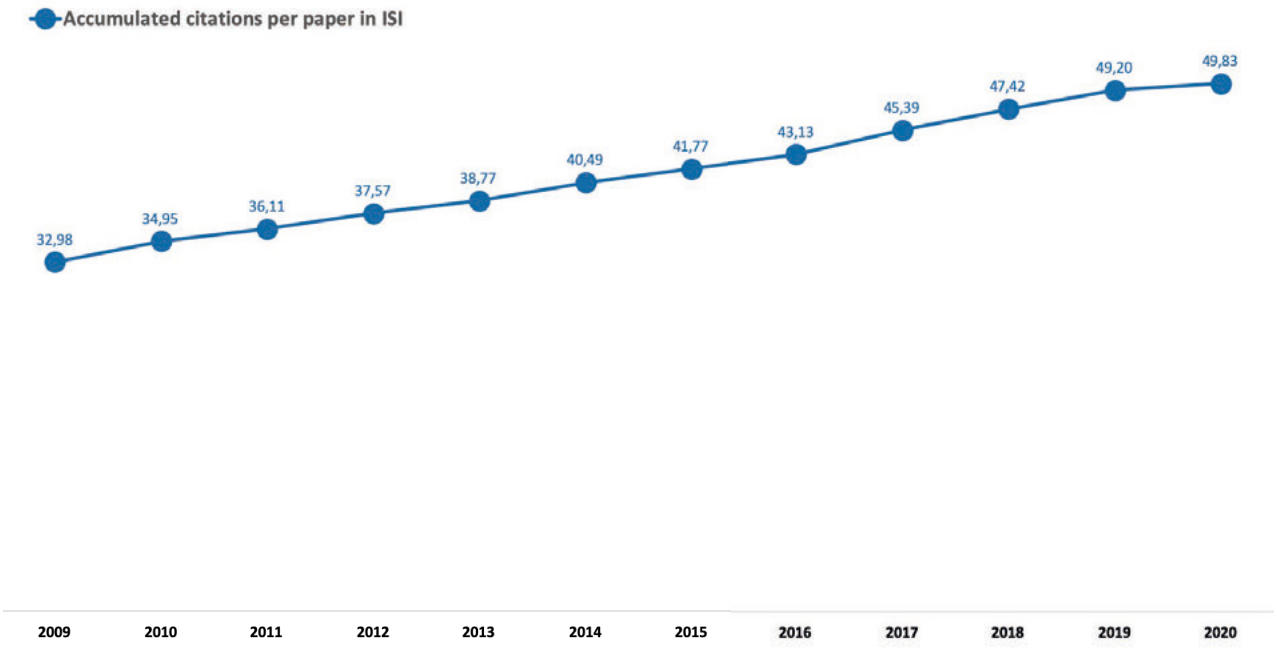
The figures below illustrate the institute's productivity during the past year. There is a clear and natural relation between the number of researchers and the number of papers in journals subject, understandably, to a small shift in time. The figures show a continuation of the increase in the number 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 Group

Towards the detection and characterisation of other Earths

In 2020, Planetary System research at IA continued the activities around the two major branches, namely Exoplanet research and Solar System atmospheres.

Exoplanet research focused on multiple complementary aspects, mostly observationally driven: 1) the search and characterization of exoplanets using state-of-the-art radial velocity data, including the detection and mass measurement of planets previously detected by the transit method (e.g. with missions such as TESS); 2) the study of astrophysical sources of noise for the detection and characterization of planets as well as methods to correct/model them; 3) the study of planet-host stars as a way to characterize planets as well as their properties and formation processes; 4) the statistical study of planet characteristics as well as the relation with the properties of the host stars; 5) the study of exoplanet atmospheres using broad-band photometry and high-resolution spectroscopy.

Our team is a major participant/player (e.g. Co-PIship and Board membership) in current (e.g. ESPRESSO@VLT and SPIROU@CFHT) and future (NIRPS@ ESO's 3.6m and HIRES@ESO's ELT) state-of-the-art ground based facilities, as well as space missions (CHEOPS, ESA – launched December 2019; Plato, ESA, 2026; ARIEL, ESA, 2028). For all of those, we are responsible for scientific tasks as well as part of the data reduction/analysis pipelines. This is complemented by other hardware (HW) and software (SW) participations responsibility of the Instrumentation team in IA. As such, the strategy of the team is to develop the above mentioned science goals taking advantage of our privileged position in these projects and facilities.

In 2020 we can highlight the strong effort done by the team in the analysis of data from the ESPRESSO spectrograph (Guaranteed Time Observations). The IA team has a strong contribution to all three working-groups of the ESPRESSO consortium: blind radial velocity search for planets in the habitable zone of solar type stars, transit follow-up to derive masses for rocky planets, and study of exoplanet atmospheres using high resolution spectroscopy. Several papers led by IA researchers have been published and others are in preparation.

Also of relevance was the analysis of the first data obtained by the CHEOPS mission. The scientific acquisition and analysis of CHEOPS data started in March 2020, and several team members have been very active in preparing and analysing the scientific observations (including leading roles in some working groups within the CHEOPS Science Team). The team was therefore involved in all the papers published by the CHEOPS consortium, and in 2021 we expect to have several results led by IA-team members.

ESPRESSO and CHEOPS will be major references for the team in the next 2-4 years, since our leading participation in these projects allows us to be in a privileged position inside the respective consortia to exploit the valuable data obtained in the 273 guaranteed nights of observations (GTO) with ESPRESSO at the VLT (until 2022) and the 80% of the time of the CHEOPS ESA mission (until 2024). To this, we should add the 725 nights of GTO for the NIRPS consortium (first light expected in late 2021). Our participation in these projects will reinforce the existing strategy and allow the team to be in the forefront of exoplanet detection and characterization. Further ahead, our secured

participation in the ESA-PLATO, ESA-ARIEL, and ESO-HIRES (ELT) projects guarantee our international leadership role beyond 2026.

On the Solar System side, research mainly focused on solar-system planet atmospheres, with clear synergies with the exoplanet side. The recent adoption by ESA of the space mission ARIEL, with a relevant IA participation, shows that the adopted strategy was correct.

ARIEL, the Atmospheric Remote-sensing Infrared Exoplanet Large-survey, was recently selected as the fourth medium-class mission in ESA's Cosmic Vision programme. During its 4-year mission, ARIEL will study what exoplanets are made of, how they formed and how they evolve, by surveying a diverse sample of about 1000 extrasolar planets, simultaneously in visible and infrared wavelengths. It is the first mission dedicated to measuring the chemical composition and thermal structures of the atmospheres of hundreds of transiting exoplanets, enabling planetary science far beyond the boundaries of the Solar System.

The Portuguese participation in the ARIEL mission is highly based in IA's contribution. In particular, the participation in several scientific work packages of the ARIEL space mission is secured by IA's researchers. Besides the scientific activities the role of IA is also in the focus of funding procurement and related projects applications (namely Prodex) and coordination with our industry and instrumentation partners regarding the ARIEL's Telescope Baffle construction in Portugal, the Payload (namely in the Optical Ground Support Equipment – OGSE) by IA's instrumentation group.

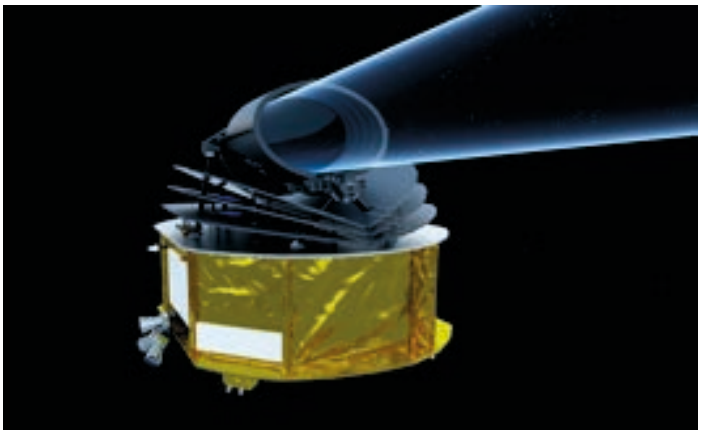


Figure: Artist's impression of Ariel.
Image Credit: ESA/STFC RAL Space/UCL/UK Space Agency/ ATG Medialab

An overview about the plan of activities concerning the strong IA's participation in this mission involves the several Science Working Groups (WG) that the Portuguese consortium is leading (or co-leading), which comprises the synergy between the study of the atmospheres of the planets in the Solar System and the exoplanets. IA is also involved in other objectives such as support calculations of the radial velocities of the exoplanets or the connection between the exoplanets and their parent star.

Together with ESA'S CHEOPS and PLATO, as well as ground based instrumentation for ESO such as ESPRESSO, NIRPS, and HIRES@ELT, ARIEL completes the instrumentation set related with planetary system's research that support the long term strategic science plan of IA.

Furthermore, the team continued different studies of the atmospheres of Venus, Mars, Saturn, and Jupiter. We can highlight here the use of space-based observations (from the missions Akatsuki for

Venus, and from Cassini for Jupiter and Saturn) to perform dynamical studies based on cloud tracking techniques (UV and IR) and for the detection and characterization of atmospheric waves. Also of relevance was the use of sophisticated 3D models to evaluate the strong impact of those waves on the atmospheric circulation of Mars and Venus. In addition, ground-based observations (VLT/UVES for Saturn, HARPSN/TNG and CFHT/ESPaDOnS for Venus) and their related high-resolution spectra provided wind velocities using our Doppler velocimetry method.

Scientific Highlights for 2020

In 2020, a total of 13 IA Press-releases were published announcing scientific or science-related results with a leading or major participation of the team. Most of them were done in an international context. The list of highlights below is based on some of these.

1. **From the nearest planetary system to the atmospheres of distant giants: the first ESPRESSO results**
   Following a long effort to design and build the ESPRESSO spectrograph for the VLT, in 2020 the IA team saw the dawn of the first scientific results obtained by this revolutionary instrument. From the detection and characterization of very low mass planets to the study of exoplanet atmospheres in unique detail, 7 refereed papers in total were published by the team. These results are just a glimpse of what ESPRESSO still has to offer.
   The first ESPRESSO result (published in Nature) revealed an extreme planet where iron is raining (Ehrenreich et al. 2020). The ultra-hot giant exoplanet WASP-76b has a day side where temperatures climb above 2400 degrees Celsius, high enough to vaporise metals. Strong winds carry iron vapour to the cooler night side where it condenses into iron droplets. Using the transmission spectroscopy technique, the observations show that iron vapour is abundant in the atmosphere of the hot day side of WASP-76b. A fraction of this iron is injected into the night side owing to the planet's rotation and atmospheric winds. There, the iron encounters much cooler environments, condenses and rains down. This result had a strong contribution from our team.
   Among other results, in a separate study, IA researchers also led the detection of the broad band spectrum of another exoplanet, HD209458b (Santos et al. 2020). The results show hints of absorbers such as TiO and Na, confirming previous results obtained using the Hubble Space Telescope. Evidence for atmospheric variability was also discussed.

   ESPRESSO data was also used to measure the mass of several transiting planets detected by space missions such as TESS. Also, data was used to confirm and refine the mass of the planet orbiting the closest star to our Sun: Proxima Centauri (Suarez-Mascareno, Faria, et al. 2020). Detected about 4 years ago using the radial-velocity method, the so-called "Proxima b" was suspected to have a mass similar to that of the Earth and orbiting at a distance from its host star that was close to the habitable zone of the system. However, given that the detection was at the limit of previous instrumentation capacity, an independent confirmation was mandatory. Now, using ESPRESSO, the planet signal was detected without any

ambiguity. Furthermore, the exquisite precision of the ESPRESSO data allowed to take into account the noise introduced by stellar activity. Altogether, the analysis allowed to confirm that the planet exists, and to measure its mass with unprecedented precision.

Figure: This illustration shows a night-side view of the exoplanet WASP-76b. The ultra-hot giant exoplanet has a day side where temperatures climb above 2400 degrees Celsius, high enough to vaporise metals. Strong winds carry iron vapour to the cooler night side where it condenses into iron droplets. To the left of the image, we see the evening border of the exoplanet, where it transitions from day to night. Credit: ESO/M. Kornmesser.

2. CHEOPS satellite opens its eye

Like for ESPRESSO, the CHEOPS mission also published its first science results in 2020. Launched in December 2019, the early months of 2020 were spent in commissioning studies. In the end of January the first image was obtained, and in March the science program started with a strong participation of our team in different working groups (including at leadership level). Furthermore, our team kept its very relevant activities related with the data reduction pipeline, a fundamental piece to the success of the mission.
One of the first observations of CHEOPS was of the transit and occultation of the planet WASP-189b, gas giant more than 1.5 times the size of Jupiter (Lendl et al. 2020). It is about 20 times closer to its host star than the Earth to the Sun. WASP-189 b is one of the hottest exoplanets known: CHEOPS occultation data suggest its temperature to be approximately 3200 degrees Celsius. The host star itself is a massive blue star 322 light years away from Earth, and it is wider at its equator than at its poles as it is spinning so fast that it is pulled outwards around its equator. This leads to "strange" photometric transit shapes, whose details can only be seen with the very precise CHEOPS data.

The new and high-precision CHEOPS observations enable a substantial revision of the planetary parameters, as well as the geometry of the planet's orbit: by combining updated parameters of the star with the transit data, scientists have found that the planet is 15% larger than previously thought, and so less dense; they have also revealed that the planet's orbit is tilted away from the stellar equator, with the planet passing over the star's poles as it circles the star.

Several other papers are now being prepared from CHEOPS observations, including with leadership of IA researchers.

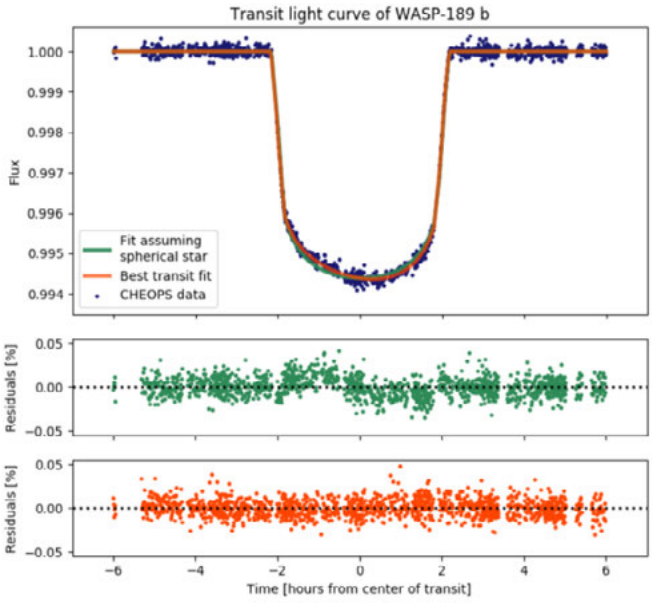


Figure: Transit of WASP-189 as observed by CHEOPS. Two different fits were done to the data: using a spherical star model and taking into account a more realistic model taking into account the effects of stellar rotation. From Lendl et al. 2020.

3. A cotton candy planet, or the first exoplanetary ring?

The detection of a growing population of exoplanets does not stop surprising astronomers. One of the recent examples is the planetary system orbiting the bright solar-type star HIP41378. The system is comprised of at least 5 planets with masses that go from about 4 times the mass of the Earth, up to about the mass of Neptune. More importantly, the outer planet in this system (planet "f", with an orbital period of 542 days) was found to have a radius (through transit photometry) similar to the one of Saturn, but its mass, as measured using radial velocities, is lower that of Neptune. This makes this planet the lowest density planet ever detected.

There is actually no simple explanation for the formation of such a low-density planet. Can such a "cotton candy" world be formed by the traditional planet formation models? Or is there another explanation for the observed low-density? To understand this, an international team led by IA's PhD student Babatunde Akinsanmi explored different explanations for the observed density. Using an in-house developed code to model the system, the results have shown that the observations can be easily explained if HIP41378f is actually a normal Neptune-like planet with a large system of rings similar in shape to the ones we see in Saturn. Absorbing ring particles can explain why the measured radius is equivalent to the one of a Saturn-like world while its mass is "small" and compatible with the one of Neptune.

Rings are ubiquitous in solar system giant planets, but they have never been unambiguously detected in an exoplanet. While other explanations are not discarded, the results that were obtained by the team show that this planet is the best exoplanet candidate so far for the presence of rings.

4. Riding through the waves of Mars and Venus

Mars has a very thin atmosphere, with nearly one hundredth the density of ours on Earth, and gravity pulls with little more than one third of the strength we feel on our planet. As a result,

dust storms can go global. For future missions to Mars, it is important to understand the planet's airy envelope and to forecast its moods. A work led by an IA researcher (Gilli et al. 2020, JGR), may improve the way we describe and forecast the Martian weather. The study suggests that waves moving upwards across Mars' thin air, and caused by air perturbations, can have a strong impact on the atmosphere as a whole. Such waves seem to interact with the periodic oscillations of the atmosphere, named diurnal tides, caused by the contrast in temperature between day and night. The study shows that the impact of gravity waves on Martian diurnal tides tend to slow down the winds at altitudes above 50 km, more in accordance with what is in fact observed on Mars. The authors used a tri-dimensional model developed by the Laboratoire de Meteorologie Dynamique, France, continuously being updated towards a more faithful representation of the Martian climate.

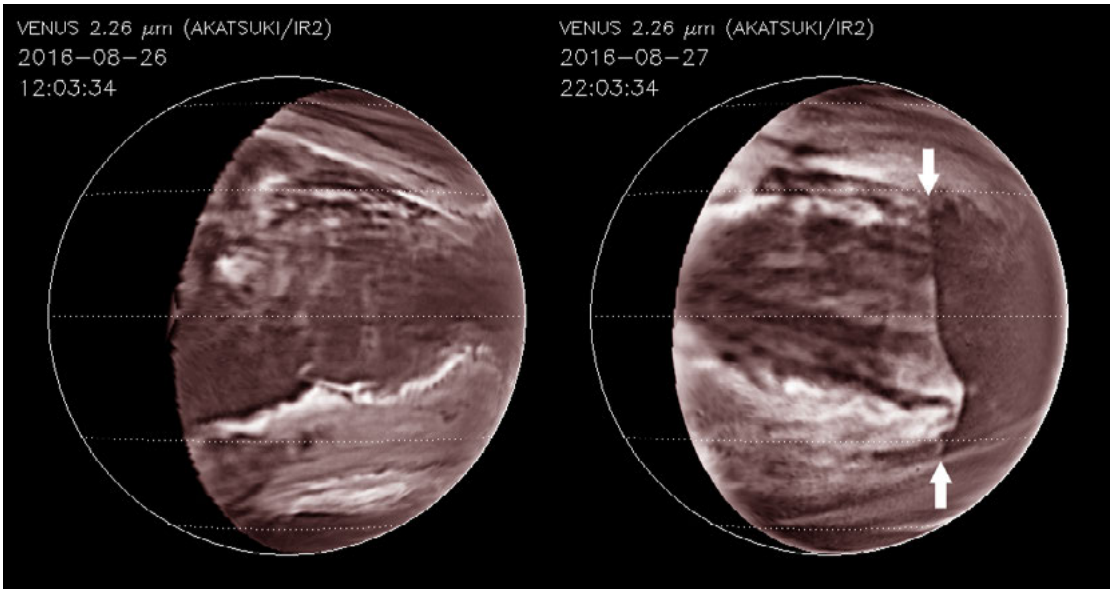


Figure: An epic planet-scale wave has been hiding in the sulphuric acid cloud layer of Venus for decades.

Another kind of waves, of planetary size proportions were studied on the atmosphere of Venus by a team led by the Japanese Space Agency (JAXA) with a strong participation of a researcher of IA (P. Machado). In the cloudy Venus, a giant atmospheric disruption, not yet seen elsewhere in the Solar System, has been rapidly moving at around 50 kilometres above the hidden surface, and unnoticed for at least 35 years. IA contributed with follow-up observations with NASA's Infrared Telescope Facility, in Hawaii, coordinated with new observations made from space with the Akatsuki orbiter.

Group meetings, Journal Clubs and other activities

In 2020, as for the previous years, the IA-planet group maintained a regular journal club and team meeting agenda. Team meetings and journal clubs are organized 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, followed by discussion. This format helps the whole team to be acquainted about the research that is being carried out and helps the students to develop presentation skills and

identify potential problems and solutions in his/her research project. Journal clubs include the presentation of one paper, followed by discussions. A journal club more specific about solar system research is also organised.

Due to the covid-19 situation, since March 2020 all regular team meetings and journal clubs were done via Zoom. The regular contact helped to minimize the impact of the confinements and decreased human contact in the team's activities.

We also organised our annual team meeting (called "2-DEMOC", this time using Zoom, where the team strategy and plans (both scientific and organisational) were discussed.

Team members actively participated in different public outreach activities, including "IAstro Junior" (co-organized with the magazine Visão), as well as with public talks and debates in schools and other outreach events.

In 2020, 3 PhD thesis were successfully finished:

- “Atmospheric correction for high resolution near infrared spectroscopy” by Solene Ulmer-Moll,
- “From ESPRESSO to Plato: detecting and characterizing Earthlike planets in the presence of stellar noise”, by Luisa Maria Serrano, and
- “Towards a comprehensive understanding of tiny stars in the near-infrared domain -Determining stellar parameters of FGK and M dwarfs from their APOGEE spectra using the spectral synthesis method” by Pedro Sarmento.

Three undergraduate students (Francisco Pimenta, Mafalda Matos, and Ana Barboza) did short research work/internships with team members.

Team funding comes mostly from IA "strategic funding" as well as from 3 FCT projects. Furthermore, funding for our participation in the PLATO mission was secured through PRODEX. We also guaranteed the continuation of this funding for the period 2020-2022, as well as a similar funding package for the ARIEL mission. We note, however, the PRODEX funding covers only the "project level activities".

In 2020, the team was organizing a large international conference on exoplanets ("Towards other Earths III: from Solar System to Exoplanets"). Unfortunately, the conference had to be cancelled due to the pandemic crisis.

Nuno Santos
Group Leader

Report from the Group

Towards a comprehensive study of stars

The main goal of this group is to understand the details of the structure and evolution of stars of low and intermediate masses, from the early stages of star formation to late stages of evolution. It also covers the study of rotation and activity both in Young Stellar Objects (YSOs) and in main-sequence stars, as well as to the modelling of star-disk interactions in the former.

In 2020, the team continued the extensive exploitation of asteroseismic data from the NASA satellite TESS (launched in 2018), in relation to which the team leads one of the working groups established by the Tess Asteroseismic Science Consortium (TASC). Following the adoption by ESA (in 2017) of the mission PLATO, the team is actively participating in the implementation of the work in the stellar part of the mission. In particular the team is leading work packages on seismic diagnostics and calculation of stellar models for the pipeline, a working group on spectroscopic characterization of the PLATO targets, a working package on the scientific validation of the PLATO as well as participates in several others. The team is also involved (leading some sub-WGs) on the preparation of the ARIEL/ESA (2028) mission through stellar characterization with asteroseismology and determination of atmospheric stellar parameters and chemical abundances. The team also continued its participation to the Gaia-ESO survey by providing stellar parameters and chemical abundances for the final data release of the survey.

On the star formation side, the team is involved in the ongoing JCMT projects, the ESO-VISTA VVVx survey, and also intensively uses the ALMA and Herschel high-quality data. The team members are also involved in the upcoming JWST (James Webb Space Telescope, scheduled for March 2021). Additionally, the team is involved in SPIRou consortium work packages focusing on the study of accretion and outflows processes in the T Tauri stars. All these efforts are aimed at understanding the complete picture of star formation by connecting the smaller scale of individual cores/YSOs (for the whole spectrum of mass low- and high-mass) to the large galactic scale of the ISM.

Scientific Highlights for 2020

1. **Unifying low- and high-mass star formation**
   Star formation takes place in giant molecular clouds, resulting in mass-segregated young stellar clusters composed of Sun-like stars, brown dwarfs, and massive O-type (50-100 $M_{\odot}$) stars. In 2020, the team continued its efforts in understanding the role of molecular filaments and hub-filament systems in the formation of stars of different masses. The team (Kumar et al.) applied the DisPerSE algorithm on the Herschel data to detect filamentary skeletons. Then a hub was defined as a junction of three or more filaments. Based on their results, it was concluded that all high-mass stars preferentially form in the density-enhanced hubs of hub-filament systems. Then, a "filaments to clusters" unified paradigm for star formation was proposed, with the following salient features: (a) low-intermediate-mass stars form slowly (10^6 yr) in the filaments and massive stars form quickly (10^5 yr) in the hub, (b) the initial mass function is the sum of stars continuously created in the hub-filament systems with all massive stars formed in the hub, (c) feedback dissipation and mass segregation arise naturally due to

hub-filament systems properties, and explain the (d) age spreads within bound clusters and the formation of isolated OB associations.

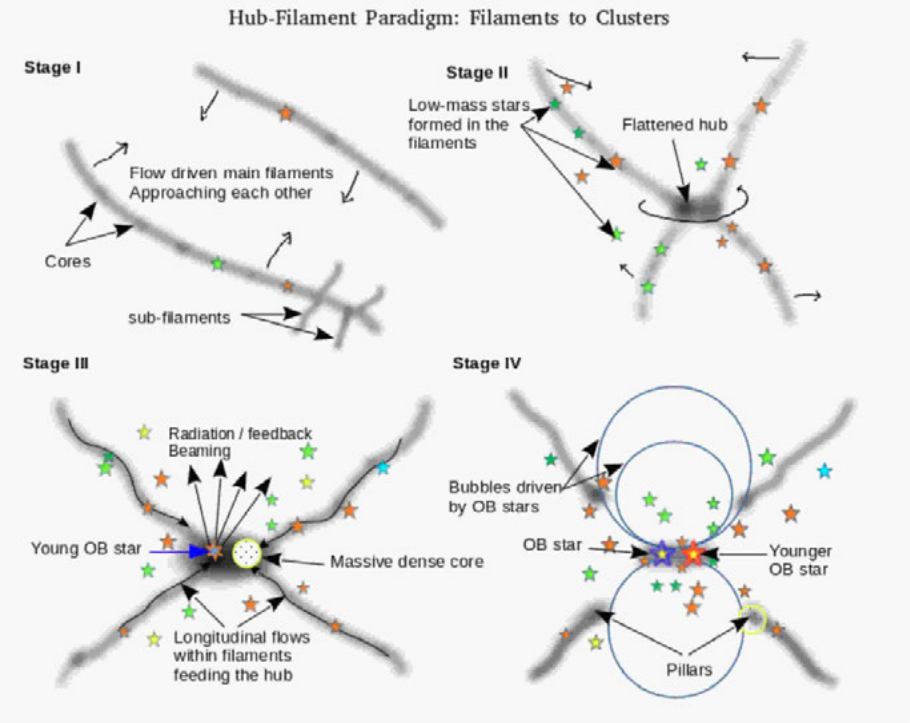


Figure: Schematic illustration of the filaments-to-clusters paradigm for star formation. Kumar et al. 2020, A&A, 642, A87.

2. Stellar pulsators in the presence of stochastic noise

As in the previous years, studying and understanding the pulsations in stars at different evolutionary stages is one of the main focuses of the team. In this context, in 2020 the team (Cunha et al) addressed a long-standing question concerning the driving of pulsations in Asymptotic Giant Branch stars. The authors proposed a new model that provides a unifying description for the driving of low-mass star pulsations throughout stellar evolution, all the way from the main sequence to the Asymptotic Giant Branch. According to the model, in the most general case the driving incorporates two sources, a stochastic and a coherent one. The model predictions concerning pulsation amplitude and phase variability, power spectrum properties, amplitude scaling with pulsation period, and mode lifetime scaling with effective temperature, are all consistent with evidence provided by the analyses of space-based and ground-based data.

3. Stellar parameters of FGK and M stars

One of the main interests and internationally recognized expertise of the team is the spectroscopic characterization of cool stars. In 2020, the team led and contributed to several articles which aimed at improving our ability to determine precise stellar parameters of FGK and M-type stars. Of these articles, two led by the IA students can be highlighted: a machine learning tool to derive effective temperature and metallicity for M dwarf stars (Antoniadis-Karnavas et al.) and Derivation of parameters for 3748 FGK stars using H-band spectra from APOGEE Data Release 14 (Sarmento et al. 2020).

In Antoniadis-Karnavas et al. (2020) an automatic computational tool was developed which can quickly and reliably derive the effective temperature and metallicity of M dwarfs using optical spectra obtained by different spectrographs with different resolutions. Development of this tool – ODUSSEAS (Observing Dwarfs Using Stellar Spectroscopic Energy-Absorption Shapes) – was very important since the derivation of spectroscopic parameters for M dwarf stars is a very difficult task, but it is very important in the fields of stellar and exoplanet characterization.

