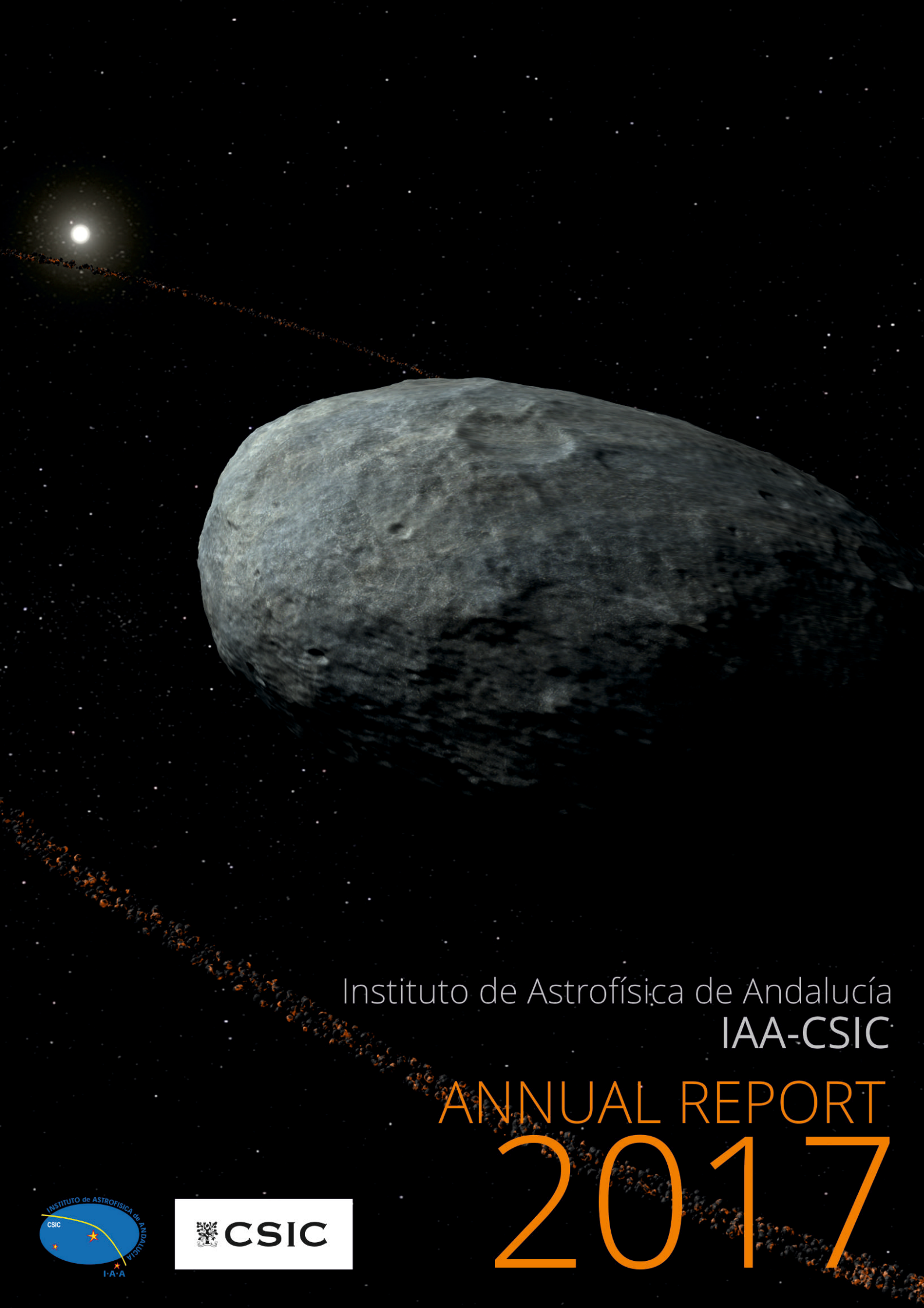

Instituto de Astrofísica de Andalucía
IAA-CSIC
ANNUAL REPORT
2017

Cover Picture

HAUMEA, artistic view. A study, led by IAA astronomers, revealed the presence of a ring around the dwarf planet Haumea, the first found in a dwarf planet and the first in a transneptunian object. Published in *Nature*, this research was awarded with the “Premio Vanguardia de la Ciencia”. This is the first time that a research in astrophysics wins this award (first ranked).

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Director's Foreword

2017 was an excellent year for the Science and Technology at the IAA. The IAA scientists participated in 297 publications with peer review, with 12% of our papers published in journal of the first decile and 86% in the first quartile. We lead more than the 24% of these publications. According to the scientific production, IAA was ranked the first center of astrophysics of the CSIC and second of Spain (based on Nature FC index). In these papers we reported a number of important discoveries with the key participation of the IAA astronomers. All of them also had a very important presence in the Media. It was the case of the discovery of the ring orbiting around the dwarf planet Haumea, the detection of dust around the closest star to the Solar System Proxima Centauri and the detection of the electromagnetic counterpart of the gravitational wave event GW170817.

We led the observations of **Haumea**, the most peculiar minor planet with an extremely elongated shape and a rapid rotation, through a stellar occultation. They permitted to establish the existence of a ring that lies on the equatorial plane of the dwarf planet, whose origin is not clear: it may have originated in a collision with another object, or in the dispersal of surface material. Thanks to a wide collaboration between the different IAA research departments and through the analysis of ALMA data, we inferred the presence of dust debris disks around **Proxima Centauri**. This discovery is important because, following the discovery of the terrestrial planet Proxima b, it is the first indication of the presence of an elaborate planetary system, and not just a single planet. Finally, researchers from the IAA took part in different observational campaigns of the electromagnetic counterpart of GW170817, covering practically all the wavelengths and using the most advanced astronomical facilities. It permitted for the first time, to observe an object in light and gravitational waves: a merging of two neutron stars that inaugurated a new era in the observation of the universe. Referring to the studies of galaxy evolution, the Calar Alto Legacy Integral Field Area Survey (**CALIFA**), led by IAA, became a prime reference. As of today, CALIFA has produced 160 papers and over 30,000 downloads of data have been performed. During 2017, many other achievements were obtained, which are described along the pages of this report.

2017 was also very important for the IAA Instrumental Development Unit: in May 2017, the **SO/PHI Flight Model Unit** was delivered and integrated with the optical unit, and is already installed in the Solar Orbiter Platform; in June, **PLATO** was officially adopted in the ESA Science Programme; the **NOMAD/EXOMARS** Science checkout and second calibration was already completed; the Power Supply of the laser altimeter (**GALA**) and the Power Supply and mechanism control electronics of the **JANUS** camera on board the **ESA JUICE** mission were ready for delivery to the consortium. The instrument **CARMENES** in CAHA was upgraded in the NIR channels internal precision, reaching an rms as good as 2-4 m/s in the determination of the radial velocities, confirmed through a comprehensive high-cadence follow-up of ***Luytens* star**. It should be mentioned that in 2017, **CARMENES found its first exoplanet**. It was also the year for the **first light for MEGARA**, the new instrument on the Gran Telescopio Canarias (GTC), in which our institute participates. MEGARA will allow the study of the chemical composition and dynamics of galaxies at different times in the history of the universe.

In July 2017 we submitted the **New Plan of Action** of the IAA for the period 2018-2021 to the CSIC. The main goal of the IAA for the PA 2018-2021 is the consolidation of its leading role in Spanish Astrophysics and to strengthen its international position, reinforcing its status of a reference center in astrophysical research. We proposed to keep optimizing the balance between observational researchers, theoreticians and engineers to define new science projects and instrumentation, maximizing their scientific return. Among other actions and in order to reach these objectives, the IAA planned to promote outstanding science and international exchange and collaborations. The IAA aimed to promote the participation and leadership

of IAA scientists and engineers in current and future large international challenges, such as world-wide scientific projects, space science missions, and world-class facilities and their instrumentation. Moreover, as the responsible CSIC center for the **Calar Alto Observatory (CAHA),** the new agreement for its operation beyond 2019 is expected to place the IAA in a prevalent leadership position.

The IAA kept committed with the Square Kilometre Array (SKA) project. SKA is, at the time of writing, in the final stages of design, and its construction is expected to start in 2019. The **IAA coordinates the scientific and technological participation of Spain in the SKA**, providing support to the scientific community as well as to technological groups from academia and industry, in close collaboration with CDTI. As a result, the negotiation for the Spanish accession to the SKA Organization between the Secretary of State for Research, Development and Innovation (MINECO) and the SKA Director General is on-going after approval by the SKA Board during its November 2017 meeting. In July 2017, the Excellence network for the scientific and technological participation of Spain in the SKA (**Red-SKA**) project was approved under the leadership of IAA-CSIC.

It was also the year in which the new **"Comisión de Igualdad del IAA"** was created with the Commitment to Establishing Gender Equality at the IAA. Other units also consolidated its important role in the institute like the **IAA International Project Office**, the **Sky Quality Technical Office, and the Unit of Scientific Culture.** The global outreach activities within the H2020 Program UPWARDS, including "The Martian Puzzle" exhibition, the app "Let's go to Mars", and **a signature documentary film about key questions on Mars ("UPWARDS, the Documentary"),** deserve a special mention.

This report was prepared with the aim of showing the reader a panorama of the scientific and technological activity developed at the IAA in 2017. This report benefited from the new Management Information System (IRIA) developed at the IAA. It centralizes the diverse information issued from the Administration into a structured inter-related system that eases the treatment of the data, and enables the flexible generation of reports and plots.

Prof. Antxon Alberdi

Director of the Instituto de Astrofísica de Andalucía

Spanish National Research Council (CSIC)

April 2018

RESEARCH ACTIVITY

The Instituto de Astrofísica de Andalucía (IAA) is the largest and most productive Astronomy center of the Consejo Superior de Investigaciones Científicas (CSIC). The research activity of IAA is carried out in the framework of four different departments:

1. Extragalactic Astronomy

2. Radioastronomy and Galactic Structure

3. Solar System

4. Stellar Physics

This research is supported by a number of research groups devoted to different astrophysical topics. The Instrumental and Technological Development Unit (UDIT), the Computer Center (CC), and the Observatory of Sierra Nevada (OSN) provide technical and scientific support to each research line.

The description of the research activity and highlights of our research groups, units and observatory during 2016 are next presented.

Additional information on the Observatory of Calar Alto is included in this report, since the IAA is the CSIC reference center for this international astronomical observatory.

This report includes the activities of the following research lines:

- AGN jets
- ARAE
- Cosmology and Astroparticle Physics
- Evolution of Galaxies
- HETH
- Low-mass stars and exoplanets
- Physics of the Interstellar Medium
- Planets and Minor Bodies
- Solar Physics
- Stellar Systems
- Stellar Variability
- Terrestrial planets' atmospheres
- Theoretical gravitation and cosmology

AGN JETS

Overview

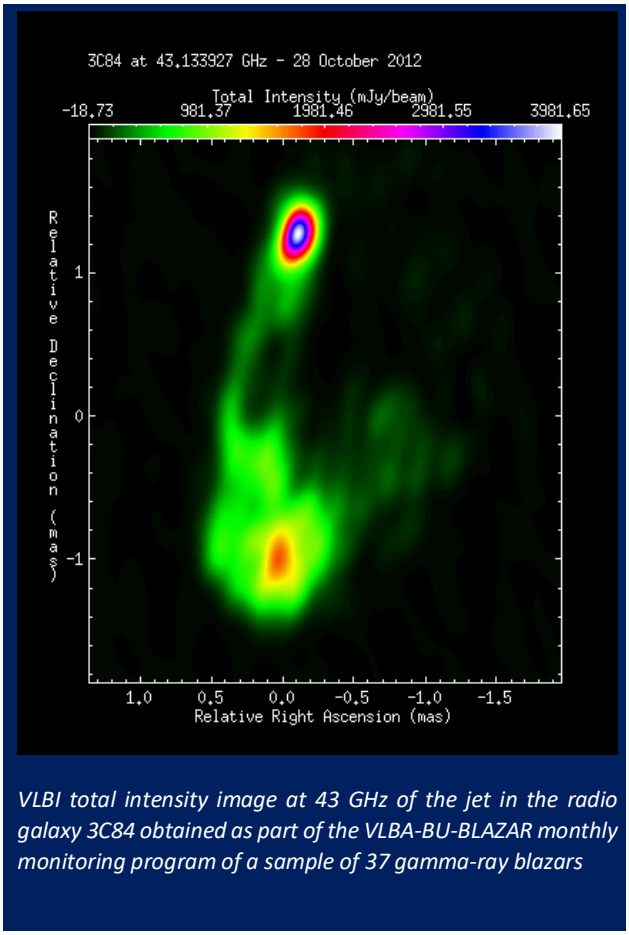
Our research group is focused on the study of relativistic jets, commonly present in multiple astrophysical sites, from active galactic nuclei (AGN), to microquasars and GRBs. For AGN, huge amounts of energy are released as a consequence of mass accretion onto supermassive black holes (SMBH), lurking in the center of these galaxies. The accretion leads to the formation of pairs of powerful and highly collimated relativistic jets, extending far beyond the size of the host galaxy.

Relativistic jets have probably an electromagnetic origin, in which helical magnetic fields may play an important role. Relativistic electrons in the jet, threaded by a magnetic field, radiate most of their energy as synchrotron and perhaps inverse Compton emission across the entire spectrum, from radio to gamma-rays. However, there are still fundamental questions related to the nature of relativistic jets that remain unsolved. Our research group is focused on obtaining a better understanding of these basic questions, and in particular to deep into our knowledge of the innermost regions, where jets are formed and the high energy emission (X and gamma-rays) are produced.

Our observational study is based on very long baseline interferometry (VLBI) observations at millimeter wavelengths and with the orbiting antenna RadioAstron, which allows the study of the innermost jet regions with an angular resolution of the order of few tens of microarcseconds. Multi-waveband observations across the whole electromagnetic spectrum, including radio, millimeter, optical, X and gamma-rays, provide the necessary information to study the origin, location, and properties of the emission at all spectral ranges registered by current instrumentation, and new facilities that are still coming (CTA, SKA), in which our group participates. Interpretation of the observations is carried out through the comparison with our numeric relativistic magnetohydrodynamic and non-thermal emission simulations.

Highlights in 2017

As part of our group participation in the VLBA-BU-BLAZAR monitoring program, consisting of monthly VLBI images of a sample of 37 gamma-ray emitting blazars, we analyzed the parsec-scale jet kinematics covering the first six years of this program [125]. In a total of 1929 VLBI images, we measured the apparent speeds of 252 emission components in 21 quasars, 12 BL Lacertae objects (BL Lacs), and 3 radio galaxies, with velocities ranging from 0.02c to 78c, with 21% of the knots being quasi-stationary. We found that quasars exhibit accelerations within the innermost 5 pc structure, while BL Lacs tend to decelerate near the upstream end of the jet. We also derived the physical parameters (Doppler factors, Lorentz factors, and viewing angle) of 120 superluminal knots and estimated the jet opening angles. While radio galaxies maintain equipartition of energy between the particles and magnetic field, 30% of the quasars and BL Lacs deviate from equipartition by a factor larger than 10, which appears to be associated with activity phases and the production of high energy, gamma-ray emission.



VLBI total intensity image at 43 GHz of the jet in the radio galaxy 3C84 obtained as part of the VLBA-BU-BLAZAR monthly monitoring program of a sample of 37 gamma-ray blazars

MEMBERS

I. Agudo, A. Fuentes, J. L. Gómez, S. Molina, S., J. E. Ruiz de Mazo.

INVITED RESEARCHERS

E. Kravchenko (Astro Space Center, Lebedev Phisical Institute, Russia), G. Bruni (Max-Planck-Institut für Radioastronomie, Germany), C. Casadio (Max-Planck-Institut für Radioastronomie, Germany), T. Traianou (Max-Planck-Institut für Radioastronomie, Germany), C. Thum (IRAM-Granada), V. Ramakrishnan (Universidad Concepción, Chile).

LINES OF RESEARCH

Multi-wavelength observations of AGN jets
Relativistic MHD and non-thermal emission simulations

ARAE (Astrofísica Robótica y de Altas Energías)

Overview

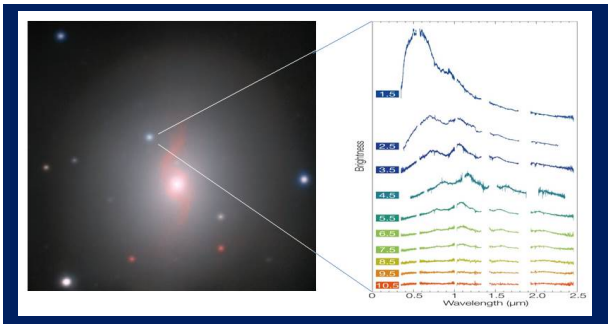
The ARAE research group (http://arae.iaa.es) was founded in 2001, although some of its members already started their activity in 1990, and belongs to the Andalusian Research Plan (PAI). Scientists and engineers are working on a variety of projects, combining their strengths. Research areas are multi-range observations of high-energy phenomena, theoretical stellar evolutionary models and models of stellar population synthesis. Significant technological developments are also carried out, regarding the robotization of small/medium size observatories and astronomical instrumentation development (ground-based and space-borne).

Highlights in 2017

- A gravitational-wave (GW) transient was identified in the electromagnetic spectrum for the first time. The event, was recorded by the LIGO detectors on 2017 Aug 17. This event (GW170817) was recorded at other wavelengths with ground- and space-based facilities. We provided the only image gathered by a Spanish facility (the Javier Gorosabel Telescope at our BOOTES-5 station in Mexico [2]). Additional spectroscopic observations at ESO confirmed the existence of a macronova and the production of heavier than Fe elements by means of the r-process nucleosynthesis in a double neutron-star post-merger fast-moving dynamical ejecta and in two slower wind regions with an indication that the merger ejected from 0.03 to 0.5 solar masses of material, including high-opacity lanthanides [216].

