Institute of Astrophysics and Space Sciences
2015 Activity Report

instituto de astrofísica
e ciências do espaço

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Portugal

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Unit Overview

The year of 2015 marks the first full year of activity of the Institute of Astrophysics and Space Sciences (IA). After years of close collaboration, the two major Portuguese research units dedicated to the study of the Universe took the final step in the creation of a research infrastructure with a national dimension – guaranteeing the foundations for a long term sustainable development of one of the most high impact areas in Portugal. The vision proposed for the IA, and for the development of Astronomy, Astrophysics and Space Sciences in Portugal, is a bold one, and one that has been clearly shown during 2015 to be within reach.

Over the course of this first year, a team of more than 120 people, including over 100 researchers, actively contributed to the development of the IA, strengthening a comprehensive portfolio of projects covering most of the topics that are presently, and for the next decade, at the forefront of research in Astrophysics and Space Sciences. These include the core of the national scientific participation in the European Southern Observatory and the European Space Agency. The Research, Development and Innovation activities at the IA, ranging from the Solar System to the large-scale properties of the Universe, and complemented by work on instrumentation and systems with potential use in Astronomy and Astrophysics projects, are structured around three Research Groups — (G1) Origin and Evolution of Stars and Planets; (G2) Galaxies, Cosmology, and the Evolution of the Universe; (G3) Instrumentation and Systems. Their work is focused on five Thematic Lines — (TL1) Towards the detection and characterisation of other Earths; (TL2) Towards a comprehensive study of stars; (TL3) The assembly history of galaxies resolved in space and time; (TL4) Unveiling the dynamics of the Universe; (TL5) Space and Ground Systems and Technologies. IA activities are further supported by the Science Communication Group, which promotes a strong connection of the IA research with the general public, with particular care for science education activities. Finally, the IA also hosts the Portuguese ALMA Centre of Expertise, part of the European ALMA Regional Centre Network, that aims to provide scientific and technical support to the European astronomical community in their use of the revolutionary Atacama Large Millimetre Array (ALMA)

Hosted by the two major Universities in Portugal (Porto and Lisbon), the IA is now established as a strong and dynamic national research infrastructure that displays an outstanding productivity. During 2015 new and exciting views of our Universe have been obtained, making use of the most powerful ground- and space-based facilities; the very fundamental structure of the Universe has been investigated, by developing some of the most state-of-the-art theoretical frameworks; our participation in the construction of the next generation of astronomical instruments has continued and increased in scope, making sure IA's science will continue to be of the highest standards well within the next decade; an ever increasing number of national and international students got involved with IA's activities, showing the attractiveness that this field of study continues to have in the younger generations; the IA's activity has reached even wider and more diverse audiences, showing well the IA's commitment to Science Communication.

After such a prolific first year, briefly summarised in the following pages, it can only be with the greatest excitement that the IA looks at the future, knowing that the best still lies ahead.

José Afonso, Nuno Santos, João Lima, Alexandre Cabral
IA Executive Board

Report from the Group

Origin and Evolution of Stars and Planets

During 2015 the group on the Origin and Evolution of Stars and Planets has dedicated a significant part of its scientific efforts towards the fulfilling of its goals concerning the development and future scientific exploitation of major ground-based projects and space-based missions, including the ESPRESSO, NIRPS, HIRES (ESO) and SPIrou (CFHT) projects, and the CHEOPS and PLATO 2.0 space missions (ESA). In particular, the team has increased its efforts towards the preparation of the ESA-selected mission PLATO 2.0, whose adoption was foreseen for November 2016. In 2015, team members organised the workshop *PLATO 2.0: Coordination of the Stellar-Properties work packages* (Porto, March 12-13 2015) and co-organised the *PLATO Stellar Science kick-off meeting* (Paris 9-10 April 2015).

As originally planned, the group has also worked towards the consolidation of the interaction between its thematic lines “Towards the detection and characterisation of other Earths” and “Towards a comprehensive study of stars”. To this aim monthly meetings were set-up gathering all members from the two thematic lines. In addition, all members also participate in the weekly Journal clubs and meetings which are organised by each thematic line.

The size of the two thematic lines has remained similar and a number of group researchers continue to effectively contribute to both research lines. During 2015, 5 researchers have left the group (although one has kept the status of collaborator and has applied to a new IFCT contract at IA, which has in the meantime been approved and the researcher is foreseen to rejoin the group during 2016). On the other hand, 5 new researchers have joined the group during 2015, one of which with an IFCT contract. Moreover, in 2015, 6 new students have started their PhD under the supervision of members of the group, while 3 ongoing students have successfully completed their PhD during the same period.

During 2015, one new FCT project and two cooperation projects have been funded with PIs from the group. Two additional FCT projects have been approved during the same period, to be started in 2016. Three applications submitted to the IFCT during 2015 have also recently been proved successful and the contracts are expected to start during 2016.

Margarida Cunha
Group Leader

Report from the Thematic Line

Towards the detection and characterisation of other Earths

In 2015, Planetary System research at IA primarily concentrated in its two major branches: Exoplanet research and Solar System atmospheres.

Regarding Exoplanets, the team focused on the detection (using radial velocity and transit methods) and characterisation of planets orbiting solar-type stars. Particular emphasis was given to very low mass (Earth- or Neptune-like) planets, and to follow-up Kepler and K2 targets. In this context, we stress our leadership position in several planet search programs with ESO/HARPS (including an ESO Large Program lead by the IA team), HARPS-N and OHP/SOPHIE telescopes/instruments.

The study of the effects of stellar activity and granulation on the detection and characterisation of very low mass planets with radial-velocities is also one of the major goals, having in mind the exploitation of data coming from future instruments such as ESPRESSO (ESO-VLT, 2018), CHEOPS (ESA, 2018), SPIROU (CFHT, 2018), NIRPS (ESO-3.6-m, 2019), Plato (ESA, 2025), and HIRES (ESO/E-ELT, 2025). In all these instruments and missions the team has major participations (e.g. Co-PI'ship and Board membership), and in all cases, our team is responsible for scientific tasks as well as part of the data reduction/analysis pipelines (among other HW and SW participations responsibility of the Instrumentation team in IA).

In the 2018-2020 horizon, this strong participation will allow us to be in a privileged position inside the various consortia to exploit the valuable data coming from these projects: 273 guaranteed nights of observations (GTO) with ESPRESSO at the VLT, and 80% of the time of the CHEOPS ESA mission (both starting in 2018). The new NIRPS project for the ESO/3.6-m telescope was also recently granted by ESO 725 nights of GTO (starting in 2019), and SPIROU will be granted between 500 and 700 GTO nights. Further ahead, our secured participation in the ESA-PLATO and ESO-HIRES (E-ELT) projects guarantee our international leadership role beyond 2025.

The study of the physical properties and chemical abundances of planet hosting stars is also a major field of research within the team. This allows us to place important constraints into the models of planet formation and evolution, as well as on the structure and composition of transiting planets.

Finally, a significant investment has been done in the development of novel methods for the detection of exoplanet atmospheres. This subject also allows us to interface with the research done in the context of Solar System atmospheres. The team has in this context developed a novel technique to detect reflected light using high-resolution methods. The first results of this analysis had a strong visibility within the international community (e.g. one ESO Press Release), becoming one of the Physic World's Top Ten Breakthroughs of 2015.

Regarding Solar System's research line, we focused our efforts in the dynamical studies of Venus' mesosphere with the Doppler velocimetry techniques we have developed and fine-tuned, and with an improved cloud tracking method based in phase correlation between images. In the framework of our new collaboration with the Japanese space mission Akatsuki, we prepared a ground based support campaign (ALMA, VLT/UVES, CFHT/ESPaDOnS) to be performed in 2016. We are now adapting our

methods (Doppler velocimetry and cloud tracking) in order to study the Giant planets' atmospheres (Jupiter and Saturn).

In the next few lines we describe three results led by our team that illustrate the high level of the research done:

1. In two published articles, researchers from the IA team have shown that the ratio of some heavy elements in a star, like Magnesium (Mg), Silicon (Si) and Iron (Fe), have a crucial influence in the composition of rocky exoplanets. In particular, the results show that the Mg/Si ratio can have a pivotal role in the structure and chemical composition of terrestrial exoplanets. This fraction is thus the key to measure some characteristics of exoplanets, like mass or radius. A detailed analysis of the chemical composition for the star will thus add strong constraints to the characterisation of exoplanets using future missions such as CHEOPS and PLATO 2.0.

2. A 5-year radial velocity campaign of Kepler's giant exoplanet candidates led by the team has found that more than 50% of the candidate planets are actually false positives (Figure 1). This result shows that the percentage of false positives in Kepler data that has previously been reported, between 10 and 20%, was too optimistic. This has strong implications in our understanding of the exoplanet population in the Kepler field. This research also found that moderately irradiated giant planets are not inflated. Detailed characterisation of the internal structure of these planets should shed new light on planet formation and evolution theories.

3. A pioneer study led by the IA team has made the first-ever spectroscopic detection of visible light reflected off an exoplanet: 51 Peg b. These observations, reported in an ESO Press-Release, also revealed new properties of this famous object, the first exoplanet ever discovered around a normal star (Figure 2). The result promises an exciting future for this technique, particularly with the advent of next generation instruments, such as ESPRESSO, on the VLT, and future telescopes, such as the E-ELT.

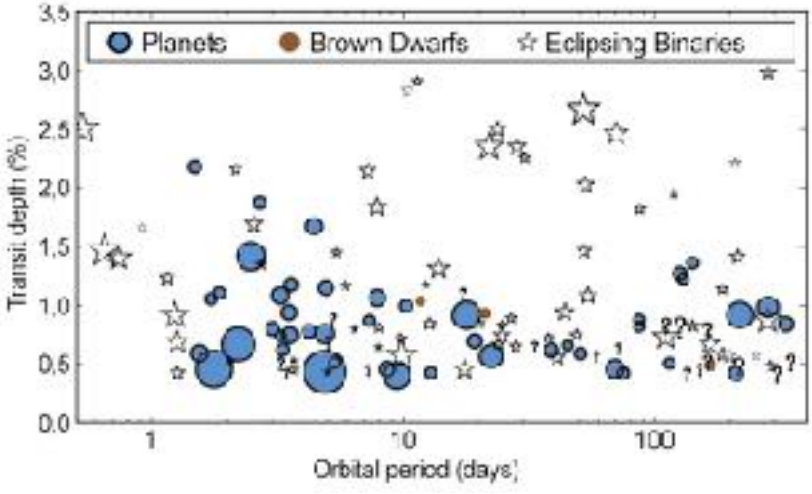

Figure 1 — Selected population of planet candidates detected by the Kepler Space Telescope. Their transit depth is displayed here as a function of their orbital period. The size of the marker is relative to the magnitude of the host. In a study led by the IA team (Santerne et al., 2015) it was found that more than 50% of the candidate planets are actually false positives. Among other things, this has strong implications for our understanding of the planet frequency in the galaxy.

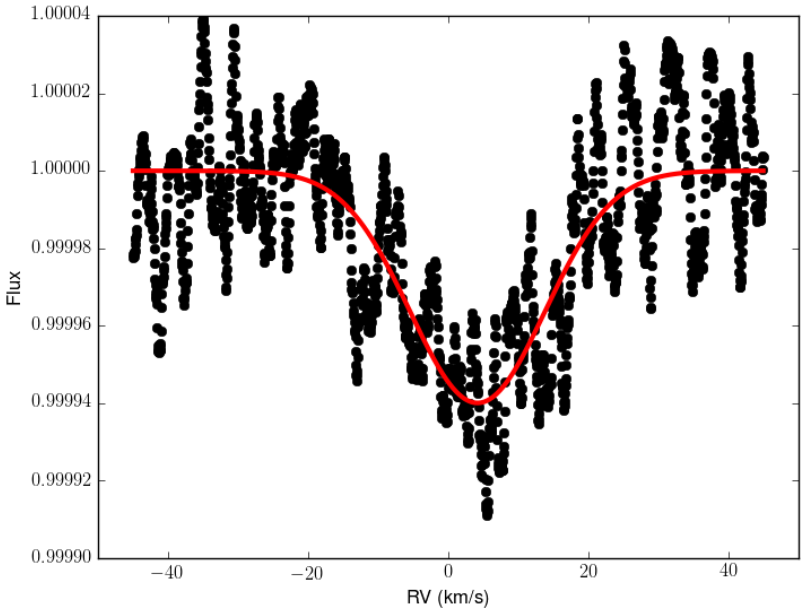

Figure 2 — Spectroscopic signature of the reflected light of 51 Peg on its short period planets (from Martins et al., 2015).

Nuno Santos
Thematic Line Leader

Report from the Thematic Line

Towards a comprehensive study of stars

During 2015 the Thematic Line activities were focused on the major topics of Star Formation and Early Evolution and Stellar Interiors and Atmospheres.

With respect to Star Formation and Early Evolution, the team focused on observational studies of both low and high mass star formation using data from optical to radio wavelengths. The team is involved in the Gaia-ESO survey in the characterisation of low-mass pre-main sequence stars members of very young clusters and associations. Besides the fundamental parameters and chemical abundances we focus on the rotation and activity (chromospheric radiative emission and accretion). Work has also been done on the estimation of mass accretion rates and flow dynamics around very active Young Stellar Objects (YSO's). In spite of high angular momentum of the accreting matter, the most active YSO's are slow rotators, with periods of several days. There must be some mechanism to remove the excess of angular momentum from the system during the first million years of their evolution. The team is involved in MHD simulations of jets around YSO's and the connection between the rotating star-disk system and the magnetised outflowing gas.

