

CENTRO DE ASTROFÍSICA UNIVERSIDADE DO PORTO

RELATÓRIO DE GESTÃO E CONTAS



ANO 2021

RELATÓRIO DE GESTÃO

Versão aprovada pela Assembleia Geral em 2022/04/19

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Caraterização da Associação

O Centro de Astrofísica da Universidade do Porto (CAUP) é uma associação científica com personalidade jurídica, tendo sido constituída em 4 de Maio de 1989 como instituição privada sem fins lucrativos, pela *Universidade do Porto* (U.Porto). Tem o estatuto de utilidade pública desde setembro de 1991.

A Associação tem por objetivo apoiar e promover a formação e investigação na área de Astronomia/Astrofísica e da instrumentação associada, quer através de iniciativas próprias, quer colaborando de forma independente com entidades públicas e/ou privadas, nomeadamente através do estabelecimento de parcerias, protocolos e intercâmbios nacionais e/ou internacionais, bem como desenvolver infraestruturas laboratoriais relacionadas com a área de atividade do CAUP.

Constituem fins do CAUP apoiar e promover, designadamente:

- *A atividade de investigação científica fundamental e aplicada em Astronomia/Astrofísica através de projetos nele desenvolvidos, bem como a aquisição de conhecimentos básicos de carácter interdisciplinar, que abram novas perspetivas à investigação aplicada;*
- *A Astronomia/Astrofísica no país através da organização de conferências, cursos de curta duração, seminários e outras atividades similares;*
- *A formação de pessoal científico e técnico, podendo conduzir à elaboração de dissertações de mestrado ou teses de doutoramento;*
- *O ensino em Astronomia/Astrofísica, nomeadamente a nível de licenciatura e pós-graduação;*
- *A divulgação científica na área de Astronomia/Astrofísica.*

Órgãos Sociais

Os elementos que estiveram em funções em 2021 foram:

- **Mesa da Assembleia Geral:**

Presidente – Universidade do Porto (João Correia da Silva)

Vice-Presidente – Mário J. P. F. G. Monteiro

Secretário – Margarida S. Cunha

- **Direção:**

Presidente – Jarle Brinchmann

Vogal – Catarina G. G. Lobo

Vogal – Daniel F. M. Folha

- **Conselho Fiscal:**

Presidente – Filipe A. L. Pires

Relator – Universidade do Porto (João Carlos Ferreira Ribeiro, Marlene Susana Amorim Teixeira Rebelo após 30/12/2021)

Vogal – Jorge Filipe S. Gameiro

Os membros do Conselho Consultivo em 2021 foram:

- **Conselho Consultivo:**

Vogal - Moira Jardine (University of St Andrews)

Vogal - Mark McCaughrean (European Space Agency)

Vogal - Yannick Mellier (Institut d'Astrophysique de Paris)

Vogal - Francesco Pepe (Observatoire de l'Université de Genève)

Os Associados do CAUP a 31 de dezembro de 2021 eram:

- Associados Fundadores (1): Universidade do Porto
- Associados Efetivos (22): Pedro P. Avelino, Jarle Brinchmann, Vitor M. M. Costa, Margarida M. S. Cunha, António J. C. da Silva, J. Paulo Maurício de Carvalho, Pedro R. L. Figueira, Daniel F. M. Folha, Jorge Filipe S. Gameiro, M. S. Nanda Kumar, Maria Teresa V. T. Lago, João J. F. G. A. Lima, Catarina G. G. Lobo, Carlos J. A. P. Martins, Manuel A. S. Monteiro, Mário J. P. F. G. Monteiro, Polychronis Papaderos, Filipe A. L. Pires, Ricardo S. S. Reis, Nuno M. C. Santos, Sérgio A. G. Sousa, Pedro T. P. Viana.

Instalações

O CAUP partilha o edifício com o *Planetário do Porto*, propriedade da U.Porto após a extinção da *Fundação para a Ciência e o Desenvolvimento* (FCD) em 2013, com uma área total útil de 3580 m². O espaço atribuído ao CAUP resulta do financiamento atribuído pelo Ministério da Ciência e Tecnologia para a construção do edifício planeado de raiz para albergar o CAUP e o Planetário do Porto.

O espaço dedicado para uso do CAUP é de 915 m², correspondendo a gabinetes, salas de seminários e reuniões, armazéns, sala de rede, biblioteca, observatório e Astroteca. A área restante é ocupada pelo Planetário, sendo uma parte desta partilhada, como o átrio e o auditório (60 lugares).

O CAUP é responsável pela gestão científica, educacional e administrativa do *Planetário do Porto*, de acordo com o contrato sobre o exercício de poderes públicos assinado com a U.Porto em julho de 2013.

Recursos Humanos

O CAUP tem recursos humanos próprios que, no final de 2021, correspondiam a um total de 36 colaboradores com contrato de trabalho. Estes podem ser agrupados por tipo de contrato e área de trabalho da seguinte forma (a 31 de dezembro de 2021):

Contratos sem termo (total de 9):

- Divulgação:
 - (1) Filipe A. L. Pires - *especialista*
 - (2) Paulo J. T. Pereira - *assessor gráfico*
 - (3) Ricardo S. S. C. Reis - *técnico*
- Informática:
 - (4) Manuel A. S. Monteiro - *especialista*
- Administração e Serviços:
 - (5) Carlos A. G. Gonçalves - *porteiro*
 - (6) Argentina M. T. Pereira - *técnico*
 - (7) Elsa M. P. P. Silva - *técnico*
 - (8) Ernesto J. Silva - *porteiro*

(9) Fernando M. S. Soares - *porteiro*

Contratos a termo (total de 27):

- Investigação:
 - (1) Vardan Zh. Adibekyan - *investigador auxiliar*
 - (2) Susana C. C. Barros - *investigador júnior*
 - (3) Diego Bossini - *investigador júnior*
 - (4) Jarle Brinchmann - *investigador principal*
 - (5) Tiago J. L. C. E. Campante - *investigador auxiliar*
 - (6) Margarida M. S. Cunha - *investigador principal*
 - (7) Morgan Deal - *investigador júnior*
 - (8) Elisa Delgado Mena - *investigador auxiliar*
 - (9) Olivier D. S. Demangeon - *investigador júnior*
 - (10) João Faria - *investigador júnior*
 - (11) José C. Fonseca - *investigador auxiliar*
 - (12) Jean Michel Gomes - *investigador júnior*
 - (13) João N. T. Gomes da Silva - *investigador júnior*
 - (14) Andrew Humphrey - *investigador júnior*
 - (15) M. S. Nanda Kumar - *investigador principal*
 - (16) Patricio Lagos - *investigador júnior*
 - (17) Carlos J. A. P. Martins - *investigador júnior*
 - (18) Jorge H. C. Martins - *investigador júnior*
 - (19) Ana S. Paulino Afonso - *investigador júnior*
 - (20) Ivan Rybak - *investigador júnior*
 - (21) Ângela R. G. Santos - *investigador júnior*
 - (22) Tom C. Scott - *investigador júnior*
 - (23) Lara G. Sousa - *investigador júnior*
 - (24) Sérgio A. G. Sousa - *investigador principal*
- Divulgação :
 - (25) Elsa M. P. S. Moreira - *técnico*
- Administração e Serviços:
 - (26) Mariana P. Júlio - *técnico*
 - (27) Sara Ramos - *técnico*

Além de contratos de trabalho, o CAUP acolhe igualmente bolseiros, quer através de contratos de bolsa próprios quer sendo instituição de acolhimento de bolseiros da FCT (ver relatório de atividades).

Síntese da Atividade em 2021

A atividade do CAUP é estruturada em torno das iniciativas desenvolvidas no âmbito das unidades, estando atribuída uma missão específica a cada uma destas unidades:

- **Unidade de Investigação (UnI):** coordenar todas as iniciativas e atividades que estão associadas à investigação, nomeadamente seminários, conferências, reuniões de trabalho, participação em projetos científicos e/ou de instrumentação, participação em consórcios nacionais e internacionais nas áreas de investigação relevantes, participação em comités científicos, etc. Com a criação da unidade de investigação Instituto de Astrofísica e Ciência do Espaço (IA), financiada pela FCT a partir de 2015 e com inicialmente duas instituições de Gestão CAUP e a FCIências.ID - Associação para a Investigação e Desenvolvimento de Ciências, as competências da UnI do CAUP passaram a ser delegadas na Coordenação do IA, onde têm assento dois elementos do CAUP em paridade com dois elementos do pólo de Lisboa. Em 2021 um novo pólo da IA foi constituído na Universidade de Coimbra.
- **Unidade de Formação (UnF):** coordenar ou apoiar todas as atividades de formação organizadas pelo CAUP ou que têm a sua participação/colaboração. Nomeadamente a formação universitária (licenciatura, mestrado e doutoramento), formação contínua, cursos avançados e organização de eventos que visam reforçar a qualidade da formação oferecida pelo CAUP.
- **Núcleo de Divulgação (ND):** organiza todas as atividades de divulgação e promoção da cultura científica, incluindo o Planetário do Porto - Centro Ciência Viva e outras iniciativas para o público e escolas que são oferecidas pelo CAUP regularmente. Também coordena a participação do CAUP em projetos nacionais e internacionais de divulgação científica e assegura ainda a componente de imagem/grafismo e de comunicação do CAUP. Esta unidade integra e co-coordena o Grupo de Comunicação de Ciência do IA.
- **Unidade de Administração e Serviços (UnAS):** assegura todas as funções e tarefas de apoio administrativo às atividades do CAUP e sua gestão. Garante o bom funcionamento das instalações e equipamentos, incluindo os serviços de Tecnologias da Informação e Comunicação (TIC), e dá apoio à gestão das atividades, projetos e eventos na componente de contabilidade e administração. Esta unidade trabalha em proximidade com a Coordenação do IA por forma a garantir uma boa gestão desta unidade de investigação.

A descrição detalhada da atividade desenvolvida em 2021 no âmbito de cada uma destas unidades é apresentada na componente de relatório de atividades.

Situação Económico-Financeira

A situação económico-financeira melhorou relativamente a 2020, tendo-se obtido um resultado líquido do exercício positivo.

O montante global de gastos desceu em relação a 2020, situando-se abaixo de um milhão e seiscentos mil euros. Os rendimentos mantiveram-se ao nível de 2020, voltando a ser superiores aos gastos, como se ilustra na Figura 1. O capital próprio teve uma ligeira diminuição enquanto as disponibilidades no final do ano subiram significativamente, situando-se agora perto dos oitocentos mil euros.

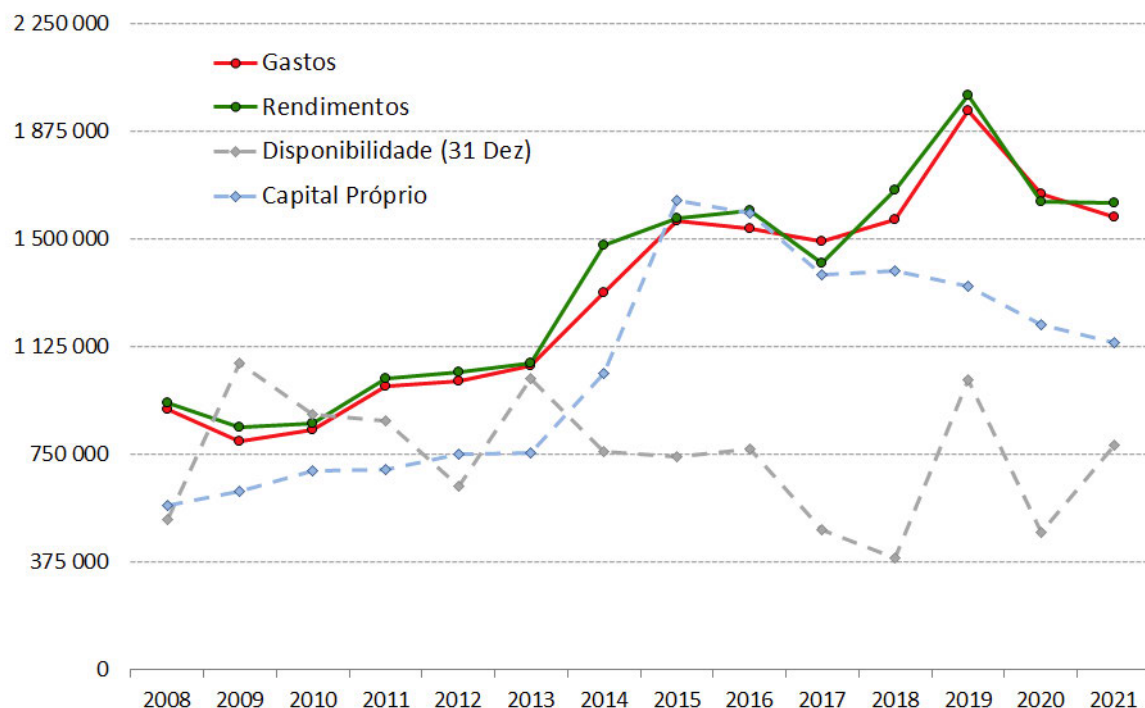


Figure 1: Evolução dos *Gastos* (linha vermelha) e dos *Rendimentos* (linha verde), para o exercício por ano fiscal, desde 2008. Os valores dados estão em euros. Também se indica as *disponibilidades* (linha cinzenta) existentes a 31 de Dezembro de cada ano e o *capital próprio* (linha azul).



Figure 2: Distribuição dos *Gastos* do exercício de 2021, correspondendo a um total de 1 579 079,25 euros.

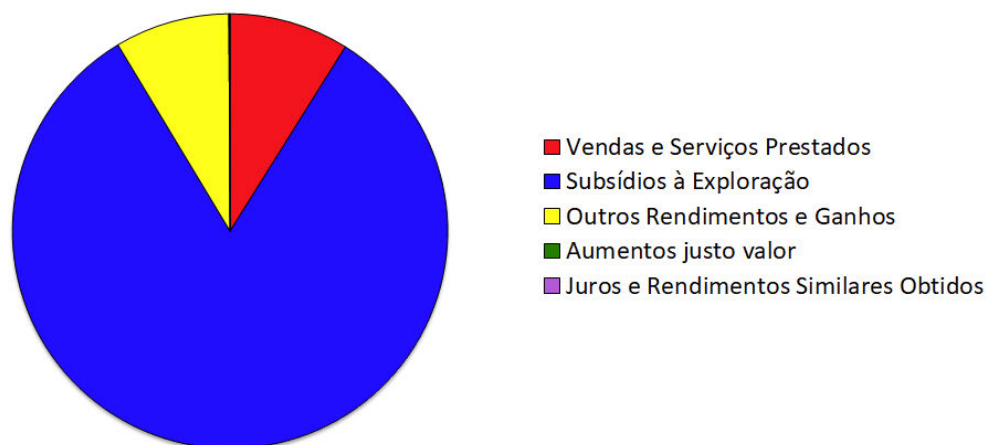


Figure 3: Distribuição dos *Rendimentos* do exercício de 2021, correspondendo a um total de 1 625 401,58 euros.

A fração dos custos com recursos humanos, quer através de despesas com o pessoal, quer através da contratação de bolseiros, continua a ser mais elevada do que em anos anteriores a 2020, consequência do abrandamento das restantes atividades devido à situação pandémica que vivemos durante os últimos 2 anos. A Figura 2 ilustra o peso relativo das diferentes componentes de *Gastos* nas contas em 2021. A maior componente das despesas do CAUP continua a ter lugar por via de financiamento assegurado através de projetos (Figura 3), pelo que tais despesas não representam um custo continuado além do contrato de financiamento aprovado.

O CAUP depende maioritariamente de financiamentos externos provenientes da *Fundação para a Ciência e a Tecnologia* (FCT), da *Comissão Europeia* (CE) e de outras entidades (ver a Figura 4).

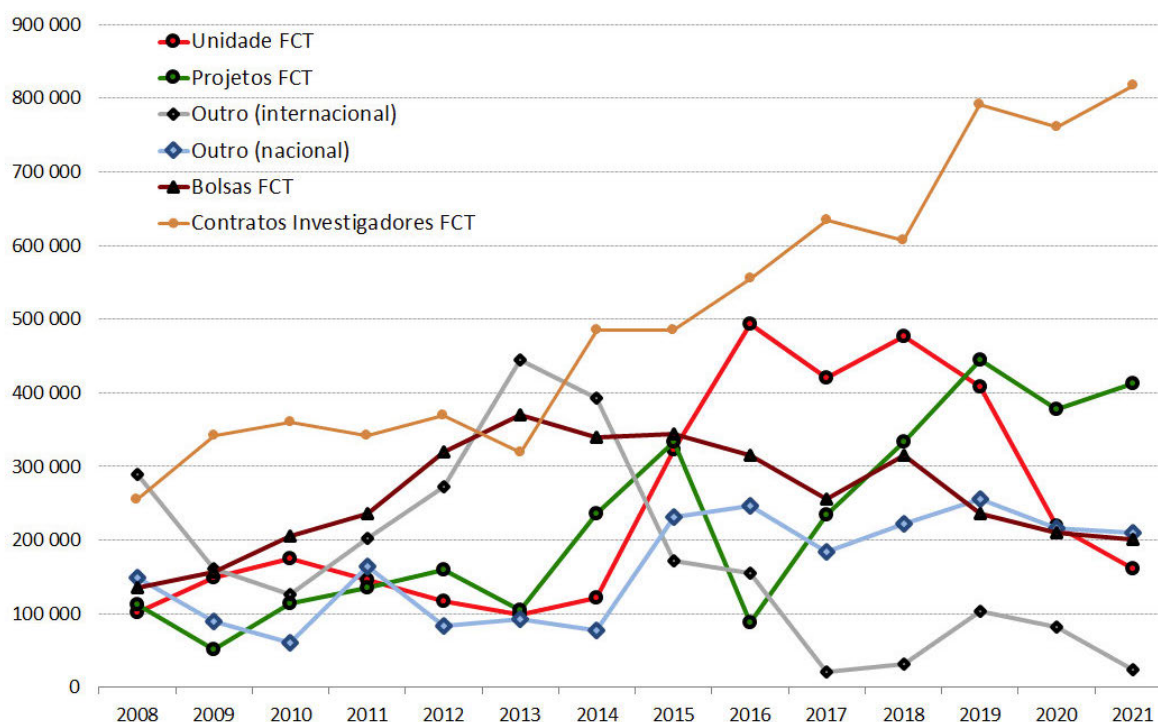


Figure 4: Distribuição das fontes de financiamento para o exercício por ano fiscal, desde 2008.

O financiamento da Unidade I&D, proveniente da FCT, continuou a diminuir em 2021, sobretudo devido à diminuição do número de deslocações realizadas, nomeadamente, em visitas de trabalho e/ou participação em reuniões, workshops e conferências..

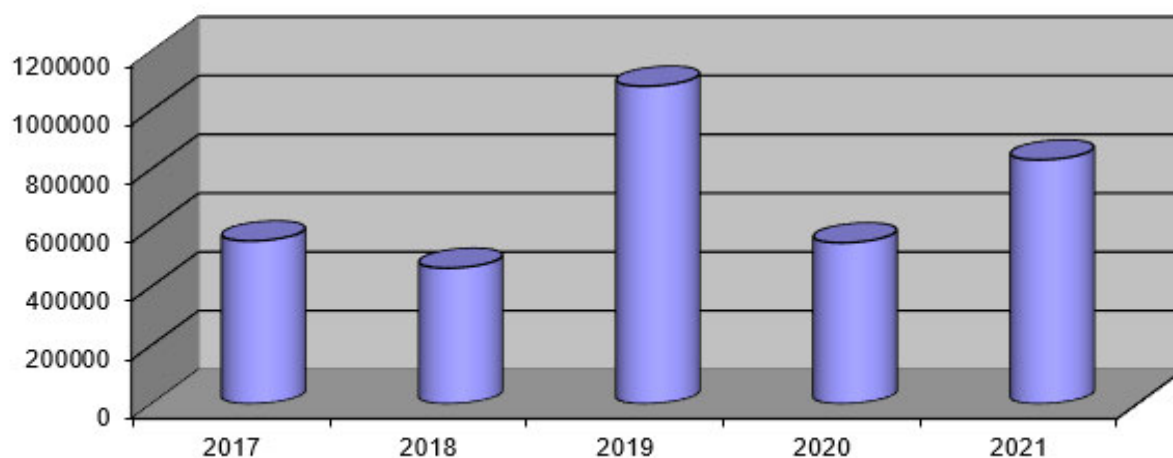
Quanto ao financiamento de projetos FCT, registou-se uma ligeira subida, reflexo da prioridade dada à execução de financiamentos de projetos de I&D que se encontram em fase terminal. O financiamento nacional, proveniente de outras fontes, manteve-se ao nível de 2020. No que respeita a outros fundos internacionais verificou-se também uma descida, ficando ao nível mais baixo desde 2017. A dificuldade que o CAUP tem tido nos últimos anos em ver aprovadas candidaturas suas a projetos financiados pela Comissão Europeia continua. Esta dificuldade está intimamente ligada à clara redução dos instrumentos que permitem financiar ciência fundamental.

O financiamento correspondente aos contratos FCT registou uma ligeira subida devido ao início de 4 novos contratos Investigador FCT. No ano de 2021, esta componente correspondeu a um total de 817 617 euros (23 investigadores envolvidos). Uma outra fonte de financiamento indireto provém das bolsas de investigação atribuídas diretamente pela FCT cujo valor global se manteve ao nível de 2020. Estas, embora não sendo executadas através do CAUP, representam um financiamento importante das atividades de investigação e formação, cuja obtenção é apenas possível através do apoio do CAUP. Em 2021, esta componente correspondeu a um total de 200 218 euros (1 investigador, 14 alunos de doutoramento e 1 BGCT na área da divulgação e promoção da cultura científica). O peso das duas componentes (contratos de investigador FCT e bolsas FCT) é também indicado na Figura 4, mostrando que o valor anual global é consideravelmente superior ao financiamento anual da Unidade de Investigação. À semelhança do que acontece com os salários dos docentes, os montantes das bolsas FCT não são incluídos nas contas do CAUP.

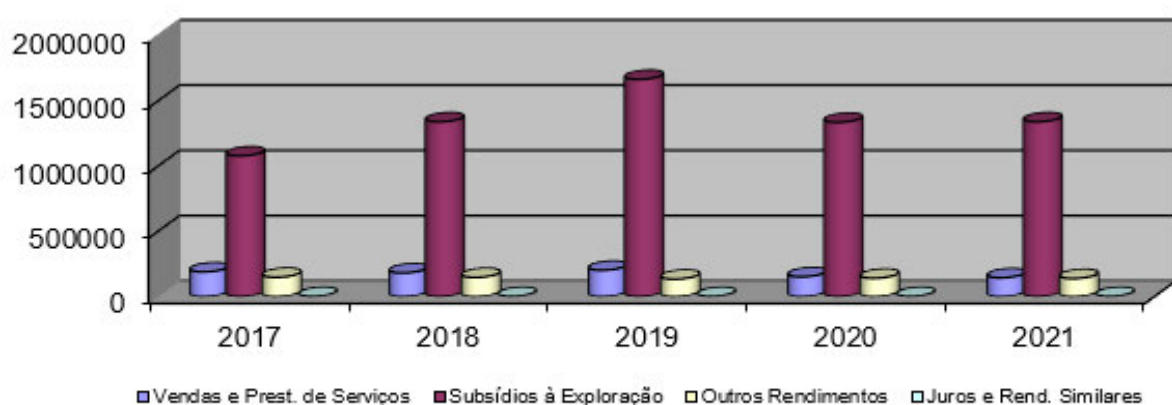
Indicadores Económico-Financeiros

Nesta seção fornecem-se alguns dos indicadores económico-financeiros das contas de 2021, em comparação com os 4 anos anteriores (valores em euros).

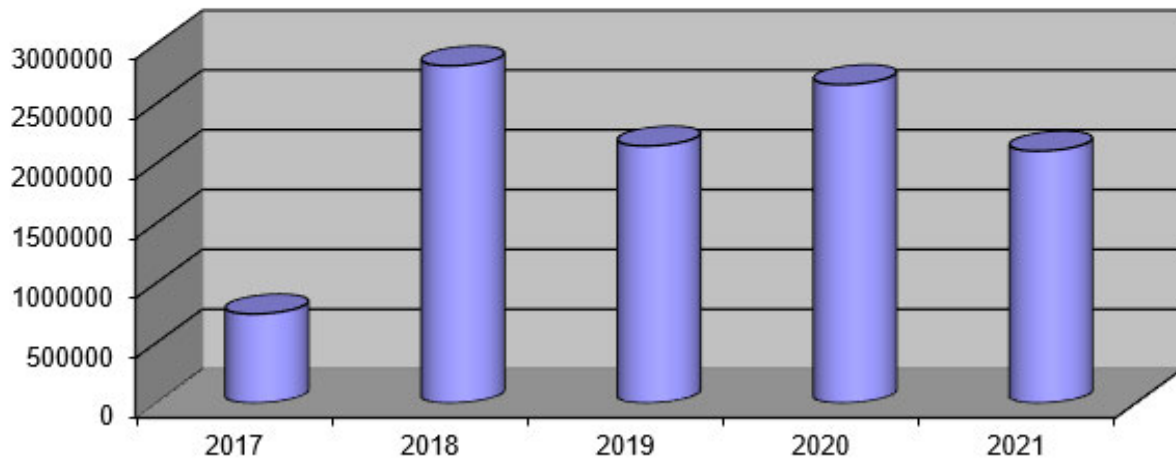
Meios Financeiros Líquidos					
	2017	2018	2019	2020	2021
Caixa	50	35	35	35	35
Depósitos Bancários	485471	389606	1009156	477264	781028
Outros Instrumentos Financ.	69000	72435	71803	70824	49381
TOTAIS	554521	462076	1080994	548123	830444



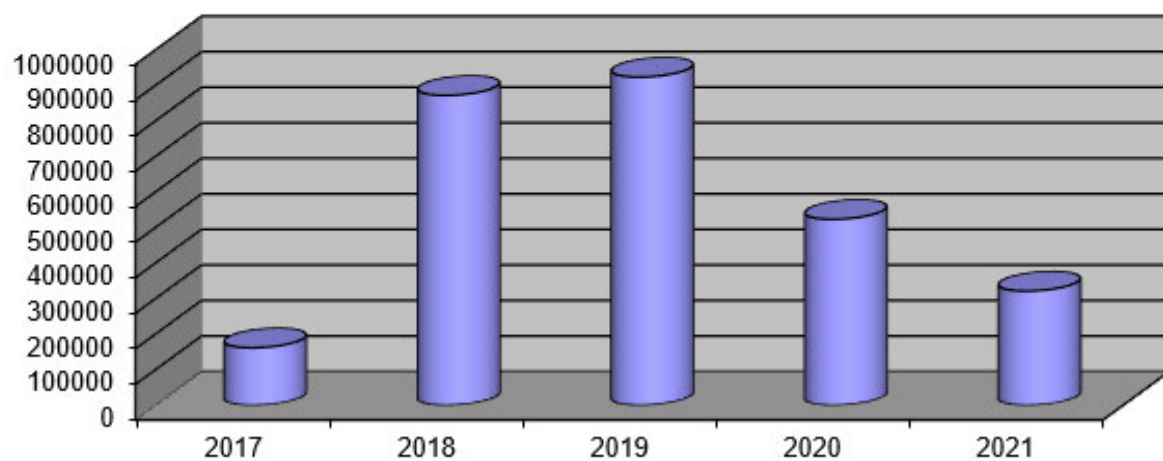
Evolução dos Rendimentos					
	2017	2018	2019	2020	2021
Vendas e Prest. de Serviços	189794	182041	202436	152362	144550
Subsídios à Exploração	1079412	1340581	1665765	1336622	1340789
Outros Rendimentos	148367	147359	134182	141325	138792
Juros e Rend. Similares	910	1271	1271	1275	1271
TOTAIS	1418483	1671252	2003654	1631584	1625402



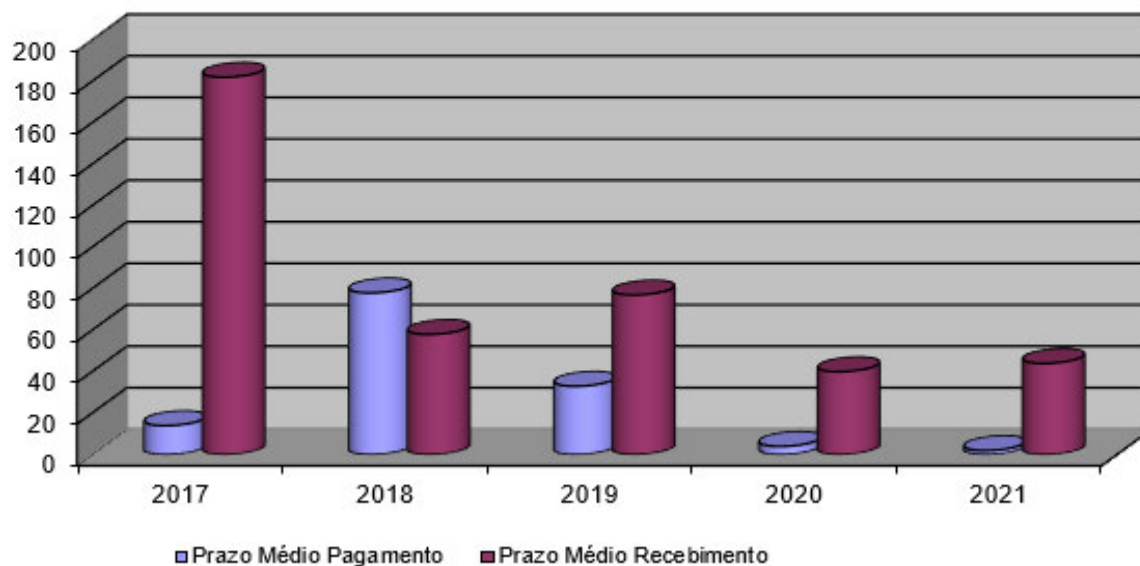
Créditos a Receber e Outros Ativos Correntes					
	2017	2018	2019	2020	2021
Créditos a Receber	467	28563	43216	16988	17672
Outros Ativos Correntes	745008	2791945	2107206	2646897	2090661
TOTAIS	745475	2820508	2150422	2663885	2108333



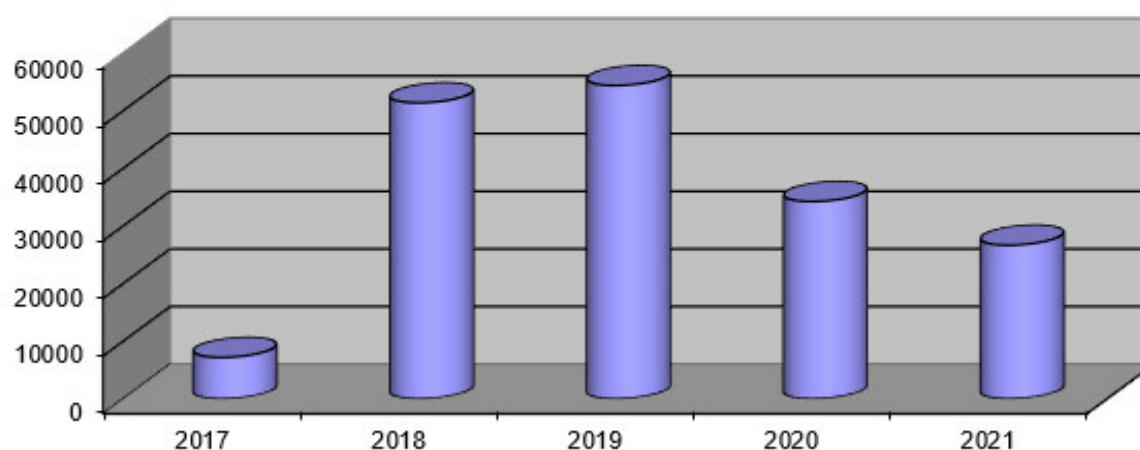
Fornecedores e Outros Passivos Correntes					
	2017	2018	2019	2020	2021
Fornecedores	0	64888	18351	886	375
Outros Passivos Correntes	161933	807441	905431	522785	321333
TOTAIS	161933	872329	923782	523671	321708



Tesouraria					
	2017	2018	2019	2020	2021
Prazo Médio Pagamento	14	78	33	4	2
Prazo Médio Recebimento	182	58	77	40	44



Activo Fixo					
	2017	2018	2019	2020	2021
Aquisições	7183	51380	54382	34248	26668
TOTAIS	7183	51380	54382	34248	26668



Obrigações Fiscais

A Direção informa que a situação perante a Segurança Social e as Finanças se encontra regularizada, pelo que não existe qualquer dívida vencida.

Perspetivas

A situação financeira da CAUP continua a depender fortemente da FCT, sendo muito baixa a percentagem de financiamento da Comissão Europeia (CE). É crucial aumentar esta percentagem para valores verdadeiramente significativos.

A pandemia de COVID-19 e a forte descida da receita do Planetário dela resultantes, continuou a ter um impacto bastante negativo nas nossas atividades durante 2021. Dos projetos financiados pela FCT destaca-se, para além da continuação de dois projetos exploratórios associados a Investigadores FCT e dos sete projetos de investigação iniciados em 2018, o início do projeto de investigação “Dark matter and metals in galaxies (DarkMAGE)”. Para 2022 esperamos uma descida no número de projetos FCT em execução, consequência do fim dos projetos de investigação iniciados em 2018, o fim de dois projetos exploratórios bem como o início de outros dois projetos do mesmo tipo. Em 2021 teve início um financiamento NORTE2020, cuja finalidade é o reforço da capacitação dos Centros Ciência Viva da Região Norte, onde se enquadra o Planetário do Porto - Centro de Ciência Viva, que terá uma duração de 2 anos. Tivemos também vários projetos financiados pela Ciência Viva - Agência Nacional para a Cultura Científica e Tecnológica.

Ao nível do financiamento internacional destaca-se a continuação do contrato com a ESA no âmbito do programa PRODEX, referente à participação no instrumento PLATO, iniciado em 2018, o COST action “*Revealing the Milky Way with Gaia*”, iniciado em 2019, e o início do projeto “SKilled, Innovative & Entrepreneurial Scientists (SKIES)”, financiado pela CE.

Na componente de bolsas externas e Estímulo ao Emprego Científico, o CAUP, no âmbito da Unidade de Investigação IA, continuará a tentar atrair, nacional e internacionalmente, excelentes candidatos, capazes de obter bolsas individuais de doutoramento e contratos de trabalho para investigação ao nível de pós-doutoramento..

De referir a continuação do contrato celebrado com a DEIMOS-Engenharia para desenvolvimento e manutenção de software para o CHEOPS (ESA small mission). Este satélite foi lançado com sucesso em 18 de dezembro de 2019 e os primeiros dados foram analisados em 2020.

A fim de melhorar a nossa solidez financeira, a CAUP também participou numa proposta de CoLab em 2021, bem como preparou uma proposta para uma infra-estrutura nacional apresentada em 2022. Aguarda-se pelos resultados.

Desde 2013 que o CAUP é responsável pela gestão administrativa do Planetário do Porto, acumulando-a com a gestão educativa e científica, como especificado no contrato assinado com a U.Porto. Esta gestão garante uma forte sinergia entre investigação científica e divulgação, que se constitui como uma mais valia no cumprimento do seu objetivo estatutário de contribuir para a divulgação científica em Astronomia e Astrofísica, proporcionando a possibilidade de continuar a atrair o interesse de jovens para esta área do conhecimento.

Aplicação dos Resultados

É convicção da Direção que o Relatório de Gestão e os demais documentos de prestação de contas retratam de forma clara e apropriada, nos aspetos materialmente relevantes, a posição financeira e o resultado das operações da entidade contabilística do CAUP.

Pelo referido, e tendo em conta que no exercício findo em 31 de dezembro de 2021 se apurou um Resultado Líquido do Exercício positivo, no montante de 46 322,33 euros (quarenta e seis mil trezentos e vinte e dois euros e trinta e três cêntimos), a Direção propõe:

- que seja aprovado o Relatório de Gestão e os demais documentos de prestação de contas;
- que a totalidade do 'Resultado Líquido do Exercício' seja transferida para 'Resultados Transitados'.



Doutor Jarle Brinchmann
(Presidente)



Prof. Doutora Catarina G. G. Lobo
(Vogal)



Prof. Doutor Daniel F. M. Folha
(Vogal)

Porto, 12 de abril de 2022.

REPORT OF ACTIVITIES

This component of the report describes the main initiatives and results obtained during the year of 2021.

The activity of CAUP is structured around Units: these are *Research*, *Training*, *Outreach* and *Administration and Services*. Each Unit has a Head, and a clearly defined mission.

The activities within each Unit are described in the sections below. The appendices list some of the major indicators of the activity.