- Gamma-ray bursts (GRBs) are generated from relativistic jets launched from catastrophic events such as massive star core collapse or binary compact star coalescence. We explored how the parameters of the correlation observed in both the X-ray and optical/UV light curves of 280 GRB afterglows relate to each other and the prompt emission phase and whether these correlations are consistent with predictions of the standard afterglow model [191].

- The binary system V404 Cygni consists of a red giant star orbiting a black hole. In 2015, a surge of accretion by the black hole caused the surrounding plasma to brighten suddenly for the first time since 1989, briefly becoming the brightest x-ray source in the sky. We combined multiwavelength observations taken during the outburst and compared how fast the flux decayed at each wavelength, which allowed to constrain the size of the emitting region, determine that the plasma within it cooled through synchrotron radiation, and measure the magnetic field around the black hole [53].



The NGC 4993 galaxy at 40 Mpc including the optical counterpart to GW170817 following the short-duration GRB 170817A. Right: the spectroscopic monitoring revealing the macronova evolution for the first 11 days

- Convective core overshooting has a strong influence on the evolution of stars of moderate and high mass. Studies of double-lined eclipsing binaries and stellar oscillations have renewed the interest in the possible dependence of overshooting on stellar mass, which has been poorly constrained by observations so far. Here, we have used a sample of 29 well-studied double-lined eclipsing binaries in key locations of the H-R diagram to infer an approximate relationship between the the classical overshooting parameter α_{ov} and the coefficient f_{ov} such as α_{ov}/f_{ov} = 11.36 +/- 0.22 [46].

MEMBERS

A. J. Castro-Tirado, M. A. Castro-Tirado, M. Cerviño Saavedra, A. Claret dos Santos, I. Carrasco García, R. Cunniffe, Y. Hu, J. C. Tello Salas, B. Zhang.

INVITED RESEARCHERS

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LINES OF RESEARCH

Robotic Astronomy
High-Energy Astrophysics
Astrophysical Transients
Theoretical Stellar Evolutionary models
Models of stellar population synthesis

COSMOLOGY AND ASTROPARTICLE PHYSICS

Overview

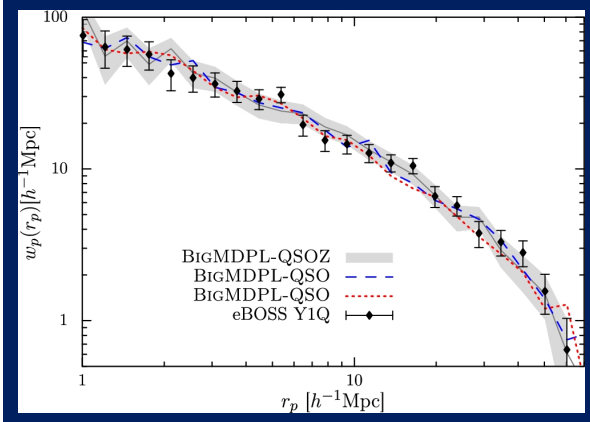
We are a cohesive group of scientists, instrumentalists and industrial partners involved in major challenges in the fields of Cosmology and Astroparticle Physics. Our research activities include the analysis of large-scale galaxy clustering measurements, the production of accurate cosmological simulations and galaxy mock catalogs and the development of instrumentation and databases for Big-Data galaxy surveys. Our network's expertise supplies a detailed interpretation of the survey results and provides new insights into the physics of the cosmos and the nature of dark energy. In order to accomplish our goals we take advantage of our involment in BOSS, eBOSS, DESI, J-PAS and Euclid to focus our research in the information encoded in the clustering properties of the matter traced by galaxies. We also work in the field of Astroparticle Physics by mostly focusing our efforts on gamma-ray cosmology. Thanks to our instrumentation developments we do collaborate in transdisciplinary projects in the fields of Neuroscience and Biomedicine. We are engaged in an intensive collaboration through coordinated work packages, workshops, meetings and exchange visits.

Highlights in 2017

- Our group led the work that presented the first-year clustering results of the QSO eBOSS sample, at redshift 0.8<z<2.2, and participated in the first measurements of the Baryon Acoustic Oscillations using QSO clustering at those redshifts. We also studied the galaxy clustering dependence on the [OII] emission line luminosity in the SDSS DR7 Main Galaxy Sample z ~ 0.1 [235, 6, 75].

- We performed a stellar-population and clustering analysis of Luminos Red Galaxies (LRGs) selected from the SDSS-III BOSS survey that shows two main populations paths converging into the same quiescent galaxy population at $z \sim 0.55$: fast-growing LRGs assemble the majority of their stellar mass very early on, while the remaining population experiences a slower growth [179].

- Our group, in collaboration with the EPS-UAM in Madrid and the Swiss compapy MPS, developed a fiber positioner robot for the new 12m Maunakea Spectroscopic Explorer telescope in Hawaii.



Clustering of quasars in the first year of the SDSS-IV eBOSS survey compared with three different clusteting models based on our MultiDark simulations

MEMBERS

F. Prada.

INVITED RESEARCHERS

J. Byun (U. Sussex, UK), J. Comparat (IFT UAM-CSIC, Spain), A. Montero Dorta (U. Utah, USA), M.A. Sánchez Conde (Stockholm U.), H. Lietzen (Tartu Obs.), G. Murray (Durham U.), R. Content (AAO, Australia), A. Niemic (LAM, France), S. Pilipenko (Lebedev, Russia), S. de Armas (IAC, Spain), J. Coronado (IFT UAM-CSIC, Spain), A. Klypin (NMSU, USA), G. Favole (ESAC, Spain), R. Wojtak (DARK, Denmark), A. Orsi (CEFCA, Spain), S. Gurung (CEFCA, Spain), S. García (UGR, Spain), S. Ramírez (UGR, Spain).

LINES OF RESEARCH

Large Scale Structure: dark matter, dark energy and cosmological parameters

Formation and evolution of dark matter halos: theory and simulations

Dark matter annihilation and decay detectability

Gamma-ray cosmology

Galaxy formation and evolution

Databases for cosmological simulations

Instrumentation for larger spectropic surveys

Transdisciplinary research in Biomedicine

EVOLUTION OF GALAXIES

Overview

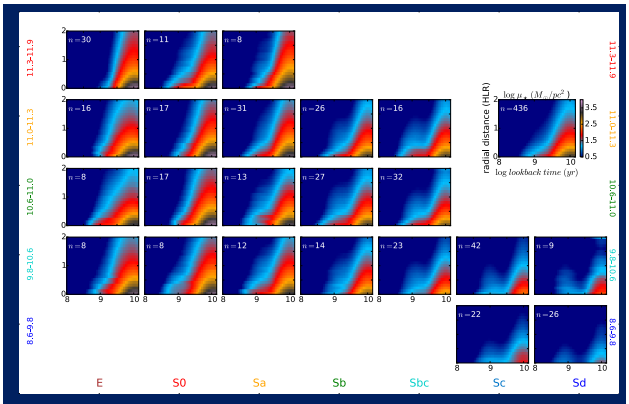
The Galaxy Evolution group develops observational and theoretical studies over a wide range of problems of galaxy structure and evolution and cosmology, from their inner stellar and diffuse ISM components to their large scale cosmological distribution and evolution. The research is complemented with an active participation in instrumental and technological projects. Our main topics include the physics of star formation, the diffuse medium in stellar clusters and galaxies, the nuclear activity in galaxies, or the environmental dependence of the structure and evolution of galaxies. These activities include supervising PhD studies, teaching Master courses, public outreach, and eScience.

Highlights in 2017

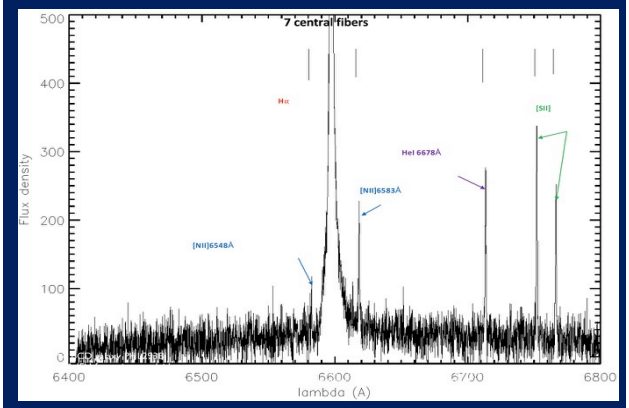
- Based on the CALIFA survey, http://pycasso.iaa.es offers the data products from the analysis of the DR3. For each galaxy, these include 2D maps and radial profiles of the stellar mass surface density, ages, metallicity, extinction, recent SFR, spatially resolved SFHs along the Hubble sequence and for mergers. Our previous findings that galaxies assemble their stellar mass from the inside-out, at any given stellar mass, stellar mass surface density, or Hubble type, are confirmed for DR3. Spatially resolved SFH indicate a fast formation and a long declining of the star formation, sustained by the slow consumption of residual gas. A mild reactivation of SF in the last 4 Gyr produces a rejuvenation of the disks, particularly in low mass late spirals. In ETGs, the initial phases are similar to those in massive early-type spirals, but E and S0 also have an active long phase of growth at 0.4<z<2, relevant for the growth of their envelope. CALIFA survey is very useful to study the role of mergers in galaxy evolution through a detailed characterization of the stellar populations, ionized gas properties and SFR in post- and early-stage mergers. Their spatially-resolved SFH were used to find the spatial extention and time scales of the enhanced SF, and the connection with the evolutionary state of the merger [93, 57, 103, 49, 50, 51].

- Empirical aperture corrections based on CALIFA were applied to all star forming SDSS galaxies to study the main sequence of star-formation (SFR vs. galaxy mass); new fittings were provided as a function of redshift that agree with galaxy formation model predictions and with integral field observations [221].

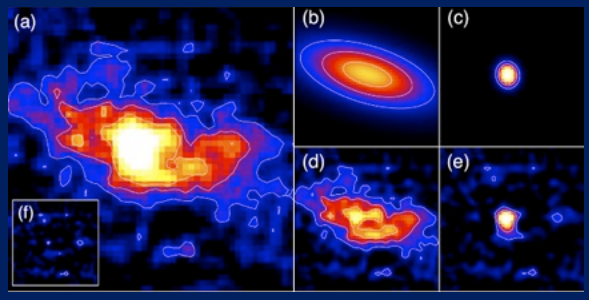
- Chandra or XMM–Newton archival data, at timescales from days to years, were analysed for a sample of 15 Seyfert 1.8/1.9 galaxies, and compared with our previous similar analysis on Seyfert 2s. We concluded that optically classified Sy 1.8/1.9 should be kept separated from Sy2 in UV/Xray studies because their intrinsic properties might be different [112].



R×t diagrams of azimuthal averaged stellar mass density as a function of stellar age and radial in the M-morphology plane*



MEGARA@GTC 1800s spectrum of the BCD galaxy PHL293B with the HR-R grating (R~18000)



Canaricam@GTC image of Mrk266SW. a) toral emission;b) Gaussian model of extended emission; c) Gaussian model of nuclear emission; d) "a-c"; d) "a-b"; f) "a-b-c"

- We studied 48 LINERs, 42 Seyferts, and 19 Starburst by means of spectral decomposition of Spitzer data, with nuclear fluxes from high-resolution images (CanariCam at GTC and others). Three components were included: stars, the ISM, and the torus. For bolometric luminosities $L_{bol}<10^{41}$ erg/s, the torus contribution is negligible. A clumpy torus fits well for the other objects; the outer radius of the torus is larger at higher L_{bol} [105].

- We analyzed a sample of 28 high luminosity high redshift (z ~ 1.5-3) quasars with new high-s/n spectra in the ultraviolet (CIVλ1549A, VLT data), and our previous Hβ data, and compared with samples of 22 low luminosity QSOs at similar redshift (GTC data) and 70 radio-quiet QSO at low redshift (z <=0.7, ground based and HST data). Comparison of Hβ and CIV line profiles indicated that the two lines arise from regions with different structure and kinematics. This, together with strong blueshifts observed in many sources (reaching extreme values of -4000 to -6000km/s) rules out CIV as a virial estimator of black hole mass. Evidence were found that Eddington ratio rather than luminosity drives such outflowing winds [266].
- MEGARA is the new multi-object spectrograph installed at the GTC. The MEGARA consortium, led by UCM, also integrates IAA-CSIC, INAOE (México), and UPM. On behalf of IAA-CSIC, Estallidos-GR took part in the MEGARA commissioning in summer 2017.

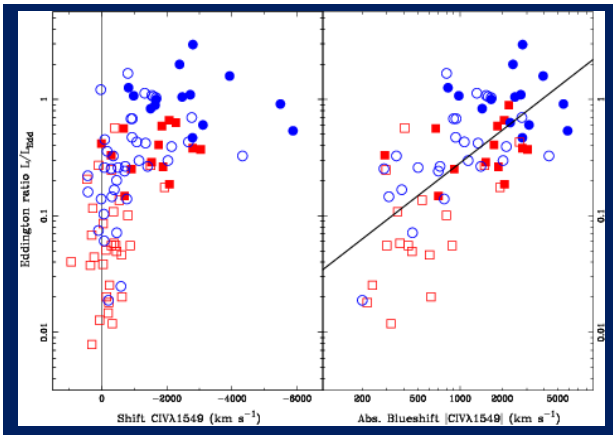
- The MOSAIC@ELT science case "Dissecting HeII emitters: spectral templates for sources of the cosmic dawn" was selected to be part of the MOSAIC phase A. The documentation was sent to ESO.

- Accurate physical properties and chemical abundances were obtained with WHT/ISIS for 9 HII regions in the galactic anticentre, confirming the decreasing O/H gradient in the 11-18 kpc range and a two-zone profile for N/O [79].

- For the first time a sample of 10 galaxies at z~3 was characterized morphologically and chemically using deep VIMOS data and UV rest-frame with the recipes in [213]. These compact strong star-forming metal-poor galaxies present properties very similar to those in the reionization epoch [9].

- A new standard of neutral gas content of non-interacting galaxies based on HI single-dish spectra of 844 AMIGA galaxies was presented. The study of compact groups included HCG 91 using HI-VLA and 3D IFS on the stellar and ionized gaseous content of its members using WiFeS and MUSE [278]. The oxygen abundance changes rapidly across the entire extent of the galaxy producing an enrichment of the interstellar medium in HGC91c preferentially along the spiral structure.

- A review of SKA studies of interest for the Spanish community in the area of HI and Galaxy Evolution was presented by the PI of AMIGA, who was designated as co-chair of the "HI Galaxy Science" SKA Science Working Group of the SKA Organization. AMIGA team extended its participation in the design of the SKA Science Data Processor and increased its involvement in the design of the SKA Regional Centres (SRCs): participated in the H2020 project AENEAS (H2020-INFRASUPP-3-2016-2017), and organised its second plenary meeting at IAA in October. We lead as well the SKA-Link project, funded by CSIC under its i-Link program, aiming to define a set of best practices to be considered in the design of the SRCs, for successfully exploiting the immense flow of science-ready data that SKA will generate.



(Left) CIV blueshift vs. L/LEdd for quasars of Population A (blue circles) and B (red squares), for both high-L high-z (filled symbols) and low-z (empty symbols) sources. (Right) Absolute values of blueshifts larger than 200 km/s

MEMBERS

C. Cortijo Ferrero, A. Damas, Segovia, A. del Olmo, S. Duarte Puertas, R. García Benito, J. Garrido Sánchez, R. M. González Delgado, J. Iglesias Páramo, M. Jones, C. Kehrig, R. López Fernández, I. Márquez, J. Masegosa, J.D. Perea, E. Pérez, E. Pérez Montero, M. Martínez Aldama, P. Ramírez Moreta, S. Sánchez Expósito, L. Verdes-Montenegro, J. M. Vílchez Medina.

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LINES OF RESEARCH

Violent star formation; Star formation in galaxies

Stellar population synthesis

The interplay between massive star formation and chemical evolution in galaxies

The influence of the environment on the evolution of galaxies

Active Galactic Nuclei; Physics of Quasars

Cosmic evolution of galaxies

Astronomical instrumentation

HETH

Overview

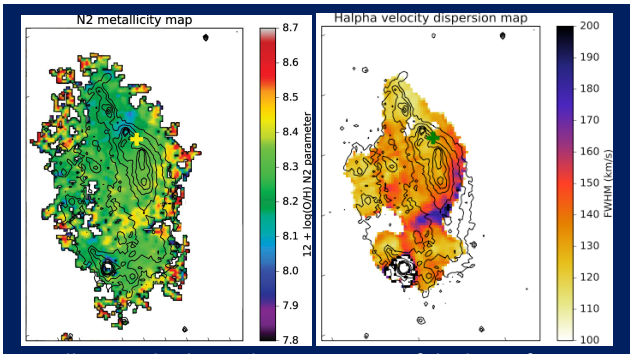
The HETH group (High-Energy Transients and their Hosts) focuses on the study of explosive transients as well as their local and host galaxy environments. In particular, we study novae, supernovae (SNe) of different types, gamma-ray bursts (GRBs) and new transients such as fast radio bursts (FRBs) or gravitational wave transients (GW). For our research we use data from different wavelengths and target-of-opportunity proposals at several facilities (ORM, OSN, CAHA, VLT, ALMA and NOEMA). In 2017 we were the most prolific group worldwide in determining redshifts of GRBs (81% led by HETH). Another interest of HETH is the study of environments of stellar explosions and their host galaxies to learn more about the progenitor objects. HETH is a young, international research group and had 8 members in 2017.