Some key scientific results, obtained in 2015, were:

1. A comparison of several diagnostic line profiles in a sample of YSO's (mainly cTTS and FUor stars) in order to estimate mass accretion rates and characterise the outflows dynamics. Also, the first detection of the photospheric spectrum of the pre-FUor star V1331 Cyg and the subsequent derivation of the stellar parameters, leading to the conclusion that the observed Balmer lines (H-alpha and H-beta) can be well reproduced with a stellar wind model, where the mass-loss rate and and collimation of the wind are variable.

2. A study of the robustness of self-similar time-independent solutions of jets/wind around Young Stellar Objects (YSO's) and their ability to provide quasi-steady jet simulations with realistic boundaries and surrounded by equatorial magnetospheres. This was achieved using MHD simulations with the PLUTO code.

3. In the context of the Gaia-ESO Survey, we conducted a comparative study of the main properties of young clusters whose population includes pre-main sequence (PMS) stars (Figure 3). The focus is on their rotation, chromospheric radiative losses and accretion in PMS stars. We also provided the demonstration that the observed photometric variability of cTTS in the young cluster NGC2264 that present AA Tau-like light curves is consistent with the inner disk warp scenario. This analysis was done by comparing infrared Spitzer IRAC and optical CoRoT light curves.

In what concerns Stellar Interiors and Atmospheres, the main goal is to understand the details of the structure and evolution of stars of low and intermediate masses. A great part of the work of the team continues to be centred on the exploitation of seismic data acquired with the NASA satellite Kepler (launched in 2009, and now operating the so-called K2 mission extension phase). Simultaneously, the team has been increasing its involvement in the stellar part of the work associated to the PLATO2.0 mission, in preparation for the adoption by ESA (in June 2016), particularly in connection to the PLATO2.0 PSPM seismic diagnostics work package. Efforts are put also in the determination of the

global properties of stars, through the analysis of spectroscopic and interferometric data. Part of this work is carried out in the context of the team's participation in the Gaia-ESO survey. Theoretical studies of stellar pulsators continue to be pursued, both in what concerns the driving of pulsations and the development of new diagnostic tools for seismic inference.

Key scientific results obtained in 2015 for Stellar Interiors and Atmospheres include:

4. The potential of using glitches to probe the base of the convection zone and the Helium ionisation zone in solar-like stars observed by Kepler. Results have been obtained for several single stars, and also for a binary that has been observed for 2 years with Kepler. A similar approach has also been implemented for convective cores in more massive stars.

5. The development and validation of the methods to determine stellar atmospheric parameters, for the GAIA-ESO Survey and other data have been further explored. The extension of the methods to M Dwarfs has also been implemented. The use of Asteroseismology to obtain global stellar parameters has also been explored with Kepler data.

6. The excitation of pulsations and the impact of rotation on pulsations have been studied for a few F stars providing new very important insights on how these complex stars pulsate and how those pulsations can be used to characterise the star. A validation using pulsating stars in binaries has been provided on how the mean density and the rotation rate are related to the a frequency separation measured in F stars (Figure 4).

Complementary to the many publications, the team also participated in several international conferences where the results of the project have been presented and discussed. We maintained an active participation in the large projects of ESA and ESO related to the Thematic Line. A specific workshop under one of this large programs was organised (PLATO2.0: Coordination of the Stellar-Properties work packages) in March.

In this period the thematic line has seen 2 Masters Dissertations and 2 PhD thesis being finished in topics directly related to the objectives of the project. Also, more students have started in 2015 their Dissertation or Thesis projects under the supervision of the team on relevant topics for the project. There have been also several visitors and seminars on the topics covered by the project.

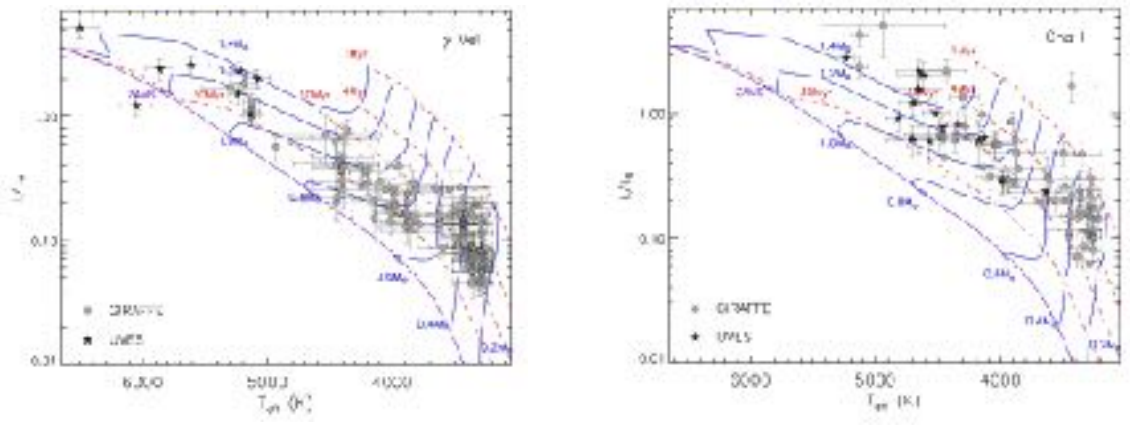

Figure 3 — HR diagram for γ Vel (left) and Cha I (right) members from both UVES and GIRAFFE data. The isochrones (dashed lines) are from 1 to 30 Myr, while the lower solid line is the ZAMS for different stellar masses (from Frasca et al., 2015).

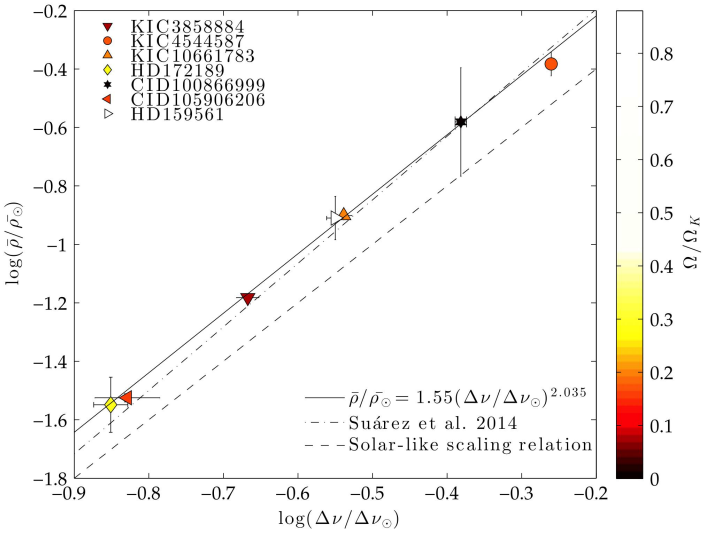

Figure 4 — Scaling of the mean density with frequency separation. These quantities were obtained for pulsating delta δ Sct Stars in binaries in order to have an independent measurement of the mean density. The observations validate the theoretical prediction, confirming the potential of using frequency separation in these stars with a highly complex pulsating spectrum.

Mário João Monteiro

Thematic Line Leader

Report from the Group

Galaxies, Cosmology, and the Evolution of the Universe

The overarching aim of the Group's research is to provide world-class contributions to the understanding of the origin and evolution of the Universe and its large-scale structures. We are exploring both the properties of the building blocks of the Universe (galaxies and clusters) and its underlying mechanisms (structure formation, dark energy and fundamental physics). In the past year the Group has focused on strengthening its expertise around the central axes of its research and development strategy. The Group has also increased its involvement in key collaborations and consortia, enhancing its international visibility and ensuring its sustainable growth for the coming years. Of special importance to this objective is its Co-leadership in MOONS, contribution to the Portuguese ALMA Centre of Expertise activities, and key leadership/participation in WODAN+EMU, Euclid, Athena, CALIFA and AzTEC projects. Also of particular note is the active participation in the Marie Curie Action – International Research Staff Exchange Scheme SELGIFS, an international collaboration focused on the study of emission-line galaxies with integral-field spectroscopy.

During 2015, the group has implemented efficient communication processes within its two thematic lines “The assembly history of galaxies resolved in space and time” and “Unveiling the dynamics of the Universe”. In both cases weekly meetings have been set-up to the discussion of coordination and scientific matters relevant to each thematic line, ensuring an efficient flow of information within the teams.

The size of both thematic lines has been essentially unchanged – 3 researchers have left and 5 new ones, including one IFCT contract, have arrived in 2015. Also, 4 new PhD students started their research work under the supervision of researchers of the group during this year.

Finally, the increasing productivity and international visibility of the Group over the past year is reflected in numerous oral conference contributions and seminars by its members, the organisation and hosting of the international conference *Back at the Edge of the Universe: latest results from the deepest astronomical surveys* (Sintra, March 15-19 2015), the face-to-face meeting of the Euclid Survey group (June 2015), and the regular inflow of visiting scientists.

The prospects for the future are excellent. Besides the envisaged new or enhanced participation in ESO and ESA projects, three new IFCT positions have been recently granted to researchers that will start their contracts in the group during 2016 – bringing important expertise to the group activities.

Polychronis Papaderos
Group Leader

Report from the Thematic Line

The assembly history of galaxies resolved in space and time

During 2015 the Thematic Line, implementing its strategic scientific plan, focused its activity in the preparation for the exploitation of the upcoming generation of SKA-percursor radio surveys, increasing the expertise in the use of ALMA, prepared for the exploitation of MOONS (the Multi Object Optical and Near-infrared Spectrograph for the VLT) and kept working in establishing FADO as a reference tool for the modelling and interpretation of both photometric and spectroscopic galaxy observations. We have also given fundamental steps into following through our science objectives beyond this decade, securing important scientific participations in fundamental ESO's and ESA's instruments and missions.

In particular, we should note: (a) our involvement in the scientific preparation and proposal of MOSAIC, the multi-object spectrograph for the E-ELT (2024+), which was selected for Phase-A studies during this year; (b) our participation in the scientific working groups of ESA's future X-ray telescope Athena (2028+), namely in "The formation and growth of the earliest supermassive black holes" and in the "Understanding the build-up of supermassive black holes and galaxies" working groups, and our involvement in the mission's definition; (c) additionally, we have taken an active role in the definition of the science case for the FLARE (First Light And Reionization Explorer) telescope, to be proposed to ESA in 2016 as a medium-mission (M5). We have also continued our strong involvement in the international projects CALIFA, AzTEC and SELGIFS.

Also during 2015, the IA organised and hosted a major international conference on the high redshift universe: "Back at the Edge of the Universe: Latest results from the deepest astronomical surveys", which took place in Sintra between the 15th and the 19th of March 2015. This conference welcomed 132 participants from 18 countries, with 9 invited talks, 78 regular presentations and 40 poster presentations. The conference was a huge success (96% participant satisfaction score) and strengthened the international visibility of the Team. Also, in 2015, Team members have served in the Hubble Space Telescope, Atacama Large Millimetre Array and ESO time allocation committees.

In what follows we highlight some of the major scientific results of the Thematic Line in 2015:

1. A comprehensive and large area study of luminous Ly-alpha emitters resulted in the discovery of a galaxy (CR7) at a redshift of z=6.604, showing the strongest evidence yet for a PopIII-like stellar population, whose emission dominates the rest-frame UV and the nebular emission, with a more normal stellar population dominating the galaxy's mass (Figure 5). No other galaxy is known today with such a strong indication for the detection of the long-theorized first population of stars. This result has only been possible due to a combination of data from X-SHOOTER, SINFONI, and FORS2 on the Very Large Telescope, justifying its inclusion in ESO's all time top 10 Astronomical Discoveries. The follow-up study of this galaxy has been secured with a range of powerful telescopes, namely with the Atacama Large Millimetre Array and the Hubble Space Telescope – observations scheduled to take place in 2016.

2. The development of the upcoming generation of whole-sky radio surveys has continued during 2015. In particular, the work done under the Key Science Project "Radio AGN in the EoR" of the

Evolutionary Map of the Universe Survey (led by IA researchers), to be performed with the Australia SKA Pathfinder, has led to improving the methods that will allow the identification of radio powerful AGN in the Epoch of Reionization. The effect of the more energetic CMB photons at very high redshifts (above z~6) has been studied and showed to be small for very young and compact radio AGN. This implies that searches for very high redshift radio sources should focus on compact sources, rather than on the most extended radio structures so typical at lower redshifts.

3. In the framework of a systematic study of the effects of interactions on the star formation history and chemodynamical evolution of galaxies, IA researchers have carried out a detailed investigation of the interacting spiral galaxy NGC 5394 using Porto3D – an Integral Field Spectroscopy (IFS) processing pipeline developed in-house. Spatially resolved emission-line maps obtained by processing of CALIFA IFS data with Porto3D (Figure 6) revealed in NGC 5394 an intense nuclear starburst, the prodigious energy output from which has led to a large-scale shock ionisation of the gas component of the galaxy and a rapid gas outflow with a velocity exceeding 200 km/s.

4. Continuing a series of comprehensive studies on the co-evolution of super-massive black holes with their galaxy hosts, and the associated Active Galactic Nuclei (AGN) phenomenon, IA researchers have explored an enigmatic class of high-redshift AGN showing very faint optical emission lines despite their strong energy output in radio wavelengths. Extremely deep optical imaging and spectroscopy of one such radio galaxy (5C 7.245) with a 10m-class telescope has allowed IA researchers to detect faint optical and UV emission roughly 26 kpc away from the galaxy nucleus, along a similar position angle to that of its radio jet. This, in conjunction with a detailed modelling of observed emission-line ratios led IA researchers to conclude that in 5C 7.245 one is witnessing a short yet important phase in the assembly history of massive galaxies, during which powerful AGN-driven feedback results in evacuation of galactic nuclei from their cold gas component.