In Sarmento et al. (2020) an alternative method to the standard APOGEE pipeline (APOGEE Stellar Parameter and Chemical Abundances Pipeline, ASPCAP) was developed to derive parameters in the near-infrared for FGK dwarfs. With this method, spectroscopic parameters for a sample of 3748 main-sequence and subgiant FGK stars have been derived from the APOGEE H-band spectra. A good agreement, within the expected uncertainties, was found when comparing these parameters with the ones obtained with ASPCAP for the same stellar spectrum. The most promising next step is to move towards colder stars and derive parameters for M dwarfs. Another paper exploring stars in this parameter space is currently in preparation.

4. Chemical mixing in low mass stars

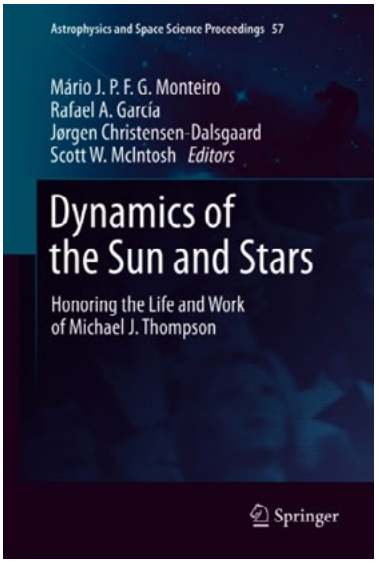
Studying and characterizing the interiors of stars with asteroseismology is one of the hottest research fields of stellar physics, and one of the main focuses of the team.

The team (Deal et al.) led a study aimed at quantifying the opposite or conjugated effects of atomic diffusion (including radiative acceleration) and rotationally induced mixing in stellar models of low mass stars, and to assess whether rotational mixing is able to prevent the strong abundance variations induced by atomic diffusion in F-type stars. The goal of the work was to estimate the impact of neglecting (which is very often done in the literature) both rotational mixing and atomic diffusion in stellar parameter inferences for stars with masses higher than 1.3 $M_{\odot}$.

The results showed that for masses lower than 1.3 $M_{\odot}$, rotation dominates the transport of chemical elements and strongly reduces the effect of atomic diffusion, with net surface abundance modifications similar to solar values. At higher mass, atomic diffusion and rotation are competing equally. Above 1.44 $M_{\odot}$, atomic diffusion dominates in stellar models with initial rotation lower than 80 km s^{-1} producing a chemical peculiarity which is not observed in Kepler Legacy stars.

The general conclusion of the work is that atomic diffusion and rotational mixing should be taken into account in stellar models in order to determine accurate stellar parameters. When atomic diffusion and shellular rotation are both included, they enable stellar evolution codes to reproduce the observed metal and helium surface abundances for stars with masses up to 1.4 $M_{\odot}$ at solar metallicity. However, if rotation is actually uniform for these stars (as observations seem to indicate), then an additional chemical mixing process is needed together with a revised formulation of rotational mixing. For higher masses, an additional mixing process is needed in any case.

5. **Dynamics of the Sun and Stars**
   The team edited a volume published by Springer in 2020. The volume is a collection of 47 original articles resulting from the contributions presented at the conference on "DYNAMICS OF THE SUN AND STARS: HONOURING THE LIFE AND WORK OF MICHAEL J. THOMPSON". The conference was focussed on dynamical aspects of the Sun and stars, based on the large amount of data available on solar and stellar oscillations, and the extensive and detailed modelling that is becoming feasible. Several of these articles are authored or co-authored by the members of the team. The book can be accessed at https://www.springer.com/gp/book/9783030553357



Group meetings, Journal Clubs and other activities

Complementary to the many publications produced, the team also participated in several international conferences where the results of the project have been presented and discussed. We maintained an active participation in the large projects of ESA and ESO (also NASA's TESS mission) related to the Group/Team selected as the backbone of IA under its strategic plan.

The team includes several PhD and MSc students working on topics related to the main goals of the group. During 2020 one MSc student (Gaëtan Devillers – University of Strasbourg/Engineering School Télécom Physique) finished his thesis in the team. Moreover, 5 PhD thesis were successfully finished:

- "Accretion versus outflow regions around Young Stellar Objects" by Raquel Albuquerque
- "Asteroseismic Characterization of Exoplanet-host Stars in Preparation for NASA's TESS and ESA's PLATO Space Missions" by Benard Nsamba
- "On the variability of young massive objects from ongoing accretion", by Guilherme Teixeira
- "Towards a comprehensive understanding of tiny stars in the near-infrared domain -Determining stellar parameters of FGK and M dwarfs from their APOGEE spectra using the spectral synthesis method" by Pedro Sarmento (also linked to the planets group) , and
- "Ciência cidadã: envolvimento do público na investigação e divulgação em astronomia" by Ilidio Costa (also linked to the science communication group)

In 2020 the team continued the organization of regular (bi-weekly) journal clubs on topics related to the research interests and the monthly team meetings. In addition, regular bi-weekly meetings have been organized focused on "stellar physics" where all the team members were invited to participate and contribute. Participation in outreach activities covering topics on stars is also frequent, including several talks and manuscripts in the *National Geographic Portugal* that cover topics related to this thematic line.

Vardan Adibekyan
Group Leader

Report from the Group

The assembly history of galaxies resolved in space and time

The adverse conditions created by the COVID19 pandemic have led to significant challenges for the group and greatly impacted its scientific work during 2020. Notwithstanding this fact, the group has continued the implementation of its strategic plan, intensifying its efforts toward the exploration of the formation history of galaxies and their structural components, of the genesis and growth of super-massive black holes (SMBHs) in galactic nuclei and their influence on the assembly history of galaxies, the mechanisms triggering and regulating starburst activity and its role on the galaxy stellar mass growth, and the influence of the environment on galaxy evolution.

These science goals which are being pursued by a team of 14 researchers, 7 collaborators and 6 PhD students, are served by the participation of IA with leadership roles in the instrument consortia of MOONS@VLT and MOSAIC@ELT of ESO, and ESA missions with key relevance to the strategy of the group (Euclid, Athena), as well as by the parallel development of highly optimized 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 that recently permitted team members 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 the future 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-α 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 the ongoing further development of IA's spectral synthesis code FADO with the capability of self-consistently modelling stellar and nebular emission jointly with an AGN power-law component. FADO, together with other tools developed at IA, 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 observations in 2022.

During 2020, 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 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, 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, age and metallicity patterns in spiral and elliptical galaxies, cooling flows and ram pressure stripping effects in galaxy clusters, gas kinematics and excitation mechanisms in elliptical galaxies, the evolution of the ionizing photon efficiency across cosmic time, massive Wolf-Rayet stars and the diffuse ionized gas in star-forming galaxies, and the nature of ultra-faint galaxies. Furthermore, using ALMA, MUSE and FADO the team is also studying the action of starbursts on the molecular gas phase in extremely metal-poor dwarf galaxies, which may be considered the best local analogues of the first proto-galactic units that emerged at the EoR. The activities of the team also encompass detailed photometric decomposition studies and the recent development of a conceptually novel tool for the robust structural characterization of galaxies via the Sérsic law. The latter publicly available tool has significant potential for an automated application to the Euclid Galaxy Legacy Survey, which is co-led by IA.

The team's expertise in current state-of-the-art telescopes and instruments is well worth stressing. Not only the team is nuclear to the activities of the Portuguese ALMA Centre of Expertise (PACE), providing manpower and expertise to support the national use of the facility and helping ESO validating its data, but during 2020 the team has shown a remarkable level of proficiency in the use of one of the most revolutionary and complex optical spectrographs currently in operation — MUSE — as detailed below.

Scientific Highlights for 2020

1. **Super-Massive Black Holes and Active Galactic Nuclei**
   The team has participated in the discovery of two giant radio galaxies (GRGs) with enormous physical sizes of 2.4 Mpc and 2.0 Mpc at redshifts z~0.17 and ~0.34 using the MeerKAT International GHz Tiered Extragalactic Exploration (MIGHTEE) survey. Various arguments support the hypothesis that the prevalence of GRGs has been significantly underestimated in the past due to limited sensitivity to low surface brightness emission. The two GRGs may be the first of a new population to be revealed through surveys like MIGHTEE which provide exquisite sensitivity to diffuse, extended emission.

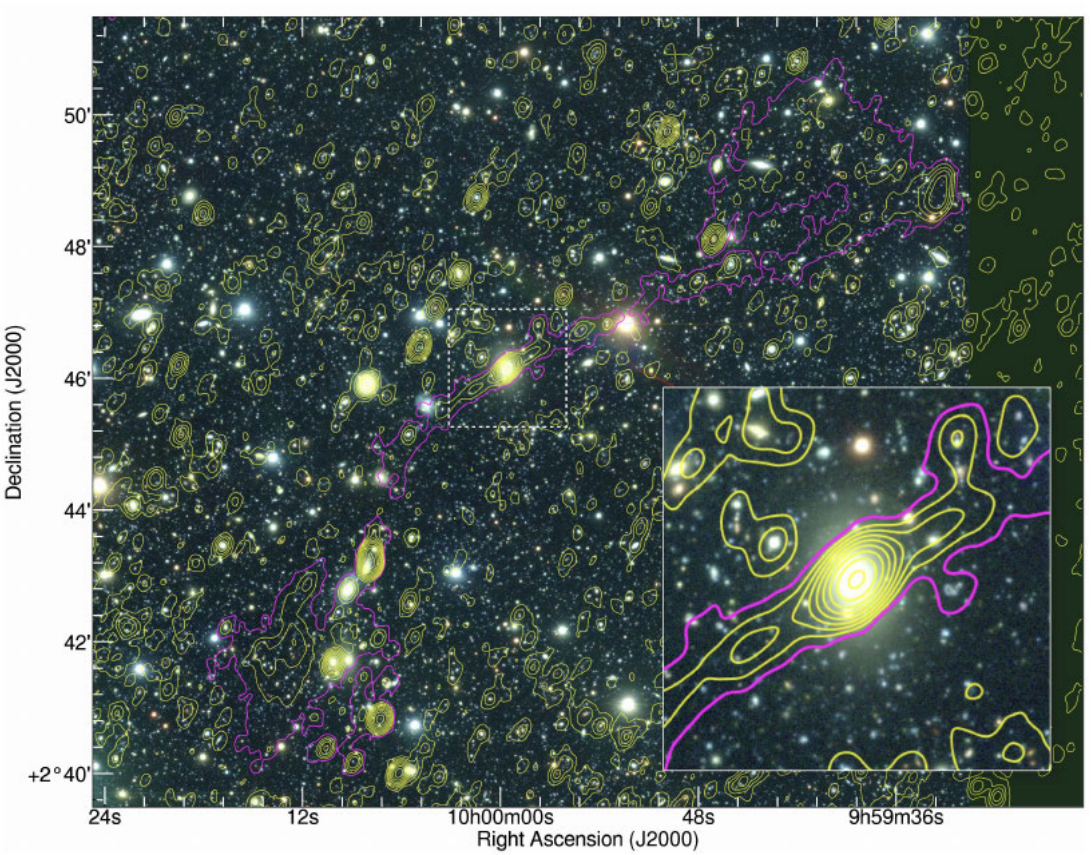


Figure: GRG1 as seen in MIGHTEE (yellow contours), overlaid on a composite optical image of that combines broadband g,r ad I data. The inset shows a zoom-in into the surface brightness maximum of the radio emission, where the host galaxy can be seen. The projected size of the gigantic radio lobes reaches 2.4 Mpc*. Figure from (Afonso et al., MNRAS).*

Continuing and extending previous work the team devised new discriminators for high-z quasars that were used for the identification of such sources with IRAM, while continuing its study with ALMA of an approved highest-z target. As part of a coherent mid-term strategy, the group also developed a tool for the estimation of the surface density of AGN that are expected to be detected in the X-ray with the Athena WFI. Furthermore, team members have developed a web-based interface that permits estimation of sensitivity limits for overlapping observations in the ALMA Science Archive. This tool will strongly support ongoing studies by the group and the community of the molecular properties of AGN hosting galaxies.

The action of a SMBH on the properties of the molecular and ionized gas has been studied in the Brightest Cluster Galaxy (BCG) M1931 (Ciocan et al. A&A submitted) using IFS with MUSE and ALMA data. This study showed that ionized and molecular gas are co-spatial and co-moving. Quite importantly, the combined analysis of ALMA data and IFS indicates that a gaseous tail protruding ~30 kpc to northwest is in the process of falling onto the nucleus, feeding the AGN and star-forming activity at a rate as high as ~100 $M_{\odot}$/yr.

Toward a better understanding of the regulatory role of AGN on galaxy evolution, the group has participated in a study (Florian et al. A&A) that examined the difference between observed gas velocity fields in massive early-type galaxies (ETGs) for galaxies with and without an AGN. The primary goal of this project was to infer the visibility timescale and

nature of kinematical perturbations in the gas being induced by an AGN. This analysis included an extended sample of 123 ETGs from the CALIFA survey that was processed with the IA-developed IFS modelling interface Porto3D. This study finds that even if the general disturbance of the gas is not a unique indicator for AGN feedback, certain kinematical irregularity parameters documented both in observations and simulations can only be reproduced through AGN feedback. Specifically, an elevated value for the deviation from simple ordered motion is a strong sign for previous episodes of AGN activity and feedback.

Further insights into the role of AGN have emerged from spectrophotometric studies (Bischetti et al., A&A) that used data from ALMA, NOEMA and JVLA to study hyper-luminous QSOs selected from WISE-SDSS. This work showed that hyper-luminous QSOs pinpoint the high-density sites where giant galaxies assemble, and that in this phase the mergers play a major role in the build-up of the final host-galaxy mass.

Team members (Silva et al., MNRAS) studied UV emission-line ratios of 145 type II quasars (QSO2s) from SDSS, and compared them against a grid of AGN photoionization models with a relevant range in gas density, gas chemical abundances, and ionization parameter. Most of the quasars were found to be 'carbon-loud', with C IV/He II ratios that are unusually high for the narrow-line region, implying higher than expected gas density (>10^6 cm^{-3}) and/or significantly supersolar-relative carbon abundance.

A study developed by team members (Breda et al., A&A) used spatially resolved IFS data and spectral synthesis models to study for the first time systematically and on the basis of a representative sample of 135 galaxies stellar age gradients in the bulge component of spiral galaxies. They found that an inversion of positive to negative age gradients occurs at log(M*/$M_\odot$)~10, which roughly coincides with the transition from lower-mass bulges whose gas excitation is powered by star formation to bulges classified as Composite, LINER, or Seyfert.

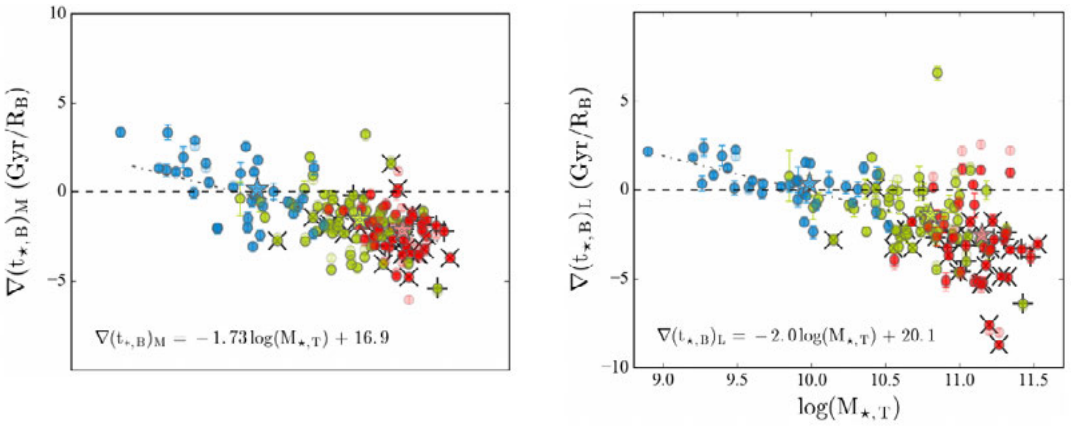


Figure: Logarithm of total stellar mass $M_{\star T}$ ($M_\odot$) vs. radial age gradient (in Gyr/R_B) within the bulge radius R_B, as obtained from mass- and light-weighted stellar age determinations (lefter and righter panel, respectively). From Breda et al. (2020a).

From age gradients they infer for massive bulges a low mean velocity of ~2 km/s for the inside-out star formation quenching process, which suggests that, on the statistical average, AGN evacuate the bulge from gas and shut off star formation on a timescale of ~2 Gyr. This

in turn suggests that negative AGN driven feedback is highly directional and places new observational constraints on models.

2. Development and applications of spectral modelling tools

In preparation for a detailed exploration of the galaxy assembly history with MOONS@VLT, BlueMUSE@VLT, MOSAIC@ELT and NIRSpec@JWST our team has further refined spectral modelling tools that it has developed over the past few years and deepened its expertise in the processing and interpretation of multi-wavelength data.

In parallel to the ongoing development of an upgraded version of the spectral synthesis code FADO (Gomes & Papaderos 2017) with the capability of self-consistently fitting Seyfert 2 galaxy spectra, the group has continued spectral modelling studies of synthetic and observed spectra for star-forming galaxies in order to quantitatively address the ability of FADO and other widely used codes of retrieving key physical and evolutionary properties of galaxies. An analysis of the dependence of the fitting result on the signal-to-noise ratio (SNR) (Pappalardo et al., A&A, submitted) has demonstrated that FADO can retrieve the mass- and light-weighted age and metallicity of galaxies even down to a SNR~10. This line of activities has been supplemented by a study of the dependence of the spectral synthesis output on the spectral coverage of the input data. To this end, (Breda et al., in prep.) have compared the output from different codes (FADO, STARLIGHT, STECKMAP) for a selected sample of star-forming and passive galaxies with available single-fiber SDSS spectra and IFS data from CALIFA, MaNGA and MUSE.

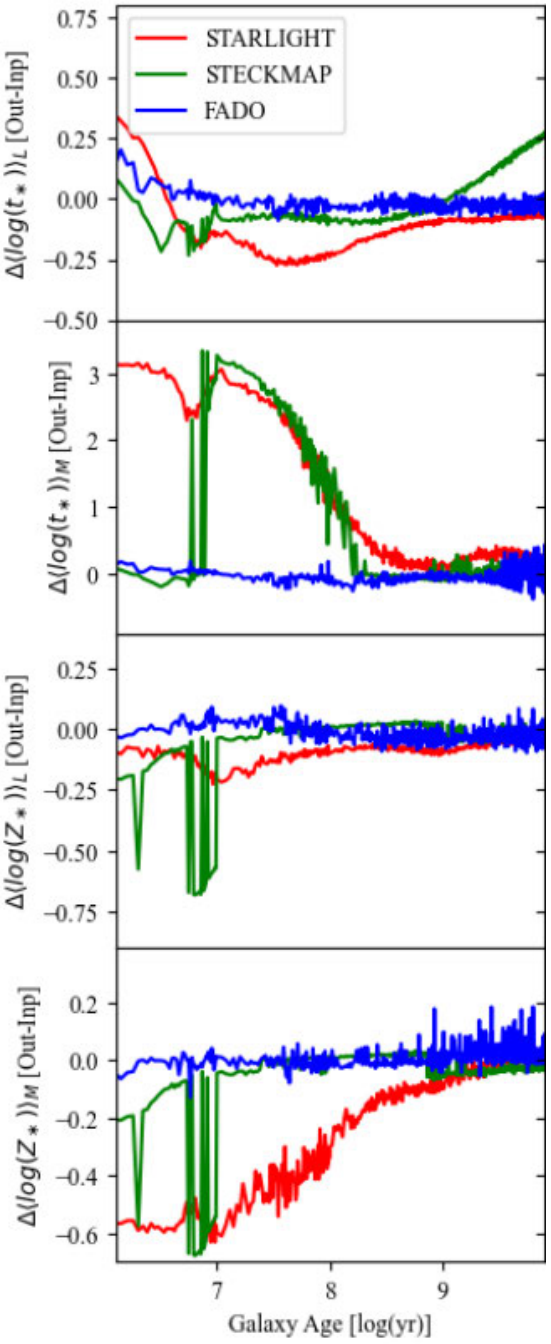


Figure: Comparison between the purely stellar population spectral synthesis (PSS) codes STARLIGHT (red) and STECKMAP (green) with the conceptually novel IA-developed PSS code FADO (blue). The upper panel shows the retrieved and input light- and mass-weighted stellar age (two upper panes) and metallicity (two bottom panels) It is apparent that, whereas STARLIGHT and STECKMAP severely overestimate

(underestimate) the age (metallicity) in early stages of galaxy evolution (<1 Gyr), FADO in all cases recovers the input age and metallicity within 0.15 dex (from Pappalardo et al., A&A submitted).

The team has continued the processing of the entire SDSS DR7 (about one million galaxies) with FADO, with several publications by group members and collaborators being in preparation. These will focus on the origin and timescales of star formation quenching, the difference between the stellar and gas-phase extinction, and the nature of the star formation main sequence.

A new spectral fitting concept allowing for consistent modelling of Wolf-Rayet features and the Paschen discontinuity was presented in Gunawardhana et al. MNRAS. Moreover, team members (Nanayakkara et al., ApJ, Maseda et al., MNRAS) studied the ionizing photon production efficiency at higher redshift with, respectively, stellar population models and by contrasting the observed Hα and UV magnitude in a selected sample of 35 LAEs.

The IA-developed IFS spectral modelling pipeline Porto3D was upgraded with the capability of modelling MUSE IFS data with FADO. This new version of the pipeline is being intensively applied to the exploration of the SFH of ALMA-observed metal-poor starburst galaxies and the inside-out growth of spiral galaxies from the MUSE Atlas of Disks (MAD) survey.

3. Structural and morphological characterization of galaxies

The group has presented (dos Reis et al., A&A) a detailed structural and colour analysis of 17 massive galaxies at z~0.5 using multi-band imaging data with the HST. Quite importantly, this project has for the first time investigated whether radial colour profiles implied by 2D bulge-disk decomposition with GALFIT are sensible from the evolutionary point of view. This was not found to be the case for about one half of the analysed galaxy sample, which points to a fundamental conceptual shortcoming of state-of-the-art 2D photometry tools. Overcoming this problem with new surface photometry concepts (e.g., the code presented by our team for a robust determination of Sérsic model parameters) appears to be of paramount importance for a reliable automated structural analysis of large galaxy samples with, e.g., Euclid. It should be noted that Galaxy Legacy Science with Euclid is at the core of the mid-term strategy of the group, and preparatory work in this regard is being carried out by several of its members. In particular, F. Buitrago examined galaxy truncations and possibilities for a physically motivated definition of galaxies using extremely deep multi-band imaging. Additionally, team members have developed and successfully tested advanced Machine Learning (ML) concepts that allow for the detection of quiescent/passive galaxies at 1.5<z<2 with Euclid & LSST at a rate that is twice as high as that of previous ML tools (Humphrey et al., in prep.).

A novel spectrophotometric bulge-disk decomposition method presented (Breda, et al., A&A) was applied to IFS data for 135 galaxies from the CALIFA survey. The main finding from this study was that in 1/3 of local spiral galaxies the disk's radial stellar surface density shows a central flattening or down-bending inside the radius of the bulge. This theoretically predicted central depletion of galactic disks, now observationally demonstrated, has far-reaching implications for our understanding of the joint evolution of bulge and disk since the early

epoch of galaxy formation, and potentially also for the slope of the bulge vs. SMBH mass relation.

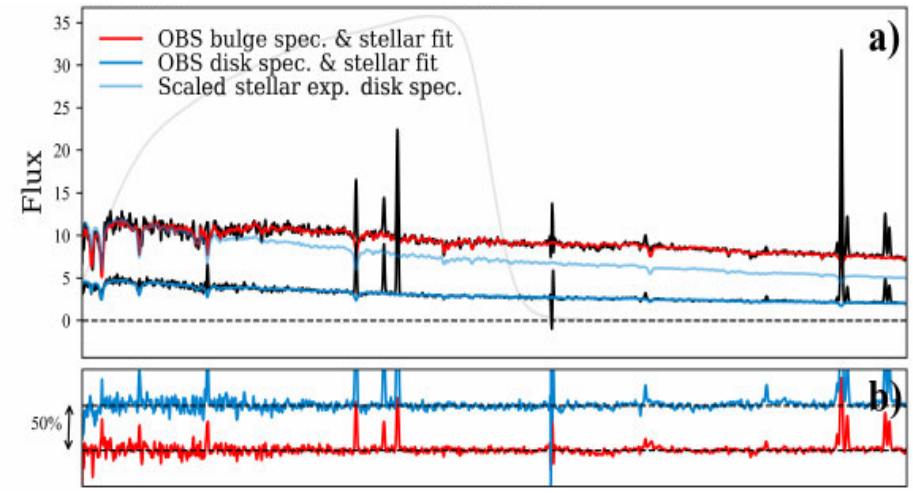


Figure: Illustration of the methodology devised in Breda et al. for the extraction of the net spectrum of the bulge through subtraction of the scaled spectrum of the disk (light-blue) from the integrated spectrum within the radius of the bulge (red). The residuals between the observed and modelled spectrum for the bulge and disk are shown in the lower panel.

4. Dwarf Galaxies: the smallest galaxy building blocks

Extending a previous study (Zoutendijk et al., A&A), our team has used stellar line-of-sight velocities obtained with MUSE for individual stars to constrain the dark matter density profile of the ultra-faint dwarf galaxy Eridanus 2. This project provided substantial evidence for a cuspy DM halo (Zoutendijk et al., A&A submitted).

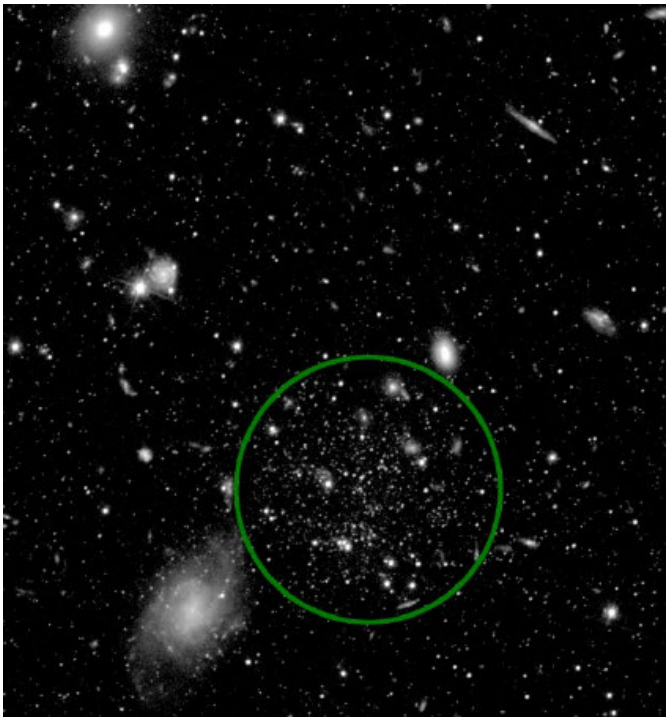


Figure: HST image of Eridanus 2 f rom (Zoutendijk et al., A&A).

Since mid 2020, the team is using the upgraded version of the pipeline Porto3D to the study of several low-metallicity starburst dwarf galaxies observed both with MUSE and ALMA. Topics to be addressed in various publications in preparation include the connection between star formation- and CO surface density, and metallicity, extinction and gas kinematics patterns.

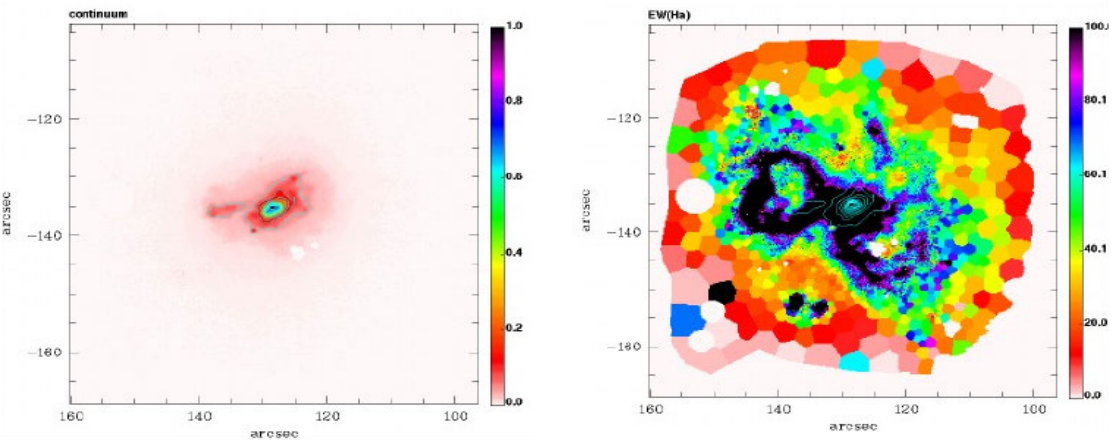


Figure: Example of the analysis with Porto3D of MUSE IFS data for the starburst dwarf galaxy He 2-10. (left) stellar continuum, (right) Hα equivalent width map, revealing a spectacular network of starburst-driven super-shells with a projected dimension of several 100 pc *from the nucleus of the galaxy.*

Group meetings, Journal Clubs and other activities

The emergence of the COVID19 pandemic has forced the team to base almost its entire internal communication on video conferences and email, which resulted in various technical challenges related to the remote processing of large data sets being centrally stored at IA's servers. Despite these conditions, the team could largely maintain its productivity, further intensify internal synergy and establish new collaborations. Throughout 2020, the team maintained a busy schedule of weekly briefings in which the team's scientific work was discussed. Additionally, regular weekly journal clubs were also continued, for the discussion of recent, mostly non-IA, scientific results.