Human Resources

By the end of 2021 the team included:

- **39 Researchers** - corresponding to
 - *12 Lecturers* (4.9 FTE): Ilídio André P. M. Costa (AE Santa Bárbara¹), Vítor M. M. Costa (ISEP), J. Paulo Maurício de Carvalho (FCUP), Pedro P. Avelino (FCUP), Daniel F. M. Folha (ISCS-Norte), Jorge F. Gameiro (FCUP), Maria Teresa V. T. Lago (FCUP, Retired), João J. G. Lima (FCUP), Catarina G. G. Lobo (FCUP), Mário J. P. F. G. Monteiro (FCUP), Nuno C. Santos (FCUP), Pedro T. P. Viana (FCUP)
 - *26 Research Positions* (24.45 FTE): Vardan Zh. Adibekyan, Susana C. C. Barros, Diego Bossini, Jarle Brinchmann, Tiago J. L. C. E. Campante, Margarida S. Cunha, António C. da Silva (FCUL), Morgan Deal, Elisa Delgado Mena, Olivier D. S. Demangeon, João P. S. Faria, Pedro Figueira (ESO), José C. Fonseca, Jean Michel Gomes, João N. T. Gomes da Silva, Andrew J. Humphrey, M. S. Nanda Kumar, Patricio Lagos, Carlos J. A. P. Martins, Jorge H. C. Martins, Ana S. Paulino Afonso, Ivan Rybak, Ângela R. G. Santos, Tom C. Scott, Lara G. Sousa, Sérgio A. G. Sousa
 - *1 Postdoctoral Researcher* (1.0 FTE): Pedro M. Palmeirim
- **22 PhD students**
 - Alexandros Antoniadis Karnavas, Rui P. L. Azevedo, Thibault Boulet, João D. R. Camacho, Abhishek Chougule, Miguel Clara, José Ricardo Correia, Eduardo Cristo, Pedro Alexandre Cunha, Tomás de Azevedo Silva, João D. F. Dias, David Grüber, Ana C. O. Leite, Nuno A. M. Moedas, Sergei Mukovnikov, Sandy G. Morais, José Rodrigues, Nuno M. Rosário, Ana Rita Silva, André Miguel A. C. V. Silva, Paulina M. Zaworska, Daniel A. D. Vaz
- **7 Outreach staff** (6,8 FTE)
 - Ilídio André P. M. Costa¹, Tania F. S. Cunha, José Dantas¹, Elsa M. P. S. Moreira, Paulo J. T. Pereira, Filipe A. L. Pires, Ricardo S. S. C. Reis
- **8 Supporting staff** (5,8 FTE)
 - Carlos A. G. Gonçalves, Mariana P. Júlio, Manuel A. S. Monteiro, Argentina M. T. Pereira, Sara Ramos, Elsa M. P. P. Silva, Ernesto J. Silva, Fernando M. S. Soares

CAUP also had 1 external supporting staff (legal adviser, corresponding to a total of 0.1 FTE).

CAUP also provides support to students enrolled in the 1st *Ciclo* (*Licenciatura em Física* and others), 2nd *Ciclo* (*Mestrado em Astronomia & Astrofísica*) at the *Faculdade de Ciências da U.Porto* (FCUP) and students from other universities/institutes.

¹ Middle and high school teacher deployed at CAUP: Planetário do Porto - Centro Ciência Viva

Several CAUP researchers collaborate in some courses of the 2nd *Ciclo* (*Mestrado em Astronomia & Astrofísica*) and of the 3rd *Ciclo* (*Programa Doutoral em Astronomia*).

The major changes in the team (researchers with a PhD) during 2021 were:

Hugo M. Tabernero Guzmán	- ended his contract in January
Charlotte Gehan	- ended her contract in April
José C. Fonseca	- started his contract in September
Ana S. Paulino Afonso	- started her contract in November
Ângela R. G. Santos	- started her contract in November

Unl – Research Unit

Research in CAUP is structured according to the organization of the research unit *Instituto de Astrofísica e Ciências do Espaço*, into five research groups. The description below focuses on activity done by CAUP members but the general description is relative to IA.

Report from the Group - Towards the detection and characterisation of other Earths

The Planetary System team at IA continued its activities around the two major branches, namely Exoplanet research and Solar System atmospheres. Additionally, with the inclusion of colleagues from the new Coimbra node, the activities also expanded to the study of minor bodies in the Solar System and the study of planetary surfaces.

Exoplanet research focused on multiple complementary aspects: 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 characterise planets as well as their properties and formation processes; 4) the statistical study of planet properties as well as the relation with the properties of the host stars; 5) the study of exoplanet atmospheres using broad-band photometry, high-resolution spectroscopy and model atmospheres.

A significant part of this research was done in the context of our top-level participation as consortium members in ESO's ESPRESSO project (started operations in 2018) and ESA's CHEOPS mission (launched in late 2019). Given our key roles and contributions in the project phase, we have been exploiting our privileged access to the definition of the science programs of ESPRESSO and CHEOPS, as well as the analysis of the obtained data. Several high impact results were published based on these data, and several others are in preparation. Data from the SPIROU@CFHT consortium has also been explored. Furthermore, making use of the know-how that was (and is) built from these projects, we are now preparing for the new NIRPS@ ESO's 3.6m, which is expected to see first light in Summer 2022.

Our high level participation in these projects reinforces the existing strategy and allows the team to be in the forefront of exoplanet detection and characterization. In this context, we are already preparing for future projects and missions such as the HIRES@ESO's ELT spectrograph (2030, approved for construction by ESO in December 2021) as well as the PLATO and ARIEL missions (ESA - 2026 and 2029, respectively). For all of those, we are responsible for scientific tasks as well as part of the data reduction/analysis pipelines.

Scientific Highlights for 2021

In 2021, a total of 8 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.

Discovery of an exoplanet with only half the mass of Venus

A research led by the IA (Demangeon et al. 2021) used the ESPRESSO spectrograph to detect a planet with only 1/2 the mass of Venus. In a system with 5 planets, it is the lowest mass planet with a mass measured using the radial-velocity method.

Three exoplanets, similar to the inner planets of the Solar System, were revealed around the star L98-59 by NASA's TESS mission. TESS, however, is not able to measure the masses of the planets, and only their radii (through transit photometry) are measured. Knowing the mass and the radius is however key to understanding the planet composition, and distinguishing between rocky planets and their ice and gas giant counterparts.

To tackle this issue, over the last two years the IA team obtained ESPRESSO data on the system (as part of our strong participation in the ESPRESSO consortium). A detailed analysis of the data allowed us to show that one of these planets (the one orbiting closer to its star) has about half the mass of Venus. This is the exoplanet with the lowest mass measured with the radial velocity method, being even smaller than the Earth. This measurement was only possible due to the many years of improvements in instruments and data analysis techniques, to which IA members made important contributions.

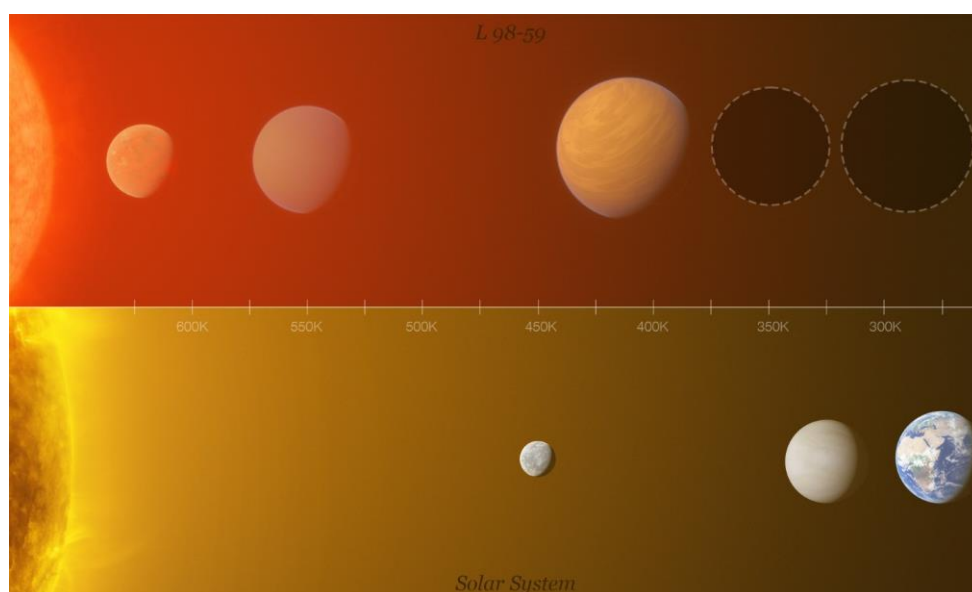


Figure: The L98-59 system when compared with our own Solar System rocky planets. Courtesy ESO.

Further to this amazing discovery, the team was also able to infer that three of the planets may contain water either inside or in their atmosphere. The two planets closest to the star are likely to be dry, but they may still

contain small amounts of water. The third planet could have up to 30% of its mass in water, thus appearing to be an ocean world.

In addition, the team also discovered that L98-59 has additional exoplanets that until now had not been detected. A fourth planet has been discovered and a fifth is suspected to be in the habitability zone, the zone at the right distance from the star for a planet to have liquid water on its surface.

These results (announced in an ESO Press Release) are an important step forward in the search for life on Earth-sized planets outside the Solar System. The detection of signs of the presence of life, the so-called biosignatures, on an exoplanet depends heavily on the ability of astronomers to study its atmosphere. However, current telescopes are not yet large enough to reach the resolution required to carry out this type of study on small rocky planets. The planetary system L98-59, just 35 light-years away from Earth, is therefore a good target for future observations of exoplanet atmospheres (e.g. with the HIRES@ELT spectrograph, a project on which the IA team is strongly involved).

Discovery of a composition link between planets and their host stars

Research done by the team has discovered that the composition of known rocky planets is closely related with the one we observe on their host stars. This result sheds new light into the processes of planet formation and evolution and can be used as input for models of planet chemistry.

Newly formed stars are surrounded by a protoplanetary disk, with a fraction of the material in this disk condensing into blocks of planet formation and the rest eventually falling to the star. Because of this common origin, it was assumed that the composition of these planetary “bricks” and low-mass rocky planets would be similar to the composition of the parent star.

However, until now the only reference available was our own Solar System and for this, the composition of the main rock-forming elements in the telluric planets (with the exception of Mercury), such as magnesium, silicon or iron, is similar to the composition of the Sun.

In a new investigation published in the prestigious journal *Science*, an international team led by IA (Adibekyan et al. 2021) managed to establish, for the first time, a correlation between the composition of rocky exoplanets and the composition of their parent stars.

This study was based on measurements of mass and radius, which were used to calculate the density of the planets, as well as on the measurement of precise and detailed chemical abundances in the planet-host stars.

High-resolution spectra, obtained with the most advanced spectrographs, mounted at large observatories across the planet, at ESO's La Silla and Paranal observatories, Mauna Kea and Roque de los Muchachos, were used.

Interestingly, the team also demonstrated that, contrary to what was supposed, this relationship is not direct.

First, the chemical relation has not a 1:1 link. Furthermore, the team revealed one intriguing result. They found that there is a gap between the iron fraction of super-Earths and super-Mercuries, which gives evidence that these planets represent distinct populations in terms of composition, which could be due to differences in the process of their formation.

Understanding the relationship between the composition of stars and their planets has been a central topic of IA research for over a decade, and one of the research lines where the team has the highest international impact.

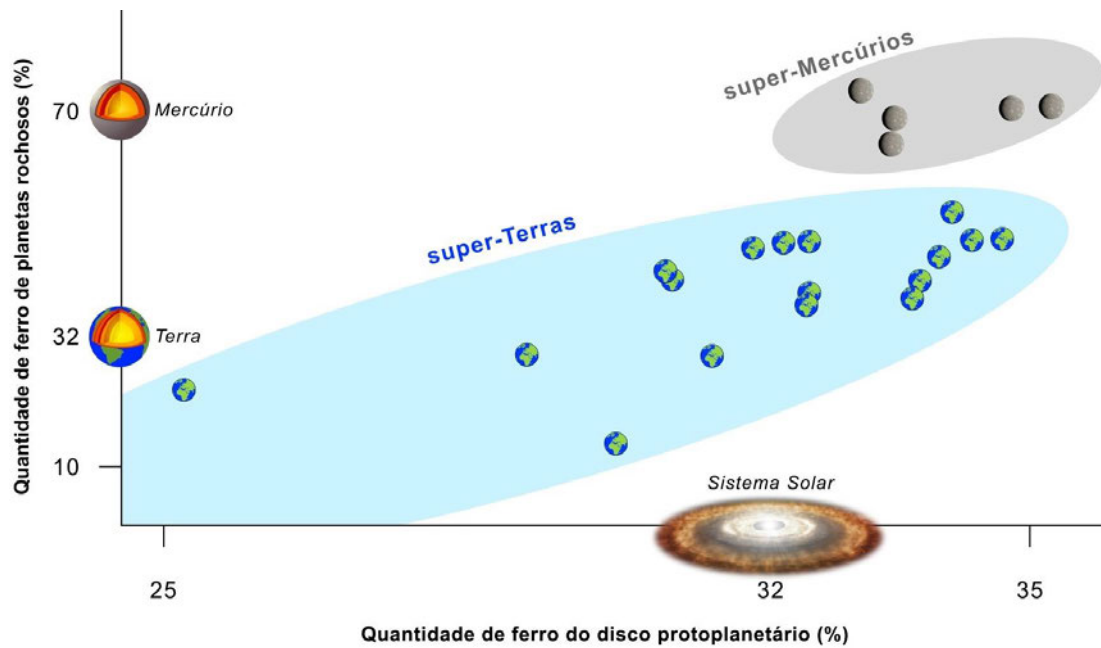


Figure: Percentage of iron from the analysed planets and from the protoplanetary disk where the planets formed.
(Credit: Adibekyan et al. (2021)/IA).

A Unique catalogue of exoplanet-host stars

The IA team develops and maintains a unique catalogue of properties of stars with planets. This catalogue, named "SWEET-Cat" (<http://sweetcat.iaastro.pt>), contains invaluable data that is key to the characterization of detected exoplanets.

Accurately characterising stars is crucial to discovering and characterising the exoplanets that orbit them. High-precision stellar parameters can help, for example, in distinguishing between the discovery of Neptune-like planets or planets similar to our own Earth.

SWEET-Cat is, in this sense, a unique catalogue in the world, as it contains, for a list of stars with planets that is constantly updated, stellar parameters that were always derived with the same method. At present, SWEET-Cat allows the community to query homogeneous and high-precision parameters of more than nine hundred stars with exoplanets.

The SWEET-Cat catalogue was originally presented in 2013, but in 2021 it was strongly updated (Sousa et al. 2021); it now also includes information on the use of parallax from the GAIA space mission (ESA). This allowed the team to increase the number of stars that have reliable data by more than 40%, and more accurately determine their masses and radii. This update was recently published in the journal *Astronomy & Astrophysics*.

The SWEET-Cat catalogue illustrates very clearly the long-term work done by the IA team to develop studies of the relationship between the properties of stars and their planets.

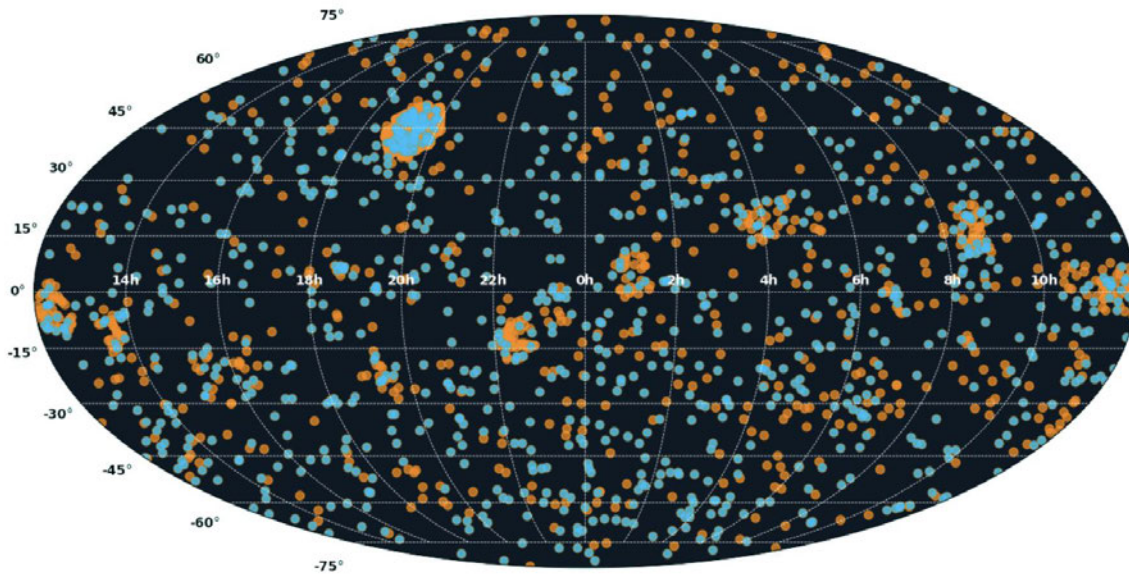


Figure: Map of the entire sky (Northern and Southern hemispheres) with the position of stars with planets in the SWEET-Cat catalogue. The yellow balls represent inhomogeneous parameters, while the blue ones are homogeneous parameters. (Credit: Sérgio Sousa - IA & U. Porto).

Group meetings, Journal Clubs and other activities

In 2021, as for the previous years, the IA-planet line maintained a regular journal club and team meeting agenda. Team meetings and journal clubs are organised every two weeks. Meetings include a presentation of “general information”, as well as a short presentation of the work being carried out by one PhD student, followed by discussion. This format helps the whole team to be acquainted with the research that is being carried out and helps the students to develop presentation skills and identify potential problems and solutions in his/her research project. Journal clubs include the presentation of recent research papers, followed by discussions.

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

Due to the covid-19 situation, all regular team meetings and journal clubs were performed remotely via Zoom. The regular contact helped to minimise the impact of the confinements and decreased human contact in the team's activities.

We also organised our annual team meeting (called "2-DEMOC"), where the team strategy and plans (both scientific and organisational) were discussed. This year's event took place in Porto, and allowed the integration of the new IA Coimbra node members in the team.

In 2021 the team also started a new series of workshops (“Planetary System's Days @ IA”), meant to present all scientific results obtained over the previous months and discuss defined scientific hot or strategic topics. Two such workshops were organised in 2021, to which all IA members were invited.

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

In 2021, 3 PhD thesis and 2 MSc dissertations were successfully finished at CAUP (several others ongoing):

- "Detection and characterization of planets orbiting oscillating red-giant stars with NASA's TESS mission", by Filipe Pereira (PhD)
- "Looking for rings and tides in transiting planets", by Babatunde Akinsanmi (PhD)
- "Radial velocity data analysis and optimization of observations for the ESPRESSO", by Saeed Hojjanpanah (PhD)
- "Composition of terrestrial planets orbiting M dwarfs", by Barbara Soares (MSc)
- "Chemical composition of super-massive planet hosts: the clue to their formation", by Mariana Reis (MSc)

and one ERASMUS+ PhD student also joined the team (for a 4-month stay, between November 2021 and February 2022). Finally, a number of undergraduate students (Barbara Oliveira, Yuri Damasceno, Ana Paulino, Telmo Monteiro, Afonso Mota, Bruna Fena, Rafael Silva, Diogo Quirino, Bernardo Campilho, Antonio Miguel Braçais Correia) also did short research work/internships with team members.

Team funding comes mostly from IA "strategic funding" as well as from 3 running FCT projects. Furthermore, funding for our participation in the PLATO and ARIEL missions was secured through PRODEX for the 2022-2023 period. We note, however, the PRODEX funding covers only the "project level activities".

Nuno Santos

Group Leader

Report from the Group - Towards a comprehensive study of stars

The year 2021 witnessed the expansion of IA with the integration of the new Coimbra node. This had a direct impact on the research scope of our Group, as extensive expertise on the fields of solar physics and space weather was now at our disposal. Together with a change in the Group leadership in July 2021, this naturally led to a revision of the Group's high-level structure and strategy. Our research activity thus currently revolves around four main thematic lines: *Star Formation*, *Stellar Physics*, *Stellar Populations* and *The Sun and the Heliosphere*.

The *Star Formation* thematic line focuses on two main areas of research:

- Star formation in the context of the large Galactic scale of the interstellar medium, focusing on the role of filamentary structures in generating the observed mass distribution from low- to high-mass stars, and the impact of feedback from massive stars.
- A detailed study of the evolution of individual pre-main-sequence stars and their circumstellar disks.

Over the past year, we have analysed submillimetre dust emission observations (using data from ESA's Herschel Space Observatory) of star forming regions in order to identify and derive physical properties of filaments, dense cores and protostars. Moreover, we continued performing infrared and millimetre studies (VLT and ALMA) of massive star formation and studied the impact of their feedback to trigger new generations of stars in the compressed layers of the cold molecular medium.

The characterization of pre-main-sequence stars and their environments and, in particular, T Tauri stars (TTs), is being achieved using several strategies, namely, photometric analysis of circumstellar disks around Classical T Tauri stars (cTTs), spectroscopic studies (UV and visible) of signatures of outflows and accretion rates, and spectropolarimetry observations using SPIRou@CFHT of the complex magnetic field structures permeating TTs. The team's involvement in SPIRou is of particular significance, with one of its members being part of the consortium's Steering Committee. We are also involved in the modelling of the topology of the magnetospheric region surrounding these objects, in devising simulations for the connection between accretion and outflows that ultimately control their evolution, and in the determination of mass accretion rates and angular momentum losses.

The *Stellar Physics* thematic line focuses on understanding the physical processes that take place in stars, from the stellar interior to the surface.

The team has a large expertise in data analysis and stellar modelling, and vast experience in probing the physics of stars. We develop, test and apply seismic inference tools aimed at retrieving information on chemical mixing and segregation in order to test, improve and validate new formulations being implemented in stellar evolution models.

The seismic analyses conducted by the team allow the measurement of the stellar mass, age, metallicity and helium abundance, the depths of the convective and helium ionisation regions, as well as the properties of stellar cores. Furthermore, we also measure and study rotation and magnetic activity in stars, both through asteroseismology and low-frequency brightness variations, in order to characterise stellar magnetic cycles and their driving mechanisms. Our research in stellar physics has strong connections with the evolution of stellar systems and their interaction with the circumstellar environment, including planets.

In the context of asteroseismology, we continue to be actively engaged in international consortia related to the NASA space missions Kepler/K2 and TESS. The exploitation of the seismic data from TESS is carried out predominantly in the context of the international consortium TASC (TESS Asteroseismic Science Consortium), in which our team is strongly involved, with representation on the Steering Committee and co-leadership of one

of its working groups. Furthermore, our team continues to be strongly involved in the preparation of the stellar science component of PLATO, with responsibilities in the design, implementation, and validation of sections of the Stellar Analysis System (SAS) pipeline, leading work packages in the framework of both the PLATO Science Management (PSM) and the PLATO Data Center (PDC). The team has also been contributing to the Ariel (ESA) consortium, in the context of which it is responsible for the determination of ages, masses, and radii of the stars in the mission's Reference Sample.

The *Stellar Populations* thematic line focuses on the precise characterization of solar-type and red-giant stars, which provides precious information that can be readily applied to several areas of research, including Galactic archaeology and Galactic chemical evolution.

The team has a vast experience in using high-resolution spectroscopy to determine stellar atmospheric parameters (namely, effective temperature, surface gravity, and metallicity), as well as the detailed surface chemical compositions of stars, which are then used to investigate the interstellar medium's elemental enrichment history across different regions of the Milky Way (or Galaxy). The team further combines the chemical compositions of stars with accurate asteroseismic age estimates to study the formation and evolution of different stellar populations of the Galaxy and of the Milky Way as a whole.

We continue to be actively engaged in several international consortia, including PLATO, Ariel, HIRES@ELT, the Maunakea Spectroscopic Explorer (MSE), ESPRESSO@VLT, NIRPS@ESO 3.6-m Telescope, SPIRou@CFHT, and the Gaia-ESO Survey (concluded), among others. Of particular note, the HIRES project successfully passed its Phase A and has started Phase B (Preliminary Design) in late 2021. Our team has a strong involvement in this project, playing a key role in the development of its scientific priorities and definition of top level requirements.

The *Sun and the Heliosphere* thematic line focuses on studying the solar atmosphere as well as the influence of solar activity on the heliosphere and the Earth's atmosphere, also known as space weather.

The team has vast experience in image processing, radiative transfer inversion, magnetohydrodynamic wave detection and analysis, and machine learning. We continue to apply these techniques to a variety of data sets, e.g., to solar spectropolarimetric observations in order to study the solar atmosphere, and to in situ observations of GNSS (Global Navigation Satellite System) signal disturbances, the Earth's magnetic field etc., to better understand how solar activity influences the Earth and near-Earth heliosphere.

We continue to participate and collaborate in several national and international projects. Members of the team are leading the Portuguese participation in the European projects SWATNet and SWAIR, are contributing actively to the EST Preparatory Phase, are building the first Portuguese solar spectropolarimeter, and are also developing the first detailed regional model of the ionosphere. We are also maintaining collaborations in the context of the SUNRISE and Solar Orbiter missions. Our participation in EST is of particular strategic importance. The Portuguese contribution to the project focuses on developing the Integral Field Spectropolarimeter based on Image Slicer, one of the team's members being Co-PI of the instrument.

Scientific highlights for 2021

1. PLATO hare-and-hounds

In Cunha et al. (2021, Monthly Notices of the Royal Astronomical Society, 508, 5864), the authors compare different approaches to the asteroseismic inference of stellar properties of main-sequence solar-like pulsators based on a pre-computed grid of models. The aim is to understand the accuracy and precision that may be expected on the inferred properties and identify critical aspects of the inference process that may need further development. Among other outcomes, the study points to the need for an extensive characterization of systematic errors resulting from model deficiencies and the importance of conducting an extensive study on the impact of

the degradation of seismic data as less bright stars are considered. This work stems from our involvement in the PLATO Science Management (PSM), in the context of which we have responsibilities in the design of sections of the Stellar Analysis System (SAS) pipeline.

2. The Galactic chemical evolution of Carbon

In Delgado Mena et al. (2021, *Astronomy & Astrophysics*, 655, A99), the authors derive carbon abundances for FGK dwarf stars in the HARPS-GTO sample, one of the aims being to study the Galactic chemical evolution of this element. They find a clear separation in terms of $[C/Fe]$ between the thin- and thick-disk populations, similarly to what has been found for α elements. They then go on to show for the first time that high- α metal-rich stars also have enhanced $[C/Fe]$ ratios when compared to thin-disk stars of similar metallicity, a trend that is observed up to a metallicity of ~ 0.2 dex. Moreover, the $[C/Fe]$ ratio shows an increasing trend with stellar age with a linear slope of 0.019 dex/Gyr, revealing the potential of abundance ratios involving carbon as age proxies.

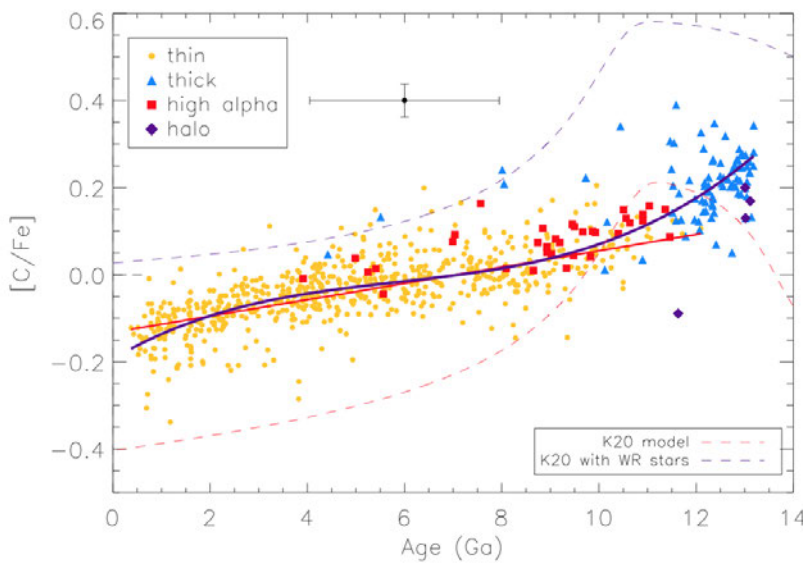


Figure 1: $[C/Fe]$ ratio as a function of age. From Delgado Mena et al. (2021).

3. An astrophysical solution to the Lithium problem?

In Deal et al. (2021, *Astronomy & Astrophysics*, 653, A48), the authors employ a self-consistent perturbative analysis of the effects on Big Bang Nucleosynthesis (BBN) of the relevant theoretical parameters, including variations of nature's fundamental constants, to gain insight into the well-known Lithium problem (i.e., the fact that the predicted abundance of Lithium-7 exceeds the observed one by a factor of a few). The authors quantify the amount of depletion needed to solve the Lithium problem and show that depletion mechanisms at work during stellar evolution, namely, transport processes of chemical elements, are able to account for it. Specifically, the combination of atomic diffusion, rotational-induced mixing, and some amount of penetrative convection allows reproducing the Lithium surface abundances of Population II stars, starting from the primordial Lithium abundance. This tentatively points to an astrophysical solution to the Lithium problem, with the aforementioned transport processes likely being the dominant contribution to its solution.

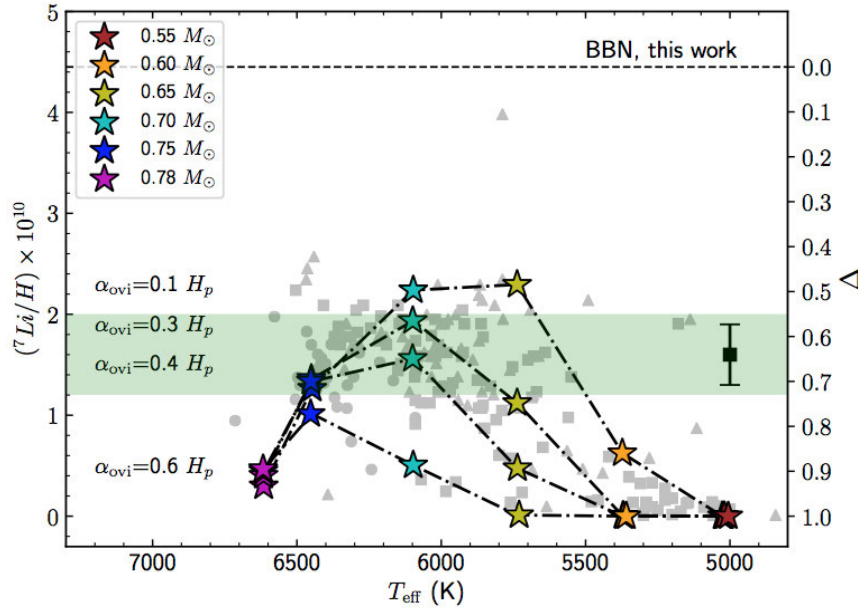


Figure 2: Lithium abundance for stellar models containing atomic diffusion, rotation, and penetrative convection. From Deal et al. (2021).

4. Asteroseismology made in Iberia

The *8th Iberian Meeting on Asteroseismology — Laying the groundwork for the road ahead* took place in October 2021 and was organised by Group members. The meeting gathered 72 registered participants from Iberia and beyond. Following the successful reinstatement in 2020 of the Iberian Meeting on Asteroseismology series, we gave continuity to this series by welcoming to this meeting the Iberian community and its diaspora — as well as some of our international collaborators — working on asteroseismology and related fields. This was a place to foster new collaborations and consolidate existing ones, discuss the challenges lying ahead, and find new, joint funding opportunities. The science program was multifaceted. At its core were a series of hands-on projects (7 in total). Hands-on projects took the form of either (i) self-contained, focused projects, (ii) the continuation of an ongoing project, (iii) or simply the exploitation of a novel idea. Meeting participants were free to join any project of their choice and, to guarantee that projects would run smoothly, we have created dedicated Zoom rooms, Slack channels, and cloud storage. We had two different types of talks during the meeting. During the opening session, we heard about the several institutes across Iberia where asteroseismology has a strong presence. Spread over the following three days, we had a number of talks (14) by young scientists. The rationale for this had to do with the pandemic and the increasing difficulty faced by young scientists in getting their work noticed by the community. Finally, we closed the meeting with a discussion on funding opportunities and a round table on a possible future joint application to Horizon Europe. The purpose of this round table was to sound out the community, identify the right funding opportunity(ies), and broadly identify the science case, with the aim of formalising our intentions during the next Iberian meeting, where we will hopefully meet in person.



Figure 3: Poster of the 8th Iberian Meeting on Asteroseismology.

Group meetings, Journal Clubs and other activities

We start by providing an overview of the internal procedures and meetings. Next, we highlight the main activity indicators for the year 2021, including funded projects, vivas, organisation of conferences and workshops, and outreach.

Regular meetings/activities

We hold biweekly Group meetings, a forum for discussing Group-related issues and strategy. These are held together with the Journal Club. Moreover, we hold so-called Stellar Physics meetings on a biweekly basis, a science forum for presenting and discussing work conducted by Group members on stellar/solar physics. In 2021, we instated Stars Day, a half-day science meeting highlighting the work conducted by Group members and fostering debate. Stars Day is meant to be an annual event (to be combined with a Christmas lunch in the post-pandemic) and is organised by the grad students. Finally, we also hold an annual 'SOAR analysis' meeting prior to IA-ON.

Website

The Group's new website was published in December 2021 and can be found at <https://estrelas.iaastro.pt/en>

Funded projects

FCT R&D projects (ongoing in 2021):

- 1 project (regular).
- Previous call (2021): 6 projects were submitted (5 regular and 1 exploratory). One project (exploratory) was retained for funding.

Estímulo and Investigador FCT (ongoing in 2021):

- 2 Investigador FCT contracts ended in December 2021 (not accounting for extensions).
- 3 Estímulo contracts (1 Junior, 1 Assistant, and 1 Associate).

- Previous Estímulo call (4th edition): 2 successful applications (1 Junior and 1 Assistant). This amounts to 5 successful applications in the first four editions.

European funding (ongoing in 2021):

- MW-GAIA COST Action (Co-I).
- SWATNet — MSCA Innovative Training Network (Co-I).

Other funding (ongoing in 2021):

- OREO (PI).

PhD/MSc vivas

PhD:

- *Detection and characterization of planets orbiting oscillating red-giant stars with NASA's TESS mission* — Filipe Pereira.

MSc:

- *The star-disk interaction in Young Stellar Objects* — Hernán Asorey.

Organisation of conferences/meetings/workshops

- 1st i4s — Iberian Space Science Summer School.
- Space Summer School 2021.
- COSPAR International Space Weather Action Teams (ISWAT) 2nd Working Meeting (Part 1).
- 8th Iberian Meeting on Asteroseismology (Imas).

Outreach

- 2 press releases.
- Partnership with National Geographic Portugal: 3 articles by Group members (1 of which by a PhD student).
- Partnership with SAPO TEK: 2 articles by Group members.
- *O Universo Online*: 2 sessions hosted by Group members.
- IAstro Summer Internship program: 4 projects by Group members during 2021 edition.
- *Semana da Leitura 2021 — Como o céu brilha nas palavras*: participation of 2 Group members.
- *Dia Internacional das Mulheres e Raparigas na Ciência 2021 — Astronomia no Feminino*: Participation of 2 Group members.
- *Dia Nacional da Cultura Científica 2020 — Livros Top – Ciência e Literatura*: Participation of 1 Group member.

Tiago Campante

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 2021. 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 supermassive 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 13 researchers, 11 collaborators and 10 students, are served by the participation of IA with leadership roles in the instrument consortia of MOONS@VLT, BlueMUSE@VLT, 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 optimised computational tools for the scientific exploitation of multi-wavelength data for galaxies near and far.

The growth of SMBHs and their observational manifestations as Active Galactic Nuclei (AGN) is being investigated by the Group both at highest redshifts and in the nearby universe. The emergence of the very first powerful AGN in the Universe, and how they shaped the earliest galaxy evolution is being studied through sub-mm observations with IRAM and the revolutionary ALMA, and by post-processing cosmological simulations to obtain quantitative predictions on the number and detectability of early SMBHs at X-rays and radio wavelengths. Building upon its expertise on the analysis and interpretation of multi-wavelength data, and as part of a coherent strategic roadmap, the Group is developing new observational discriminators for the detection of proto-AGN at the Epoch of Reionization (EoR). It also acts as a strong driver in the development of 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 its operation in 2023.

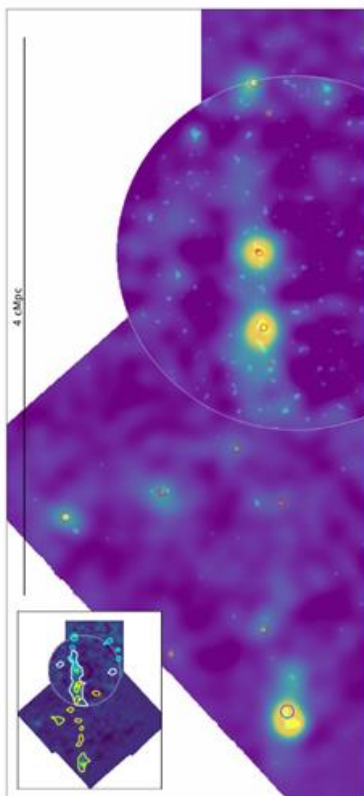
During 2021, the team continued having a key involvement in the preparation of guaranteed time observations with MOONS and in the definition of strategies for the reduction and analysis of data from it. IA researchers assume major roles in several MOONS Science and Technical Working Groups (WGs), including the co-leadership of the AGN WG and the technical WG-1, and have an active role in the scientific WGs on Physics of the ISM, Passive galaxies and stellar continuum, Galaxy environment, Large-Scale Structures, High- z Universe and the EoR, Clusters/Protoclusters, and in the technical WGs on Mock Catalogues from Simulations,

Determination of Redshift and Physical Parameters from Spectra, and on the Determination of Environmental Parameters.