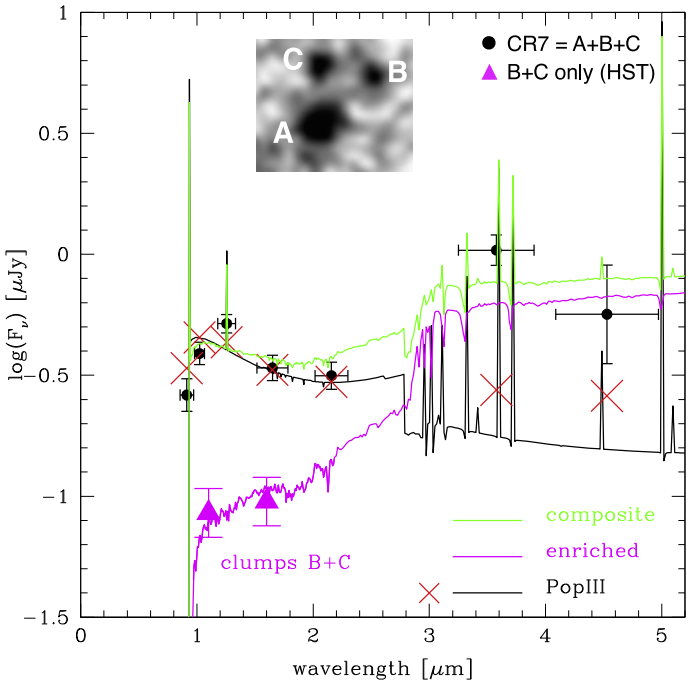

Figure 5 — The SED of z=6.6 “CR7” galaxy from observed optical (rest-frame FUV) to observed MIR (rest-frame optical) – black dots – plus HST photometry for clumps B+C – magenta triangles. The green line shows the predicted SED summing the two populations after rescaling the PopIII SED by a factor of 0.8. The study shows that a PopIII contribution is required to explain the SED of this galaxy, in particular the He II λ1640 line and the corresponding excess in the J band, while a normal stellar population or an AGN are simply not able to. CR7 shows the strongest evidence yet for the detection of the long-theorized first population of stars (from Sobral et al., 2015).

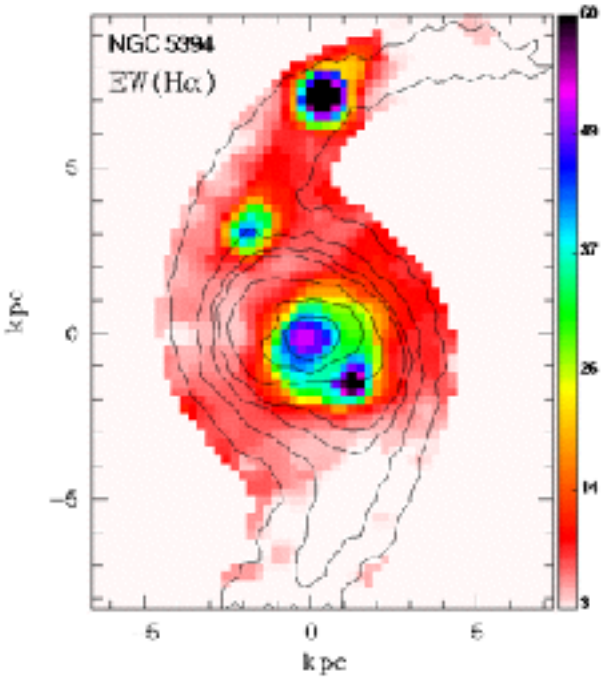

Figure 6 — Map of the H-alpha equivalent width, a measure of the relative intensity of ionised gas and stellar emission, for NGC 5394. The measurement was derived from CALIFA IFS data with the IA data processing pipeline Porto3D, with contours delineating the morphology of the stellar component. The map depicts regions with strong ongoing star-forming activity (EW(Ha) > 50 Å) in the nucleus and the northern spiral arm of the galaxy (adapted from Roche et al., 2015).

José Afonso
Thematic Line Leader

Report from the Thematic Line

Unveiling the dynamics of the Universe

In 2015 the Thematic Line on “Unveiling the dynamics of the Universe”, implementing its strategic scientific plan, focused its activities around ESPRESSO (ESO), EUCLID and eLISA (ESA) missions.

Relative to EUCLID, 2015 was a very active year for the IA members of the Euclid Survey group. It was the year of the Mission Preliminary Design Report (PDR), a milestone for the space mission. Together with the IA Instrumentation and Systems Group, we participated in the development of ECTile, the mission observation planning software developed at IA and performed viability studies of observing strategy scenarios to produce reference surveys (Figure 7). The IA also organised and hosted the face-to-face meeting of the Euclid Survey group (Lisbon, June 2015), and took charge of the organisation of the Euclid Consortium meeting 2016, the major international annual meeting of the Euclid collaboration (involving over 1000 researchers), to be hosted by the Portuguese participation in June 2016. Over the coming months, the IA mission survey group will be focused on the goals of the Conceptual Design Report, the next major mission milestone. With the feasibility of the primary goals having been demonstrated, we will focus on survey optimisation to maximise the scientific return of the mission.

We also plan to reinforce our presence in several science working groups of Euclid, namely through the new Work Package on Higher-order weak lensing statistics, created in the Euclid Weak Lensing Working Group and co-lead by a member of the Team, the cosmological simulations WP and the gravitational collapse and voids WP. There is also room for more active participation in the Theory group, even more relevant as we get closer to launch, as can be recognised by the active contribution to the review "Cosmology and Fundamental Physics with the Euclid Satellite" (to be submitted in 2016) and by the leadership of one WP there.

Concerning the eLisa mission, currently in the science preparation stage, several efforts have been made during 2015 towards securing the involvement of Thematic Line members. These involved, in particular, a characterisation of the cosmic microwave anisotropy of domain wall networks (which includes a detailed computation of the B-mode polarisation). This work may be viewed as an important stepping stone in the computation of the gravitational wave background generated by domain wall networks and may also be relevant towards the involvement in other future missions (such as COrE+). Moreover, we have built up on previous studies of the stochastic gravitational wave background generated by cosmic string and cosmic superstring networks, and improved the theoretical and numerical characterisation of this spectrum, a work that will continue through 2016. Topological defects are a relevant source in the frequency range of the gravitational wave background spectrum that may be probed with eLISA, and, therefore, understanding and accurately characterising their gravitational wave background is essential to this mission. Our work in this area may play a key role in increasing the involvement of the IA in the eLISA Consortium (but also on other projects such as SKA).

Finally, concerning ESPRESSO, its fundamental physics GTO was extensively prepared in 2015, including the selection of the target list and the development and validation of some of the necessary software tools. We are now preparing the instrument commissioning in mid-2017. The GTO data

collection and analysis is foreseen for the period 2018-20, and the publication of the first cosmology results is expected in 2020.
In addition to the above missions, the TL has been extremely active in the theoretical modeling of early and late-time cosmological scenarios and the study of their potential impact on the observational properties of the Universe. A few key scientific results obtained in 2015 include:

1. A novel Horndeski model was proposed in which gravity's vacuum is described by a de Sitter geometry. Under this assumption an adjustment mechanism was considered able to screen any value of the vacuum energy of the matter fields. The most general scalar-tensor cosmological models with second order equations of motion that have a fixed de Sitter critical point for any kind of material content, were further discussed, and cosmological evolutions were explored, such as outlined for the models in Figure 8. This analysis was awarded an honorable mention in the Gravity Research Foundation essay competition 2015.

2. The interior dynamics of accreting black holes in Eddington-inspired Born-Infeld gravity was investigated, and it was shown that accretion has an enormous impact on their inner structure. It was found that, unlike in general relativity, there is a minimum accretion rate bellow which the mass inflation instability, which drives the centre-of-mass streaming density to exponentially high values in an extremely short interval of time, does not occur. It was further shown that, above this threshold, mass inflation takes place inside black holes very much in the same way as in general relativity, but is brought to a halt at a maximum energy density which is, in general, much smaller than the fundamental energy density of the theory. It was conjectured that some of these results may be a common feature of modified gravity theories in which significant deviations from general relativity manifest themselves at very high densities.

3. Members of the TL used astrophysical and atomic clock tests of the stability of the fine-structure constant, together with Type Ia supernova and Hubble parameter data, to constrain the simplest class of dynamical dark energy models where the same degree of freedom is assumed to provide both the dark energy and the fine-structure variation. It was shown that current data tightly constrains the parameters, with the atomic clock tests dominating the constraints. The forthcoming generation of high-resolution ultra-stable spectrographs will enable significantly tighter constraints.

4. The phenomenology of f(R) gravity has been scrutinised motivated by the possibility to account for the self-accelerated cosmic expansion without invoking dark energy sources. Besides, this kind of modified gravity is capable of addressing the dynamics of several self-gravitating systems alternatively to the presence of dark matter. It has been established that both metric and Palatini versions of these theories have interesting features but also manifest severe and different downsides. A hybrid combination of theories, containing elements from both these two formalisms, turns out to be also very successful accounting for the observed phenomenology and is able to avoid some drawbacks of the original approaches. A review article was written by members of the TL, focusing on the formulation of this hybrid metric-Palatini approach and its main achievements in passing the local tests and in applications to astrophysical and cosmological scenarios, where it provides a unified approach to the problems of dark energy and dark matter.

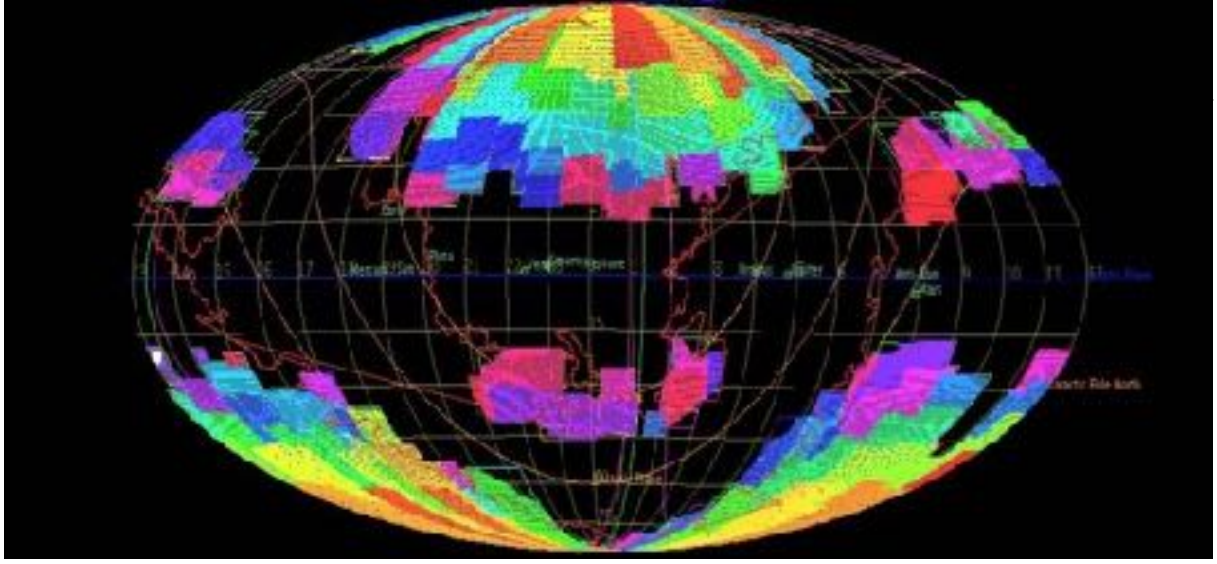

Figure 7 — The present Euclid reference survey fulfilling all mission specifications, shown in a Mollweide projection of the entire sky in ecliptic coordinates with the ecliptic North pole up. Jagged line is an iso-contour of extinction. Different colours indicate different years of the survey. This reference survey has been produced by the IA team, being one of the contributions of the Portuguese participation to EUCLID.

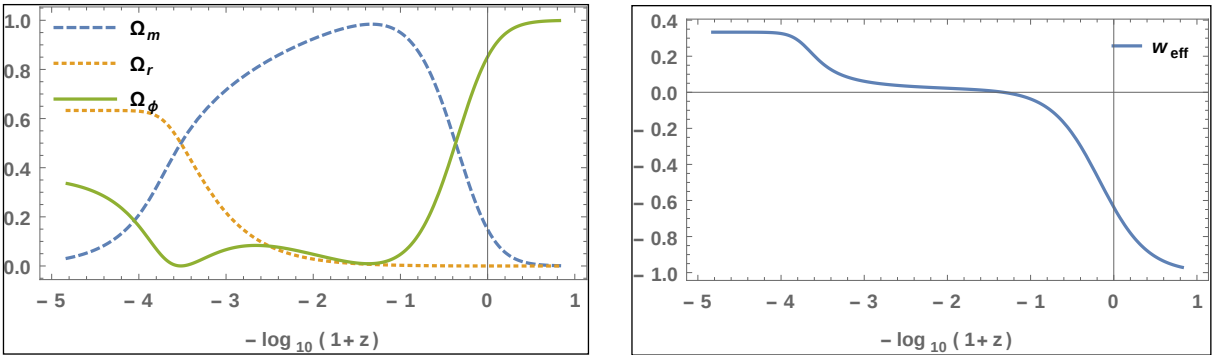

Figure 8 — Evolution of the abundances and of the effective equation of state parameter for a specific tripod model. The latter consists of the simplest and phenomenologically interesting model with three non-vanishing potentials. Even though the qualitative good features of a viable model are present, it is clear that the field contribution is too large at present to be compatible with current observational bounds. In order to avoid this problem, one needs to implement nonlinear terms (from Martin-Moruno & Nunes, 2015).