Highlights in 2017

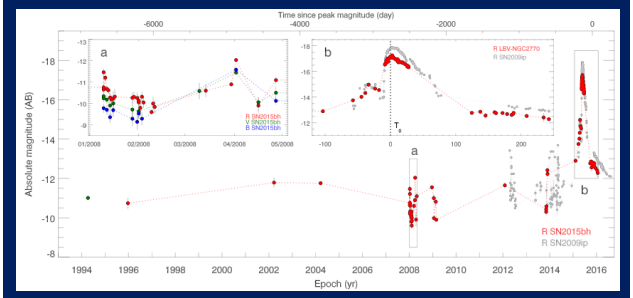
- ***The first electromagnetic counterpart to a gravitational wave source.*** 2017 saw not only the Nobel Prize in Physics for the discovery of gravitational waves, but also the first object ever to be observed in both gravitational waves and electromagnetic radiation. On Aug. 17, a GW trigger and a short GRB turned out to be coming from the same source, a binary neutron star merger in a late-type galaxy at 40 Mpc. This event both confirmed the association of some GW events to binary NS mergers and those mergers being the source of short GRBs and marks the beginning of multimessenger astronomy. HETH was involved in several large collaborations (e.g. VINROUGE, PI N. Tanvir, and ePESSTO, PI S. Smartt) and participated in 7 publications. HETH was also involved in public outreach on this event in national and international newspapers, radio and TV programs.

- ***MUSE study of a GRB host.*** Spatially resolved studies of GRB hosts are still rare. We presented a thorough study with MUSE/VLT of the host galaxy of GRB100316D (z=0.059), one of the closest GRB hosts detected so far. Detailed maps of metallicities, star-formation and other properties show that the GRB is near but not within the most metal poor and highest SF region (see figure). Kinematics reveal some evidence for small disturbances, a possible bar and inflow of gas. [119]. This galaxy is the showcase of the MUSE sample which contains a total of 9 low-redshift GRB hosts.

- ***GRB 161219B/SN2016cja.*** HETH is world leader in the study of GRB-SN and we discovered all GRB-SN identified in 2017. The supernova associated to GRB161219B, published in 2017, was the second closest of the last decade, providing us with a unique opportunity to use the 10.4m GTC telescope to perform a detailed study of the supernova and its host galaxy. We found that the SN was only powered by the decay of radioactive Ni, excluding a magnetar as central engine, as it has been found for some other GRB-SNe [32].



Metallicity and velocity disperision map of the host of GRB10031D with MUSE



SN 2015bh and variation of its progenitor monitored over 21 years

- ***SN 2015bh – a giant LBV outburst or a real SN?*** SN 2015bh was a peculiar type IIn supernova, with long-term pre-explosion activity of the LBV progenitor over at least 21 years (see figure, [270]). Evidence for early mass ejection is also found in the spectra of the SN. The object shows similarities to SN 2009ip and a number of other events, thus defining a new class of SN/impostor. The SN was hosted in NGC 2770, a MW-type spiral galaxy that now has had its 4th SN since 1999. It is currently still unclear whether the star actually exploded or only underwent a major outburst, which will have to be determined in very late observation of the remnant of survivor star.

MEMBERS

K. Bensch, Z. Cano, L. Izzo, D. A. Kann, R. Sánchez-Ramírez, C. C. Thöne, A. de Ugarte Postigo.

INVITED RESEARCHERS

J. Fishman (NASA Marshall Space flight center, Huntsville).

LINES OF RESEARCH

Gamma-ray bursts
Supernovae (Type IIn, broad-line Ic, SLSNe, GRB-SNe)
GRB and SN host galaxies and GRB/SN environments
Dwarf galaxies in 3D
X-ray binaries and magnetars
Novae and nova remnants
Cosmology; Astronomical instrumentation

LOW-MASS STARS AND EXOPLANETS

Overview

Our group "Physics of low-mass stars, exoplanets and associated instrumentation" studies the physics of planetary systems and their low-mass stars. In the last years, the community has focused on these stars because of the great interest they present for the discovery of temperate rocky planets that could sustain liquid water. Therefore, we work in all possible aspects of the problem, from the general statistics and physics of the formation and evolution of exoplanets and their atmospheres to the internal structure and magnetic activity of their stars. The group includes personnel with experience in theory of stellar structure and evolution, magnetic activity, asteroseismology, observations with space- and ground-based instruments, technical development of new instrumentation, project management and system engineering.

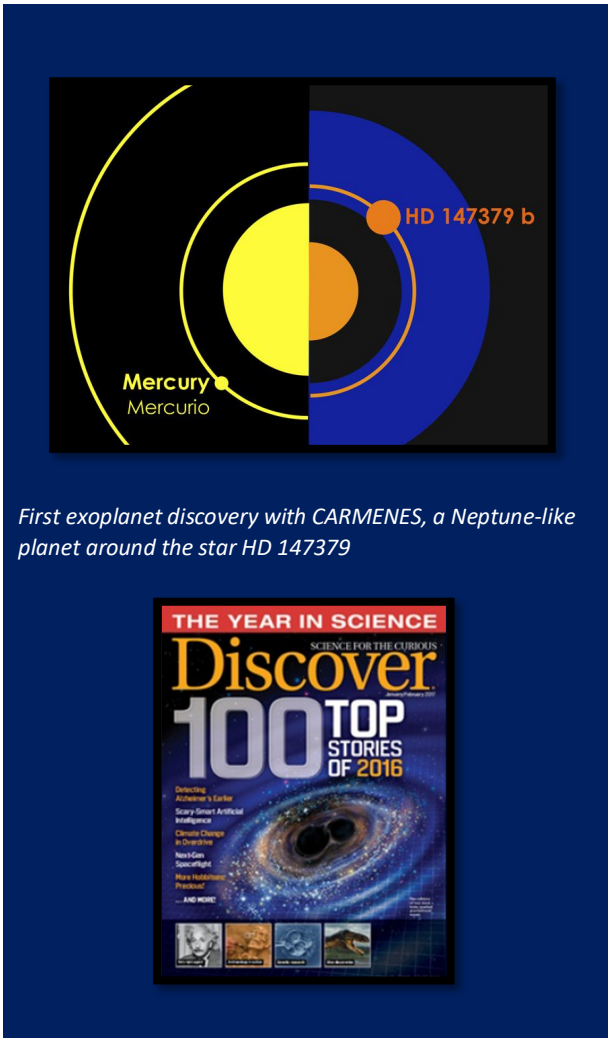
Highlights in 2017

- CARMENES, a world-wide unique instrument that started its scientific operation at CAHA observatory in Jan. 1, 2016 is collecting high-precision radial velocity measurements simultaneously in the optical and the near infrared for a survey of around 300 M-dwarf stars to search and characterize temperate rocky exoplanets. In 2017, the total number of stars surveyed amounts to 338, including the closest M dwarfs Barnard's star (1.8 pc), Wolf 359 (2.0 pc), Ross 128 (3.4 pc), GJ 54.1 (3.7 pc), Luyten's star (3.8 pc) and ultracool objects like TRAPPIST-1 (M8, 12 pc) and Teegarden (M7V, 3.8 pc). CARMENES is already the largest exoplanet survey for M dwarfs to date, with more than 16,000 high-resolution spectra in the VIS and NIR. It is already demonstrating its capabilities by improving the orbital solutions of known exoplanets, building a new and unique catalog of 324 high-resolution M-dwarf spectra in the VIS and NIR and showing tens of possible new exoplanet detections.

- HIRES is a second-generation instrument for the Extremely Large Telescope (ELT), conceptually similar to CARMENES. During 2017, our group, belonging to the HIRES consortium and the Project Office, continued its participation in the Phase A of the project, which was successfuly reviewed in December.

- Proxima Cen: In an interdepartamental work, our group reported the discovery of dust structures around our nearest neighbour [12].

- The paper on the discovery of Proxima b was nominated to the Canopus awards and became the main topic of the Breakthrough Prize Foundation Discuss Conference 2017. This work appeared listed as the



First exoplanet discovery with CARMENES, a Neptune-like planet around the star HD 147379

second in the top ten of Discover magazine's 100 top scientific stories.

MEMBERS

P. J. Amado, E. Casal López, M. Fernández, E. Mirabet, C. T. Rodríguez López, E. Rodríguez Martínez.

INVITED RESEARCHERS

J. Alonso-Floriano (Leiden, Netherlands), R. Luque (IAC, Spain), M. A. C. Perryman (UCD-Dublin, Ireland), Z. Modroño-Berdiñas (Univ. de Chile, Chile).

LINES OF RESEARCH

Stellar structure and evolution of very low-mass stars
Asteroseismology
Exoplanets
Magnetic activity
Astronomical instrumentation
Stellar structure and evolution of very low-mass stars

PLANETS AND MINOR BODIES

Overview

Three are the research areas comprising the group "Planets and minor bodies of the SolarSystem": Planets, minor bodies of the Solar System and Cosmic Dust Laboratory.

Broadly speaking, this group aims to provide us with an integrated view of the Solar System (excluding the Sun) making use of observational data obtained from ground and space. Moreover, several members of the group are focused on the development of models of planetary and cometary atmospheres in the Solar System.

Regarding the data obtained from space, it has to be noted that we are involved in 5 planetary missions from the scientific as well as from the technical point of view. All technological challenges that we face are mostly devoted to electronics engineering, being developed by members of the UDIT.

The main objectives are:

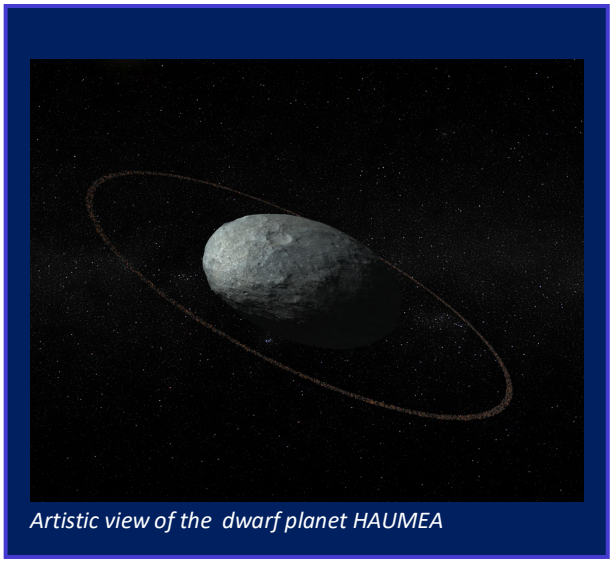
a) Minor bodies: formation and evolution.

- Ground and space observations in multi-spectral ranges.
- Theoretical modeling regarding both thermophysical and coagulation processes, and physical properties of dust in comets and Main-Belt Comets by Monte Carlo dust tail models.

Because TNOs are believed to be the least evolved objects within our solar system, they carry very important information on the initial phases of the solar system, with also implications to other solar systems. Therefore their study is important in order to understand the early phases of solar system formation.

b) Planetary atmospheres and surfaces:

- Origin and evolution of the water content and its derivates in the atmospheres of the Giant Planets and Titan. Determination of the turbulent tranport and chemical schemes controlling the measured vertical profiles by the HIFI instrument on board the Herschel Space Telescope -ESA-.
- We are developing applications for the scientific exploitation of the data provided by the laser altimeter (BeLA) on board the Bepi Colombo mission. These data are related to Mercury geology, geodesy, interior and surface characteristics.
- We are directed involved (CoPI level) from a theoretical and technological point of view in the NOMAD (Nadir and Occultation for Mars Discovery) instrument on board of the ESA ExoMars TGO Orbiter.
- IAA Cosmic Dust Laboratory (CODULAB): Experimental study of the angle dependence of the scattering matrices of dust samples of interest for the Solar System research.i.e.mineral dust particles that are potential candidates for being present in the planetary and cometary atmospheres of the Solar System (e.g. olivines, pyroxenes, basalt, palagonite, calcite, carbon, etc). The CODULAB provides experimental data in support of the research lines described above.



Artistic view of the dwarf planet HAUMEA

Highlights in 2017

- Determination of the size, shape, density and ring of the dwarf planet Haumea.
- Commisioning phase of NOMAD on board Exomars.
- Integration of the instrument BELA in the Beppi Colombo payload to be launched to Mercury in 2018.

MEMBERS

J. M. Castro Marín, R. D. Duffard, J. Escobar, E. Fernández, P. J. Gutiérrez, J. Jiménez Ortega, M. Lampón, L. M. Lara, J. J. López Moreno, I. Martínez Navajas, N. F. Morales Palomino, F. Moreno, O. Muñoz, J. L. Ortiz, J. Rodrigo Campos, P. Santos.

INVITED RESEARCHERS

E. Frattin (Universitá di Padova), A. Campo Bagatín (Universidad de Alicante), P. Maier (MPE), A. Álvarez Candal (Observatorio Nacional de Rio de Janeiro), J. L. Gómez González (CAB-CSIC)

LINES OF RESEARCH

Planets and minor bodies of the Solar System

Dust in the Solar System

PHYSICS OF THE INTERSTELLAR MEDIUM

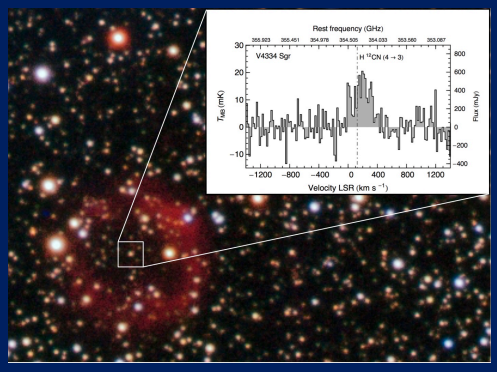
Overview

This group studies the formation, evolution and death of stars at different spatial and mass scales accross distinct environments.

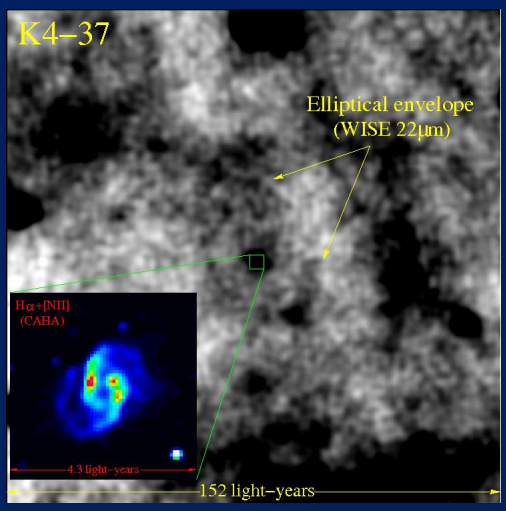
The early stages of star and planet formation are studied through radio interferometric observations and modelling of the observed emission. Infalling molecular envelopes, dusty circumstellar discs and ionised radio jets in young stellar objects are studied. The architecture of nearby exoplanetary systems is inferred by studying the leftover debris dust structures after the end of the planet formation process. High angular resolution observations are used for analysing the multiplicity of massive stars.

The final stages of a star's life are studied by the multi-wavelength characterization of evolved stars and the wind-blown bubbles around them, to understand the processes that shape planetary nebulae (PNe) and the circumstellar medium around massive stars.

Radio interferometric monitoring of supernova (SN) explosions and their distribution in Ultra Luminous Infrared Galaxies (ULIRGs) is also carried out to determine the SN and star formation rates. We also disentangle the mechanisms for gas and dust heating at the central regions of ULIRGs. High-energy phenomena are studied at different scales.



Optical image of the born-again star V4334 Sgr, aka Sakurai's object, superposed by the APEX spectrum of the H^{12}CN line



WISE image at 22 microns (black means brighter) of the planetary nebula K4-37 showing the large elliptical envelope. The inset (bottom left) shows the Halpha image of the bipolar nebula obtained with CAFOS/CAHA

Highlights in 2017

- We reported the first detection of HCN in the hydrogen-poor envelope of born-again stars, putting a lower limit on the amount of H ejected during the born-again event [267].

- Archival data of the WISE satellite at 22 microns revealed the existence of a very large elliptical shell around K4-37, a bipolar planetary nebula with multiple axes, as derived from the internal nebular kinematics at optical wavelengths. The analysis of these observations allowed us to reconstruct the last 400,000 years of mass ejection from the central star of K4-37 [173].

- Using ALMA observations, we found evidence of belts of dust around Proxima Centauri, the star closest to our Sun. These dust structures might constitute small-scale analogs to our solar system Kuiper or asteroid belts, suggesting a planetary system with a complex dynamical history and elaborate architecture around this star [12].

- We imaged a highly collimated radio jet from the intermediate-mass protostar FIR3 in OMC-2. The jet presents a thermal (free-fee) core (VLA 11) and a non-thermal lobe (VLA 12N, 12C, 12S). The non-thermal emission likely arises from electrons that have been accelerated to relativistic velocities in strong shocks. We proposed that these shocks triggered the formation of the low-mass protostar HOPS 108 that falls in the path of the jet, towards the non-thermal lobe [196].

- IC 883 is a luminous infrared galaxy (LIRG) classified as a starburst-active galactic nucleus (AGN) composite. We

reported on our radio follow-up at three frequencies that provided direct and unequivocal evidence of the AGN activity in IC883, through the ejection of a new component in the VLBI jet. On the other hand, our analysis of archival X-ray data, together with the detection of a transient radio source with luminosity typical of bright supernovae, gave further evidence of the ongoing star formation activity, which dominates the energetics of the system. The AGN contributes less than 2 % of the total IR luminosity of the system. The corresponding Eddington factor is $\sim 10^{-3}$, suggesting this is a low-accretion rate engine, as often found in Low Luminosity AGNs [237].