Team members are core participants in the Portuguese ALMA Centre of Expertise, providing support to ALMA users in Portugal, and also providing, in the context of the European ALMA Regional Centre, scientific and technical assistance to ESO on the validation of ALMA data before being delivered to the respective PIs. It is also worth pointing out that team members actively participate in IA public outreach activities, not only providing frequent public talks on galaxies and the Universe, but also in major institutional initiatives such as IAstro Junior or Ignite IAstro.

Finally, during 2020, the team organized the three-day online workshop "Exploiting Archives for Radio Astronomy in the SKA-era" with 70 participants and co-organized the online national conference "30th Encontro Nacional de Astronomia e Astrofísica" with 152 participants.

Polychronis Papaderos
Group Leader

Report from the Group

Unveiling the dynamics of the Universe

This report highlights contributions to the group's strategic plan and vision for beyond 2021. We focus essentially on the ESPRESSO, Euclid and LISA missions.

We emphasize that the ESPRESSO GTO (Guaranteed Time Observations) program was significantly affected by the COVID pandemic, since ESO observatories were closed for the entire Period 105 (1 April 2020 – 30 September 2020) and the early part of Period 106 (1st October 2020 – 31 March 2021). Nevertheless, preparatory work continued on data analysis pipelines, which are now ready and fully optimized for ESPRESSO fundamental physics data.

Relative to LISA, unfortunately, due to the coronavirus pandemic, several projects were temporarily put on hold due to a restructuring and redefining of the Consortium's internal rules. However, in 2020, the first official LISA paper (i.e., a publication carrying the official seal of the Cosmology WG) about cosmic strings was published, where an IA-Cosmology team member was a first-tier author (JCAP 04 (2020) 034). The publication is the culmination of more than two years of work within the LISA Cosmology WG and it studies in detail the capability of LISA to probe cosmic strings. Amongst other issues, the analysis has shown that the stochastic gravitational wave background is one of the more relevant cosmological backgrounds that LISA can probe, thus reinforcing the mission's interest in this area. Relative to the Working Group "Fundamental Physics" with LISA, a white paper (Gen.Rel.Grav. 52 (2020) 8, 81) was also published where the aim was to further delineate and sharpen the future potential of the LISA mission in the area of fundamental physics. Furthermore, several team members have also been actively contributing to the LISA Cosmology White Paper (to be published soon).

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 various science working groups (SWG), and in the Survey Design. The national participation in the mission is coordinated by members of IA's Cosmology group. The activities of Survey Design, even though coordinated by members of the Cosmology group, have a strong component of software development, and are reported in the Instrumentation and Systems group section. In 2020, these activities led to the award of a STAR prize, as reported elsewhere. The participation in SWGs include members of both Cosmology and Galaxies groups. Concerning the Cosmology group, the participation in the various Euclid SWGs where team members have responsibilities continued as planned and was reinforced with active presence in additional work packages. A selection of these activities include: leadership of the high-order weak lensing statistics key project; participation in analyses of the impact of shear measurement biases in cosmological forecasts; leadership in the cosmic distance duality standard paper (published), leadership in the forecasts of extended cosmological models standard paper (submitted), co-authorship in 10 Euclid papers (published in 2020) plus various others (to be published in 2021).

The IA continued, during 2020, with a significant role in the European COST Network “CANTATA”, CA 15117. Since its conception, team members have been part of the team which designed, and prepared the e-COST project, which eventually got approval and was financed for a period of 4 years, starting from March 2016 and finally ended in 2020. CANTATA is an international network that considers, in a coordinated and multidisciplinary way, the possibility to go beyond General Relativity (GR) at ultraviolet (quantum gravity) and infrared (cosmology) scales, scenarios on which Einstein’s theory fails. This is done by combining complementary aspects of theoretical physics, cosmology and astrophysics. The main goal of this initiative is to construct an effective theory of gravity capable of encompassing both the phenomenology related to the lack of a quantum field theory of gravity, and the phenomenology related to the various astrophysical scales (e.g. self-gravitating systems, galaxies, large scale structure) that cannot be explained within the framework of GR without including dark matter and dark energy. The research carried out within CANTATA culminated in 2020 with a book to be published by Springer Nature Switzerland AG Publishers in 2020, where three IA-Cosmology participated actively with contributions.

Scientific Highlights for 2020

1. **Leadership of Euclid Standard Project Paper**
   Several team members contributed to this paper (Martinelli et al. A&A), where it was shown that in metric theories of gravity with photon number conservation, the luminosity and angular diameter distances are related via the Etherington relation, also known as the distance duality relation (DDR). A violation of this relation would rule out the standard cosmological paradigm and point to the presence of new physics. The authors quantified the ability of Euclid, in combination with contemporary surveys, to improve the current constraints on deviations from the DDR in the redshift range $0 < z < 1.6$. It was found that for parametric methods Euclid (in combination with external probes) can improve current constraints by approximately a factor of six, while for non-parametric methods Euclid can improve current constraints by a factor of three.

2. **Participation in Euclid Standard Project Paper**
   Within the context of full-sky weak lensing surveys such as Euclid, convergence maps (mass maps) offer an important advantage over the more studied shear fields in terms of cosmological exploitation. While it carries the same information, the lensing signal is more compressed in the convergence maps than in the shear field, which simplifies otherwise computationally expensive analyses, such as the ones required for non-Gaussianity studies. The HOWLS project, co-led by a team member, aims at optimizing the cosmological non-Gaussian information that can be extracted from future Euclid lensing data, and for that it needs to rely on accurate mass maps. In preparation of that project, a study with the participation of team members (Pires et al., A&A) presents a new mass-inversion method that aims to reduce the information loss during the mass inversion process used in producing mass maps. This analysis shows that the errors introduced by the mass inversion on high-order moments are reduced by factors of up to 10, when compared to conventional methods.

3. **Full analytical approximation to the stochastic gravitational wave background generated by cosmic string networks**

   Team members (Sousa et al., PRD) derived a full analytical approximation to the stochastic gravitational wave background generated by the loops that are produced throughout the cosmological evolution of cosmic string networks. It was shown that this approximation not only predicts the amplitude of the radiation-era plateau exactly, but also provides a good fit to the high-frequency cutoff and to the low-frequency peak generated by the loops that decay during the matter era, irrespective of cosmic string tension and of the length of loops created. It was then found that it provides a good quantitative description of the full stochastic gravitational wave background across the relevant frequency range.

4. **Approaching the non-linearities in the large scale structure**

   In view of the approaching precision cosmology era, the presence of nonlinearities in the forthcoming observations will be unavoidable. According to that, the need for a well-posed theoretical framework is essential in the following two regards: i) to correctly estimate relativistic effects without theoretical biases, such that comparison between predictions and observations is free from traps as gauge and coordinate dependences at nonlinear level; ii) combining independent probes as seen along our past (light-)cone in order to test gravity theories. With this in mind, team member's activity has provided progresses along these lines of research according to what enlisted here: (i) In a recent publication (Fanizza et al., JCAP), rigorous prescriptions for cosmological observables defined on a Lorentzian manifold have been provided, in particular for what concerns averages on the observer's past light-cone, where most of our observations lie. (ii) In one other article (Fanizza et al., Gen.Rel.Grav.), it was shown that in light of multi-messenger cosmology, in the framework of a simple modification of gravity, possible deviations from General Relativity were exploited by investigating the difference between luminosity distance for photons and gravitational waves. These are expected to be the same in General Relativity hence, a deviation for this equality could be a hint about deviation from Einstein theory on cosmological scales. Limit on a Starobinski-like gravity model were obtained in this regard in the abovementioned work.

5. **A review on the Effective field theory of dark energy**

   The discovery of cosmic acceleration has triggered a consistent body of theoretical work aimed at modelling its phenomenology and understanding its fundamental physical nature. In recent years, a powerful formalism that accomplishes both these goals has been developed, the so-called effective field theory of dark energy. It can capture the behaviour of a wide class of modified gravity theories and classify them according to the imprints they leave on the smooth background expansion history of the Universe and on the evolution of linear perturbations. The effective field theory of dark energy is based on a Lagrangian description of cosmological perturbations which depends on a number of functions of time, some of which are non-minimal couplings representing genuine deviations from General Relativity. Such a formalism is thus particularly convenient to fit and interpret the wealth of new data that will be provided by future galaxy surveys. Despite its recent appearance, this formalism has already allowed a systematic investigation of what lies beyond the General Relativity

landscape and provided a conspicuous number of theoretical predictions and observational results. In this review (Frusciante et al. Phys. Rept.), a team member reported on these achievements.

6. **Testing F(Q) gravity with redshift space distortions**

Team members (Barros et al. Phys. Dark Univ.) performed a Bayesian statistical analysis using redshift space distortions data to test a model of Symmetric Teleparallel Gravity where gravity is non-metrical. The cosmological background mimics a ΛCDM evolution but differences arise in the perturbations. The linear matter fluctuations were numerically evolved and the study of the growth rate of structures was analysed in this cosmological setting. The best fit parameters reveal that the σ_8 tension between Planck and large scale structure data can be alleviated within this framework.

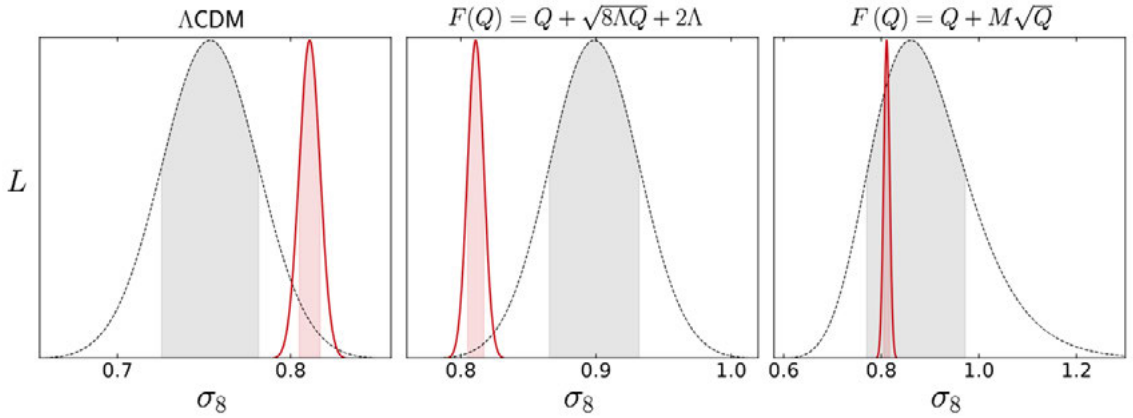


Figure: Likelihood for σ_8 (curves) and respective 1σ interval (shaded region), for several models labeled on top (dashed lines), and the Planck reference (solid lines). The figure shows that the third model alleviates the σ_8 tension.

Group meetings, Journal Clubs and other activities

The group “Unveiling the Dynamics of the Universe” carried out journal clubs and seminars on a weekly basis, and group meetings once every month. All the relevant information can be found in the following link: http://ia-cosmoclub.wikidot.com

The themes discussed during the approximately 30 journal clubs (http://ia-cosmoclub.wikidot.com/previous-meetings-2020) ranged from theoretical aspects to observational topics. Approximately forty-five papers were discussed throughout 2020.

The group also organized COSMONATA, the annual meeting that brings together Portuguese researchers working abroad in the field of cosmology and the researchers in Portugal. Group members continued their dedication to outreach by giving public talks at schools via videoconfere and participating in online events organized by the Science Communication Group.

Francisco Lobo
Group Leader

Report from the Group

Instrumentation and Systems

Due to the pandemic situation that affected everyone, 2020 was a very hard year for the Instrumentation and Systems group. On the one hand, several observatories were closed and several project related international activities were cancelled, on the other hand, new projects started and the pressure to keep the pace on the instrument design, assembly, integration and test was considerable.

During 2020, the following instruments had engineering and implementation activities at IA:

- NIRPS, MOONS and HIRES, for the European Southern Observatory (ESO);
- EUCLID, CHEOPS, PLATO, ARIEL and ATHENA, for the European Space Agency (ESA).

Currently the I&S group 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.

The I&S group was composed of 18 people. 9 researchers (with PhD) 4 engineers and 5 PhD students. Some researchers are also part of the other two scientific groups and PhD students are mainly focused on their thesis work, leading to a man power availability to the running project of about 10 FTE.

Since the beginning of 2019 when the labs and integration facilities in Lisbon moved to the Campus of the Faculty of Sciences of the University of Lisbon, the number of MSc students doing their thesis with the I&S group increased significantly (6 during 2020), with a corresponding growth in the visibility of our activities within the University.

During 2020, the following researchers and PhD Students terminated the participation in the instrumentation and systems group:

- David C. Alves (Researcher) left in November 2020
- Solène C. Ulmer-Moll* (PhD student) concluded the PhD thesis, titled *“Atmospheric Correction for High Resolution Near Infrared Spectroscopy”*, in 15/05/2020.
- Tiago Magalhães (PhD student) concluded the PhD thesis, titled *“Spatial Coherence Mapping of Structured Astrophysical Sources”*, in 08/05/2020.

There were no arrivals in 2020, both in terms of researchers and PhD students.

In terms of new themes of research, somehow supported by background expertise in Astronomy Instruments / Space missions, are consolidated by the work of three PhD students supervised by group researchers:

a) Development of tools/models for Atmospheric Dispersion Compensators, resulting from the work done/projected on different instruments such as Espresso, NIRPS and HIRES. This work will be concluded by the beginning of next year.

b) Stabilization 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 stabilization levels of few ppm are required over long periods of observation.

c) 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 planets in the habitable zone.

In the following is listed the activity detail of the running projects.

1. **NIRPS(ESO)**

   NIRPS is a new (fast-track instrument) high resolution spectrograph working at near-infrared bands, that is being designed for the ESO 3.6-m telescope (La Silla-Paranal Observatory). NIRPS will work together with the existing HARPS spectrograph, allowing us to obtain simultaneous optical and near-IR spectra of stars. The major goal of NIRPS is to detect and characterize planets orbiting late type stars. The NIRPS consortium includes a strong participation from IA, including in the development of hardware and software (the Atmospheric Dispersion Correctors – ADC), and in the definition of the scientific activities.

   2020 was planned to be the year where the ADC would be commissioned in the ESO 3.6 m telescope in La Silla and that the instrument would see its first light. Unfortunately, due to the confinement, the activities in the observatory were postponed, expected to happen in after April 2021, and therefore the activities were reduced to the preparation of the commissioning mission (planning and development of data analysis tools).

2. **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 2020 the activities focused on integration of the large structure that will interface with the telescope and on the test of all the mechanisms that the RFE will comprise. It is expected that the fully integrated RFE is transferred during the second half of 2021 to UKATC in Edinburgh for Preliminary tests in Europe before its integration in Chile.

Figure: Current Status of the MOONS (ESO) FC lenses at Officina Stellare where they are being manufactured and integrated in the FC barrel.

Figure: The MOONS (ESO) RFE during integration and tests of the retraction and screen mechanisms.

3. HIRES (ESO)

HIRES is the project for a high resolution spectrograph to be installed at the ESO ELT telescope. The concept of HIRES 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.

After finishing Phase A studies in 2017, during 2020 the work was focused on the Pre-phase B activities, namely on the consortium definition, on the preliminary re-design of the instrument, on the consolidation of cost estimates, on the consolidation of science cases and plans for the GTO program.

Phase B is foreseen to start mid 2021.

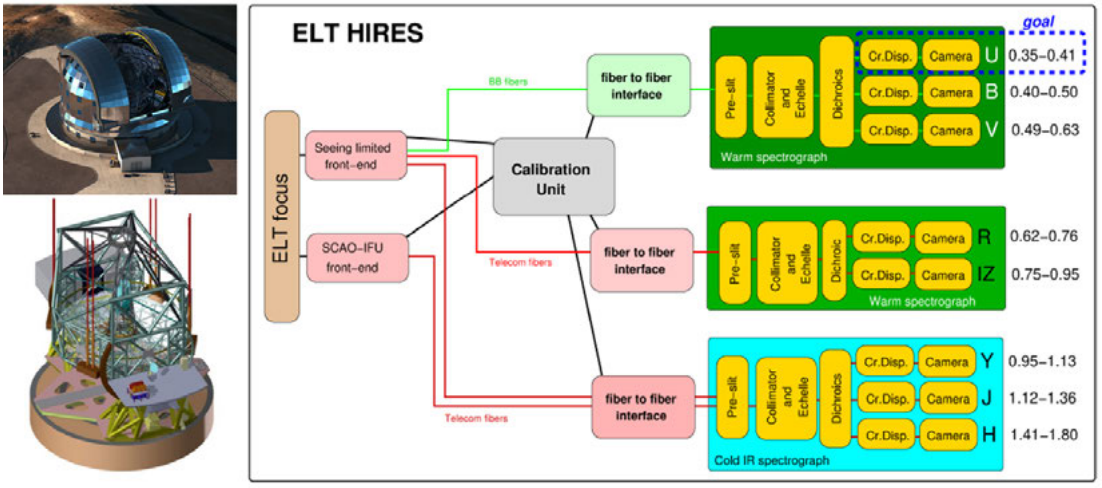


Figure: HIRES (ESO) at the ELT and instrument architectural design, outlining the instrument subsystems: Front End (seeing-limited and AO assisted with SCAO unit), Fibre Link, Calibration Unit, VIS-Blue, VIS-Red and NIR (cold spectrograph).

4. 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 various science working groups, and in the Survey Design, which is an activity of support to the Euclid Consortium Lead.

In 2020, 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, compliant with all constraints and requirements.

This year there were considerable improvements in the generated surveys, and we produced four reference surveys. The major improvement was achieved with the introduction of a new patch scheduling algorithm (replacing the previous look-ahead algorithm). Unlike its predecessor, this new algorithm ensures a minimal rotation of the telescope, which will keep thermal variations of the telescope to a minimum, improving the temporal stability of the PSF. In parallel, visits to PSF calibration targets were also implemented, which was a complex task due to the scarcity of targets and the need to have almost no rotations of the telescope prior to calibration. In addition, the region-of-interest (ROI) was redesigned by the survey group (ECSURV), with participation from IA's team. The resulting ROI provides better sky quality but less eligible area and is less uniformly distributed along the year; this prompted a re-design of the calibrations schedule. A reference survey that included all these improvements was delivered, on September 2020, as part of the delivery pack for the Survey and Calibrations Operations Mid-Term Review (SCOMT). The delivery also included the new document Mission Operations Concept Document part C, under IA's custody. Part of the SCOMT objectives were to assess the feasibility of the reference survey produced, within the constraints of the mission. The work presented by ECSURV passed the review, with no raised issues.

In 2020, the group was present in 6 meetings (all online, due to virus pandemics):

— Euclid Sky Survey Working Group meeting (ESSWG#13), 2-3 March 2020.
— Calibration Working Group meeting (CalWG#05), 15-17 April 2020.
— Euclid Consortium Meeting 2020, 4-7, May, 2020.
— SCOMT Review survey demos, 1 October 2020.
— SCOMT Review Panel co-location meeting, 14 October 2020.
— Euclid Sky Survey Working Group meeting (ESSWG#14), 15 December, 2020.

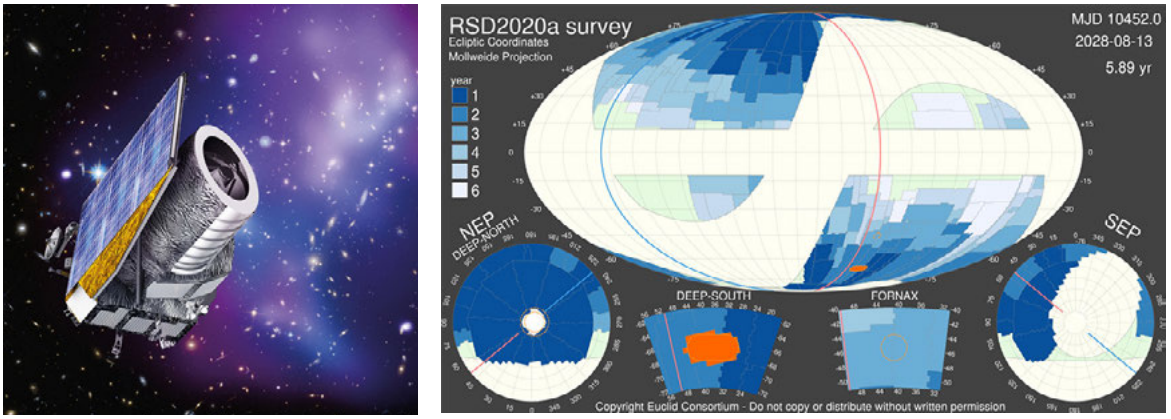


Figure: Euclid ESA's mission (left) and the mosaic of the regions that will have been covered by Euclid after its six years of expected lifetime, on a Mollweide projection of the celestial sphere in ecliptic coordinates. Credits: Euclid Consortium/ECSURV (right).

5. 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 to 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 a stronger relation 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 are responsible for the calibration of the pipeline.

In 2020, after its successful launch we were involved in the in orbit commissioning (IOC) to check the status of the instrument. The IOC review was successful, CHEOPS is running well and started scientific observations. IA will continue to give maintenance support to the data reduction pipeline during the CHEOPS mission.

6. 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, has been 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 the PLATO cameras on the ground.

Regarding the contribution to the OGSE, in August 2020 the Instrumentation group delivered the first unit of the Room Temperature Collimator to CSL (Belgium). The performance and calibration report produced showed full compliance of the developed equipment with the CSL initial requirements.

The second collimator is now on the stage of integration. The delivery date for this second unit to CSL is foreseen to May 2021?

The second funding phase by Prodex is now being finalized, which shall allow the procurement of the light source required for integration on the second collimator unit.

The activities regarding other work packages associated to instrumentation, namely with SW work, in Star Centroids and Target Position, our team continued to produce documentation and supporting algorithms, in the scope of the activities led by LESIA group.

Figure: PLATO (ESA) White light collimator during integration. Detail of the fibre holder (left) and mirror gimbal (right).

7. 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 in ARIEL and with the OGSE team regarded the elaboration of an OGSE concept design report, integrating the Portuguese – IA contribution associated to the VIS-NIR optical source and modulator.

To this date and with a continuous activity throughout the whole year of 2020, there have been a series of activities and contributions regarding the definition of the System Requirements, in preparation of the SRR milestone in the beginning of 2021.

In terms of funding of the activities, the LoE issued by the Portuguese delegation was delivered to the Prodex Office and the official grant is now available for pursuing ARIEL OGSE activities.

8. 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 its kick off in June 2020.

This activity will focus on the development of the engineering model of the metrology system that is responsible for measuring the telescope internal pointing, activity that will have a 24 month duration. The current work is now focusing on the definition of the system and user requirements that will define the design of the metrology solution.

Highlights for 2020

1. The Special Talent And Recognition (STAR) award, acknowledges annually, since 2017, exceptional contributions to the mission made by groups and individual members of the Euclid consortium. Every year, all the roughly 2000 Euclid members have the opportunity to indicate nominees for the 6 categories of the prize. A jury then selects a winner per category among all the nominees. The Euclid Consortium Survey group (ECSURV) was awarded the STAR award of 2020 in the Team category. The ECSURV team has 14 members from Italy, France and Portugal, including 4 researchers from IA.

2. All the parts for the MOONS Rotating Front End Structure, after manufacturing by CUNHOL (Portugal), are now at the IA (Lisbon) MOONS integration room and the entire main structure, including its retraction and screen mechanisms, have been fully integrated and successfully tested. The system includes a powerful retractor mechanism that is in charge of retracting the entire fibre positioning support structure for metrology purposes and to provide the required distance from the calibration screen during instrument calibrations.

3. Our participation in the ESA PLATO project accomplished the delivery of the first unit of the ambient collimator to CSL. Starting integration of 2nd collimator with an expected delivery date of mid 2021.

4. For the ESA ARIEL project. The Prodex funding was approved (200k euros) for the development of the VIS-NIR OGSE. The conceptual design was approved and a preliminary design is on course.

5. IA led a proposal for an international consortium for the development of the onboard metrology system for the ESA Athena mission. This activity, resulting from an ESA tender with 900k euros funding for a 24 month project duration, was granted to our consortium and the work started in mid 2020.

6. HIRES restart of activities following a positive answer from ESO to prepare the beginning of phase B in mid-2021. The I&S group has a very relevant participation on this consortium, with the responsibility of one of the major work package (the instrument front end that interfaces with the telescope) and has several key persons in the project management and systems engineering team.

Alexandre Cabral
Group Leader

Report from the Group

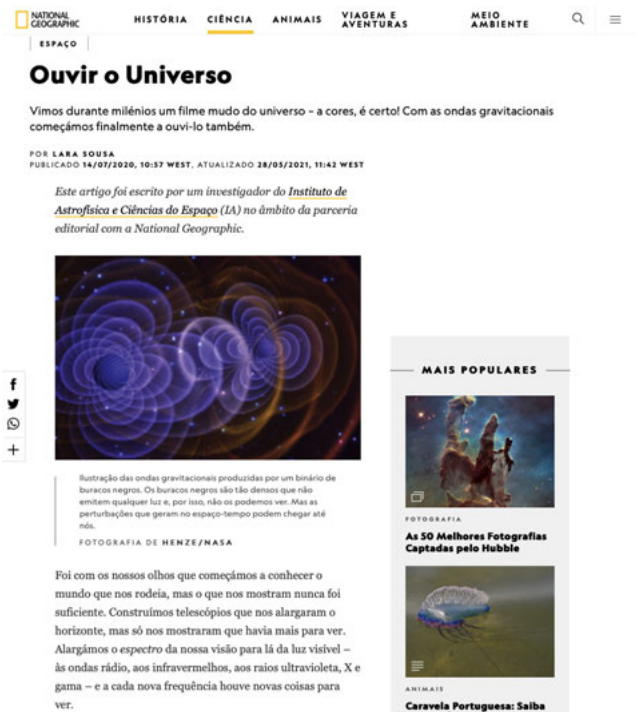
Science Communication

The year of 2020 was marked by the COVID-19 Pandemic which deeply influenced the activity of the **Science Communication Group** at IA (**SCG**). Due to the new social paradigm, most of the presential initiatives, which are a key feature of the SCG strong activity, were cancelled. Despite this, the SCG was able to quickly adapt and reinforce its online presence, transforming much of its activity to an online format.

During 2020 the SCG organized and participated in several public outreach initiatives which reached, in presence, a total participation of more than **24,659 people**. This number corresponds to less than **35%** of the 2019 reach due to the COVID-19 Pandemic, which resulted in the cancelations of almost all presential public events. On the other hand, with an intense investment on online activities, the SCG was able to obtain **46,504 views** and an increase in the number of followers in IA social networks. As an example, in 2020, IA's channel on YouTube got **21 600 views** and has now **1770 subscribers**, which are **468%** and **673%** increases, respectively, in relation to the same previous period.

The public activities directly organized by IA reached about **22,369 people** in presence and **14,755 online views**, including, among others, planetarium presentations, 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 sessions, exhibitions, showcases, workshops and short courses, having reached about **2,290 people** in presence and **22,736 online views**.

The SCG has been responsible for the creation of the "ESPRESSO exoplanet portal" website which incorporates several educational contents produced during 2020. These contents include three interactive online application where users can explore and learn about three detection methods of exoplanets (astrometry, radial velocities and transits), one interactive online application to learn about the concept of habitable zone, two educational online games, and an interactive map of the sky with information graphics presenting the stars being observed by ESPRESSO.



The SCG has established new partnerships with National Geographic Portugal and SAPO Tek websites, for the production of articles for the public. This increases the visibility of IA since, for example, SAPO Tek reaches about 2 million people. In 2020 the SCG produced **7 articles** for National Geographic and 1 for SAPO Tek. The SCG also created several media contents, such as **32 videos** (Youtube), and contents for its official webpage.