Another important field of the activities of the Group centres on spatially resolved investigations of galaxies with IFS and deep multi-band photometry. Using MUSE and the CALIFA and MaNGA IFS galaxy surveys, 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 ionising photon efficiency across cosmic time, massive Wolf-Rayet stars and the diffuse ionised gas in star-forming galaxies, and the nature of ultra-faint galaxies. Furthermore, using ALMA, MUSE and FADO the team is studying the action of starbursts on the molecular gas phase in extremely metal-poor dwarf galaxies, which may be considered the best local analogs of the first proto-galactic units that emerged at the EoR. The activities of the team also encompass the development of Machine Learning tools for the identification of high- z AGN and the characterization of galaxies from the Euclid Galaxy Legacy Survey, which is co-led by IA.

Scientific Highlights for 2021

1. The cosmic web back to 1.3 billion years after the Big Bang detected in Lyman- α



The IA researcher Jarle Brinchmann has participated in an unprecedentedly deep exploration of Ly α emission at high redshift. This project, which used a total integration time of 140 hours with MUSE@VLT led to the discovery of diffuse extended Ly α emission at $3.1 < z < 4.5$ (i.e., between 1.3 and ~ 2 Gyr after the Big Bang) tracing cosmic web filaments on scales of 2.5–4 Mpc in comoving scale (Bacon... Brinchmann et al. A&A 647A, 107B). Among the 22 overdense regions identified, five are likely to harbor very extended Ly α emission at high significance with an average surface brightness of 5×10^{-20} erg s $^{-1}$ cm $^{-2}$ arcsec $^{-2}$. Quite importantly, 70% of the total Ly α luminosity from these filaments comes from beyond the circumgalactic medium of any identified Ly α emitter. Fluorescent Ly α emission powered by the cosmic UV background can only account for less than 34% of this emission at $z \approx 3$ and for not more than 10% at higher redshift.

Fig.1: Extended diffuse Ly α emission at $z=3.07$ in one of the (22) overdensities discovered in the MUSE UltraDeep by Bacon ... Brinchmann et al. (2021).

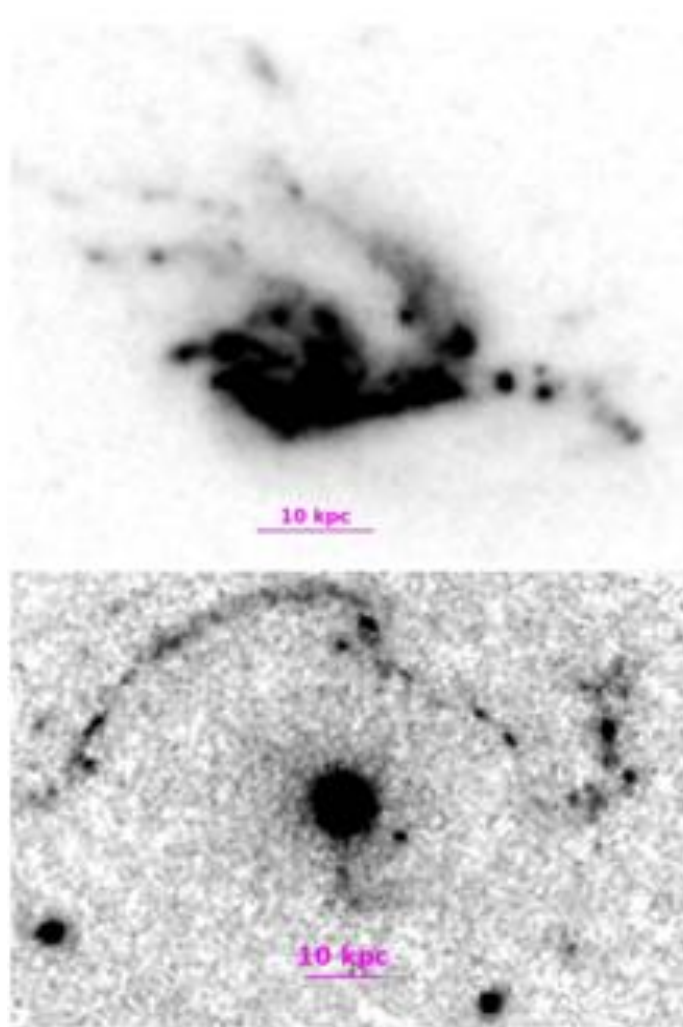
A key insight from this study has been that this diffuse Ly α emission requires the presence of a large population of ultra low-luminosity Ly α emitters (< 1040 erg s $^{-1}$), provided that the faint end of the Ly α luminosity function extends down to luminosities lower than $10^{38} - 10^{37}$ erg s $^{-1}$, and the clustering of these Ly α emitters is significant (filling factor $< 1/6$). If the discovered Ly α emitters are powered by star formation, then this implies star formation rates (SFRs) $< 10^{-4} M_{\odot}$ yr $^{-1}$. These observations provide the first detection of the cosmic web in Ly α emission in typical filamentary environments and the first observational clue indicating the existence of a large population of ultra low-luminosity Ly α emitters at high redshift.

2. Using Machine Learning tools to study galaxies

A project by the team led to the development and validation of a ML technique for estimating galaxy redshifts in the Euclid Galaxy Legacy Survey (Humphrey et al. 2021, under internal review within the Euclid consortium) and the efficient discrimination between high- z quasars and foreground Galactic stars (Cunha & Humphrey, in prep.). This is part of a larger effort by the team for Euclid to use ML to exploit the large dataset expected.

3. Influence of the environment on galaxy evolution

The team has continued its studies of the action of the environment on galaxy evolution, both in clusters and compact galaxy groups, and in individual galaxy pairs in a strong gravitational interaction.



Durret, Chiche, Lobo & Jauzac (2021, A&A 648A, 63D) have searched a sample of 40 galaxy clusters from the DAFT/FADA and CLASH surveys at $0.2 < z < 0.9$ for jellyfish galaxies, and identified on HST ACS images ~ 100 such systems with clear signs of ram pressure stripping and morphological distortions. Based on best-fitting synthetic spectral energy distribution to multi-wavelength data they inferred the stellar mass of their sample galaxies to $10^9 - 10^{11} M_{\odot}$, and their SFR to $0.1 - 60 M_{\odot} \text{ yr}^{-1}$.

Interestingly, more than half of the sample in one of the studied clusters (MACS0717) shows intense star-forming activity with specific SFRs as high as $> 10^{-9} \text{ yr}^{-1}$. The sample of these newly identified jellyfish galaxies constitutes a valuable basis of future work.

Fig. 2: Example of a jellyfish galaxy (upper panel) and a morphologically distorted spiral galaxy (lower panel) from the sample by Durret, Chiche, Lobo & Jauzac (2021), demonstrating the action of ram pressure stripping and gravitational interactions on the evolution of galaxies in clusters.

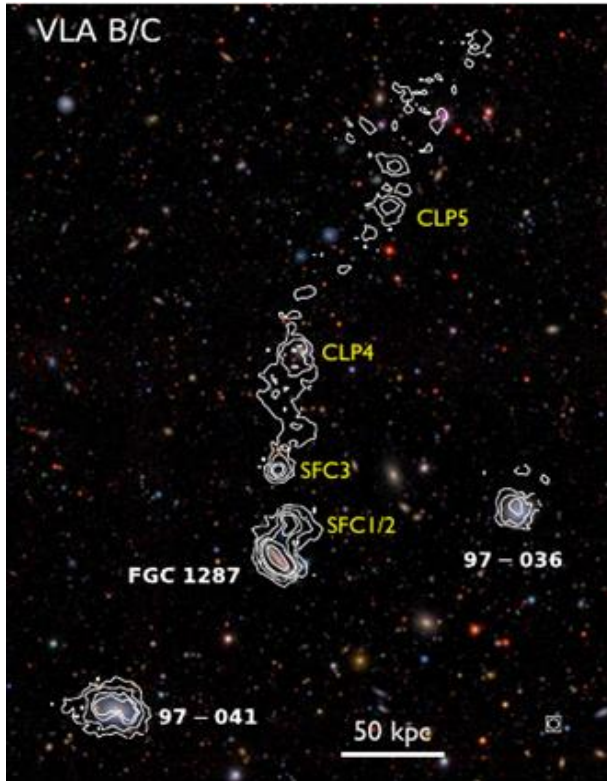


Fig. 3: FGC 1287 galaxy triplet: HI VLA B/C-configuration HI column density map as contours on a composite SDSS g, r, i-band image, coded as BGR. HI contours are at column densities of 0.5, 1.6, 3.1, 4.7, 6.2, 9.3, and $12.5 \times 10^{20} \text{ atom cm}^{-2}$. The three HI detected galaxies are marked together with the projected positions of principal HI clumps in the FGC 1287 tail (from Scott ... Lagos et al. 2021, MNRAS, submitted).

Further insights into the role of the environment on galaxy evolution could be gained through interferometric HI studies of the galaxy triplet FGC 1287 in the outskirts of the galaxy cluster Abell 1367. [Scott ... Lagos et al. \(2021, MNRAS, submitted\)](#) have detected a 250 kpc long HI tail north-west of FGC 1287. The nature of this feature is enigmatic, given that observations with XMM-Newton do not reveal X-ray emission in the volume of the galaxy triplet, which places an upper limit of $2.6 \times 10^{-5} \text{ cm}^{-3}$ on the electron density and makes unlikely that the observed tail has resulted from the interaction of neutral hydrogen with the hot intracluster medium. In a similar context, [Scott, Sengupta, Lagos et al. \(2021, MNRAS 503, 39\)](#) used data from the Giant Metrewave Radio Telescope (GMRT) for a comparative study of the HI properties of two ultra-diffuse galaxies, one of those in the outskirts of a Hickson Compact Group and the other one truly isolated.

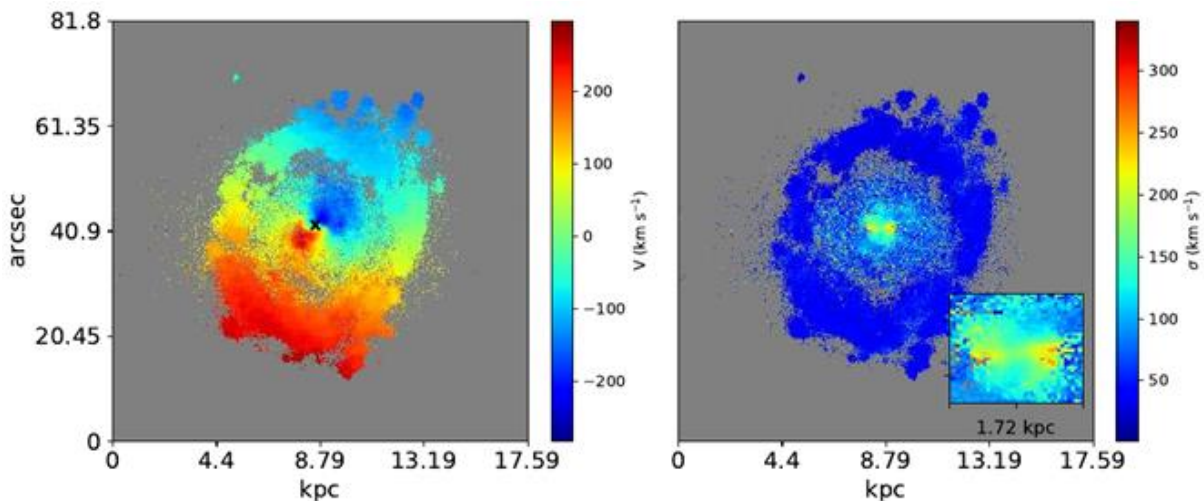


Fig. 4: Example of the analysis of group dominant galaxies by [Lagos ... Scott et al. \(2021, in prep.\)](#). Gas velocity (left panel) and gas velocity dispersion (right panel) obtained for the galaxy ESO0507-G025 from fitting the

[NII] 6583 emission line. The position of the continuum maximum is indicated by the X symbol. A zoom into the velocity dispersion map of the nuclear region of the galaxy is shown in the inset panel. North is up and east is to the left.

A parallel line of investigation by the team focuses on the star formation history and gas excitation mechanisms in massive ($>10^{12} M_{\odot}$) galaxies in the densest known galaxy clusters (Pagotto .. [Brinchmann et al. 2021, A&A 649A, 63P](#)) and in group-dominant galaxies ([Lagos ... Scott et al. 2021, in prep.](#)). Lagos et al., by applying the IA-developed spectral synthesis code FADO ([Gomes & Papaderos 2017](#)) to deep MUSE IFS data for 18 group-dominant galaxies (all of those classified as Ellipticals and S0) were able to accurately subtract the underlying stellar continuum and perform a thorough analysis of the gas-phase metallicity and excitation diagnostics. An insight gained from this study is that the centers of group-dominant galaxies typically show LINER-like emission-line ratios that possibly hint at an AGN, and that extranuclear star-forming regions in some S0s are chemically homogeneous. Various lines of evidence presented by these authors suggest that group-dominant galaxies likely acquired their cold gas via gas-cloud accretion and/or cooling flows. Finally, the rôle of strong galaxy interactions on the star formation history and chemical patterns of galaxies was studied in the galaxy merger NGC 1487 by applying FADO to MUSE IFS data (Buzzo ... [Papaderos et al. 2021, MNRAS 503, 10](#)). This study found flat and in some cases inverted oxygen abundance gradients that presumably reflect the combined effect of gas inflows and mixing of heavy elements within the turbulent gas medium of this galaxy merger.

4. Studying the nature of dark matter in ultra-faint dwarfs

Ultra-faint dwarfs (UFDs) contain very few stars relative to their dark matter (DM) content, with many cases of stars contributing less than 1% of the total mass of the galaxy. This means that they have a very small effect on the gravitational potential of the galaxy and they can be used as test particles in a DM dominated potential. For this reason UFDs are suitable laboratories to study the density profile of DM and distinguish between competing theoretical concepts, such as a cuspy NFW profile and a DM profile exhibiting a central density plateau. Jarle Brinchmann is the PI of a survey of a sample of UFDs using MUSE (MUSE-Faint). Recently, this project led to constraints on the DM density profile of Eridanus II (Zoutendijk, Júlio, Brinchmann, ..., Vaz et al 2021, A&A, submitted), showing that if there is a core in this UFD it must be much smaller than those seen in more massive, star-forming dwarfs. This insight rules out modified DM as the origin of those cores.

A significant step forward has been possible through two MSc research projects completed at IA in 2021: a study of stellar kinematics for the borderline dwarf Leo T by the student Daniel Vaz has helped improving constraints on axion DM in a certain energy range by two orders of magnitude (Regis, Macro, Vaz, Brinchmann et al 2021; PhL 81436075R). Additionally, the student Mariana Julio has studied with MUSE the transition dwarf Antlia B to place limits on scalar field DM.

5. Star formation quenching at the centres of massive spiral galaxies

Our knowledge about the photometric and structural properties of bulges in late-type galaxies (LTGs) is founded upon image decomposition into a Sérsic model for the central luminosity excess of the bulge and an exponential model for the more extended underlying disk. A study led by IA researchers (Papaderos, Breda, Humphrey, Gomes, Ziegler & Pappalardo 2021, A&A in press) argued that the standard practice of adopting an exponential model for the disk all the way to its center is inadequate because it implicitly neglects the well-established fact of star formation (SF) quenching in the centres of massive LTGs: Extrapolating the fit to the observable star-forming zone of the disk (outside the bulge) inwardly overestimates the true surface brightness of the disk in its central SF-quenched zone, consequently it leads to a systematic underestimation of the luminosity of the bulge. This effect (referred to as δ_{io}) was for the first time quantitatively studied by IA-researchers based on predictions from evolutionary synthesis models and by using the IA-developed tool RemoveYoung (Gomes & Papaderos

2016) to infer the luminosity contribution of young stellar populations in the bulge and disk. The IA team demonstrated that δ_{io} in massive LTGs can reach values of up to ~ 2.5 (0.7) B (K) mag, consequently the neglect of SF quenching in state-of-the-art galaxy decomposition studies introduces important biases in scaling relation involving bulge luminosities. Framed in the picture of galaxy downsizing and inside-out SF quenching, δ_{io} is expected to differentially impact galaxies across redshift and stellar mass M_* , thus leading to systematic and complex biases in the scatter and slope of various galaxy scaling relations. One conjecture made is that correction for the δ_{io} effect will lead to a down-bending of the bulge versus SMBH mass relation for galaxies below $\log(M_*/M_\odot) \sim 10.7$. This could offer an element for understanding the scarcity and weakness of accretion-powered nuclear activity in low-mass spiral galaxies.

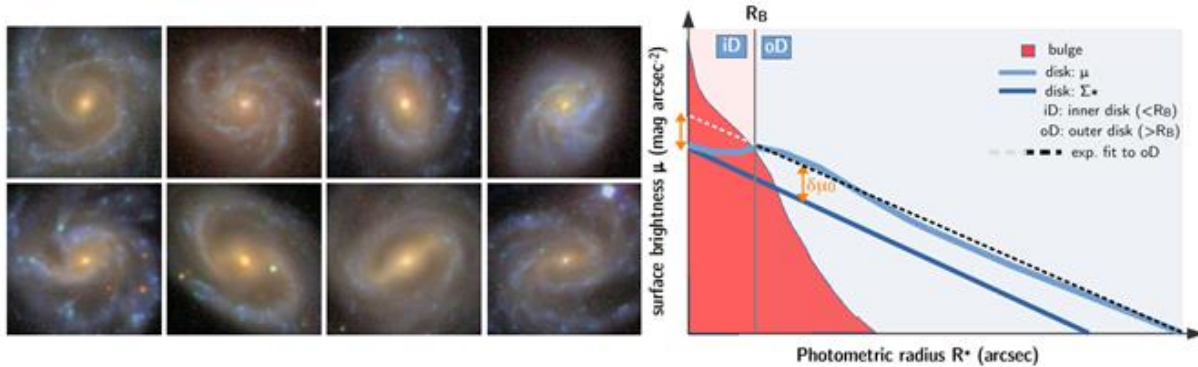


Fig. 5: **left:** SDSS true-color thumbnails illustrating the typical morphology of Milky Way-sized LTGs in the local Universe, with their central SF-quenched zone and the surrounding blue star-forming disk. **right:** Schematic representation of the bulge (shaded red area) and the disk (light blue) in a face-on late-type galaxy. The surface brightness profile of the disk results from the projection of an exponential stellar surface density Σ_* (dark blue), whereby the mass-to-light ratio in the inner SF-quenched zone of the disk (iD) within the bulge radius R_B is higher than that in the outer ($R^* > R_B$) star-forming zone of the disk (oD). A consequence of this is that the central surface brightness of the disk is fainter by $\delta\mu_0$ mag than the value implied by inward extrapolation of the exponential fit to the outer disk (dashed line) and that standard bulge-disk decomposition overestimates the integrated magnitude of the disk within R_B by δ_{io} (mag). This in turn entails an over subtraction of the disk and an underestimation of the luminosity of the bulge (from Papaderos, Breda, Humphrey, Gomes, Ziegler & Pappalardo 2021, A&A in press).

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, and 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 2021, 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.

The dynamics of the team is also reflected in the continued development and intensive testing of Machine Learning and spectral fitting tools, which will strongly support its scientific activities in the context of Euclid, MOONS@VLT, MOSAIC@ELT and BlueMUSE@VLT, the organisation of the IA-internal workshop "1st Galaxies Day @ IA" (April 2021), and in the co-organization of the three-day online conference "Massively Parallel Large Area Spectroscopy from Space" (Co-Chair: J. Brinchmann) with 189 participants (June 2021).

Polychronis Papaderos

Group Leader

Report from the Group - Unveiling the dynamics of the Universe

This report highlights contributions in the main subjects of research in the cosmology group, centering around dark energy, modified gravity and cosmic defects. We focus essentially on the Euclid, ESPRESSO and LISA missions.

Euclid is a mission dedicated to the exploration of the dark universe through the measurement of the properties of the cosmological large-scale structure. IA is strongly involved in this mission, participating in the consortium board, in various Science Working Groups and in the Survey Design. This year several members and collaborators of the IA cosmology group have participated, sometimes as lead-authors, in the writing of more than 20 pre-launch key and standard papers, some already published in 2021, and others to be published next year. One of our members is now deputy of the Euclid Survey Working Group and the new Survey model owner.

The ESPRESSO spectrograph is an instrument of interest to several groups in IA. For cosmology, its main interest lies in the possibility of measuring variations of the fundamental constant. As planned, its data analysis for fundamental physics data was processed this year. This resulted in the paper “Fundamental physics with ESPRESSO: Precise limit on variations in the fine-structure constant towards the bright quasar HE 0515-4414” to be published in A&A, with authorship of several IA members.

LISA will be a large-scale space mission designed to detect gravitational waves. This year, the project for cosmic string parameter estimation has resumed, after a hiatus of almost two years due to the pandemic and a reorganisation of the consortium. The objective of this project is to provide templates for the different cosmic string models that may be probed with LISA and to start building a template catalogue for the mission. This project has now been adopted as a Work Package by the LISA science group. LISA Science white papers are in their final stages of preparation both for the cosmology working group and the fundamental physics working group; these have co-authorship of several team members.

This year the biennial edition of the “Review of Particle Physics” went live in December, with the section on Cosmological Parameters co-authored by one team member.

Scientific Highlights for 2021

New constraint on the fine-structure constant variations

The strong intervening absorption system at redshift $z=1.15$ towards the very bright quasar HE 0515-4414 is the most studied absorber for measuring possible cosmological variations in the fine-structure constant, α . This quasar was observed for 16.1 h with the Very Large Telescope and the new ESPRESSO spectrograph. This culminated in the first ESPRESSO constraint on relative variations in α with parts-per-million precision, $\Delta\alpha/\alpha = 1.3 \pm 1.3_{\text{stat}} \pm 0.4_{\text{stat}}$. The high resolving power of the ESPRESSO spectrum enabled the identification of very narrow components within the absorption profile allowing a more robust analysis of $\Delta\alpha/\alpha$. These results are presented in the paper “Fundamental physics with ESPRESSO: Precise limit on variations in the fine-structure

constant towards the bright quasar HE 0515-4414” (Murphy et al. to be published in A&A), with several team members as authors.

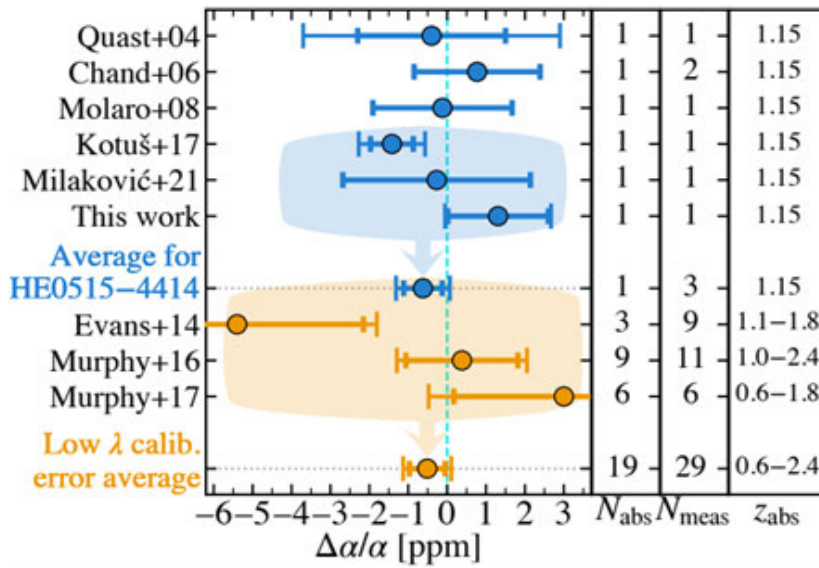


Figure 1: Measurements of the fine structure constant variation in the $z=1.1508$ absorber towards HE0515-4414 (blue points) and recent measurements corrected (or insensitive) to wavelength calibration errors (orange points).

Euclid preparation papers

The first Euclid pre-launch key paper, “Euclid preparation: I. The Euclid Survey” is ready to be published in A&A, with several team members in Lisbon as core authors. This paper presents the building of the Euclid reference survey: the sequence of pointings of the Euclid Wide Survey, Deep fields, Auxiliary fields for calibrations and spacecraft movements followed by Euclid as it operates in a step-and-stare mode from its orbit around the Lagrange point L2. The resulting reference survey fulfils all constraints and is a good proxy for the final solution. Its wide survey covers 14,500 square degrees. A number of CAUP node members are also active participants in Euclid and are co-authors of other Euclid preparation papers.

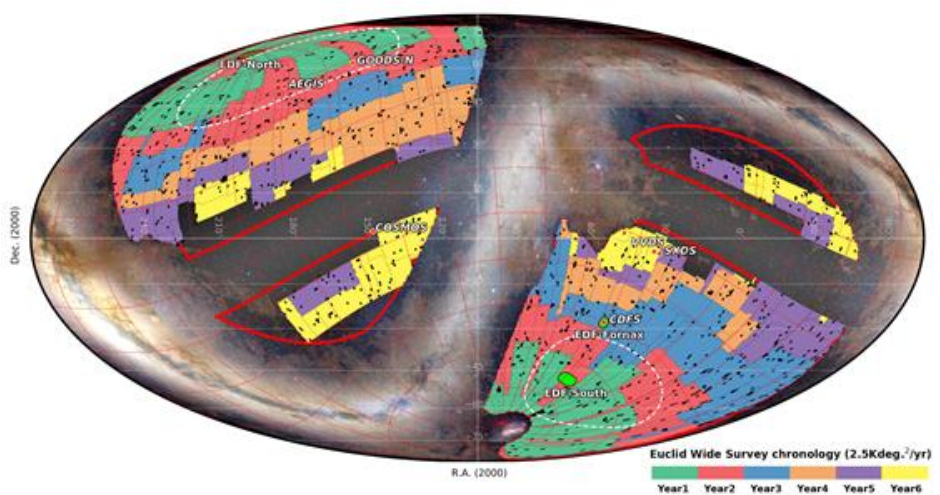


Figure 2: Reference Survey Definition 2021A (14514 square degrees) chronology shown in celestial coordinates. Region-of-interest boundaries are shown as solid red lines. The three Euclid Deep fields (bright green) and the six Euclid Auxiliary fields (red diamonds, not in size) are shown.

Group meetings, Journal Clubs and other activities

The cosmology group held almost ten seminars during 2021. These were mostly online zoom seminars due to the current pandemic situation.

The group also had regular weekly journal club meetings. In total the group held 37 “CosmoClub” online zoom meetings in 2021. Every week a different team member brings one paper (sometimes more) for discussion.

Details can be found in <http://ia-cosmocub.wikidot.com>

Team members were also actively engaged throughout 2021 with the Science Communication group for several outreach activities.

Three students of the cosmology team successfully completed their PhD thesis in 2021.

Report from the Group – Instrumentation and Systems

CAUP participates in the scientific and technical development of Astronomical Instrumentation, which transverses both major scientific areas in CAUP. 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.

Several CAUP members continued to be involved in the scientific definition of astronomical instrumentation through IA and several projects have been running in collaboration with other Portuguese teams. Given the interlinked nature of this Group, no effort is made to separate activity in Lisbon from that in Porto but the hardware work is all carried out in the laboratories in Lisbon.

Due to the pandemic situation that continues to affect everyone, 2021 was again a very hard year for the Astronomical Instrumentation and Systems Group (AISG). The observatories were closed, all the work was done remotely and the delivery times of parts and manufacturing services became much longer than normal. Nevertheless, as seen in this report, we were able to progress significantly in the current running projects and prepare the ones to come in the next year.

During 2021, the following instruments had engineering and implementation activities at IA:

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

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

During 2021, Bachar Wehbe concluded his PhD thesis, titled “*Atmospheric Dispersion Correction for High Resolution Astronomical Instruments*” and also became a researcher of IA.

Two new PhD students started their work at the end of the year: Inês Leite and Nuno Gonçalves.

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

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

Following is listed the activity detail of the running projects.

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 characterise 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 scientific activities.

2021 saw the conclusion of the commissioning of the ADC in the ESO 3.6 m telescope in La Silla. Due to the confinement, all the activities were done remotely, increasing the complexity and time required to achieve the success. First light for science is foreseen in 2022.

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 2021 the activities focused on the conclusion of the tests of all the mechanisms that the RFE will comprise and also in the integration of a new metrology system that the team was in charge of. It is now expected that the fully integrated RFE is transferred during the first half of 2022 to UKATC in Edinburgh for Preliminary tests in Europe before its integration in Chile. The field corrector manufacturing was concluded (and systems were accepted) and the structure that will interface it with the telescope started its manufacturing in 2021 (to be concluded in the beginning of 2022).

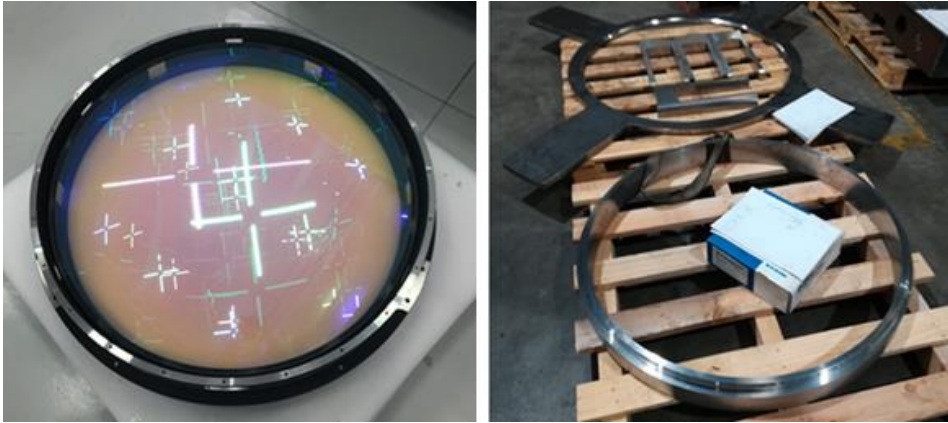


Figure: The MOONS (ESO) FC lenses at Officina Stellare (Italy) and the current status of the structure that will support it in CUNHOL (Portugal).



Figure: The MOONS (ESO) RFE during integration on the new rotation metrology subsystem.

HIRES (ESO)

HIRES is the project for a high resolution spectrograph to be installed at the ESO E-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 the finishing of the Phase A studies in 2017, during 2021 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 GTO program. In the final days of 2021, the Instrument got the green light from ESO to start. Phase B is foreseen to Kick off March 2022.

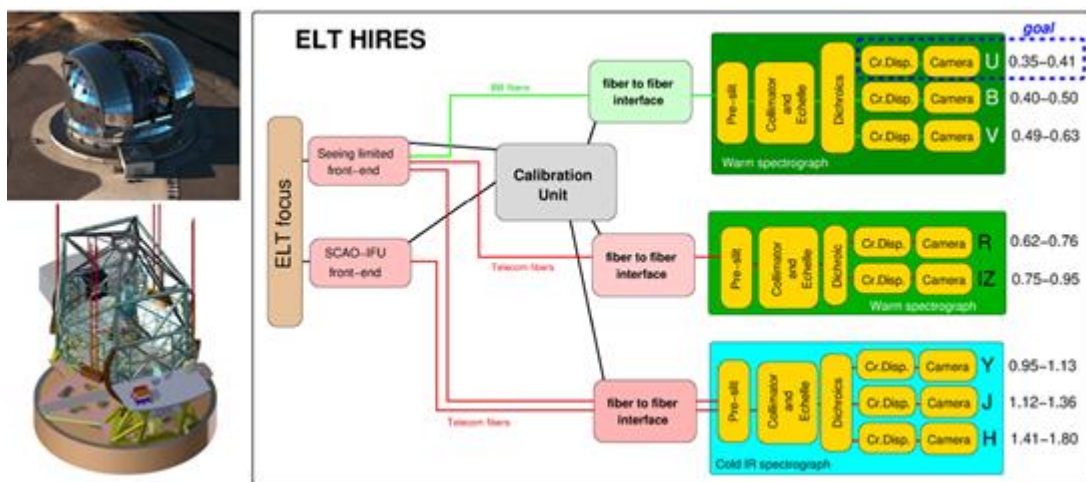


Figure: HIRES (ESO) at the ELT and instrument architectural design, outlining the instrument subsystems: Front End (seeing-limited and AO assisted with SCAO unit), Fibre Link, Calibration Unit, VIS-Blue, VIS-Red and NIR (cold spectrograph).

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 2021, 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 further consolidated the development of the survey generating tool.

The major novelty was the introduction of a scheme to avoid observing very bright stars. At first, this was implemented by skipping tiles of a tessellation. Later, this was further improved by adapting the tessellation to snug tightly around bright stars. This also required the adaptations of the patch scheduling, to skip across the holes left behind by bright stars. Another source of attention was the injection of the SOP (special operations) windows. These are spacecraft maintenance slots that need to take place exactly once every four weeks (around noon, on Mondays). It had a major impact on development, given its stringent requirements and the coupling with the PSF calibrations (another stringent target). The inner workings of the tool were also improved with the implementation of a new framework for designing the intermediate survey; a mid-stage survey made of only calibrations and deep-fields.

A few smaller activities also took place. The covering of deep-field south shape, a stadium, was improved with a tighter set of patterns. The instruments FoV (VIS and NISP) were measured as build, requiring an adaptation to its precise contours, with impact on the tessellation. The range of alpha and solar aspect angles (that strongly conditions the movements of the spacecraft) was reduced slightly, requiring some adaptations to the surrounding algorithms. In total, three reference surveys were delivered this year. The first, the RSD2021A, was delivered in July. A second survey was delivered in September, the RSD2021B, for the SVT-1 validity review (by ESA). A third survey was delivered, the RSD2021C that fixed some inconsistencies spotted in the review.

The year ended with the development of an additional four surveys, one to incorporate all the latest specifications and corrections, and three more to test a few scenarios, all to be delivered in time for the Mission Keypoint Review, to be held in January 2022.

In 2021 we also participated as leading authors in writing the first Euclid key paper; Euclid preparation: I. The Euclid Wide Survey (in press, A&A accepted, arXiv preprint: <https://arxiv.org/abs/2108.01201>)

As launch approaches, a more intensive calendar of survey meetings was put in place by ESA. The group was present in these new regular bi-weekly meetings with ESA.

CHEOPS (ESA)

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

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

In 2021, CHEOPS will continue to run well within specifications and continue to get scientific observations of high precision. IA continues to give maintenance support to the data reduction pipeline during the CHEOPS mission. In the final trimester of 2021, the CHEOPS consortium has started discussion for the possibility of an extension to the mission and this will be proposed in 2022.

PLATO (ESA)

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

Regarding the contribution to the OGSE, since the beginning of 2021, the collimator built by IA was integrated in the CSL (Be) setup and is contributing to the process of integration and test of the Plato cameras. The IA team has been supporting CSL in the operation of the collimator, in particular adapting/configuring the collimator software to meet the specifications of Electronic GSE built by the Belgium team.

During 2021, a second collimator was also mounted and prepared to be shipped to CSL Belgium in the beginning of 2022.

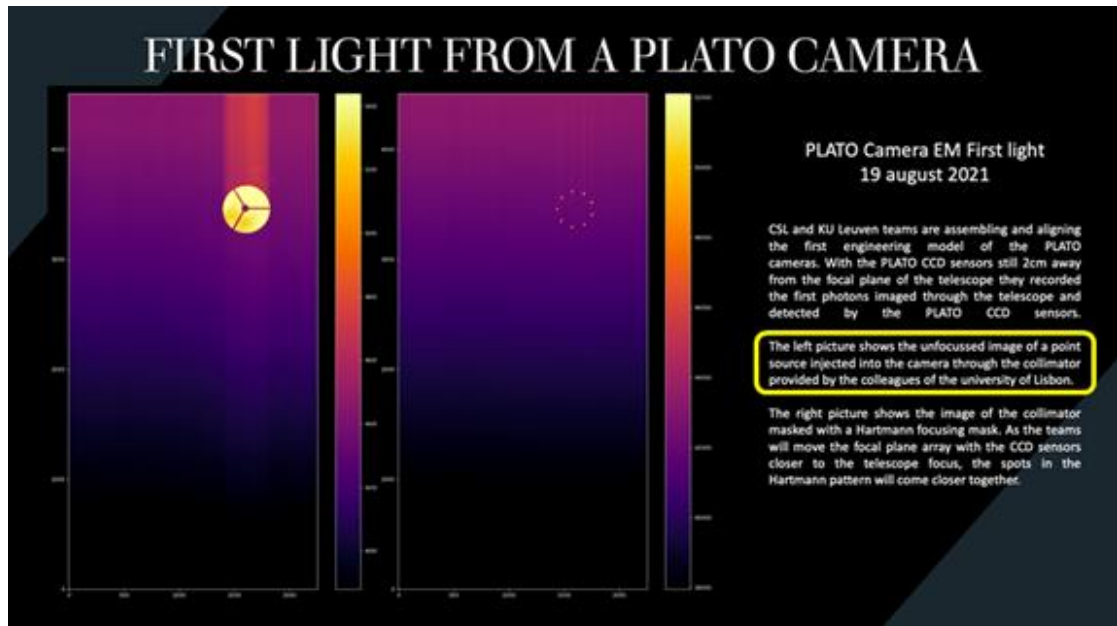


Figure: PLATO (ESA) First light from Plato camera using the White light collimator built by IA.