Francisco Lobo
Thematic Line Leader

Report from the Group

Instrumentation and Systems

The mission of the Instrumentation Group of IA is to participate in the scientific and technical development of Astronomical Instrumentation.

During 2015, the following instruments had engineering and implementation activities at IA: ESPRESSO, MOONS, EUCLID, e-LISA, PLATO, CHEOPS, SPIROU and ATHENA. Besides this running projects, IA Instrumentation Group was also involved in meetings for the preparation of consortiums or proposals for future projects like HIRES and NIRPS that will start the engineering phase next year.

Currently the Group participates in a considerable number of projects, involving all its human resources. The group is composed of 20 people. 11 researchers (with PhD) 6 engineers and 3 PhD students. Several researchers are also part of the other two scientific groups and PhD students are mainly focused on their thesis work, leading to a manpower availability to the running projects of around 10 FTE.

Below, a short summary is given for the 2015 activity in each of the running projects.

1. ESPRESSO: 2015 was the year where the MAIV phase (Manufacturing Assembly, integration and Test) started and was dedicated also to the integration of the Interfaces in the ESO-Paranal Observatory telescope and ground structures to support the Coudé Train Elements. This activity was performed by the IA instrumentation group (consuming a considerable number of resources) and comprised 4 missions in the Paranal observatory with 15 days each. The IA labs in Portugal were also prepared for the components tests that started to be received in the end of 2015 (both optical and mechanical).

2. MOONS: during 2015, the activity for the powerful Multi-Object Optical & Near-infrared Spectrograph for the VLT was focused on the conclusion of the instrument preliminary design in view of the Preliminary Design Review (PDR) that took place in the last weeks of October in the ESO headquarters in Garching (Germany). IA is responsible for the design of the Rotating Front End and the Instrument Field Corrector. This milestone was passed successfully and the last months of 2015 were used to prepare the beginning of the Detailed Design phase.

3. EUCLID: during 2015 the Mission Preliminary Design Report (PDR) took place. The development of ECTile, the mission observation planning software, took place, and the code was used to explore observing strategy scenarios and produce reference surveys. Contributions to the Mission Operation Concept Document (part B) technical report, delivered as part of the Mission-PDR data package, were made by the Group.

4. e-LISA: The e-Lisa Project is part of the preparatory works demanded by ESA in order to verify the feasibility and TRL level of specific sub-systems that shall be integrated on the LISA mission. This project in particular is associated to the development of the High Power Laser Head at the level of a EQM (Engineering Qualifying Model) and where specific aspects related to the stabilised laser

source, optical amplifier and optical bench shall be prototyped and tested against a very strict set of requirements. The consortium responsible for this project is composed by Lusospace (PT), IA (PT), LZH (DE) and CRSC (CZ). The consortium is led by Lusospace and the specific role of the Instrumentation Group of IA is the modelling of all active and passive optical components in terms of the control loops that shall be implemented to stabilise the laser source with regard to the Frequency noise and RIN (Relative Intensity Noise). The Instrumentation group is also responsible for the development of an ultra-low noise optical power meter that shall be used externally sample the Laser Head beam and feedback a control signal for the RIN suppression loop. During 2015, the PDR milestone was achieved, with the approval of all the subsystem concepts integrating the High Power Laser Head.

5. PLATO: The participation of the Instrumentation Group of IA in PLATO is associated to the development of a specific OGSE (Optical Ground Support Equipment) associated to the CCD position with respect to the Telescope during the environmental tests (ambient temperatures) and in the sequence of the Assembly and Integration phase. In fact, the integration phase requires the precise positioning of the CCD with regard to the telescope unit during integration, and the parameters of mounting (distance to the last optical surface, tip and tilt angles) must be stable during the tests, which include vibration, thermal and vacuum tests. The purpose of the OGSE being developed by the Instrumentation and Systems Group is to create an optical tool that allows the verification of this particular positioning before and after the tests. The OGSE is in fact a large beam white light optical collimator with different masks, including a Hartmann mask that allows measuring the precise positioning of the CCD at ambient temperatures. During 2015, several activities were performed during what is designated as phase B studies, in preparation of the PDR phase. These activities included several meeting of the MAIV team (Manufacture, Assembly Integration and Verification) in preparation of all the tasks that shall be performed during this project. A second activity being developed by the Group is at the level of data processing (image processing and modelling) with the evaluation of the PSF characteristics with regard to all the disturbances present onboard (e.g., aberrations, jitter, parasitic movements) and development of algorithms for onboard processing.

6. CHEOPS: During 2015, the IA team had a contribution for the mission science operation centre, more specifically for the CHEOPS data reduction pipeline where we are responsible for the calibration. This year we have started the implementation of the code and respective documentation for the pipeline software. The milestone “Ground Segment Critical Design Review” was achieved and passed successfully in October.

7. SPIROU: In 2015 period we were invested in the scientific preparation for this upcoming near infra-red, spectrograph and the manufacture and procurement of some of its hardware elements. In IA specifically, our contribution consisted of: (a) Participation in the scientific discussion for the definition of the SPIRou GTO (Guaranteed Time Observations). This involved a discussion of the relative importance of the different subprograms (such as blind search for planets and transit follow-up, among others) and their time allocation, as well of the preparatory studies required for the definition of the input catalogue; (b) The mechanical design of several hardware elements were thoroughly verified, and the parts were procured and produced by a local manufacturer. Final products were quality controlled, labeled and sent to France.

8. ATHENA: During 2015, following a range of scientific activities in support of the definition of Athena, we have increased our participation in the Athena Working Groups and Topical Panels. Contacts with industry have been explored in order to identify other contributions to the mission from Portugal, that could be the basis for a stronger and more wide-ranging national participation in the mission. Thermal insulation, ground support equipment and contributions to the WFI Instrument Science Centre are possibilities that are being considered in more detail.

Alexandre Cabral
Group Leader

Report from the Thematic Line

Space and Ground Systems and Technologies

As noted in the objectives of the thematic line of Space and Ground Systems and Technologies, there is a list of topics that represent prospective areas that must be addressed. These areas are set as a natural consequence of the built-in competences in different themes and also work as key enablers for the development of new capabilities in related fields.

These objectives can be considered broad in terms of coverage of the different fields of knowledge and the prioritisation of the activities in certain areas is set considering **a)** the development of capabilities spawning from running projects, b**)** exploitation of in-house expertise in new missions and instruments, as well as **c)** opening new themes of research associated to the general objectives of the Thematic Line, keeping the scientific goals of IA (in both instrumentation and space sciences) in mind.

Although the human resources in Instrumentation and Systems can still be considered reduced and as a limiting factor for the full coverage of the TL objectives, the various areas of research are being gradually addressed and eventually resulting in new funded activities or mission participations for the Instrumentation Group.

In this context, 2015 was rich in new initiatives that can be briefly presented as follows, here indexed to the general key objectives:

1. Development of Capabilities: In Optical Metrology, exploitation of modelocked lasers for distance metrology systems, resulting in a PhD dissertation to be presented during 2016. Development of a demonstrator of an angular metrology system based in optical cavities for measurement of angles with microrad accuracies. Also in this field, a protocol with INTA (Sp) was signed for the support of a joint effort in the development of Long Period Fiber Gratings (LPG) based sensors, dedicated to aerospace and astronomical missions. A proposal for funding was submitted by the spanish partner to a H2020 funding call, considering our participation as consultants and co-developers of LPG sensors. Also in this context, gamma radiation hardness tests of the LPGs developed in-house shall be performed during 2016.

2. New missions and Instruments: As a tool to increase the visibility and benefit from eventual joint H2020/ESA initiatives to promote new technologies and instruments for space, we participated in a GMV (Sp) project called IODisplay, funded by the European Community (http://www.iodisplay.eu/), which was aimed to identify and down-select a portfolio of In-Orbit Demonstration (IOD) missions achievable in the H2020 timeframe, through assessing the current European IOD needs and capabilities (in terms of technologies, carriers and launchers) and promote the increase of the technological maturity of the proposed solutions. In this context, we proposed two legacy solutions supported by Adaptive Technologies and Optical Metrology Themes of, respectively, a system for Optical focal plane stabilisation in astronomical imaging systems and a Long Distance Metrology System based on the Frequency Sweeping technique. Both techniques result directly from in-house development activities. In the same context of Optical Metrology, We have been expanding our activities in the stabilisation of Optical Sources for high accuracy long distance metrology systems, as a new area of development. This initiative has been materialised in a new funded ESA project associated to the development of the Laser Head for the LISA mission, where we were able to join a

consortia that is developing the Engineering model of the Laser Head, in a project lead by a partner from the Portuguese industry, along with Czech and German institutes. Further initiatives in this area are being pursued, in order to be able to capitalize knowledge and experience acquired from the present activity.

3. New themes of research: Also in the area of Multi Aperture Telescopes and as noted in the thematic line objectives, a particular area of research is being pursued as a PhD thesis, associated to the design of an instrument that will allow to evaluate the presence of correlation-induced spectral changes (Wolf effect) in the astronomical far-field spectra. In particular, we want to measure the spatial distribution of the spatial coherence of the nearest astronomical light source, the sun, at the granule-scale. At the present time, we are building a simulator that will allow us to propagate coherence functions of a given astronomical source to the image plane of an imaging system. This will drive the design of the instrument. Two particular models are also being implemented in order to allow distinguishing between the Wolf effect and the Doppler effect in the observed spectral shift.

Manuel Abreu
Thematic Line Leader

Report from the Group

Science Communication

During 2015, the Science Communication Group (SCG) at IA organised and participated in several public outreach initiatives which reached a total audience of about 40,000 people (direct interaction). The public activities organised by IA included planetarium presentations, monthly periodic outreach sessions, hands-on laboratories and special public events and talks. The SCG team has also participated in several initiatives promoted by other institutions, like Ciência Viva or ESEROPT, contributing with talks, observations of the night sky, planetarium sessions, workshops and short courses.

The SCG has been involved in the national promotion of two major international campaigns: "NameExoWorlds", by the International Astronomical Union (IAU), and "Desafio CHEOPS", by the European Space Agency (ESA). This last campaign consisted of a challenge for the submission of drawings that will be miniaturised and engraved on two plaques to be put on the CHEOPS satellite. More than 800 drawings were received from children in Portugal.

The team created, produced and translated several planetarium shows and movies which were presented at the Porto Planetarium, and also produced and made available to the media 22 press releases related to IA's science and outreach activities. This number of press releases resulted in 380 references in national news media with a total Automatic Advertisement Value (AAV) of more than 2,200,000 €. Some of the IA's news have been referred in international news media like BBC, Time, NY Times, National Geographic and New Scientist.

The science communication and education work at IA has been presented in conferences with contributions including six posters, six talks and one invited talk. The conferences include the European Planetary Science Congress (EPSC 2015) and the 3rd Science Communication Congress SciCom PT 2015. The team is responsible for publications like the book "AstroHomus" and several articles for monthly columns. Throughout 2015, the SCG has also conducted several training sessions for professors, science communication officers, students and general public.

IA has set a partnership with the Leiden Observatory/University of Leiden to produce Astronomy educational contents for educators. This project, with an international dimension, has the objective of producing Astronomy topic based presentations. Each presentation will have a guideline for educators and will be initially produced in portuguese and english. A future aim is to have these presentations translated to several languages. In the frame of the Astronomy literacy project, IA is also a partner in the production of a global Astronomy Literacy document.

In 2015 was created the "Portuguese Language Expertise Centre for the Office of Astronomy for Development (of the International Astronomical Union)" PLOAD. This is one of the new coordinating offices announced at the IAU General Assembly in Honolulu, Hawaii on 13th of August, 2015. It is hosted by Núcleo Interativo de Astronomia (NUCLIO), in collaboration with IA. The PLOAD's main objectives are to establish a strong collaborative network between Portuguese speaking countries and communities and empower these countries and communities with the necessary tools to build their own local support structures and strategy development in Astronomy and Space Sciences.

The strategy of the SCG for the 2016/2018 period envisions the production of Astronomy related educational and science communication contents for several specific target audiences, with a special focus on students and professors. This production will be strengthened by the involvement on the “Astronomy Literacy” international project. These contents, can exist by themselves or be connected to other activities like planetarium sessions, hands-on activities or exhibitions. The production of these materials will place IA as the main institution in Portugal in terms of the production of Astronomy related contents. IA’s participation in the coordination of PLOAD will allow the dissemination of its contents throughout the Portuguese language countries which engulfs 240 million people, giving to the IA’s Science Communication a stronger international dimension.

Figure 9 — Special IA-organised observation event on March 20 which took place simultaneously at the Planetário do Porto — Centro Ciência Viva (top) and at the Astronomical Observatory of Lisbon (bottom). This event had a combined attendance of more than 1000 people and a strong press coverage with the main Portuguese TV channels performing live coverage of the event.