During 2020, the second version of the book "**Big Ideas in Astronomy: A Proposed Definition of Astronomy Literacy**[1] was written and translated to Portuguese and 9 more languages, under the coordination of the SCG. A website for this project was also developed. This book is the first outcome of the Astronomy Literacy project, led by IA and the University of Leiden. It was produced within the framework of the IAU Commission C1 for Astronomy Education and Development, in particular within the Working Group on Literacy and Curriculum Development, in alignment with the IAU's strategy to foster the use of astronomy in teaching and education at school level.

The team produced and made available to the media **24 press releases** (21 national, 3 international) related to the science produced by the Institute or to its outreach activities. This number of press releases resulted in about **416** references in national news media with a total Automatic Advertisement Value (AAV) of about **€ 4 159 754,30.** We also made available through our webpage and partners, **4 news releases**.

IA has been mentioned by international news media, for example: Space.com, Science Post, Space in Africa, Jornal de Angola, Phys.org, and Cronaca Torino. IA was also mentioned by Media INAF – Istituto Nazionale di Astrofisica in Italia.

The science communication and education work at IA has been presented in national and international conferences with invited and contributed talks and workshops – 12 invited talks, 9 invited workshops and 9 contributed talks. The conferences include, among others, the II Shaw-IAU Workshop on Astronomy for Education, 13th IAU – Abdul Jabbar Astronomy Workshop, the 8º Congresso SciComPt and the 30º Encontro Nacional de Astronomia e Astrofísica. The team published one PhD thesis and three papers in conference proceedings and is responsible for several articles for monthly columns.

The SCG has co-supervised the dissertation project of two students from Mestrado em Comunicação de Ciência from the Faculdade de Ciências Sociais e Humanas da Universidade Nova de Lisboa, 8 students' short projects and internships from the Licenciatura em Animação Digital of the Universidade Lusófona and four summer internships organized by IA.

During 2020, the SCG has conducted several training sessions for teachers, science communication officers, students and the general public.

The SCG is responsible for the creation and development of several national projects like Ler+Espaço, Tour Ignite IAstro or the IAstro Júnior. IA also participated in the Cientificamente Provável programme, a partnership by the Portuguese Government, implemented through the network of school libraries, partnering with 5 schools, and in the Clubes Ciência Viva na Escola, a Ciência Viva project, partnering with 13 schools.

IA provides the scientific management of the Planetário do Porto CCV activities, all of which are developed, organized and implemented by members of the IA SCG, having reached in 2020, **22551 people** through fixed domed and portable planetarium sessions, hands-on laboratories and online activities.

IA has an ongoing partnership with the Leiden Observatory/ University of Leiden for the development of an Astronomy Literacy Project. This international joint-project aims to define global astronomy education goals to be applied in worldwide school curricula. Another goal of this project is the production of localized astronomy educational contents in several languages, together with educational guidelines for educators.

PLOAD
Grupo Lusófono de **Astronomia** para o Desenvolvimento

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.

The strategy of the SCG for the 2021-2022 period envisions the continuation of the implementation of public engagement activities, with students from various school cycles in particular and the production of Astronomy related educational and science communication contents for several specific target audiences, with a special focus on students and teachers. This production will be strengthened by the involvement in the "Astronomy Literacy" international project. These contents can exist by themselves or be produced with specific uses such as planetarium sessions, hands-on activities or exhibitions. The production of these materials will place IA as the main institution in Portugal in terms of the production of Astronomy related contents. IA's strong involvement in the PLOAD will allow the dissemination of its contents throughout the Portuguese speaking countries which engulfs 240 million people, giving to the IA's Science Communication a real international dimension.

João Retrê and Filipe Pires
Group Leaders

Other reports

The Portuguese ALMA Centre of Expertise

The Portuguese ALMA Centre of Expertise (PACE) has been a member of the ALMA Regional Centre Network since 2014, with the goals of strengthening the Portuguese ALMA user community and developing technical and scientific expertise in the area. PACE's staff is formed by 14 members, including students, technical and administrative support, and science communication. In the following, we describe the main PACE activities performed in 2020:

— The ALMA Science Archive (ASA) Project
In collaboration with the Informatics Department at the Faculty of Sciences of the University of Lisbon, PACE is developing with the computer engineer António Dias a meta-data analysis tool able to combine archival data with a faster and efficient method. This may result in more powerful scientific analysis providing, through a user-guided interface, enhanced data products not available at present in the Alma Science Archive. This work constitutes the core of António Dias MSc thesis in Computer Engineering, entitled "Better Science through an enhanced user interface with the ALMA Archive".
The preliminary results of this project have been presented at the European Week of Astronomy (EAS) 2020 and the ARC Software Tools Workshop in Chalmers, highlighting relevant links to other node's works within the radio community.

— VLBI QA2 participation
In response to a request from Ciriaco Goddi, who indicated a lack of manpower for supporting the upcoming ALMA VLBI campaign and the urgency of identifying and forming new analysts, PACE participated in the first VLBI QA2 training workshop in Leiden, in February 2020. Follow-up activities were in the meantime delayed, due to the COVID-19 situation.

— ALMA User tests
Replying to an ESO request for help, PACE has been involved in ALMA User tests. The OT user test week occurred in February 2020 and saw the participation of Rodrigo Carvajal.

— PACE has organised the workshop "Exploiting Archives for Radio Astronomy in the SKA-era". initially planned to June 2020, to take place at the Faculty of Sciences of the University of Lisbon, it was postponed as a virtual meeting to November 2020.

— A new course in Radioastronomy, proposed by PACE members, has started during the academic year 2019/2020. In this context, PACE established a collaboration with the Regional Government of Azores to gain access to the 13-m geodetic radio telescope in Santa Maria Island for astrophysical purposes. The facility has a very high interest for educational purposes (higher education training), of extreme relevance for the future of radio astronomy in the country. The first observing runs, planned for May 2020 with students of the Radioastronomy Course, were unfortunately postponed due to the COVID-19 situation.

— Outreach Event with PACE participation: “IAU100: OS PRÓXIMOS 100 ANOS DA UNIÃO ASTRONOMICA INTERNACIONAL” in the “Pavilhão do Conhecimento”, the national science center of Portugal.

The evolution of PACE, following the ARC Network Strategic Plan 2019 – 2025, will include the more and more activities related to the support for the national participation in SKA. PACE researchers have been participating in SKA for many years now, and the Portuguese SKA participation opens a range of potential funding opportunities that PACE will be ready to use.

Ciro Pappalardo
PACE Lead Scientist

Scientific Output

Books [3]

1. J. A. Hodge, **J. Afonso**, L. Pentericci, D. Sobral, 2020; *Uncovering Early Galaxy Evolution in the ALMA and JWST Era*; Cambridge University Press, Proceedings of the International Astronomical Union Symposia and Colloquia, 15, 352
2. **C. J. A. P. Martins**, 2020; *The Universe Today. Our Current Understanding and How It Was Achieved*; Springer International Publishing, Astronomers' Universe
3. **M. J. P. F. G. Monteiro**, R. Garcia, J. Christensen-Dalsgaard, S. W. McIntosh, 2020; *Dynamics of the Sun and Stars. Honoring the Life and Work of Michael J. Thompson*; Springer International Publishing, ASSSP, 57

Published articles [201]

1. G. Drouart, N. Seymour, T. J. Galvin, **J. Afonso**, J. R. Callingham, C. de Breuck, M. Johnston-Hollitt, A. D. Kapińska, M. D. Lehnert, J. Vernet, 2020; *The GLEAMing of the first supermassive black holes*; Publications of the Astronomical Society of Australia, 37, e026
2. E. Marfil, **H. M. Tabernero**, D. Montes, J. Caballero, M. G. Soto, J. I. González Hernández, A. Kaminski, E. Nagel, S. V. Jeffers, A. Reiners, 2020; *Stellar atmospheric parameters of FGK-type stars from high-resolution optical and near-infrared CARMENES spectra*; Monthly Notices of the Royal Astronomical Society, 492, 4, 5470
3. V. M. Passegger, A. Bello-García, J. Ordieres-Meré, J. Caballero, A. Schweitzer, A. González-Marcos, I. Ribas, A. Reiners, A. Quirrenbach, P. J. Amado et al. (*including:* **H. M. Tabernero**), 2020; *The CARMENES search for exoplanets around M dwarfs. A deep learning approach to determine fundamental parameters of target stars*; Astronomy and Astrophysics, 642, A22, 26
4. C. Abia, **H. M. Tabernero**, S. A. Korotin, D. Montes, E. Marfil, J. Caballero, O. Straniero, N Prantzos, I. Ribas, A. Reiners, 2020; *The CARMENES search for exoplanets around M dwarfs. Rubidium abundances in nearby cool stars*; Astronomy and Astrophysics, 642, A227, 15
5. J. Kemmer, S. Stock, D. Kossakowski, A. Kaminski, K. Molaverdikhani, M. Schlecker, J. Caballero, P. J. Amado, N. Astudillo-Defru, X. Bonfils et al. (*including:* **P. Figueira**, **N. C. Santos**), 2020; *Discovery of a hot, transiting, Earth-sized planet and a second temperate, non-transiting planet around the M4 dwarf GJ 3473 (TOI-488)*; Astronomy and Astrophysics, 642, A236, 20
6. L. Bisigello, U. Kuchner, C. J. Conselice, S. Andreon, M. Bolzonella, P.-A. Duc, B. Garilli, **A. Humphrey**, C. Maraston, M. Moresco et al. (*including:* **J. Brinchmann**, **I. Tereno**), 2020; *Euclid: the selection of quiescent and star-forming galaxies using observed colours*; Monthly Notices of the Royal Astronomical Society, 494, 2, 2337
7. *Euclid* Collaboration, A. Blanchard, S. Camera, C. Carbone, V. F. Cardone, S. Casas, S. Clesse, S. Ilić, M. Kilbinger, T. D. Kitching et al. (*including:* **J. Brinchmann**, **C. S. Carvalho**, **A. C. da Silva**, **I. Tereno**), 2020; *Euclid preparation. VII. Forecast validation for Euclid cosmological probes*; Astronomy and Astrophysics, 642, A191, 66
8. *Euclid* Collaboration, V. Guglielmo, R. Saglia, F. J. Castander, A. Galametz, S. Paltani, R. Bender, M. Bolzonella, P. Capak, O. Ilbert et al. (*including:* **C. S. Carvalho**, **A. C. da Silva**, **I. Tereno**), 2020; *Euclid preparation. VIII. The Complete Calibration of the Colour-Redshift Relation survey: VLT/KMOS observations and data release*; Astronomy and Astrophysics, 642, A192, 19
9. *Euclid* Collaboration, G Desprez, S. Paltani, J. Coupon, I. Almosallam, A. Alvarez-Ayllon, V. Amaro, M. Brescia, M. Brodwin, S. Cavuoti et al. (*including:* **J. Brinchmann**, **C. S. Carvalho**, **A. C. da Silva**, **A. Humphrey**, **I. Tereno**), 2020; *Euclid preparation. X. The Euclid photometric-redshift challenge*; Astronomy and Astrophysics, 644, A31, 24
10. **J. L. Sobrinho**, P. Augusto, 2020; *Stellar mass primordial black holes as cold dark matter*; Monthly Notices of the Royal Astronomical Society, 496, 1, 60
11. **P. P. Avelino**, 2020; *Parameter-free velocity-dependent one-scale model for domain walls*; Physical Review D, 101, 2
12. **L. Sousa**, **P. P. Avelino**, G. S. F. Guedes, 2020; *Full analytical approximation to the stochastic gravitational wave background generated by cosmic string networks*; Physical Review D, 101, 10
13. **P. P. Avelino**, 2020; *Comparing parametric and non-parametric velocity-dependent one-scale models for domain wall evolution*; Journal of Cosmology and Astroparticle Physics, 2020, 4
14. **P. P. Avelino**, B. F. de Oliveira, R. S. Trintin, 2020; *Performance of weak species in the simplest generalization of the rock-paper-scissors model to four species*; Physical Review E, 101, 6
15. **P. P. Avelino**, **R. P. L. Azevedo**, 2020; *Boltzmann's H-theorem, entropy and the strength of gravity in theories with a nonminimal coupling between matter and geometry*; Physics Letters B, 808
16. **V. M. C. Ferreira**, **P. P. Avelino**, **R. P. L. Azevedo**, 2020; *Lagrangian description of cosmic fluids: Mapping dark energy into unified dark energy*; Physical Review D, 102, 6
17. **P. P. Avelino**, B. F. de Oliveira, J. V. O. Silva, 2020; *Rock-paper-scissors models with a preferred mobility direction*; Europhysics Letters, 132, 4
18. **R. P. L. Azevedo**, **P. P. Avelino**, 2020; *Second law of thermodynamics in nonminimally coupled gravity*; Europhysics Letters, 132, 3

19. **P. P. Avelino**, **L. Sousa**, 2020; *Domain walls and other defects in Eddington-inspired Born-Infeld gravity*; Physical Review D, 102, 10

20. C. Jiang, T. R. Bedding, Stassun K. G., D. Veras, E. Corsaro, D. L. Buzasi, P. Mikołajczyk, Q.-S. Zhang, J.-W. Ou, **T. L. Campante** et al. (*including:* **B. Nsamba**, **D. Bossini**, **M. S. Cunha**), 2020; *TESS Asteroseismic Analysis of the Known Exoplanet Host Star HD 222076*; The Astrophysical Journal, 896, 1

21. W. J. Chaplin, A. M. Serenelli, A. Miglio, T. Morel, J. T. Mackereth, F. Vincenzo, H. Kjeldsen, S. Basu, W. H. Ball, A. Stokholm et al. (*including:* **D. Bossini**, **T. L. Campante**, **M. Vrard**), 2020; *Age dating of an early Milky Way merger via asteroseismology of the naked-eye star ν Indi*; Nature Astronomy, 4, 4, 382

22. M. Villar-Martín, M. Perna, **A. Humphrey**, N. Castro-Rodriguez, L. Binette, P. Pérez-González, S. Mateos, A. Cabrera-Lavers, 2020; *Peculiar emission line spectra of core extremely red BOSS quasars at z˜2-3: orientation and/or evolution?*; Astronomy and Astrophysics, 634, A116, 20

23. I. Tutusaus, M. Martinelli, V. F. Cardone, S. Camera, S. Yahia-Cherif, S. Casas, A. Blanchard, M. Kilbinger, F. Lacasa, Z. Sakr et al. (*including:* **I. Tereno**), 2020; *Euclid: The importance of galaxy clustering and weak lensing cross-correlations within the photometric Euclid survey*; Astronomy and Astrophysics, 643, A70, 17

24. P. Auclair, J. J. Blanco-Pillado, D. G. Figueroa, A. C. Jenkins, M. Lewicki, M. Sakellariadou, S. Sanidas, **L. Sousa**, D. A. Steer, J. M. Wachter, S. Kuroyanagi, 2020; *Probing the gravitational wave background from cosmic strings with LISA*; Journal of Cosmology and Astroparticle Physics, 2020, 4

25. E. Semenova, M. Bergemann, **M. Deal**, A. M. Serenelli, C. J. Hansen, A. J. Gallagher, A. Bayo, T. Bensby, A. Bragaglia, G. Carraro, 2020; *The Gaia-ESO survey: 3D NLTE abundances in the open cluster NGC 2420 suggest atomic diffusion and turbulent mixing are at the origin of chemical abundance variations*; Astronomy and Astrophysics, 643, A164, 15

26. M. den Brok, C. M. Carollo, S. Erroz-Ferrer, M. Fagioli, **J. Brinchmann**, E. Emsellem, D. Krajnović, R. A. Marino, M. Onodera, S. Tacchella, P. M. Weilbacher, J. Woo, 2020; *The MUSE Atlas of Discs (MAD): Ionized gas kinematic maps and an application to diffuse ionized gas*; Monthly Notices of the Royal Astronomical Society, 491, 3, 4089

27. M. A. Schmitz, J.-L. Starck, F. Ngole Mboula, N. Auricchio, **J. Brinchmann**, V. Capobianco, R. Clédassou, L. Conversi, L. Corcione, N. Fourmanoit, 2020; *Euclid: Nonparametric point spread function field recovery through interpolation on a graph Laplacian*; Astronomy and Astrophysics, 636, A78, 18

28. S. Pires, V. Vandenbussche, V. Kansal, R. Bender, L. Blot, D. Bonino, A. Boucaud, **J. Brinchmann**, V. Capobianco, J. Carretero et al. (*including:* **I. Tereno**), 2020; *Euclid: Reconstruction of weak-lensing mass maps for non-Gaussianity studies*; Astronomy and Astrophysics, 638, A141, 16

29. S. Y. Haffert, R. G. van Holstein, C. Ginski, **J. Brinchmann**, I. A. G. Snellen, J. Milli, T. Stolker, C. U. Keller, J. H. Girard, 2020; *CS Cha B: A disc-obscured M-type star mimicking a polarised planetary companion*; Astronomy and Astrophysics, 640, L12, 8

30. M. L. P. Gunawardhana, **J. Brinchmann**, P. M. Weilbacher, P. Norberg, A. Monreal-Ibero, T. Nanayakkara, M. den Brok, L. A. Boogaard, W. Kollatschny, 2020; *Stellar populations and physical properties of starbursts in the antennae galaxy from self-consistent modelling of MUSE spectra*; Monthly Notices of the Royal Astronomical Society, 497, 3, 3860

31. C. Xie, S. Y. Haffert, J. de Boer, M. A. Kenworthy, **J. Brinchmann**, J. H. Girard, I. A. G. Snellen, C. U. Keller, 2020; *Searching for proto-planets with MUSE*; Astronomy and Astrophysics, 644, A149, 14

32. M. Martinelli, **C. J. A. P. Martins**, S. Nesseris, D. Sapone, I. Tutusaus, A. Avgoustidis, S. Camera, C. Carbone, S. Casas, S. Ilić et al. (*including:* **J. Brinchmann**, **I. Tereno**), 2020; *Euclid: Forecast constraints on the cosmic distance duality relation with complementary external probes*; Astronomy and Astrophysics, 644, A80, 13

33. **J. Brinchmann**, V. N. Bennert, 2020; *LLAMA: The MBH–σ⋆ relation of the most luminous local AGNs*; Astronomy and Astrophysics, 634, A114, 29

34. R. Neri, P. Cox, A. Omont, A. Beelen, S. Berta, T. Bakx, M. D. Lehnert, A. J. Baker, V. Buat, A. Cooray et al. (*including:* **H. Messias**), 2020; *NOEMA redshift measurements of bright Herschel galaxies*; Astronomy and Astrophysics, 635, A7, 17

35. **B. Wehbe**, **A. Cabral**, G. Avila, 2020; *On-sky measurements of atmospheric dispersion – I. Method validation*; Monthly Notices of the Royal Astronomical Society, 499, 1, 183

36. M. Gaudel, A. Maury, A. Belloche, S. Maret, Ph. André, P. Hennebelle, M. Galametz, L. Testi, S. Cabrit, **P. M. Palmeirim**, 2020; *Angular momentum profiles of Class 0 protostellar envelopes*; Astronomy and Astrophysics, 637, A92, 51

37. **I. Ayuso**, J. A. R. Cembranos, 2020; *Nonminimal scalar-tensor theories*; Physical Review D, 101, 4

38. V. Silva Aguirre, J. Christensen-Dalsgaard, S. Cassisi, M. Miller Bertolami, A. M. Serenelli, D. Stello, A. Weiss, G. Angelou, C. Jiang, Y. Lebreton et al. (*including:* **D. Bossini**), 2020; *The Aarhus red giants challenge. I. Stellar structures in the red giant branch phase*; Astronomy and Astrophysics, 635, A164, 13

39. J. Christensen-Dalsgaard, V. Silva Aguirre, S. Cassisi, M. Miller Bertolami, A. M. Serenelli, D. Stello, A. Weiss, G. Angelou, C. Jiang, Y. Lebreton et al. (*including:* **D. Bossini**), 2020; *The Aarhus red giants challenge. II. Stellar oscillations in the red giant branch phase*; Astronomy and Astrophysics, 635, A165, 21

40. **C. Jiang**, **M. S. Cunha**, J. Christensen-Dalsgaard, Q.-S. Zhang, 2020; *Variations of the mixing character of dipolar mixed modes in red giant stars*; Monthly Notices of the Royal Astronomical Society, 495, 1, 621

41. Y. Doi, T. Hasegawa, R. S. Furuya, S. Coudé, C. L. H. Hull, **D. Arzoumanian**, P. Bastien, M. C.-Y. Chen, J. Di Francesco, R. Friesen, 2020; *The JCMT BISTRO Survey: Magnetic Fields Associated with a Network of Filaments in NGC 1333*; The Astronomical Journal, 899, 1

42. D. J. Armstrong, T. A. Lopez, **V. Zh. Adibekyan**, R. A. Booth, E. M. Bryant, K. A. Collins, M. Deleuil, A. Emsenhuber, C. X. Huang, G. W. King et al. (*including:* **N. C. Santos**, **S. G. Sousa**, **S. C. C. Barros**, **E. Delgado Mena**, **O. Demangeon**, **P. Figueira**, **S. Hojjatpanah**), 2020; *A remnant planetary core in the hot-Neptune desert*; Nature, 583, 7814, 39

43. R. Cloutier, J. D. Eastman, J. E. Rodriguez, N. Astudillo-Defru, X. Bonfils, A. Mortier, C. A. Watson, M. Stalport, M. Pinamonti, F. Lienhard et al. (*including:* **N. C. Santos**, **P. Figueira**), 2020; *A Pair of TESS Planets Spanning the Radius Valley around the Nearby Mid-M Dwarf LTT 3780*; The Astronomical Journal, 160, 1

44. E. Hébrard, R. F. Díaz, A. C. M. Correia, A. Collier Cameron, J. Laskar, D. Pollacco, J.-M. Almenara, D. R. Anderson, **S. C. C. Barros**, I. Boisse et al. (*including:* **O. Demangeon**), 2020; *Discovery and characterization of the exoplanets WASP-148b and c. A transiting system with two interacting giant planets*; Astronomy and Astrophysics, 640, A32, 16

45. N. Schanche, G. Hébrard, A. Collier Cameron, S. Dalal, B. Smalley, T. G. Wilson, I. Boisse, F. Bouchy, D. J. A. Brown, **O. Demangeon**, 2020; *WASP-186 and WASP-187: two hot Jupiters discovered by SuperWASP and SOPHIE with additional observations by TESS*; Monthly Notices of the Royal Astronomical Society, 499, 1, 428

46. M. Lendl, Sz. Csizmadia, A. Deline, L. Fossati, D. Kitzmann, K. Heng, S. Hoyer, S. Salmon, W. Benz, C. Broeg et al. (*including:* **S. C. C. Barros**, **O. Demangeon**, **N. C. Santos**, **S. G. Sousa**), 2020; *The hot dayside and asymmetric transit of WASP-189 b seen by CHEOPS*; Astronomy and Astrophysics, 643, A94, 10

47. A. Mortier, M. R. Zapatero-Osorio, L. Malavolta, Y. Alibert, K. Rice, J. Lillo-Box, A. Vanderburg, M. Oshagh, L. A. Buchhave, **V. Zh. Adibekyan** et al. (*including:* **E. Delgado Mena**, **S. G. Sousa**, **S. C. C. Barros**, **A. Cabral**, **O. Demangeon**, **P. Figueira**, **C. J. A. P. Martins**, **N. J. Nunes**, **N. C. Santos**), 2020; *K2-111: an old system with two planets in near-resonance*; Monthly Notices of the Royal Astronomical Society, 499, 4, 5004

48. F. Leclercq, R. Bacon, A. Verhamme, T. Garel, J. Blaizot, **J. Brinchmann**, S. Cantalupo, A. Claeyssens, S. Conseil, T. Contini, 2020; *The MUSE Hubble Ultra Deep Field Survey. XIII. Spatially resolved spectral properties of Lyman α haloes around star-forming galaxies at z > 3*; Astronomy and Astrophysics, 635, A82, 20

49. S. Muzahid, J. Schaye, R. A. Marino, S. Cantalupo, **J. Brinchmann**, T. Contini, M. Wendt, L. Wisotzki, J. Zabl, N. Bouché, 2020; *MUSEQuBES: calibrating the redshifts of Ly α emitters using stacked circumgalactic medium absorption profiles*; Monthly Notices of the Royal Astronomical Society, 496, 2, 1013

50. **J. F. Ferreira**, P. Tanga, **P. Machado**, E. Corsaro, 2020; *A survey for occultation astrometry of main belt: expected astrometric performances*; Astronomy and Astrophysics, 641, A81, 10

51. E. Cohen, **M. Cortês**, A. Elitzur, L. Smolin, 2020; *Realism and causality. I. Pilot wave and retrocausal models as possible facilitators*; Physical Review D, 102, 12

52. E. Cohen, **M. Cortês**, A. Elitzur, L. Smolin, 2020; *Realism and causality. II. Retrocausality in energetic causal sets*; Physical Review D, 102, 12

53. **P. P. Avelino**, **M. S. Cunha**, W. J. Chaplin, 2020; *Modelling stochastic signatures in classical pulsators*; Monthly Notices of the Royal Astronomical Society, 492, 3, 4477

54. G. Dréau, **M. S. Cunha**, **M. Vrard**, **P. P. Avelino**, 2020; *On using dipolar modes to constrain the helium glitch in red giant stars*; Monthly Notices of the Royal Astronomical Society, 497, 1, 1008

55. **M. S. Cunha**, **P. P. Avelino**, W. J. Chaplin, 2020; *From solar-like to mira stars: a unifying description of stellar pulsators in the presence of stochastic noise*; Monthly Notices of the Royal Astronomical Society, 499, 4, 4687

56. B. E. Nelson, E. B. Ford, J. Buchner, R. Cloutier, R. F. Díaz, **J. P. Faria**, N. Hara, V. M. Rajpaul, S. Rukdee, 2020; *Quantifying the Bayesian Evidence for a Planet in Radial Velocity Data*; The Astronomical Journal, 159, 2

57. T. Harko, **F. S. N. Lobo**, **H. M. R. da Silva**, 2020; *Cosmic stringlike objects in hybrid metric-Palatini gravity*; Physical Review D, 101, 12

58. R. Maiolino, M. Cirasuolo, **J. Afonso**, F. E. Bauer, R. A. A. Bowler, O. Cucciati, E. Daddi, G. De Lucia, C. J. Evans, H. Flores et al. (*including:* **C. Pappalardo**), 2020; *MOONRISE: The Main MOONS GTO Extragalactic Survey*; The Messenger, 180, 180, 24

59. S. Hoyer, P. Guterman, **O. Demangeon**, **S. G. Sousa**, M. Deleuil, J. C. Meunier, J. C. Meunier, W. Benz, 2020; *Expected performances of the Characterising Exoplanet Satellite (CHEOPS). III. Data reduction pipeline: architecture and simulated performances*; Astronomy and Astrophysics, 635, A24, 14

60. N. Hara, F. Bouchy, M. Stalport, I. Boisse, J. Rodrigues, J.-B Delisle, A. Santerne, G. W. Henry, L. Arnold, N. Astudillo-Defru et al. (*including:* **O. Demangeon**, **N. C. Santos**), 2020; *The SOPHIE search for northern extrasolar planets. XVI. HD 158259: A compact planetary system in a near-3:2 mean motion resonance chain*; Astronomy and Astrophysics, 636, L6, 17

61. **A. M. Silva**, **S. G. Sousa**, **N. C. Santos**, **O. Demangeon**, **P. M. M. Silva**, S. Hoyer, P. Guterman, M. Deleuil, D. Ehrenreich, 2020; *archi: pipeline for light curve extraction of CHEOPS background stars*; Monthly Notices of the Royal Astronomical Society, 496, 1, 282

62. J. Lillo Box, **P. Figueira**, A. Leleu, L. Acuña, **J. P. Faria**, N. Hara, **N. C. Santos**, A. C. M. Correia, P. Robutel, M. Deleuil et al. (*including:* **S. G. Sousa**), 2020; *Planetary*

system LHS 1140 revisited with ESPRESSO and TESS; Astronomy and Astrophysics, 642, A121, 20

63. J. Lillo-Box, T. A. Lopez, A. Santerne, L. D. Nielsen, **S. C. C. Barros**, M. Deleuil, L. Acuña, O. Mousis, **S. G. Sousa**, **V. Zh. Adibekyan** et al. (*including:* **O. Demangeon**, **P. Figueira**, **S. Hojjatpanah**, **N. C. Santos**), 2020; *Masses for the seven planets in K2-32 and K2-233. Four diverse planets in resonant chain and the first young rocky worlds*; Astronomy and Astrophysics, 640, A48, 18

64. **A. R. Costa Silva**, **E. Delgado Mena**, **M. Tsantaki**, 2020; *Chemical abundances of 1111 FGK stars from the HARPS-GTO planet search sample. III. Sulfur*; Astronomy and Astrophysics, 634, A136, 10

65. **P. I. T. K. Sarmento**, **E. Delgado Mena**, B. Rojas-Ayala, S. Blanco-Cuaresma, 2020; *Derivation of parameters for 3748 FGK stars using H-band spectra from APOGEE Data Release 14*; Astronomy and Astrophysics, 636, A85, 19