MEMBERS

A. Alberdi, G. Anglada, A. K. Díaz-Rodríguez, J. F. Gómez, M. A. Guerrero, L. F. Miranda, M. Osorio, M. A. Pérez-Torres, N. Ramírez-Olivencia.

INVITED RESEARCHERS

L. F. Rodríguez (UNAM, Mexico), E. Macías (Boston University, USA), G. Niccolini (Université de Nice, France), O. Suárez (OCA, France), I. de Gregorio-Monsalvo (JAO, Chile), R. Ortiz Moraes (University do Sao Paulo, Brasil), X. Fang (Hong-Kong University, Hong-Kong), J. S. Rechy García (UNAM, Mexico), E. I. Santamaría (Universidad de Guadalajara-CUCEI, Mexico), L. M. Romano Corradi (GTC, Spain), G. Ramos Larios (Inst. de Astronomía y Meteorología, Universidad de Guadalajara, Mexico), J. Sánchez-Bermúdez (ESO).

LINES OF RESEARCH

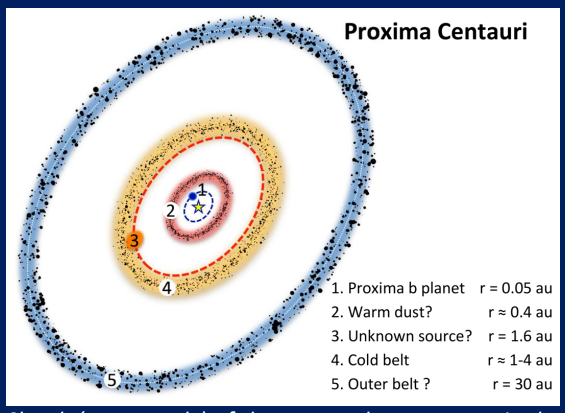
Massive stars and their surroundings

Star and planet formation modeling and observation

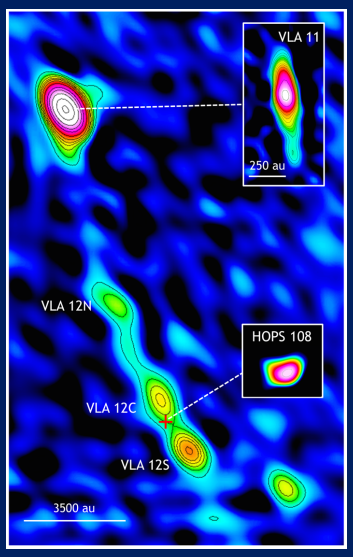
Multi-wavelength study of PNe and their precursors

Stellar endproducts, accretion phenomena and the ISM in LIRGs and ULIRGs

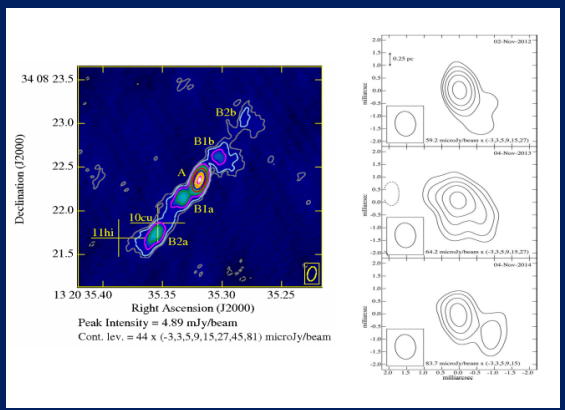
Prospective Science work for SKA



Sketch (not to scale) of the proposed components in the Proxima Centauri planetary system



VLA image of the 3 cm continuum emission of the radio jet from the intermediate-mass protostar FIR3 in OMC-2 showing the thermal core (VLA11) and the non-thermal lobe (VLA 12N, 12C, 12S). Insets show the 5 cm emission at higher angular resolution of the thermal core of the radio jet and of the protostar HOPS 108



eMERLIN (left) and VLBA (right) images of IC 883. The VLBA images show the ejection of a new component from the core of the central AGN

SOLAR PHYSICS

Overview

The IAA's Solar Physics Group (SPG) main scientific interests root in solar spectropolarimetry and magnetic fields from all the three points of view: theoretical, observational, and instrumental. Investigations and developments are carried out on:

- the radiative transfer equation (RTE) for polarized light in the presence of magnetic fields, in order to work out the sensitivities of the Stokes spectrum on the various physical quantities of the solar photosphere,
- the inversion of the RTE for its use on the interpretation of spectropolarimetric meas-urements in terms of the thermodynamic, magnetic, and dynamic parameters of the Sun,
- the structure and physical nature of photospheric magnetic structures like plage and network flux tubes, the umbra, the penumbra, and the moat of sunspots, and the internetwork magnetic fields,
- the design, development, and construction of solar instrumentation.

Highlights in 2017

Science

- Detection of emission in the Si I 1082.7 nm line core in sunspot umbrae.

- 16 papers on the first scientific results from the *Sunrise* second flight. Among them:
  - · Spectropolarimetric evidence for a siphon flow along an emerging magnetic flux tube
  - · High resolution evidence of relationship between convectively driven sinks and magnetic fields in the quiet Sun.
  - · Unprecedented description of two emergences of magnetic flux close to each other.

Instrumentation

- Milestones in the development of the SO/PHI magnetograph for the ESA's Solar Orbiter mission:
  - · E-Unit flight model (FM) delivery
  - · E-Unit spare model (FS) fabrication
  - · E-Unit FS tests

- Agreement for the development of INFACT (Inversion Factory), an evolution of our electronic inverter for the radiative transfer equation (for *Solar Orbiter*), for the Daniel K. Inouye Solar Telescope (DKIST, Hawaii).

Flight model for the SO/PHI electronics unit

- Second half of the activities related to the development of large format liquid crystal variable retarders for the European Solar Telescope.

MEMBERS

D. Álvarez García, B. Aparicio del Moral, F. J. Bailén Martínez, M. Balaguer Jiménez, L. R. Bellot Rubio, J. P. Cobos Carrascosa, J. C. Del Toro Iniesta, F. Girela Rejón, D. Hernández-Expósito, M. Herranz de la Revilla, P. Labrousse, A.C. López Jiménez, A. J. Moreno Mantas, D. Orozco Suárez, A. Sánchez Gómez.

INVITED RESEARCHERS

D. Utz (University of Graz, Austria), J. I. Campos Rozo (University of Graz, Austria), V. Hansteen (University of Oslo, Norway), A. Ortiz Gil (University of Oslo, Norway).

LINES OF RESEARCH

Quiet-Sun and active region magnetism
Magnetic coupling of the solar atmosphere
Diagnostics techniques in spectropolarimetry
Solar cycle
Solar instrumentation

STELLAR SYSTEMS

Overview

The Stellar Systems Group (SSG) was created in 1988. Since then, our research interests have diversified, even though the group has grown at a lower pace. The group's development departed from two fundamental concepts: (1) Internationalization, understood as the establishment of collaborations with leading international astronomical research centres and researchers and the incorporation of international researchers. (2) Specialization, understood as the hiring and promotion of leading researchers. As a result, we incorporated four Ramón y Cajal Fellows since the creation of the scientific team, which has increased the productivity and impact of it. We are leading the study of stellar clusters, massive stars, and the Galactic Centre. Currently, the group is studying the connection between star-forming processes and spatial and kinematic structures at different scales (http://ssg.iaa.es), is carrying out an unprecedented study of the Galactic Centre region (http://gc.iaa.es) and performing the most complete catalogue of Galactic massive stars.

The ERC Consolidator Grant GALACTICNUCLEUS is still in operation, and we are leading or actively involved in four main surveys connected with stellar clusters, Galactic Centre, Galactic structure and massive stars (Gaia-ESO Survey, GALACTICNUCLEUS Survey, GALANTE, and GOSSS). By the end of 2017, the Galactic Centre Group (GCG) had acquired about 80% of the data for the GALACTICNUCLEUS survey (see http://gc.iaa.es), and the first target fields of GALANTE survey were reduced and analysed.

Highlights in 2017

- Almost 4000 variable stars identified within the central 10 pc of the Milky Way [65]

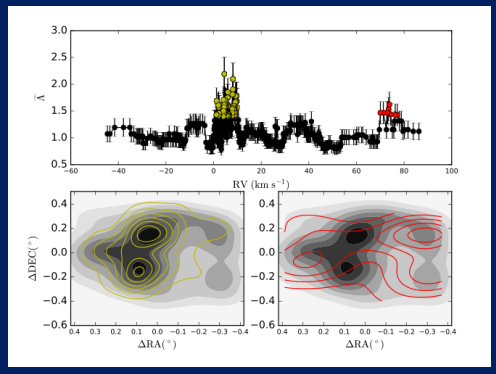
- Catalogue of more than 1850 Galactic stellar clusters with membership analysis by thre different methods (see in http://ssg.iaa.es) [244]

- First detection of RR Lyrae stars in the central 10 pc of the Milky Way [67]

- Study of brown dwarfs in RCW 38. It shows that mass and density of a cluster do not appear to influence brown dwarf formation frequency [186]

- Velocity pattern in the field of NGC 2264 derived from the Spectrum of Kinematic Groupings (SKG) [104]

Brown dwarfs in the stellar cluster RCW 38



Spectrum of Kinematic Groupings in the field of NGC 2264 (top pannel). Spatial distribution of NGC 2264 kinematic grouping [yellow, bottom left] and a farther concentration possibly associated to the Outer Arm [red, bottom right]

MEMBERS

E. J. Alfaro, M. T. Costado, A. J. Delgado, H. Dong, A. T. Gallego, E. Gallego, E., A. Lorenzo, F. Nogueras, R. Schödel, A. Sota.

INVITED RESEARCHERS

A. Feldmeier-Krause (U. of Chicago), P.F. Roche (U. of Oxford), M. C. Sánchez-Gil (U. de Cádiz), B. Shahzamanian-Sichani (Koln Universitat), C.M. Telesco (U. of Florida).

LINES OF RESEARCH

Galactic Centre
Massive Stars
Formation and Destruction of Stellar Clusters

STELLAR VARIABILITY

Overview

Within the framework of research activity related with the M3 ESA mission PLATO2.0 we are developing techniques and pipelines to extract information from the massive light curves expected to be obtained by this mission.

Our experience spread over all the fields concerning asteroseismology, namely, the way to check in detail stellar interiors from the theoretical point of view to the observational issues.

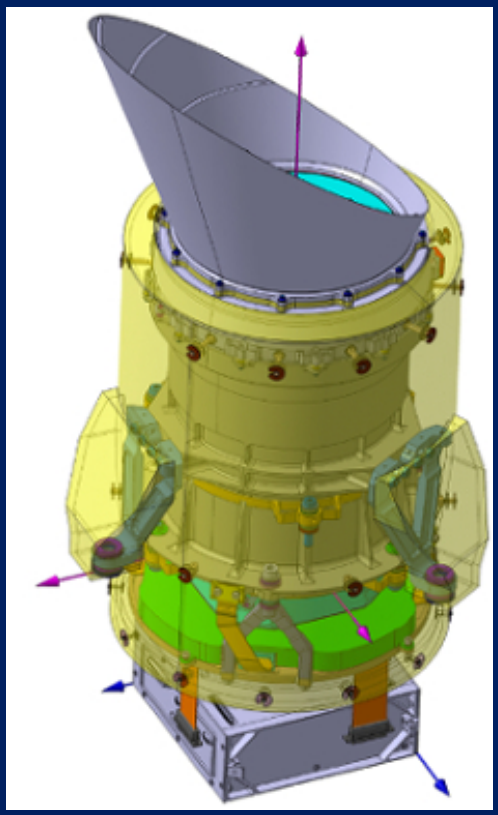
Highlights in 2017

- On 21st June 2017 the PLATO mission has been officially adopted by the European Space Agency as their 3rd Medium Class mission. The PLATO mission will be launched in 2026 and will observe planetary transits and stellar oscillations with an unprecedented quality and precision. http://plato-project.iaa.es/

- Organization of "Time and Measurement" workshop. An open discussion was established connecting time with time series. http://tmw.iaa.es

- In collaboration with the team in the University of Granada and using a sample of 10 eclipsing binary systems with a δ Sct component and the unique δ Sct star discovered with a transiting planet, WASP-33, we were able to refine the Δν / ρ relation. Using this relation and parallaxes, we obtained independent values for the masses and radii, allowing us to calculate the surface gravities without any constraints from spectroscopic or binary analysis [92].

- Part of the team was involved in the developement in the asteroseismic tool TOUCAN. http://plato-project.iaa.es/project/toucan



One of the cameras of the PLATO spacecraft
Credit: PLATO mission consortium

MEMBERS

G. Cortés, S. De Franciscis, R. Garrido, M. Lares-Martiz, P. López de Coca, J. Pascual-Granado, J. R. Rodón.

INVITED RESEARCHERS

J. D. Scargle (NASA Ames Research Center, USA), S. Chapman (Univ. of Warwick, UK), N. Watkins (Univ. of Warwick, UK).

LINES OF RESEARCH

Stellar Variability
Pulsation
Time series
Fractal analysis

TERRESTIAL PLANET'S ATMOSPHERES

Overview

We investigate the Earth's atmosphere by retrieving, processing and analysing data of MIPAS and SABER space-based instruments and ground-based SATI. Special focus is on the study of the effects of solar particles and solar radiation on atmospheric composition, and trends in temperature and species abundances. We also study atmospheric electricity in planetary atmospheres and are preparing for the analysis of the ASIM and TARANIS missions. In 2017 we started the *SAINT* project funded by the EU H2020 program. The ERC *eLightning* project continues its development of numerical models of atmospheric lightning. We coordinated the EU H2020 project *UPWARDS*, devoted to the exploitation of Mars Express data and the development of new tools for Exomars. We also continued the analysis of the variability of the Martian upper atmosphere using GCM models and IUVS-MAVEN observations. The Group collaborates on the study of exo-atmospheres with CARMENES data.

Highlights in 2017

- We published a new solar dataset to be used in the next climate assessment report of the IPCC [166].

- A numerical model showed for the first time that streamer collisions are essential precursors of the X-rays and HF radio emissions detected in long electric discharges [155]. Our models showed that different lightning properties can produce different shapes, sizes and intensities of transient optical emissions in Venus, Jupiter and Saturn [210].

- The analysis of MAVEN/IUVS measurements of NO nightglow on Mars using a Global Climate Model, confirmed the predicted increase of this emission towards the winter pole [263].

- SATI measurements showed OH layers variations of 4km and 40K in a few hours due to waves [94].

MEMBERS

A. Cala, B. Funke, M. García Comas, A. Gardini, M. Gomes, F. González Galindo, M. González, F.J. Gordillo, B.N. Hill, S. Jiménez Monferrer, N. Kieu, A. Luque, M. J. López González, M. López Puertas, M. Á. López Valverde, A. Malagón, M. Passas, A. Pelegrina, F. J. Pérez Invernón, A. Sánchez López, J. Sánchez del Río.

INVITED RESEARCHERS

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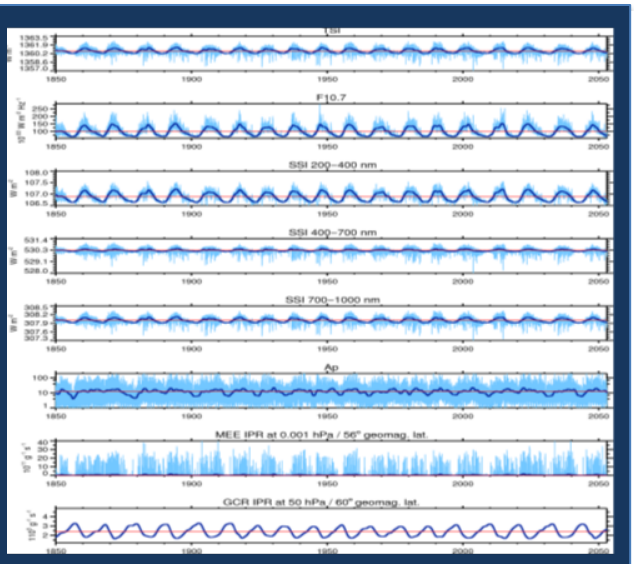
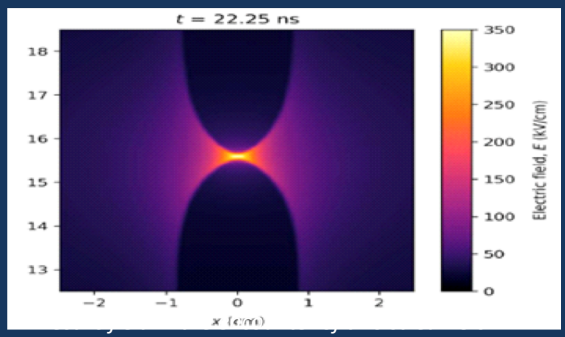
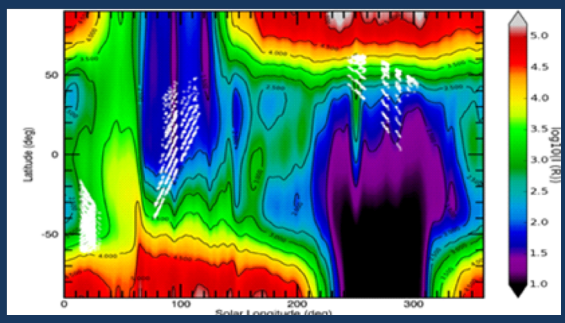


Solar parameters (1850-2050) generated to predict Sun's effects on climate





Seasonal variability of NO nightglow on Mars predicted by a Global Climate Model

LINES OF RESEARCH

Earth's middle atmosphere variability and its impact on climate

Atmospheric Electricity in Planetary Atmospheres

Thermal structure and composition of the Terrestrial planetary atmospheres and exo-atmospheres

Remote sensing of planetary atmospheres in IR and UV

THEORETICAL GRAVITATION AND COSMOLOGY

Overview

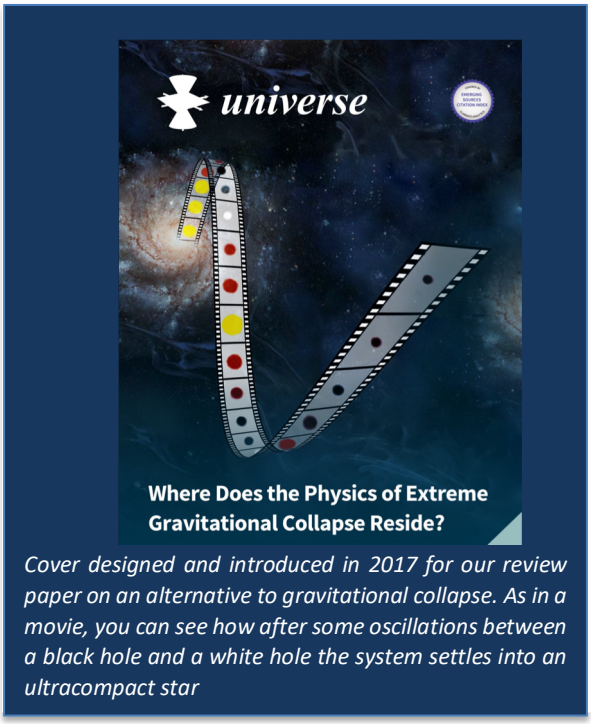
20th-century physics totally changed the way we understood the world by giving birth to two revolutionary theories, General Relativity (GR) and Quantum Mechanics (QM). However, it has left us with a giant puzzle which might turn to be the seed of a new revolution. Instead of having a single theoretical framework with which to understand nature, we have two, and two which are mutually inconsistent, at least as far as we can see. In order to describe a system or process in physics we have first to decide which of these two realm it belongs to. Then, we can proceed with the corresponding machinery. The situation is not particularly appealing, but one might pass over in silence if there were no system or process belonging to both realms at once. But this is not the case, there are at least two situations that ask for GR and QM at the same time: The formation and evolution of black holes and the origin and evolution of the Universe as a whole, the subject of Cosmology.