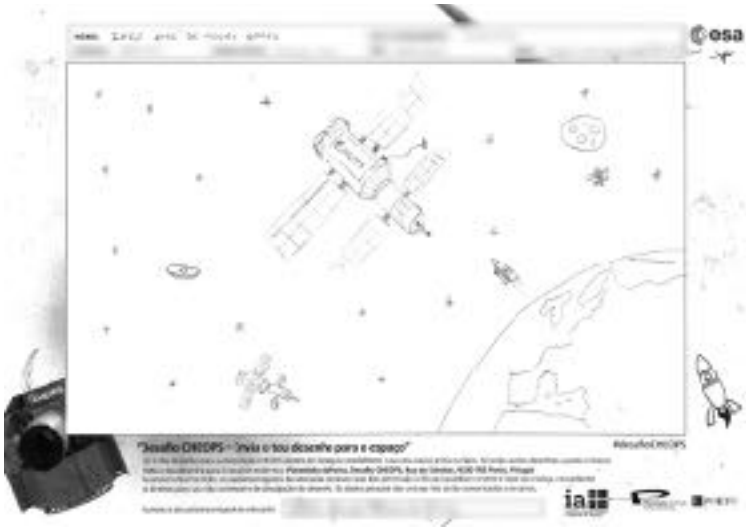

Figure 10 — One of the more than 800 drawings received in Portugal as a result of the initiative "Desafio CHEOPS” (CHEOPS Challenge). As part of the development of ESA’s CHEOPS observatory, European children with ages ranging from 8 to 14, were invited to submit drawings that could be selected to be sent onboard the satellite. In total, 3000 were selected, 88 of which from Portuguese children.

João Retrê and Daniel Folha
Group Leaders

Other reports

The Portuguese ALMA Centre of Expertise

IA hosts the Portuguese ALMA Centre of Expertise (PACE), which is part of the European ALMA Regional Centre (ARC) Network. The EU ARC is a coordinated network of institutes, managed by ESO, that provides scientific and technical support to the European astronomical community in their use of the Atacama Large Millimetre Array (ALMA). PACE, as a Centre of Expertise, has for main duties the enhancement of its own expertise in ALMA technical and scientific matters, support the Portuguese community in its use of ALMA, namely through face-to-face interaction, and support ESO in the ALMA data Quality Assurance stage 2 (QA2) activities.

During 2015, PACE continued to support an increasing interest of the portuguese astronomical community in ALMA. For Cycle 3 observations (deadline in April 2015), PACE supported the submission of 23 proposals with Portuguese participation (8 of which with a Portuguese PI), a substantial increase from the previous Cycle (11 proposals with a Portuguese participation, 3 of which with a Portuguese PI, submitted for Cycle 2 in 2014). Seven of the submitted Cycle-3 proposals were accepted for observations (A and B gradings), more than doubling the 3 proposals accepted for observations in 2014. It is worth noting that one of the A-grade accepted proposal had a Portuguese PI.

Also in 2015, PACE researchers participated in scientific and technical activities related to ALMA: QA2 Analysis sessions at ESO, Science Assessor at the ALMA Cycle 3 Review Panel, data analysis for the Weak Calibrator and Calibrator Cone Search projects, participation in the ESO ALMA Community Days at ESO and the ALMA all-hands (ARC internal) meeting in Smogen, Sweden. Additionally, PACE organised the Portuguese ALMA Community Days, in February 2015, in preparation for the ALMA Cycle 3 proposal submission period (23 registered participants from the Portuguese community).

Hugo Messias
Lead Scientist

Scientific Output

The list of the main indicators of Scientific Productivity of the IA in 2015 is given below.

Books
(http://www.iastro.pt/research/books.html)

1. Pedro Figueira, Susana Neves, Astro – Homus. Fot. Susana Neves. [Porto] : CAUP, 2015. ISBN 978-972-98162-1-5

Articles in Internacional Journals
(http://www.iastro.pt/research/papers.html)

1. K. N. Abazajian, K. Arnold, J. Austermann, B. A. Benson, C. Bischoff, J. J. Bock, J. R. Bond, J. Borrill, I. Buder, D. L. Burke, E. Calabrese, J. E. Carlstrom, C. S. Carvalho, C. L. Chang, H. C. Chiang, S. Church, A. Cooray, T. M. Crawford, B. P. Crill, K. S. Dawson, S. Das, M. J. Devlin, M. Dobbs, S. Dodelson, O. Doré, J. Dunkley, J. L. Feng, A. A. Fraisse, J. Gallicchio, S. B. Giddings, D. Green, N. W. Halverson, S. Hanany, D. Hanson, S. R. Hildebrandt, A. Hinks, R. Hlozek, G. Holder, W. L. Holzapfel, K. Honscheid, G. Horowitz, W. Hu, J. Hubmayr, K. Irwin, M. Jackson, W. C. Jones, R. Kallosh, 2015; Inflation physics from the cosmic microwave background and large scale structure; Astroparticle Physics, Volume 63, p. 55

2. K. N. Abazajian, K. Arnold, J. Austermann, B. A. Benson, C. Bischoff, J. J. Bock, J. R. Bond, J. Borrill, E. Calabrese, J. E. Carlstrom, C. S. Carvalho, C. L. Chang, H. C. Chiang, S. Church, A. Cooray, T. M. Crawford, K. S. Dawson, S. Das, M. J. Devlin, M. Dobbs, S. Dodelson, O. Doré, J. Dunkley, J. Errard, A. A. Fraisse, J. Gallicchio, N. W. Halverson, S. Hanany, S. R. Hildebrandt, A. Hinks, R. Hlozek, G. Holder, W. L. Holzapfel, K. Honscheid, W. Hu, 2015; Neutrino physics from the cosmic microwave background and large scale structure; Astroparticle Physics, Volume 63, p. 66

3. P. A. R. Ade, N. Aghanim, C. Armitage-Caplan, M. Arnaud, M. Ashdown, F. Atrio-Barandela, J. Aumont, H. Aussel, C. Baccigalupi, A. J. Banday, R. B. Barreiro, R. Barrena, M. Bartelmann, J.G. Bartlett, E. Battaner, K. Benabed, A. Benoît, A. Benoit-Levy, J.-P. Bernard, M. Bersanelli, P. Bielewicz, I. Bikmaev, J. Bobin, J. J. Bock, H. Böhringer, A. Bonaldi, J. R. Bond, J. Borrill, F. R. Bouchet, M. Bridges, M. Bucher, R. Burenin, C. Burigana, R. C. Butler, J.-F. Cardoso, P. Carvalho, A. Catalano, A. Challinor, A. Chamballu, R.-R. Chary, X. Chen, H. C. Chiang, L.-Y. Chiang, G. Chon, P. R. Christensen, E. Churazov, S. Church, D. L. Clements, S. Colombi, L. P. L. Colombo, B. Comis, F. Couchot, A. Coulais, B. P. Crill, A. Curto, F. Cuttaia, A. C. da Silva, H. Dahle, L. Danese, R. D. Davies, R. J. Davis, P. de Bernardis, A. de Rosa, G. de Zotti, J. Delabrouille, J.-M. Delouis, J. Démoclès, F.-X. Désert, C. Dickinson, J. M. Diego, K. Dolag, H. Dole, S. Donzelli, O. Doré, M. Douspis, X. Dupac, G. Efstathiou, T. A. Enβlin, H. K. Eriksen, F. Feroz, A. Ferragamo, F. Finelli, I. Flores-Cacho, O. Forni, M. Frailis, E. Franceschi, S. Fromenteau, S. Galeotta, K. Ganga, R. T. Génova-Santos, M. Giard, G. Giardino, M. Gilfanov, Y. Giraud-Héraud, J. González-Nuevo, K. Górski, K. Grainge, S. Gratton, A. Gregorio, N. E. Groeneboom, A. Gruppuso, F. K. Hansen, D. Hanson, D. Harrison, A. Hempel, S. Henrot-Versillé, C. Hernández-Monteagudo, D. Herranz, S. R. Hildebrandt, E. Hivon, M. Hobson, W. A. Holmes, A. Hornstrup, W. Hovest, K. M. Huffenberger, G. Hurier, N. Hurley-Walker, A. H. Jaffe, T. R. Jaffe, W. C. Jones, M. Juvela, E. Keihänen, R. Keskitalo, I. Khamitov, T. S. Kisner, R. Kneissl, J. Knoche, L. Knox, M. Kunz, H. Kurki-Suonio, G. Lagache, A. Lähteenmäki, J.-M. Lamarre, A. Lasenby, R. J. Laureijs, C. R. Lawrence, P. Leahy, R. Leonardi, J. León-Tavares, J. Lesgourgues, C. Li, A. Liddle, M. Liguori, P. B. Lilje, M. Linden-Vørnle, M. López-Caniego, P. M. Lubin, J. F. Macías-Pérez, C. J. MacTavish, B. Maffei, D. Maino, N. Mandolesi, M. Maris, D. J. Marshall, P. G. Martin, E. Martínez-González, S. Masi, M. Massardi, S. Matarrese, F. Matthai, P. Mazzotta, S. Mei, P. R. Meinhold, A. Melchiorri, J.-B. Melin, L. Mendes, A. Mennella, M. Migliaccio, K. Mikkelsen, S. Mitra, M.-A. Miville-Deschênes, A. Moneti, L. Montier, G. Morgante, D. Mortlock, D. Munshi, J. A. Murphy, P. Naselsky, A. Nastasi, F. Nati, P. Natoli, N. P. H. Nesvadba, C. B. Netterfield, H. U. Nørgaard-Nielsen, F. Noviello, D. Novikov, I. Novikov, I. J. O'Dwyer, M. Olamaie, S. Osborne, C. A. Oxborrow, F. Paci, L. Pagano, F. Pajot, D. Paoletti, F. Pasian, G. Patanchon, T. J. Pearson, O. Perdereau, L. Perotto, Y. Perrott, F. Perrotta, F. Piacentini, M. Piat, E. Pierpaoli, D. Pietrobon, S. Plaszczynski, E. Pointecouteau, G. Polenta, N. Ponthieu, L. Popa, T. Poutanen, G. W. Pratt, G. Prézeau, S. Prunet, J.-L. Puget, J. P. Rachen, W. T. Reach, R. Rebolo López, M. Reinecke, M. Remazeilles, C. Renault, S. Ricciardi, T. Riller, I. Ristorcelli, G. Rocha, C. Rosset, G. Roudier, M. Rowan-Robinson, J. A. Rubiño-Martin, C. Rumsey, B. Rusholme, M. Sandri, D. Santos, R. D. Saunders, G. Savini, M. P. Schammel, D. Scott, M. D. Seiffert, E. P. S. Shellard, T. W. Shimwell, L. Spencer, J.-L. Starck, V. Stolyarov, R. Stompor, A. Streblyanska, R. Sudiwala, R. Sunyaev, F. Sureau, D. Sutton, A.-S. Suur-Uski, J.-F. Sygnet, J. A. Tauber, D. Tavagnacco, L. Terenzi, L. Toffolatti, M. Tomasi, D. Tramonte, M. Tristram, M. Tucci, J. Tuovinen, M. Türler, G. Umana, L. Valenziano, J. Valiviita, B. Van Tent, L. Vibert, P. Vielva, F. Villa, N. Vittorio, L. A. Wade, B. D. Wandelt, M. White, S. D. M. White, D. Yvon, A. Zacchei, A. Zonca, 2015; Planck 2013 results. XXXII. The updated Planck catalogue of Sunyaev-Zeldovich sources; Astronomy and Astrophysics, Volume 581, p. A14

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5. V. Zh. Adibekyan, N. C. Santos, P. Figueira, C. Dorn, S. G. Sousa, E. Delgado Mena, G. Israelian, A. A. Hakobyan, C. Mordasini, 2015; From stellar to planetary composition: Galactic chemical evolution of Mg/Si mineralogical ratio; Astronomy and Astrophysics, Volume 581, p. L2

6. V. Zh. Adibekyan, L. Benamati, N. C. Santos, S. Alves, C. Lovis, S. Udry, G. Israelian, S. G. Sousa, M. Tsantaki, A. Mortier, A. Sozzetti, J. R. de Medeiros, 2015; Chemical

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32. I. Tereno, C. S. Carvalho, J. Dinis, R. Scaramella, J. Amiaux, C. Burigana, J.-C. Cuillandre, A. C. da Silva, A. de Rosa, E. Maiorano, M. Maris, D. M. Oliveira, P. Franzetti, B. Garilli, P. Gomez-Alvarez, M. Meneghetti, S. Wachter, and the Euclid collaboration; 2015; Euclid Space Mission: building the sky survey; Statistical Challenges in 21st Century Cosmology; (Eds.)Heavens, A. F.; Starck, J.-L.; Krone-Martins, A., Cambridge University Press, Volume 10, Page 379

33. K. Verma, J. P. S. Faria, H. M. Antia, S. Basu, A. Mazumdar, M. J. P. F. G. Monteiro, T. Appourchaux, W. J. Chaplin, R. A. García, T. S. Metcalfe; 2015; Asteroseismic estimate of helium abundance of 16 Cyg A,B; The Space Photometry Revolution; (Eds.)García, R.A.; Ballot, J., EPJ Web of Conferences, Volume 101, Page 06066

34. J. B. Whitmore, P. Molaro, M. Centurión, H. Rahmani, T. M. Evans, M. T. Murphy, I. I. Agafonova, P. Bonifacio, S. D'Odorico, S. A. Levshakov, S. Lopez, C. J. A. P. Martins, P. Petitjean, D. Reimers, R. Srianand, G. Vladilo, M. Wendt; 2015; Bounds on α change in towards HE 2217-2818; Varying Fundamental Constants and Dynamical Dark Energy; (Eds.)Martins, C. J. A. P.; Molaro, P., Memorie della Società Astronomica Italiana, Volume 85, Page 63