66. M. Baratella, V. D'Orazi, G. Carraro, S. Desidera, S. Randich, L. Magrini, **V. Zh. Adibekyan**, R. Smiljanic, L. Spina, M. Tsantaki et al. (*including:* **S. G. Sousa**, **E. Delgado Mena**), 2020; *The Gaia-ESO Survey: a new approach to chemically characterising young open clusters. I. Stellar parameters, and iron-peak, α-, and proton-capture elements*; Astronomy and Astrophysics, 634, A34, 15

67. B. Zoutendijk, **J. Brinchmann**, L. A. Boogaard, M. L. P. Gunawardhana, T.-O. Husser, S. Kamann, A. F. Ramos Padilla, M. M. Roth, R. Bacon, M. den Brok, S. Dreizler, D. Krajnović, 2020; *The MUSE-Faint survey. I. Spectroscopic evidence for a star cluster in Eridanus 2 and constraints on MACHOs as a constituent of dark matter*; Astronomy and Astrophysics, 635, A107, 16

68. S. Kamann, B. Giesers, N. Bastian, **J. Brinchmann**, S. Dreizler, F. Göttgens, T.-O. Husser, M. Latour, P. M. Weilbacher, L. Wisotzki, 2020; *The binary content of multiple populations in NGC 3201*; Astronomy and Astrophysics, 635, A65, 6

69. T.-O. Husser, M. Latour, **J. Brinchmann**, S. Dreizler, B. Giesers, F. Göttgens, S. Kamann, M. M. Roth, P. M. Weilbacher, M. Wendt, 2020; *A stellar census in globular clusters with MUSE Extending the CaT-metallicity relation below the horizontal branch and applying it to multiple populations*; Astronomy and Astrophysics, 635, A114, 26

70. S. Kamann, E. Dalessandro, N. Bastian, **J. Brinchmann**, M. den Brok, S. Dreizler, B. Giesers, F. Göttgens, T.-O. Husser, D. Krajnović, 2020; *The peculiar kinematics of the multiple populations in the globular cluster Messier 80 (NGC 6093)*; Monthly Notices of the Royal Astronomical Society, 492, 1, 966

71. S. Boldt, M. Oshagh, S. Dreizler, M. Mallonn, **N. C. Santos**, A. Claret, A. Reiners, E. Sedaghati, 2020; *Stellar activity consequence on the retrieved transmission spectra through chromatic Rossiter-McLaughlin observations*; Astronomy and Astrophysics, 635, A123, 7

72. S. Dib, S. Bontemps, N. Schneider, D. Elia, V. Ossenkopf-Okada, M. Shadmehri, **D. Arzoumanian**, F. Motte, M. Heyer, A. Nordlund, B. Ladjelate, 2020; *The structure and characteristic scales of molecular clouds*; Astronomy and Astrophysics, 642, A177, 18

73. E. Fiorellino, D. Elia, Ph. André, A. Men'shchikov, S. Pezzuto, E. Schisano, V. Könyves, **D. Arzoumanian**, M. Benedettini, D. Ward-Thompson, 2020; *The census of dense cores in the Serpens region from the Herschel Gould Belt Survey*; Monthly Notices of the Royal Astronomical Society, 500, 4, 4257

74. **G. Fanizza**, M. Gasperini, G. Marozzi, G. Veneziano, 2020; *Generalized covariant prescriptions for averaging cosmological observables*; Journal of Cosmology and Astroparticle Physics, 2020, 2

75. **G. Fanizza**, G. Franchini, M. Gasperini, L. Tedesco, 2020; *Comparing the luminosity distance for gravitational waves and electromagnetic signals in a simple model of quadratic gravity*; General Relativity and Gravitation, 52, 111

76. E. Barausse, E. Bertin, T. Hertog, S. A. Hughes, P. Jetzer, P. Pani, T. Sotiriou, N. Tamanini, H. Witek, K. Yagi et al. (*including:* **I. Ayuso**, **T. Barreiro**, **F. T. O. Cabral**, **N. Frusciante**, **F. S. N. Lobo**, **C. J. A. P. Martins**, **J. P. Mimoso**, **N. J. Nunes**, **D. Rubiera-Garcia**, **A. C. da Silva**, **D. Vernieri**), 2020; *Prospects for fundamental physics with LISA*; General Relativity and Gravitation, 52, 81, 22

77. **G. Gilli**, F. Forget, A. Spiga, T. Navarro, E. Millour, L. Montabone, A. Kleinböhl, D. M. Kass, D. J. McCleese, J. T. Schofield, 2020; *Impact of Gravity Waves on the Middle Atmosphere of Mars: A Non-Orographic Gravity Wave Parameterization Based on Global Climate Modeling and MCS Observations*; Journal of Geophysical Research: Planets, 125, 3

78. **N. Frusciante**, F. Pace, 2020; *Growth of non-linear structures and spherical collapse in the Galileon Ghost Condensate model*; Physics of the Dark Universe, 30

79. **N. Frusciante**, L. Perenon, 2020; *Effective field theory of dark energy: A review*; Physics Reports, 857, 1

80. **N. Frusciante**, S. Peirone, **L. Atayde**, A. de Felice, 2020; *Phenomenology of the generalized cubic covariant Galileon model and cosmological bounds*; Physical Review D, 101, 6

81. A. Zavagno, Ph. André, F. Schuller, N. Peretto, Y. Shimajiri, **D. Arzoumanian**, T. Csengeri, M. Figueira, G. Fuller, V. Könyves et al. (*including:* **P. M. Palmeirim**), 2020; *The role of Galactic H II regions in the formation of filaments. High-resolution submilimeter imaging of RCW 120 with ArTéMiS*; Astronomy and Astrophysics, 638, A7, 8

82. N. Peretto, A. Rigby, Ph. André, V. Könyves, G. Fuller, A. Zavagno, F. Schuller, **D. Arzoumanian**, S. Bontemps, T. Csengeri et al. (*including:* **P. M. Palmeirim**), 2020; *The accretion history of high-mass stars: an ArTéMiS pilot study of infrared dark clouds*; Monthly Notices of the Royal Astronomical Society, 496, 3, 3482

83. E. Altamura, S. Brennan, A. Leśniewska, V. Pintér, **S. N. Reis**, T. Pursimo, J. P. U. Fynbo, S. Geier, K. E. Heintz, P. Møller, 2020; *Serendipitous Discovery of a Physical Binary Quasar at z = 1.76*; The Astronomical Journal, 159, 3

84. D. Ehrenreich, C. Lovis, R. Allart, M. R. Zapatero-Osorio, F. Pepe, S. Cristiani, R. Rebolo López, **N. C. Santos**, F. Borsa, **O. Demangeon** et al. (*including:* **S. G. Sousa**, **M. Abreu**, **V. Zh. Adibekyan**, **A. Cabral**, **J. P. Coelho**, **P. Figueira**, **C. J. A. P. Martins**, **M. A. Monteiro**, **M. J. P. F. G. Monteiro**, **N. J. Nunes**, **P. Santos**), 2020; *Nightside condensation of iron in an ultrahot giant exoplanet*; Nature, 580, 7805, 597

85. A. Suárez Mascareño, **J. P. Faria**, **P. Figueira**, C. Lovis, M. Damasso, J. I. González Hernández, R. Rebolo López, S. Cristiani, F. Pepe, **N. C. Santos** et al. (*including:* **V. Zh. Adibekyan**, **S. Hojjatpanah**, **M. Abreu**, **D. C. Alves**, **S. C. C. Barros**, **A. Cabral**, **J. Coelho**, **C. J. A. P. Martins**, **M. A. Monteiro**, **M. J. P. F. G. Monteiro**, **N. J. Nunes**, **A. Oliveira**, **G. Pariani**, **P. Santos**, **S. G. Sousa**), 2020; *Revisiting Proxima with ESPRESSO*; Astronomy and Astrophysics, 639, A77, 24

86. M. Damasso, A. Sozzetti, C. Lovis, **S. C. C. Barros**, **S. G. Sousa**, **O. Demangeon**, J. P. Faria, J. Lillo Box, S. Cristiani, F. Pepe et al. (*including:* **N. C. Santos**, **V. Zh. Adibekyan**, **M. Abreu**, **D. C. Alves**, **D. Bossini**, **A. Cabral**, **J. Coelho**, **P. Figueira**, **C. J. A. P. Martins**, **M. A. Monteiro**, **M. J. P. F. G. Monteiro**, **N. J. Nunes**, **A. Oliveira**, **J. M. Rebordão**, **P. Santos**, **H. M. Tabernero**), 2020; *A precise architecture characterization of the π Mensae planetary system*; Astronomy and Astrophysics, 642, A31, 14

87. B. Toledo-Padrón, C. Lovis, A. Suárez Mascareño, **S. C. C. Barros**, J. I. González Hernández, A. Sozzetti, F. Bouchy, M. R. Zapatero-Osorio, R. Rebolo López, S. Cristiani et al. (*including:* **N. C. Santos**, **S. G. Sousa**, **H. M. Tabernero**, **D. Bossini**, **V. Zh. Adibekyan**, **P. Figueira**, **N. J. Nunes**, **M. Abreu**, **D. C. Alves**, **A. Cabral**, **J. Coelho**, **O. Demangeon**, **C. J. A. P. Martins**, **M. J. P. F. G. Monteiro**, **M. A. Monteiro**, **A. Oliveira**, **P. Santos**), 2020; *Characterization of the K2-38 planetary system. Unraveling one of the densest planets known to date*; Astronomy and Astrophysics, 641, A92, 14

88. R. Allart, L. Pino, C. Lovis, **S. G. Sousa**, N. Casasayas-Barris, M. R. Zapatero-Osorio, M. Cretignier, E. Palle, F. Pepe, S. Cristiani et al. (*including:* **N. C. Santos**, **O. Demangeon**, **H. M. Tabernero**, **V. Zh. Adibekyan**, **A. Cabral**, **P. Figueira**, **C. J. A. P. Martins**, **N. J. Nunes**), 2020; *WASP-127b: a misaligned planet with a partly cloudy atmosphere and tenuous sodium signature seen by ESPRESSO*; Astronomy and Astrophysics, 644, A155, 18

89. P. Bonifacio, P. Molaro, **V. Zh. Adibekyan**, D. Aguado, Y. Alibert, C. Allende Prieto, E. Caffau, S. Cristiani, G. Cupani, P. Di Marcantonio et al. (*including:* **P. Figueira**, **C. J. A. P. Martins**, **N. J. Nunes**, **N. C. Santos**, **S. G. Sousa**), 2020; *ESPRESSO highlights the binary nature of the ultra-metal-poor giant HE 0107–5240*; Astronomy and Astrophysics, 633, A129, 7

90. K. Takami, H. Nakagawa, H. Sagawa, P. Krause, I. Murata, Y. Kasaba, T. Kuroda, S. Aoki, T. Kouyama, T. Kostiuk, T. A. Livengood, **G. Gilli**, 2020; *Evaluation of a method to retrieve temperature and wind velocity profiles of the Venusian nightside mesosphere from mid-infrared CO_2 absorption line observed by heterodyne spectroscopy*; Earth, Planets and Space, 72, 1

91. T. Nanayakkara, **J. Brinchmann**, K. Glazebrook, R. J. Bouwens, L. Kewley, K.-V. Tran, M. Cowley, D. Fisher, G. G. Kacprzak, I. Labbe, C. Straatman, 2020; *Reconstructing the Observed Ionizing Photon Production Efficiency at z ~ 2 Using Stellar Population Models*; The Astrophysical Journal, 889, 2

92. P. Bordé, R. F. Díaz, O. L. Creevey, C. Damiani, H. J. Deeg, P. Klagyivik, G. Wuchterl, D. Gandolfi, M. Fridlund, F. Bouchy et al. (*including:* **S. C. C. Barros**), 2020; *Transiting exoplanets from the CoRoT space mission. XXIX. The hot Jupiters CoRoT-30 b and CoRoT-31 b*; Astronomy and Astrophysics, 635, A122, 17

93. D. Hidalgo, E. Pallé, R. Alonso, D. Gandolfi, M. Fridlund, G. Nowak, R. Luque, T. Hirano, A. B. Justesen, W. D. Cochran et al. (*including:* **P. Figueira**), 2020; *Three planets transiting the evolved star EPIC 249893012: a hot 8.8-$M_\oplus$ super-Earth and two warm 14.7 and 10.2-$M_\oplus$ sub-Neptunes*; Astronomy and Astrophysics, 636, A89, 13

94. I. Carleo, D. Gandolfi, O. Barragán, J. H. Livingston, C. M. Persson, K. W. F. Lam, A. A. Vidotto, M. N. Lund, C. V. D'Angelo, K. A. Collins et al. (*including:* **L. M. Serrano**), 2020; *The Multiplanet System TOI-421: A Warm Neptune and a Super Puffy Mini-Neptune Transiting a G9 V Star in a Visual Binary*; The Astronomical Journal, 160, 3

95. **R. Gonçalves**, **P. Machado**, T. Widemann, J. Peralta, S. Watanabe, A. Yamazaki, T. Satoh, M. Takagi, K. Ogohara, Y. J. Lee, A. Harutyunyan, **J. Silva**, 2020; *Venus' cloud top wind study: Coordinated Akatsuki/UVI with cloud tracking and TNG/HARPS-N with Doppler velocimetry observations*; Icarus, 335

96. N. Espinoza, R. Brahm, T. Henning, A. Jordán, C. Dorn, F. Rojas, P. Sarkis, D. Kossakowski, M. Schlecker, M. R. Díaz et al. (*including:* **V. Zh. Adibekyan**, **S. C. C. Barros**, **O. Demangeon**, **N. C. Santos**, **S. G. Sousa**), 2020; *HD 213885b: a transiting 1-d-period super-Earth with an Earth-like composition around a bright (V = 7.9) star unveiled by TESS*; Monthly Notices of the Royal Astronomical Society, 491, 2, 2982

97. N. Astudillo-Defru, R. Cloutier, S. X. Wang, J. Teske, R. Brahm, C. Hellier, G. R. Ricker, R. K. Vanderspek, D. W. Latham, S. Seager et al. (*including:* **P. Figueira**, **N. C. Santos**), 2020; *A hot terrestrial planet orbiting the bright M dwarf L 168-9 unveiled by TESS*; Astronomy and Astrophysics, 636, A58, 13

98. J. Peralta, T. Navarro, C. W. Vun, A. Sánchez-Lavega, K. McGouldrick, T. Horinouchi, T. Imamura, R. Hueso, J. P. Boyd, G. Schubert et al. (*including:* **P. Machado**), 2020; *A Long-Lived Sharp Disruption on the Lower Clouds of Venus*; Geophysical Research Letters, 47, 11

99. **S. N. Reis**, **F. Buitrago**, **P. Papaderos**, **I. Matute**, **J. Afonso**, **S. Amarantidis**, **I. P. Breda**, **J. M. Gomes**, **A. Humphrey**, **C. Lobo** et al. (*including:* **S. Lorenzoni**, **C. Pappalardo**, **A. Paulino-Afonso**, **T. C. Scott**), 2020; *Structural analysis of massive galaxies using HST deep imaging at z < 0.5*; Astronomy and Astrophysics, 634, A11, 26

100. **M. S. Silva**, **A. Humphrey**, **P. Lagos**, **S. G. Morais**, 2020; *Carbon-loud SDSS BOSS type II quasars at z > 2: high-density gas or secondary production of carbon?*; Monthly Notices of the Royal Astronomical Society, 495, 4, 4707

101. M. Cirasuolo, A. Fairley, P. Rees, O. A. Gonzalez, W. Taylor, R. Maiolino, **J. Afonso**, C. J. Evans, H. Flores, S. Lilly et al. (*including:* **M. Abreu**, **S. Amarantidis**, **J. Brinchmann**, **F. Buitrago**, **A. Cabral**, **L. S. M. Cardoso**, **J. Coelho**, **J. M. Gomes**, **A. Humphrey**, **I. Matute**, **H. Messias**, **A. Oliveira**, **P. Papaderos**, **C. Pappalardo**, **P. Santos**, **I. Tereno**), 2020; *MOONS: The New Multi-Object Spectrograph for the VLT*; The Messenger, 180, 10

102. E. Malefahlo, **M. Santos**, M. Jarvis, S. White, J. Zwart, 2020; *The optically selected 1.4-GHz quasar luminosity function below 1 mJy*; Monthly Notices of the Royal Astronomical Society, 492, 4, 5297

103. **M. S. N. Kumar**, **P. M. Palmeirim**, **D. Arzoumanian**, S.-I. Inutsuka, 2020; *Unifying low- and high-mass star formation through density-amplified hubs of filaments. The highest mass stars (>100 M⊙) form only in hubs*; Astronomy and Astrophysics, 642, A87, 21

104. A. A. Hakobyan, L. V. Barkhudaryan, A. G. Karapetyan, M. H. Gevorgyan, G. A. Mamon, D. Kunth, **V. Zh. Adibekyan**, M. Turatto, 2020; *Supernovae and their host galaxies - VII. The diversity of Type Ia supernova progenitors*; Monthly Notices of the Royal Astronomical Society, 499, 1, 1424

105. C. Worley, P. Jofré, B. M. Rendle, A. Miglio, L. Magrini, D. Feuillet, A. Gavel, R. Smiljanic, K. Lind, A. J. Korn et al. (*including:* **S. G. Sousa**), 2020; *The Gaia-ESO Survey: Spectroscopic-asteroseismic analysis of K2 stars in Gaia-ESO. The K2 Galactic Caps Project*; Astronomy and Astrophysics, 643, A83, 32

106. **M. Le Delliou**, E. Huguet, M. Fontanini, 2020; *Teleparallel theory as a gauge theory of translations: Remarks and issues*; Physical Review D, 101, 2

107. J. Lorca Espiro, **M. Le Delliou**, 2020; *Dark energy from topology*; Journal of Cosmology and Astroparticle Physics, 2020, 03

108. A. Del Popolo, M. Deliyergiyev, **M. Le Delliou**, L. Tolos, F. Burgio, 2020; *On the change of old neutron star masses with galactocentric distance*; Physics of the Dark Universe, 28

109. **M. Le Delliou**, J. Lorca Espiro, 2020; *Is the cosmological constant of topological origin?*; Physics of the Dark Universe, 29

110. A. Del Popolo, **M. Le Delliou**, M. Deliyergiyev, 2020; *Neutron Stars and Dark Matter*; Universe, 6, 12, 222

111. A. Del Popolo, M. Deliyergiyev, **M. Le Delliou**, 2020; *Solution to the hyperon puzzle using dark matter*; Physics of the Dark Universe, 30

112. **M. Deal**, M.-J. Goupil, J. P. Marques, D. R. Reese, Y. Lebreton, 2020; *Chemical mixing in low mass stars I. Rotation against atomic diffusion including radiative acceleration*; Astronomy and Astrophysics, 633, A23, 15

113. A. Palmese, J. Annis, J. Burgad, A. Farahi, M. Soares-Santos, B. Welch, M. da Silva Pereira, H. Lin, S. Bhargava, D. Hollowood et al. (*including:* **P. T. P. Viana**), 2020; *Stellar mass as a galaxy cluster mass proxy: application to the Dark Energy Survey redMaPPer clusters*; Monthly Notices of the Royal Astronomical Society, 493, 4, 4591

114. **F. S. N. Lobo**, J. P. Mimoso, M. Visser, 2020; *Cosmographic analysis of redshift drift*; Journal of Cosmology and Astroparticle Physics, 2020, 04

115. **F. S. N. Lobo**, A. Simpson, M. Visser, 2020; *Dynamic thin-shell black-bounce traversable wormholes*; Physical Review D, 101, 12

116. R. Korolev, **F. S. N. Lobo**, S. V. Sushkov, 2020; *General constraints on Horndeski wormhole throats*; Physical Review D, 101, 12

117. **B. J. Barros**, B. Dănilă, T. Harko, **F. S. N. Lobo**, 2020; *Black hole and naked singularity geometries supported by three-form fields*; The European Physical Journal C, 80, 7, 617

118. T. Berry, **F. S. N. Lobo**, A. Simpson, M. Visser, 2020; *Thin-shell traversable wormhole crafted from a regular black hole with asymptotically Minkowski core*; Physical Review D, 102, 6

119. **F. T. O. Cabral**, **F. S. N. Lobo**, D. Rubiera-Garcia, 2020; *Cosmological bounces, cyclic universes, and effective cosmological constant in Einstein-Cartan-Dirac-Maxwell theory*; Physical Review D, 102, 8

120. **F. T. O. Cabral**, **F. S. N. Lobo**, D. Rubiera-Garcia, 2020; *The cosmological principle in theories with torsion: the case of Einstein-Cartan-Dirac-Maxwell gravity*; Journal of Cosmology and Astroparticle Physics, 2020, 10

121. T. Harko, **F. S. N. Lobo**, 2020; *Beyond Einstein's General Relativity: Hybrid metric-Palatini gravity and curvature-matter couplings*; International Journal of Modern Physics D, 29, 13

122. **F. S. N. Lobo**, G. J. Olmo, E. Orazi, D. Rubiera-Garcia, A. Rustam, 2020; *Structure and stability of traversable thin-shell wormholes in Palatini f(R) gravity*; Physical Review D, 102, 10

123. **F. T. O. Cabral**, **F. S. N. Lobo**, D. Rubiera-Garcia, 2020; *Fundamental Symmetries and Spacetime Geometries in Gauge Theories of Gravity—Prospects for Unified Field Theories*; Universe, 6, 12, 238

124. R. Korolev, **F. S. N. Lobo**, S. V. Sushkov, 2020; *Kinetic gravity braiding wormhole geometries*; Physical Review D, 102, 10

125. J. L. Rosa, J. P. S. Lemos, **F. S. N. Lobo**, 2020; *Stability of Kerr black holes in generalized hybrid metric-Palatini gravity*; Physical Review D, 101, 4

126. G. Panotopoulos, **D. Vernieri**, I. Lopes, 2020; *Quark stars with isotropic matter in Horava gravity and Einstein-aether theory*; The European Physical Journal C, 80, 6, 537

127. **M. T. Clara**, **C. J. A. P. Martins**, 2020; *Primordial nucleosynthesis with varying fundamental constants. Improved constraints and a possible solution to the lithium problem*; Astronomy and Astrophysics, 633, L11, 7

128. **J. M. A. Vilas Boas**, D. M. N. Magano, **C. J. A. P. Martins**, A. Barbecho, C. Serrano, 2020; *Distinguishing freezing and thawing dark energy models through measurements of the fine-structure constant*; Astronomy and Astrophysics, 635, A80, 12

129. C. M. J. Marques, **C. J. A. P. Martins**, 2020; *Low-redshift constraints on homogeneous and isotropic universes with torsion*; Physics of the Dark Universe, 27

130. M. R. Wilczynska, J. K. Webb, M. Bainbridge, J. D. Barrow, S. E. I. Bosman, R. F. Carswell, M. P. Dąbrowski, V. Dumont, C.-C. Lee, **A. C. O. Leite** et al. (*including:* **C. J. A. P. Martins**), 2020; *Four direct measurements of the fine-structure constant 13 billion years ago*; Science Advances, 6, 17

131. **J. R. C. C. C. Correia**, **C. J. A. P. Martins**, 2020; *Quantifying the effect of cooled initial conditions on cosmic string network evolution*; Physical Review D, 102, 4

132. **J. R. C. C. C. Correia**, **C. J. A. P. Martins**, 2020; *Abelian-Higgs cosmic string evolution with CUDA*; Astronomy and Computing, 32

133. V. Silva Aguirre, D. Stello, A. Stokholm, J. Rørsted Mosumgaard, W. H. Ball, S. Basu, D. Bossini, L. Bugnet, D. L. Buzasi, **T. L. Campante** et al. (*including:* **M. Vrard**, **M. S. Cunha**, **M. J. P. F. G. Monteiro**, **L. F. Pereira**), 2020; *Detection and Characterization of Oscillating Red Giants: First Results from the TESS Satellite*; The Astrophysical Journal Letters, 889, 2

134. G. Orellana-González, E. Ibar, R. Leiton, A. P. Thomson, C. Cheng, R. J. Ivison, R. Herrera-Camus, **H. Messias**, P. Calderón-Castillo, P. Calderón-Castillo, T. Hughes, L. Leeuw, 2020; *Cosmic evolution of moleculty from an empirical relationship between L1.4 GHz and L'CO*; Monthly Notices of the Royal Astronomical Society, 495, 2, 1760

135. A. B. A. Queiroz, F. Anders, C. Chiappini, A. Khalatyan, B. X. Santiago, M. Steinmetz, M. Valentini, A. Miglio, **D. Bossini**, B. Barbuy, 2020; *From the bulge to the outer disc: StarHorse stellar parameters, distances, and extinctions for stars in APOGEE DR16 and other spectroscopic surveys*; Astronomy and Astrophysics, 638, A76, 31

136. *Euclid* Collaboration, P. Paykari, T. D. Kitching, H. Hoekstra, R. Azzollini, V. F. Cardone, M. Cropper, C. A. J. Duncan, A. Kannawadi, L. Miller et al. (*including:* **J. Brinchmann**, **A. C. da Silva**, **I. Tereno**), 2020; *Euclid preparation. VI. Verifying the performance of cosmic shear experiments*; Astronomy and Astrophysics, 635, A139, 18

137. A. Maciel, **M. Le Delliou**, **J. P. Mimoso**, 2020; *New perspectives on the TOV equilibrium from a dual null approach*; Classical and Quantum Gravity, 37, 12

138. R. Yunis, C. R. Argüelles, N. E. Mavromatos, **A. Moliné**, A. Krut, M. Carinci, J. A. Rueda, R. Ruffini, 2020; *Galactic center constraints on self-interacting sterile neutrinos from fermionic dark matter ("ino") models*; Physics of the Dark Universe, 30

139. M. L. Gutiérrez Albarrán, D. Montes, M. Gómez Garrido, **H. M. Tabernero**, J. I. González Hernández, E. Marfil, A. Frasca, A. C. Lanzafame, A. Klutsch, E. Franciosini et al. (*including:* **S. G. Sousa**), 2020; *The Gaia-ESO Survey: Calibrating the lithium–age relation with open clusters and associations I. Cluster age range and initial membership selections*; Astronomy and Astrophysics, 643, A71, 37

140. P. Gaulme, J. Jackiewicz, F. Spada, D. Chojnowski, B. Mosser, J. McKeever, A. Hedlund, **M. Vrard**, M. Benbakoura, C. Damiani, 2020; *Active red giants: Close binaries versus single rapid rotators*; Astronomy and Astrophysics, 639, A63, 18

141. W. H. Ball, W. J. Chaplin, M. B. Nielsen, L. González-Cuesta, S. Mathur, A. R. G. Santos, R. A. García, D. L. Buzasi, B. Mosser, **M. Deal** et al. (*including:* **B. Nsamba**, **T. L. Campante**, **M. S. Cunha**), 2020; *Robust asteroseismic properties of the bright planet host HD 38529*; Monthly Notices of the Royal Astronomical Society, 499, 4, 6084

142. M. Steinmetz, G. Guiglion, P. J. McMillan, G. Matijevič, H. Enke, G. Kordopatis, T. Zwitter, M. Valentini, C. Chiappini, L. Casagrande et al. (*including:* **D. Bossini**), 2020; *The Sixth Data Release of the Radial Velocity Experiment (RAVE). II. Stellar Atmospheric Parameters, Chemical Abundances, and Distances*; The Astronomical Journal, 160, 2

143. M. Steinmetz, G. Matijevič, H. Enke, T. Zwitter, G. Guiglion, P. J. McMillan, G. Kordopatis, M. Valentini, C. Chiappini, L. Casagrande et al. (*including:* **D. Bossini**), 2020; *The Sixth Data Release of the Radial Velocity Experiment (RAVE). I. Survey Description, Spectra, and Radial Velocities*; The Astronomical Journal, 160, 2

144. L. Zhou, D. Elbaz, M. Franco, B. Magnelli, C. Schreiber, T. Wang, L. Ciesla, E. Daddi, M. E. Dickinson, N. M. Nagar et al. (*including:* **H. Messias**), 2020; *GOODS-ALMA: Optically dark ALMA galaxies shed light on a cluster in formation at z = 3.5*; Astronomy and Astrophysics, 642, A155, 17

145. **B. J. Barros**, **T. Barreiro**, **N. J. Nunes**, 2020; *Spherical collapse in coupled quintessence with a Λ CDM background*; Physical Review D, 101, 2

146. **E. M. Teixeira**, A. Nunes, **N. J. Nunes**, 2020; *Disformally coupled quintessence*; Physical Review D, 101, 8

147. **B. J. Barros**, **T. Barreiro**, T. S. Koivisto, **N. J. Nunes**, 2020; *Testing F(Q) gravity with redshift space distortions*; Physics of the Dark Universe, 30