The activities regarding other work packages associated with 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.

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 of IA – instrumentation in ARIEL and together with the OGSE team led by Oxford University, were associated with the definition of the OGSE requirements.

The main effort of the team resulted in the System Requirements Review (SRR) milestone being achieved successfully in the first months of 2021. Since then, work progressed to the completion of the next milestone, the PDR, which will occur in February 2022.

The contribution of IA in the OGSE will include the development of the Visible and Near IR illumination unit, as well as in the development of a reference detector to monitor source intensity fluctuations. Regarding this last issue, the team is preparing a cryo/vacuum setup to test the reference detectors in a 70K environment.

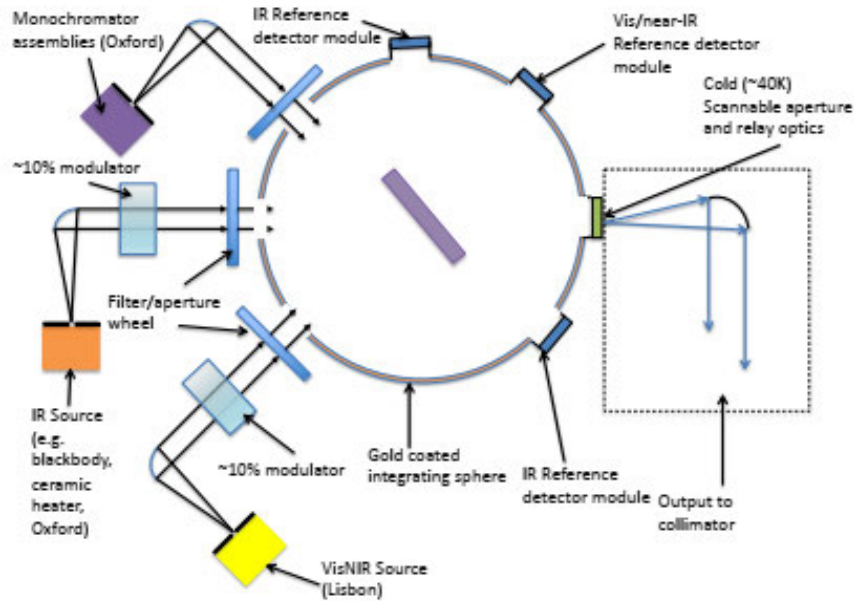


Figure: Schematics of the light source of the Ariel OGSE, which will integrate the VisNir source and the VisNIR reference detectors.

ATHENA (ESA)

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

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

During the year of 2021 the team successfully achieved the SRR milestone and is now on course for the PDR, which will occur in the beginning of 2022.

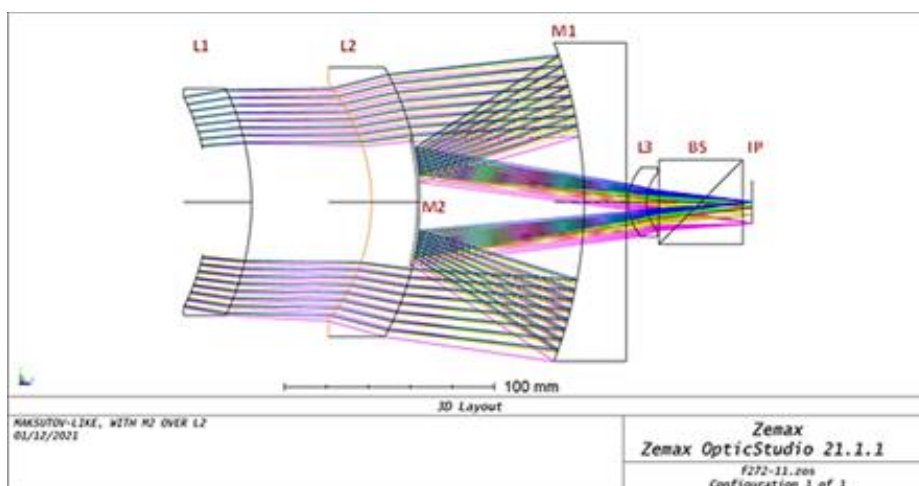


Figure: Depiction of the optical telescope being developed for the Athena OBM.

Highlights for 2021

1. The conclusion and acceptance of the MOONS field corrector, comprising two lenses with 900 mm diameter for the ESO Very Large Telescope.

2. The successful commission on the sky of the NIRPS ADC in the 3.6m telescope of the La Silla ESO observatory.
3. First light of a Plato Camera using our collimator. Second collimator being finalised for delivery to CSL
4. ARIEL OGSE System requirements review: successful milestone
5. Athena OBM System requirements review: successful milestone
6. HIRES green light to go from the European Southern Observatory.

Alexandre Cabral (Lisbon)

Group Leader

Research projects/programmes

During 2021 there were 18 funded projects in CAUP, which provided most of the funds available for research related expenses, as well as for outreach and basic expenses. The research projects that in 2021 were supported by national and European funds are:

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

- SKilled, Innovative & Entrepreneurial Scientists (SKIES) (GA N° 101006212)
PI: Jarle Brinchmann
[start date: 01 March 2021 – end date: 31 August 2022]
- 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 March 2022]
- Zoom-In ON hIgh-mass Star forMation (ZIONISM) (IF/00956/2015/CP1273/CT0002)
PI: Nanda Kumar
[start date: 15 December 2016 – end date: 14 March 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 June 2022]
- 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 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 July 2022]

- 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 May 2022]
- 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]
- Dark matter and metals in galaxies (DarkMAGE) (PTDC/FIS-AST/4862/2020)
PI: Jarle Brinchmann
[start date: 1 September 2021 – end date: 31 August 2024]

(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: Francisco Lobo
[start date: 1 January 2020 – end date: 31 December 2023]

(iv) 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 Científica e Tecnológica FCT/CAPES)
PI: Andrew Humphrey
[start date: 1 May 2018 – end date: 31 December 2022]
- Evolution of realistic cosmic strings and superstrings (Convénio FCT/CNRS)
PI: Carlos Martins
[start date: 1 July 2021 – end date: 30 June 2023]

(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 2022]

Outreach projects

During 2021, there were 6 funded outreach projects in CAUP, which provide funds available for outreach related expenses. These were:

- AstroCamp 2021
PI: Carlos Martins
[start date: 1 January 2021 – end date: 31 December 2021]
- Ciência Viva no Verão em Rede 2021
PI: Filipe Pires
[start date: 1 July 2021 – end date: 30 September 2021]
- Formação ESERO
PI: Filipe Pires/Ilídio Costa
[start date: 1 January 2021 – end date: 31 December 2021]
- Light Fingerprints - Europlanet Society
PI: Nuno Santos
[start date: 1 January 2021 – end date: 31 December 2022]
- SDSS block grants for Plate distribution
PI: Filipe Pires/Ilídio Costa
[start date: 1 January 2021 – end date: 31 December 2022]
- Capacitação dos Centros de Ciência Viva (NORTE-09-5864-FSE-000027)
PI: Filipe Pires
[start date: 1 April 2021 – end date: 31 March 2023]

Research grants

Several grants have been active in 2021 with financial support of CAUP or with CAUP as the host institution.

Ongoing Post-Doctoral grants:

1. Pedro M. Palmeirim, Postdoctoral grant (SFRH/BPD/110176/2015), Fundação para a Ciência e a Tecnologia, 01 September 2016

Ongoing PhD grants:

1. Ana Rita Silva, PhD grant (2021.07856.BD), Fundação para a Ciência e a Tecnologia, 01 October 2021
2. Nuno A. M. Moedas, PhD grant (UI/BD/152075/2021), Fundação para a Ciência e a Tecnologia, 15 September 2021
3. João D. F. Dias, PhD grant (SFRH/BD/150990/2021), Fundação para a Ciência e a Tecnologia, 01 February 2021
4. Nuno M. Rosário, PhD grant (2020.05472.BD), Fundação para a Ciência e a Tecnologia, 01 February 2021
5. André Miguel A. C. V. Silva, PhD grant (2020.05387.BD), Fundação para a Ciência e a Tecnologia, 01 January 2021
6. David Grüber, PhD grant (2020.07632.BD), Fundação para a Ciência e a Tecnologia, 01 October 2020
7. Miguel T. Clara, PhD grant (2020.07530.BD), Fundação para a Ciência e a Tecnologia, 01 October 2020
8. Abhishek Chougule, PhD grant (PD/BD/150439/2019), Fundação para a Ciência e a Tecnologia, 01 October 2019
9. Tomás de Azevedo Silva, PhD grant (PD/BD/150416/2019), Fundação para a Ciência e a Tecnologia, 01 October 2019
10. Thibault Boulet, PhD grant (PD/BD/150426/2019), Fundação para a Ciência e a Tecnologia, 01 October 2019
11. Sandy G. Morais, PhD grant (PD/BD/135228/2017), Fundação para a Ciência e a Tecnologia, 01 October 2017

Completed PhD grants in 2021:

1. Rui P. L. Azevedo, PhD grant (SFRH/DB/132546/2017), Fundação para a Ciência e a Tecnologia, 01 January 2018 to 31 December 2021
2. Vasco M. C. Ferreira, PhD grant (PD/BD/135229/2017), Fundação para a Ciência e a Tecnologia, 01 October 2017 to 30 November 2021
3. Bachar Wehbe, PhD grant (PD/BD/135225/2017), Fundação para a Ciência e a Tecnologia, 01 October 2017 to 02 June 2021
4. L. Filipe Pereira, PhD grant (PD/BD/135227/2017), Fundação para a Ciência e a Tecnologia, 01 October 2017 to 30 November 2021
5. Babatunde Akinsanmi, PhD grant (PD/BD/135226/2017), Fundação para a Ciência e a Tecnologia, 01 October 2017 to 31 August 2021
6. José Ricardo Correia, PhD grant (SFRH/BD/130445/2017), Fundação para a Ciência e a Tecnologia, 01 September 2017 to 31 October 2021

The ongoing Research grants (PhD students, master students or graduates) were:

1. Pedro Alexandre C. Cunha, Research assistantship grant for PhD degree (CIAAUP-12/2021-BI-D), CAUP, 15 November 2021
2. Andreas W. Neitzel, Research assistantship grant for MSc degree (CIAAUP-08/2021-BI-M), CAUP, 01 September 2021
3. Bárbara M. T. B. Soares, Research assistantship grant for MSc degree (CIAAUP-09/2021-BI-M), CAUP, 15 July 2021

4. Sergei Mukovnikov, Research assistantship grant - MSc (CIAAUP-11-2020-BIM), CAUP, 05 November 2020

Completed research grants (PhD students, master students or graduates) in 2021 were:

1. Alexandros Antoniadis Karnavas, Research assistantship grant for PhD degree (CIAAUP-10/2021-BID), CAUP, 01 October 2021 to 31 December 2021
2. Bernardo M. B. R. S. Campilho, Research assistantship grant for MSc degree (CIAAUP-11/2021-BIM), CAUP, 01 October 2021 to 31 December 2021
3. João D. R. Camacho, Research assistantship grant for PhD degree (CIAAUP-01/2021/BID), CAUP, 15 March 2021 to 31 December 2021
4. Eduardo A. S. Cristo, Research assistantship grant for PhD degree (CIAAUP-12-2020-BID), CAUP, 01 January 2021 to 31 December 2021
5. José Rodrigues, Research assistantship grant for PhD degree (CIAAUP-09/2020-BID), CAUP, 01 November 2020 to 31 October 2021
6. Alexandros Antoniadis Karnavas, Research assistantship grant - MSc (CIAAUP-22/2019-BIM), CAUP, 01 October 2019 to 30 September 2021

The ongoing Science and Technology Management Grants were:

1. Tania F. S. Cunha, Science and Technology Management Grant (SFRH/BGCT/143136/2019), Fundação para a Ciência e a Tecnologia, 01 February 2019

Scientific Output and Activities

The scientific output of CAUP in 2021 was (see below):

Papers in refereed journals	143
Papers in proceedings	4
Communications in international meetings	84
Communications in national meetings	21
Observing runs	23

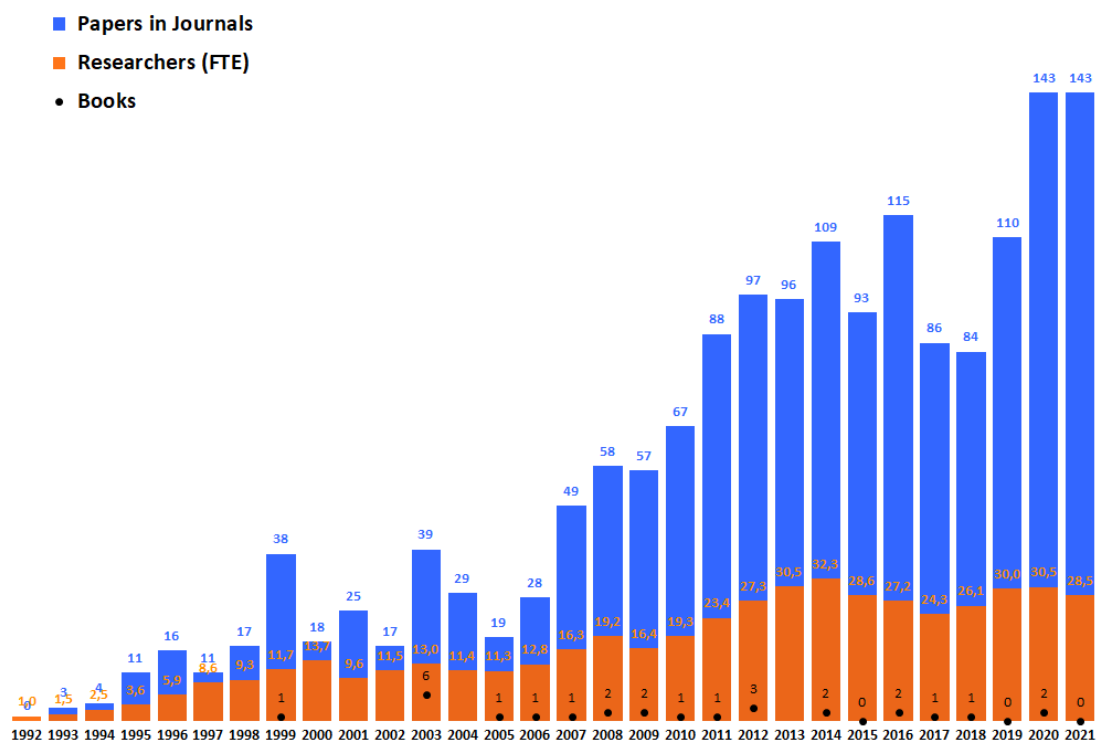


Figure 5: Blue bars - CAUP Publications in refereed journals per year; Orange bars - number of researchers with a PhD in full-time-equivalent (FTE) units; dots - books edited/published per year.

The h-index of CAUP is 135 (for a total of 97 120 accumulated citations).

If only refereed papers - as defined by ISI - are considered, the average number of citations per article is above 56. The evolution of this number over the years can be seen in Figure 7. The curve shows that the quality of the papers produced by CAUP (as measured by the average number of citations) continues to increase steadily.

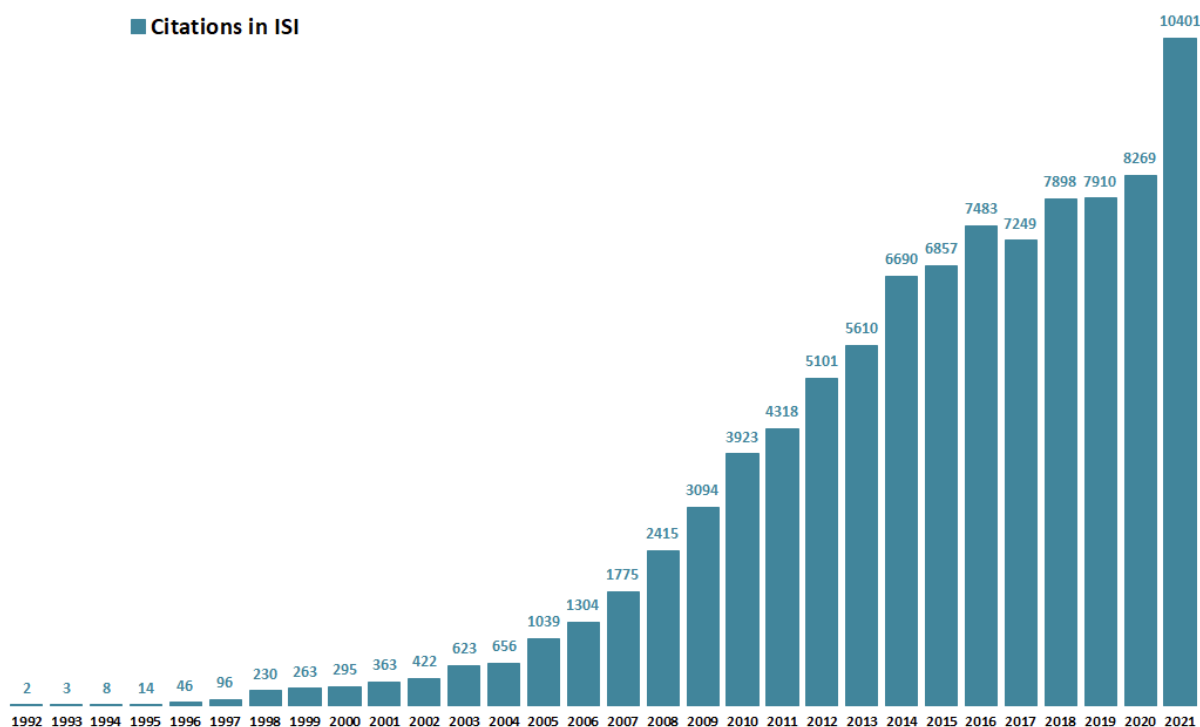


Figura 6: Citations per year from ISI using all entries in the database with CAUP/IA Porto in the affiliation.

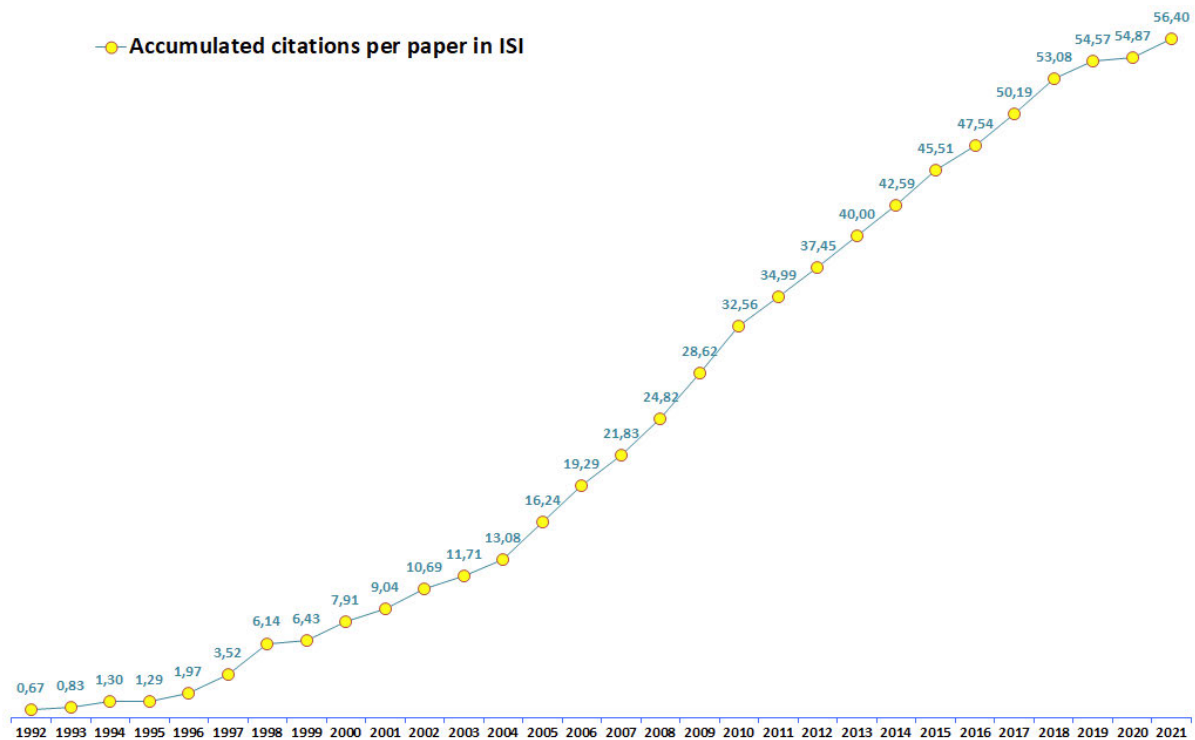


Figura 7: Accumulated citations per paper in ISI using all entries in the database with CAUP in the affiliation.

During 2021 CAUP organized, or co-organized, the following conferences, workshops, meetings or schools:

- Cosmonata 2021; 21 December 2021; online, Portugal
- Starts Day 2021; 7 December 2021; online, Portugal
- 2nd Planetary Systems day @ IA; 3 December 2021; online, Portugal
- IA-ON8; Instituto de Astrofísica e Ciências do Espaço 8th internal workshop; 10 to 12 November 2021; 10-11 online and 12 presencial in Coimbra, Portugal
- 2DEMOC; 21 to 22 October 2021; online, Portugal
- 8th Iberian Meeting on Asteroseismology: Laying the groundwork for the road ahead; 18 to 21 October 2021, online, Portugal
- Fundamental cosmology from the ELT and space, 4th Azores School on Observational Cosmology, 6th Azores International Advanced School in Space Sciences; 6 to 12 September 2021; Angra do Heroísmo, Açores, Portugal
- Massively Parallel Large Area Spectroscopy from Space; 21 to 23 June 2021; online, Portugal
- 1st Galaxies day @ IA; 22 April 2021; online, Portugal
- 1st Planetary Systems day @ IA; 2 February 2021; online, Portugal
- F2F Meeting ESPRESSO; 25 to 29 January 2021; online, Portugal

Several team members also integrated the scientific organizing committees of international Meetings/Conferences and have continued to serve as Referees in all major international astronomy research journals. Several members of CAUP were also involved in activities within international Consortia and/or Working Groups.

In 2021 some members of the Research Unit served as National Delegates to European Organizations (ESA, ESO), served individually as experts in several international organisations, integrate on an individual basis European Commission Research Structures, or integrate the Scientific Committees, Commissions and/or Working Groups of the International Astronomical Union (IAU). CAUP researchers also served as members of the FCT scientific council, as evaluators for FCT panels (projects and/or grants) and in panels of several European programmes.

In 2021, due to travel restrictions CAUP received only 5 visitors to develop collaborative work with team members, most of them being supported under the ongoing exchange programmes and projects, and organized 21 scientific seminars, as well as frequent journal clubs in the various groups, mostly held online.

Refereed publications in 2021

1. R. Østensen, M. Martinelli, **C. J. A. P. Martins**, S. Nesseris, I. Tutusaus, A. Blanchard, S. Camera, C. Carbone, S. Casas, V. Pettorino et al. (including: **I. Tereno**), 2021; *Euclid: Constraining dark energy coupled to electromagnetism using astrophysical and laboratory data*; *Astronomy & Astrophysics*, 654, A148, 14
2. T. Mishenina, N. Basak, **V. Zh. Adibekyan**, C. Soubiran, V. Kovtyukh, 2021; *Chemical composition of stars with massive planets*; *Monthly Notices of the Royal Astronomical Society*, 504, 3, 4252
3. A. A. Hakobyan, A. G. Karapetyan, L. V. Barkhudaryan, M. H. Gevorgyan, **V. Zh. Adibekyan**, 2021; *Type Ia supernovae in the star formation deserts of spiral host galaxies*; *Monthly Notices of the Royal Astronomical Society: Letters*, 501, 1, L52
4. A. M. Serenelli, A. Weiss, C. Aerts, G. Angelou, David Baroch, N. Bastian, P. G. Beck, M. Bergemann, Joachim M. Bestenlehner, Ian Czekala et al. (including: **B. Nsamba**), 2021; *Weighing stars from birth to death: mass determination methods across the HRD*; *The Astronomy and Astrophysics Review*, 29, 4, 146
5. E. Marfil, **H. M. Tabernero**, D. Montes, J. A. Caballero, F. J. Lázaro, J. I. González Hernández, E. Nagel, V. M. Passegger, A. Schweitzer, I. Ribas, 2021; *The CARMENES search for exoplanets around M dwarfs. Stellar atmospheric parameters of target stars with STEPARSYN*; *Astronomy & Astrophysics*, 656, A162, 25
6. P. J. Amado, F. F. Bauer, C. Rodríguez López, E. Rodríguez, C. Cardona Guillén, M. Perger, J. A. Caballero, M. J. López-González, I. Muñoz Rodríguez, F. J. Pozuelos et al. (including: **N. C. Santos**), 2021; *The CARMENES search for exoplanets around M dwarfs. Two terrestrial planets orbiting G 264-012 and one terrestrial planet orbiting Gl 393*; *Astronomy & Astrophysics*, 650, A188, 24
7. A. Suárez Mascareño, M. Damasso, N. Lodieu, A. Sozzetti, V. J. Sánchez Béjar, S. Benatti, M. R. Zapatero Osorio, G. Micela, R. Rebolo López, S. Desidera et al. (including: **H. M. Tabernero**), 2021; *Rapid contraction of giant planets orbiting the 20-million-year-old star V1298 Tau*; *Nature Astronomy*
8. *Euclid* Collaboration, A. Pocino, I. Tutusaus, F. J. Castander, P. Fosalba, M. Crocce, A. Porredon, S. Camera, V. F. Cardone, S. Casas et al. (including: **J. Brinchmann, C. S. Carvalho, A. C. da Silva, I. Tereno**), 2021; *Euclid preparation. XII. Optimizing the photometric sample of the Euclid survey for galaxy clustering and galaxy-galaxy lensing analyses*; *Astronomy & Astrophysics*, 655, A44, 21
9. S. A. Stanford, D. C. Masters, B. Darvish, D. Stern, J. G. Cohen, P. Capak, N. Hernitschek, I. Davidzon, J. D. Rhodes, D. B. Sanders et al. (including: **J. Brinchmann, I. Tereno, C. S. Carvalho, A. C. da Silva**), 2021; *Euclid Preparation. XIV. The Complete Calibration of the Color-Redshift Relation (C3R2) Survey: Data Release 3*; *The Astrophysical Journal Supplement Series*, 256, 1
10. **P. P. Avelino**, B. F. de Oliveira, R. S. Trintin, 2021; *Weak species in rock-paper-scissors models*; *Europhysics Letters*, 134, 4
11. **R. P. L. Azevedo, P. P. Avelino**, 2021; *Distance-duality in theories with a nonminimal coupling to gravity*; *Physical Review D*, 104, 8

12. Kate E. Furnell, C. A. Collins, Lee S. Kelvin, I. K. Baldry, P. A. James, M. Manolopoulou, R. Mann, Paul A. Giles, A. Bermeo, M. Hilton et al. (including: **P. T. P. Viana**), 2021; *The growth of intracluster light in XCS-HSC galaxy clusters from $0.1 < z < 0.5$* ; Monthly Notices of the Royal Astronomical Society, 502, 2, 2419
13. B. C. Addison, D. Wright, P. D. Nicholson, B. Cale, T. Mocnik, D. Huber, P. P. Plavchan, R. A. Wittenmyer, A. Vanderburg, W. J. Chaplin et al. (including: **T. L. Campante**), 2021; *TOI-257b (HD 19916b): a warm sub-saturn orbiting an evolved F-type star*; Monthly Notices of the Royal Astronomical Society, 502, 3, 3704
14. M. L. Hill, S. R. Kane, **T. L. Campante**, Z. Li, P. A. Dalba, T. D. Brandt, T. R. White, B. J. S. Pope, K. G. Stassun, B. J. Fulton et al. (including: **D. Bossini**, **M. S. Cunha**), 2021; *The American Astronomical Society, find out more The American Astronomical Society, find out more The Institute of Physics, find out more The Institute of Physics, find out more Asteroseismology of iota Draconis and Discovery of an Additional Long-per*; The Astronomical Journal, 162, 5
15. **S. G. Morais**, **A. Humphrey**, M. Villar Martín, L. Binette, M. Silva, 2021; *Electron energy distributions in the extended gas nebulae associated with high-z AGN: Maxwell–Boltzmann versus κ distributions*; Monthly Notices of the Royal Astronomical Society, 506, 1, 1389
16. I. Negueruela, A.-N. Chené, **H. M. Taberner**, R. Dorda, J. Borissova, A. Marco, R. Kurtev, 2021; *A massive open cluster hiding in full sight*; Monthly Notices of the Royal Astronomical Society, 505, 2, 1618
17. C. Soubiran, L. Casamiquela, T. Cantat-Gaudin, L. Chemin, F. Anders, M. Romero-Gómez, F. Figueras, A. Bragaglia, L. Balaguer-Núñez, R. Carrera et al. (including: **D. Bossini**), 2021; *3D kinematics and age distribution of the open cluster population*; Astronomy & Astrophysics, 647, A19, 15
18. Regis, M, Taoso, M, **D. A. D. Vaz**, **J. Brinchmann**, B. Zoutendijk, N. Bouché, M. Steinmetz, 2021; *Searching for light in the darkness: Bounds on ALP dark matter with the optical MUSE-faint survey*; Physics Letters B, 814, 1360, 11
19. Ilaria Pagotto, D. Krajnović, M. den Brok, E. Emsellem, **J. Brinchmann**, P. M. Weilbacher, W. Kollatschny, M. Steinmetz, 2021; *Optical emission lines in the most massive galaxies: Morphology, kinematics, and ionisation properties*; Astronomy & Astrophysics, 649, A63, 27
20. C. Xie, S. Y. Haffert, J. de Boer, M. A. Kenworthy, **J. Brinchmann**, J. H. Girard, I. A. G. Snellen, C. U. Keller, 2021; *A MUSE view of the asymmetric jet from HD 163296*; Astronomy & Astrophysics, 650, L6, 9
21. B. Zoutendijk, **J. Brinchmann**, N. Bouché, M. den Brok, D. Krajnović, Konrad Kuijken, M. V. Maseda, J. Schaye, 2021; *The MUSE-Faint survey II. The dark-matter density profile of the ultra-faint dwarf galaxy Eridanus 2*; Astronomy & Astrophysics, 651, A80, 23
22. L. H. T. Oudshoorn, F. P. Israel, **J. Brinchmann**, M. B. C. Kloppenburg, A. G. A. Brown, J. Bally, T. Gull, P. T. Boyd, 2021; *The peculiar nebula Simeis 57. II. Distance, nature and excitation*; Astronomy & Astrophysics, 650, A171, 13
23. M. den Brok, D. Krajnović, E. Emsellem, **J. Brinchmann**, M. V. Maseda, 2021; *Dynamical modelling of the twisted galaxy PGC 046832*; Monthly Notices of the Royal Astronomical Society, 508, 4, 4786
24. A. Leleu, Y. Alibert, N. Hara, M. J. Hooton, T. G. Wilson, P. Robutel, J.-B. Delisle, J. Laskar, S. Hoyer, C. Lovis et al. (including: **V. Zh. Adibekyan**, **S. C. C. Barros**, **O. Demangeon**, **P. Figueira**, **C. J. A. P. Martins**, **N. J. Nunes**, **N. C. Santos**, **S. G. Sousa**), 2021; *Six transiting planets and a chain of Laplace resonances in TOI-178*; Astronomy & Astrophysics, 649, A26, 29
25. **B. Wehbe**, **A. Cabral**, L. Sbordone, G. Avila, 2021; *On-sky measurements of atmospheric dispersion – II. Atmospheric models characterization*; Monthly Notices of the Royal Astronomical Society, 503, 3, 3818
26. **A. Cabral**, **B. Wehbe**, 2021; *Simple concept for atmospheric dispersion corrector on-sky commissioning tests*; Journal of Astronomical Telescopes, Instruments, and Systems, 7, 3
27. S. R. Kane, J. L. Bean, **T. L. Campante**, P. A. Dalba, T. Mocnik, J. Pepper, M. C. Turnbull, G. R. Ricker, R. K. Vanderspek, D. W. Latham, 2021; *Science Extraction from TESS Observations of Known Exoplanet Hosts*; Publications of the Astronomical Society of the Pacific, 133, 0144, 12

28. **M. S. Cunha**, I. W. Roxburgh, V. Aguirre Børsen-Koch, W. H. Ball, S. Basu, W. J. Chaplin, M.-J. Goupil, **B. Nsamba**, J. M. J. Ong, D. R. Reese et al. (including: **T. L. Campante**, **M. T. Clara**, **M. J. P. F. G. Monteiro**), 2021; *PLATO hare-and-hounds exercise: asteroseismic model fitting of main-sequence solar-like pulsators*; Monthly Notices of the Royal Astronomical Society, 508, 4, 5864
29. B. C. Allanach, N. Bich Ngoc, P. N. Diep, H. Parsons, K. Pattle, T. Hoang, D. Ward-Thompson, L. N. Tram, C. L. H. Hull, M. Tahani et al. (including: **D. Arzoumanian**), 2021; *Observations of Magnetic Fields Surrounding LkHa 101 Taken by the BISTRO Survey with JCMT-POL-2*; The Astronomical Journal, 908, 10, 20
30. A. -R. Lyo, J. Kim, S. Sadavoy, D. Johnstone, D. L. Berry, K. Pattle, W. Kwon, P. Bastien, T. Onaka, J. Di Francesco et al. (including: **D. Arzoumanian**), 2021; *The JCMT BISTRO Survey: An 850/450 μ m Polarization Study of NGC 2071IR in Orion B*; The Astrophysical Journal, 918, 2
31. A. Sozzetti, M. Damasso, A. S. Bonomo, Y. Alibert, **S. G. Sousa**, **V. Zh. Adibekyan**, M. R. Zapatero Osorio, J. I. González Hernández, **S. C. C. Barros**, J. Lillo-Box et al. (including: **N. C. Santos**, **A. Cabral**, **P. Figueira**, **C. J. A. P. Martins**, **N. J. Nunes**), 2021; *A sub-Neptune and a non-transiting Neptune-mass companion unveiled by ESPRESSO around the bright late-F dwarf HD 5278 (TOI-130)*; Astronomy & Astrophysics, 648, A75, 25
32. A. Osborn, D. J. Armstrong, B. Cale, R. Brahm, R. A. Wittenmyer, F. Dai, I. J. M. Crossfield, E. M. Bryant, V. Zh. Adibekyan, R. Cloutier et al. (including: **E. Delgado Mena**, **S. G. Sousa**, **S. C. C. Barros**, **O. Demangeon**, **S. Hojjatpanah**, **N. C. Santos**), 2021; *TOI-431/HIP 26013: a super-Earth and a sub-Neptune transiting a bright, early K dwarf, with a third RV planet*; Monthly Notices of the Royal Astronomical Society, 507, 2, 2782
33. J. F. Otegi, F. Bouchy, R. Helled, D. J. Armstrong, M. Stalport, A. Psaridi, J.-B. Delisle, K. G. Stassun, **E. Delgado Mena**, **N. C. Santos** et al. (including: **S. Hojjatpanah**, **V. Zh. Adibekyan**, **P. Figueira**, **S. G. Sousa**, **S. C. C. Barros**), 2021; *TESS and HARPS reveal two sub-Neptunes around TOI 1062*; Astronomy & Astrophysics, 653, A105, 14
34. F. Murgas, N. Astudillo-Defru, X. Bonfils, I. J. M. Crossfield, J.-M. Almenara, J. H. Livingston, K. G. Stassun, J. Korth, J. Orell-Miquel, G. Morello et al. (including: **P. Figueira**, **N. C. Santos**), 2021; *TOI-674b: An oasis in the desert of exo-Neptunes transiting a nearby M dwarf*; Astronomy & Astrophysics, 653, A60, 21
35. B. C. Addison, E. Knudstrup, I. Wong, G. Hébrard, P. Dorval, I. A. G. Snellen, S. Albrecht, A. Bello-Arufe, J.-M. Almenara, I. Boisse et al. (including: **O. Demangeon**, **N. C. Santos**), 2021; *The American Astronomical Society, find out more The American Astronomical Society, find out more The Institute of Physics, find out more The Institute of Physics, find out more TOI-1431b/MASCARA-5b: A Highly Irradiated Ultrahot Jupiter Orbiting One o*; The Astronomical Journal, 162, 6
36. W. Benz, C. Broeg, A. Fortier, N. Rando, T. Beck, M. Beck, D. Queloz, D. Ehrenreich, P. F. L. Maxted, K. Isaak et al. (including: **S. C. C. Barros**, **O. Demangeon**, **N. C. Santos**, **S. G. Sousa**), 2021; *The CHEOPS mission*; Experimental Astronomy, 51, 1, 109
37. A. Bonfanti, L. Delrez, M. J. Hooton, T. G. Wilson, L. Fossati, Y. Alibert, S. Hoyer, A. J. Mustill, H. P. Osborn, **V. Zh. Adibekyan** et al. (including: **S. G. Sousa**, **S. C. C. Barros**, **O. Demangeon**, **N. C. Santos**), 2021; *CHEOPS observations of the HD 108236 planetary system: a fifth planet, improved ephemerides, and planetary radii*; Astronomy & Astrophysics, 646, A157, 19
38. L. Delrez, D. Ehrenreich, Y. Alibert, A. Bonfanti, L. Borsato, L. Fossati, M. J. Hooton, S. Hoyer, F. J. Pozuelos, S. Salmon et al. (including: **V. Zh. Adibekyan**, **S. G. Sousa**, **S. C. C. Barros**, **O. Demangeon**, **N. C. Santos**), 2021; *Transit detection of the long-period volatile-rich super-Earth v2 Lupi d with CHEOPS*; Nature Astronomy, 5, 775
39. M. I. Swayne, P. F. L. Maxted, A. H. M. J. Triaud, **S. G. Sousa**, C. Broeg, H. -. Florén, P. Guterman, A. E. Simon, I. Boisse, A. Bonfanti et al. (including: **S. C. C. Barros**, **O. Demangeon**, **N. C. Santos**), 2021; *The EBLM project - VIII. First results for M-dwarf mass, radius, and effective temperature measurements using CHEOPS light curves*; Monthly Notices of the Royal Astronomical Society, 506, 1, 306
40. N. Unger, D. Ségransan, D. Queloz, S. Udry, C. Lovis, C. Mordasini, E. Ahrer, W. Benz, F. Bouchy, J.-B. Delisle et al. (including: **N. C. Santos**, **P. Figueira**), 2021; *The HARPS search for southern extra-*