35. J. Zwart, J. Wall, A. Karim, C. Jackson, R. Norris, J. Condon, J. Afonso, M. Jarvis, F. Navarrete, I. Prandoni, E. Rigby, H.J.A. Rottgering, M. Santos, M. Sargent, N. Seymour, R. Taylor, T. Vernstrom and I. Heywood; 2015; Astronomy Below the Survey Threshold in the SKA Era; Proceedings of Advancing Astrophysics with the Square Kilometre Array (AASKA14). 9 -13 June, 2014. Giardini Naxos, Italy. Online at http://pos.sissa.it/cgi-bin/reader/conf.cgi?confid=215/172

Technical Reports

1. HIRES Blue Book; Iss. 1 (119 pages) ,15-01-2015
2. (e-LISA) High-power Laser Head for a Gravitational Wave Observatory Mission: TN3 – Design Definition File; Iss.B Rev.01 (210 pages) ,JUL-2015
3. MOONS Reliability Analysis; Iss. 1 (18 pages) , 13-08-2015
4. MOONS Rotating Front End Sub-system Design and Performance Report; Iss. 1 (63 pages) ,17-08-2015
5. MOONS Instrumentation Software Functional Specification; Iss. 1 (112 pages) ,17-08-2015

6. (EUCLID) Mission Operation Concept Document part B: Reference Survey; Iss. 6.8 (88 pages) ,11-09-2015

7. (CHEOPS) SOC Data Reduction Test Report; Iss.1 Rev. 0 (7 pages) ,13-11-2015

8. (CHEOPS) SOC Data Reduction Requirements Document; Iss.3 Rev.3 (26 pages) ,15-11-2015

9. (CHEOPS) WP10 (Data Reduction) Design Definition Document; Iss.2 Rev.3 (59 pages) ,15-11-2015

10. (CHEOPS) Data Reduction Test Specification; Iss.1 Rev. 0 (58 pages) ,19-11-2015

Communications – Internacional Meetings
(http://www.iastro.pt/research/communications.html)

1. V. Zh. Adibekyan; 2015; Heavy metal rules: The star-planet connection; The Origins of Planetary Systems: from the Current View to New Horizons, Tokyo, Japan

2. V. Zh. Adibekyan; 2015; Composition of rocky planets based on the host star chemistry: What observations are telling us?; Pathways towards habitable planets, Bern, Switzerland

3. V. Zh. Adibekyan, P. Figueira, N. C. Santos, S. G. Sousa, J. P. S. Faria, E. Delgado Mena, M. Oshagh, M. Tsantaki, A. A. Hakobyan, J. I. González Hernández, L. Suárez-Andrés, G. Israelian; 2015; Identifying the best elements for chemical tagging: The impact of the number of lines on measured scatter; Gaia-ESO Survey Third Science Meeting, Vilnius, Lithuania

4. A. S. P. Afonso; 2015; Structural Evolution of H-alpha selected galaxies from HiZELS; Back at the Edge of the Universe: latest results from the deepest astronomical surveys, Sintra, Portugal

5. S. Anton; 2015; Chasing off-center AGNs with Gaia; Gaia for AGN and Extragalatic Science, GAGNES Colloquium, Paris, France

6. P. P. Avelino; 2015; Interacting dark energy: the role of microscopic feedback in the dark sector; IberiCOS 2015 Xth Iberian Cosmology Meeting, Aranjuez, Spain

7. P. P. Avelino, L. Sousa; 2015; Observational Constraints on Varying-alpha Domain Walls; IberiCOS 2015 Xth Iberian Cosmology Meeting, Aranjuez, Spain

8. S. C. C. Barros; 2015; K2-19, The first K2 muti-planetary system showing TTVs; K2 SciCon, Santa Barbara, CA, U.S.A.

9. S. C. C. Barros; 2015; K2-19, The first K2 muti-planetary system showing TTVs; OHP2015: Twenty years of giant exoplanets, Saint-Michel-l'Observatoire, France

10. S. C. C. Barros; 2015; K2-19, The first K2 muti-planetary system showing TTVs; XXIX IAU General Assembly, Honolulu, HI, U.S.A.

11. I. P. Breda; 2015; Spatially resolved star formation history and kinematics of the metal-poor star-forming galaxy UGC 4722; ESTALLIDOS 2015: Census and Fundamental properties of Star-Forming galaxies, Granada, Spain

12. I. P. Breda, P. Papaderos, J. M. Gomes; 2015; A spatially resolved exploration of the nature and assembly history of pseudo-bulges in the CALIFA galaxy survey; Demographics and environment of AGN from multi-wavelength surveys, Chania, Crete

13. J. Brinchmann; 2015; Estimating gas masses and dust-to-gas ratios from optical spectroscopy at low and intermediate redshift; Understanding Nebular Emission in High-Redshift Galaxies, Pasadena, CA, U.S.A.

14. J. Brinchmann; 2015; Time-scales for galaxy evolution; Confronting Ideas on Galactic Metamorphoses, Braunwald, Switzerland

15. J. Brinchmann; 2015; Pixel-spectroscopy of the sky – galaxies seen through MUSE; Leiden Observatory Scienceday 2015, Leiden, The Netherlands

16. J. Brinchmann; 2015; MUSEWISE/Data management; MUSE GTO Busy Weeks, Goslar, Germany

17. L. A. Buchhave, L. Affer, A. S. Bonomo, D. Charbonneau, A. Collier Cameron, R. Cosentino, C. D. Dressing, X. Dumusque, P. Figueira, A. F. M. Fiorenzano, S. Gettel, A. Harutyunyan, R. D. Haywood, J. Johnson, D. W. Latham, E. Lopez, M. Lopez-Morales, C. Lovis, L. Malavolta, M. Mayor, G. Micela, A. Mortier, F. Motalebi, V. Nascimbeni, F. Pepe, G. Piotto, D. F. Phillips, D. Pollacco, D. Queloz, K. Rice, D. Sasselov, D. Ségransan, A. Sozzetti, S. Udry, A. Vanderburg, C. A. Watson; 2015; Precisely Measuring the Masses of Transiting Exoplanets with HARPS-N; XXIX IAU General Assembly, Honolulu, HI, U.S.A.

18. F. Buitrago; 2015; The outskirts of massive early-type galaxies at < z >= 0.65 in the Hubble Ultra Deep Field; European Week of Astronomy and Space Science (EWASS 2015), La Laguna, Spain

19. F. Buitrago; 2015; Are the most massive galaxies substantially different using the deepest surveys?; Getting a grip on galactic girths, Tokyo, Japan

20. F. Buitrago; 2015; Are the most massive galaxies substantially different using the deepest surveys?; The Spectral Energy Distribution of high redshift galaxies: lessons learned and open questions, Sexten, Italy

21. F. Buitrago; 2015; The low surface brightness haloes of massive galaxies in ultradeep imaging and their relative importance; DEX XI Workshop 2015, Edinburgh, U.K.

22. L. S. M. Cardoso, J. M. Gomes, P. Papaderos; 2015; Impact of a toy AGN model in stellar population properties with state-of-the-art spectral synthesis; ESTALLIDOS 2015: Census and Fundamental properties of Star-Forming galaxies, Granada, Spain

23. M. S. Cunha; 2015; Probing the cores of red giants; XXIX IAU General Assembly, Focus meeting 17, Honolulu, HI, U.S.A.

24. M. S. Cunha; 2015; Seismic diagnostics and stellar parameters output Synthesis of WG4 splinter session; PLATO Stellar Science kick-off meeting, Paris, France

25. M. S. Cunha; 2015; Asteroseismic data set and prospects; PICS Kick-off meeting: Understanding the nature of pulsations and the physics of the Ap stars, Grenoble, France

26. M. S. Cunha; 2015; Pulsation excitation mechanisms; PICS Kick-off meeting: Understanding the nature of pulsations and the physics of the Ap stars, Grenoble, France

27. M. S. Cunha, K. Perraut, I. M. Brandão, V. Antoci; 2015; 78 Vir: a hot roAp star candidate?; KASC8/TASC1 Workshop, Aarhus, Denmark

28. M. S. Cunha, D. Stello, P. P. Avelino, J. Christensen-Dalsgaard, R. H. D. Townsend; 2015; Period spacing variations in red giants: what impact they have on asteroseismic diagrams and what do they tell us about the stars' evolution state?; KASC8/TASC1 Workshop, Aarhus, Denmark

29. E. Delgado Mena; 2015; C/O ratios for planet hosts: comparing two oxygen indicators; Pathways towards habitable planets, Bern, Switzerland

30. C. D. Dressing, S. Gettel, D. Charbonneau, L. A. Buchhave, X. Dumusque, J. Vandenberg, A. S. Bonomo, L. Malavolta, F. Pepe, A. C. Cameron, D. W. Latham, S. Udry, G. W. Marcy, H. Isaacson, A. W. Howard, G. R. Davies, V. Silva Aguirre, H. Kjeldsen, T. R. Bedding, E. Lopez, R. Cosentino, P. Figueira, A. F. M. Fiorenzano, A. Harutyunyan, J. A. Johnson, M. Lopez-Morales, C. Lovis, M. Mayor, G. Micela, E. Molinari, F. Motalebi, D. F. Phillips, G. Piotto, D. Queloz, K. Rice, D. Sasselov, D. Ségransan, A. Sozzetti, C. A. Watson, S. Basu, T. L. Campante, J. Christensen-Dalsgaard, S. D. Kawaler, T. S. Metcalfe, R. Handberg, M. N. Lund, M. Lundkvist, D. Huber, W. J. Chaplin; 2015; The composition of Small Planets & Their Host Stars; Extreme Precision Radial Velocities, New Haven, CT, U.S.A.

31. J. P. S. Faria, N. C. Santos, P. Figueira; 2015; A radial-velocity search for planets around metal-poor stars; Extreme Precision Radial Velocities, New Haven, CT, U.S.A.

32. P. Figueira; 2015; Near infra-red Radial Velocity precision searches to mitigate Stellar Noise; Extreme Precision Radial Velocities, New Haven, CT, U.S.A.

33. P. Figueira; 2015; ESPRESSO Exoplanets GTO: Preparatory Studies & Target Selection; ESPRESSO 12th Progress Meeting, Genève, Swizerland

34. P. Figueira, J. P. S. Faria, V. Zh. Adibekyan, M. Oshagh, N. C. Santos; 2015; A pragmatic Bayesian perspective on correlation analysis: your next new tool for GES; Gaia-ESO Survey Third Science Meeting, Vilnius, Lithuania

35. J. M. Gomes; 2015; Spectral synthesis in the era of integral field spectroscopy; ESTALLIDOS 2015: Census and Fundamental properties of Star-Forming galaxies, Granada, Spain

36. J. M. Gomes; 2015; The remarkable heterogeneity of early-type galaxies from the CALIFA survey; CALIFA Busy Week VIII, Arcetri, Italy

37. J. M. Gomes, L. S. M. Cardoso, P. Papaderos; 2015; Rebetiko: A tool to quantify the impact of nebular and AGN emission on stellar mass determinations of galaxies; Demographics and environment of AGN from multi-wavelength surveys, Chania, Crete

38. C. Jiang, J. Christensen-Dalsgaard; 2015; Using Phase Shift to Characterize the Mixed Modes in Red Giant Stars; KASC8/TASC1 Workshop, Aarhus, Denmark

39. P. Lagos; 2015; IFU studies of low-metallicity star-forming galaxies; ESTALLIDOS 2015: Census and Fundamental properties of Star-Forming galaxies, Granada, Spain

40. A. C. O. Leite, C. J. A. P. Martins; 2015; The ESPRESSO Road to Fundamental Cosmology; International PhD School "F. Lucchin": Science and Technology with E-ELT, Erice, Italy

41. A. C. O. Leite, C. J. A. P. Martins; 2015; Mapping dark energy with fundamental couplings; 19th annual International Conference on Particle Physics and Cosmology (COSMO-15), Warsaw, Poland

42. A. C. O. Leite, C. J. A. P. Martins; 2015; Target selection criteria for the GTO of fine-structure constant variations; ESPRESSO 12th Progress Meeting, Genève, Swizerland

43. A. C. O. Leite, C. J. A. P. Martins; 2015; Optimization of ESPRESSO Fundamental Physics Tests; IberiCOS 2015 Xth Iberian Cosmology Meeting, Aranjuez, Spain

44. A. C. O. Leite, C. J. A. P. Martins; 2015; Optimization of ESPRESSO Fundamental Physics Tests; 50 Rencontres de Moriond, Gravitation: 100 years after GR, La Thuile, Italy

45. F. S. N. Lobo; 2015; From the Einstein-Rosen bridge and geons to the modern renaissance of traversable wormholes; The Time Machine Factory, Torino, Italy

46. F. S. N. Lobo; 2015; Novel stability approach of thin-shell gravastars; Fourteenth Marcel Grossmann Meeting – MG14, Roma, Italy

47. F. S. N. Lobo; 2015; A novel approach to thin-shell wormholes and applications; Fourteenth Marcel Grossmann Meeting – MG14, Roma, Italy

48. F. S. N. Lobo; 2015; From the Flamm-Einstein-Rosen bridge to the modern renaissance of traversable wormholes; Fourteenth Marcel Grossmann Meeting – MG14, Roma, Italy

49. F. S. N. Lobo; 2015; Irreversible matter creation processes through a nonminimal curvature-matter coupling; Fourteenth Marcel Grossmann Meeting – MG14, Roma, Italy

50. F. S. N. Lobo; 2015; Soliton models for thick branes; Fourteenth Marcel Grossmann Meeting – MG14, Roma, Italy

51. S. Lorenzoni; 2015; Lymanbreak galaxies in the epoch of reionization; Back at the edge of the Universe, Sintra, Portugal

52. S. Lorenzoni; 2015; Lymanbreak galaxies in the epoch of reionization; Science with MOS: towards the E-ELT Era, Cefalu, Italy

53. S. Lorenzoni; 2015; High redshift galaxies selection methods: SED fitting Vs. Lyman-break technique; Modelling galaxies through cosmic time, Cambridge, United Kingdom

54. S. Lorenzoni; 2015; Lyman-break galaxies in the Epoch of Reionization; Exploring the Universe with JWST, Leiden, Netherlands

55. P. Machado; 2015; Characterization of planetary atmospheres: from the Solar System to Exoplanets; Scientific Problems of Space Exploration – Mars and Beyond, Lisbon, Portugal

56. P. Machado, T. Widemann, D. Luz, J. Peralta; 2015; Space-based (VEx/VIRTIS) and ground-based (CFHT/ESPaDOnS) simultaneous observations of Venus' cloud tops wind circulation regimes. Consistency, complementarity and cross-validation of the Doppler

velocimetry and cloud tracking techniques; Ground and space observatories: a joint venture to planetary science, Santiago, Chile

57. P. Machado, D. Luz, J. M. Oliveira, J. Peralta; 2015; Cloud tracked winds at the lower cloud level using Venus' night side observations at 2.28 μm with TNG/NICS; European Planetary Science Congress 2015, Nantes, France

58. P. Machado, T. Widemann, J. Peralta, D. Luz; 2015; Ground and space based cloud-top wind velocities using CFHT/ESPaDOnS (Doppler velocimetry) and VEx/VIRTIS (cloud tracking) coordinated measurements; European Planetary Science Congress 2015, Nantes, France

59. L. Malavolta, P. Figueira; 2015; Impact of Sky Background on Precise Radial velocities; Extreme Precision Radial Velocities, New Haven, CT, U.S.A.