The main activity of our group is to investigate these two situations and to search for ways of combining the gravitational and the quantum realms. For that we use a wide range of techniques: From geometrical techniques in GR to group-theoretical and condensed matter techniques. This research line of the IAA contains a number of specific subtopics that we pass now to briefly describe.

1. We are interested in making a comparison between the collapse process in standard GR and that in other gravitational theories that incorporate modifications to GR. In particular, we are analyzing the effect that a specific regularization of the classical singularity would have in the process of collapse itself and in the final forms of equilibrium one could attain.

2. We are further developing the group-theoretical quantization scheme to attack the problem of quantization of GR or at least, of subsectors of it reduced by symmetry considerations. To apply these techniques we are firstly developing a gauge theoretical version of GR mixed with other interactions such that the internal and spacetime symmetries appear on an equal footing.

3. Analogue Gravity: Condensed matter systems with emergent geometrical properties have already been proved as very important in the understanding of which type of quantum corrections one could expect to see when probing gravity at high energies. For instance, they provide a way of studying the high-energy properties of Hawking radiation. We are analyzing whether the dynamics of GR can also be obtained as an emergent phenomenon.



Cover designed and introduced in 2017 for our review paper on an alternative to gravitational collapse. As in a movie, you can see how after some oscillations between a black hole and a white hole the system settles into an ultracompact star

4. We are investigating an alternative mechanism that does not need the existence of the standard Higgs. It relies on the possibility of mixing gravity with other interactions and on the group-theoretical quantization of non-Abelian Yang-Mills theories.

Highlights in 2017

We continued developing our alternative model for the fate of collapsing bodies. On the one hand, we provided a calculation of the meantime of a black hole to turn white [20]. On the other hand, we proposed that the presence of echoes of gravitational waves in collapsing processes might be the first detectable signal of quantum gravitational effects [18].

In another front, we revised Weyl unified theory of electromagnetism and gravity at the light of novel developments in the so-called Weyl-Transverse gravity. We found that most of the original criticisms dissapear in a new incarnation of Weyl theory [19].

MEMBERS

V. Aldaya, C. Barceló.

INVITED RESEARCHERS

L. J. Garay (UCM), L.C. Barbado (U. Vienna, Austria), R. Carballo-Rubio (SISSA, Italy), M. Visser (U. Victoria, New Zealand).

LINES OF RESEARCH

Gravitational collapse and semiclassical gravity
Group theoretical quantization
Analogue and emergent gravity
Origin of masses of elementary particles

CALAR ALTO OBSERVATORY

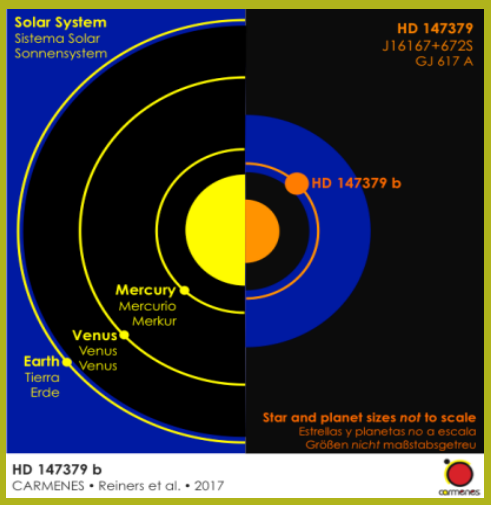
The IAA is also the reference institute for the Calar Alto Hispano-Alemán observatory (CAHA). The German-Spanish Astronomical Center at Calar Alto is located on the mountain range of Los Filabres, in Almería, at a height of 2167m. CAHA is operated jointly by the Max-Planck-Institut für Astronomie (MPIA, Heidelberg, Germany) and the IAA. Calar Alto provides three telescopes with apertures of 1.23m, 2.2m and 3.5m to the general community. A 1.5m-telescope, also located on the mountain, is operated under the control of the Observatory of Madrid. The ideal atmospheric conditions for astronomical observations and aperture size of the telescopes at CAHA make of it the most important astronomical observatory in the continental Europe.

The CAHA telescopes are equipped with state-of-the-art astronomical instrumentation including direct imaging optical and near-infrared cameras, and intermediate- and high-dispersion spectrographs. The observatory itself has its own technical installations: clean rooms, electronic, mechanic and computing facilities, and all-sky cameras and sensors to monitor the quality of the night sky. The observatory offers aluminizing services as it has the largest aluminizing chamber in Europe, which can host mirrors with diameters up to 4m. It is also defined as Singular Scientific-technical infra-structure of MINECO (ICTS) for Astronomy.

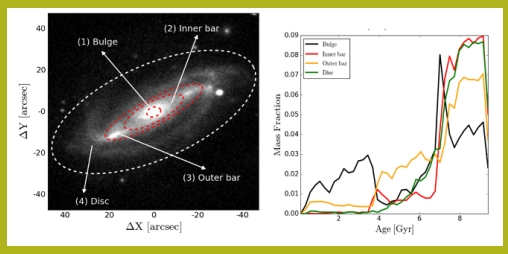
SCIENTIFIC RESULTS IN 2017

SEARCH FOR PLANETS WITH CARMENES SUCCESSFUL

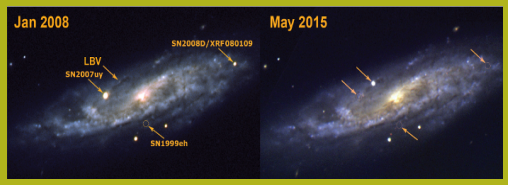
Since 2016, German and Spanish researchers are hunting for planets with the Carmenes spectrograph. The first results, obtained with the Calar Alto Observatory 3.5m telescope and published on October, 4th 2017, analyze seven known planetary systems and proves its excellent performing. They have now discovered their first star with an exoplanet. The star is a so-called M-dwarf only about half as massive as the Sun, its planet with the name HD 147379b is slightly more massive than Neptune. HD 147379b orbits its star once every 86 days at a distance that is only a third of the distance between Earth and the Sun. At this location, the planet is located inside the so-called habitable zone where water could exist in liquid form. However, it is unlikely that life could develop on this planet because it probably has no solid surface.



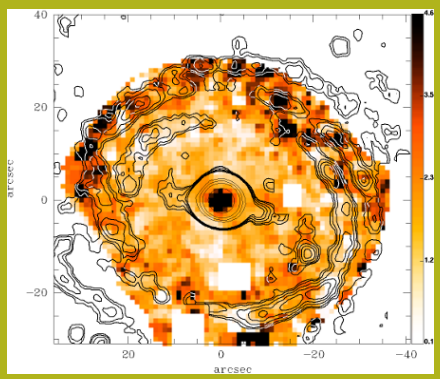
Exoplanet HD147379 discovered with CARMENES



Evolution of the different regions in NGC6032 as a function of time, the peak at 7 billion yrs corresponding to the buckilng event



Galaxy NGC2770. Left: position of Luminous Blue Variable star (LBV) where explosion was detected in 2015



Early-type galaxy from the CALIFA sample. In contours, the tenuous spiral arms detected

New clues on the formation process of Milky Way-like galaxies

Researchers from the Granada University (UGR, Spain) lead a study which gives new details about the formation process of the structure of our galaxy, the Milky Way: a series of observational studies which showed the distribution and characteristics of the stars in barred spiral galaxies like the Milky Way, giving new insights on the formation process of this kind of galaxies.

Polarized light from a brown dwarf: where lies the dust at play?

The brown dwarf 2MASS J04221413+1530525 shows linear polarization of its light which could be due to dust in its Jupiter-like atmosphere, or in the interstellar medium. Brown dwarfs, sometimes known as “failed stars”, fill the gap between low mass stars and giant gaseous planets. They are faint objects, difficult to study and, as such, some of their characteristics are not well known. An international team searched for polarized light in a sample of brown dwarfs with CAFOS – a method which helps to know the properties of these objects –, and has found polarized light in one of them, although its poorly determined distance does not allow us to determine the exact cause of the polarization.

Rewinding stellar evolution: The last 400,000 years of mass loss from a star

Planetary Nebulae (PNe) are the last evolutionary phase of stars with initial masses between 0.8 and 8 solar masses. They appear as a compact central star (the remains of the progenitor star) surrounded by a bright shell of expanding gas, produced during the previous red giant phase, when the star blew away its external layers. In a few tens of thousand years, PNe disperse in the interstellar medium. Although more than 3,500 PNe are known to date in the Milky Way, many of them lack appropriate observations to place them in the general context of PN evolution. The study of K4-37, one of these less observed PNe, gave new hints to this context.

SN2015bh: end of star or supernova “impostor”?

Astronomers spot an intense explosion of a massive star, which, according to records, experienced frequent eruptions for at least 20 years. The analysis of the outburst does not allow to discern between a real supernova - an explosive event marks the end of a star - or a giant eruption implying a massive change in the star’s evolutionary course. Massive stars end their lives in supernova explosions, highly energetic events that can be as luminous as the entire starlight from their host galaxies. However, there are events called "supernova impostors” which, despite their intensity, are not the end of the star’s life. This could very well be the case of SN 2015bh, a star which had suffered at least 21 years of violent eruptions and which, together with a number of other objects, could be a member of a new class.

Stellar formation shoots are observed in a type of galaxy where, in theory, stars are no longer born

CALIFA project allowed to detect, in three early-type galaxies, a very tenuous arms where stars are being formed. The data contradict the widespread belief that in old galaxies stars are no longer born. Early-type galaxies are characterized by their spheroidal shape, lacking in remarkable features, and by their reddish color that comes from a very aged star population. They are very massive galaxies where star formation stopped billions of years ago. However, an international astronomers team found, in three early-type galaxies from the close universe, a very tenuous structure similar to the spiral galaxies arms that has star under formation.

TECHNOLOGICAL ACTIVITIES IN 2017

Calar Alto Observatory will improve its instruments with co-financing of ERDF funds

The Monitoring Commission of the agreement signed with the "Ministerio de Economía, Industria y Competitividad" for the execution of the "MIOCA-Mejora del Instrumental del Observatorio de Calar Alto" project, was set up. The project’s budget of 1.129.098 €, will allow to consolidate the competitiveness of CAHA.

The Spanish-German Astronomical Center (CAHA) has the purpose of the management, maintenance, operation and scientific exploitation of the Calar Alto Observatory, making it available to the international astronomical community, as well as giving the capacity and the infrastructure needed for carrying out astronomical observation programs and developing innovative concepts concerning instrumentation. Now, CAHA faces up an improvement of its instrumentation in order to continue at the forefront of the astronomical observation.

CARMENES Consortium makes the official delivery of the instrument to Calar Alto Observatory

On April 4th, 2017, the official delivery of this instrument to the observatory by the instrument's PIs from the Landessternwarte (Univ. Heidelberg) and Instituto de Astrofísica de Andalucía (IAA-CSIC) took place at the CSIC headquarters within a scientific conference, opened by the CSIC’s President, where the latest discoveries of the instrument were analyzed.

SIERRA NEVADA OBSERVATORY

The Sierra Nevada Observatory (OSN) is a high mountain observatory located at Loma de Dílar (2896m altitude) within the Sierra Nevada National Park (Granada, Spain). The observatory is operated by the IAA. It consists of a main building which hosts two Nasmyth optical telescopes of 90-cm and 1.50-m diameter each (hereafter T90 and T150). The astronomical instruments attached to those telescopes are two similar 2048x2048 CCD cameras and a Strömgren-Crawford simultaneous six-channel photometer. Owing of the upgrade of Albireo, a low- and intermediate-resolution optical spectrograph, the instrument has not been operatived during 2017. The technical maintenance of the telescopes and instruments is supported by the UDIT (Instrumental and Technological Development Unit) staff belong to IAA.

Its southernmost high altitude location in continental Europe together with the dry climatic conditions of Sierra Nevada makes the observatory an excelent place for carrying out other experiments and studies. For this, in addition to the main building, there are secondary facilities which complete the infrastructure available. In this sense, the Spectral Airglow Temperature Imager (SATI) is a Fabry-Perot spectrometer belonging to the IAA's Terrestial Planets Atmospheres Group and it is dedicated to the study of the high layers of the Earth's atmosphere.

Observations and scientific results in 2017

Due to the size of their telescopes, the OSN is specially suited for projects requiring a prompt response (Target of Opportunity, ToO) and/or monitoring observations during long periods of time. Some of them were:

- An exhaustive study of the "supernova impostor" SN 2015bh in NGC2770 in the final stage of its evolution using different observations of the outbursts obtained in several years.
- Photometric observations of comet 67P/Churyumov-Gerasimenko carried out using the T150 telesope in support of the Rosseta mission.
- Multisite observations to detect the presence of a ring around the dwarf planet Haumea, including T150.
- A complementary photometric monitoring programme of a sample of interesting objects for the CARMENES project.

Collaborations in 2017

The observatory continued its collaboration with the Huelva University on the installation of the OSN fireball detection station. These detection cameras are part of the SMART project to monitor the sky in order to analyse the interplanetary matter impacting our planet. In the geoscientific field, a GPS station belonging to the Topo-Iberia project was used to perform integred studies on topography and 4-D evolution.

Sierra Nevada Observatory at twilight

An accurate and complete weather station is a fundamental instrument for an observatory located at very high altitude. Extreme conditions of temperature, wind, humidity, pressure, etc., as well as rapid variations in their values can affect the observations. For this, the observatory started in 2017 collaborations with two companies, FT Technologies and Lambrecht Meteo, in order to test new weather sensors.

Together with the IAA Sky Quality Office, the OSN was present at several meetings and courses for the defense and protection of the dark sky.

As in previous years, the observatory performed observations related to educational activities: observing practices of the Master in Astronomy and Astrophysics organized by the Valencia International University and observing sessions for the PIIISA project to introduce Andalucian Secondary students to the research.

The OSN also participated in multiple outreach activities, such as the summer scientific campus organizated by the Granada University. It must be particularly emphasized the guided visits, public observations, and talks organized at OSN every summer since 2006 (https://www.osn.iaa.csic.es/general/visita-guiada).

MEMBERS

OSN Director: S. Martín Ruiz.

OSN Technical Support Head: L. Costillo Iciarra and M. Abril

Members: F. J. Aceituno Castro, V. M. Casanova Escurín, J. L. de la Rosa Álvarez, A. López Comazzi, J.A. Mirasol Junco, T. Pérez Silvente, J. A. Ruiz Bueno, F. Sánchez Funes, A. Sota Ballano.

UDIT INSTRUMENTAL AND TECHNOLOGICAL DEVELOPMENT UNIT

THE **UDIT** PRIME OBJECTIVES ARE THE TECHNOLOGICAL DEVELOPMENT OF SCIENTIFIC INSTRUMENTATION AND TECHNICAL SUPPORT TO THE IAA SCIENTISTS AND OBSERVATORIES.

The Instrumental and Technological Development Unit (Unidad de Desarrollo Instrumental y Tecnológico, UDIT) has been in operation at the IAA since its foundation in 1975. State-of-the-art instruments designed and built at the UDIT for balloon and terrestrial rocket payloads in early times and for space missions and ground-based observatories nowadays have put the IAA on the map as a reference center for technological-challenging research projects. The technical production at the UDIT can be split into two major lines:

- Analysis, design, integration, and verification of astronomical instruments for ground-based telescopes, especially for the telescopes at Calar Alto Observatory (CAHA) and Sierra Nevada Observatory (OSN).