- solar planets. XLVI. 12 super-Earths around the solar type stars HD 39194, HD 93385, HD 96700, HD 154088, and HD 189567; Astronomy & Astrophysics, 654, A104, 19*
41. Gy. M. Szabó, D. Gandolfi, A. Brandeker, Sz. Csizmadia, Z. Garai, N. Billot, C. Broeg, D. Ehrenreich, A. Fortier, L. Fossati et al. (including: **S. C. C. Barros, O. Demangeon, N. C. Santos, S. G. Sousa**), 2021; *The changing face of AU Mic b: stellar spots, spin-orbit commensurability, and transit timing variations as seen by CHEOPS and TESS; Astronomy & Astrophysics, 654, A159, 15*
 42. A. Fumagalli, A. Saro, S. Borgani, T. Castro, M. Costanzi, P. Monaco, E. Munari, E. Sefusatti, A. Amara, N. Auricchio et al. (including: **J. Brinchmann, I. Tereno**), 2021; *Euclid : Effects of sample covariance on the number counts of galaxy clusters; Astronomy & Astrophysics, 652, A21, 15*
 43. V. Abril-Melgarejo, B. Epinat, Wilfried Mercier, T. Contini, L. A. Boogaard, **J. Brinchmann**, H. Finley, L. Michel-Dansac, E. Ventou, Philippe Amram, 2021; *The Tully-Fisher relation in dense groups at $z \sim 0.7$ in the MAGIC survey; Astronomy & Astrophysics, 647, A152, 45*
 44. L. A. Boogaard, R. J. Bouwens, D. A. Riechers, P. van der Werf, R. Bacon, J. Matthee, M. Stefanon, A. Feltre, M. V. Maseda, H. Inami et al. (including: **J. Brinchmann**), 2021; *Measuring the Average Molecular Gas Content of Star-forming Galaxies at $z = 3-4$; The Astrophysical Journal, 916, 12, 19*
 45. J. Zabl, N. Bouché, L. Wisotzki, J. Schaye, F. Leclercq, T. Garel, M. Wendt, I. Schroetter, S. Muzahid, S. Cantalupo et al. (including: **J. Brinchmann**), 2021; *MusE GAs FLOW and Wind (MEGAFLOW). VIII. Discovery of a MgII emission halo probed by a quasar sightline; Monthly Notices of the Royal Astronomical Society, 507, 3, 4294*
 46. R. Bacon, D. Mary, T. Garel, J. Blaizot, M. V. Maseda, J. Schaye, L. Wisotzki, S. Conseil, **J. Brinchmann**, F. Leclercq, 2021; *The MUSE Extremely Deep Field: The cosmic web in emission at high redshift; Astronomy & Astrophysics, 647, A107, 26*
 47. A. R. G. Santos, S. Mathur, R. A. García, **M. S. Cunha, P. P. Avelino**, 2021; *On the relation between active-region lifetimes and the autocorrelation function of light curves; Monthly Notices of the Royal Astronomical Society, 508, 1, 267*
 48. **H. M. R. da Silva**, T. Harko, **F. S. N. Lobo**, J. L. Rosa, 2021; *Cosmic strings in generalized hybrid metric-Palatini gravity; Physical Review D, 104, 12*
 49. S. Hoyer, D. Gandolfi, D. J. Armstrong, M. Deleuil, L. Acuña, J. R. de Medeiros, E. Goffo, J. Lillo-Box, **E. Delgado Mena**, T. A. Lopez et al. (including: **S. G. Sousa, V. Zh. Adibekyan, S. Hojjatpanah, S. C. C. Barros, O. Demangeon, P. Figueira, N. C. Santos**), 2021; *TOI-220 b: a warm sub-Neptune discovered by TESS; Monthly Notices of the Royal Astronomical Society, 505, 3, 3361*
 50. S. Hoyer, D. Gandolfi, D. J. Armstrong, M. Deleuil, L. Acuña, J. R. de Medeiros, E. Goffo, J. Lillo-Box, **E. Delgado Mena**, T. A. Lopez et al. (including: **S. G. Sousa, V. Zh. Adibekyan, S. Hojjatpanah, S. C. C. Barros, O. Demangeon, P. Figueira, N. C. Santos**), 2021; *TOI-220 b: a warm sub-Neptune discovered by TESS; Monthly Notices of the Royal Astronomical Society, 505, 3, 3361*
 51. L. Magrini, N. Lagarde, C. Charbonnel, E. Franciosini, S. Randich, R. Smiljanic, G. Casali, C. Viscasillas Vázquez, L. Spina, K. Biazzo et al. (including: **E. Delgado-Mena**), 2021; *The Gaia-ESO survey: Mixing processes in low-mass stars traced by lithium abundance in cluster and field stars; Astronomy & Astrophysics, 651, A84, 16*
 52. H. P. Osborn, D. J. Armstrong, **V. Zh. Adibekyan**, K. A. Collins, **E. Delgado Mena**, S. B. Howell, C. Hellier, G. W. King, J. Lillo-Box, L. D. Nielsen et al. (including: **N. C. Santos, S. C. C. Barros, O. Demangeon, P. Figueira, S. G. Sousa**), 2021; *A hot mini-Neptune in the radius valley orbiting solar analogue HD 110113; Monthly Notices of the Royal Astronomical Society, 502, 4, 4842*
 53. **P. I. T. K. Sarmiento**, B. Rojas-Ayala, **E. Delgado Mena**, S. Blanco-Cuaresma, 2021; *Determination of spectroscopic parameters for 313 M dwarf stars from their APOGEE Data Release 16 H-band spectra; Astronomy & Astrophysics, 649, A147, 29*
 54. B. Ciocan, B. Ziegler, M. Verdugo, **P. Papaderos**, K. Fogarty, M. Donahue, M. Postman, 2021; *The VLT-MUSE and ALMA view of the MACS 1931.8-2635 brightest cluster galaxy; Astronomy & Astrophysics, 649, A23, 27*
 55. S. Pelletier, B. Benneke, A. Darveau-Bernier, A. Boucher, N. J. Cook, C. Piaulet, L. Coulombe, E. Artigau, D. Lafrenière, S. Delisle et al. (including: **J. H. C. Martins**), 2021; *Where Is the Water?*

- Jupiter-like C/H Ratio but Strong H₂O Depletion Found on τ Boötis b Using SPIRou*; The Astronomical Journal, 162(2, 73, 19
56. A. Boucher, A. Darveau-Bernier, S. Pelletier, D. Lafrenière, E. Artigau, N. J. Cook, R. Allart, M. Radica, R. Doyon, B. Benneke et al. (including: **J. Gomes da Silva, P. Figueira, J. H. C. Martins, N. C. Santos**), 2021; *Characterizing Exoplanetary Atmospheres at High Resolution with SPIRou: Detection of Water on HD 189733 b*; The Astrophysical Journal, 162, 6
 57. E. Artigau, G. Hébrard, C. Cadieux, T. Vandal, N. J. Cook, R. Doyon, J. Gagné, C. Moutou, E. Martioli, A. Frasca et al. (including: **J. H. C. Martins, N. C. Santos, P. Figueira, J. Gomes da Silva**), 2021; *TOI-1278 B: SPIRou Unveils a Rare Brown Dwarf Companion in Close-in Orbit around an M Dwarf*; The Astronomical Journal, 162, 4
 58. M. Latour, A. Calamida, T.-O. Husser, S. Kamann, S. Dreizler, **J. Brinchmann**, 2021; *A stellar census in globular clusters with MUSE. A new perspective on the multiple main sequences of ω Centauri*; Astronomy & Astrophysics, 653, L8, 8
 59. F. Durret, S. Chiche, **C. Lobo**, M. Jauzac, 2021; *Jellyfish galaxy candidates in MACS J0717.5+3745 and 39 other clusters of the DAFT/FADA and CLASH surveys*; Astronomy & Astrophysics, 648, A63, 38
 60. S. Pezzuto, M. Benedettini, J. Di Francesco, **P. M. Palmeirim**, E. Schisano, G. Li Causi, Ph. André, **D. Arzoumanian**, J.-P. Bernard, G. E. Bontemps, 2021; *Physical properties of the ambient medium and of dense cores in the Perseus star-forming region derived from Herschel Gould Belt Survey observations*; Astronomy & Astrophysics, 645, A55, 49
 61. B. Nsamba, **N. A. M. Moedas, T. L. Campante, M. S. Cunha**, J.-C. Suárez, **M. J. P. F. G. Monteiro**, J. M. Fernandes, C. Jiang, **B. Akinsanmi**, 2021; *Asteroseismic modelling of solar-type stars: a deeper look at the treatment of initial helium abundance*; Monthly Notices of the Royal Astronomical Society, 500, 1, 54
 62. E. Sedaghati, R. J. MacDonald, N. Casasayas-Barris, H. J. Hoeijmakers, Henri M. J. Boffin, F. Rodler, R. Brahm, M. Jones, A. Sánchez-López, I. Carleo et al. (including: **P. Figueira**), 2021; *A spectral survey of WASP-19b with ESPRESSO*; Monthly Notices of the Royal Astronomical Society, 505, 1, 435
 63. F. Borsa, R. Allart, **H. M. Tabernero**, M. R. Zapatero-Osorio, S. Cristiani, F. Pepe, R. Rebolo López, **N. C. Santos, V. Zh. Adibekyan**, V. Bourrier et al. (including: **O. Demangeon, S. G. Sousa, A. Cabral, P. Figueira, C. J. A. P. Martins, N. J. Nunes**), 2021; *Atmospheric Rossiter–McLaughlin effect and transmission spectroscopy of WASP-121b with ESPRESSO*; Astronomy & Astrophysics, 645, A24, 14
 64. F. Pepe, S. Cristiani, R. Rebolo López, **N. C. Santos**, H. Dekker, **A. Cabral**, P. Di Marcantonio, **P. Figueira**, G. Lo Curto, C. Lovis et al. (including: **V. Zh. Adibekyan, M. Abreu, D. Castro Alves, S. C. C. Barros, J. Coelho, O. Demangeon, J. P. Faria, C. J. A. P. Martins, M. A. Monteiro, M. J. P. F. G. Monteiro, N. J. Nunes, A. Oliveira, J. M. Rebordão, P. Santos, S. G. Sousa, H. M. Tabernero**), 2021; *ESPRESSO at VLT. On-sky performance and first results*; Astronomy & Astrophysics, 645, A96, 26
 65. K. W. F. Lam, Sz. Csizmadia, N. Astudillo-Defru, X. Bonfils, D. Gandolfi, P. Padovani, M. Esposito, C. Hellier, T. Hirano, J. H. Livingston et al. (including: **N. C. Santos, P. Figueira**), 2021; *GJ 367b: A dense, ultrashort-period sub-Earth planet transiting a nearby red dwarf star*; Science, 374, 6572, 1271
 66. V. Van Eylen, N. Astudillo-Defru, X. Bonfils, J. H. Livingston, T. Hirano, R. Luque, K. W. F. Lam, A. B. Justesen, J. N. Winn, D. Gandolfi et al. (including: **S. C. C. Barros, P. Figueira, N. C. Santos**), 2021; *Masses and compositions of three small planets orbiting the nearby M dwarf L231-32 (TOI-270) and the M dwarf radius valley*; Monthly Notices of the Royal Astronomical Society, 507, 2, 2154
 67. P. Benni, A. Burdanov, V. Krushinsky, A. Bonfanti, G. Hébrard, J.-M. Almenara, S. Dalal, **O. Demangeon**, M. Tsantaki, J. Pepper, 2021; *Discovery of a young low-mass brown dwarf transiting a fast-rotating F-type star by the Galactic Plane eXoplanet (GPX) survey*; Monthly Notices of the Royal Astronomical Society, 505, 4, 4956
 68. F. Shi, D. W. Kurtz, D. L. Holdsworth, H. Saio, **M. S. Cunha**, H. Zhang, J. Fu, G. Handler, 2021; *Discovery of multiple p-mode pulsation frequencies in the roAp star, HD 86181*; Monthly Notices of the Royal Astronomical Society, 506, 4, 5629

69. B. Charnay, J. Mendonça, L. Kreidberg, Nicolas B. Cowan, J. E. Taylor, Taylor J. Bell, **O. Demangeon**, Billy Edwards, C. A. Haswell, G. Morello, 2021; *A survey of exoplanet phase curves with Ariel*; Experimental Astronomy
70. S. Dalal, F. Kiefer, G. Hébrard, J. Sahlmann, **S. G. Sousa**, T. Forveille, X. Delfosse, L. Arnold, N. Astudillo-Defru, X. Bonfils et al. (including: **O. Demangeon**, **N. C. Santos**), 2021; *The SOPHIE search for northern extrasolar planets. XVII. A wealth of new objects: Six cool Jupiters, three brown dwarfs, and 16 low-mass binary stars*; Astronomy & Astrophysics, 651, A11, 27
71. **C. Pappalardo**, **L. S. M. Cardoso**, **P. Papaderos**, **J. Afonso**, **I. P. Breda**, **A. Humphrey**, **T. C. Scott**, **S. Amarantidis**, **I. Matute**, **R. Carvajal** et al. (including: **S. Lorenzoni**, **P. Lagos**), 2021; *Self-consistent population spectral synthesis with FADO. II. Star formation history of galaxies in spectral synthesis methods*; Astronomy & Astrophysics, 651, A99, 19
72. W. Wang, D. Wylezalek, C. de Breuck, J. Vernet, **A. Humphrey**, M. Villar Martín, M. D. Lehnert, S. Kolwa, 2021; *Mapping the “invisible” circumgalactic medium around a $z \sim 4.5$ radio galaxy with MUSE*; Astronomy & Astrophysics, 654, A88, 35
73. R. Carvajal, **I. Matute**, **J. Afonso**, **S. Amarantidis**, **D. D. Barbosa**, **P. A. C. Cunha**, **A. Humphrey**, 2021; *Exploring New Redshift Indicators for Radio-Powerful AGN*; Galaxies, 9, 4, 86
74. M. Villar Martín, B. H. C. Emonts, A. Cabrera Lavers, E. Bellocchi, A. Alonso Herrero, **A. Humphrey**, B. Dall’Agnol de Oliveira, T. Storchi-Bergmann, 2021; *Interactions between large-scale radio structures and gas in a sample of optically selected type 2 quasars*; Astronomy & Astrophysics, 650, A84, 31
75. **D. Arzoumanian**, R. S. Furuya, T. Hasegawa, M. Tahani, S. Sadavoy, C. L. H. Hull, D. Johnstone, P. M. Koch, S.-I. Inutsuka, Y. Doi, 2021; *Dust polarized emission observations of NGC 6334. BISTRO reveals the details of the complex but organized magnetic field structure of the high-mass star-forming hub-filament network*; Astronomy & Astrophysics, 647, A78, 29
76. Z. Guo, P. W. Lucas, C. Contreras Peña, L. C. Smith, C. Morris, R. Kurtev, J. Borissova, J. Alonso-García, D. Minniti, A.-N. Chené et al. (including: **M. S. N. Kumar**), 2021; *Analysis of physical processes in eruptive YSOs with near-infrared spectra and multiwavelength light curves*; Monthly Notices of the Royal Astronomical Society, 504, 1, 830
77. M. T. Beltrán, V. M. Rivilla, R. Cesaroni, L. T. Maud, D. Galli, L. Moscadelli, A. Lorenzani, A. Ahmadi, H. Beuther, T. Csengeri et al. (including: **M. S. N. Kumar**), 2021; *Fragmentation in the massive G31.41+0.31 protocluster*; Astronomy & Astrophysics, 648, A100, 15
78. D. L. Holdsworth, **M. S. Cunha**, D. W. Kurtz, V. Antoci, D. R. Hey, D. M. Bowman, O. Kobzar, D. L. Buzasi, O. Kochukhov, E. Niemczura, 2021; *TESS cycle 1 observations of roAp stars with 2-min cadence data*; Monthly Notices of the Royal Astronomical Society, 506, 1, 1073
79. I. Kondo, J. C. Yee, D. Bennett, T. Sumi, N. Koshimoto, I. Bond, A. Gould, A. Udalski, Y. Shvartzvald, Y. K. Jung et al. (including: **N. Peixinho**), 2021; *OGLE-2018-BLG-1185b: A Low-mass Microlensing Planet Orbiting a Low-mass Dwarf*; The Astronomical Journal, 162(2), 77, 18
80. M. Balaton, J. Cavadas, P. Simeão Carvalho, **J. J. G. Lima**, 2021; *Programming Ozobots for teaching astronomy*; Physics Education, 56, 4
81. D. Elia, M. Merello, S. Molinari, E. Schisano, A. Zavagno, D. Russeil, P. Mège, P. G. Martin, L. Olmi, M. Pestalozzi et al. (including: **P. M. Palmeirim**), 2021; *The Hi-GAL compact source catalogue – II. The 360° catalogue of clump physical properties*; Monthly Notices of the Royal Astronomical Society, 504, 2, 2742
82. **V. C. Tavares**, **C. J. A. P. Martins**, 2021; *Varying alpha generalized Dirac-Born-Infeld models*; Physical Review D, 103, 2
83. **C. J. A. P. Martins**, 2021; *Primordial nucleosynthesis with varying fundamental constants. Degeneracies with cosmological parameters*; Astronomy & Astrophysics, &, A47, 11
84. **C. B. D. Fernandes**, **C. J. A. P. Martins**, **B. A. R. Rocha**, 2021; *Constraining alternatives to a cosmological constant: Generalized couplings and scale invariance*; Physics of the Dark Universe, 31, 1007, 15

85. **J. R. C. C. C. Correia, C. J. A. P. Martins**, 2021; *Abelian-Higgs cosmic string evolution with multiple GPUs*; Astronomy and Computing, 34
86. **M. Deal, C. J. A. P. Martins**, 2021; *Primordial nucleosynthesis with varying fundamental constants. Solutions to the lithium problem and the deuterium discrepancy*; Astronomy & Astrophysics, 653, A48, 13
87. **J. Esteves, C. J. A. P. Martins, B. G. Pereira, C. S. Alves**, 2021; *Cosmological impact of redshift drift measurements*; Monthly Notices of the Royal Astronomical Society: Letters, 508, 1, L53
88. **J. R. C. C. C. Correia, C. J. A. P. Martins**, 2021; *High resolution calibration of the cosmic strings velocity dependent one-scale model*; Physical Review D, 104, 6
89. **A. R. R. Almeida, C. J. A. P. Martins**, 2021; *Scaling solutions of wiggly cosmic strings*; Physical Review D, 104, 4
90. Gaia Collaboration , T. Antoja, P. J. McMillan, G. Kordopatis, P. Ramos, A. Helmi, E. Balbinot, T. Cantat-Gaudin, L. Chemin, F. Figueras et al. (including: **D. Bossini**), 2021; *Gaia Early Data Release 3. The Galactic anticentre*; Astronomy & Astrophysics, 649, A8, 38
91. Gaia Collaboration , A. G. A. Brown, A. Vallenari, T. Prusti, J. de Bruijne, C. Babusiaux, M. Biermann, O. L. Creevey, D. W. Evans, L. Eyer et al. (including: **D. Bossini**), 2021; *Gaia Early Data Release 3. Summary of the contents and survey properties*; Astronomy & Astrophysics, 649, A1, 20
92. Gaia Collaboration , S. Klioner, F. Mignard, L. Lindegren, U. Bastian, P. J. McMillan, J. Hernández, D. Hobbs, M. Ramos-Lerate, M. Biermann et al. (including: **D. Bossini**), 2021; *Gaia Early Data Release 3. Acceleration of the Solar System from Gaia astrometry*; Astronomy & Astrophysics, 649, A9, 19
93. Gaia Collaboration , X. Luri, L. Chemin, G. Clementini, H. E. Delgado, P. J. McMillan, M. Romero-Gómez, E. Balbinot, A. Castro-Ginard, R. Mor et al. (including: **D. Bossini**), 2021; *Gaia Early Data Release 3. Structure and properties of the Magellanic Clouds*; Astronomy & Astrophysics, 649, A7, 35
94. Gaia Collaboration , R. L. Smart, L. M. Sarro, J. Rybizki, C. Reylé, A. C. Robin, N. C. Hambly, U. Abbas, M. A. Barstow, J. de Bruijne et al. (including: **D. Bossini**), 2021; *Gaia Early Data Release 3. The Gaia Catalogue of Nearby Stars*; Astronomy & Astrophysics, 649, A6, 44
95. T. S. Metcalfe, J. L. Van Saders, S. Basu, D. L. Buzasi, J. J. Drake, R. Egeland, D. Huber, S. H. Saar, K. G. Stassun, W. H. Ball et al. (including: **T. L. Campante**), 2021; *Magnetic and Rotational Evolution of ρ CrB from Asteroseismology with TESS*; The Astrophysical Journal, 921, 2
96. M. D'Onofrio, T. Stolker, S. Y. Haffert, A. Y. Kesseli, R. G. van Holstein, Y. Aoyama, **J. Brinchmann**, G. Cugno, J. H. Girard, G. Marleau, 2021; *Characterizing the Protolunar Disk of the Accreting Companion GQ Lupi B*; The Astronomical Journal, 162, 6
97. C. Danielski, Anna Brucalassi, S. Benatti, **T. L. Campante, E. Delgado-Mena**, M. Rainer, G. G. Sacco, **V. Zh. Adibekyan**, K. Biazzo, **D. Bossini** et al. (including: **S. G. Sousa**), 2021; *The homogeneous characterisation of Ariel host stars*; Experimental Astronomy, 83D, 24
98. **C. Gehan**, B. Mosser, E. Michel, **M. S. Cunha**, 2021; *Automated approach to measure stellar inclinations: validation through large-scale measurements on the red giant branch*; Astronomy & Astrophysics, 645, A124, 25
99. J. T. Mackereth, A. Miglio, Y. Elsworth, B. Mosser, S. Mathur, R. A. García, D. Nardiello, O. J. Hall, M. Vrad, W. H. Ball et al. (including: **D. Bossini, T. L. Campante**), 2021; *Prospects for Galactic and stellar astrophysics with asteroseismology of giant stars in the TESS continuous viewing zones and beyond*; Monthly Notices of the Royal Astronomical Society, 502, 2, 1947
100. E. Michel, M. Haywood, B. Famaey, B. Mosser, R. Samadi, **M. J. P. F. G. Monteiro**, H. Kjeldsen, K. Belkacem, A. Miglio, R. Garcia et al. (including: **T. L. Campante, M. S. Cunha**), 2021; *Chronos - take the pulse of our galactic neighbourhood*; Experimental Astronomy, 51, 3, 945
101. E. Michel, M. Haywood, B. Famaey, B. Mosser, R. Samadi, **M. J. P. F. G. Monteiro**, H. Kjeldsen, K. Belkacem, A. Miglio, R. A. Garcia et al. (including: **T. L. Campante, M. S. Cunha**), 2021; *Chronos - take the pulse of our galactic neighbourhood. After Gaia: Time domain information, masses and ages for stars*; Experimental Astronomy, 51, 3, 945

102. G. Dréau, B. Mosser, Y. Lebreton, **C. Gehan**, T. Kallinger, 2021; *Seismic constraints on the internal structure of evolved stars: From high-luminosity RGB to AGB stars*; *Astronomy & Astrophysics*, 650, A115, 19
103. J. Montalbán, J. T. Mackereth, A. Miglio, F. Vincenzo, C. Chiappini, G. Buldgen, B. Mosser, A. Grottsch-Noels, R. Scuflaire, **M. Vrad**, 2021; *Chronologically dating the early assembly of the Milky Way*; *Nature Astronomy*, 5, 7, 640
104. A. Miglio, C. Chiappini, J. T. Mackereth, G. R. Davies, K. Brogaard, L. Casagrande, W. J. Chaplin, L. Girardi, D. Kawata, J. Montalbán et al. (including: **D. Bossini**), 2021; *Age dissection of the Milky Way discs: Red giants in the Kepler field*; *Astronomy & Astrophysics*, 645, A85, 24
105. M. N. Lund, R. Handberg, D. L. Buzasi, L. Carboneau, O. J. Hall, **L. F. Pereira**, D. Huber, D. R. Hey, T. Van Reeth, T'DA Collaboration, 2021; *TESS Data for Asteroseismology: Light-curve Systematics Correction*; *The Astrophysical Journal*, 257, 2
106. **M. Deal**, **M. S. Cunha**, Z. Keszthelyi, K. Perraut, D. L. Holdsworth, 2021; *Fundamental properties of a selected sample of Ap stars: Inferences from interferometric and asteroseismic constraints*; *Astronomy & Astrophysics*, 650, A125, 20
107. O. Carrión González, A. García Muñoz, **N. C. Santos**, J. Cabrera, Sz. Csizmadia, H. Rauer, 2021; *Constraining the radius and atmospheric properties of directly imaged exoplanets through multi-phase observations*; *Astronomy & Astrophysics*, 655, A92, 20
108. Ó. Carrión-González, A. García Muñoz, **N. C. Santos**, J. Cabrera, Sz. Csizmadia, H. Rauer, 2021; *Catalogue of exoplanets accessible in reflected starlight to the Nancy Grace Roman Space Telescope*; *Astronomy & Astrophysics*, 651, A7, 31
109. B. M. Morris, L. Delrez, A. Brandeker, A. C. Cameron, A. E. Simon, D. Futyan, G. Olofsson, S. Hoyer, A. Fortier, B.-O. Demory et al. (including: **S. C. C. Barros**, **O. Demangeon**, **N. C. Santos**, **S. G. Sousa**), 2021; *CHEOPS precision phase curve of the Super-Earth 55 Cancri e*; *Astronomy & Astrophysics*, 653, A173, 15
110. L. Borsato, G. Piotto, D. Gandolfi, V. Nascimbeni, G. Lacedelli, F. Marzari, N. Billot, P. F. L. Maxted, **S. G. Sousa**, A. C. Cameron et al. (including: **S. C. C. Barros**, **O. Demangeon**, **N. C. Santos**), 2021; *Exploiting timing capabilities of the CHEOPS mission with warm-Jupiter planets*; *Monthly Notices of the Royal Astronomical Society*, 506, 3, 3810
111. T. M. Schmidt, P. Molaro, M. T. Murphy, C. Lovis, G. Cupani, S. Cristiani, F. Pepe, R. Rebolo López, **N. C. Santos**, **M. Abreu** et al. (including: **V. Zh. Adibekyan**, **D. Castro Alves**, **A. Cabral**, **J. Coelho**, **P. Figueira**, **A. C. O. Leite**, **C. J. A. P. Martins**, **M. A. Monteiro**, **M. J. P. F. G. Monteiro**, **P. Santos**, **S. G. Sousa**), 2021; *Fundamental physics with ESPRESSO: Towards an accurate wavelength calibration for a precision test of the fine-structure constant*; *Astronomy & Astrophysics*, 646, A144, 26
112. **H. M. Tabernero**, M. R. Zapatero Osorio, R. Allart, F. Borsa, N. Casasayas-Barris, **O. Demangeon**, D. Ehrenreich, J. Lillo-Box, C. Lovis, E. Pallé et al. (including: **S. G. Sousa**, **N. C. Santos**, **V. Zh. Adibekyan**, **S. C. C. Barros**, **J. P. Faria**, **P. Figueira**, **S. Hojjatpanah**, **C. J. A. P. Martins**, **J. H. C. Martins**, **N. J. Nunes**, **A. Cabral**, **J. P. Coelho**, **M. J. P. F. G. Monteiro**, **M. A. Monteiro**, **A. Oliveira**, **P. Santos**), 2021; *ESPRESSO high-resolution transmission spectroscopy of WASP-76 b*; *Astronomy & Astrophysics*, 646, A158, 17
113. N. Casasayas-Barris, E. Pallé, M. Stangret, V. Bourrier, **H. M. Tabernero**, F. Yan, F. Borsa, R. Allart, M. R. Zapatero Osorio, C. Lovis et al. (including: **S. G. Sousa**, **N. C. Santos**, **V. Zh. Adibekyan**, **O. Demangeon**, **P. Figueira**, **C. J. A. P. Martins**, **N. J. Nunes**), 2021; *The atmosphere of HD 209458b seen with ESPRESSO. No detectable planetary absorptions at high resolution*; *Astronomy & Astrophysics*, 647, A26, 19
114. J. Lillo-Box, **J. P. Faria**, A. Suárez Mascareño, **P. Figueira**, **S. G. Sousa**, H. M. Tabernero, C. Lovis, **A. M. Silva**, **O. Demangeon**, S. Benatti et al. (including: **N. C. Santos**, **S. Hojjatpanah**, **V. Zh. Adibekyan**, **A. Cabral**, **C. J. A. P. Martins**, **N. J. Nunes**), 2021; *HD 22496 b: The first ESPRESSO stand-alone planet discovery*; *Astronomy & Astrophysics*, 654, A60, 12
115. V. Bourrier, C. Lovis, M. Cretignier, R. Allart, X. Dumusque, J.-B. Delisle, A. Deline, **S. G. Sousa**, **V. Zh. Adibekyan**, Y. Alibert et al. (including: **S. C. C. Barros**, **O. Demangeon**, **P. Figueira**,

- C. J. A. P. Martins, N. C. Santos**), 2021; *The Rossiter–McLaughlin effect revolutions: an ultra-short period planet and a warm mini-Neptune on perpendicular orbits*; *Astronomy & Astrophysics*, 654, A152, 19
116. A. Jiménez Muñoz, J. F. Macías-Pérez, A. Secroun, W. Gillard, B. Kubik, N. Auricchio, A. Balestra, C. Bodendorf, D. Bonino, E. Branchini et al. (including: **J. Brinchmann, I. Tereno**), 2021; *Euclid: Estimation of the Impact of Correlated Readout Noise for Flux Measurements with the Euclid NISP Instrument*; *Publications of the Astronomical Society of the Pacific*, 133, 1027
 117. **M. Deal**, O. Richard, S. Vauclair, 2021; *Matter accretion in metal-poor stars down to extremely metal-poor stars and the lithium problem*; *Astronomy & Astrophysics*, 646, A160, 13
 118. F. Schuller, Ph. André, Y. Shimajiri, A. Zavagno, N. Peretto, **D. Arzoumanian**, T. Csengeri, V. Könyves, **P. M. Palmeirim**, S. Pezzuto, 2021; *Probing the structure of a massive filament: ArTéMiS 350 and 450 μm mapping of the integral-shaped filament in Orion A*; *Astronomy & Astrophysics*, 651, A36, 17
 119. M. Poulain, F. R. Marleau, R. Habas, P.-A. Duc, R. Sánchez-Janssen, P. R. Durrell, S. Paudel, S. L. Ahad, **A. Chougule**, O. Müller, 2021; *Structure and morphology of the MATLAS dwarf galaxies and their central nuclei*; *Monthly Notices of the Royal Astronomical Society*, 506, 4, 5494
 120. F. R. Marleau, R. Habas, M. Poulain, P.-A. Duc, O. Müller, S. Lim, P. R. Durrell, R. Sánchez-Janssen, S. Paudel, S. Lammim Ahad et al. (including: **A. Chougule**), 2021; *Ultra diffuse galaxies in the MATLAS low-to-moderate density fields*; *Astronomy & Astrophysics*, 654, A105, 32
 121. J. Gomes da Silva, **N. C. Santos, V. Zh. Adibekyan, S. G. Sousa, T. L. Campante, P. Figueira, D. Bossini, E. Delgado Mena, M. J. P. F. G. Monteiro**, P. de Laverny, A. Recio-Blanco, C. Lovis, 2021; *Stellar chromospheric activity of 1674 FGK stars from the AMBRE-HARPS sample. I. A catalogue of homogeneous chromospheric activity*; *Astronomy & Astrophysics*, 646, A77, 22
 122. **V. Zh. Adibekyan, N. C. Santos, O. Demangeon, J. P. Faria, S. C. C. Barros**, M. Oshagh, **P. Figueira, E. Delgado Mena, S. G. Sousa**, G. Israelian, **T. L. Campante**, A. A. Hakobyan, 2021; *Stellar clustering and orbital architecture of planetary systems*; *Astronomy & Astrophysics*, 649, A111, 9
 123. **S. G. Sousa, V. Zh. Adibekyan, E. Delgado Mena, N. C. Santos**, B. Rojas-Ayala, **B. Soares, H. Legoinha**, S. Ulmer-Moll, **J. D. Camacho, S. C. C. Barros** et al. (including: **O. Demangeon, M. A. Monteiro**), 2021; *SWEET-Cat 2.0: The Cat just got SWEETer. Higher quality spectra and precise parallaxes from Gaia eDR3*; *Astronomy & Astrophysics*, 656, A53, 13
 124. M. Cointepas, J.-M. Almenara, X. Bonfils, F. Bouchy, N. Astudillo-Defru, F. Murgas, J. F. Otegi, A. Wyttenbach, D. R. Anderson, E. Artigau et al. (including: **P. Figueira, N. C. Santos**), 2021; *TOI-269 b: an eccentric sub-Neptune transiting a M2 dwarf revisited with ExTrA*; *Astronomy & Astrophysics*, 650, A145, 18
 125. C. Moutou, J.-M. Almenara, G. Hébrard, **N. C. Santos**, K. G. Stassun, S. Deheuvels, **S. C. C. Barros**, P. Benni, A. Bieryla, I. Boisse et al. (including: **O. Demangeon**), 2021; *TOI-1296b and TOI-1298b observed with TESS and SOPHIE: two hot Saturn-mass exoplanets with different densities around metal-rich stars*; *Astronomy & Astrophysics*, 653, A147, 12
 126. J. V. Seidel, D. Ehrenreich, R. Allart, H. J. Hoeijmakers, C. Lovis, V. Bourrier, L. Pino, A. Wyttenbach, **V. Zh. Adibekyan**, Y. Alibert et al. (including: **O. Demangeon, P. Figueira, C. J. A. P. Martins, N. J. Nunes, N. C. Santos, H. M. Tabernero**), 2021; *Into the storm: diving into the winds of the ultra-hot Jupiter WASP-76 b with HARPS and ESPRESSO*; *Astronomy & Astrophysics*, 653, A73, 16
 127. **O. Demangeon**, S. Dalal, G. Hébrard, **B. Nsamba**, F. Kiefer, J. D. Camacho, J. Sahlmann, L. Arnold, N. Astudillo-Defru, X. Bonfils et al. (including: **T. L. Campante, J. P. Faria, S. G. Sousa, N. C. Santos**), 2021; *The SOPHIE search for northern extrasolar planets. XVIII. Six new cold Jupiters, including one of the most eccentric exoplanet orbits*; *Astronomy & Astrophysics*, 653, A78, 23
 128. J. Lillo-Box, Á. Ribas, B. Montesinos, **N. C. Santos, T. L. Campante, M. S. Cunha**, D. Barrado, E. Villaver, **S. G. Sousa**, H. Bouy et al. (including: **L. F. Pereira**), 2021; *Uncovering the ultimate planet impostor. An eclipsing brown dwarf in a hierarchical triple with two evolved stars*; *Astronomy & Astrophysics*, 653, A40, 18