148. S. R. Kane, S. Yalçınkaya, H. P. Osborn, P. A. Dalba, L. D. Nielsen, A. Vanderburg, T. Mocnik, N. R. Hinkel, C. Ostberg, E. M. Esmer et al. (*including:* **T. L. Campante**), 2020; *Transits of Known Planets Orbiting a Naked-eye Star*; The Astronomical Journal, 160, 3

149. B. Ladjelate, Ph. André, V. Könyves, D. Ward-Thompson, A. Men'shchikov, A. Bracco, **P. M. Palmeirim**, A. Roy, Y. Shimajiri, J. M. Kirk et al. (*including:* **D. Arzoumanian**), 2020; *The Herschel view of the dense core population in the Ophiuchus molecular cloud*; Astronomy and Astrophysics, 638, A74, 22

150. J. Di Francesco, J. Keown, C. Fallscheer, Ph. André, B. Ladjelate, V. Könyves, A. Men'shchikov, S. Stephens-Whale, Q. Nguyen-Luong, P. G. Martin et al. (*including:* **D. Arzoumanian**, **P. M. Palmeirim**), 2020; *Herschel Gould Belt Survey Observations of Dense Cores in the Cepheus Flare Clouds*; The Astrophysical Journal, 904, 2

151. A. Bracco, D. Bresnahan, **P. M. Palmeirim**, **D. Arzoumanian**, Ph. André, D. Ward-Thompson, A. Marchal, 2020; *Compressed magnetized shells of atomic gas and the formation of the Corona Australis molecular cloud*; Astronomy and Astrophysics, 644, A5, 10

152. A. C. Deshpande, T. D. Kitching, V. F. Cardone, P. L. Taylor, S. Casas, S. Camera, C. Carbone, M. Kilbinger, V. Pettorino, Z. Sakr et al. (*including:* **I. Tereno**), 2020; *Euclid: The reduced shear approximation and magnification bias for Stage IV cosmic shear experiments*; Astronomy and Astrophysics, 636, A95, 16

153. M. Pöntinen, M Granvik, A. A. Nucita, L. Conversi, B. Altieri, N. Auricchio, C. Bodendorf, D. Bonino, M. Brescia, V. Capobianco et al. (*including:* **I. Tereno**), 2020; *Euclid: Identification of asteroid streaks in simulated images using StreakDet software*; Astronomy and Astrophysics, 644, A35, 12

154. J. Florian, B. Ziegler, M. Hirschmann, **P. Papaderos**, E. Choi, M. Frigo, **J. M. Gomes**, R. S. Somerville, 2020; *Ionized gas kinematics of massive elliptical galaxies in CALIFA and in cosmological zoom-in simulations*; Astronomy and Astrophysics, 635, A41, 19

155. **I. P. Breda**, **P. Papaderos**, **J. M. Gomes**, J. M. Vílchez, B. Ziegler, M. Hirschmann, L. S. M. Cardoso, **P. Lagos**, **F. Buitrago**, 2020; *Stellar age gradients and inside-out star formation quenching in galaxy bulges*; Astronomy and Astrophysics, 635, A177, 7

156. **I. P. Breda**, **P. Papaderos**, **J. M. Gomes**, 2020; *Indications of the invalidity of the exponentiality of the disk within bulges of spiral galaxies*; Astronomy and Astrophysics, 640, A20, 12

157. K. Perraut, **M. S. Cunha**, A. Romanovskaya, D. Shulyak, T. Ryabchikova, V. Hocdé, N. Nardetto, D. Mourard, A. Meilland, F. Morand, 2020; *Benchmarking the fundamental parameters of Ap stars with optical long-baseline interferometric measurements*; Astronomy and Astrophysics, 642, A101, 13

158. **A. Cardesín-Moinelo**, G. Piccioni, A. Migliorini, D. Grassi, V. Cottini, D. Titov, R. Politi, F. Nuccilli, P. Drossart, 2020; *Global maps of Venus nightside mean infrared thermal emissions obtained by VIRTIS on Venus Express*; Icarus, 343

159. O. Carrión González, A. Garcia Muñoz, J. Cabrera, Sz. Csizmadia, **N. C. Santos**, H. Rauer, 2020; *Directly imaged exoplanets in reflected starlight: the importance of knowing the planet radius*; Astronomy and Astrophysics, 640, A136, 22

160. J.-F. Donati, D. Kouach, C. Moutou, R. Doyon, X. Delfosse, E. Artigau, S. Baratchart, M. Lacombe, G. Barrick, G. Hébrard et al. (*including:* **P. Figueira**, **N. C. Santos**), 2020; *SPIRou: NIR velocimetry and spectropolarimetry at the CFHT*; Monthly Notices of the Royal Astronomical Society, 498, 4, 5684

161. **H. M. Tabernero**, C. Allende Prieto, M. R. Zapatero-Osorio, J. I. González Hernández, C. del Burgo, R. García-López, R. Rebolo López, M. Abril-Abril, R. Barreto, J. Calvo Tovar, 2020; *HORuS transmission spectroscopy of 55 Cnc e*; Monthly Notices of the Royal Astronomical Society, 498, 3, 4222

162. **N. C. Santos**, **E. A. S. Cristo**, **O. Demangeon**, M. Oshagh, R. Allart, **S. C. C. Barros**, F. Borsa, V. Bourrier, N. Casasayas-Barris, D. Ehrenreich et al. (*including:* **J. P. Faria**, **P. Figueira**, **J. H. C. Martins**, **H. M. Tabernero**,**V. Zh. Adibekyan**, **A. Cabral**, **C. J. A. P. Martins**, **N. J. Nunes**, **S. G. Sousa**), 2020; *Broadband transmission spectroscopy of HD 209458b with ESPRESSO: evidence for Na, TiO, or both*; Astronomy and Astrophysics, 644, A51, 13

163. M. V. Maseda, R. Bacon, D. Lam, J. Matthee, **J. Brinchmann**, J. Schaye, I. Labbe, K. B. Schmidt, L. A. Boogaard, R. J. Bouwens, 2020; *Elevated ionizing photon production efficiency in faint high-equivalent-width Lyman-α emitters*; Monthly Notices of the Royal Astronomical Society, 493, 4, 5120

164. A. Feltre, M. V. Maseda, R. Bacon, J. Pradeep, F. Leclercq, H. Kusakabe, L. Wisotzki, T. Hashimoto, K. B. Schmidt, J. Blaizot et al. (*including:* **J. Brinchmann**), 2020; *The MUSE Hubble Ultra Deep Field Survey. XV. The mean rest-UV spectra of Lyα emitters at $z > 3$*; Astronomy and Astrophysics, 641, A118, 26

165. S. Bhargava, P. M. Giles, A. K. Romer, T. Jeltema, J. A. Mayers, A. Bermeo, M. Hilton, R. Wilkinson, C. Vergara Cervantes, C. A. Collins et al. (*including:* **P. T. P. Viana**), 2020; *The XMM Cluster Survey: new evidence for the 3.5-keV feature in clusters is inconsistent with a dark matter origin*; Monthly Notices of the Royal Astronomical Society, 497, 1, 656

166. M. B. Nielsen, W. H. Ball, M. R. Standing, A. H. M. J. Triaud, D. L. Buzasi, L. Carboneau, Stassun K. G., S. R. Kane, W. J. Chaplin, E. P. Bellinger et al. (*including:* **M. Vrard**, **M. Deal**, **T. L. Campante**), 2020; *TESS*

asteroseismology of the known planet host star λ^2 Fornacis; Astronomy and Astrophysics, 641, A25, 11

167. **I. Yu. Rybak**, 2020; *Revisiting Y junctions for strings with currents: Transonic elastic case*; Physical Review D, 102, 8

168. **I. Ayuso**, D. Sáez Gómez, 2020; *Extremal Cosmological Black Holes in Horndeski Gravity and the Anti-Evaporation Regime*; Universe, 6, 11, 210

169. **B. Wehbe**, **A. Cabral**, **J. H. C. Martins**, **P. Figueira**, **N. C. Santos**, G. Avila, 2020; *The impact of atmospheric dispersion in the performance of high-resolution spectrographs*; Monthly Notices of the Royal Astronomical Society, 491, 3, 3515

170. **J. P. Faria**, **V. Zh. Adibekyan**, E. M. Amazo-Gómez, **S. C. C. Barros**, **J. D. Camacho**, **O. Demangeon**, **P. Figueira**, A. Mortier, **M. Oshagh**, F. Pepe et al. (*including:* **N. C. Santos**, **J. Gomes da Silva**, **A. R. Costa Silva**, **S. G. Sousa**, **S. Ulmer-Moll**, **P. T. P. Viana**), 2020; *Decoding the radial velocity variations of HD 41248 with ESPRESSO*; Astronomy and Astrophysics, 635, A13, 16

171. N. Crouzet, B. F. Healy, G. Hébrard, P. R. McCullough, D. Long, P. Montañés Rodríguez, I. Ribas, F. Vilardell, E. Herrero, E. Garcia-Melendo et al. (*including:* **N. C. Santos**), 2020; *XO-7 b: A Transiting Hot Jupiter with a Massive Companion on a Wide Orbit*; The Astronomical Journal, 159, 2

172. **A. Antoniadis-Karnavas**, **S. G. Sousa**, **E. Delgado Mena**, **N. C. Santos**, **G. D. C. Teixeira**, V. Neves, 2020; *ODUSSEAS: a machine learning tool to derive effective temperature and metallicity for M dwarf stars*; Astronomy and Astrophysics, 636, A9, 15

173. D. M. Glaser, H. E. Hartnett, S. J. Desch, C. T. Unterborn, A. D. Anbar, S. Buessecker, T. Fisher, S. Glaser, S. R. Kane, C. M. Lisse et al. (*including:* **N. C. Santos**), 2020; *Detectability of Life Using Oxygen on Pelagic Planets and Water Worlds*; The Astrophysical Journal, 893, 163

174. **L. M. Serrano**, M. Oshagh, H. M. Cegla, **S. C. C. Barros**, **N. C. Santos**, **J. P. Faria**, **B. Akinsanmi**, 2020; *Can we detect the stellar differential rotation of WASP-7 through the Rossiter-McLaughlin observations?*; Monthly Notices of the Royal Astronomical Society, 493, 4, 5928

175. **S. Hojjatpanah**, **M. Oshagh**, **P. Figueira**, **N. C. Santos**, E. M. Amazo-Gómez, **S. G. Sousa**, **V. Zh. Adibekyan**, **B. Akinsanmi**, **O. Demangeon**, **J. P. Faria**, **J. Gomes da Silva**, N. Meunier, 2020; *The correlation between photometric variability and radial velocity jitter. Based on TESS and HARPS observations*; Astronomy and Astrophysics, 639, A35, 20

176. **B. Akinsanmi**, **S. C. C. Barros**, **N. C. Santos**, **M. Oshagh**, L. M. Serrano, 2020; *Constraining the oblateness of transiting planets with photometry and spectroscopy*; Monthly Notices of the Royal Astronomical Society, 497, 3, 3484

177. **V. Zh. Adibekyan**, **S. G. Sousa**, **N. C. Santos**, **P. Figueira**, C. Allende Prieto, **E. Delgado Mena**, J. I. González Hernández, P. de Laverny, A. Recio-Blanco, **T. L. Campante** et al. (*including:* **J. P. Faria**, **T. Boulet**), 2020; *Benchmark stars, benchmark spectrographs. Detailed spectroscopic comparison of ESPRESSO, PEPSI, and HARPS data for Gaia benchmark stars*; Astronomy and Astrophysics, 642, A182, 16

178. D. Bashi, S. Zucker, **V. Zh. Adibekyan**, **N. C. Santos**, T. Trifonov, L. Tal-Or, T. Mazeh, 2020; *Occurrence rates of small planets from HARPS. Focus on the Galactic context*; Astronomy and Astrophysics, 643, A106, 10

179. **B. Akinsanmi**, **N. C. Santos**, **J. P. Faria**, M. Oshagh, **S. C. C. Barros**, A. Santerne, S. Charnoz, 2020; *Can planetary rings explain the extremely low density of HIP 41378 f?*; Astronomy and Astrophysics, 635, L8, 8

180. **S. C. C. Barros**, **O. Demangeon**, R. F. Díaz, J. Cabrera, **N. C. Santos**, **J. P. Faria**, **L. F. Pereira**, 2020; *Improving transit characterisation with Gaussian process modelling of stellar variability*; Astronomy and Astrophysics, 634, A75, 12

181. **R. M. G. Albuquerque**, **J. F. Gameiro**, S. Alencar, **J. J. G. Lima**, C. Sauty, C. Melo, 2020; *Accretion in low-mass members of the Orion Nebula Cluster with young transition disks*; Astronomy and Astrophysics, 636, A86, 16

182. L. Bonne, S. Bontemps, N. Schneider, S. D. Clarke, **D. Arzoumanian**, Y. Fukui, K Tachihara, T. Csengeri, R. Guesten, A. Ohama, 2020; *Formation of the Musca filament: evidence for asymmetries in the accretion flow due to a cloud-cloud collision*; Astronomy and Astrophysics, 644, A27, 23

183. N. Aghanim, Y. Akrami, **F. Arroja**, M. Ashdown, J. Aumont, C. Baccigalupi, M. Ballardini, A. J. Banday, R. B. Barreiro, N. Bartolo, 2020; *Planck 2018 results. I. Overview and the cosmological legacy of Planck*; Astronomy and Astrophysics, 641, A1, 56

184. Y. Akrami, **F. Arroja**, M. Ashdown, J. Aumont, C. Baccigalupi, M. Ballardini, A. J. Banday, R. B. Barreiro, N. Bartolo, S. Basak, 2020; *Planck 2018 results. IX. Constraints on primordial non-Gaussianity*; Astronomy and Astrophysics, 641, A9, 47

185. Y. Akrami, **F. Arroja**, M. Ashdown, J. Aumont, C. Baccigalupi, M. Ballardini, A. J. Banday, R. B. Barreiro, N. Bartolo, S. Basak, 2020; *Planck 2018 results. X. Constraints on inflation*; Astronomy and Astrophysics, 641, A10, 61

186. E. Petigura, J. H. Livingston, K. Batygin, S. M. Mills, M. Werner, H. Isaacson, B. J. Fulton, A. W. Howard, L. M. Weiss, N. Espinoza et al. (*including:* **S. C. C. Barros**), 2020; *K2-19b and c are in a 3:2 Commensurability but out of Resonance: A Challenge to Planet Assembly by Convergent Migration*; The Astronomical Journal, 159, 1

187. J. Pepper, S. R. Kane, J. E. Rodriguez, N. R. Hinkel, J. D. Eastman, T. Daylan, T. Mocnik, P. A. Dalba, B. S. Gaudi, Stassun K. G. et al. (*including:* **T. L. Campante**,

D. Bossini), 2020; *TESS Reveals HD 118203 b to be a Transiting Planet*; The Astronomical Journal, 159, 6

188. **A. Paulino-Afonso**, D. Sobral, B. Darvish, B. Ribeiro, I. Smail, P. Best, A. Stroe, J. Cairns, 2020; *VIS3COS III. Environmental effects on the star formation histories of galaxies at z ~ 0.8 seen in [O II], Hδ, and Dn4000*; Astronomy and Astrophysics, 633, A70, 19

189. M. Franchini, C. Morossi, P. Di Marcantonio, M. Chavez, **V. Zh. Adibekyan**, A. Bayo, T. Bensby, A. Bragaglia, F. Calura, S. Duffau et al. (*including:* **E. Delgado Mena**, **S. G. Sousa**), 2020; *The Gaia-ESO Survey: Carbon Abundance in the Galactic Thin and Thick Disks*; The Astrophysical Journal, 888, 2

190. L. A. Dos Santos, D. Ehrenreich, V. Bourrier, R. Allart, G. W. King, M. Lendl, C. Lovis, S. Margheim, J. Meléndez, J. V. Seidel, **S. G. Sousa**, 2020; *Search for helium in the upper atmosphere of the hot Jupiter WASP-127 b using Gemini/Phoenix*; Astronomy and Astrophysics, 640, A29, 5

191. G. Casali, L. Spina, L. Magrini, A. I. Karakas, C. Kobayashi, A. Casey, S. Feltzing, M. Van der Swaelmen, M. Tsantaki, P. Jofré et al. (*including:* **S. G. Sousa**, **V. Zh. Adibekyan**), 2020; *The Gaia-ESO survey: the non-universality of the age-chemical-clocks-metallicity relations in the Galactic disc*; Astronomy and Astrophysics, 639, A127, 17

192. J. V. Seidel, M. Lendl, V. Bourrier, D. Ehrenreich, R. Allart, **S. G. Sousa**, H. M. Cegla, X. Bonfils, U. Conod, A. Grandjean, 2020; *Hot Exoplanet Atmospheres Resolved with Transit Spectroscopy (HEARTS). VI. Non-detection of sodium with HARPS on the bloated super-Neptune WASP-127b*; Astronomy and Astrophysics, 643, A45, 10

193. J. Alonso-Santiago, I. Negueruela, A. Marco, **H. M. Tabernero**, N. Castro, 2020; *Three open clusters containing Cepheids: NGC 6649, NGC 6664, and Berkeley 55*; Astronomy and Astrophysics, 644, A136, 22

194. **B. J. Barros**, **E. M. Teixeira**, **D. Vernieri**, 2020; *Bouncing cosmology in f(R , G) gravity by order reduction*; Annals of Physics, 419

195. **M. Tsantaki**, **D. T. Andreasen**, **G. D. C. Teixeira**, 2020; *FASMA 2.0: A Python package for stellar parameters and chemical abundances*; The Journal of Open Source Software, 5, 50

196. E. Schisano, S. Molinari, D. Elia, M. Benedettini, L. Olmi, S. Pezzuto, A. Traficante, M. Brescia, S. Cavuoti, A. Di Giorgio et al. (*including:* **P. M. Palmeirim**), 2020; *The Hi-GAL catalogue of dusty filamentary structures in the Galactic plane*; Monthly Notices of the Royal Astronomical Society, 492, 4, 5420

197. A. Boucaud, M. Huertas-Company, C. Heneka, E. E. O. Ishida, N. Sedaghat, R. S. de Souza, B. Moews, H. Dole, M. Castellano, E. Merlin et al. (*including:* **A. M. M. Trindade**), 2020; *Photometry of high-redshift blended galaxies using deep learning*; Monthly Notices of the Royal Astronomical Society, 491, 2, 2481

198. P. A. Zyla, R. M. Barnett, J. Beringer, Dahl, O., D. A. Dwyer, D. E. Groom, C. -J. Lin, K. S. Lugovsky, Pianori, E., D. J. Robinson et al. (*including:* **A. R. Liddle**), 2020; *Review of Particle Physics*; Progress of Theoretical and Experimental Physics, 2020, 8

199. L. D. Nielsen, D. Gandolfi, D. J. Armstrong, J. S. Jenkins, M. Fridlund, **N. C. Santos**, F. Dai, **V. Zh. Adibekyan**, R. Luque, J. H. Steffen et al. (*including:* **S. C. C. Barros**, **O. Demangeon**, **S. Hojjatpanah**, **S. G. Sousa**), 2020; *Mass determinations of the three mini-Neptunes transiting TOI-125*; Monthly Notices of the Royal Astronomical Society, 492, 4, 5399

200. V. Könyves, Ph. André, **D. Arzoumanian**, N. Schneider, A. Men'shchikov, S. Bontemps, B. Ladjelate, P. Didelon, S. Pezzuto, M. Benedettini, 2020; *Properties of the dense core population in Orion B as seen by the Herschel Gould Belt survey*; Astronomy and Astrophysics, 635, A34, 29

201. D. Bacon, R. Battye, P. Bull, S. Camera, P. G. Ferreira, I. Harrison, D. Parkinson, A. Pourtsidou, **M. G. Santos**, L. Wolz, 2020; *Cosmology with Phase 1 of the Square Kilometre Array Red Book 2018: Technical specifications and performance forecasts*; Publications of the Astronomical Society of Australia, 37, e007

Book chapters and Proceedings [19]

1. **M. Abreu**, **D. C. Alves**, **A. Cabral**, **J. Coelho**, **P. Santos**, L. Clermont, A. Baeke, B. Vandenbussche; 2020; *A white light collimator for Plato camera integration support*; Space Telescopes and Instrumentation 2020: Optical, Infrared, and Millimeter Wave; (Eds.)Makenzie Lystrup; Marshall D. Perrin; Natalie Batalha; Nicholas Siegler; Edward C. Tong, SPIE, Proceedings of the SPIE, 11443

2. **A. Cabral**, **B. Wehbe**; 2020; *A simple concept for atmospheric dispersion correctors on-sky commissioning tests*; Ground-based and Airborne Instrumentation for Astronomy VIII; (Eds.)Christopher J. Evans, Julia J. Bryant, Kentaro Motohara, SPIE, Proceedings of the SPIE, 11447

3. **A. Cabral**, **M. Abreu**, **J. Coelho**, **P. Santos**, **A. Oliveira**, **I. M. Leite**, **J. Afonso**, P. Rees, W. Taylor, S. Watson; 2020; *MOONS, the next ESO VLT's multi-object spectrograph: the field corrector and the rotating front end*; Ground-based and Airborne Instrumentation for Astronomy VIII; (Eds.)Christopher J. Evans; Julia J. Bryant; Kentaro Motohara, SPIE, Proceedings of the SPIE, 11447

4. **A. Chougule**, N. Przybilla, M. S. Dimitrijević, V. Schaffenroth; 2020; *The impact of improved Stark-broadening widths on the modeling of double-ionized chromium lines in hot stars*; Spectral Line Shapes in Astrophysics and Related Topics; (Eds.)Drahomir Chochol; Julius Koza; Ales Kucera; Lubos Neslusan; Vladimir Porubcan; Theodor Pribulla, Astronomical Institute of the Slovak Academy of Sciences, 50, 1, 139

5. M. Cirasuolo, O. A. Gonzalez, P. Rees, I. R. Bryson, A. Fairley, W. Taylor, **J. Afonso**, S. Lilly, C. J. Evans, H. Flores et al. (*including:* **M. Abreu**, **A. Cabral**, **J. Coelho**, **A. Oliveira**, **P. Santos**); 2020; *Crescent MOONS: an update on the ongoing construction of the new VLT's multi-object spectrograph*; Ground-based and Airborne Instrumentation for Astronomy VIII; (Eds.)Christopher J. Evans; Julia J. Bryant; Kentaro Motohara, SPIE, Proceedings of the SPIE, 11447

6. **I. A. Costa**, C. Morais, **M. J. P. F. G. Monteiro**; 2020; *COASTRO: @n Astronomy Condo - Development of teachers' knowledge of Astronomy through a citizen science project*; INTED2020 - 14th International Technology, Education and Development Conference; (Eds.)L. Gómez Chova, A. López Martínez, I. Candel Torres, IATED Academy, 6518

7. **I. A. Costa**, C. Morais, **M. J. P. F. G. Monteiro**; 2020; *CoAstro: @n Astronomy Condo - Teachers' Attitudes and Epistemological Beliefs Towards Science in a Citizen Science Project*; Education and New Developments 2020; (Eds.)Mafalda Carmo, inScience Press, 113

8. **M. S. Cunha**; 2020; *Diagnostics from Solar and Stellar Glitches*; Dynamics of the Sun and Stars; (Eds.)Mário J.P.F.G. Monteiro; Rafael A. García; Jørgen Christensen-Dalsgaard; Scott W. McIntosh, Springer, Astrophysics and Space Science Proceedings, 57, 185

9. J. H. Girard, S. Y. Haffert, J. Bae, P. Zeidler, J. de Boer, A. J. Bohn, R. G. van Holstein, **J. Brinchmann**, I. A. G. Snellen, R. Bacon, C. U. Keller; 2020; *Planet formation with all flavors of adaptive optics: VLT/MUSE's laser tomography adaptive optics to directly image young accreting exoplanets*; Adaptive Optics Systems VII; (Eds.)Laura Schreiber; Dirk Schmidt; Elise Vernet, SPIE, Proceedings of the SPIE, 11448

10. I. Guinouard, J.-P. Amans, D. Horville, D. Lee, **A. Cabral**, P. Rees, S. Watson, W. Taylor, H. Flores; 2020; *Final characteristics and performances of the fibres of MOONS*; Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation IV; (Eds.)Ramón Navarro; Roland Geyl, SPIE, Proceedings of the SPIE, 11451

11. R. J. Laureijs, G. D. Racca, Y. Mellier, P. Musi, L. Brouard, T. Böenke, L. Gaspar Venancio, E. Maiorano, A. Short, P. Strada et al. (*including:* **J. Dinis**, **A. C. da Silva**, **I. Tereno**, **J. Brinchmann**); 2020; *Euclid mission status after mission critical design*; Space Telescopes and Instrumentation 2020: Optical, Infrared, and Millimeter Wave; (Eds.)Makenzie Lystrup; Marshall D. Perrin; Natalie Batalha; Nicholas Siegler; Edward C. Tong, SPIE, Proceedings of the SPIE, 11443

12. **I. M. Leite**, **A. Cabral**; 2020; *An optical metrology system for the measurement of the refractive index of glass*; EOS Annual Meeting (EOSAM 2020); (Eds.)H. Michinel; M. F. Costa; O. Frazão, EDP Sciences, 238

13. A. Marconi, **M. Abreu**, **V. Zh. Adibekyan**, M. Aliverti, C. Allende Prieto, P. J. Amado, M. Amate, E. Artigau, S. R. Augusto, S. C. C. Barros et al. (*including:* **A. Cabral**, **P. Figueira**, **A. Humphrey**, **C. J. A. P. Martins**, **M. A. Monteiro**, **N. J. Nunes**, **S. G. Sousa**); 2020; *ELT-HIRES, the high resolution spectrograph for the ELT: the Phase A study and the path to construction*; Ground-based and Airborne Instrumentation for Astronomy VIII; (Eds.)Christopher J. Evans; Julia J. Bryant; Kentaro Motohara, SPIE, Proceedings of the SPIE, 11447

14. **I. Matute**, **J. Afonso**, L. Bizzocchi, **C. Pappalardo**, H. Messias, **S. Amarantidis**; 2020; *Towards the first radio galaxies*; Uncovering Early Galaxy Evolution in the ALMA and JWST Era; (Eds.)Elisabete da Cunha; Jacqueline Hodge; José Afonso; Laura Pentericci; David Sobral, Cambridge University Press, Proceedings of the International Astronomical Union, 15, 352, 353

15. T. Nanayakkara, **J. Brinchmann**, MUSE Collaboration; 2020; *Probing the ISM of Heiiλ1640 emitters at $z = 2$–4 via MUSE*; Challenges in Panchromatic Modelling with Next Generation Facilities; (Eds.)Médéric Boquien; Elisabeta Lusso; Carlotta Gruppioni; Patricia Tissera, Cambridge University Press, Proceedings of the International Astronomical Union, 341, 235

16. **C. Pappalardo**, **P. Papaderos**, **J. M. Gomes**, **L. S. M. Cardoso**, **A. Paulino-Afonso**, **I. Matute**, **S. Amarantidis**; 2020; *Galaxy Evolution through spectral fitting tools: A comparative study between STECKMAP and FADO*; Uncovering Early Galaxy Evolution in the ALMA and JWST Era; (Eds.)Elisabete da Cunha; Jacqueline Hodge; José Afonso; Laura Pentericci; David Sobral, Cambridge University Press, Proceedings of the International Astronomical Union, 15, 352, 119

17. **C. I. S. A. Rocha**, **C. J. G. N. Pereira**, **M. S. Cunha**, **M. J. P. F. G. Monteiro**, **B. Nsamba**, **T. L. Campante**; 2020; *16 Cygni A: A Testbed for Stellar Core Physics*; Dynamics of the Sun and Stars; (Eds.)Mário J.P.F.G. Monteiro; Rafael A. García; Jørgen Christensen-Dalsgaard; Scott W. McIntosh, Springer, Astrophysics and Space Science Proceedings, 57, 281

18. R. Sánchez-Janssen, F. Hammer, S. Morris, J.-G. Cuby, L. Kaper, M. Steinmetz, **J. Afonso**, B. Barbuy, E. Bergin, A. Finoguenov; 2020; *MOSAIC: the high multiplex and multi-IFU spectrograph for the ELT*; Ground-based and Airborne Instrumentation for Astronomy VIII; (Eds.)Christopher J. Evans; Julia J. Bryant; Kentaro Motohara, SPIE, Proceedings of the SPIE, 11447

19. **B. Wehbe**, **A. Cabral**, G. Avila; 2020; *A novel method for on-sky measurements of atmospheric dispersion*; Ground-based and Airborne Instrumentation for Astronomy VIII; (Eds.)Christopher J. Evans; Julia J. Bryant; Kentaro Motohara, SPIE, Proceedings of the SPIE, 11447

International Scientific Communications [49]

1. **V. Zh. Adibekyan**; 2020; *Frontiers of Stellar Spectroscopy: the Precision – Accuracy Interface*; Frontiers of Stellar Physics: the Theory-Observation Interface, Zagreb, Croácia