60. C. J. A. P. Martins; 2015; From Precision Spectroscopy to Fundamental Cosmology: Testing GR and the Equivalence Principle; 19th annual International Conference on Particle Physics and Cosmology (COSMO-15), Warsaw, Poland

61. C. J. A. P. Martins; 2015; Fundamental Cosmology in the E-ELT Era – Theoretical Motivation & Status Quo; Science and Technology with E-ELT, Erice, Italy

62. C. J. A. P. Martins; 2015; Fundamental Cosmology in the E-ELT Era – The Dark Side, The E-ELT & The Road Ahead; Science and Technology with E-ELT, Erice, Italy

63. C. J. A. P. Martins; 2015; The UVES Large Program for Testing Fundamental Physics: Latest Results and Constraints on Dark Energy; 50 Rencontres de Moriond, Gravitation: 100 years after GR, La Thuile, Italy

64. C. J. A. P. Martins; 2015; COrE+: Mapping our cosmic origins; 50 Rencontres de Moriond, Gravitation: 100 years after GR, La Thuile, Italy

65. C. J. A. P. Martins; 2015; The UVES Large Program for Testing Fundamental Physics: Status and Dark Side Constraints; IberiCOS 2015 Xth Iberian Cosmology Meeting, Aranjuez, Spain

66. J. H. C. Martins; 2015; Detecting the optical reflected spectrum of 51 Peg b; Exoplanet Focus Meeting for the Chilean Scientific Community, Santiago, Chile

67. J. H. C. Martins; 2015; Reflected light from exoplanets via high resolution spectroscopy; Astrobiology and Planetary Atmospheres, Santiago, Chile

68. J. H. C. Martins; 2015; Exoplanet Reflections: the light from 51 Peg b; OHP2015 : 20 Years of Giant Exoplanets, Observatoire Haute Provence, France, Saint-Michel-l'Observatoire, France

69. I. Matute; 2015; The Institute of Astrophysics and Space Sciences: pushing for a stronger PT involvement in Athena/WFI; WFI ATHENA, second proto-consortium meeting, Leicester, U.K.

70. H. Messias, S. Dye, N. M. Nagar, G. Orellana; 2015; Herschel-ATLAS and ALMA. HATLAS J142935.3-002836, a lensed major merger at redshift 1.027; ALMA/Herschel Archival Workshop 2015, Garching, Germany

71. H. Messias, J. M. Oliveira, B. Mobasher, J. Afonso; 2015; Hot-dust (690 K) Luminosity Density and Its Evolution in the Last 7.5 Gyr; Gas, Dust, and Star-Formation in Galaxies from the Local to Far Universe, Platanias, Greece

72. H. Messias, J. Afonso, M. Salvato, B. Mobasher, A. M. Hopkins; 2015; The infrared as a means to identify extremely obscured active galactic nuclei; Exploring the Hot and Energetic Universe: The first Scientific Conference dedicated to the Athena X-ray Observatory, Madrid, Spain

73. H. Messias, J. Afonso, M. Salvato, B. Mobasher, A. M. Hopkins; 2015; Identifying and characterizing the dusty AGN population with JWST; Exploring the Universe with JWST, Noordwijk, The Netherlands

74. J. P. Mimoso; 2015; The cosmological divide: local collapse versus global expansion; GR 100 Years, Lisbon

75. J. P. Mimoso; 2015; Conformal Time and Radiation; Xth Iberian Cosmology Meeting, Aranjuez, Spain

76. J. P. Mimoso, T. Harko, F. S. N. Lobo, D. Pavón; 2015; Particle production from a gravitational non-minimal curvature-matter coupling; ERE2015 – Spanish Relativity Meeting: Stepping into the second century, Palma de Mallorca, Spain

77. F. Motalebi, F. Pepe, A. C. Cameron, D. Charbonneau, D. W. Latham, E. Molinari, S. Udry, L. Affer, A. S. Bonomo, L. A. Buchhave, R. Cosentino, C. D. Dressing, X. Dumusque, P. Figueira, A. F. M. Fiorenzano, S. Gettel, A. Harutyunyan, R. D. Haywood, J. A. Johnson, E. Lopez, M. Lopez-Morales, C. Lovis, L. Malavolta, M. Mayor, G. Micela, A. Mortier, V. Nascimbeni, D. F. Phillips, G. Piotto, D. Pollacco, D. Queloz, K. Rice, D. Sasselov, D. Ségransan, A. Sozzetti, A. Vanderburg, C. A. Watson; 2015; The HARPS-N Rocky Planet Search; Extreme Precision Radial Velocities, New Haven, CT, U.S.A.

78. N. J. Nunes; 2015; Cosmology of the de Sitter Horndeski model; Fourteenth Marcel Grossmann Meeting – MG14, Roma, Italy

79. G. J. Olmo, D. Rubiera-Garcia, A. Sánchez; 2015; Resolution of black hole singularities in Palatini gravity; VIII Black Holes Workshop, Lisbon, Portugal

80. M. Oshagh; 2015; How stellar activity a ects exoplanet's parameters estimation and exoplanet's atmosphere characterization; Pathways 2015: Pathways Towards Habitable Planets, Bern, Switzerland

81. M. Oshagh; 2015; The physical link between simultaneous photometry and radial-velocity observations: Application to the CoRoT-7 system; CHEOPS Science Workshop #3, Madrid, Spain

82. C. Pappalardo; 2015; A panchromatic view of the Herschel Virgo Cluster Survey background sources; Terzo Workshop sull'Astronomia Millimetrica in Italia, Bologna, Italy

83. C. Pappalardo; 2015; Evolution of low FIR luminosities galaxies at $z < 1$; European Week of Astronomy and Space Science (EWASS 2015), La Laguna, Spain

84. C. Pappalardo; 2015; SED analysis of low FIR luminosity galaxies at $z < 1$; Cefalù 2015 Workshop: Science with MOS: towards the E-ELT Era, Cefalù, Italy

85.C. Pappalardo; 2015; SED analysis of low FIR luminosity galaxies at z < 1; Modelling galaxies through cosmic times, Cambridge, U.K.

86.J. Retrê, D. Luz, P. Machado, R. Agostinho; 2015; Involving the Public and Students in Planetary Science; European Planetary Science Congress 2015, Nantes, France

87.B. Rojas-Ayala; 2015; Digging out the little red gems and likely companions; A New Galactic Survey – Vatican VVV Workshop, Castel Gandolfo, Italy

88.B. Rojas-Ayala; 2015; Photometric Metallicities for Early M Dwarfs from Colour-Colour Diagrams; IAU Symposium 314: Young Stars & Planets Near the Sun, Atlanta, GA, U.S.A.

89.A. Rozas-Fernández; 2015; Spherical collapse in a Unified Dark Matter model with fast transition; Encuentros Relativistas Españoles 2015, Mallorca, Spain

90.D. Sáez Gómez; 2015; Issues in the reconstruction of dark energy models by using cosmography; Fourteenth Marcel Grossmann Meeting – MG14, Roma, Italy

91.I. Saltas; 2015; Reconstructing the dark sector of our universe; IberiCOS 2015 Xth Iberian Cosmology Meeting, Aranjuez, Spain

92.I. Saltas; 2015; Starobinsky, Higgs inflation and quantum gravity; 19th annual International Conference on Particle Physics and Cosmology (COSMO-15), Warsaw, Poland

93.I. Saltas; 2015; Bridging cosmology and astrophysics with gravitational waves; GR 100 years in Lisbon, Lisbon, Portugal

94.A. Santerne; 2015; Suivi spectroscopique: de Kepler à PLATO; Atelier PLATO France #2, Grenoble, France

95.A. Santerne; 2015; Towards the detection of nearby exoEarths; Pathways towards habitable planets, Bern, Switzerland

96.A. Santerne; 2015; The physical properties of giant exoplanets within 400 days; OHP2015: Twenty years of giant exoplanets, Saint-Michel-l'Observatoire, France

97.A. Santerne; 2015; The physical properties of giant exoplanets within 400 days; K2SciCon, Santa Barbara, CA, U.S.A.

98.A. Santerne; 2015; Collaborations pro/am en exoplanètes; Pro/Am-WETAL 2015, Giron, France

99.A. Santerne; 2015; The physical properties of giant exoplanets within 400 days; Extreme Solar System III, Waikoloa Village, HI, U.S.A.

100.A. R. G. Santos, M. S. Cunha, P. P. Avelino, T. L. Campante, W. J. Chaplin; 2015; Contribution from sunspots to the observed frequency shifts; SOLARNET III / HELAS VII / SpaceInn Conference "The Sun, the stars, and solar-stellar relations", Freiburg, Germany

101.A. R. G. Santos, M. S. Cunha, P. P. Avelino, T. L. Campante, W. J. Chaplin; 2015; Sunspot cycle reconstruction: an empirical tool; 2nd SOLARNET MEETING: Solar and stellar magnetic activity, Palermo, Italy

102.N. C. Santos, M. Oshagh; 2015; Exploring the impact of stellar activity on high-precision photometric transit observations; OHP2015: Twenty years of giant exoplanets, Saint-Michel-l'Observatoire, France

103.N. C. Santos; 2015; Measuring the reflected light spectrum of exoplanets at high resolution; Exoplanet Atmosphere Characterization with Space-Borne Optical Photometry, Noordwijk, The Netherlands

104.N. C. Santos; 2015; Stellar activity and exoplanets; Exoplanet Atmosphere Characterization with Space-Borne Optical Photometry, Noordwijk, The Netherlands

105.N. C. Santos; 2015; The quest for other Earths; Frontiers of space science and technology, Noordwijk, The Netherlands

106.N. C. Santos; 2015; Detection of Reflected light of exoplanets with high resolution spectroscopy; ESPRESSO 12th Progress Meeting, Genève, Swizerland

107.N. C. Santos; 2015; The interesting case of HD41248: planets or spots?; Extreme Precision Radial Velocities, New Haven, CT, U.S.A.