129. **E. Delgado Mena, V. Zh. Adibekyan, N. C. Santos**, M. Tsantaki, J. I. González Hernández, **S. G. Sousa**, S. Bertrán de Lis, 2021; *Chemical abundances of 1111 FGK stars from the HARPS GTO planet search program. IV. Carbon and C/O ratios for Galactic stellar populations and planet hosts*; Astronomy & Astrophysics, 655, A99, 14
130. **V. Zh. Adibekyan**, C. Dorn, **S. G. Sousa, N. C. Santos**, B. Bitsch, G. Israelian, C. Mordasini, **S. C. C. Barros, E. Delgado Mena, O. Demangeon** et al. (including: **J. P. Faria, P. Figueira, B. Soares**), 2021; *A compositional link between rocky exoplanets and their host stars*; Science, 374, 6565, 330
131. Z.-X. Fu, C. Sengupta, Ramya Sethuram, Bikram Pradhan, Mridweeka Singh, K. Misra, **T. C. Scott**, Y. -Z. Ma, 2021; *Interacting system NGC 7805/6 (Arp 112) and its tidal dwarf galaxy candidate*; Reports on progress in physics, 21, 2, 8
132. **T. C. Scott**, C. Sengupta, **P. Lagos**, A. Chung, O. I. Wong, 2021; *Resolved H I in two ultra-diffuse galaxies from contrasting non-cluster environments*; Monthly Notices of the Royal Astronomical Society, 503, 3, 3953
133. O. I. Wong, A. R. H. Stevens, B.-Q. For, T. Westmeier, M. Dixon, S.-H. Oh, G. I. G. Józsa, T. N. Reynolds, K. Lee-Waddell, J. Román et al. (including: **T. C. Scott**), 2021; *WALLABY pre-pilot survey: two dark clouds in the vicinity of NGC 1395*; Monthly Notices of the Royal Astronomical Society, 507, 2, 2905
134. **C. J. A. P. Martins**, P. Peter, **I. Yu. Rybak**, E. P. S. Shellard, 2021; *Generalized velocity-dependent one-scale model for current-carrying strings*; Physical Review D, 103, 0435, 17
135. **C. J. A. P. Martins**, P. Peter, **I. Yu. Rybak**, E. P. S. Shellard, 2021; *Charge-velocity-dependent one-scale linear model*; Physical Review D, 104, 10
136. J. Delabrouille, Maximilian H. Abitbol, N. Aghanim, Yacine Ali-Haïmoud, D. Alonso, M. Alvarez, A. J. Banday, J.G. Bartlett, Baselmans, K. Basu et al. (including: **C. J. A. P. Martins**), 2021; *Microwave spectro-polarimetry of matter and radiation across space and time*; Experimental Astronomy, 51, 3, 1471
137. V. Van Grootel, F. J. Pozuelos, A. Lethuillier, S. Charpinet, L. Delrez, M. Beck, A. Fortier, S. Hoyer, **S. G. Sousa**, B. N. Barlow et al. (including: **S. C. C. Barros, O. Demangeon, N. C. Santos**), 2021; *A search for transiting planets around hot subdwarfs. I. Methods and performance tests on light curves from Kepler, K2, TESS, and CHEOPS*; Astronomy & Astrophysics, 650, A205, 19
138. **I. Yu. Rybak, L. Sousa**, 2021; *CMB anisotropies generated by cosmic string loops*; Physical Review D, 104, 0235, 16
139. Anna Brucalassi, M. Tsantaki, L. Magrini, **S. G. Sousa**, C. Danielski, K. Biazzo, G. Casali, M. Van der Swaelmen, M. Rainer, **V. Zh. Adibekyan, E. Delgado Mena**, N. Sanna, 2021; *Determination of stellar parameters for Ariel targets: a comparison analysis between different spectroscopic methods*; Experimental Astronomy, 15
140. C. F. Manara, A. Frasca, L. Venuti, M. Siwak, G. Herczeg, N. Calvet, J. Hernández, L. Tychoniec, M. Gangi, J. M. Alcalá et al. (including: **J. F. Gameiro**), 2021; *PENELLOPE: The ESO data legacy program to complement the Hubble UV Legacy Library of Young Stars (ULLYSES). I. Survey presentation and accretion properties of Orion OB1 and σ -Orionis*; Astronomy & Astrophysics, 650, A196, 46
141. **H. M. Tabernero**, R. Dorda, I. Negueruela, E. Marfil, 2021; *The nature of VX Sagittarii. Is it a TZO, a RSG, or a high-mass AGB star?*; Astronomy & Astrophysics, 646, A98, 13
142. E. Palte, R. Luque, M. R. Zapatero Osorio, H. Parviainen, M. Ikoma, **H. M. Tabernero**, M. Zechmeister, A. J. Mustill, V. S. J. Bejar, N. Narita, F. Murgas, 2021; *ESPRESSO mass determination of TOI-263b: an extreme inhabitant of the brown dwarf desert*; Astronomy & Astrophysics, 650, A55, 9
143. K. Pattle, S.-P. Lai, J. Di Francesco, S. Sadavoy, D. Ward-Thompson, D. Johnstone, T. Hoang, **D. Arzoumanian**, P. Bastien, S. Coudé, 2021; *JCMT POL-2 and BISTRO Survey Observations of Magnetic Fields in the L1689 Molecular Cloud*; The Astrophysical Journal, 907, 88, 21

144. L. Cabona, **P. T. P. Viana**, M. Landoni, **J. P. Faria**, 2021; *Scheduling strategies for the ESPRESSO follow-up of TESS targets*; Monthly Notices of the Royal Astronomical Society, 503, 4, 5504
145. J. Teske, S. X. Wang, A. Wolfgang, T. Gan, M. Plotnykov, D. J. Armstrong, R. P. Butler, B. Cale, J. D. Crane, W. S. Howard et al. (including: **V. Zh. Adibekyan**, **S. C. C. Barros**, **O. Demangeon**, **S. Hojjatpanah**, **S. G. Sousa**), 2021; *The Magellan-TESS Survey. I. Survey Description and Midsurvey Results*; The Astrophysical Journal Supplement Series, 256, 2
146. **Demangeon, O. D. S.**, M. R. Zapatero Osorio, Y. Alibert, **S. C. C. Barros**, **V. Adibekyan**, **H. M. Tabernero**, **A. Antoniadis-Karnavas**, **J. D. Camacho**, A. Suárez Mascareño, M. Oshagh, et al. (including: **S. G. Sousa**, **N. C. Santos**, **J. Faria**, **P. Figueira**, **C. J. A. P. Martins**), 2021; Warm terrestrial planet with half the mass of Venus transiting a nearby star; *Astronomy and Astrophysics*, Volume 653,p A41

Proceedings published in 2021

1. N. Bouché, D. Krajnović, E. Emsellem, Wilfried Mercier, J. Schaye, B. Epinat, J. Richard, B. Zoutendijk, V. Abril-Melgarejo, J. Brinchmann, R. Bacon, T. Contini, L. A. Boogaard, L. Wisotzki, M. V. Maseda, M. Steinmetz; 2021; *Cored dark-matter profiles in $z \approx 1$ star forming galaxies*; SF2A-2021: Proceedings of the Annual meeting of the French Society of Astronomy and Astrophysics; (Eds.)A. Siebert, K. Baillié, E. Lagadec, N. Lagarde, J. Malzac, J.-B. Marquette, M. N'Diaye, J. Richard, O. Venot, French Society of Astronomy and Astrophysics, 379
2. L. Cabona, P. T. P. Viana, M. Landoni, J. P. Faria; 2021; *Applications of Bayesian framework to optimal observational design strategies*; Nuovo Cimento C – Colloquia and Communications in Physics, Società Italiana di Fisica, 044, 2-3
3. I. A. Costa, C. Morais, M. J. P. F. G. Monteiro; 2021; *CoAstro: @n astronomy condo – Teachers' attitudes and epistemological beliefs towards science in a citizen science project*; Education Applications & Developments VI; (Eds.)Mafalda Carmo, inSciencePress, Advances in Education and Educational Trends, 6, 66
4. A. Nigoche-Netro, G. Ramos-Larios, R. F. Díaz, E. de la Fuente, P. Lagos, A. Ruelas-Mayorga, J. Mendez-Abreu, S. N. Kemp; 2021; *Dark matter content of ETGs and its relation to the local density of galaxies*; Galaxy Evolution and Feedback across Different Environments, Proceedings of the International Astronomical Union, 15, 359, 42

International Scientific Communications in 2021

1. **V. Zh. Adibekyan**; 2021; *Telluric planets, made of star-stuff*; Workshop Sciences and Technologies for Space – a ground up overview, Online, Portugal
2. **V. Zh. Adibekyan**; 2021; *Observational evidence of the compositional link between rocky planets and their hosts*; AASTCS 8: Habitable Worlds, Online, Estados Unidos da América
3. **V. Zh. Adibekyan**, M. Carena; 2021; *Interface with WP11: Requirements from WP11 to WP122*; PLATO WP122 Liege workshop #4, Online, Bélgica
4. **V. Zh. Adibekyan**; 2021; *A compositional link between rocky exoplanets and their host stars*; PLATO Atmospheres Workshop, Online, Bélgica
5. **V. Zh. Adibekyan**; 2021; *A compositional link between rocky exoplanets and their host stars*; Astronomy in the Crossroads of Interdisciplinary and Multidisciplinary Sciences, Online, Arménia
6. **V. Zh. Adibekyan**; 2021; *The chemical link between stars and their rocky planets*; EANA 2021, Online,

7. **V. Zh. Adibekyan**; 2021; *Earth-like planets around Solar-like stars*; PLATO Mission Conference 2021, Online,
8. **V. Zh. Adibekyan**; 2021; *A compositional link between rocky exoplanets and their host stars*; Ariel Consortium Science Workshop, Online, Reino Unido
9. **V. Zh. Adibekyan**; 2021; *Benchmark stars, benchmark spectrographs!*; HRMOS Science Workshop, Online, Itália
10. **V. Zh. Adibekyan**; 2021; *Stellar clustering and orbital architecture of planetary systems*; Astronomy in the Crossroads of Interdisciplinary and Multidisciplinary Sciences, Online, Arménia
11. **V. Zh. Adibekyan**; 2021; *Benchmark stars, benchmark spectrographs!*; Astronomy in the Crossroads of Interdisciplinary and Multidisciplinary Sciences, Online, Arménia
12. **V. Zh. Adibekyan**; 2021; *The Chemical link between stars and their rocky planets*; TESS Science Conference II, Online, Estados Unidos da América
13. **B. Akinsanmi**; 2021; *The quest to find rings around exoplanets*; African Astronomical Society Meeting 2021, Online
14. **A. Antoniadis-Karnavas**; 2021; *ODUSSEAS: a machine learning tool to derive effective temperature and metallicity for M Dwarf stars*; Where the Earth Meets the Sky, Online, Dinamarca
15. **A. Antoniadis-Karnavas**; 2021; *ODUSSEAS: a machine learning tool to derive effective temperature and metallicity for M Dwarf stars*; Towards the Comprehensive Characterization of Exoplanets: Science at the Interface of Multiple Measurement Techniques, Online, Estados Unidos da América
16. **A. Antoniadis-Karnavas**; 2021; *ODUSSEAS: a machine learning tool to derive effective temperature and metallicity for M Dwarf stars*; CoolStars 20.5, Online, Estados Unidos da América
17. **S. C. C. Barros**; 2021; *Status of the WG5 Feature characterise*; Virtual CHEOPS science team meeting #21, Online
18. **S. C. C. Barros**; 2021; *Status of the WG5 Feature characterise*; Virtual CHEOPS science team meeting #22, Online
19. **S. C. C. Barros**; 2021; *Status of the WG5 Feature characterise*; Virtual CHEOPS science team meeting #23, Online
20. **D. Bossini**; 2021; *Homogeneous determination of age and mass for stars in Ariel targets*; Ariel Consortium Science Workshop, Online
21. **T. Boulet, T. L. Campante, V. Zh. Adibekyan, A. M. Serenelli**; 2021; *The legacy of high-precision Asteroseismology in the TESS southern continuous viewing zone for Galactic archaeology*; 8th Iberian Meeting on Asteroseismology, Porto, Portugal
22. **T. Boulet, T. L. Campante, V. Zh. Adibekyan, A. M. Serenelli**; 2021; *The Legacy of High-precision Asteroseismology for Chemical Clock Dating and Galactic Archaeology*; PLATO Mission Conference 2021, Online
23. **T. Boulet, T. L. Campante, V. Zh. Adibekyan, A. M. Serenelli**; 2021; *The Search for Chemical Clocks with TESS and APOGEE*; Star Clusters: the Gaia Revolution, Online, Espanha
24. **J. Brinchmann**; 2021; *NFM observations of exoplanets and stars*; MUSE Busy Week, Online
25. **J. Brinchmann**; 2021; *Antlia B - The astrophysical nature of the source*; MUSE Busy Week, Toulouse, França
26. **J. Brinchmann**; 2021; *MUSE-Faint - an update*; MUSE Busy Week, Toulouse, França
27. **T. L. Campante**; 2021; *Homogeneous determination of age and mass for stars in the Ariel input catalog*; Ariel Virtual Consortium Meeting, Online
28. **T. L. Campante**; 2021; *Synergy between asteroseismology and exoplanetary science*; The Star-Planet Connection, Online
29. **R. Carvajal, I. Matute, J. Afonso, S. Amarantidis, D. D. Barbosa, P. A. C. Cunha, A. Humphrey**; 2021; *Using Machine Learning to identify high-redshift Radio Galaxy candidates*; 50th Young European Radio Astronomers Conference, Online, França
30. **R. Carvajal, I. Matute, J. Afonso, S. Amarantidis, D. D. Barbosa, P. A. C. Cunha, A. Humphrey**; 2021; *Using a series of Machine Learning Models for the detection of high-redshift Radio Galaxy*

- candidates*; IAP Colloquium: Debating the potential of Machine Learning in astronomical surveys, Online, França
31. **R. Carvajal, J. Afonso, I. Matute, S. Amarantidis, D. D. Barbosa, P. A. C. Cunha, A. Humphrey;** 2021; *Using ensemble Machine Learning to predict high- redshift Radio Galaxy detections*; SPARCS X 2021, Online, África do Sul
 32. **J. R. C. C. C. Correia, C. J. A. P. Martins;** 2021; *Coding the Cosmos: A new generation of superstring simulations*; EuroHPC Summit Week 2021, Online
 33. **J. R. C. C. C. Correia, C. J. A. P. Martins;** 2021; *High resolution calibration of string modelling*; COSMO'21 Conference, Online, Estados Unidos da América
 34. **J. R. C. C. C. Correia, C. J. A. P. Martins;** 2021; *High resolution calibration of string modelling*; 16th Marcel Grossmann Meeting, Online
 35. **I. A. Costa;** 2021; *Comunicação e bem estar planetário - Museus e Projetos Inclusivos*; III Encontro Ibérico Comunicacion Y Periodismo Científico, Barcelona, Espanha
 36. **I. A. Costa;** 2021; *MW GAIA: Bringing the Milky Way to schools - the CoAstro example*; WG5 Workshop: Bringing the Milky Way to schools 2021, Online,
 37. **I. A. Costa;** 2021; *Citizen science: from a scientific technique to a science education and communication method – the CoAstro practical example*; Science&You 2021, Metz, França
 38. **I. A. Costa;** 2021; *CoAstro: @n Astronomy Condo — a New Citizen Science Proposal for Communicating Astronomy with the Public*; CAP Conference: Communicating Astronomy with the Public 2021, Online, Austrália
 39. **M. Deal, O. Richard, S. Vauclair;** 2021; *Lithium abundance dispersion in metal-poor stars*; CoolStars 20.5, Online, Estados Unidos da América
 40. **M. Deal;** 2021; *Processus de transport des éléments chimiques: Impact sur la structure interne des étoiles et des exoplanètes*; ExoSystème II, Toulouse, França
 41. **M. Deal;** 2021; *Transport of chemical elements in main-sequence stars*; PLATO Mission Conference 2021, Online
 42. **M. Deal, O. Richard, S. Vauclair;** 2021; *Lithium abundance dispersion un metal poor stars*; CoolStars 20.5, Online, Estados Unidos da América
 43. **M. Deal, O. Richard, S. Vauclair, C. J. A. P. Martins;** 2021; *Lithium abundance dispersion in metal-poor stars*; Journées de la SF2A 2021, Online, França
 44. **E. Delgado Mena;** 2021; *Carbon and C/O ratios for Galactic stellar populations and planet hosts*; ESO Workshop The Star-Planet Connection, Online,
 45. **E. Delgado Mena;** 2021; *Stellar abundances sub-WG*; Ariel Summer Consortium Meeting, Online
 46. **E. Delgado Mena;** 2021; *Searching for planets around evolved massive stars in open clusters: lessons from HARPS*; HRMOS Science Workshop, Online, Itália
 47. **E. Delgado Mena;** 2021; *RV variations in evolved stars in open clusters: planets, oscillations or stellar activity?*; ESO Workshop The Star-Planet Connection, Online,
 48. **E. Delgado Mena;** 2021; *Carbon and C/O ratios for Galactic stellar populations and planet hosts*; PLATO WP122 Scientific Workshop #1, Online,
 49. **C. Gehan;** 2021; *Seismology of solar-type pulsators: outstanding observational results*; Workshop on Pulsations in Intermediate-mass, Massive and/or Multiple Stars, Online, Reino Unido
 50. **J. Gomes da Silva;** 2021; *The relationship between activity and age in late-type stars*; PLATO HOW#2: Uncertainties in stellar properties determination, Online,
 51. **M. S. N. Kumar;** 2021; *Filaments, Hubs, Coalescence and Cluster Formation*; ISM 2021 Conference, Online, Líbano
 52. **C. J. A. P. Martins;** 2021; *BBN with GUTs*; XV Iberian Cosmology Meeting, Online, Portugal
 53. **C. J. A. P. Martins;** 2021; *ELT: How to Prepare a Revolution*; PLANCKS 2021 Meeting, Online, Portugal
 54. **C. J. A. P. Martins;** 2021; *Coding the Cosmos: A New Generation of Superstring Simulations*; EuroHPC Summit Week 2021, Online,

55. **C. J. A. P. Martins**; 2021; *Recent Fundamental Physics Theoretical Developments*; ESPRESSO Science Team Workshop, Online,
56. **C. J. A. P. Martins**; 2021; *Astrophysical spectroscopy tests of the Einstein Equivalence Principle: the ESPRESSO era*; Second EPS Conference on Gravitation: measuring gravity, Online, Reino Unido
57. **C. J. A. P. Martins**; 2021; *Varying fundamental constants and dark energy in the ESPRESSO era*; 16th Marcel Grossmann Meeting, Online, Itália
58. **C. J. A. P. Martins**; 2021; *Alternatives to Lambda: Torsion, Generalized Couplings, and Scale Invariance*; 16th Marcel Grossmann Meeting, Online, Itália
59. **C. J. A. P. Martins**; 2021; *Observational constraints on nonlinear matter extensions of general relativity*; 16th Marcel Grossmann Meeting, Online, Itália
60. **C. J. A. P. Martins**; 2021; *Closing the cosmological loop with the redshift drift*; 16th Marcel Grossmann Meeting, Online, Itália
61. **C. J. A. P. Martins**; 2021; *Teaching Relativity at the AstroCamp*; 16th Marcel Grossmann Meeting, Online, Itália
62. **C. J. A. P. Martins**; 2021; *Primordial nucleosynthesis with varying fundamental constants: Improved constraints and a possible solution to the Lithium problem*; COSMO'21 Conference, Online, Estados Unidos da América
63. **N. A. M. Moedas**; 2021; *Investigating the chemical evolution in solar-like stars: Effect of turbulent mixing in stellar models*; 8th Iberian Meeting on Asteroseismology, Porto, Portugal
64. **A. Paulino-Afonso**; 2021; *Artificial redshifting and host mass bias*; CRISP meeting, Peniche, Portugal
65. **J. Rodrigues, S. C. C. Barros, N. C. Santos**; 2021; *FULMAR: Follow-Up Lightcurves Multitool Assisting Radial velocities*; Tess Science Conference II, Online,
66. **J. Rodrigues, S. C. C. Barros, N. C. Santos**; 2021; *Follow-Up Lightcurves Multitool Assisting Radial velocities (FULMAR)*; Europlanet Science Congress 2021, Online,
67. **N. M. Rosario, S. C. C. Barros, O. Demangeon, N. C. Santos, B. Akinsanmi**; 2021; *Measure the spin-up of hot Jupiters due to tides*; TESS Science Conference II, Online, Estados Unidos da América
68. **I. Yu. Rybak**; 2021; *Dynamics and Y-junctions of superconducting (transonic) cosmic strings*; IberiCOS 2021, Coimbra, Portugal
69. **N. C. Santos**; 2021; *A solar telescope for planet hunters*; The Star-Planet Connection, Online
70. **N. C. Santos**; 2021; *Finding the lowest mass planets with ESPRESSO*; EANA 2021 Conference, Online,
71. **N. C. Santos**; 2021; *PoET: a solar telescope for planet hunters*; NASA ExoPAG Study Analysis Group (SAG) 21 Community Symposium, Online,
72. **N. C. Santos**; 2021; *A compositional link between rocky exoplanets and their host stars*; ESO Workshop The Star-Planet Connection, Online
73. **N. C. Santos**; 2021; *Exoplanet Science: from ground to space*; Workshop Sciences and Technologies for Space – a ground up overview, Online, Portugal
74. **T. C. Scott**; 2021; *Galaxy Clusters: What we are learning from cold gas in late type galaxies*; The Past, Present and Future of the VLA: Celebrating 40 Years, Online
75. **A. M. Silva, J. P. Faria, N. C. Santos, S. G. Sousa, P. T. P. Viana**; 2021; *A semi-Bayesian implementation of template matching for precise radial Velocities*; Statistical Challenges in Modern Astronomy VII, Online, Estados Unidos da América
76. **A. M. Silva, J. P. Faria, N. C. Santos, S. G. Sousa, P. T. P. Viana**; 2021; *A Bayesian template matching approach applied to HARPS: towards the improvement of the RV precision*; EAS 2021, Online, Países Baixos
77. **H. Silva**; 2021; *U(1) Local Strings in hybrid metric-Palatini gravity*; 16th Marcel Grossmann Meeting, Online
78. **H. Silva**; 2021; *U(1) Local Strings in generalized hybrid metric-palatini gravity*; 16th Marcel Grossmann Meeting, Online
79. **H. Silva**; 2021; *U(1) local cosmic strings in hybrid metric-Palatini gravity*; 30th Workshop on General Relativity and Gravitation in Japan, Online, Japão

80. **T. A. Silva**; 2021; *A curious planetary system: A Dense Hot Super Mercury and a Cold Jupiter*; STARS and PLANETS in the ULTRAVIOLET: A Cross-Community Symposium, Online, Estados Unidos da América
81. **B. Soares, V. Zh. Adibekyan, N. C. Santos, E. Delgado Mena, S. G. Sousa**; 2021; *From stellar to planetary compositions*; ESO Workshop The Star-Planet Connection, Online
82. **B. Soares, V. Zh. Adibekyan, N. C. Santos, E. Delgado Mena, S. G. Sousa, A. A. Godizov**; 2021; *Chemical composition of rocky planets orbiting M dwarfs*; EANA 2021, Online
83. **L. Sousa**; 2021; *Probing cosmic superstrings with gravitational waves*; Gravitational wave probes of physics beyond the standard model, Online, Polónia
84. **S. G. Sousa**; 2021; *SWEET-CAT v2: What can homogeneous stellar parameters provide to planetary systems studies?*; PLATO WP122 Scientific Workshop #1, Online

National Scientific Communications in 2021

1. **V. Zh. Adibekyan**; 2021; *The chemical link between stars and their rocky planets*; 31st National Astronomy and Astrophysics Meeting, Online, Portugal
2. **V. Zh. Adibekyan**; 2021; *Stellar clustering and orbital architecture of planetary systems*; 2nd Planetary Systems day, Online, Portugal
3. **V. Zh. Adibekyan**; 2021; *Towards a comprehensive study of Stars and stellar systems*; Estágios de Verão IAstro 2021, Online, Portugal
4. **R. Carvajal, I. Matute, J. Afonso, S. Amarantidis, D. D. Barbosa, P. A. C. Cunha, A. Humphrey**; 2021; *Obtaining High-redshift Radio Galaxy candidates with Machine Learning*; IA-ON8, Coimbra, Portugal
5. **A. Chougule, J. M. Gomes, P. Papaderos**; 2021; *Active Galaxies: where matter meets cosmic monsters*; Encontro com a Ciência e Tecnologia em Portugal, Online, Portugal
6. **A. Chougule, J. M. Gomes, P. Papaderos**; 2021; *An extensive collection of Seyfert 2 galaxy templates*; 31st National Astronomy and Astrophysics Meeting, Online, Portugal
7. **J. R. C. C. Correia, C. J. A. P. Martins**; 2021; *On improving string modelling*; IberiCOS 2021, Online, Portugal
8. **I. A. Costa**; 2021; *Parcerias com os Clubes Ciência Viva na Escola*; Encontro Mobilizador - Clubes Ciência Viva nas Escolas, Porto, Portugal
9. **I. A. Costa**; 2021; *Parcerias com os Clubes Ciência Viva na Escola*; Encontro Mobilizador - Clubes Ciência Viva nas Escolas, Vila Nova de Gaia, Portugal
10. **I. A. Costa, B. D. Fields**; 2021; *Communicating Science... what for? - the Porto Planetarium - Ciência Viva Center case*; Estágios de Verão IAstro 2021, Online, Portugal
11. **I. A. Costa**; 2021; *Ciência cidadã em contexto escolar: de uma técnica investigativa a um método de ensino e comunicação de ciência – um exemplo nacional*; Encontro Nacional de Ciência Cidadã 2021, Porto, Portugal
12. **I. A. Costa**; 2021; *Astronomy fade out in portuguese compulsory schooling: a crossroads for astronomy national stakeholders*; 31st Encontro Nacional de Astronomia e Astrofísica, Online, Portugal
13. **I. A. Costa**; 2021; *A Ciência Cidadã como método de comunicação de ciência: o caso do projeto CoAstro*; 9.ª edição do Congresso Anual de Comunicação de Ciência SciComPt, Online, Portugal
14. **E. A. S. Cristo**; 2021; *Unveiling the atmosphere of HD 209458b with ESPRESSO*; 1st Planet Systems Day, Online, Portugal
15. **J. Gomes da Silva**; 2021; *Trends in stellar chromospheric activity*; 1st Planet Systems Day, Online, Portugal
16. **P. Lagos**; 2021; *IFS studies in star-forming dwarf galaxies and group-dominant galaxies*; 1st Galaxies Day @ IA, Online, Portugal
17. **N. A. M. Moedas**; 2021; *Effect of turbulent mixing on stellar surface abundances*; IA-ON8, Coimbra, Portugal
18. **E. M. P. S. Moreira, S. Pereira**; 2021; *Science Communication overview*; IA-ON8, Online, Portugal
19. **S. Pereira, C. Leote, F. A. L. Pires, J. Retrê, T. F. S. Cunha**; 2021; *Conteúdos educativos em astronomia: estratégias e parcerias em ligação com a sociedade*; SciComPt 2021, Online, Portugal

20. **N. M. Rosario**; 2021; *Measure the spin-up of hot-Jupiters due to tides*; 31st National Astronomy and Astrophysics Meeting, Online, Portugal
21. **I. Yu. Rybak**; 2021; *CMB from standard and current-carrying cosmic strings*; 31st National Astronomy and Astrophysics Meeting, Online, Portugal
22. **A. R. G. Santos**; 2021; *Solar and stellar magnetic activity*; Stars Day 2021, Online, Portugal
23. **A. R. G. Santos**; 2021; *Signatures of stellar magnetic activity from space-based photometry*; IA-ON8, Coimbra, Portugal
24. **A. M. Silva, J. P. Faria, N. C. Santos, S. G. Sousa, P. T. P. Viana**; 2021; *A new paradigm for the estimation of precise stellar radial velocities: towards the development of an innovative data analysis software*; IA-ON8, Online, Portugal
25. **A. M. Silva, J. P. Faria, N. C. Santos, S. G. Sousa, P. T. P. Viana, C. Hanhart**; 2021; *A semi-Bayesian implementation of template matching for precise radial Velocities*; Encontro com a Ciência e Tecnologia em Portugal, Online, Portugal
26. **T. A. Silva**; 2021; *Transmission spectroscopy measurements of exoplanets with ESPRESSO*; IA-ON8, Online, Portugal
27. **T. A. Silva**; 2021; *A curious planetary system: A Dense Hot Super Mercury and a Cold Jupiter*; 31st National Astronomy and Astrophysics Meeting, Online, Portugal
28. **B. Soares, V. Zh. Adibekyan, N. C. Santos, E. Delgado Mena, S. G. Sousa**; 2021; *A compositional link between rocky exoplanets and their host stars*; 2nd Planets Day, Porto, Portugal

Visitors

The researchers/lecturers that have visited CAUP in 2021 were:

1. Amelia L. Drew, DAPTP/CMS, University of Cambridge, United Kingdom, 29 November - 3 December 2021
2. Patrick Peter, IAP, France, 28 November - 4 December 2021
3. Christophe Sauty, Observatoire de Paris, France, 2 - 6 November 2021
4. Chadi Meskini, University of Montpellier, France, 2 - 6 November 2021
5. Monserrat Villar Martín, Centro de Astrobiología (CSIC/INTA), Spain, 6 - 14 October 2021

Scientific Seminars

1. André, Ph.; 2021; *The role of molecular filaments in the origin of stellar masses*
2. Bellini, E.; 2021; *Shear shear: weak lensing with one mode*
3. Bonoli, S.; 2021; *miniJPAS: a preview of the Universe in 56 colors*
4. Cantat-Gaudin, T.; 2021; *Painting a portrait of the Milky Way disc with Gaia and star clusters*
5. Castander, F. J.; 2021; *The PAU Survey*
6. Chiappini, C.; 2021; *Galactic Archaeology with precise ages, chemistry and kinematics: what have we learned?*
7. Daddi, E.; 2021; *Observing the formation of the first generations of galaxy clusters at high redshift*
8. Di Valentino, E.; 2021; *Investigating cosmic discordances*
9. Foreman-Mackey, D.; 2021; *Open-source software for probabilistic data analysis in astronomy*
10. Gil de Paz, A.; 2021; *MEGARA & TARSIS, from the highest-resolution to the widest-field 2D spectroscopy*
11. Goswami, S.; 2021; *On the effects of Initial Mass function on the galactic chemical enrichment: the role of Pair Instability Supernovae*
12. Lee, Y. J.; 2021; *Brightness modulations of our nearest terrestrial planet Venus*
13. Mainieri, V.; 2021; *AGN outflows at cosmic noon and their impact of the host galaxies*
14. Miglio, A.; 2021; *Asteroseismic ages for galactic archaeology: strengths and limitations*
15. Peter, P.; 2021; *Unitarily inequivalent quantum bouncing models*

16. Quintin, J.; 2021; *Isotropisation in the approach to a singularity*
17. Rompineve, F.; 2021; *Gravitational Waves as probe of QCD axion quality*
18. Scolnic, D.; 2021; *New Advances with Type Ia Supernovae To Measure The Expansion of the Universe*
19. Seidel, J. V.; 2021; *Hotter than Hell: Understanding highly-irradiated worlds through transmission spectroscopy*
20. Sherwin, B.; 2021; *New ways of testing cosmic tensions with galaxy surveys and CMB lensing*
21. Steindl, T.; 2021; *Putting Hayashi and Henyey behind: Combining asteroseismology and state of the art pre-main sequence models*

Observing Runs

1. M. Beltran, V. Rivilla, M. S. N. Kumar; The large-scale kinematics of the protocluster G31, IRAM, 30m Telescope, 8-10 July 2021
2. S. Inutsuka, D. Arzoumanian, M. S. N. Kumar, R. Furuya; Polarization observations of S106 and W3/4 complexes to map the magnetic fields, JCMT. 9-11 August 2021
3. B. Wehbe and the NIRPS team, NIRPS FE commissioning, La Silla ESO 3.6m telescope, 2-7 December 2021
4. C. Sengupta, T. C. Scott, Y. Chandola, H. Chen, P. Lagos, Y. Ma, D. Tramonte, H. Ye; HI observations of ultra-diffuse galaxies (UDGs) in galaxy groups; MKT-20121; MeerKAT; 15 May - 2 September 2021
5. M. Sun, F. Combes, L. Cortese, T. C. Scott, S. Sivanandam, E. Brinks, M. Fumagalli, M. Yagi, J. Palous, W. Cramer, M. Fossati, A. Boselli, A. Kabátová, R. Grossová; ALMA JELLY - Survey of Nearby Jellyfish and Ram Pressure Stripped Galaxies; 2021.1.01616.L; ALMA
6. S. Sousa, N. Santos, E. Delgado Mena, V. Adibekyan, Rojas Ayala, Mortier, P. Figueira, O. Demangeon, Israelian, S. Barros, J. 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 P107
7. J. Brinchmann and the MUSE GTO team; 105.208V.001; MUSE/VLT; 2021-09-01 to 2021-09-11, P107
8. J. Brinchmann and the MUSE GTO team; 108.22AM.001; MUSE/VLT; 2021-10-03 to 2021-10-10, P108
9. J. Brinchmann and the MUSE GTO team; 108.22AM.001; MUSE/VLT; 2021-10-31 and 2021-11-02, P108
10. J. Brinchmann and the MUSE GTO team; 108.22AM.001; MUSE/VLT; 2021-11-30 to 2021-12-09, P108
11. A. R. F. Sanchez, M. L. P. Gunawardhana, M. Maseda, A. Myszka, K. Glazebrook, J. Matthee, L. Boogard, J. Brinchmann, S. Sweet; N/A; KOALA/AAT; 2021-12-28 to 2022-01-03
12. T. L. Campante, N. C. Santos, V. Adibekyan, M.S. Cunha, Pushing the boundaries of cool-dwarf asteroseismology with ESPRESSO; Program ID: 109.236P; Echelle SPectrograph for Rocky Exoplanets and Stable Spectroscopic Observations (ESPRESSO) at the Very Large Telescope (VLT); Period 109
13. C. Danielski, T. L. Campante, M. Tsantaki, E. Delgado Mena, et al.; Building a public catalogue of homogeneously characterised Ariel exoplanet-host stars; Program ID: 109.23J9; Ultraviolet and Visual Echelle Spectrograph (UVES) at the Very Large Telescope (VLT); Period 109
14. S. Grunblatt, T. L. Campante, F. Pereira, D. Veras, Planetary Archaeology: Characterizing Planet Candidates Transiting Evolved Stars; Program ID: N085; High Resolution Echelle Spectrometer (HIRES) at the W. M. Keck Observatory; Semester 2021B
15. S. Grunblatt, T. L. Campante, F. Pereira, D. Veras, Planetary Archaeology: Characterizing Planet Candidates Transiting Evolved Stars; Program ID: N098; High Resolution Echelle Spectrometer (HIRES) at the W. M. Keck Observatory; Semester 2021A
16. D. Sobral, E. Dodd, J. Calhau, T. Cornish, N. Amos, A. Jenkins, M. Cox, J. Matthee, A. Paulino-Afonso; TIHMPSS: The INT Halo Metal Poor Star Survey; C50/N3/P6; WFC/INT; November 4-12, 2021
17. Manara, J. F. Gameiro et al., PENELLOPE: the ESO data legacy program to complete the Hubble UV Legacy Library of Young Stars (ULLYSES) [106.20Z8.001 1106.C-1047(A) 23.8 h ESPRESSO/VLT; 106.20Z8.003 1106.C-1047(C) 23.7 h ESPRESSO/VLT; 106.20Z8.005 1106.C-1047(E) 43.1 h ESPRESSO/VLT; 106.20Z8.009 1106.C-1047(I) 34.6 h UVES/VLT; 106.20Z8.010 1106.C-1047(J) 7.8 h UVES/VLT; 106.20Z8.011 1106.C-1047(K) 30.7 h UVES/VLT; 106.20Z8.002 1106.C-1047(B) 12.6 h UVES/VLT]

- h XSHOOTER/VLT; 106.20Z8.004 1106.C-1047(D) 10 h XSHOOTER/VLT; 106.20Z8.006 1106.C-1047(F) 15.9 h XSHOOTER/VLT]
18. F. Pepe, O. Demangeon et al., Detection and characterization of Earth-like planets with ESPRESSO, 106.21M2, ESPRESSO at VTL, May 13 2021, P107
 19. D. Armstrong, T. A. Silva et al., HARPS observer pool; HARPS 3.6m; 28 Dec - 3 Jan
 20. E. Delgado Mena et al.; “RV variations in evolved stars in open clusters: planets, oscillations or stellar activity?”; 105.20AZ (moved to period 107) and 108.22LE (other observers); HARPS/ESO-La Silla 3.6m; period 108 remote observing
 21. D. Armstrong, E. Delgado Mena et al.; “Uncovering the origin of remnant planets in the hot Neptunian Desert; 108.21YY, HARPS/ESO-La Silla 3.6m., P108 remote observing
 22. J. Gomes da Silva et al.; “Follow-up observations of G 9-40b with ESPRESSO: A temperate super-Earth or sub-Neptune?”; 108.22BT; ESPRESSO/VLT P108 service mode
 23. M. Rainer, E. Delgado Mena et al.; “A precise characterisation of the ARIEL stars“, 2021B-25, LBT/PEPSI, period 2021B

UnF – Training Unit

Head (for 2012-2021): Carlos J. A. P. Martins

The CAUP Training Unit provides support for those studying astronomy and astrophysics related subjects at U. Porto. CAUP offers a unique environment for research projects and training at all levels, whether provided in-house, supplied to schools and other partners, or benefiting from our extensive international network of collaborators and partners.

Some of the unit-specific activities and outcomes during 2021 were as follows:

- **Doctoral level:**
 - A total of 5 PhD theses were completed in the calendar year 2021: B. Akinsnami, V. Ferreira, S. Hojjatpanah, L. Pereira, B. Webhe.
 - As of 31 December, CAUP was host to 27 PhD research projects.
- **Masters level:**
 - A total of 7 Master's thesis were completed in the calendar year 2021: A. Almeida, H. Asorey, P. Cunha, M. Júlio, B. Rocha, H. Silva, B. Soares.
 - As of 31 December, CAUP was host to 5 Master's thesis projects.
- **Undergraduate level:**
 - CAUP runs an extremely active program of research internships for undergraduate (and first-year masters) students, most (though not all) in the context of FCUP's PEEC program.
 - A total of 12 such internships were completed in 2021. Several of these students published the results of their work in peer-reviewed publications (sometimes as first authors), and also presented them in oral communications at international and national scientific meetings.
 - As of 31 December, 15 new internships were either in progress or scheduled to start in early 2022.