2. **V. Zh. Adibekyan**; 2020; *Stellar flares with ESPRESSO*; ESPRESSO Science Team Meeting, Palermo, Itália

3. **V. Zh. Adibekyan**; 2020; *ESPRESSO's look at fine structures of stellar surfaces using exoplanet transits*; ESPRESSO Science Team Meeting, Palermo, Itália
4. **V. Zh. Adibekyan**; 2020; *Observational evidence of the compositional link between rocky planets and their hosts*; PLATO ESP 2020 - Planetary interiors and system architectures, Online,
5. **B. Akinsanmi**; 2020; *Planet Love-number measurements from transit light curves*; PLATO ESP 2020 - Planetary interiors and system architectures, Online,
6. **B. Akinsanmi**, **N. C. Santos**, **J. P. Faria**, M. Oshagh, **S. C. C. Barros**, A. Santerne, S. Charnoz; 2020; *Possible case of exoplanetary rings around HIP 41378 f*; Europlanet Science Congress 2020, Online,
7. **A. Antoniadis-Karnavas**, **S. G. Sousa**, **E. Delgado Mena**, **N. C. Santos**, **G. D. C. Teixeira**, V. Neves; 2020; *ODUSSEAS: a machine learning tool to derive Teff and [Fe/H] for M dwarf stars*; Exoplanets III, Online, Alemanha
8. B. J. Barros; 2020; *The sigma_8 tension in the light of Q-gravity*; Teleparallel Gravity Workshop 2020, Online, Estónia
9. **S. C. C. Barros**; 2020; *Improving transit characterisation with Gaussian process modelling of stellar variability*; PLATO ESP 2020 - Planetary interiors and system architectures, Online, Alemanha
10. **S. C. C. Barros**; 2020; *Status of the WG5 Feature characterise*; CHEOPS Science Team Meeting #18, Online, Reino Unido
11. **D. Bossini**; 2020; *PARAM and Gaia parallax: a new constraint for stellar age and mass*; Frontiers of Stellar Physics: the Theory-Observation Interface, Zagreb, Croácia
12. **T. Boulet**; 2020; *How to best prepare TESS 2-min cadence light curves of solar-type stars for seismic analysis?*; 7th Iberian Meeting on Asteroseismology, Online, Portugal
13. **J. Brinchmann**; 2020; *Large galaxies in Euclid*; Euclid Consortium conference 2020, Online, Espanha
14. **J. Brinchmann**; 2020; *Some thoughts on tiling from a legacy perspective*; Euclid Consortium conference 2020, Online, Espanha
15. **J. Brinchmann**; 2020; *Bounds on Axion-like Dark Matter with MUSE-Faint*; MUSE Consortium Busy Week Spring 2020, Online, Alemanha
16. **J. Brinchmann**; 2020; *Ultra-faint Dwarfs - an Update*; MUSE Consortium Busy Week Spring 2020, Online, Alemanha
17. **J. Brinchmann**; 2020; *An update on MUSE-Faint*; MUSE Consortium Busy Week Spring 2020, Online, Alemanha
18. **F. Buitrago**; 2020; *High redshift massive galaxies, and their surprising size evolution*; European Astronomical Society 2020 meeting, Online, Países Baixos
19. **F. Buitrago**; 2020; *Truncations at high redshift*; XIVth Spanish Astronomical Society Meeting, Online, Espanha
20. F. Buitrago, M. Accardo; 2020; *Summary of all Extragalactic Astronomy contributions*; XIVth Spanish Astronomical Society Meeting, Online, Espanha
21. **F. Buitrago**, L. Galbany, A. Castillo-Morales, S. Nadathur; 2020; *Round table on professional prospects*; XIVth Spanish Astronomical Society Meeting, Online, Espanha
22. **D. M. L. Castelão**; 2020; *Testing cosmological structure formation in Unified Dark Matter-Energy models*; 6th IDPASC/LIP PhD Students Workshop, Online,
23. **I. A. Costa**; 2020; *CoAstro: @n Astrononomy Condo*; Space Talks online series – Ecsite (European Network of Science Centres and Museums) Space Group, Online, Bélgica
24. **I. A. Costa**; 2020; *CoAstro: @n Astronomy Condo – Teachers´ Attitudes and Epistemological Beliefs Towards Science in a Citizen Science Project*; International Conference on Education and New Developments 2020, Online, Croácia
25. **I. A. Costa**; 2020; *CoAstro: @n Astronomy Condo – Development of Teachers´ Knowledge of Astronomy Trough a Citizen Science Project*; INTED2020 - 14th Annual International Technology, Education and Development Conference, Online, Espanha
26. **M. Deal**; 2020; *Evolution de la composition chimique de surface des étoiles et impact sur l'âge*; ExoSystèmes I, Paris, França
27. N. Frusciante; 2020; *EFT of DE: current constraints and forecasts*; Progress on Old and New Themes in Cosmology (PONT) 2020, Online, França
28. **N. Frusciante**; 2020; *Research at the Cosmology group at IA*; Virtual Iberian Gravitational Wave Meeting, Online,
29. **C. Gehan**, B. Mosser, E. Michel, **M. S. Cunha**; 2020; *Automated approach to measure stellar inclinations: validation through large-scale measurements on the red giant branch*; Red Giant Workshop, Graz, Áustria
30. **G. Gilli**, S. Lebonnois, F. Forget, E. Millour, Coordenação I.A.; 2020; *Impact of non- orographic Gravity Waves (GW) in the middle atmosphere of Venus and Mars by the IPSL- LMDZ GCM*; TRAPPIST Habitable Atmosphere Intercomparison (THAI), Online,
31. **G. Gilli**, **P. Machado**; 2020; *How known planet from the Solar System would be seen if they were exoplanets*; Ariel General Conference 2020, Nortwijk, Países Baixos
32. **A. Humphrey**; 2020; *Selecting Quiescent Galaxies using Euclid Mock Photometry*; Euclid Galaxies Evolution SWG, Online
33. **A. Humphrey**; 2020; *Identifying Passive Galaxies at High-z using a Nonlinear Fusion of Classifiers*; Exploiting Archives for Radio Astronomy in the SKA- era, Online, Portugal
34. J. Lillo Box, T. A. Lopez, A. Santerne, L. D. Nielsen, **S. C. C. Barros**, M. Deleuil, O. Mousis, **S. G. Sousa**, **V. Zh. Adibekyan**, D. J. Armstrong, D. Barrado, D. Bayliss, D. J. A. Brown, **O. Demangeon**, X. Dumusque, **P. Figueira**, **S. Hojjatpanah**, H. P. Osborn, **N. C. Santos**, S. Udry;

2020; *Masses for the seven planets in K2-32 and K2-233. Four diverse planets in resonant chain and the first young rocky worlds*; XIVth Spanish Astronomical Society Meeting, Online, Espanha

35. **F. S. N. Lobo**, S. V. Sushkov; 2020; *Wormholes in the Horndeski theory of gravity*; 17th Russian gravitational conference (RUSGRAV-17, S. Petersburg, Rússica
36. **F. S. N. Lobo**; 2020; *Beyond Einstein's General Relativity*; Recent Advances in Science and Technology (RAST)2020, Sarang, India
37. **I. Matute**; 2020; *Better Science Through an Enhanced User Interface with the ALMA Archive*; European Astronomical Society 2020 meeting, Online,
38. T. Navarro, **G. Gilli**, S. Lebonnois, F. Lefèvre, *Euclid* Collaboration; 2020; *Structure and Variability of the Venus Upper Atmosphere revealed by a General Circulation Model*; American Geophysical Union (AGU) Meeting, Online,
39. **J. Retrê**; 2020; *Astronomical Phenomena*; 13th IAU-Abdul Jabbar Astronomy Workshop, Online,
40. **J. Retrê**, P. Russo; 2020; *Big Ideas in Astronomy*; II Shaw-IAU Workshop on Astronomy for Education, Online,
41. **J. Retrê**; 2020; *Comunica a tua Ciência*; Give me More Space Congress - Physis, Online,
42. R. Scaramella, **J. Dinis**; 2020; *ECSURV STAR Prize: Team*; Euclid Consortium Meeting 2020, Online, Espanha
43. **A. M. Silva**, **S. G. Sousa**, **N. C. Santos**, **O. Demangeon**, R. A. Matson; 2020; *archi: pipeline for light curve extraction of CHEOPS background stars*; Europlanet Science Congress 2020, Online,
44. **J. Silva**, **P. Machado**, J. Peralta, **G. Gilli**, **D. C. Espadinha**, **M. Silva**, **R. Gonçalves**; 2020; *Characterising Atmospheric Gravity Waves on Venus*; SWT #14 of the Akatsuki Space Mission, ISAS/JAXA Sagamihara Campus, Japão
45. **J. Silva**, **P. Machado**, J. Peralta, K. Brasch; 2020; *Characterising Atmospheric Gravity Waves on the Nightside of Venus - A Systematic Study*; Europlanet Science Congress 2020, Online,
46. **I. Tereno**; 2020; *ECSURV: Euclid Survey*; Euclid Consortium Meeting 2020, Online, Espanha
47. **I. Tereno**, J. Dinis; 2020; *Scheduling the Euclid Surveys*; Euclid Consortium Meeting 2020, Online, Espanha
48. **S. Ulmer-Moll**; 2020; *Telluric correction with TAPAS and Molecfit in the near-infrared*; SPIRou Science team meeting, Online, França
49. **B. Wehbe**, **A. Cabral**, G. Avila; 2020; *A novel method for on-sky measurements of atmospheric dispersion*; SPIE Astronomical Telescopes + Instrumentation, Online,

National Scientific Communications [59]

1. **V. Zh. Adibekyan**; 2020; *Stars TL overview*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
2. **I. Ayuso**; 2020; *Observational constraints on cosmological solutions of f(Q) theories*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
3. **R. P. L. Azevedo**, **P. P. Avelino**; 2020; *Nonminimally coupled gravity and the perfect fluid Lagrangian*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
4. **B. J. Barros**; 2020; *Q-gravity*; Jornadas de Doutoramento, Lisboa, Portugal
5. S. A. Berge, **J. R. C. C. C. Correia**, **C. J. A. P. Martins**; 2020; *Measuring Cosmic String Loops One by One*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
6. **T. Boulet**, **T. L. Campante**, **V. Zh. Adibekyan**, A. M. Serenelli; 2020; *Galactic archaeology of solar-type stars with the NASA TESS mission*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
7. **A. Cabral**; 2020; *A experiência portuguesa no desenvolvimento de alguns dos maiores espectrógrafos do Observatório Europeu do Sul*; FÍSICA 2020, Lisboa, Portugal
8. **A. Cabral**; 2020; *MOONS: the next ESO VLT's multi-object spectrograph*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
9. **J. D. Camacho**; 2020; *Modelling stellar activity signals in radial velocity data with Gaussian processes regression network*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
10. **R. Carvajal**, **J. Afonso**, **I. Matute**, **S. Amarantidis**; 2020; *Searching for the earliest AGN in the radio sky*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
11. **R. Carvajal**, **J. Afonso**, **I. Matute**; 2020; *The first radio galaxies in the Universe*; Jornadas de Doutoramento, Lisboa, Portugal
12. **R. Carvajal**, **J. Afonso**, **I. Matute**, **S. Amarantidis**; 2020; *Mining the radio sky toward the earliest AGN*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
13. **M. T. Clara**; 2020; *Asteroseismology with ESA & PLATO Mission: Testing Modelling Requirements for Subgiant Stars*; IJUP 2020, Porto, Portugal
14. **M. T. Clara**; 2020; *Modelling Stars with Mixed Modes*; 7th Iberian Meeting on Asteroseismology, Online, Portugal
15. **M. T. Clara**, **M. S. Cunha**, **T. L. Campante**; 2020; *Modelling Stars with Mixed Modes*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
16. **J. R. C. C. C. Correia**, **C. J. A. P. Martins**; 2020; *Overcooling string simulations*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal

17. **I. A. Costa**, **E. M. P. S. Moreira**; 2020; *Science communication to research and research for science communication*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
18. **I. A. Costa**, **M. J. P. F. G. Monteiro**, **D. F. M. Folha**, **F. A. L. Pires**; 2020; *Astroteca: a divulgação da astronomia através do seu ensino*; Ciência 2020, Online, Portugal
19. **I. A. Costa**; 2020; *CoAstro: @n Astronomy Condo – research and science communication in a Portuguese citizen science project*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
20. **I. A. Costa**; 2020; *CoAstro: um Condomínio de Astronomi@ – uma nova proposta para a ciência cidadã*; Congresso SiComPt 2020, Online, Portugal
21. **M. Deal**; 2020; *Transport processes in solar-like main-sequence stars*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
22. **B. Dias**, **J. R. C. C. C. Correia**, **C. J. A. P. Martins**; 2020; *Domain wall evolution in contracting universes*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
23. **J. Esteves**, **C. S. Alves**, **C. J. A. P. Martins**; 2020; *Redshift drift cosmology: Optimizing the differential redshift drift*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
24. **M. S. N. Kumar**; 2020; *Filaments to Clusters: A new universal paradigm of star formation*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
25. **C. Leote**; 2020; *How to speak to different audiences*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
26. **C. Leote**; 2020; *How to prepare a scientific poster*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
27. **C. Leote**, **S. Pereira**, **J. Retrê**, **P. Machado**, **G. Gilli**, **M. Silva**, **R. Gonçalves**, **P. I. T. K. Sarmento**, **A. Cardesín-Moinelo**, **P. J. T. Pereira**; 2020; *A Solar System board game in times of a pandemic*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
28. **C. Leote**, **S. Pereira**, **J. Retrê**, **P. Machado**, **G. Gilli**, **J. Silva**, **M. Silva**, **R. Gonçalves**, **P. I. T. K. Sarmento**, **P. J. T. Pereira**; 2020; *ET - A Solar System board game in times of a pandemic*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
29. **C. Llinares**; 2020; *Weighted density fields as improved probes of modified gravity models*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
30. **C. J. A. P. Martins**; 2020; *Constraining the fine-structure constant 13 billion years ago*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
31. **C. B. D. Fernandes**, **C. J. A. P. Martins**; 2020; *Constraining gravity with generalized couplings*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
32. **B. A. R. Rocha**, **C. J. A. P. Martins**; 2020; *Constraining the scale invariance model at low redshifts*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
33. **V. C. Tavares**, **C. J. A. P. Martins**; 2020; *Varying Fine Structure Constant Generalized DBI Models*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
34. **J. H. C. Martins**, **N. C. Santos**; 2020; *A Nobel for the discovery of other worlds*; Jornadas da Física do IST, Lisboa, Portugal
35. **I. Matute**; 2020; *Better Science Through A Complementary User Interface With The ALMA Archive*; Exploiting Archives for Radio Astronomy in the SKA- era, Online, Portugal
36. **I. Matute**, **C. Pappalardo**, **J. Afonso**, Z. Çelik Orhan; 2020; *Better Science Through an Enhanced User Interface with the ALMA Archive*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
37. **I. Matute**, **J. Afonso**, **S. Amarantidis**, **M. Abreu**, **R. Carvajal**; 2020; *The participation of IA/FCUL in the ATHENA X-ray Mission: WFI science towards the earliest AGNs*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
38. **J. P. Mimoso**; 2020; *Generalising the Tolman-Oppenheimer-Volkov equilibrium condition*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
39. **C. Pappalardo**, T. İkiz; 2020; *Galaxies Star Formation Histories in spectral synthesis methods*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
40. **C. Pappalardo**; 2020; *Galaxies evolution over the MOONS*; Master Projects Presentations, Lisboa, Portugal
41. **C. Pappalardo**; 2020; *Exploring Galaxies at the Edge of the Universe with ALMA*; Master Projects Presentations, Lisboa, Portugal
42. **C. P. Pereira**; 2020; *Stabilization of calibration light sources for High Accuracy Photometry Instruments*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
43. **C. P. Pereira**; 2020; *Photometric Light Curves in the study and characterization of other worlds*; Jornadas de Doutoramento, Lisboa, Portugal
44. **C. P. Pereira**; 2020; *Não só com Grandes Telescópios se faz Ciência*; Encontro Nacional de Estudantes de Física 2020, Coimbra, Portugal
45. **C. P. Pereira**; 2020; *Não só com Grandes Telescópios se faz Ciência*; Encontro Nacional de Estudantes de Física 2020, Coimbra, Portugal
46. **C. P. Pereira**, **M. Abreu**, **A. Cabral**; 2020; *Stabilization of calibration light sources for High Accuracy Photometry Instruments*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
47. **S. Pereira**, **P. J. T. Pereira**, **J. Retrê**, **F. A. L. Pires**; 2020; *Astronomy in Culture: partnerships with art schools and cultural agents*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal

48. **R. S. S. C. Reis**, **S. Pereira**; 2020; *Communicating science to the public and the media*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
49. **S. N. Reis**, **F. Buitrago**, **P. Papaderos**, **I. Matute**, **J. Afonso**, **S. Amarantidis**, **I. P. Breda**, **J. M. Gomes**, **A. Humphrey**, **C. Lobo**, **S. Lorenzoni**, **C. Pappalardo**, **A. Paulino-Afonso**; 2020; *Structural analysis of massive galaxies using Hubble Space Telescope deep imaging at $z < 0.5$*; Ciências Research Day 2020, Lisboa, Portugal
50. **J. Retrê**; 2020; *Summary of outreach activities and plans for the future*; IA-ON 7 - 7th internal IA workshop, Online, Portugal
51. **J. Retrê**; 2020; *Futuros Cientistas a Comunicar Ciência*; Encontros de Comunicação em Ciência(s), Online, Portugal
52. **J. Retrê**; 2020; *Science News vs. Fake News*; Debates de Porto de Histórias XXI e do Grupo Universitário de Debates e Opiniões, Faculdade de Ciências da Universidade do Porto, Portugal
53. **M. C. Rosa**, **C. J. A. P. Martins**; 2020; *Evolution of Domain Walls in a Sine-Gordon Potential*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
54. **N. C. Santos**; 2020; *Um Nobel à procura de Outras Terras*; FÍSICA 2020, Lisboa, Portugal
55. **N. C. Santos**; 2020; *Portugal in Space for Science and Exploration*; Ciência 2020, Online, Portugal
56. **A. M. Silva**, **J. P. Faria**, **N. C. Santos**, **P. T. P. Viana**, **S. G. Sousa**; 2020; *A Bayesian approach to precise Radial Velocities*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
57. **J. Silva**, **P. Machado**, J. Peralta, **G. Gilli**, R. Hueso, **D. C. Espadinha**, **M. Silva**, **R. Gonçalves**; 2020; *Characterising Atmospheric Gravity Waves on Venus*; Jornadas Doutorais do Departamento de Física, Lisboa, Portugal
58. **T. A. Silva**; 2020; *A curious planetary system: An Ultra-Dense Hot Super Earth and a Cold Jupiter*; 30th Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
59. **T. A. Silva**; 2020; *M-dwarf stars with planets: towards the characterization of the smaller planet host stars*; IJUP 2020, Porto, Portugal

Seminars at IA [26]

1. Amazo-Gómez, E. M.; 2020; *GPS a new method to determine rotation periods*
2. Arzoumanian, D.; 2020; *Understanding the observed properties of interstellar filaments: Insights into the initial conditions of star formation*
3. Brax, P.; 2020; *Charged Dark Matter and the H0 Tension*
4. Buldgen, G.; 2020; *The solar modelling problem: where do we stand, where are we going?*
5. Carvajal, R.; 2020; *Stacking UV-selected Lyman-Break Galaxies in the ALMA Frontier Fields*
6. Casas, S.; 2020; *Measuring Dark Energy with non-linear observables in the Euclid era*
7. Charnay, B.; 2020; *Physics and chemistry of temperate sub-Neptunes*
8. Cosme, C.; 2020; *Freeze-in dark matter production through the neutrino portal in an early matter era*
9. Davis, A. C.; 2020; *Constraining Modified Gravity Models with Casimir Force Experiments*
10. Di Dio, E.; 2020; *The dipole power spectrum induced by relativistic effects*
11. Dib, S.; 2020; *The 1001 modes of Star Formation*
12. Fabbian, G.; 2020; *Precision cosmology with CMB lensing, delensing and cross-correlation with galaxy surveys*
13. Fernandes, J. M.; 2020; *European Solar Telescope: a place in the Sun for Portugal*
14. Gadotti, D. A.; 2020; *Nuclear discs in external galaxies and the Milky Way: building "bulges" without mergers*
15. Gehan, C.; 2020; *Red giant seismology: large-scale measurements of the core rotation and stellar inclination, and new constraints on the angular momentum transport through modelling*
16. Grimm,. N.; 2020; *Galaxy Power Spectrum in General Relativity*
17. Lepori, F.; 2020; *Weak lensing observables in relativistic N-body simulations*
18. Martins, C. J. A. P.; 2020; *CosmoESPRESSO: A Second-year Progress Report*
19. Masoura, V. A.; 2020; *The co-evolution of the AGNs and their host galaxies*
20. Mezcua, M.; 2020; *Feeding and feedback from little monsters: black holes in dwarf galaxies*
21. Millán-Irigoyen, I.; 2020; *Analysis of stellar population properties using new single stellar population templates and stellar population synthesis codes*
22. Oudmaijer, R.; 2020; *High resolution observations of Massive Young Stellar Objects*
23. Renzi, F.; 2020; *Hubble speed from first principles*
24. Sousa-Silva, C.; 2020; *Finding an Alien Biosphere with Computational Chemistry*
25. Vilenkin, A.; 2020; *Black holes from vacuum bubbles*
26. Zumalacárregui, M.; 2020; *Dark Energy, the Hubble Problem and Gravitational-wave Propagation*

Organization of Conferences [6]

1. *JWST master class workshop*; 14 to 15 May 2020; Porto, Portugal
2. *Towards Other Earths III: from Solar System to Exoplanets*; 1 to 5 June 2020; Lamego, Portugal – CANCELLED due to COVID-19

3. *30th Encontro Nacional de Astronomia e Astrofísica*; 9 to 11 September 2020; Porto, Portugal
4. *IA-ON7 - Instituto de Astrofísica e Ciências do Espaço 7th internal workshop*; 19 to 22 October 2020; Portugal
5. *Exploiting Archives for Radio Astronomy in the SKA-era*; 23 to 25 November 2020; Lisboa, Portugal
6. *COSMONATA 2020*; 23 December 2020; Online, Portugal

Observing runs [25]

1. S. A. G. Sousa, A. Mortier, N. C. Santos, B. Rojas Ayala, S. Ulmer-Moll, V. Adibekyan, Israelian, J. Camacho, O. Demangeon, S. C. C. Barros, A. Antoniadis Karnavas, E. Delgado Mena, P. Figueira, J. Faria, M. Tsantaki, "Know the star to know the planet: improving SWEET-CAT with homogeneous planet-host parameters", UVES, UT2@VLT ESO, SM P106
2. S. A. G. Sousa, N. C. Santos, E. Delgado Mena, V. Adybekian, B. Rojas Ayala, A. Mortier, P. Figueira, O. Demangeon, Israelian, S. C. C. Barros, J. P. Faria, M. Tsantaki, A. Antoniadis Karnavas, "Know the star to know the planet: improving the catalog of exoplanet host stars with homogeneous parameters", UVES, UT2@VLT ESO, SM P105
3. T. C. Scott, P. Lagos, E. Brinks, C. Senguputa, "Searching for evidence of metal poor cold gas infall to low z galaxies", VLA B and C array HI, 40hrs, 31 January 2020 to 8 August 2020
4. P. Lagos, A. Saburova, T. C. Scott, S. Paudel, C. Sengupta, O. Egorov, R. Uklein, "Low metallicity TDGs", SCORPIO-2 multi-mode spectrograph on the Special Astrophysical Observatory of the Russian Academy of Sciences (SAO RAS) 6-m Big Telescope Alt-azimuth (BTA) telescope, 19/20 February 2020
5. C. Sengupta (PI), FAST HI survey of UDGs in and around the Coma cluster, PT2020_0079, FAST 500m single dish 14.9hrs, October 2020
6. K. Hambleton, M. S. Cunha, V. Antoci (3 Co-PIs) and TASC WG41; TESS High-Frequency A-F Pulsators: Understanding the Driving of Oscillations in intermediate-Mass Stars; DDT/TESS 20-sec cadence mode; Cycle 3 (one year)
7. S. Grunblatt et al. (including M. S. Cunha), Planetary Archaelogy: Exploring the Planet Population Around Evolved Stars with TESS, TESS FFI, Cycle 3 (one year
8. D. Holdsworth, D. Kurtz, and M. Cunha; Asteroseismology of TIC 350146296: the shortest oscillating Ap star with a rich pulsation spectrum; TESS 20-sec cadence mode; sectors 27 to 30
9. D. Holdsworth, D. Kurtz, and M. S. Cunha; Testing the Oblique Pulsator Model with simultaneous SAAO and TESS photometry; Holdsworth-2020-05-40-inch-327, SHOC / 40 inch; 23 September 2020 - 20 October 2020
10. L. Maud, A. Ginsburg, R. Galvan-Madrid, F. van der Tak, A. Sanchez-Monge, M. Beltran, R. Cesaroni, C. Goddi, P. Klaassen, M. Hogerheijde, L. Moscadelli, D. Harsono, S. Purser, A. Izquierdo, V. Allen, M. S. Nanda Kumar, H. Beuther, V. M. Rivilla, L. Testi, M. Hoare, K. Johnston, N. Indriolo; Disk Stabilty, Grain Growth and Ionization in the proto-O-star G17.64+0.16 VLA/20B-099 Karl Jansky Very Large Array
11. J. L. Yun, P. Palmeirim, D. Arzoumanian; Yebes 40 m telescope; 32hours + 35 hours during the 1st semester 2020 in service mode
12. M. Rainer, E. Delgado Mena, et al.; "A precise characterisation of the ARIEL stars", AOT42/20, HARPS-N in TNG (Observatorio Roque de los Muchachos, La Palma), period 2020A and 2020B
13. C. Danielski, E. Delgado Mena et al.; "A precise characterisation of the ARIEL stars", 105.20P2, 106.21QS, UVES/VLT; P105-106 service mode
14. J. P. Faria; HARPS pool of observations, HARPS, ESO 3.6m, 9-15 December
15. V. Adibekyan; ESPRESSO GTO observations; ESPRESSO; 24 Feb -04 March
16. C. Danielski, T. L. Campante, M. Tsantaki, E. Delgado Mena et al.; "A precise characterisation of the ARIEL stars"; Program ID: 106.21QS; Ultraviolet and Visual Echelle Spectrograph (UVES) at the Very Large Telescope (VLT); Period 106
17. S. Benatti, T. L. Campante, M. Rainer., N. Sanna, et al.; "A precise characterisation of the ARIEL stars"; Program ID: A41TAC_45; High Accuracy Radial Velocity Planet Searcher (HARPS-N) at the Telescopio Nazionale Galileo (TNG); Period AOT41
18. C. Danielski, T. L. Campante, M. Tsantaki, E. Delgado Mena, et al.; "A precise characterisation of the ARIEL stars"; Program ID: 105.20P2; Ultraviolet and Visual Echelle Spectrograph (UVES) at the Very Large Telescope (VLT); Period 105
19. S.Ulmer-Moll, P. Figueira, N. C. Santos, J. H. Martins, J. P. Faria; "Probing micro-tellurics and their impact on radial velocities"; 106.2166; ESPRESSO VLT; 2020/P106
20. S. Amarantidis, L. Bizzocchi, J. Afonso, I. Matute, C. Pappalardo; "Towards the first Radio Galaxies in the Universe"; 227-19; IRAM 30m telescope; 21-23 of March 2020
21. S. Amarantidis, L. Bizzocchi, J. Afonso, I. Matute, C. Pappalardo; "Towards the first Radio Galaxies in the Universe"; 227-19; IRAM 30m telescope; 12-14 of May 2020
22. E. Delgado Mena et al.; "RV variations in evolved stars in open clusters: planets, oscillations or stellar activity?"; 105.20AZ (cancelled due to covid-19); 106.21DH (other observers), ESO-La Silla 3.6m.
23. S. Amarantidis, L. Bizzocchi, J. Afonso, I. Matute, C. Pappalardo; "Towards the first Radio Galaxies in the Universe"; 227-19; IRAM 30m telescope; 14-17 of July 2020

24. J. Brinchmann, MUSE GTO team; “A survey of ultra-faint galaxies with MUSE”, 104.D-0199; MUSE on VLT-UT4; 20/02/2020-24/02/2020
25. Manara, J. F. Gameiro et al., PENELLOPE: the ESO data legacy program to complete the Hubble UV Legacy Library of Young Stars (ULLYSES)

Outreach talks [118]