- Analysis, design, integration, and verification of astronomical instruments for interplanetary scientific missions.

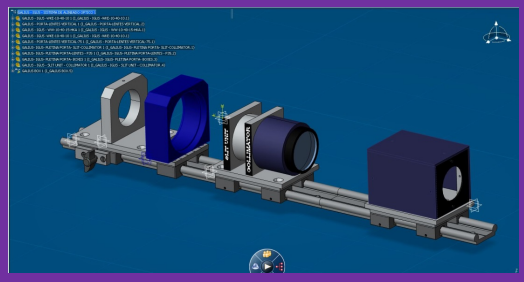
GROUND BASED INSTRUMENTS

CARMENES. The NIR channel performances on the sky achieved a RVs of 2-4 m/s, confirmed through comprehensive high-cadence follow-up of *Luytens* star.

MEGARA (GTC). The IAA contributed with the software suite MEGARA-FMPT. Arrived to GTC on March 2017, and after the integration and commissioning, on 24th July took place its official first light.

MIMA (Multi-Spectral Imager Mesopause Airglow). The instrument, based upon a well proven concept of the instrument SATI currently working at OSN, is a portable ground based image (2D) VIS-NIR spectrometrer with 5 channels for long long-term monitoring of mesopause change. Completely designed by IAA engineers in collaboration with the York University along 2017.

Artificial view of the MIMA instrument



GALIUS mechanical design

GALIUS (GrAnada LIghtning Ultrafast Spectrograph), a portable, high spectral resolution imaging spectrograph that achieves unprecedented high speeds, designed to work in the ultraviolet, visible and near infrared spectral ranges. The project aims at determining key spectral properties (electron density and temperature, electric current electric field, etc) of the different temporal phases (streamers, leaders, return stroke and arcs) of lightning in order to understand lightning dynamics and the chemical influence of lightning in the atmosphere. The instrument, designed by IAA engineers, initiated its assembly in the IAA lab.

HIRES (High Resolution Spectrograph for E-ELT). The IAA is involved in the thermal design of ZYHJ and BVRI channels. The phase A documentation was delivered and review by ESO.

GREST (Get Ready for EST). The IAA is in charge of the development of large size liquid crystals modulators for EST. We manufacture 15cmx15cm cells, 6 times lager than those currently available on the market.

SPACE PROJECTS:

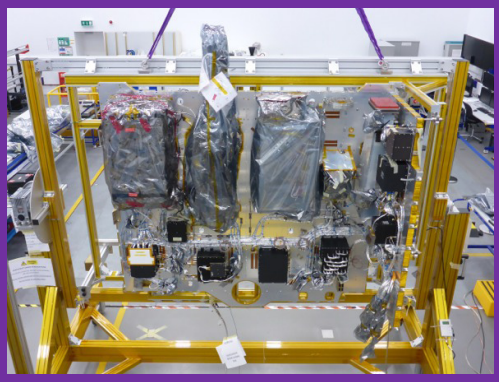
PHI (Polarimetric and Helioseismic Imager for the ESA Solar Orbiter mission). The IAA is the co-PI institution and its Solar Physics group coordinates the Spanish team. IAA is responsible for the electronics unit and the harness work packages. In 2017 we did the mechanical integration and test of the E-Unit FM model, delivered to MPS for integration with the O-Unit and the integration with the fly harness. We manufacturated, integrated and tested the E-Unit FS model, and delivered QM and FM models of the RTE module.

NOMAD (Nadir and Occultation for Mars Discovery for the ESA ExoMars-TGO mission). The IAA is the co-PI institution of the international consortium led by IASB-BIRA (Belgium). The mission, and NOMAD, completed the second set of important science calibration tests before a year of aerobraking gets underway. Its first science operation is expected for March 2018.

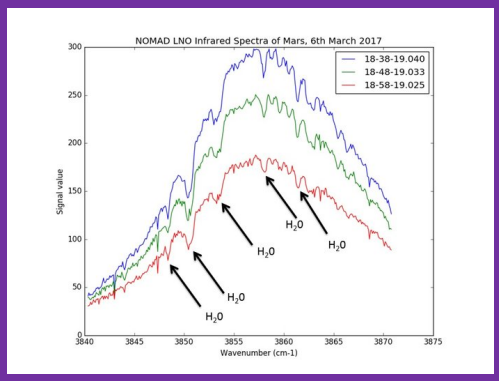
GALA (GAnymede Laser Altimeter) and **JANUS** (Jovis, Amorum ac Natorum Undique Scrutator) for the ESA mission JUICE. The IAA is responsible for the power supply modules of both instruments, and the filter wheel and mechanism controller module (FWM-MCM) of the JANUS camera. The activities were focused in the finalization the manufacturing and testing of the engineering models (EM) of the Power Supply-Motion Control boards (PSM-MCM) for both JANUS and GALA. At the same time, the environmental tests to characterize the JANUS filter wheel with the integration model were done; also the Structural thermal model (STM) of the filter wheel was finished to be delivered.

PLATO (PLAnetary Transits and Oscillation of stars, ESA). The IAA is responsible for the MEUs (Main Electronic Units) for the control and acquisition of the "normal" cameras. The B2 phase activities continued in the course of 2017, and in June 2017 the mission was finally adopted in the ESA Science Programme. At the IAA, the three prototype boards of the MEU were designed and manufactured. The iPDF was delayed to to 2018.

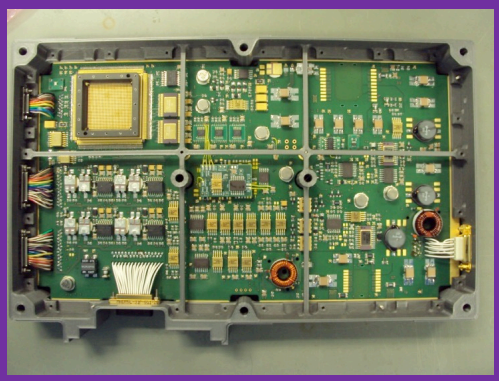
SUNRISE III. The IAA is in charge of the control hardware and software for the **IMaX+** and **SCIP** instruments. In the course of 2017 activities were focused on the conceptual design of the control system of both instruments.



SO/PHI E-UNIT FM during the fly harness integration



Water vapour spectra detected by NOMAD



JANUS PSM-MCM engineering board

UDIT Members

Electronics: M. Abril, D. Álvarez, B. Aparicio, L. P. Costillo, F. J. Girela, M. Herranz, J. M. Jerónimo, J. Jiménez, P. Labrousse, H. Magán, I. Martínez, J. L. Ramos, N. Robles, J. Rodrigo, J. Sánchez, M. R. Sanz, A. Tobaruela.

Mechanics: S. Becerril, I. Bustamante, R. Calvo, E. Mirabet, F. Álvarez, M. A. Sánchez.

Optics: F. J. Bailén, A. Maza.

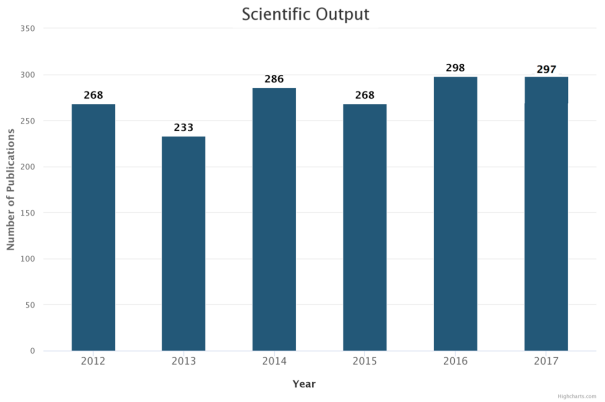
Project Management: M. Balaguer, J. M. Castro, A. López, J. F. Rodriguez.

Software: J. P. Cobos, A. García, J. M. Gómez, D. Hernández, J.M. Ibáñez, R. Morales, A. J. Moreno, M. Passas, C. Pastor, A. Sánchez.

SCI PUBLICATIONS

The research activity carried out at the IAA-CSIC during 2017 can be measured by the number of publications in scientific journals included in the Science Citation Index (SCI), i.e., international journals recognized by their quality and impact. This year, this activity has resulted in 297 papers published in journals of the SCI.

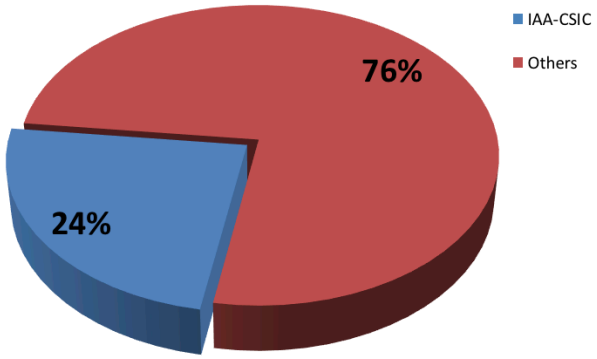
The complete list of the IAA-CSIC publications in 2017 is given in the Annex at the end of this report. The evolution of the number of SCI publications since 2012 is shown below. The number of publications shows a steady increasing trend with time. The IAA-CSIC publications in 2017 exceeds the average of the previous 5 years by almost 10%.

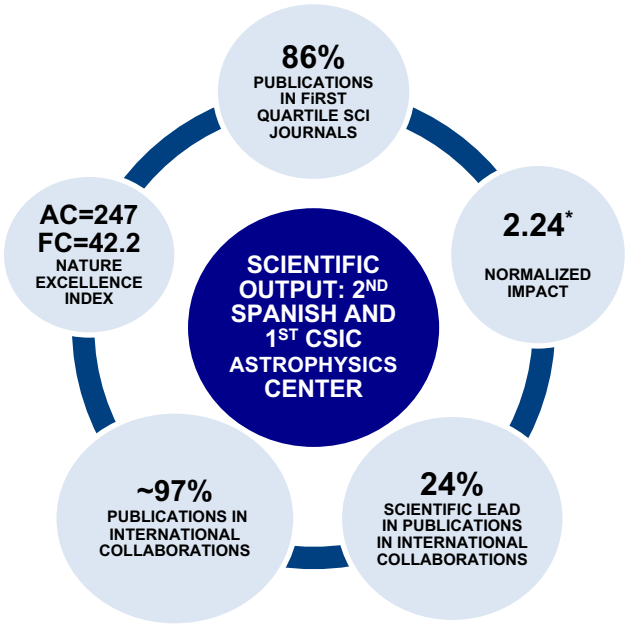


The publications of the IAA-CSIC are mostly distributed in high impact journals (see the figure in the following page). About 86% of our publications are made in journals of the first quartile (top 25% journals). Among these publications, 12% are made in the first decile (top 10% journals). Most of the IAA-CSIC scientific results are published in Astronomy & Astrophysics and Monthly Notices of the Royal Astronomical Society, the main European astronomical journals. A significant fraction of these results are published in Astrophysical Journal, the most important American astronomical journal.

Other aspects of the scientific research of the IAA and its quantitative results are the leadership and internationalization of these publications. About a quarter (24%) of the IAA SCI 2017 publications are led by IAA scientists, i.e. their first author belongs to the IAA. This is consistent with the leadership of the IAA in the last 5 years. Furthermore, 97% of the IAA publications include authors from international institutions, probing the extraordinary level of internationalization of the IAA research.

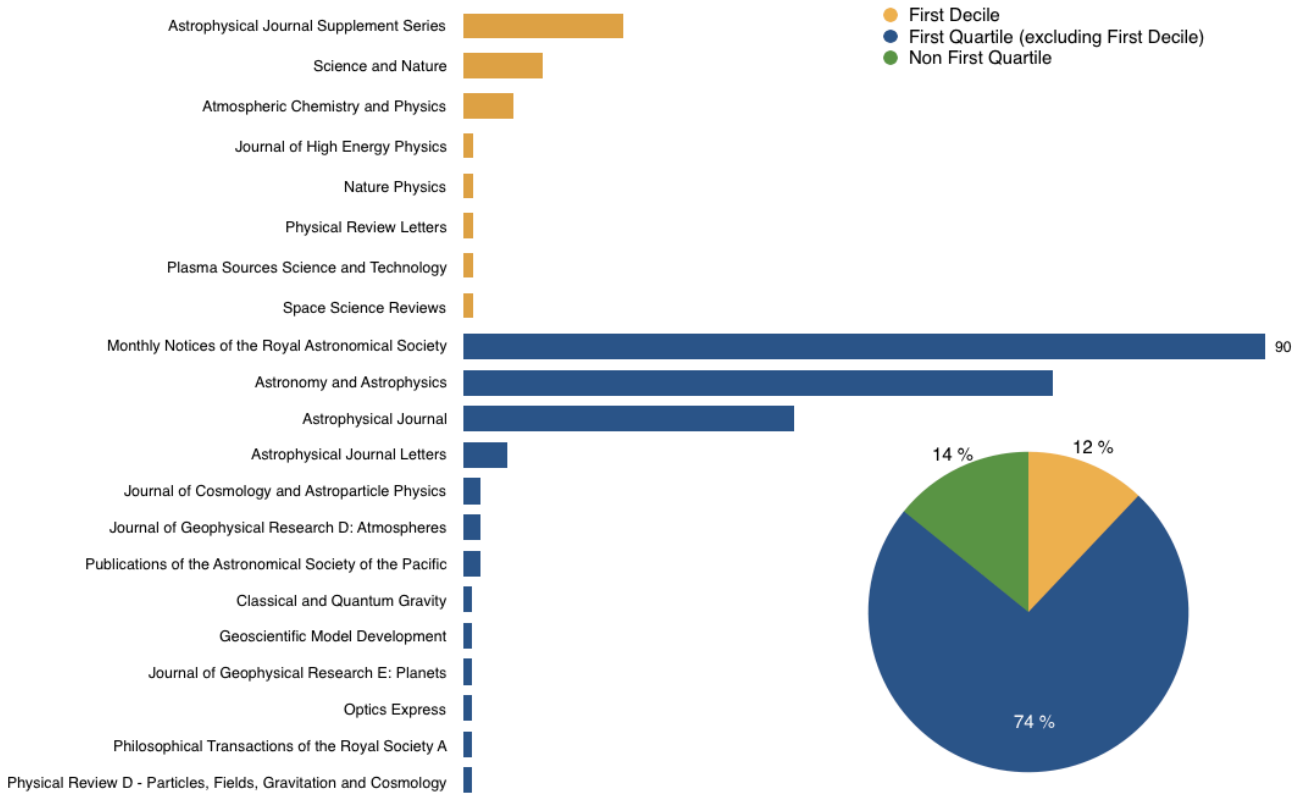
Publications Leadership 2017





In the tracking of scientific papers made by Nature, they provide the Article Count (**AC**), which accounts for the total number of papers for a given institution, and the Fractional Count (**FC**), that takes into account both the percentage of authors from that institution and the number of affiliated institutions. According to these **Nature indices** the scientific output of the IAA in 2017 ranks, among the Spanish centers devoted to research in astrophysics, the second position in Spain and the first one among the centers of CSIC.

*Since the numbers for calculating the normalized impact for 2017 are not available at the time of submitting this report, the normalized impact corresponds to that of 2016.


First Decile
First Quartile (excluding First Decile)
Non First Quartile
Astrophysical Journal Supplement Series
Science and Nature
Atmospheric Chemistry and Physics
Journal of High Energy Physics
Nature Physics
Physical Review Letters
Plasma Sources Science and Technology
Space Science Reviews
Monthly Notices of the Royal Astronomical Society
Astronomy and Astrophysics
Astrophysical Journal
Astrophysical Journal Letters
Journal of Cosmology and Astroparticle Physics
Journal of Geophysical Research D: Atmospheres
Publications of the Astronomical Society of the Pacific
Classical and Quantum Gravity
Geoscientific Model Development
Journal of Geophysical Research E: Planets
Optics Express
Philosophical Transactions of the Royal Society A
Physical Review D - Particles, Fields, Gravitation and Cosmology
90
14 %
12 %
74 %

EDUCATION

PHD THESES

"El Componente social en espacios protegidos: contribución al estudio de la percepción de la población local en el espacio natural Sierra Nevada "

Author: Alicia Pelegrina López

Supervisors: Francisco Serrano Bernardo

Universidad de Granada Jun 02, 2017

"Diseño e implementación de un espectrógrafo y un polarímetro para el análisis de plasmas de aire producidos por eventos luminosos transitorios en la mesosfera terrestre"

Author: María Passas Varo

Supervisors: Francisco José Gordillo Vázquez, Alejandro Luque Estepa

Universidad de Granada Jun 19, 2017

"Multi-band galaxy surveys"

Author: William Schoenell

Supervisors: Narciso Benítez Lozano

Universidad de Granada Sep 28, 2017

"A multi-frequency study of the star formation histories of galaxies in the integral field area survey CALIFA"

Author: Rafael López Fernández

Supervisors: Rosa María González Delgado

Universidad de Granada Sep 29, 2017

"Propiedades físicas de los objetos transneptunianos y centauros."