- Future projects: All research projects offered by CAUP researchers for the academic year 2021-22 were compiled and published in a CAUP Projects Booklet, available at the CAUP website (and in printed form at selected events). This lists both projects intended for PhD and Masters theses and those intended for undergraduate internships. An updated edition is to be released in the Spring of each year, pertaining to the following academic year.
- Senior training:
 - We organize our own graduate-level courses, mostly responding to the perceived needs of the students in the unit. These can be either 'classical' graduate courses (open to everyone, and mostly theoretical) or 'hands-on' (practical, with limited attendance and primarily for students). In 2021 two such courses were organized: Python for Astronomers (J. Martins, A. Silva) and Cosmology in the Radio Sky (J. Fonseca).
 - Due to COVID-19 it was not possible to organize soft skills training activities in 2021, since these cannot be efficiently organized in an online format.
 - We also organize continuing education courses, mostly aimed at high-school teachers (in association with FCUP's continuing education programme, FOCO) but open to others (undergraduate or high-school students, etc). In 2021 we ran one edition of the course The Physics of Everyday Life (C. Martins, 25h, online) and two editions of the course History of the Universe (J. Carvalho/C. Martins, 25h, one online and one in person).
 - In September we organized the 4th Azores School on Observational Cosmology, jointly with ESO and in the framework of the CosmoESPRESSO Project. This edition was held (in person) in Angra do Heroísmo (Terceira Island) and was entitled Fundamental Cosmology from the ELT and Space. The school had a total of 25 students (selected following an application process and 8 lecturers. The school directors were Carlos Martins and Michele Cirasuolo (ESO). The school included a vast programme of complementary activities for school students and the general public.
- Junior training:
 - In 2021 we organized the tenth edition of the AstroCamp (scientific director C. Martins). This is a 2-week selective residential school/summer camp for highly motivated high-school students (from the 10th, 11th and 12th grades), which took place on 8-22 August, at the CEIA in Paredes de Coura. Camp activities for the students included classes (30h, in English), observations, community service, and other leisure activities. The camp was held in person (with the exception of one student) and included 15 students, 5 camp monitors and 3 teachers. The camp included participants from Brazil, Croatia, Germany, Poland, Portugal and Spain.
 - We offered to participate in the 2021 edition of Ciência Viva's OCJF project, by hosting virtual internships, but this was refused by Ciência Viva, who insisted that the internships should maintain the traditional in person format.
- Other activities:
 - Due to COVID-19 the usual 'Astronomy Students Day', aimed at undergraduate and masters students, was not organized; instead the electronic version of the 2021 CAUP Project Booklet was sent via e-mail to all U.Porto students doing relevant undergraduate and masters degrees.
 - In October-November 2021 we participated in the International Space Week's 'Space Goes to School' event, organized by Ciência Viva's ESERO office, giving 78 online talks and 32 in person talks across continental Portugal as well as in the Azores and Madeira islands.

ND – Outreach Unit

Head (for 2009-2021): Filipe A. L. Pires, who is also the Executive Director of the Porto Planetarium.

Context

Science outreach in astronomy and astrophysics is defined in CAUP's bylaw as one of its activities. CAUP develops the vast majority of its outreach initiatives through the Porto Planetarium, an infrastructure that it fully manages on behalf of the University of Porto. The Porto Planetarium is a Ciência Viva Centre (CCV) and is one of the 20 science centres that comprise the national Network of Ciência Viva Centres. This network is coordinated under the auspices of the national agency Ciência Viva, and it has a varied offer for schools and the public, both in-house and at other places and institutions.

CAUP co-coordinates IA's Science Communication Group and CAUP's Outreach Unit is fully committed in the effort to bring IA contents to the public, in particular through its work in the Porto Planetarium. Planetário do Porto is a ESO Outreach Partner Organization.

During 2021 we continued undertaking efforts to better integrate the Planetarium into the UPorto Culture structures and Ciência Viva Network.

The year of 2021 was marked by the COVID-19 Pandemic which deeply influenced the activity of the Outreach Unit. The effects were more severe than those in 2020, in part because there was a saturation of online events.

Highlights

The activities developed by CAUP's Outreach Unit during 2021 reached out to more than 16383 people. The Porto Planetarium CCV received 7657 visitors for sessions and 3052 at the hands-on laboratories. About 70% of the visitors were students on school visits. Activities at schools had the participation of 1997 students and we reached more than 5112 people through other science outreach activities including online events, not counting social media interactions nor news features sent to media outlets.

During 2021 we produced one new short planetarium show about CHEOPS science.

Human Resources

During 2021, the human resources allocated to the Outreach Unit were:

- 4 CAUP contracts at 1.0 full time equivalent (fte): Filipe Pires, Paulo Pereira, Ricardo Reis and Elsa Moreira.
- 1 Gestão Ciência e Tecnologia (BGCT) grants (direct FCT contracts), via the Ciência Viva national agency, for Planetarium activities, at 1 fte: Tânia Cunha.
- 2 teachers in “Mobilidade Estatutária” (deployed teacher), under a public servant contract with the Ministry of Education, via the Ciência Viva national agency, for Planetarium activities, at 1 fte: Ilídio André Costa and, since September, José Dantas.

Regular Activities at the Porto Planetarium

Educational offer for schools: the offer implemented in 2017 continued to expand in 2021 by adding new didactic sequences.

- Planetarium shows: 7657 visitors.

- Online presentations: because of the restrictions caused by the pandemic, we did 2 free online sessions for the general public, engaged around 4 600 people
- Hands-on Laboratories: 3052 visitors.
- “Mais Perto das Estrelas”: Monthly sessions consisting of an introductory planetarium session to the night sky and observations of the night sky with small telescopes. Because of the limitations caused by Covid19 and bad weather conditions, only the October and November sessions took place. Total number of participants: 50.

Regular Activities at schools

- Portable Planetarium: planetarium sessions presented for a total of 1997 children.
- General talks given at schools by ND elements and researchers, in particular in the context of the ESERO PT initiative “O Espaço vai à Escola” (mentioned in the UnF section) and “Cientificamente Provável”.
- Workshops and observations in schools for a total of 257 participants.

Regular activities in collaboration:

Academia de Robótica - 11 students 2020/2021 and 14 students 2021/2022

Special events:

17 december 2020 to 7 january 2021

Training action “Telescópios”, Clube Ciência Viva, Escola Sec. Paços de Ferreira



Training action for 7th and 12th grade students at the Escola Secundária de Paços de Ferreira, under the scope of the Clubes Ciência Viva nas Escolas. Online for 12th graders, face-to-face for 7th graders. (17 december, 6 january and 7 january)

17 january

Planetário em Casa: «Há Formas no Espaço»



Due to the state of emergency and the mandatory confinement, the Planetário do Porto – Centro Ciência Viva held a free online session showing an flatscreen version of the "Há Formas no Espaço" session. Currently with 2303 visualisations (826 FB + 1477 YT)

23 january

Fórum Nacional Clubes Ciência Viva na Escola



The Planetário do Porto participated with a virtual stand and the availability to answer questions throughout the event.

24 january

Planetário em Casa: «Sol: a nossa estrela»



Due to the state of emergency and the mandatory confinement, the Planetário do Porto – Centro Ciência Viva held a free online session showing a flat screen version of the session "The Sun: our star". Currently with 2334 visualizations (1453 FB + 881 YT)

5 february

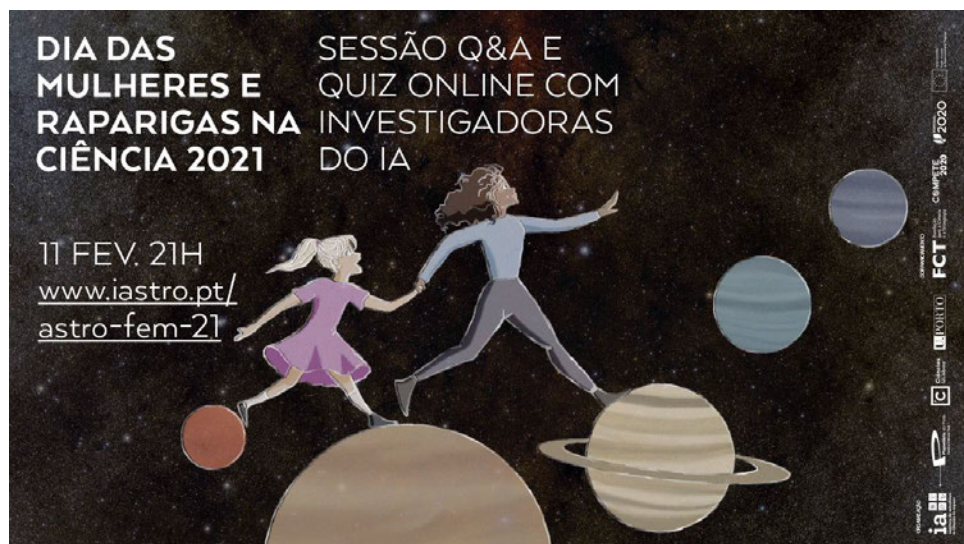
50 anos | Missão Tripulada Apollo 14



Due to the pandemic it was not possible to hold the normal program of talks. The proposal was to visit the exhibition module "Meteoritos, rochas extraterrestres" at the Planetário do Porto where visitors could read the history of the oldest known rock fragment on Earth.

11 february

Dia Internacional das Mulheres e Raparigas na Ciência 2021



In line with the United Nations strategy to reduce gender inequality in STEM (Science, Technology, Engineering and Mathematics) areas, February 11th was declared in 2015 as the International Day of Women and Girls in Science. The Instituto de Astrofísica e Ciências do Espaço (IA) and the Planetário do Porto join, as usual, these celebrations, with an online session with researchers from the IA, as well as through several initiatives on social networks.

Online event broadcasted on February 11th at 9pm with Catarina Lobo, Margarida Cunha, Lara Sousa, Gabriella Gilli and Teresa Lago. The event took place online and got about 703 views.

Three videos were made to pre-launch the event with three of the participants with a total of 691 views.

29 e 30 march

University & Culture European Summit



Jointly hosted by the University of Porto and the Portuguese National Plan for the Arts in the framework of the Portuguese Presidency of the Council of the European Union, the Summit aimed at discussing a cultural agenda for Higher Education Institutions capable of fostering the Union by creating new attitudes towards issues that are focal societal challenges for Europe and the world. It was held online on the 29th and the 30th of March 2021. The Planetário do Porto was invited to participate in the social program of the event, and produced the video “Exploring the skies”, featured in “Day 1, Morning”, currently with 1184 visualisations.

<https://youtu.be/5iVCaIgRrZA?t=11381>

8 may

Concerto Rodrigo Amado, Nuno Rebelo e Antónia Jorge Gonçalves



Musical concert, broadcasted online from the Planetário do Porto, with Rodrigo Amado and Nuno Rebelo, with live illustration by António Jorge Gonçalves, part of the program Germinal 2021/Cão Danado.

16 may

Dia Nacional dos Cientistas 2021



In 2016, through Resolution N° 228/2016 of the Portuguese Parliament, may 16th was established as the National Scientists' Day. The date coincides with the birthday of the former Minister of Science and Higher Education José Mariano Gago, aiming to celebrate and recognize the historical, relevant and innovative contribution of the scientific community to the advancement of knowledge, progress and well-being of society. The Planetário do Porto – Centro Ciência Viva marks the date with a free children's session (limited to room capacity) "There are shapes in space", on May 16 (Sunday) at 11:00 am.

27 a 29 may

Mostra da Universidade do Porto



This year the Mostra da Universidade do Porto was in an online format, during 3 days the Universidade do Porto presented its educational offer, research and services. The Planetarium participated with a virtual stand

1 june

Dia Mundial da Criança



The Planetário do Porto – Centro Ciência Viva marked the date with a children's session, at 4pm, free entrance for children.

2 a 4 june

MW-Gaia: Bringing the Milky Way to schools 2021



Workshop organized by the Planetário do Porto – Centro de Ciência Viva, the Instituto de Astrofísica e Ciências do Espaço (Portugal) and Vilnius University (Lithuania), whose aim was to bring together the research, teaching and scientific dissemination communities, by presenting the work that has been done over the years in the exploration of our Milky Way, but also showing the attempts to transform this knowledge into useful and powerful tools for teaching, dissemination of astronomy and science communication in general.

30 june

Dia do Asteroide



June 30th was decreed by the United Nations as Asteroid Day, in order to draw attention to the risk of asteroid impact. To mark this day, the Planetário do Porto – Centro Ciência Viva had a special program.

16:00 – Immersive session

16:45 – Guided visit to the "Meteoritos: rochas extraterrestres" exhibition module

17:00 – Talk with Nuno Peixinho, researcher from the Universidade de Coimbra and Instituto de Astrofísica e Ciências do Espaço.

15 july to 15 september

Ciência Viva no Verão 2021



The Planetário do Porto participated in the program “Ciência Viva no Verão 2021” with its own program of observations at the Planetarium and joint activities with the Galeria da Biodiversidade and the Museu do Côa.

3, 6 and 10 August – "Around the Sun" activity in conjunction with the Galeria da Biodiversidade.

7 and 8 August – Public observation in Foz Côa, joint activity with Museu do Côa.

12 August – Public observation at Planetário do Porto.

5 august

50 anos Missão tripulada Apollo 15



Session of the “Noites no Pátio do Museu”, at the Reitoria da Universidade do Porto, to celebrate the 50th anniversary of the Apollo 15 mission. With the presence of Alexandre Cabral from the Instituto de Astrofísica e Ciências do Espaço and Faculdade de Ciência da Universidade de Lisboa, Ricardo Conde, President of Portugal Space.

10 august

À Distância de um Clique – Noite Europeia dos Investigadores 2021



European Researchers' Night 2021 build-up event, which consisted of an online workshop which illustrates, using street lighting as a reference, how astronomers use the brightness of stars to determine their distance.

10 september

CHEOPS, à procura de outros mundos



European Researchers' Night 2021 build-up event, with public presentation of the immersive fulldome show "CHEOPS: Hello Universe", followed by a chat with researcher Sérgio Sousa (Instituto de Astrofísica e Ciências do Espaço and Universidade do Porto), Portuguese representative in the CHEOPS consortium board.

18:30 – Premiere of the fulldome show CHEOPS: Hello Universe

19:00 – Chat with researcher Sérgio Sousa (IA & U. Porto), Portuguese representative in the CHEOPS consortium board

18 september

Luzes na escuridão – NEI2021



Special reopening session and European Researchers' Night 2021 build-up event.

- 15:00 Fulldome shows "O espantoso telescópio" and "Luzes na escuridão".

24 september

Noite Europeia dos Investigadores 2021



The Planetário do Porto participated in the national consortium coordinated by Ciência Viva. The theme was "sustainability" and we had a program focused on light pollution.

Program

- 21:00 Talk "O fim do céu escuro", with Luís Lopes, Amateur Astronomer and professor at the Dep. de Ciência de Computadores da Faculdade de Ciências da Universidade do Porto.
- 22:00 Planetarium show "Luzes na Escuridão" and the game "Conta as Estrelas" to measure light pollution.

5 october

Semana Mundial do Espaço 2021



In the week that celebrates the anniversary of Sputnik's launch, on October 4th, 1957, the Planetário do Porto joined the celebrations of the World Space Week with a special program.

- 15h00 “O Espaço à conversa”, with scientist-astronaut Ana Pires (INESC-TEC)
- 16h00 Immersive movie “O Despertar da Era Espacial”

22 e 23 october

Concerto COBRACORAL



COBRACORAL

Voice and circular rhythms are foundational elements for this vocal collective that explores the intersection of contemporary music with hypnagogic vocal states. Founded by the artists Catarina Miranda (PT), Clélia Colonna (PT/FR) and Ece Canli (PT/TR) this vocal research is organized around a circular pulse system, where the three voices are interrelated through visual and gestural codes, from a rhythmic matrix to dynamics of reaction and mutation. Serialism, hypnosis and contemporary voice practices are synthesized by the female vocal machine. Illustrations & Projection Mapping Inês Castanheira. The show was produced for the dome of the Planetário do Porto, during the production several tests were made and the planetarium team guided the artists.

4 november

CONCERTO Abdul Moimême, Lionel Marchetti & Jorge Quintela



Electronic music concert with LIONEL MARCHETTI and ABDUL MOIMÊME and video by JORGE QUINTELA, Sonoscopia production. The show was produced for the dome of the Planetário do Porto, during the production several tests were made and the planetarium team guided the artists.

11 to 27 november

Ruído



A science outreach play about gravitational waves, by Raquel Sousa and Lara Sousa, a Noitarder production. All the presentations were fully booked.

- 11 nov, at 21:00 | 12 nov, at 21:00 | 13 nov, at 19:00
- 24 nov, at 19:00 | 25 nov, at 21:00 | 26 nov, at 21:00 | 27 nov, at 19:00

20 to 28 november

Porto/Post/Doc 2021



Porto PostDoc is a film and media festival of which the OPorto Planetarium has been hosting the immersive section. This year the Planetarium had 2 distinct programs with an overall of 5 films.

- 20 nov às 17h30 | 21 nov às 17h30 | 22 nov às 17h30
- 28 nov às 17h30

24 november

Dia Nacional da Cultura Científica e 23º Aniversário do Planetário do Porto



This year the national week for science started with the celebrations for the 25th anniversary of Ciência Viva. The Planetário do Porto joined the celebrations with the following program:

19h theater session "Ruido"

21h special planetarium session with free admission "Os grandes mistérios do Universo"

29 november

Filmagens da longa metragem "Safe Only"



The Planetário do Porto received the filming of 2 scenes from Diogo Costa Amarante's first feature film. In the first scene Planetário was transformed into a recording studio, in the second the main character comes to find his grandmother inside a planetarium watching a session.

20 december

Lançamento do livro “O menino que queria ver o outro lado da Lua”



Release of the book by 10-year-old Vicente Morgado. As he really likes space themes, he wanted to launch his book at the Planetarium.

21 december

O dia mais curto



In 2021, the ninth edition of "O DIA MAIS CURTO", a short film festival that is already a cinematic tradition, took place. The U. Porto joined this initiative for the second time, with the exhibition of 3 live programs, in 3 different spaces of the university: Planetário do Porto CCV, Galeria da Biodiversidade and Casa Comum (Reitoria da U.Porto). The Planetarium hosted a children's program "Amiguinhos".

Clubes Ciência Viva nas Escolas

In the context of the Clubes Ciências Viva nas Escolas project, promoted by the Ciência Viva national agency, for the implementation of various Astronomy & Astrophysics activities with schools, protocols were established with 70 schools: EB JI de Macieira, JI Uchas – Aveleda, Agrupamento de Escolas D.Dinis, Agrupamento de Escolas de Santa Maria da Feira, AE Soares Basto, EB Lustosa, EB/JI Telheiro – São Miguel, EB de Sousela, AE Paços de Ferreira, AE Carlos Amarante, Agrupamento de Escolas Abel Salazar, AE Ribeiro Sanches, AE Pedrouços, AE Vilela

AE Penafiel Sudeste, Agrupamento de Escolas Professor Abel Salazar, Agrupamento de Escolas de Pinheiro, Agrupamento de Escolas Eng. Fernando Pinto de Oliveira, Agrupamento de escolas Dr. Flávio Gonçalves, Agrupamento de Escolas de Caminha, AE Arqueólogo Mário Cardoso, AE Paredes de Coura, AE Souselo, AE Canas de Senhorim, AE Valadares, AE Santa Bárbara, AE de Abação, Agrupamento Tomaz Pelayo, AE Santa Cruz da Trapa, AE D Afonso Henriques, AE Rates, AE Garcia de Orta, Escola Básica Irmãos Passos, Agrupamento de Escolas de Rio Tinto, AE Vialonga, AE Dr Carlos Pinto Ferreira, Agrupamento de Escolas Latino Coelho, Agrupamento de Escolas de Monserrate, Agrupamento de Escolas nº1 de Gondomar, Paços de Brandão, AE Senhora da Hora, AE Perafita, AE António Sérgio, AE Cristelo, AE Maia, AE Aurélia de Sousa, AE Carregado, AE Frazão, AE Viso, AE Sophia de Mello Breyner, AE Amares, Escola Básica e Secundária Dr. Vieira de Carvalho, Agrupamento de Escolas da Gafanha da Encarnação, AE Infante D Henrique, ES Almeida Garrett, AE D. Pedro I, Escola Secundária de Rocha Peixoto, Agrupamento de Escolas de Ponte de Lima, Agrupamento de Escolas de Santa Iria da Azóia, AE Lavra, AE D Mafalda, AE Resende, AE Daniel Faria, AE Rodrigues de Freitas, AE Manuel Laranjeira, Escola Básica e Secundária À Beira Douro, AE Armamar, AE Clara de Resende, AE Fernando Namora.

Staff Training:

19 & 20 April SDSS Plates training course

The Sloan Digital Sky Survey (SDSS) is committed to working towards making the science and engineering results of our surveys accessible to the public, and is also enthusiastic about supporting the use of SDSS data for training and education. SDSS do this through informal and formal education, citizen science, news, and social media.

18 June, 30 June, 01 July Network for Astronomy School Education (NASE) training course

NASE is a program for post-graduates. The main objective of NASE is to educate new generations of teachers and re-educate the current ones. We work with university professors in order to train future teachers and we cooperate with the departments of education in order to train experienced primary and secondary school teachers. NASE created a basic course for training teachers aiming at:

- teaching astronomy to teachers
- teaching teachers how to teach astronomy

05 to 09 of July EMERGENCE@UPorto 2021, Digital Media Science Communication Hackathon

Emergence hackathon brings together scientists, techies, artists, and others, to collaboratively create digital media-based projects that communicate complex concepts in scientific research.

In this intensive 5 day-long event participants are immersed in a collaborative setting where they are guided through the process of exploring various digital media technologies (e.g., Film, Interactive Technologies, VR) with a focus on creating stories for both linear and experiential formats. Throughout the event each team is assigned a mentor, who takes the producer role of the team, ensuring that each team is well on track and assisting with any resources needed.

ATTENDANCE AT CONTINUING EDUCATION / OTHER COURSES

- Congresso, VI Erasmus+ Equity and Inclusion Seminar, online, 30/11
- Seminário, Que papel para o feedback, para as rubricas e para os alunos na Avaliação Pedagógica?, online, 24/11
- Congresso, Jornadas de Educação: da escola que temos à escola que queremos, Santa Maria da Feira, 20/11
- Seminário, Ponto do Cidadão: um roteiro para a prática multidisciplinar, online, 18/11
- Encontro, Educar pela positiva, online, 4/11
- Seminário, Contextualising STEM Carrers in Integrated STEM Teaching, online, 2/11
- Encontro, Bullying: violência não é brincadeira!, online, 21/10
- Oficina (workshop), 3rd Shaw-IAU Workshop on Astronomy for Education, online, 12 a 15/10
- Encontro, Escola Amiga da Criança – Professores Notáveis!, online, 5/10
- Oficina (workshop), Metodologias, Métodos e Situações de Aprendizagem: Propostas e Estratégias de Ação, online, 25/9
- Conferência, 6º Encontro sobre Inovação Pedagógica Supertabi – 3ª sessão, online, 18/9
- Conferência, 6º Encontro sobre Inovação Pedagógica Supertabi – 2ª sessão, online, 11/9
- Encontro, VI Jornadas Pedagógicas TEIP – da sala de aula às tecnologias digitais: um percurso com sentido obrigatório, online, 8/9
- Conferência, 6º Encontro sobre Inovação Pedagógica Supertabi – 1ª sessão, online, 4/9
- Oficina (workshop), Ferramentas para os professores alcançarem a sua realização pessoal e profissional,

online, 15/7

- Oficina (workshop), NASE course BOXES ONLINE: Astroculture, online, 1/7
- Oficina (workshop), NASE course BOXES ONLINE: Astrophysics, online, 30/6
- Encontro, Ciência 2021, online, 28 a 30/6
- Oficina (workshop), NASE course BOXES ONLINE: Astrobiology, online, 18/6
- Oficina (workshop), NASE course BOXES ONLINE: Astronomy, online, 8/6
- Seminário, Formação de professores: o que foi feito e o que está por fazer, online, 2/6
- Seminário, Inteligência Artificial na Educação: o quê e quando, online, 26/5
- Seminário, A Nova Geração de Manuais, online, 12/5
- Seminário, Manuais e outros REDs: experiências e perspectivas, online, 12/5
- Oficina (workshop), E@D nas Escolas, online, 3/3 a 12/5
- Encontro, X A Ciência por quem a faz e por quem a ensina, online, 8/5
- Encontro, Novidades no ensino da Biologia-Geologia, online, 6/5
- Encontro, Novidades no ensino das Ciências Naturais, São João da Madeira, 29/4
- Seminário, A Escola depois do E@D, online, 28/4
- Seminário, Seminário Permanente de Políticas de Ciência, Comunicação e Cultura, online, 22/4
- Seminário, SELFIE tool for schools, online, 21/4
- Encontro, Nova geração de manuais escolares, online, 20/4
- Oficina (workshop), I Workshop Ibero-Americano de Educação Inclusiva, online, 14 a 16/4
- Encontro, Ambientes híbridos de aprendizagem, online, 8/4
- Seminário, Ecossistema(s) de Educação Digital e Ambientes Híbridos de Aprendizagem – Um Processo de Inovação Sustentada, online, 31/3
- Seminário, Apps & Companhia, online, 23/3
- Seminário, Saídas de campo virtuais em ambiente Google Earth – Serra da Freita (Arouca), online, 16/3
- Seminário, Geologia aos 12 anos... Que desafios?, online, 11/3
- Seminário, Capacitar para a relação pedagógica com os alunos, online, 10/3
- Seminário, Alterações climáticas: mitigação ou adaptação?, online, 9/3
- Seminário, "Olhar" a Terra | Mobile learning, online, 4/3
- Encontro, O manual como ferramenta de aprendizagem ativa, online, 2/3
- Seminário, À conversa com... Os nossos alunos: O manual escolar de Biologia e Geologia, online, 25/2
- Seminário, "Olhar" a Terra | Tectónica, online, 25/2
- Encontro, Recursos Educativos Digitais de Geologia, online, 23/2
- Encontro, E@D... e agora?, online, 18/2
- Seminário, "Olhar" a Terra | Sismologia, online, 18/2
- Seminário, Estudo eficiente de ciências exatas – uma visão da neuropsicologia, online, 12/2
- Seminário, "Olhar" a Terra | Vulcanismo, online, 11/2
- Encontro, O ensino das Ciências através de laboratórios remotos e virtuais, online, 11/2
- Seminário, Avaliação das Aprendizagens – Propostas e Estratégias de Ação, online, 10/2
- Encontro, Paleontologia na sala de aula: práticas presenciais e em E@D, online, 9/2
- Encontro, Saúde Mental para professores e alunos!, online, 3/2
- Seminário, Dinamizar o E@D com a Escola Virtual, online, 3/2
- Encontro, Tempos de pandemia – A importância da ciência, online, 2/2
- Seminário, A Biologia e a Geologia nos objetivos de desenvolvimento sustentável, online, 28/1
- Congresso, Building the Future Imatch, online, 26 a 28/1
- Seminário, Boas Práticas – Projeto Piloto de Desmaterialização de Manuais Escolares, online, 27/1
- Encontro, Dinossauros em Portugal e sua evolução, online, 26/1

- Encontro, Avaliar com Sentido Pedagógico: Fundamentos e Práticas, online, 14/1
- Seminário, O papel da mulher na construção das Geociências – o caso da Paleontologia, online, 12/1

SUPERVISION OF SHORT PROJECTS/INTERNSHIPS

- Cristina Alexandra da Silva Carvalho, Ciências da Educação, Licenciatura, janeiro a maio
- Mariana Barbosa, Educação Básica, Licenciatura, janeiro a abril
- Maria Inês Rebelo, Educação Básica, Licenciatura, janeiro a abril

TEACHING OF COURSES, SHORT COURSES OR OTHERS

- Oficina de formação (30 horas), Gondomar, Ensino das Ciências orientado para a resolução de problemas: rumo à alfabetização científica, 06/02/2021 a 27/03/2021
- Oficina de formação (30 horas), Gondomar, Ensino das Ciências orientado para a resolução de problemas: rumo à alfabetização científica, 6/3/2021 a 27/03/2021
- Curso (25 horas), online, Compreender a Terra através do Espaço – 3ª edição, 1/4/2021 a 29/05/2021
- Curso (25 horas), online, Compreender a Terra através do Espaço – 4ª edição, 9/10/2021 a 23/12/2021
- Curso (25 horas), online, Compreender a Terra através do Espaço – 5ª edição, 9/10/2021 a 23/12/2021
- Ação de Curta Duração (4 horas), online, Descobrir o Universo com Telescópios Escolares – 2ª edição, 29/05/2021
- Ação de Curta Duração (6 horas), online, Astrocultura I, 13/10/2021 a 27/10/2021
- Ação de Curta Duração (6 horas), online, Astrocultura II, 27/10/2021 a 10/11/2021
- Ação de Curta Duração (4 horas), online, Descobrir o Universo com Telescópios Escolares – 3ª edição, 23/10/2021
- Curso (6 horas), Funchal, Ensino das Ciências orientado para a resolução de problemas: rumo à alfabetização científica, 26 e 27/11/2021. Ação de Curta Duração (4 horas), online, Descobrir o Universo com Telescópios Escolares – 4ª edição, 4/12/2021

Contributed/Invited Talks & Posters

INVITED:

- Ilídio André Costa, Parcerias com os Clubes Ciência Viva na Escola, Encontro Mobilizador – Clubes Ciência Viva nas Escolas, Porto, Portugal, 2021/11/16
- Ilídio André Costa, Parcerias com os Clubes Ciência Viva na Escola, Encontro Mobilizador – Clubes Ciência Viva nas Escolas, Vila Nova de Gaia, Portugal, 2021/11/17
- Ilídio André Costa, Comunicação e bem estar planetário – Museus e Projetos Inclusivos, III Encontro Ibérico Comunicación Y Periodismo Científico, Barcelona, Espanha 2021/09/21
- Ilídio André Costa, Communicating Science... what for? – the Porto Planetarium – Ciência Viva Center case, Estágios de Verão IAstro 2021, Online, 2021/07/16
- Ilídio André Costa, MW GAIA: Bringing the Milky Way to schools – the CoAstro example, MW-Gaia: Bringing the Milky Way to schools 2021, Online, 2021/06/04

ACCEPTED BY SUBMISSION

- Ilídio André Costa, Ciência cidadã em contexto escolar: de uma técnica investigativa a um método de ensino e comunicação de ciência – um exemplo nacional, Encontro Nacional de Ciência Cidadã 2021, Porto, Portugal, 2021/11/25

- Ilídio André Costa, Citizen science: from a scientific technique to a science education and communication method – the CoAstro practical example, Science&You 2021, Metz, França, 2021/11/19
- Ilídio André Costa, Astronomy fade out in portuguese compulsory schooling: a crossroads for astronomy national stakeholders, XXXI Encontro Nacional de Astronomia e Astrofísica & Sociedade Portuguesa de Astronomia, online, 2021/09/09
- Ilídio André Costa, A Ciência Cidadã como método de comunicação de ciência: o caso do projeto CoAstro, 9.^a edição do Congresso Anual de Comunicação de Ciência SciComPt, online, 2021/06/25
- Ilídio André Costa, CoAstro: @n Astronomy Condo — a New Citizen Science Proposal for Communicating Astronomy with the Public, CAP Conference: Communicating Astronomy with the Public 2021, online, 2021/05/24

CONFERENCES

PARTICIPATION

- Encontro, Encontro Nacional de Ciência Cidadã 2021, Porto, 25 e 26/11, <https://www.cienciacidadada.pt/encontrocc2021>
- Conferência, Science&You 2021, Metz, 16 a 19/11, <http://www.science-and-you.com/en/science-you-2021>
- Encontro, XXXI Encontro Nacional de Astronomia e Astrofísica & Sociedade Portuguesa de Astronomia, online, 8 a 10 de setembro, <https://enaaxxi.github.io>
- Congresso, 9.^a edição do Congresso Anual de Comunicação de Ciência SciComPt, online, 23 a 26/6, <http://scicom.pt/index.php/scicompt-2021>
- Conferência, CAP Conference: Communicating Astronomy with the Public 2021, online, 24 a 27/5, <https://www.communicatingastronomy.org/cap2021>
- Dec 2021 – Third Shaw-IAU Workshop on Astronomy for Education, Online
- Nov 2021 – 2nd Workshop on Astronomy Beyond the Common Senses for Accessibility and Inclusion, Online

ORGANIZATION

- Conferência, Communicating Astronomy with the Public 2022, Sidney, s/d, s/url, WG member
- Encontro, Encontro Nacional de Ciência Cidadã 2021, Porto & online, 25 e 26/11, <https://www.cienciacidadada.pt/encontrocc2021>

Membro da Comissão Organizadora & Científica

- Workshop – MW-Gaia: Bringing the Milky Way to schools, online, June 2021, SOC and LOC member, COST ACTION – CA18104 Revealing the Milky Way with Gaia

PARTICIPATION IN COMMITTEES

PARTICIPATION IN WORKING GROUPS

- Representantes Nacionais da European Association for Astronomy Education
- Embaixadores do European Space Education Resource Office (ESERO) – Portugal
- Membros do European Network of Science Centers and Museums (Ecsite) Space Group
- Membros do EROAD – European Regional Office of Astronomy for Development – Portugal
- Membros do Pale Blue Dot: Astronomy for Global Citizenship and Environmental Awareness
- Membros do Cartas Com Ciência – Associação Native Scientist
- Membros do Grupo de trabalho de Formação – Rede Portuguesa de Ciência Cidadã – CC.pt
- Membros do Citizen Science & Open Science Community of Practice – Citizen Science Global Partnership
- Membros da European Science Education Research Association (ESERA)
- Membros da RICAP – Rede Iberoamericana de Ciência Participativa
- Membros da Rede de Comunicação de Ciência e Tecnologia de Portugal (SciComPT)
- Parceiros do projeto The Impact of Career-Long Professional Learning on Physics Teacher Identity, Wellbeing and Self Efficacy.

- Parceiros do projeto (componente de comunicação do projeto) do Cosmology and Fundamental Physics with ESPRESSO (CosmoESPRESSO)
- Parceiros do CoAstro: um Condomínio de @stronomia
- Deputy for "CA18104 Revealing the Milky Way with Gaia – WG5: Impact, Inclusiveness and Outreach"
- Collaborator for "IAU EC WG on Astronomy for Equity and Inclusion sWG5: Inclusive Outreach (Inspiring Stars)"
- Collaborator for "IAU EC WG on Astronomy for Equity and Inclusion sWG7: Hospitals, Children's Homes, Nursing Homes and Prisons"

PARTICIPATION IN PANELS/COMMITTEES

- Comissão de avaliação externa, Agência de Avaliação e Acreditação do Ensino Superior (A3ES)
- Division C Education, Outreach and Heritage – IAU
- Executive Committee WG Junior Members – IAU
- Network for Astronomy School Education (NASE) – IAU
- Commission of Astronomy Education and Development – IAU
- Commission of Communicating Astronomy with the Public – IAU
- Working Group – Communicating Astronomy with the Public (CAP) Conferences – IAU
- Astronomy Education Resources (AstroEDU) – IAU
- Working group – Key Initiatives in Education, Outreach and Development – IAU

PEER REVIEW IN JOURNALS

- Education Applications & Developments VI, InScience Press
- APEDuC Journal – Research and Practices in Science, Mathematics and Technology Education, Associação Portuguesa de Educação em Ciências (APEDuC)
- Revista Educação em Foco, Universidade Federal de Juiz de Fora
- Avaliador da componente pedagógica dos materiais submetidos ao Projecto EDULOG – Casa das Ciências
- CAPjournal, International Astronomical Union – Communicating Astronomy with the Public
- AstroEdu Journal, União Astronómica Internacional

UnAS – Administration and Services Unit

Head (for 2012-2021): Manuel A. S. Monteiro

This Unit integrates all supporting services necessary to build an efficient and effective set of resources that provide adequate support for the different activities in CAUP and IA.

During 2020 the pandemic caused by covid-19 introduced unexpected challenges that required changes to standard working methods and procedures. These continued to evolve and adapt to the situation during 2021 which helped to recover most of the lost productivity. Cyber security continues to be a great concern due to the increase of tailored phishing campaigns.

During this year:

- One staff member continues to be dedicated to support the principal investigators of european and national projects, and as a project manager for IA;
- The staff member dedicated to public procurement and human resources left CAUP;
- Network security policies hardened to decrease the number of potential attack vectors;
- Update of several web services and migration to a new server.

Regarding project management, the overall activity of the year included:

- Preparation and submission to FCT of 10 *pedidos de pagamento*;
- Submission to FCT of 13 *pedidos de pagamento* for *Investigador FCT*;
- Preparation and submission to *Ciência Viva* of 2 *pedidos de pagamento*;
- Preparation and submission of 3 *pedidos de pagamento* for other funding.