1. C. Lobo; “A nossa galáxia e as outras: uma viagem através do Universo”, Escola Secundária Antero de Quental, São Miguel, Açores, 7.2.
2. C. Lobo; “A nossa galáxia e as outras: uma viagem através do Universo”, Observatório Astronómico de Santana, São Miguel, Açores, 7.2..
3. N. J. Nunes; “The Winter’s sky”, Externato António Sérgio, Beringel, 22 January
4. N. J. Nunes; “The Autumn’s sky”, Escola Básica Jacinto Correia, 27 October
5. N. J. Nunes; “Surfing a gravitational wave”, Externato S. José, 20 October
6. N. J. Nunes; “How do we weight the Universe?”, Escola Secundária da Amadora, 28 de February
7. N. J. Nunes; “How do we weight the Universe?”, Escola B+S Dr. Ângelo Augusto da Silva, Funchal, Madeira, 16 January
8. N. J. Nunes; “How do we weight the Universe?”, Escola B+S padre Manuel Álvares, Ribeira Brava, Madeira, 15 January
9. C. J. A. P. Martins; “ELT - How to Prepare a Revolution”, CEIA-PPCB, Paredes de Coura, 18 August
10. C. J. A. P. Martins; “The Physics of Life”, CEIA-PPCB, Paredes de Coura, 20 August
11. C. J. A. P. Martins; “A Física da Vida e dos Extraterrestres”, ES Camilo Castelo Branco, Famalicão, 2 October
12. C. J. A. P. Martins; “A Física da Atmosfera e do Aquecimento Global”, ES António Bento Franco, Ericeira, 9 October
13. C. J. A. P. Martins; “A Física da Atmosfera e do Aquecimento Global”, ES José Falcão, Miranda do Corvo, 12 October
14. C. J. A. P. Martins; “A Física do Big Bang”, ES Vergílio Ferreira, Lisboa, 16 October
15. C. J. A. P. Martins; “A Física do Big Bang”, ES da Portela, Loures, 19 October
16. C. J. A. P. Martins; “A Física da Radioactividade e do Cancro”, ES de Rio Tinto 19 October
17. C. J. A. P. Martins; “A Física da Radioactividade e do Cancro”, ES de Paredes, 23 October
18. C. J. A. P. Martins; “A Física da Vida e dos Extraterrestres”, ES António Damásio, Lisboa, 28 October
19. C. J. A. P. Martins; “A Física da Atmosfera e do Aquecimento Global”, ES Pinhal do Rei, Marinha Grande, 30 October
20. C. J. A. P. Martins; “A Física do Big Bang”, ES de Esmoriz, 3 November
21. C. J. A. P. Martins; “A Física da Atmosfera e do Aquecimento Global”, Colégio Júlio Dinis, Porto, 4 November
22. C. J. A. P. Martins; “A Física da Radioactividade e do Cancro”, Nobel International School Algarve, Lagoa, 5 November
23. C. J. A. P. Martins; “A Física da Atmosfera e do Aquecimento Global”, ES de Ourique, 10 November
24. C. J. A. P. Martins; “A Física da Vida e dos Extraterrestres”, ES de Ponte de Sor, 13 November
25. C. J. A P. Martins; “A Física da Gravidade e dos Satélites”, ES João Gonçalves Zarco, Matosinhos, 20 November
26. C. J. A. P. Martins; “O Projecto ELT: Como se prepara uma revolução”, AJC UBI, Covilhã, 27 November
27. S. A. G. Sousa; À descoberta de Outros Mundos, “Noites do Observatório”, Planetário Calouste Gulbekian, Lisbon, 28 February
28. S. A. G. Sousa; À descoberta de novos Mundos, “Encontro Nacional de Estudantes de Física”; Coimbra, 21 February
29. S. A. G. Sousa; “À Descoberta de Planetas Extra-Solares”, Espaço vai à escola, Escola Básica e Secundária Sidónio Pais, Caminha, Zoom, 8 October
30. S. A. G. Sousa; “À Descoberta de Planetas Extra-Solares”, Espaço vai à escola, Agrupamento de Escolas de Freixo, Viana do Castelo, Zoom, 9 Out
31. S. A. G. Sousa; “À Descoberta de Planetas Extra-Solares”, Espaço vai à escola, EB23 Abação, Guimarães, Zoom, 14 October
32. S. A. G. Sousa; “À Descoberta de Planetas Extra-Solares”, Espaço vai à escola, Escola Básica e Secundária Dr.Jaime Magalhães Lima, Aveiro, Zoom, 15 October
33. S. A. G. Sousa; “À Descoberta de Planetas Extra-Solares”, Espaço vai à escola, Esc. A. Calazans Duarte, Marinha Grande, Zoom, 22 October
34. S. A. G. Sousa; “À Descoberta de Planetas Extra-Solares”, Espaço vai à escola, Colégio de Gaia, Zoom, 29 October
35. S. A. G. Sousa; “À Descoberta de Planetas Extra-Solares”, Espaço vai à escola, Escola Básica e Secundária de Anadia, Zoom, 30 October
36. S. A. G. Sousa; “À Descoberta de Planetas Extra-Solares”, Espaço vai à escola, Escola Básica e Secundária do Vale do Âncora (Agrupamento de Escola Sidónio Pais), Zoom, 5 November
37. S. A. G. Sousa; “À Descoberta de Planetas Extra-Solares”, Espaço vai à escola, Escola Manuel Figueiredo, Torres Novas, Zoom, 12 November

38. N. C. Santos; “Como fazer para detetar e ‘apesar’ a outras Terras?”; ciclo de conferências Astronomia e Sociedade organizado pelo Clube Ciência Viva da
39. Escola do Agrupamento de Escolas Dr. Serafim Leite, 17 October
40. N. C. Santos; Palestra e debate no ciclo de Conversas “A Descoberta do Universo”, com T. L. Campante, Planetário Centro Ciência Viva de Braga, 18 September
41. N. C. Santos; “Dias Abertos FCUP: ação sobre Espectroscopia”, 13 February
42. J. P. M. de Carvalho; “Um Universo de Informação: Propriedades e Aplicações da Luz”, Escola E.B. 2,3 Abação (S. Tomé), Lugar de Cortinhas, Guimarães, 8 October
43. J. P. M. de Carvalho; “O Universo: Escalas e Conteúdo”, Escola EBS Dr. Luís Maurílio da Silva Dantas, Câmara de Lobos, 13 October
44. J. P. M. de Carvalho; “Um Universo em Expansão - Origem e Evolução”, Agrupamento de Escolas de Abade de Baçal, Bragança, 14 October
45. J. P. M. de Carvalho; “Da Idade da Magia a Galileu”, Escola E.B. 2,3 Abação (S. Tomé), Lugar de Cortinhas, Guimarães, Data: 14 October
46. J. P. M. de Carvalho; “Um Universo em Expansão - Origem e Evolução”, Escola E.S. Dr. Joaquim Gomes Ferreira Alves, Valadares - V.N. Gaia, 15 October
47. J. P. M. de Carvalho; “O Universo: Escalas e Conteúdo”, Escola EBS Clara de Resende, Porto, 20 October
48. J. P. M. de Carvalho; “O Universo: Escalas e Conteúdo”, Agrupamento de Escolas da Gafanha da Encarnação, Gafanha da Encarnação, 20 October
49. J. P. M. de Carvalho; “O Universo: Escalas e Conteúdo”, Escola E.B. 2,3 Abação (S. Tomé) , Lugar de Cortinhas, Guimarães, 21 October
50. J. P. M. de Carvalho; “O Universo: Escalas e Conteúdo, Agrupamento de Escolas Viseu Norte, Abraveses, Viseu, 22 October
51. J. P. M. de Carvalho; “O Universo: Escalas e Conteúdo, Escola Secundária de Rio Tinto, Rio Tinto, 23 October
52. J. P. M. de Carvalho; “Da Idade da Magia a Galileu”, Colégio de Ermesinde, Ermesinde, 27 October
53. J. P. M. de Carvalho; “Da Idade da Magia a Galileu”, Instituto Profissional da Bairrada, Oliveira do Bairro, 27 October
54. J. P. M. de Carvalho; “Da Idade da Magia a Galileu”, Escola Básica Alfredo da Silva Albarraque-Sintra, Rio de Mouro, 28 October
55. J. P. M. de Carvalho; “Da Idade da Magia a Galileu”, Escola Básica Alfredo da Silva Albarraque-Sintra, Rio de Mouro, 28 October
56. J. P. M. de Carvalho; “Da Idade da Magia a Galileu”, Escola E.B. 2,3/S Dr. Daniel de Matos, Vila Nova de Poiares, 29 October
57. J. P. M. de Carvalho; “Da Idade da Magia a Galileu”, Escola E.B. 2,3/S Dr. Daniel de Matos, Vila Nova de Poiares, 29 October
58. J. P. M. de Carvalho; “Da Idade da Magia a Galileu”, Escola Básica António Gedeão, Odivelas, 30 October
59. J. P. M. de Carvalho; “O Universo: Escalas e Conteúdo, Agrupamento de Escolas Viseu Norte, Abraveses, Viseu, 5 November
60. J. P. M. de Carvalho; “O Universo: Escalas e Conteúdo”, Agrupamento de Escolas Amadeo de Souza-Cardoso, Telões, Amarante, 6 November
61. J. P. M. de Carvalho; “O Universo: Escalas e Conteúdo”, Agrupamento de Escolas Amadeo de Souza-Cardoso, Telões, Amarante, 6 November
62. J. P. M. de Carvalho; “Da Idade da Magia a Galileu”, Escola Básica António Gedeão, Odivelas, 16 November
63. J. P. M. de Carvalho; “O Universo: Escalas e Conteúdo”, Agrupamento de Escolas Amadeo de Souza-Cardoso, Telões, Amarante, 19 November
64. I. A. Costa; “O CoAstro vai à FEUP”, Faculdade de Engenharia da Faculdade do Porto, Porto, Portugal, 12 February
65. I. A. Costa; “O CoAstro vai à FCUP”, Faculdade de Ciências da Faculdade do Porto, Porto, Portugal, 20 November
66. I. A. Costa; “Um dia muito Especial”, ESERO-Portugal – O Espaço vai à Escola, Marinha Grande (virtual), Portugal, 30 October
67. I. A. Costa; “Com a verdade me enganas”, ESERO-Portugal – O Espaço vai à Escola, Machico (virtual), Portugal, 29 October
68. I. A. Costa; “Com a verdade me enganas”, ESERO-Portugal – O Espaço vai à Escola, Machico (virtual), Portugal, 27 October
69. I. A. Costa; “Um dia muito Especial”, ESERO-Portugal – O Espaço vai à Escola, Gondomar (virtual), Portugal, 26 October
70. I. A. Costa; “Com a verdade me enganas”, ESERO-Portugal – O Espaço vai à Escola, Lisboa (virtual), Portugal, 23 October
71. I. A. Costa; “Ótica do Patrono”, Agrupamento de Escolas Dr. Carlos Pinto
72. Ferreira, Vila do Conde, Portugal, 06 February
73. Margarida Cunha; “A música das Estrelas”, TEDxCampoSantana, evento TED, auditório do Museu da Farmácia, Lisboa
74. João L. Yun; “Tertúlia Vida no Universo”, Biblioteca Arquitecto Cosmelli SantAnna, 6 February
75. João L. Yun; “Impacto global no planeta Terra: a espécie humana e a catástrofe climática”, Agrupamento de Escolas Rainha Santa Isabel, Leiria, 12 February
76. João L. Yun; “Impacto global no planeta Terra: a espécie humana e a catástrofe climática”, Escola Secundária Amélia Rey Colaço, Linda-a-Velha, 19 February

77. João L. Yun; “Planeta Terra: catástrofe climática, ansiedade e a espécie humana”, VO.U. - Associação de Voluntariado Universitário do Porto (via Zoom), 29 April
78. A. Cabral; “A Engenharia Física na FCUL”, Liceu Francês, Lisboa, 21 January
79. A. Cabral; “Em busca de planetas extrassolares”, Descobre a ULisboa (Reitoria da ULisboa), 29 January
80. A. Cabral; “The Nobel Prize in Physics 2019, for the discovery of an exoplanet orbiting a solar-type”, Instituto Superior de Engenharia de Lisboa (ISEL), 20 February
81. A. Cabral; “Grandes telescópios, espectrógrafos e a luz em busca de planetas extra solares”, Escola Secundária da Amadora, 27 February
82. A. Cabral; “Em busca de planetas extrassolares”, Dia Aberto FCUL [online], 03 June
83. A. Cabral; “Os grandes telescópios do ESO”, Actividade Ciência Viva, O Espaço vai à Escola, Escola Secundária Marques Castilho, Águeda [online], 07 October
84. A. Cabral; “Os grandes telescópios do”, Actividade Ciência Viva, O Espaço vai à Escola, Escola Passos Manuel, Lisboa [online], 07 October
85. A. Cabral; “Os grandes telescópios do ESO”, Actividade Ciência Viva, O Espaço vai à Escola, Agrupamento de Escolas de Vialonga [online], 07 October
86. A. Cabral; “SPACE EU”, Actividade Ciência Viva [online], 08 October
87. A. Cabral; “Os grandes telescópios do ESO”, Actividade Ciência Viva, O Espaço vai à Escola, Escola Secundária de Latino Coelho, Lamego [online], 08 October
88. A. Cabral; “Observatório Europeu do Sul, Uma Janela para o Universo”, Agrupamento de Escolas de Santiago do Cacém, Centro Ciência Viva do Lousal [online], 24 November
89. A. Cabral; “Da Montanha para o Cosmos”, O Universo Online (IA) [online], 19 December
90. T. L. Campante; “A sinfonia das estrelas”; Clubes Ciência Viva na Escola (CCVnE), Agrupamento de Escolas Dr. Serafim Leite, São João da Madeira, Portugal,16 October
91. I. Tereno; “Shedding light on the Dark Universe”, Ciencias Research Day remote (host: FCUL), 27 October
92. C. Pereira; “Asteróides... mais que meros calhaus!”, Programa Viver Astronomia (Online), 30 May
93. Iris Breda; “Dia das Mulheres e Raparigas na Ciência”, online, 11 February
94. Iris Breda; “Celebration of 20 years of Portugal at ESO”, online, 27 June
95. P. Machado; “Ciência Q&A: Outros Mundos”, IA, 24 November
96. P. Machado; “ESERO (ESA)”, Ciência Viva - Pavilhão do Conhecimento, 16 October
97. P. Machado; Estágio “Planetary Atmospheres”, IA (online), 22-24 e 30 July
98. P. Machado; Dia aberto FCUL, 3 June
99. P. Machado; “Venera 7 - 50 anos”, TSF Rádio, December
100. P. Machado; “Missão espacial ARIEL conta com uma forte participação de investigadores portugueses”, National Geographic Portugal, 18 November
101. P. Machado; “ARIEL moves from blueprint to reality”, ESA webpage, 12 November
102. P. Machado; “Portugal in Space for Science and Exploration”, Encontro Ciência, 4 November
103. P. Machado; “À Descoberta do Universo”, Exploratório - CCV Coimbra, 24 October
104. P. Machado; “Estação Espacial Internacional”, Jornal Expresso, 3 November
105. P. Machado; “ARIEL”, Entrevista ESA - (video), 15 January
106. P. Machado; “100 anos IAU escolas”, Pavilhão Conhecimento - Ciência Viva, 30 January
107. J. Brinchmann, “En tur innom astronomiens og fysikkens verden”, Askim VGS, Norway, 04 February
108. J. Brinchmann, “Universets mørke side”, Askim, Norway, 06 February
109. J. Brinchmann, “MUSE - O Instrumento mais Procurado no VLT”, Zoom, 25 June
110. J. P. Mimoso; “The Nobel Prize in Physics: black holes in theory and observations”, Lisboa, FCUL, Nobel Seminar of the Physics Department, in collaboration with Koralja Music (CENTRA), 18 November (through zoom)
111. J. P. Mimoso; “The Nobel Prize in Physics: black holes shinning in theory and observations”, Lisboa, ISEL, Nobel Seminar, in collaboration with Koralja Music (CENTRA), 14 December (through zoom)
112. S. Pereira; “Estrelas que brilham no tempo: Jerry Nelson”, Planetário Calouste Gulbenkian, 25 January
113. S. Pereira; “Estrelas que brilham no tempo: Beatrice Hill Tinsley”, Planetário Calouste Gulbenkian, 29 February
114. D. F. M. Folha; “Astrobiologia: o contexto cósmico da vida”, São João da Madeira, 17 January
115. D. F. M. Folha; “Água no Universo”, Escola Básica Conde de Arnoso, Santa Maria Arnoso, Vila Nova Famalicão, à distância, 9 October
116. D. F. M. Folha; “Água no Universo”, Colégio Valsassina, Lisboa, à distância, 30 October
117. D. F. M. Folha; “Água no Universo”, Escola B/S Airães Felgueiras, Airães, Felgueiras, à distância, 30 October
118. J. Afonso; “O lado brilhante do Universo”, online public presentation for “The Universe Online” initiative (Institute of Astrophysics and Space Sciences), 4 April

Reports [2]

1. E. Duarte, PLATO-UOL-PDC-DD-0002, Issue 3.8, PLATO: Target Star Position Calculation ATBD, January 2020 (55 pp)
2. E. Duarte, PLATO-UOL-PDC-TN-0003, Issue 1.0, PLATO: IGM modelling, Justification Document, December 2020 (115 pp)

External seminars by IA researchers [13]

1. C. J. A. P. Martins; From Alpha to Omega, ITP Seminar, University of Heidelberg
2. (Germany), 26 May
3. C. J. A. P. Martins; From Alpha to Omega, UEMA Seminar, State University of Maranhão (Brazil), 7 July
4. C. J. A. P. Martins; Varying Fundamental Constants, From Alpha to Omega, INFN Newton 1665 Seminar (Online), 21 October
5. Nuno C. Santos; “HD209458: analysis of the Chromatic Rossiter effect”, ESPRESSO Science Team Meeting, Palermo, Italy, 4-7 February
6. Polychronis Papaderos; “Extremely metal-poor blue compact dwarf galaxies”, Institut Astrophysique de Paris, France, 11 December
7. V. Adibekyan; “Heavy Metal Rules: How do super-massive planets form?”; ESO, Santiago, Chile, 5 March
8. V. Adibekyan; “Heavy Metal Rules: Exoplanet incidence and metallicity”; Universidad Diego Portales, Santiago, Chile, 6 March
9. Pedro Palmeirim; “A dusty view of star formation along filaments and ionised bubbles”; DRAO Scientific Seminar, Dominion Radio Astrophysical Observatory, Canada; 13 May
10. Morgan Deal; “Transport of chemical elements in stars in the light of asteroseismology”, LUPM, Montpellier, France, October
11. Jarle Brinchmann; “First results from MUSE-Faint Tracing the dark with light - constraining dark matter in ultra-faint galaxies with MUSE”, ESO Vitacura, Santiago, Chile, 17 February
12. Jarle Brinchmann; “First results from MUSE-Faint Tracing the dark with light - constraining dark matter in ultra-faint galaxies with MUSE”, ITA University of Oslo, Oslo, Norway, 12 February
13. Andrew Humphrey; “Identifying Passive Galaxies at High-z using a Nonlinear Fusion of Classifiers”, Deutsches Zentrum für Luft- und Raumfahrt (DLR): Institut für Datenwissenschaften, Germany, 10 December

PhD Completed [9]

1. L. B. Bezerra, 2020, Concepção de Observatório Solar científico-educacional apoiado por modelo interativo de comunicação em ciência, Doctoral Program in Teaching and Science Outreach (UPorto), Supervisor(s): **J. F. Gameiro**, H. Santos
2. B. Nsamba, 2020, Asteroseismic characterization of exoplanet-host stars in preparation for NASA’s TESS and ESA's PLATO space missions, Doctoral Program in Astronomy (3rd cycle) (UPorto), Supervisor(s): **M. J. P. F. G. Monteiro**, **T. L. Campante**
3. G. D. C. Teixeira, 2020, Asteroseismology of Deeply Embedded OB Stars in Star Forming HII Regions, Doctoral Program in Astronomy (3rd cycle) (UPorto), Supervisor(s): **M. S. N. Kumar**, **M. J. P. F. G. Monteiro**
4. L. M. Serrano, 2020, From ESPRESSO to Plato: detecting and characterizing Earth-like planets in the presence of stellar noise, Doctoral Program in Astronomy (3rd cycle) (UPorto), Supervisor(s): **N. C. Santos**
5. **P. I. T. K. Sarmento**, 2020, Towards a comprehensive understanding of the tiny stars at NIR wavelengths, Doctoral Program in Astronomy (3rd cycle) (UPorto), Supervisor(s): B. Rojas-Ayala, **E. Delgado Mena**
6. R. M. G. Albuquerque, 2020, Accretion versus outflow regions around Young Stellar Objects, Doctoral Program in Astronomy (3rd cycle) (UPorto), Supervisor(s): **J. J. G. Lima**, **J. F. Gameiro**, C. Sauty
7. S. Ulmer-Moll, 2020, High resolution spectroscopy: a new window into exoplanets, Doctoral Program in Astronomy (3rd cycle) (UPorto), Supervisor(s): **P. Figueira**, **N. C. Santos**
8. I. A. Costa, 2020, Ciência cidadã: envolvimento do público na investigação e divulgação em astronomia, Doctoral Program in Science Teaching and Divulgation (UPorto), Supervisor(s): C. Morais, **M. J. P. F. G. Monteiro**
9. T. Magalhães, 2020, Spatial Coherence Mapping of Structured Astrophysical Sources, Doutoramento em Astronomia e Astrofísica (ULisboa), Supervisor(s): **J. M. Rebordão**

MSc Projects Completed [6]

1. D. A. D. Vaz, 2020, The Nature of Leo T ultra-Faint Dwarf, Master in Astronomy, Supervisor(s): **J. Brinchmann**
2. H. M. G. Silva, 2020, What are HI profiles of cluster galaxies telling us?, Master in Astronomy, Supervisor(s): **T. C. Scott**, **C. Lobo**
3. M. Rosa, Domain wall evolution beyond quartic potentials with GPUs and CUDA, Supervisor(s): **C. J. A. P. Martins**
4. C. Domingues, A Metrologia no Controlo de Qualidade de Equipamentos de Radiodiagnóstico, Supervisor(s): **A. Cabral**

5. I. Leite, An optical metrology system for the measurement of the refractive index of glass, Supervisor(s): **A. Cabral**
6. N. Gonçalves, 2020, Absolute distance measurement by the phase shifting method, Supervisor(s): **M. Abreu**

BSc Traineeships / Projects completed [51]

(under the supervision of IA researchers)

1. Catarina Pinto, "How do you build a Universe", FCUL, October 2019/January 2020
2. Carlos Marçal, "Dark energy and gravitational waves", FCUL, October 2019/January 2020
3. Siri Alva Berge, "Measuring Cosmic String Loops One by One", June-September computational physics internship, Uppsala
4. Joshua Esteves, "Optimizing the differential redshift drift", February-June M2 internship, Montpellier
5. Praveen Kumar, "Constraining dark energy with alpha measurements", March-July M2 internship, Marseille
6. Bernardo Dias, "Domain walls in collapsing universes", PEEC 2019-20
7. Bruno Rocha, "Constraining the scale invariance model at low redshifts", PEEC 2019-20
8. Carlos Fernandes, "Constraining gravity with generalized couplings", PEEC 2019-20
9. Diogo Gomes, "Comparing field theory and Goto-Nambu walls", PEEC 2019-20
10. Vasco Tavares, "Varying Fine Structure Constant Generalized DBI Models", PEEC 2019-20
11. Vítor Ferreira, "Varying fundamental constants and nucleosynthesis", PEEC 2019-20
12. Mafalda Matos, "CHEOPS light curve analysis", Undergraduate last year project, February 2020
13. Barbara Soares, "SWEET-Cat – Spectroscopic Characterization of stars with exoplanets", PEEC-Extra-curricular project FCUP; February/July 2020
14. Henrique Legoinha, "SWEET-Cat – Spectroscopic Characterization of stars with exoplanets", PEEC-Extra-curricular project FCUP; February/July 2020
15. Francisco Pimenta; "Análise de atividade estelar usando stacked periodograms de dados espectroscópicos projeto para a cadeira", cadeira Projeto em Astrofísica, March/June 2020
16. Marco Dourado, "Filamentos moleculares: berços de estrelas, a análise da rádio-astronomia e do satélite Herschel", Laboratório de Astrofísica, September/December 2020
17. Ana Barboza, "Classifying exoplanets with machine learning", UC Projecto em Astrofísica, February/June 2020
18. Ana Barboza, "SOAP+: modelling stellar activity using solar data", Research project, September 2020
19. Susana Carneiro; "Trocado por miúdos: Preparação de uma atividade de comunicação de Astronomia"; Science Communication projects; IAstro Summer Internships (for university students); 13/31 July 2020
20. Bruna Fena; "Trocado por miúdos: Preparação de uma atividade de comunicação de Astronomia"; Science Communication projects; IAstro Summer Internships (for university students); 13/31 July 2020
21. Ariana Dias; "Trocado por miúdos: Preparação de uma atividade de comunicação de Astronomia"; Science Communication projects; IAstro Summer Internships (for university students); 13/3 July 2020
22. Alexandra Afonso; "Trocado por miúdos: Preparação de uma atividade de comunicação de Astronomia"; Science Communication projects; IAstro Summer Internships (for university students); 13/31 July 2020
23. Bernardo Campilho, "Atomic diffusion computation with MESA", February/June 2020
24. João Gonçalves, "Searching For SMBHs In The Early Universe", Laboratório de Astrofisica Proj. #11, FIR-Peakers, October 2020
25. Fabio Carmo; "MOONS VLT Next-Generation Opt-NIR Spectrograph", Estágios de Verão - Internship summer school for University Students, July 2020
26. Bruno Carrazedo; "MOONS VLT Next-Generation Opt-NIR Spectrograph", Estágios de Verão - Internship summer school for University Students, July 2020
27. Nuno Morujão, "Velocity corrections on binary star systems for the Eridanus II ultra-faint galaxy", February/December 2020
28. Weslley Victor da Costa Vieira, "Development of software to improve uncertainty estimations on velocity of stars", February/December 2020
29. Sílvia Tang, "Educational short film animations in Astronomy Literacy", B.Sc. curricular internship, July 2019/February 2020
30. Mariana Peres, "Educational short film animations in Astronomy Literacy", B.Sc. curricular internship, July 2019/February 2020
31. Catarina Ramos, "Educational short film animations in Astronomy Literacy", B.Sc. curricular internship, August/October 2020
32. Henrique Vitoriano, "Educational short film animations in Astronomy Literacy", B.Sc. curricular internship, August/October 2020
33. Monise dos Santos, "Educational short film animations in Astronomy Literacy", B.Sc. curricular internship, August/October 2020

34. Patrícia dos Santos, “Educational short film animations in Astronomy Literacy”, B.Sc. curricular internship, August/October 2020
35. Anni da Paz, “Educational short film animations in Astronomy Literacy”, B.Sc. curricular internship, August/October 2020
36. Miguel dos Santos, “Educational short film animations in Astronomy Literacy”, B.Sc. curricular internship, August/October 2020
37. Ariana Dias, “IA Summer Internship in Science Communication”, summer internship, 13/31 July 2020
38. Bruna Fena, “IA Summer Internship in Science Communication”, summer internship, 13/31 July 2020
39. Susana Carneiro, “IA Summer Internship in Science Communication”, summer internship, 13/31 July 2020
40. Diana Tavares, “Conteúdos educativos online”, Science Communication MSc. curricular internship, 10 August/9 November 2020
41. Afonso Pais, “Estágio Curricular no IA – Comunicação de Ciência e Promoção da Cultura Científica”, Science Communication MSc. curricular internship, October/December 2020
42. Daniel Filipe Gonçalves, “Time Domain Astronomy: Following the Tesselation of the Universe I”, IA 2019-03-BIC
43. Artur Gil Monteiro Guerreiro, “Time Domain Astronomy: Following the Tesselation of the Universe II”, Labs. Astrophysics
44. Marta André Botas, “The study of Voids in the Universe”, Labs. Astrophysics
45. Lucas da Costa Monteiro, “Scaling solutions in Bianchi I models with anisotropic stress”, Labs. Astrophysics
46. Maria Gonçalves, “Exploring the impact of modifications of gravity law on cosmological observables”, October 2019/February 2020
47. Maria Guadalupe Mendonça, “Exploring the impact of modifications of gravity law on cosmological observables”, July 2020
48. Maria Eduarda Pimentel, “Exploring the impact of modifications of gravity law on cosmological observables”, July 2020
49. Ana Marta Cruz de Sousa, “Dossier de Promoção – O Design como método de Persuasão”, February/June 2020
50. Afonso Mota, “Exoplanet composition and stellar abundances”, October 2020/January 2012
51. Leandro Silva, “Building cross-correlation masks for ESPRESSO”, October 2020/January 2021

COVER PICTURE "*CHEOPS, Hello Universe!*", *Fulldome movie frame*, 2020 © IA, Mulligan Studio

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