Author: Estela del Mar Fernández Valenzuela

Supervisors: José Luis Ortiz Moreno, René Damián Duffard

Universidad de Granada Oct 27, 2017

"THE SHAPE OF THE IONISED GAS ABUNDANCE DISTRIBUTION IN SPIRAL GALAXIES"

Author: Laura Sánchez Menguiano

Supervisors: Sebastián Francisco Sánchez Sánchez

Universidad de Granada Dec 20, 2017

TEACHING

Master and PhD Programs

Title: ***Astrobiología y Planetas Extrasolares III***
Authors: **Miguel Angel López Valverde y Juan Carlos Suárez**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: Universidad de Granada (UGR)
Hours: 32
Date: April and May, 2017

Title: ***Astrofísica de Altas Energías***
Authors: **Alberto Javier Castro Tirado, Martín Antonio Guerrero Roncel, Binbin Zhang**
Program: Física y Matemáticas – FISYMAT
University: Universidad de Granada (UGR)
Hours: 30
Date: March – May, 2017

Title: ***Cosmología y galaxias***
Authors: **Emilio Alfaro Navarro**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: Universidad de Granada (UGR)
Hours: 30
Date: January, 2017

Title: ***Detectores de radiación***
Authors: **Jorge Iglesias Páramo**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: Universidad de Granada (UGR)
Hours: 15
Date: October - December, 2017

Title: ***Radioastronomía e Interferometría***
Authors: **José Francisco Gómez Rivero, Antonio Maria Alberdi Odriozola, Guillem Josep Anglada Pons**
Program: Física y Matemáticas – FISYMAT
University: Universidad de Granada
Hours: 60
Date: October 2017 – February 2018

Title: ***Curso de Astrofísica Estelar***
Authors: **Javier Pascual Granado**
Program: Máster Online en Astronomía y Astrofísica
University: Universidad Internacional de Valencia
Hours: 30
Date: July-October, 2017

Title: ***Thermal and non-thermal radio emitting process in Astrophysics***
Authors: **Miguel Pérez-Torres**
Program: Máster de Física Avanzada
University: Universidad de Valencia
Hours: 10
Date: February and March, 2017

Title: **Galactic and Extragalactic Astronomy**
Authors: Mirjana Povic
Program: PhD in A&A
Organizer: Ethiopian Space Science and Technology Institute (ESSTI)
Hours: 75
Date: March - May, 2017

Title: **Stellar interior and evolution and Radiation Measurements in Astrophysics**
Authors: Mirjana Povic
Program: MSc in A&A
Organizer: ESSTI
Hours: 75
Date: November 2017 - January 2018

Title: **Computational and statistical astrophysics**
Authors: Mirjana Povic, Seblu Humne
Program: MSc in A&A
Organizer: ESSTI
Hours: 75
Date: November - December, 2017

Other Programs

Title: ***Physics of the Interstellar Medium***
Authors: **Enrique Pérez Jiménez**
Program: Courses at IAA-CSIC
Organizer: IAA-CSIC
Hours: 10
Date: November 2017

Title: ***Integral Field Spectrosocopy: stellar populations and interstellar medium analysis***
Authors: **Rubén García Benito**
Program: School of Astronomy and Space Science
Organizer: Nanjing University (China)
Hours: 24 hours
Date: September 2017

Title: **Luz y Gravitación**
Authors: Emilio J. Alfaro
Program: XIX Curso de Verano de la UAL "La luz que nos llega del cielo"
Organizer: Universidad de Almería
Hours: 2,5 hours
Date: July, 2017

Title: **First OPTICON instrumentation school**
Authors: Christina Thöne, Antonio de Ugarte
Program: OPTICON Schools –H2020
Organizer: Dark Cosmology Center
Hours: 80 hours
Date: July, 2017

INTERNATIONAL

SEMINARS

Francisco José Aceituno Castro (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Calar Alto, presente y futuro"
Date: Jan 12, 2017

José Francisco Gómez Rivero (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Witnessing the birth of a planetary nebula"
Date: Jan 19, 2017

★ **Joel Sanchez-Bermudez** (Max Planck Institute for Astronomy)
Title: "GRAVITY/VLTI early scientific results: multiplicity and imaging"
Date: Jan 20, 2017

Luca Izzo (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Novae as Lithium factories in the Milky Way"
Date: Jan 26, 2017

★ **Rosario Brunetto** (Institut d'Astrophysique Spatiale)
Title: "Asteroid surfaces: irradiation and VIS-IR micro-spectroscopy in the laboratory"
Date: Jan 31, 2017

★ **Juan Usón** (Instituto de Astrofísica de Canarias (IAC))
Title: "Living on the Edge: Superthin Galaxies and the Cosmic UV Background"
Date: Feb 02, 2017

★ **Leslie Hunt** (Osservatorio Astrofisico di Arcetri)
Title: "Molecular gas and dust in low-metallicity starbursts"
Date: Feb 09, 2017

★ **Sergio Toledo Redondo** (European Space Agency)
Title: "Cold plasma and magnetic reconnection at the magnetopause boundary layer"
Date: Feb 16, 2017

Michael Jones (Instituto de Astrofísica de Andalucía - CSIC)
Title: "The impact of environment and confusion of the observed HI galaxy population"
Date: Feb 23, 2017

★ **Luis Ho** (Peking University)
Title: "Supermassive Black Holes: Impact on Galaxy Formation and Evolution"
Date: Mar 02, 2017

★ **Orsolya Fehér** (Lorand Eotvos University)
Title: "Revealing the circumstellar environment of eruptive young stars"
Date: Mar 08, 2017

★ **Joyce Byun** (University of Sussex)
Title: "Recovering information beyond the power spectrum of large-scale structure"
Date: Mar 09, 2017

★ **Michael Perryman** (European Space Agency)
Title: "Space astrometry: the Hipparcos and Gaia missions"
Date: Mar 16, 2017

★ **Michael Perryman** (European Space Agency)
Title: "Detection of gravitational waves from space: the LISA mission "
Date: Mar 23, 2017

★ **Qiusheng Gu** (Nanjing University)
Title: "Star formation in nearby early-type galaxies"
Date: Mar 30, 2017

Sebastiano de Franciscis (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Fractal analysis in pulsating stars: what is and what we can learn from it"
Date: Apr 06, 2017

Rosa María González Delgado (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Spatially resolved star formation history of CALIFA galaxies: Implications for galaxy formation"
Date: Apr 20, 2017

★ **Jorge García Rojas** (Instituto de Astrofísica de Canarias)
Title: "The large abundance discrepancy phenomenon in planetary nebulae"
Date: Apr 27, 2017

★ **J.L. Jaramillo** (Université de Bourgogne)
Title: "Gravitational waves: the 'other light' from Cosmos"
Date: Apr 28, 2017

★ **Francisco M. Gómez Campos** (Universidad de Granada)
Title: "Blender 3D, el programa definitivo"
Date: May 09, 2017

★ **Gerald J. Fishman** (NASA Marshall Space Flight Center)
Title: "The Early History of Gamma-ray Bursts"
Date: May 11, 2017

★ **Viggo Hansteen** (University of Oslo)
Title: "Bombs and flares at the Surface and Lower Atmosphere of the Sun"
Date: May 18, 2017

★**John Cannon** (Macalester College)
Title: "The Faint End of the HI Mass Function"
Date: May 25, 2017

Fernando Bordons Mesonero (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Servicios Administrativos en el IAA"
Date: Jun 01, 2017

★ **Jeff Scargle** (NASA Ames Research Center)
Title: "The Dynamic Universe: Adventures in Time Series Analysis "
Date: Jun 08, 2017

José Carlos del Toro Iniesta (Instituto de Astrofísica de Andalucía - CSIC)
Title: "An overview of the first science from the Sunrise II mission"
Date: Jun 29, 2017

Antxon Alberdi Odriozola (Instituto de Astrofísica de Andalucía - CSIC)
Title: "High resolution radio imaging of nearby star-forming galaxies: on the way to SKA"
Date: Sep 07, 2017

★**Jackeline Rechy Garcia** (Universidad Nacional Autónoma de México)
Title: "Hydrodynamical models of planetary nebulae with [WC] central stars "
Date: Sep 14, 2017

★ **Matt Visser** (Victoria Univeristy)
Title: "Analogue spacetimes"
Date: Sep 21, 2017

★ **José Miguel Rodríguez-Espinosa** (Instituto de Astrofísica de Canarias (IAC))
Title: "High-z proto-clusters with the GTC"
Date: Sep 27, 2017

★ **Melanie Köehler** (Queen Mary University of London)
Title: "Dust evolution in the interstellar medium "
Date: Oct 05, 2017

★ **Ian Bird** (CERN)
Title: "SKA and LHC: Pioneering Exabyte-scale scientific "
Date: Oct 16, 2017

★ **Michael Wise** (ASTRON)
Title: "SKA Science Data Centres: A Platform for Global Astronomy"
Date: Oct 16, 2017

★ **Olga Suarez** (Observatoire de la Côte d'Azur)
Title: "Bringing science to kids and general public at the Observatoire de la Côte d'Azur"
Date: Oct 19, 2017

Zachariah Ezekiel Wesley Cano (Instituto de Astrofísica de Andalucía - CSIC)
Title: "The Supernovae that Accompany Gamma-ray bursts"
Date: Oct 26, 2017

David Alexander Kann (Instituto de Astrofísica de Andalucía - CSIC)
Title: "W170817/GRB 170817A/AT2017gfo: A Tryptich of Rosetta Stones for Compact Object Astrophysics"
Date: Nov 02, 2017

Rafael Morales Muñoz (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Conclusions after the first work of Master's degree in Data Science at the IAA"
Date: Nov 09, 2017

José Luis Ortiz Moreno (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Surprising characteristics of the dwarf planet Haumea revealed by a stellar occultation"
Date: Nov 16, 2017

Rafael Morales Muñoz (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Fighting in Maya ruins: Data Engineering, Data Science, computation clusters and the trans-neptunian search tool"
Date: Nov 23, 2017

Binbin Zhang (Instituto de Astrofísica de Andalucía - CSIC)
Title: "GRB 170817A: a peculiar low-luminosity short gamma-ray burst associated with a NS-NS merger gravitational wave signal"
Date: Nov 30, 2017

★ **Alvaro Rojas** (Pontificia Universidad Católica de Chile)
Title: "The Galactic Bulge at the crossroads of stellar populations"
Date: Dec 12, 2017

★ **Alejandro Clocchiatti** (Pontificia Universidad Católica de Chile)
Title: "Type Ia Supernovae and the Discovery of Cosmic Acceleration"
Date: Dec 12, 2017

VISITING SCIENTISTS

Alba Aller Egea
Not assigned
16/10/2017 - 27/10/2017

Francisco Javier Alonso-Floriano
Leiden Observatory
24/07/2017 - 30/07/2017

Alvaro Alvarez Candal
Observatorio Nacional de Rio de Janeiro
20/04/2017 - 05/05/2017

Javier Blasco Herrera
Oxford Nanopore Technologies
03/07/2017 - 07/07/2017

Tom Broadhurst
Universidad del País Vasco
23/02/2017 - 25/02/2017

Gabriele Bruni
Max Planck Institute for Radioastronomy
20/03/2017 - 24/03/2017

Joyce Byun
University of Sussex
15/09/2017 - 23/09/2017
02/05/2017 - 05/05/2017
06/03/2017 - 10/03/2017

Adriano Campo Bagatin
Universidad de Alicante
27/03/2017 - 31/03/2017

José Iván Campos Rozzo
University of Graz
12/10/2017 - 12/12/2017

John Cannon
Macalester College
25/05/2017 - 25/05/2017

Raúl Carballo Rubio
Not assigned
06/09/2017 - 13/09/2017

Carolina Casadio
Max Planck Institute for Radioastronomy
23/10/2017 - 27/10/2017

Jean-Yves Chaufray
CNRS (Centre National de la Recherche Scientifique)
26/06/2017 - 30/06/2017

Roberto Cid Fernandes
Universidade Federal de Santa Catarina
25/09/2017 - 03/10/2017
01/02/2017 - 28/02/2017

Robert Content
Australian Astronomical Observatory
03/09/2017 - 06/09/2017

José Luis Contreras
Universidad Complutense de Madrid
18/07/2017 - 19/07/2017

Javier Coronado
Instituto de Física Teórica - UCM/CSIC
16/11/2017 - 17/11/2017

Romano L.M. Corradi
Instituto de Astrofísica de Canarias (IAC)
23/10/2017 - 25/10/2017

Itziar de Gregorio Monsalvo
Joint ALMA Observatory
19/07/2017 - 20/07/2017

Renato Dupke
Observatorio Nacional de Rio de Janeiro
26/09/2017 - 15/10/2017
22/04/2017 - 18/06/2017

Florence Durret
Institut d'Astrophysique de Paris
13/02/2017 - 19/02/2017

Xuan Fang
University of Hong Kong
19/09/2017 - 29/09/2017

Anja Feldmeier-Krause
University of Chicago
15/05/2017 - 19/05/2017

Elisa Frattin
Universitá di Padova
27/10/2017 - 15/12/2017

Juan Luís Gómez González
Centro de Astrobiología - CSIC
09/01/2017 - 30/06/2017

Omaira González Martín
Centro de Radioastronomía y Astrofísica, UNAM
15/05/2017 - 20/05/2017

Hannes Gröller
University of Arizona
12/06/2017 - 16/06/2017

Hansteen, Viggo
University of Oslo
01/01/2017 – 31/12/2017

Rubén Herrero Illana
European Southern Observatory
17/07/2017 - 01/08/2017

Walter Huchtmeier
Max Planck Institute for Radioastronomy
21/03/2017 - 23/03/2017

Leslie Hunt
Osservatorio Astrofisico di Arcetri
07/02/2017 - 10/02/2017

Yolanda Jiménez Teja
Observatorio Nacional de Rio de Janeiro
04/05/2017 - 26/05/2017

Antonio Kanaan
Universidade Federal de Santa Catarina
25/09/2017 - 03/10/2017

David Alexander Kann
Thueringer Landessternwarte Tautenburg
09/02/2017 - 11/02/2017

Anatoly Klypin
New Mexico State University
20/11/2017 - 24/11/2017

Melanie Köhler
Queen Mary University of London
05/10/2017 - 05/10/2017

Evgeniya V. Kravchenko
Astro Space Center of Lebedev Physical Institute
30/09/2017 - 30/11/2017

Heidi Lietzen
Tartu Observatoorium
05/06/2017 - 09/06/2017

Emilio Llorente Pérez
Generalitat de Catalunya
02/10/2017 - 03/10/2017

Rafael López Fernández
Instituto de Astrofísica de Andalucía - CSIC
03/05/2017 - 11/06/2017

Enrique Macías Quevedo
Boston University
13/12/2017 - 13/12/2017

Juan Martinez-Sykora
Lockheed Martin Solar and Astrophysics Laboratory (LMSAL)
19/06/2017 - 23/06/2017

Paola Marziani
Osservatorio Astronomico di Padova
27/02/2017 - 10/03/2017

Zaira Modroño Berdiñas
Universidad de Chile
19/06/2017 - 23/06/2017

Antonio David Montero Dorta
University of Utah
16/03/2017 - 16/06/2017
16/01/2017 - 16/02/2017

Graham Murray
Durham University
03/09/2017 - 06/09/2017

Gilles Niccolini
Université de Nice Sophia Antipolis
12/07/2017 - 18/07/2017

Anna Niemiec
Laboratoire d'Astrophysique de Marseille
19/11/2017 - 24/11/2017

Mireia Nievas
Universidad Complutense de Madrid
18/07/2017 - 19/07/2017

Samantha Rachel Oates
University of Warwick
07/11/2017 - 10/11/2017

Ada Ortiz Carbonell
University of Oslo
01/01/2017-31/12/2017

Michael Perryman
University College Dublin
06/03/2017 - 21/04/2017

Sergey Pilipenko
Lebedev Physical Institute
13/11/2017 - 17/11/2017

Gu Qiusheng
Instituto de Astrofísica de Andalucía - CSIC
26/03/2017 - 04/04/2017

Gerardo Ramos Larios
Universidad de Guadalajara
22/05/2017 - 04/06/2017

Venkatessh Ramakrishnan
Universidad de Concepción
22/05/2017 - 04/06/2017

Jackeline Rechy García
Universidad Nacional Autónoma de México
19/07/2017 - 19/09/2017

Ulises Reyes
Universidad de Sinaloa
14/06/2017 - 01/09/2017

Pactrick Roche
Oxford University
20/03/2017 - 21/03/2017

Luis Felipe Rodriguez
Centro de Radioastronomía y Astrofísica, UNAM
15/05/2017 - 17/05/2017

Joel Sánchez Bermúdez
Max Planck Institute for Astronomy
16/01/2017 - 25/01/2017

Miguel Ángel Sánchez Conde
Instituto de Física Teórica - UCM/CSIC
16/11/2017 - 17/11/2017

María del Carmen Sánchez Gil
Universidad de Cádiz
19/06/2017 - 24/06/2017

Edgar Ivan Santamaria
Universidad de Guadalajara
05/09/2017 - 30/11/2017

Anthony Schmalzried
Not assigned
04/12/2017 - 05/12/2017

William Schoenell
Universidade de São Paulo
01/06/2017 - 21/06/2017

Banafsheh Shahza
University of Cologne
15/05/2017 - 26/05/2017

Doris Stoppacher
Instituto de Física Teórica - UCM/CSIC
08/06/2017 - 09/06/2017

Olga Suárez Fernádez
Observatoire de la Côte d'Azur
15/10/2017 - 21/10/2017

Charlie Telesco
University of Florida
20/03/2017 - 21/03/2017

Clemens Thum
IRAM
2017

Sergio Toledo Redondo
European Space Agency
14/02/2017 - 17/02/2017

Dominik Utz
University of Graz
07/11/2017 - 15/11/2017

Eskil Varenius
Onsala Space Observatory
28/03/2017 - 30/03/2017

Matt Visser
University of Victoria
06/09/2017 - 06/10/2017

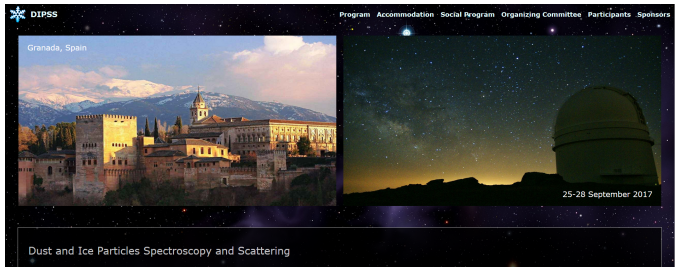
WORKSHOPS AND MEETINGS

Mars Atmosphere Modelling and Observations Workshop
Granada, Spain Jan 17 - 20, 2017
IAA members of the Local Organizing Commitee:
M. López Valverde, F. González Galindo, A. Cala Hurtado, M. López Puertas, J. López Moreno, M. García Comas, A. Pelegrina López, B. Funke, S. Jiménez Monferrer
http://www.granadacongresos.com/mamo