Regarding human resources, the overall activity of the year included:

- 5 Research work contracts;
- 6 Research fellowship contracts;
- 17 Academic internship contracts;
- 1 Work contracts.

The staff has participated in specific training actions/events, including:

- *Sessão de Esclarecimento | Fatura Eletrónica* - 20 January, Miroma (Marlene Cruz; Manuel Monteiro; Argentina Pereira)
- *Lançamento do programa Horizonte Europa* - 2 February, online, PERIN (Elsa Silva)
- *Sessões Esclarecimento - Concurso PTDC + PeX 2021– Projetos de ICDT em Todos os Domínios Científicos + Projetos Exploratórios* - 8 February, online, FCiências.ID (Elsa Silva)
- *Jornadas Horizonte Europa - Pilares II & III – visão sobre o novo Programa-Quadro de I&I* - 8 February, online, ANI / PERIN (Elsa Silva)
- *Jornadas Horizonte Europa - Sessão temática Pilar II – Cluster 4: Digital, Industria e Espaço* - 9 February, online, ANI / PERIN (Elsa Silva)
- *Jornadas Horizonte Europa - Sessão temática Pilar II – Cluster 2: Cultura, Criatividade e Inclusão Social* - 9 February, online, ANI / PERIN (Elsa Silva)
- *Jornadas Horizonte Europa – Sessão Temática Assuntos Legais e Financeiros* - 19 February, online, ANI / PERIN (Elsa Silva)
- *A Cultura Científica como fator de Recuperação e Resiliência* - 24 February, online, Ciência Viva (Elsa Silva)
- *Pré-Sessão ERC* - 4 March, online, PERIN-FCT (Elsa Silva)
- *As Mulheres e o Emprego: desta vez um debate com homens e mulheres* - 8 March, online, CIP (Elsa Silva)
- *Sessão ERC* - 9 March, online, organizado pelo PERIN-FCT (Elsa Silva)
- *Webinar session: How to prepare a successful proposal in Horizon Europe* - 24 March, online, CE (Elsa Silva)
- *ERC Mentoring Initiative* - 20 April, on-line, organizado pelo PERIN-FCT (Elsa Silva)
- *Webinar session: A successful proposal for Horizon Europe: Scientific-technical excellence is key, but don't forget the other aspects* - 21 April, online, CE (Elsa Silva)
- *Sessão sobre o Plano de Igualdade de Género na U.Porto e Candidaturas ao Horizonte Europa* - 19 May, online, UP (Elsa Silva)
- *Warm Up Session (Call Calendar Pillar I and Widening & ERA)* - 26 May. online, PERIN-FCT (Elsa Silva)
- *Webinar session: The Funding & tenders Portal for beginners* - 27 May, online, CE (Elsa Silva)
- *Webinar session: Dissemination & Exploitation in Horizon Europe* - 9 June, online, CE (Elsa Silva)
- *A revisão do CCP de 2021 e as Medidas Especiais de Contratação Pública* - 13-14 September, IGAP (Marlene Cruz)
- *ELT Instrument Control Software* - 23 September, ESO (Manuel Monteiro)
- *Horizonte Europa - As lições e novidades do primeiro ano* - 6 December, online, UP / PERIN (Elsa Silva)

CONTAS

Balanço individual em 31 de Dezembro de 2021, valores em euro:

RUBRICAS	NOTAS	DATAS	
		31/12/2021	31/12/2020
ACTIVO			
Activo não corrente			
Activos fixos tangíveis	5	100 142,16	216 045,51
Activos intangíveis	4	6 569,26	8 898,29
Investimentos financeiros	15.2	19 208,35	14 921,57
		125 919,77	239 865,37
Activo corrente			
Inventários	6	4 291,76	4 327,37
Créditos a receber	8	17 672,02	16 987,89
Estado e Outros Entes Públicos	8	11 955,70	22 697,89
Diferimentos	8	7 175,21	9 966,24
Outros ativos correntes	8/15.1	2 090 660,78	2 646 896,72
Caixa e depósitos bancários	15.3	781 063,00	477 298,51
		2 912 818,47	3 178 174,62
Total do activo		3 038 738,24	3 418 039,99
FUNDOS PATRIMONIAIS E PASSIVO			
Fundos Patrimoniais			
Resultados transitados	8	998 773,50	1 026 233,29
Ajustamentos/Outras variações nos fundos patrimoniais	8	93 721,80	204 059,44
		1 092 495,30	1 230 292,73
Resultado líquido do período	8	46 322,33	-27 459,79
Total dos fundos patrimoniais		1 138 817,63	1 202 832,94
Passivo			
Passivo corrente			
Fornecedores	8	374,95	885,60
Estado e outros entes públicos	8	42 343,56	42 833,41
Diferimentos	8	1 535 868,97	1 648 703,39
Outros passivos correntes	8	321 333,13	522 784,65
		1 899 920,61	2 215 207,05
Total do passivo		1 899 920,61	2 215 207,05
Total dos fundos patrimoniais e do passivo		3 038 738,24	3 418 039,99

Demonstrações Financeiras

Alterações no capital

Demonstração individual das alterações nos fundos patrimoniais no período de 2020

DESCRIÇÃO	NOTAS	Fundos Patrimoniais atribuídos aos instituidores da entidade-mãe								Interesses que não controlam	Total dos fundos patrimoniais
		Fundos	Excedentes Técnicos	Reservas	Resultados Transitados	Excedentes de revalorização	Ajustamentos/Outras variações nos fundos patrimoniais	Resultado líquido do período	Total		
POSIÇÃO NO INÍCIO DO PERÍODO 2020	1				970617,63		310382,02	55615,66	1336615,31		1336615,31
ALTERAÇÕES NO PERÍODO											
Primeira adoção de novo referencial contábilístico								0,00	0,00		0,00
Alterações de políticas contábilísticas											
Diferenças de conversão de demonstrações financeiras											
Realização de excedente de revalorização											
Excedentes de revalorização											
Ajustamentos por impostos diferidos											
Outras alterações reconhecidas nos fundos patrimoniais					55615,66		-106322,58	-55615,66	-106322,58		-106322,58
	2				55615,66		-106322,58	-55615,66	-106322,58		-106322,58
RESULTADO LÍQUIDO DO PERÍODO	3							-27459,79	-27459,79		-27459,79
RESULTADO INTEGRAL	4=2+3							-83075,45	-133782,37		-133782,37
OPERAÇÕES COM INSTITUIDORES NO PERÍODO											
Fundos											
Subsídios, doações e legados											
Distribuições											
Outras operações											
	5										0,00
POSIÇÃO NO FIM DO PERÍODO 2020	6=1+2+3+5				1026233,29		204059,44	-27459,79	1202832,94		1202832,94

Demonstração individual das alterações nos fundos patrimoniais no período de 2021

DESCRIÇÃO	NOTAS	Fundos Patrimoniais atribuídos aos instituidores da entidade-mãe								Interesses que não controlam	Total dos fundos patrimoniais
		Fundos	Excedentes Técnicos	Reservas	Resultados Transitados	Excedentes de revalorização	Outras variações nos fundos patrimoniais	Resultado líquido do período	Total		
POSIÇÃO NO INÍCIO DO PERÍODO 2021	6				0,00		0,00	-83075,45	-83075,45		-83075,45
ALTERAÇÕES NO PERÍODO											
Primeira adoção de novo referencial contábilístico											
Alterações de políticas contábilísticas											
Diferenças de conversão de demonstrações financeiras											
Realização de excedente de revalorização											
Excedentes de revalorização											
Ajustamentos por impostos diferidos											
Outras alterações reconhecidas nos fundos patrimoniais					-27459,79		-110337,64	27459,79	-110337,64		-110337,64
	7				-27459,79		-110337,64	27459,79	-110337,64		-110337,64
RESULTADO LÍQUIDO DO PERÍODO	8							46322,33	46322,33		46322,33
RESULTADO INTEGRAL	9=7+8							73782,12	-64015,31		-64015,31
OPERAÇÕES COM INSTITUIDORES NO PERÍODO											
Fundos											
Subsídios, doações e legados											
Distribuições											
Outras operações											
	10										0,00
POSIÇÃO NO FIM DO PERÍODO 2021	6+7+8+10				-27459,79		-110337,64	-9293,33	-147090,76		-147090,76

Fluxos de Caixa

RUBRICAS	NOTAS	PERÍODOS	
		31-12-2021	31-12-2020
Fluxos de Caixa das actividades operacionais-método directo			
Recebimento de Clientes e Utentes		143 865,64	178 892,19
Pagamentos de subsídios			
Pagamentos de apoios			
Pagamentos de bolsas		-76 272,91	-83 028,87
Pagamento a fornecedores		-84 007,86	-135 706,45
Pagamentos ao pessoal		-1 258 390,91	-1 233 145,39
Caixa gerada pelas operações		-1 274 806,04	-1 272 988,52
Pagamento/recebimento do imposto s/ rendimento			
Outros recebimentos/pagamentos		1 582 453,16	764 088,21
FLUXO DE CAIXA DAS ACTIVIDADES OPERACIONAIS		307 647,12	-508 900,31
Fluxos de caixa das actividades de investimento			
Pagamentos respeitantes a :			
Activos fixos tangíveis		-26 667,85	-43 730,46
Activos intangíveis			
Investimentos financeiros		-4 286,78	-541,87
Outros activos			
Recebimentos provenientes de:			
Activos fixos tangíveis			
Activos intangíveis			
Investimentos financeiros			
Outros activos			
Subsídios ao investimento		25 800,60	20 004,95
Juros e rendimentos similares		1 271,40	1 274,85
Dividendos			
FLUXO DE CAIXA DAS ACTIVIDADES DE INVESTIMENTO		-3 882,63	-22 992,53
Fluxos de caixa das actividades de financiamento			
Recebimentos provenientes de:			
Financiamentos Obtidos			
Realização de fundos			
Cobertura de prejuízos			
Doações			
Outras operações de financiamento			
Pagamentos respeitantes a:			
Financiamento Obtidos			
Juros e gastos similares			
Dividendos			
Redução de fundos			
Outras operações de financiamento			
FLUXO DE CAIXA DAS ACTIVIDADES DE FINANCIAMENTO		0,00	0,00
VARIAÇÃO DE CAIXA E SEUS EQUIVALENTES		303 764,49	-531 892,84
EFEITO DAS DIFERENÇAS CÂMBIO			
CAIXA E SEUS EQUIVALENTES NO INICIO PERIODO		477 298,51	1 009 191,35
CAIXA E SEUS EQUIVALENTES NO FIM PERIODO		781 063,00	477 298,51

Resultados por natureza

RENDIMENTOS E GASTOS	NOTAS	PERÍODOS	
		31/12/2021	31/12/2020
Vendas e serviços prestados	9	144 549,77	152 361,96
Subsídios, doações e legados á exploração	7	1 340 788,67	1 336 622,08
Custo das mercadorias vendidas e das matérias consumidas	6	-0,30	-1,95
Fornecimentos e serviços externos	10	-90 690,14	-103 720,03
Gastos com o pessoal	11	-1 257 929,90	-1 318 987,25
Aumentos/reduções justo valor	15.2	-1 443,10	-979,20
Outros rendimentos	12	138 791,74	141 325,31
Outros gastos	13	-84 895,54	-91 732,43
Resultado antes de depreciações, gastos de financiamento e impostos		189 171,20	114 888,49
Gastos/reversões de depreciação e de amortização	5/6	-144 120,27	-143 623,13
Resultado operacional (antes de gastos de financiamento e impostos)		45 050,93	-28 734,64
Juros e rendimentos similares obtidos	9/14	1 271,40	1 274,85
Juros e gastos similares suportados	14	0,00	0,00
Resultado antes de impostos		46 322,33	-27 459,79
Resultado líquido do período		46 322,33	-27 459,79

Anexo às demonstrações financeiras do período findo em 31 de Dezembro de 2021.

(Montantes expressos em euros).

1. NOTA INTRODUTÓRIA

O Centro de Astrofísica da Universidade do Porto, contribuinte 502 216 450, com sede na Rua das Estrelas, s/n, no Porto, criado em Maio de 1989 (Programa Mobilizador de Ciência e Tecnologia), iniciou as atividades em Outubro de 1990.

É uma associação científica e técnica privada, sem fins lucrativos e reconhecida de utilidade pública.

Inscribe entre os seus objectivos apoiar e promover a Astronomia, nomeadamente:

- a investigação científica;
- a formação ao nível pós-graduado e universitário;
- o ensino da Astronomia ao nível não universitário (ensino básico e secundário);
- e a divulgação da ciência e promoção da cultura científica.

2. REFERENCIAL CONTABILÍSTICO DE PREPARAÇÃO DAS DEMONSTRAÇÕES FINANCEIRAS

As demonstrações financeiras anexas estão em conformidade com todas as normas que integram o Sistema de Normalização Contabilística para as Entidades do Sector Não Lucrativo (ESNL). Devem entender-se como fazendo parte daquelas normas as Bases para a Apresentação de Demonstrações Financeiras, os Modelos de Demonstrações Financeiras, o Código de Contas e as Normas Contabilísticas e de Relato Financeiro (NCRF-ESNL) e as Normas Interpretativas.

Sempre que o ESNL não responda a aspetos particulares de transações ou situações, são aplicadas supletivamente e pela ordem indicada, as Normas Internacionais de Contabilidade, adotadas ao abrigo do Regulamento (CE) n.º 1606/2002, do Parlamento Europeu e do Conselho, de 19 de Julho; e as Normas Internacionais de Contabilidade (IAS) e Normas Internacionais de Relato Financeiro (IFRS), emitidas pelo IASB, e respetivas interpretações SIC-IFRIC.

Adoção pela primeira vez das Normas Contabilísticas e de Relato Financeiro (NCRF-ESNL)

Desde 01 de Janeiro de 2010 até 31 de Dezembro de 2011, o CENTRO DE ASTROFISICA elaborou e aprovou, demonstrações financeiras de acordo com o SNC, conforme legislação em vigor.

Em 31 de Dezembro de 2012, a preparação destas demonstrações financeiras foi efetuada de acordo com o Sistema de Normalização Contabilística para as Entidades do Sector não Lucrativo (ESNL), não havendo no entanto lugar a quaisquer ajustamentos, nem foi afetada a comparabilidade dos exercícios.

3. PRINCIPAIS POLÍTICAS CONTABILÍSTICAS, ALTERAÇÕES NAS ESTIMATIVAS CONTABILÍSTICAS E ERROS

As principais políticas contabilísticas adoptadas na preparação das demonstrações financeiras anexas são as seguintes:

3.1- Bases de apresentação

As demonstrações financeiras anexas foram preparadas no pressuposto da continuidade das operações, a partir dos livros e registos contabilísticos da empresa, mantidos de acordo com as NCRF-ESNL em vigor à data da elaboração das demonstrações financeiras.

3.2 - Rédito

O rédito é mensurado pelo justo valor da contraprestação recebida ou a receber.

O rédito proveniente da prestação de serviços é reconhecido com referência à data da transacção, desde que as seguintes condições sejam satisfeitas:

- O montante do rédito pode ser mensurado com fiabilidade;
- É provável que benefícios económicos futuros associados à transacção fluam para o CENTRO DE ASTROFÍSICA;

3.3 – Subsídios e outros apoios

Os subsídios apenas são reconhecidos quando há uma certeza razoável de que o CENTRO DE ASTROFÍSICA irá cumprir com as condições de atribuição dos mesmos e de que os mesmos irão ser recebidos.

Os subsídios associados à aquisição de activos não correntes são reconhecidos inicialmente no capital próprio, sendo subsequentemente imputados numa base sistemática como rendimentos do exercício durante as vidas úteis dos activos com os quais se relacionam.

Outros subsídios são, de uma forma geral, reconhecidos como rendimentos de uma forma sistemática durante os períodos necessários para os balancear com os gastos que é suposto compensarem.

3.4- Ativos fixos tangíveis

Os ativos fixos tangíveis adquiridos até 31 de Dezembro de 2009, encontram-se registados ao custo considerado, deduzido das correspondentes depreciações acumuladas.

Os activos fixos tangíveis adquiridos após essa data são inicialmente registados ao custo de aquisição o qual inclui o custo de compra, quaisquer custos directamente atribuíveis às actividades necessárias para colocar os activos na localização e condição necessárias para funcionarem da forma pretendida e, quando aplicável, a estimativa inicial dos custos de desmantelamento e remoção dos activos.

As depreciações são calculadas, após o momento em que o bem se encontra em condições de ser utilizado, de acordo com método da linha recta, em conformidade com o período de vida útil estimado para cada grupo de bens.

As taxas de depreciação utilizadas correspondem aos seguintes períodos de vida útil estimada:

Designação	Anos
Equipamento básico	4 – 10
Equipamento administrativo	3 – 10
Outros activos tangíveis	3 – 10

As vidas úteis e método de depreciação dos vários bens são revistos anualmente. O efeito de alguma alteração a estas estimativas é reconhecido na demonstração dos resultados prospectivamente.

As despesas de manutenção e reparação (dispêndios subsequentes) que não são susceptíveis de gerar benefícios económicos futuros são registadas como gastos no período em que são incorridos.

O ganho (ou a perda) resultante da alienação ou abate de um activo fixo tangível é determinado como a diferença entre o montante recebido na transacção e a quantia escriturada do activo e é reconhecido em resultados no período em que ocorre a alienação.

3.5 - Intangíveis

Os activos intangíveis adquiridos são registados ao custo deduzido de amortizações e perdas por imparidade acumuladas. As amortizações são reconhecidas numa base de linha recta durante a vida útil estimada dos activos intangíveis. As vidas úteis e método de amortização dos vários activos intangíveis são revistos anualmente. O efeito de alguma alteração a estas estimativas é reconhecido na demonstração dos resultados prospectivamente.

3.6 - Imparidade de activos fixos tangíveis e intangíveis

Em cada data de relato é efectuada uma revisão das quantias escrituradas dos activos fixos tangíveis e intangíveis da empresa com vista a determinar se existe algum indicador de que possam estar em imparidade. Se existir algum indicador, é estimada a quantia recuperável dos respectivos activos a fim de determinar a extensão da perda por imparidade (se for o caso).

Quando não é possível determinar a quantia recuperável de um activo individual, é estimada a quantia recuperável da unidade geradora de caixa a que esse activo pertence.

A quantia recuperável do activo ou da unidade geradora de caixa consiste no maior de entre o justo valor deduzido de custos para vender e o valor de uso. Na determinação do valor de uso, os fluxos de caixa futuros estimados são descontados usando uma taxa de desconto antes de impostos que reflecta as expectativas do mercado quanto ao valor temporal do dinheiro e quanto aos riscos específicos do activo ou da unidade geradora de caixa relativamente aos quais as estimativas de fluxos de caixa futuros não tenham sido ajustadas.

Sempre que a quantia escriturada do activo ou da unidade geradora de caixa for superior à sua quantia recuperável, é reconhecida uma perda por imparidade. A perda por imparidade é registada de imediato na demonstração dos resultados na rubrica de “Perdas por imparidade”.

A reversão de perdas por imparidade reconhecidas em exercícios anteriores é registada quando há evidências de que as perdas por imparidade reconhecidas já não existem ou diminuíram, sendo reconhecida na demonstração de resultados na rubrica “Reversões de perdas por imparidade”, e efectuada até ao limite da quantia que estaria reconhecida (líquida de amortizações) caso a perda não tivesse sido registada.

3.7 - Activos e passivos financeiros

Os activos e os passivos financeiros são reconhecidos no balanço quando o CENTRO DE ASTROFÍSICA se torna parte das correspondentes disposições contratuais.

Cientes e dívidas de terceiros

As dívidas de clientes e de outros terceiros encontram-se registadas pelo seu valor nominal deduzido de eventuais perdas de imparidade. As perdas de imparidade correspondem à diferença entre a quantia inicialmente registada e o seu valor recuperável, sendo este o valor presente dos “cash-flows” esperados, descontados à taxa efectiva, as quais são reconhecidas na demonstração dos resultados do período em que são em que são estimadas.

Caixa e equivalentes a caixa

Os montantes incluídos na rubrica de caixa e seus equivalentes correspondem aos valores em caixa, depósitos à ordem e a prazo.

Contas a pagar

As contas a pagar são registadas pelo seu valor nominal dado que não vencem juros e o efeito do desconto é considerado imaterial.

3.8 - Juízos de valor críticos e principais fontes de incerteza associada a estimativas

Na preparação das demonstrações financeiras anexas foram efectuados juízos de valor e estimativas e utilizados diversos pressupostos que afectam as quantias relatadas de activos e passivos, assim como as quantias relatadas de rendimentos e gastos do período. Durante o decurso do ano de 2021, não ocorreram alterações de políticas contabilísticas ou estimativas relevantes, relativamente às utilizadas na preparação e apresentação das demonstrações financeiras do exercício findo em 31 de Dezembro de 2020.

As estimativas e os pressupostos subjacentes foram determinados com base no melhor conhecimento existente à data de aprovação das demonstrações financeiras dos eventos e transacções em curso, assim como na experiência de eventos passados e/ou correntes.

Contudo, poderão ocorrer situações em períodos subsequentes que, não sendo previsíveis à data de aprovação das demonstrações financeiras, não foram consideradas nessas estimativas. As alterações às estimativas que ocorram posteriormente à data das demonstrações financeiras serão corrigidas de forma prospectiva. Por este motivo e dado o grau de incerteza associado, os resultados reais das transacções em questão poderão diferir das correspondentes estimativas.

Os principais juízos de valor e estimativas efectuadas na preparação das demonstrações financeiras anexas foram os seguintes:

Activos fixos tangíveis / estimativas de vidas úteis

As depreciações são calculadas sobre o custo de aquisição sendo utilizado o método da linha recta, a partir da data em que o activo se encontra disponível para utilização, utilizando-se as taxas que melhor reflectem a sua vida útil estimada. Os valores residuais dos activos e as respectivas vidas úteis são revistos e ajustados, se necessário em cada data de relato.

3.9 - Acontecimentos subsequentes

Os acontecimentos após a data do balanço que proporcionem informação adicional sobre condições que existiam à data do balanço (“adjusting events”) são reflectidos nas demonstrações financeiras. Os eventos após a data do balanço que proporcionem informação sobre condições que ocorram após a data do balanço (“non adjusting events”) são divulgados nas demonstrações financeiras, se forem considerados materiais.

3.10 - Especialização dos exercícios

As receitas e despesas são registadas de acordo com o princípio da especialização de exercícios, pelo qual estas são reconhecidas à medida em que são geradas, independentemente do momento em que são recebidas ou pagas. As diferenças entre as receitas e despesas geradas e os correspondentes montantes facturados são registadas nas rubricas de diferimentos.

4. ACTIVOS INTANGÍVEIS

Durante os períodos findos em 31 de Dezembro de 2021 e 31 de Dezembro de 2020, o movimento ocorrido na quantia escriturada dos activos intangíveis, bem como nas respectivas amortizações acumuladas, foi o seguinte:

	Activos intangíveis: quantias brutas escrituradas	Projectos de desenvolvi mento	Programas de computador			Activos intangív eis em curso	Totais
		Outros		Marcas comerciais			
	Saldo Inicial		4.077,14	17.492,90			21.570,04
	Adições						
	Revalorizações						

	Transferências						
	Alienações						
	Sinistros						
	Abates						
	Saldo Final		4.077,14	17.492,90			21.570,04

	Activos intangíveis: amortizações	Projectos de desenvolvimento	Programas de computador			Activos intangíveis em curso	Totais
		Outros		Marcas comerciais			
	Saldo Inicial		4.077,14	8.594,61			12.671,75
	Reforços			2.329,03			2.329,03
	Reversões						
	Alienações						
	Sinistros						
	Abates						
	Saldo Final		4.077,14	10.923,64			15.000,78

5. ACTIVOS FIXOS TANGÍVEIS

Durante os períodos findos em 31 de Dezembro de 2021 e 31 de Dezembro de 2020, o movimento ocorrido na quantia escriturada dos activos fixos tangíveis, bem como nas respectivas depreciações acumuladas, foi o seguinte:

Activos fixos tangíveis: quantias brutas escrituradas	Equipamento básico	Equipamento de transporte	Equipamento administrativo	Outros activos fixos tangíveis	Activos fixos tangíveis em curso	Totais
Saldo Inicial	988.098,14	35.400,00	792.027,06	45.266,88		1.860.792,08
Adições	26.183,88		483,97			26.667,85
Revalorizações						
Alienações						
Transferências						
Abates	-779,96		-848,32	-85,80		-1.714,08
Saldo Final	1.013.502,06	35.400,00	791.662,71	45.181,08		1.885.745,85

Activos fixos tangíveis: depreciações	Equipamento básico	Equipamento de transporte	Equipamento administrativo	Outros activos fixos tangíveis	Activos fixos tangíveis em curso	Totais
Saldo Inicial	799.166,75	35.400,00	773.315,74	36.864,08		1.644.746,57

Reforços	120.410,59		17.926,22	3.454,43		141.791,24
Reversões						
Alienações						
Abates			-848,32	-85,80		-934,12
Saldo Final	919.577,34	35.400,00	790.393,64	40.232,71		1.785.603,69

6. CUSTO DAS MERCADORIAS VENDIDAS E MATÉRIAS CONSUMIDAS

O custo das mercadorias vendidas e das matérias consumidas reconhecido nos períodos findos 31 de Dezembro de 2021 e em 31 de Dezembro de 2020 é detalhado conforme segue:

CMVMC		Mercadorias	TOTAIS
Em 31.12.2021	Saldo Inicial	4.327,37	4.327,37
	Compras		
	Regularizações (+/-)	-35,31	-35,31
	Saldo Final	4.291,76	4.291,76

	CMVMC	0,30	0,30
Em 31.12.2020	Saldo Inicial	4.358,22	4.358,22
	Compras	62,50	62,50
	Regularizações (+/-)	-91,40	-91,40
	Saldo Final	4.327,37	4.327,37
	CMVMC	1,95	1,95

7. SUBSÍDIOS E OUTROS APOIOS

O montante dos subsídios, reconhecidos nos períodos findos em 31 de Dezembro de 2021 e em 31 de Dezembro de 2020, é detalhado como se segue:

No que se refere aos subsídios relacionados com activos, os valores recebidos são reconhecidos como réditos à medida que os bens subsidiados vão sendo amortizados.

Os subsídios à exploração são reconhecidos como réditos, na medida em que o gasto é realizado.

Relação dos subsídios obtidos e outros apoios			Quantias Concedidas	
			2021	2020
Não reembolsáveis	Subsídios relacionados com activos	Estado e Outros Entes Públicos	25.800,60	11.164,95
		Outras Entidades		8.840,00
		Subtotais	25.800,60	20.004,95

		Estado e Outros Entes Públicos	1.284.961,19	1.246.901,74
		Outras Entidades	55.827,48	89.720,34
	Subsídios à exploração	Subtotais	1.340.788,67	1.336.622,08
Totais			1.366.589,27	1.356.627,03

8. INSTRUMENTOS FINANCEIROS

CRÉDITOS A RECEBER						
	Quantia Nominal		Imparidade		Valor Liquido	
	2021	2020	2021	2020	2021	2020
Cientes Correntes	17.672,02	16.987,89			17.672,02	16.987,89
Cientes Cob. Duvidosa						
Totais	17.672,02	16.987,89	0	0	17.672,02	16.987,89

	OUTROS ATIVOS CORRENTES	
	2021	2020

Fornecedores (Saldos contrários)		
Adiant. e outras operações c/ pessoal		
Adiant. A fornecedores de investimentos		
Devedores por acréscimo de rendimentos		
Juros a receber		
Subsídios a receber	75.000,00	85.000,00
Outros acréscimos de rendimentos	187.821,55	93.674.21
Outros devedores	1.778.458,33	2.397.398,51
Totais	2.041.279,88	2.576.072,72

	ESTADO E OUTROS ENTES PÚBLICOS	
	2021	2020
Finanças	4.781,30	-5.740,89
Segurança Social e Fundo de Compensação	25.606,56	25.876,41
Totais	30.387,86	20.135,52

Saldos Devedores		
Retenção Imp. s/ Rendimento		
Iva Restituição	3.659,68	2.567,93
Iva a recuperar	8.296,02	20.129,96
Restantes impostos		
Totais	11.955,70	22.697,89
Saldos Credores		
Corrente		
Retenção Imp. s/ Rendimento	16.737,00	16.957,00
Iva a pagar		
Contribuições seg. social	24.955,38	25.242,84
Outras Tributações (Fundo de Compensação)	651,18	633,57
Totais	42.343,56	42.833,41

	DIFERIMENTOS	
	2021	2020
Gastos a reconhecer		
Seguros	791,95	904,15
Outros gastos diferidos	6.383,26	9.062,09
Totais	7.175,21	9.966,24
Rendimentos a reconhecer		
Subsídios	1.535.836,45	1.648.053,44
Outros rendimentos	32,52	649,95
Totais	1.535.868,97	1.648.703,39

	OUTROS PASSIVOS CORRENTES	
	2021	2020
Não correntes		
Clientes (saldos contrários)		
Pessoal		
Fornecedores de investimentos		
Totais	0	0
Correntes		
Clientes (saldos contrários)	301,70	301,70
Pessoal	46,45	
Fornecedores de investimentos		
Credores por acréscimos de gastos		
Remunerações a pagar	182.357,00	176.413,09
Outros acréscimos de gastos	1.289,39	2.831,40
Outros Credores	137.338,59	343.238,46
Totais	321.333,13	522.784,65

	FORNECEDORES	
	2021	2020
Fornecedores, conta corrente	374,95	885,60
Fornecedores, títulos a pagar		
Fornecedores, faturas em rec. conf.		
Totais	374,95	885,60

MOVIMENTOS NAS RUBRICAS DE FUNDOS PATRIMONIAIS				
	Saldo Inicial	Aumentos	Reduções	Saldo Final
Fundos				
Reservas				
Resultados transitados	1.026.233,29		27.459,79	998.773,50
Excedentes de revalorização				
Outras variações nos fundos patrimoniais	204.059,44	25.800,60	136.138,24	93.721,80

Resultado líquido do exercício	-27.459,79	46.322,33	-27.459,79	46.322,33
Totais	1.202.832,94	72.122,93	136.138,24	1.138.817,63

9. RÉDITO

Em 31 de Dezembro de 2021 e em 31 de Dezembro de 2020 os réditos apresentavam a seguinte composição:

Quantias dos réditos reconhecidas no período	2021	2020
	Réditos reconhecidos no período	Réditos reconhecidos no período
Venda de bens	1,14	7,41
Prestação de serviços	144.548,63	152.354,55
Juros	1.271,40	1.274,85
Royalties		
Dividendos		
Totais	145.821,17	153.636,81

10. FORNECIMENTOS E SERVIÇOS EXTERNOS

A rubrica de “Fornecimentos e serviços externos” em 31 de Dezembro de 2021 e 31 de Dezembro de 2020 é detalhada conforme se segue:

Fornecimentos e Serviços Externos	2021	2020
Subcontratos	2.137,88	2.385,10
Serviços Especializados:	38.472,30	42.006,86
Trabalhos Especializados	9.803,10	10.651,80
Publicidade e propaganda	516,60	446,64
Vigilância e Segurança		93,09
Honorários	5.722,50	13.269,00
Conservação e Reparação	21.841,05	16.806,33
Outros Serviços Especializados	589,05	740,00
Materiais	10.563,06	23.926,27
Energia e fluídos	419,27	135,70
Deslocações, Estadas e Transportes	25.895,18	22.857,42
Serviços Diversos:	13.202,45	12.408,68
Rendas e Alugueres		
Comunicação	722,84	142,48
Seguros	2.714,91	2.400,44

Contencioso e notariado	302,50	1.786,40
Limpeza, higiene e conforto		
Outros Serviços	9.462,20	8.079,36
Totais	90.690,14	103.720,03

11. GASTOS COM O PESSOAL

A rubrica de “Gastos com o pessoal” em 31 de Dezembro de 2021 e em 31 de Dezembro de 2020 detalha-se da seguinte forma:

Gastos com o Pessoal	2021	2020
Remunerações do Pessoal	1.027.032,05	1.083.644,67
Encargos sobre Remunerações	221.060,05	225.315,19
Seguro de acidentes de trabalho e doenças profissionais	7.699,51	7.986,75
Outros gastos com Pessoal	2.138,29	2.040,64
Totais	1.257.929,90	1.318.987,25

12. OUTROS RENDIMENTOS

A composição da rubrica de “Outros rendimentos e ganhos” em 31 de Dezembro de 2021 e 31 de Dezembro de 2020 é conforme se segue:

Outros Rendimentos	2021	2020
Descontos de pronto pagamento		
Rendimentos e ganhos rest. Activos financeiros	53,98	53,32
Rendimentos e ganhos em Inv. não financeiros		66,66
Outros	138.737,76	141.205,33
Totais	138.791,74	141.325,31

13. OUTROS GASTOS

A decomposição da rubrica de “Outros gastos e perdas” em 31 de Dezembro de 2021 e em 31 de Dezembro de 2020 é conforme se segue:

Outros Gastos	2021	2020
Impostos	54,41	59,08
Perdas em Inventários		
Gastos e Perdas em Investimentos Não Financ.	779,96	
Outros	84.061,17	91.673,35
Totais	84.895,54	91.732,43

14. JUROS E OUTROS RENDIMENTOS E GASTOS SIMILARES

Os gastos e perdas de financiamento em 31 de Dezembro de 2021 e 31 de Dezembro de 2020 são detalhados conforme se segue:

Juros e Rendimentos Similares Obtidos	2021	2020
Juros Depósitos	10,15	10,15
Outros	1.261,25	1.264,70
Totais	1.271,40	1.274,85

Juros e Gastos Similares Suportados	2021	2020
Juros Suportados		
Diferenças de câmbio desfavoráveis		
Outros		
Totais	0	0

15. OUTRAS INFORMAÇÕES

15.1. Outros Ativos Correntes

OUTROS ATIVOS CORRENTES						
	Quantia Nominal		Aum/Red.J.Valor		Valor Liquido	
	2021	2020	2021	2020	2021	2020

Obrigações do Tesouro	50.824,00	71.803,20	-1.443,10	-979,20	49.380,90	70.824,00
Totais	50.824,00	71.803,20	-1.443,10	-979,20	49.380,90	70.824,00

15.2. Investimentos Financeiros

INVESTIMENTOS FINANCEIROS						
	Quantia Nominal		Imparidade		Valor Liquido	
	2021	2020	2021	2020	2021	2020
Fundo Compensação	19.208,35	14.921,57			19.208,35	14.921,57
Totais	19.208,35	14.921,57	0	0	19.208,35	14.921,57

15.3 Desagregação dos valores inscritos na rubrica caixa e depósitos bancários

Caixa, Depósitos e Outros Inst. Financeiros	2021	2020
Caixa	35,00	35,00

Depósitos Bancários	781.028,00	477 263,51
Total	781.063,00	477 298,51

16. DATA DE AUTORIZAÇÃO PARA EMISSÃO

As demonstrações financeiras do exercício findo em 31 de Dezembro de 2021 foram aprovadas pela Direcção e autorizadas para emissão em 01-04-2021.

RELATÓRIO E PARECER DO CONSELHO FISCAL

RELATÓRIO E PARECER DO CONSELHO FISCAL

Senhores Associados do Centro de Astrofísica da Universidade do Porto,

Em conformidade com a legislação em vigor e com o mandato que nos foi confiado, vimos submeter à vossa apreciação o nosso Relatório e Parecer que abrange a atividade por nós desenvolvida e os documentos de prestação de contas do CAUP – Centro de Astrofísica da Universidade do Porto, relativos ao exercício findo em 31 de dezembro de 2021, os quais são da responsabilidade da Direção.

Acompanhamos a evolução da atividade do Centro, da sua contabilidade e o cumprimento do normativo legal e estatutário em vigor, tendo recebido da Direção e serviços do CAUP todas as informações e esclarecimentos solicitados.

No âmbito das nossas funções analisamos o Relatório de Gestão da Direção e as contas do exercício findo em 31 de dezembro de 2021, que compreendem o Balanço (que evidencia um total de 3.038.738,24 euros e um total dos fundos patrimoniais de 1.138.817,63 euros, incluindo um resultado líquido do período de 46.322,33 euros), a Demonstração dos Resultados, a Demonstração dos Fluxos de Caixa e o respetivo Anexo, composto pelas notas explicativas.

A análise dos documentos acima referidos permite concluir pela boa compreensão da situação financeira do CAUP em 31 de dezembro de 2021, assim como pela satisfação das disposições legais e estatutárias aplicáveis.

Face ao referido, o Conselho Fiscal do CAUP – Centro de Astrofísica da Universidade do Porto, pronuncia-se com o seguinte parecer:

Que seja aprovado o Relatório de Gestão, a proposta nele expressa, bem como as Contas referentes ao ano findo a 31 de dezembro de 2021.

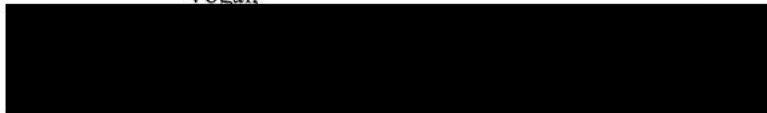
Porto, 18 de abril de 2022.

Presidente,



(Dr. Filipe Pires)

Vogal,



(Prof. Jorge T. Gamito)

Relator,



(Dra. Mariana Rebelo)