108.N. C. Santos; 2015; Reflected light spectroscopy of exoplanets: the case of 51 Peg b; CHEOPS Science Workshop #3, Madrid, Spain

109.I. Tereno; 2015; 100 years of gravitational lensing; GR 100 years in Lisbon, Lisbon, Portugal

110.I. Tereno, J. Dinis, C. S. Carvalho; 2015; Implementation Pipeline: ECSURV suite of tools; Euclid Consortium Meeting, Lausanne, Switzerland

111.M. Tsantaki; 2015; Stellar parameters in medium resolution; Gaia-ESO Survey Third Science Meeting, Vilnius, Lithuania

112.D. Wittman; 2015; Toward Self-Interaction Constraints With a New Sample of Merging Galaxy Clusters; Dark Matter – Cairo, Cairo, Egypt

Communications – National Meetings
(http://www.iastro.pt/research/communications.html)

1. A. S. P. Afonso; 2015; Saving mankind by looking for wandering stars; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

2. A. S. P. Afonso; 2015; The little or no evolution in Milky Way-like galaxies up to z=2.23; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

3. A. S. P. Afonso; 2015; The perks of being a local galaxy; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

4. A. S. P. Afonso; 2015; Standing on the shoulders of giants; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

5. S. Anton; 2015; SKA@pt; Innovation Opportunities and Portuguese Participation in the SKA, Lisboa, Portugal

6. I. P. Breda; 2015; A spatially resolved exploration of the nature and assembly history of pseudo-bulges in the CALIFA galaxy survey; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

7. F. Buitrago; 2015; Scientific volunteering in East Africa: Opportunities in Astronomy; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

8. A. Cabral; 2015; A Metrologia no Laboratório de Óptica, Lasers e Sistemas da FCUL: do ensino às aplicações espaciais; Simpósio de Metrologia 2015, Porto, Portugal

9. A. Cabral; 2015; Grandes telescópios, espectrógrafos e a luz na busca de planetas extra solares; 5º Encontro de Professores de Física e Química, Almada, Portugal

10. P. Crawford; 2015; The hole argument and the genesis of general relativity; GR 100 years in Lisbon, Lisbon, Portugal

11. J. M. Gomes; 2015; Extended nebular emission and gas excitation mechanisms in early-type galaxies from the CALIFA galaxy survey; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

12. A. C. O. Leite, C. J. A. P. Martins; 2015; Optimization of ESPRESSO Fundamental Physics Tests; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

13. A. C. O. Leite, C. J. A. P. Martins; 2015; Optimization of ESPRESSO Fundamental Physics Tests; IJUP 2015 – Encontro de Investigação Jovem da Universidade do Porto, Porto, Portugal

14. F. S. N. Lobo; 2015; Beyond Einstein's General Relativity: 100 years-on; GR 100 years in Lisbon, Lisbon, Portugal

15. F. S. N. Lobo; 2015; Beyond Einstein's General Relativity: 100 years-on; 100 anos de Relatividade Geral, Porto, Portugal

16. F. S. N. Lobo; 2015; Gravitational induced particle production through a nonminimal curvature-matter coupling; Primeiro Encontro de Cosmologia e Gravitação à Beira da Serra da Estrela, Covilhã, Portugal

17. S. Lorenzoni; 2015; Lyman-break galaxies in the Epoch of Reionization; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

18. C. J. A. P. Martins; 2015; Was Einstein Right? Testing GR and the Equivalence Principle, 100 years on; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

19. H. Messias, N. M. Nagar, F. E. Bauer, D. Elbaz, J. Afonso; 2015; The Universe through lenses; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

20. H. Messias, J. Afonso, M. Salvato, B. Mobasher, A. M. Hopkins; 2015; Identifying and characterizing the dusty AGN population with JWST; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

21. J. P. Mimoso; 2015; Conformal Time and Radiation; UBI, Covilhã

22. J. P. Mimoso, F. S. N. Lobo, S. Capozziello; 2015; Generalized energy conditions in Extended Gravity re-examined: the modified Gauss-Bonnet theory case study"; Encontro Nacional de Astronomia e Astrofísica, XXV ENAA, IST, Lisboa

23. N. J. Nunes; 2015; Cosmology of the de Sitter Horndeski models; GR 100 years in Lisbon, Lisbon, Portugal

24. N. J. Nunes; 2015; Cosmology of the de Sitter Horndeski models; 100 anos de Relatividade Geral, Porto, Portugal

25. N. J. Nunes; 2015; Cosmology of the de Sitter Horndeski model; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

26. C. Pappalardo; 2015; Physical properties of a population of low FIR luminosity galaxies at $z < 1$; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

27. N. Roche; 2015; MUSE 3D Spectroscopy and Kinematics of the Interacting Radio Galaxy PKS 1934-63; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

28. I. Saltas; 2015; Unimodular gravity and the cosmological constant; Primeiro Encontro de Cosmologia e Gravitação à Beira da Serra da Estrela, Covilhã, Portugal

29. T. C. Scott; 2015; Evolution of late-type galaxies in galaxy clusters: cold gas; XXV Encontro Nacional de Astronomia e Astrofísica, Lisboa, Portugal

Organisation of Seminars
(http://www.iastro.pt/research/seminars.html)

1. Östlin, G.; 2015; How Lyman alpha radiation gets out of galaxies (or not)

2. Adibekyan, V. Zh.; 2015; Identifying the best iron-peak and alpha-capture elements for chemical tagging: The impact of the number of lines on measured scatter

3. Afonso, A. S. P.; 2015; Structural Evolution of the Milky Way-like galaxies over the last 11 Gyrs

4. Amendola, L.; 2015; Testing gravity at high and small redshift

5. Arroja, F.; 2015; Planck constraints on primordial non-Gaussianity and implications for inflation

6. Asmus, D.; 2015; VLT mid-infrared observations and active galactic nuclei

7. Beltrán Jiménez, J.; 2015; Piercing the Vainshtein screen

8. Bonfils, X.; 2015; ExTrA : Exoplanets in Transit and their Atmospheres

9. Bouwens, R.; 2015; Star-Forming Galaxies in the First Two Billion Years of the Universe

10. Buitrago, F.; 2015; Astronomer's guide to massive galaxies: I don't care or I love it?

11. Cardoso, A.; 2015; The real nature of quantum particles

12. Carloni, S.; 2015; A new approach to the analysis of the phase space of f(R)-gravity

13. Cembranos, J. A. R.; 2015; f(R) phenomenology

14. Courcol, B.; 2015; SOPHIE at the era of low mass planets

15. de la Cruz Dombriz, A.; 2015; Consistency and generalised tests in extended theories of gravity

16. Eggl, S.; 2015; NEOShield: Near-Earth Asteroid Deflection from a European perspective

17. Ferreira, J.; 2015; Emission Line Galaxy Populations in CANDELS at 0.1<z<5 using Panchromatic Broadband Photometry

18. Figueira, P.; 2015; Twenty years of discoveries in Exoplanets

19. Flachi, A.; 2015; Chiral Gap Effect in Curved Space

20. Garcia Muñoz, A.; 2015; Mapping clouds of exoplanets

21. Herdeiro, C. A. R.; 2015; Can a black hole have hair?

22. Jacobs, C.; 2015; Celestial Reference Frames based on AGN: Issues in tying radio to optical frames

23. Jiang, C.; 2015; Listening to the music of red giant stars using Asteroseismology

24. Kholtygin, A.; 2015; Massive stars and their remnants

25. Khostovan, A. A.; 2015; Evolution of the Hb+[OIII] and [OII] luminosity functions and the [OII] star-formation history of the Universe up to z~5

26. Krone-Martins, A.; 2015; Early 21st Century Astrometry: Taking the measure of the Universe

27. López San Juan, C.; 2015; J-PAS : Mapping the Universe with 56 narrow-band optical filters

28. Le Delliou, M.; 2015; Method of detection of Dark Energy-Dark Matter interaction in Non-virialised clusters

29. Lillo Box, J.; 2015; Planets at twilight: implications on their formation and evolution

30. Lindgren, S. M. B.; 2015; High-resolution studies of M dwarfs

31. Lorenzoni, S.; 2015; The rapid evolution of galaxies in the first billion years of the Universe

32. Martìn-Benito, M.; 2015; Gauge-invariant perturbations in hybrid Loop Quantum Cosmology

33. Martins, C. J. A. P.; 2015; The Dark Side of the Universe – A Status Report

34. Martins, C. J. A. P.; 2015; Was Einstein right? Testing GR and the Equivalence Principle, 100 years on

35. Martins, Z.; 2015; Astrobiology: origin and the detection of life in our solar system

36. Matthee, J.; 2015; Galaxy formation in the first 3 Gyrs with wide field Lyman-alpha surveys

37. Matute, I.; 2015; AGNs in the ALHAMBRA survey and across cosmic time

38. Messias, H.; 2015; Science with ALMA – getting ready for Cycle3

39. Messias, H.; 2015; Setting new cosmology constraints with ALMA

40. Minamitsuji, M.; 2015; Disformal transformation of cosmological perturbations

41. Moitinho de Almeida, A.; 2015; Visual Exploration of Big (Astronomical) Data

42. Pace, G.; 2015; What is ULME and why it will help us find exo-planets

43. Palmeirim, P. M.; 2015; Understanding star formation along interstellar filaments: prestellar core properties from HERSCHEL data

44. Pappalardo, C.; 2015; Stardust Memories (sorry Woody)

45. Pappalardo, C.; 2015; Evolution of low luminosity FIR sources at z < 0.5

46. Passegger, V.; 2015; Characterization of star-planet systems

47. Röttgering, H. J. A.; 2015; The formation and evolution of galaxy clusters and proto-clusters: Recent results from optical, IR, X-ray and LOFAR radio studies

48. Rubiera-Garcia, D.; 2015; Meaning, implications and resolution of space-time singularities in Palatini gravity

49. Russo, P.; 2015; Global Programmes in Astronomy Education and Public Outreach

50. Sáez Gómez, D.; 2015; Modifying General Relativity: is it worth it?

51. Sáez Gómez, D.; 2015; Testing the Standard cosmological model with model-independent parametrizations: some issues

52. Sahlmann, J.; 2015; Exoplanet science with astrometry from ground and space

53. Saltas, I.; 2015; A different view on the dark sector of the Universe

54. Sawicki, I.; 2015; Testing Gravity at Cosmological Scales

55. Schellenberger, G.; 2015; Cosmological constraints and X-ray instrumental calibration impacts from a local sample of galaxy clusters

56. Sobral, D.; 2015; Out of this world: the first 2 Gyrs of cosmic time with the widest Lyman-alpha surveys

57. Sravan Kumar, K.; 2015; Cosmological attractor models

58. Stroe, A.; 2015; When Galaxy Clusters Collide: the impact of merger shocks on cluster gas and galaxy evolution

59. Suárez, J.-C.; 2015; Connectivity test reveals for the first time non-analytic functions underlying lightcurves of pulsating stars

60. Trujillo, I.; 2015; Build-up of stellar halos

61. Tsiopa, O.; 2015; Pulkovo observatory

62. Vilella Rojo, G; 2015; Galaxy evolution studies with the J-PLUS survey

63. Wittman, D.; 2015; Merging Clusters as Dark Matter Probes

Organisation of Conferences
(http://www.iastro.pt/research/conferences.html)

1. Portuguese ALMA National Community Day; 24 February 2015; Lisboa, Portugal

2. PLATO2.0: Coordination of the Stellar-Properties work packages; 12 to 13 March 2015; Porto, Portugal

3. DEEP15: Back at the Edge of the Universe; 15 to 19 March 2015; Sintra, Portugal

4. Erasmus+: European Astrobiology Campus; 20 to 21 March 2015; Porto, Portugal

5. Habitability in the Universe: From the Early Earth to Exoplanets; 22 to 27 March 2015; Porto, Portugal

6. EUCLID ECSURV meeting: Preparation of the Euclid Reference Survey to be included in the Preliminary Design Review Documentation delivered to ESA in October; 27 to 29 May 2015; Lisbon, Portugal

7. 2-DEMOC 2015: Exoplanet Group Internal Meeting; 23 to 24 July 2015; Vila Nova de Foz Côa, Portugal

8. 2nd SpaceInn Technical Review; 6 October 2015; Porto, Portugal

9. ESPRESSO Day @ IA; 3 November 2015; Porto, Portugal

10. IA-ON2; Institute of Astrophysics and Space Sciences 2nd internal workshop; 12 to 13 November 2015; Lisbon, Portugal

PhD Thesis completed
(under the supervision of IA researchers)

1. Exoplanets: GAIA and the Importance of Spectroscopic Follow-up, Lisa Benamati, June 2015, Doctoral Degree in Astronomy, University of Porto. Advisors: Nuno C. Santos (IA), Alessandro Sozzetti (INAF Torino).

2. Multiwavelength High Precision Radial Velocities: Pushing Precision and Characterizing Astrophysical Sources of Noise, Diana da Cunha, April 2015, Doctoral Degree in Astronomy, University of Porto. Advisors: Pedro R. L. Figueira (IA), Nuno M. C. Santos (IA).

3. Deriving Precise Parameters for Moderate and Fast Rotating Stars, Maria Tsantaki, January 2015, Doctoral Degree in Astronomy, University of Porto. Advisors: Nuno C. Santos (IA), Sérgio G. Sousa (IA).

MSc Thesis completed
(under the supervision of IA researchers)

1. Parametric stellar convection models, T. B. Silva, 2015, Masters Degree in Astronomy, University of Porto. Advisors: M. J. P. F. G. Monteiro (IA), M. Bazot (IA).

2. Diagnostic line profiles and modelling of the accretion and outflow regions around YSOs, R. M. G. Albuquerque, 2015, Masters Degree in Astronomy, University of Porto. Advisors: J. J. G. Lima (IA), J. F. Gameiro (IA).

3. Optimization of ESPRESSO Fundamental Physical Tests, A. C. O. Leite, 2015, Masters Degree in Astronomy, University of Porto. Advisors: C. J. A. P. Martins.

4. Probing the Formation of Galaxies using Lyman-alpha Emission and Absorption, S. G. Morais, 2015, Masters Degree in Astronomy, University of Porto. Advisors: A. Humphrey, P. Lagos.

5. Using the fine structure constant to probe Dark Energy, D. Corre, 2015, Masters Degree in Astronomy, University of Porto. Advisors: C. J. A. P. Martins.

BSc Traineeships/Projects completed
(under the supervision of IA researchers)

1. Mission Euclid: modelling in Class and Montephyton, Carolina Rodrigues, June 2015, Physics Degree - Project in Astronomy and Astrophysics, University of Lisbon. Advisors: Ismael Tereno (IA).

2. 3D Mapping of a z~1 superstructure, Guilherme Teixeira, June 2015, Physics Degree - Project in Astronomy and Astrophysics, University of Lisbon. Advisors: David Sobral (IA).

3. Search for chemical components in the spectrum of Uranus with ALMA, João Ferreira, June 2015, Physics Degree - Project in Astronomy and Astrophysics, University of Lisbon. Advisors: Hugo Messias (IA).

4. Search for chemical components in the spectrum of Mars with ALMA, José Silva, June 2015, Physics Degree - Project in Astronomy and Astrophysics, University of Lisbon. Advisors: Hugo Messias (IA).

5. The angular variation of cosmological parameters as a measure of the non-inhomogeneity of the Universe, Katrine Marques, June 2015, Physics Degree - Project in Astronomy and Astrophysics, University of Lisbon. Advisors: C. Sofia Carvalho (IA).

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