7th Solar Orbiter Workshop: Exploring the solar Environs
Granada, Spain Apr 03 - 07, 2017
IAA members of the Scientific Organizing Commitee:
J. del Toro Iniesta, L. Bellot Rubio
IAA members of the Local Organizing Commitee:
J. del Toro Iniesta, A. Ortiz Carbonell
http://spg.iaa.es/solo2017/

SKA-link kick-off meeting
Granada, Spain Apr 03 - 04, 2017
IAA members of the Scientific Organizing Commitee:
L. Verdes-Montenegro, S. Sánchez, J. Garrido
IAA members of the Local Organizing Commitee:
M. Fernández-Peña, J. Garrido, S. Sánchez, J.R. Rodón
http://amiga.iaa.es/p/330-SKA-Link.htm

Time & Measurement Workshop
Granada, Spain Jun 06 - 08, 2017
IAA members of the Scientific Organizing Commitee:
R. Garrido Haba, L. Verdes-Montenegro Atalaya, J. Pascual Granado, S. de Franciscis
IAA members of the Local Organizing Commitee:
J. Rodón Ortiz, J. Pascual Granado, M. Fernandez-Peña Mollá, S. de Franciscis
http://tmw.iaa.es/



Dust and Ice Particles Spectroscopy and Scattering
Granada, Spain Sep 25 - 28, 2017
IAA members of the Organizing Commitee:
J. Escobar Cerezo, D. Guirado Rodriguez, O. Muñoz Gómez
http://www.iem.csic.es/fismol/DIPSS/index.shtml

La bóveda celeste como recurso científico, cultural, medioambiental y turístico (curso UIMP)
Granada, Spain Sept 18 - 22, 2017
IAA members of the Scientific and Local OC:
J.M. Vílchez, A. Pelegrina
https://bit.ly/2wOBvi9

Fifth Workshop on Robotic Autonomous Observatories
Mazagón, Spain Oct 16 - 20, 2017
IAA members of the Scientific Organizing Commitee:
A. Castro Tirado
IAA members of the Local Organizing Commitee:
F. Rendón Martos, R. Cunniffe, Y. Hu, J. Tello Salas, B. Zhang
http://astrorob.iaa.es

SKA-Link face-2-face meeting
Granada, Spain Oct 17, 2017
IAA members of the SOC:
L. Verdes-Montenegro, J. Garrido
IAA members of the Local Organizing Commitee:
M. Fernández-Peña, J. Garrido, S. Sánchez, J. R. Rodón, M. Lares
http://amiga.iaa.es/p/330-SKA-Link.htm

AENEAS 1st All-hands Meeting
Granada, Spain Oct 18-20, 2017
IAA members of the Local Organizing Commitee:
L. Verdes-Montenegro, M. Fernández-Peña, J. Garrido, S. Sánchez, J. R. Rodón, M. Lares
https://bit.ly/2Ht5OQr

Spanish X-ray Astronomy 2017: the path towards Athena
Granada, Spain Oct 23 - 25, 2017
IAA members of the Scientific Organizing Commitee:
M. Guerrero Roncel, I. Márquez Pérez, J. Masegosa Gallego
IAA members of the Local Organizing Commitee:
S. Cazzoli, M. Guerrero Roncel, C. Kehrig, I. Márquez Pérez, J. Masegosa Gallego
https://bit.ly/2H71AKE

Little Workshop on Large Scale Structure
Granada, Spain Nov 20 - 24, 2017
IAA member of the Scientific and Local OC:
F. Prada Martínez
https://www.iaa.csic.es/meetings/little-workshop-large-scale-structure

STAFF

RESEARCHERS

Permanent Staff

Alberdi Odriozola, Antxon
Aldaya Valverde, Víctor
Alfaro Navarro, Emilio Javier
Anglada i Pons, Guillem Josep
Barceló Serón, Carlos
Bellot Rubio, Luis Ramón
Benítez Lozano, Narciso
Castro Tirado, Alberto Javier
Cerviño Saavedra, Miguel
Claret dos Santos, Antonio
del Olmo Orozco, Ascensión
del Toro Iniesta, José Carlos
Delgado Sánchez, Antonio Jesús
Fernández Hernández, Matilde
Funke, Bernd
Garrido Haba, Rafael
Gómez Fernández, José Luis
Gómez Rivero, José Francisco
González Delgado, Rosa María
Gordillo Vázquez, Francisco José
Guerrero Roncel, Martín
Gutiérrez Buenestado, Pedro José
Iglesias Páramo, Jorge
Lara López, Luisa María
López de Coca Castañer, Pilar
López González, María José
López Jiménez, Antonio Carlos
López Moreno, José Juan
López Puertas, Manuel
López Valverde, Miguel Angel
Márquez Pérez, Isabel
Masegosa Gallego, Josefa
Miranda Palacios, Luis Felipe
Moreno Danvila, Fernando
Muñoz Gómez, Olga
Olivares Martín, José Ignacio
Ortiz Moreno, José Luis
Perea Duarte, Jaime David
Pérez Jiménez, Enrique
Pérez Montero, Enrique
Pérez Torres, Miguel Angel
Prada Martínez, Francisco
Rodríguez Gómez, Julio Federico
Rodríguez Martínez, Eloy
Ruedas Sánchez, José
Schoedel, Rainer
Verdes-Montenegro Atalaya, Lourdes
Vílchez Medina, José Manuel

Emeriti

Rolland Quintanilla, Angel

ERC Consolidator Grant

Luque Estepa, Alejandro
Schoedel, Rainer

Ramón y Cajal Members

Agudo Rodríguez, Juan Iván
de Ugarte Postigo, Antonio
Duffard, René Damián
García Comas, Maia Leire
Thöne, Christina

Juan de la Cierva Members

Cano, Zachariah Ezekiel Wesley
Kann, David Alexander
Zhang, Binbin

Postdoc Fellows

Amado González, Pedro José
Cazzoli, Sara
Cortijo Ferrero, Clara
Costado Dios, María Teresa
Damas Segovia, Ancor Efren
de Franciscis, Sebastiano
Dong, Hui
Duffard, René Damián
García Benito, Rubén
Gardini, Angela
González Galindo, Francisco
González García, Manuel Jesús
González García, Marta
Guirado Rodriguez, Daniel
Izzo, Luca
Jones, Michael Gordon
Kehrig, Carolina
Marcos Caballero, Airam Eduardo
Martín Ruiz, Susana
Molina, Sol Natalia
Orozco Suárez, David
Osorio Gutiérrez, Mayra Carolina
Pascual Granado, Javier
Rodríguez López, Cristina Teresa
Sánchez de Miguel, Alejandro
Sánchez Ramírez, Rubén
Santos Sanz, Pablo

PhD Students

Bensch, Katarzyna Anna
Boaventura Teixeira Gomes, Miguel
Carrasco García, Irene María
Casal López, Estefania
Castro Tirado, Miguel Ángel
Díaz Rodríguez, Ana Karla
Duarte Puertas, Salvador
Escobar Cerezo, Jesús
Fernández Valenzuela, Estela del Mar
Fuentes Fernández, Antonio
Gallego Calvente, Aurelia Teresa
Gallego Cano, Eulalia
Hill, Brittany Nicole
Jiménez Monferrer, Sergio
Kieu, Thi Ny
Lampón González-Albo, Manuel
Lares Martiz, Mariel
López Fernández, Rafael
Lorenzo Gutiérrez, Antonio
Malagón Romero, Alejandro Francisco
Nogueras Lara, Francisco
Pérez Invernón, Francisco Javier
Ramírez Olivencia, Naim
Ramírez moreta, Pablo
Ramos Carmona, Ester
Sánchez López, Alejandro
Sánchez Menguiano, Laura
Tello Salas, Juan Carlos

ENGINEERS AND TECHNICIANS

Mechanics

Alvarez Moreno, Fernando
Becerril Jarque, Santiago
Bustamante Díaz, María Isabel
Calvo Ortega, Rocio
Mirabet Puig, Eduard
Sánchez Carrasco, Miguel Andrés

Electronics

Abril Martí, Miguel
Alvarez García, Daniel
Aparicio del Moral, Beatriz
Balaguer Jiménez, María
Castro Marín, José María
Cobos Carrascosa, Juan Pedro
Cortés Moreno, Guillermo
Costillo Iciarra, Luis Pedro
Girela Rejón, Fernando Javier
Hernández Expósito, David
Herranz de la Revilla, Miguel
Jerónimo Zafra, José María
Jiménez Ortega, Jaime
Labrousse, Pierre
Magan Madinabeitia, Héctor
Martínez Navajas, Ignacio
Morales Palomino, Nicolás Francisco
Moreno Mantas, Antonio Jesús
Ramos Más, José Luis
Robles Muñoz, Nicolás Francisco
Rodrigo Campos, Julio
Sánchez del Río, Justo
Sánchez Gómez, Antonio
Sanz Mesa, María del Rosario
Tobaruela Abarca, Angel

Optics

Bailén Martínez, Francisco Javier
Maza Gutierrez, Antonio

OSN Maintenance/Support

Aceituno Castro, Francisco José
Casanova Escurín, Víctor Manuel
de la Rosa Alvarez, José Luis
López Comazzi, Francisco Alejandro
Mirasol Junco, José Alberto
Pérez Silvente, Tomás
Ruiz Bueno, José Antonio
Sánchez Funes, Fernando
Sota Ballano, Alfredo

Software

Cala Hurtado, Antonio
Cunniffe, Ronan
García Segura, Antonio Jesús
Garrido Sánchez, Julian
Gómez López, Juan Manuel
Husillos Rodríguez, César
Ibáñez Mengual, José Miguel
Morales Muñoz, Rafael
Passas Varo, María
Pastor Morales, María del Carmen
Rodón Ortiz, José Ramón
Ruiz del Mazo, José Enrique
Sánchez Expósito, Susana

SERVICES AND ADMINISTRATION

Administration Services

Bordons Mesonero, Fernando
Cortés Guerrero, María Ángeles
de Castro Díaz, Rosa Irene
Fernandez-Peña Mollá, Marina
Gómez Finnett, Susana Alicia
González Esteva, Alonso Mª
Heredia Maldonado, María José
Herrera Jiménez, Eva María
Madrid Gómez, Carmen Elisa
Molina Guerrero, Josefina
Nieto Serrano, Concepción
Pelegrina López, Alicia
Rodríguez Hernández, Adrián
Torrededia Rodrigo, Cristina

Computer Center

Bayo Muñoz, Francisco Manuel
Guijarro Jiménez, Juan José
Parra Garófano, Rafael

General Services

Molero Delgado, José Francisco
Molina Rodrigo, Antonio
Navarro Ayala, Francisco
Quiles Gutiérrez, Antonio Manuel
Rendón Martos, Francisco

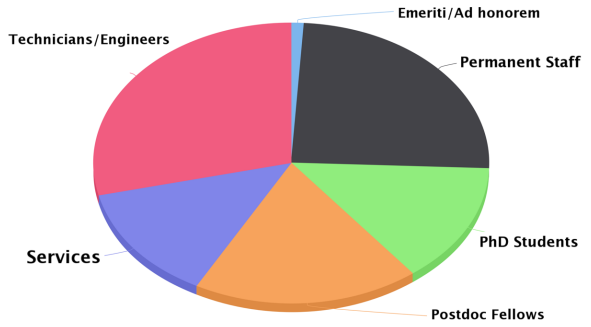
Library

Arco Sarmiento, María Ángeles

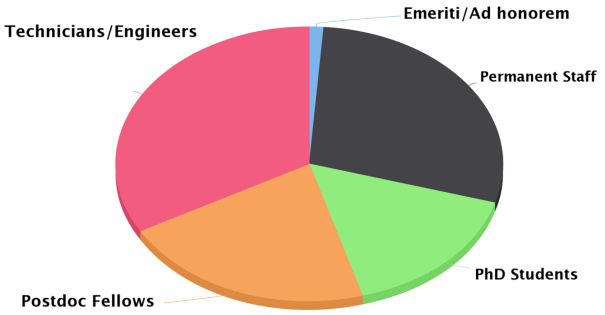
Outreach and Communication Unit

García Gómez-Caro, Emilio José
López de la Calle, Silbia

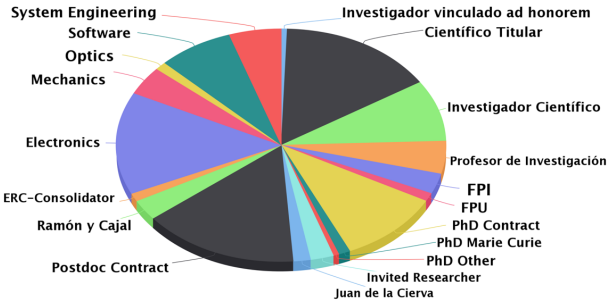
The 2017 IAA staff was distributed among the following general groups. The staff was mainly composed by scientists, with a non negligible fraction of technicians and engineers.



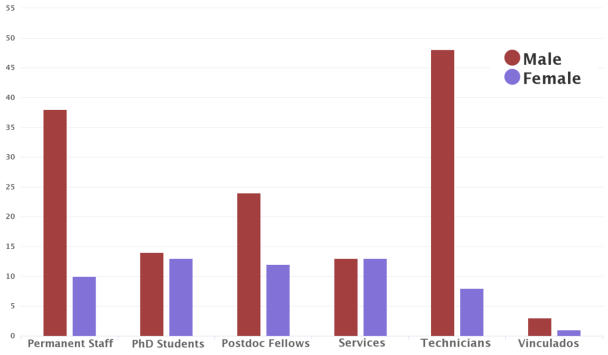
The scientific and technical personnel can be arranged among these overall categories.



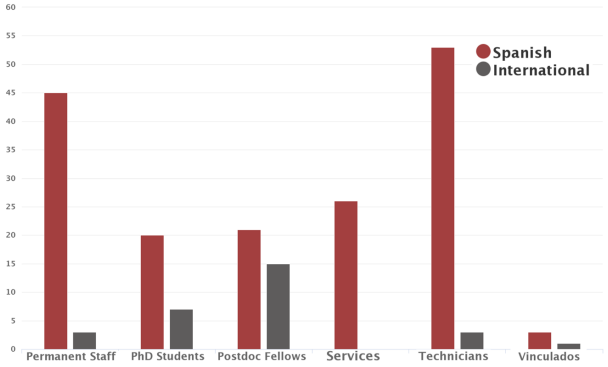
These can be disgregated into the different technician, engineer, and scientific groups.



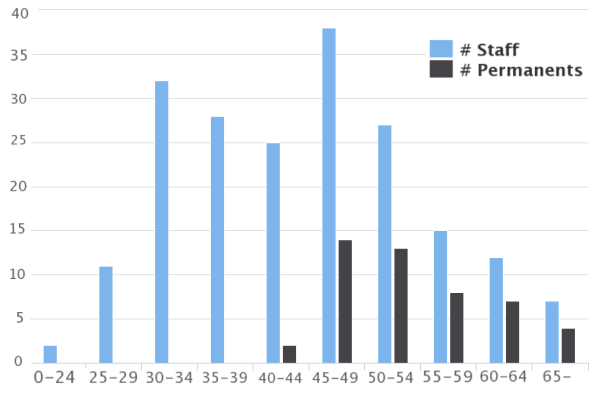
The gender and nationality distribution of the different groups are shown next. The fraction of women was closer to parity among services, PhD students and post-doctoral fellows.



The fraction of international staff was larger among post-doctoral fellows and PhD students.



Finally, the distribution of all the IAA staff and those of scientists with permanent positions by age reveals the aging of the last group.



PUBLIC OUTREACH

PROJECTS HELD DURING 2017

The activities of the IAA-CSIC **Communication, Education and Public Outreach Unit** cover almost all existing formats to communicate science.

- Popular Science Journal *IAA: Información y Actualidad Astronómica*. Issued once every four months, it is devoted to high school and university students, as well as general public interested in astronomy (http://revista.iaa.es). Issues in 2017: 51, 52, 53.

- *El Radioscopio*, a weekly popular science radio program in collaboration with Canal Sur Radio and broadcasted by Radio Andalucía Información. http://radioscopio.iaa.es

- *Lucas Lara* popular talks. These conferences began in 1995. We celebrate nine talks every year. https://www.iaa.csic.es/lucas_lara

- *¿Eres de óptico o de radio?* Summer weekend astronomical and tourist event that includes a visit to the IAA-CSIC Observatory of Sierra Nevada (OSN) and to the IRAM 30-meter radioantenna in Sierra Nevada (Granada).

- *The European Researchers' Night* takes place every year all over Europe and beyond the last Friday of September. We took part in the event in Granada on Friday 29 "moving" its research to the center of the city.

- *PIIISA Project*. A multidisciplinary project designed to initiate high school students in the work with scientists. The IAA-CSIC is the founder of the project. http://www.piiisa.es

-Granada Book Fair, *Carpa de la ciencia*. A house for science surrounded by book stands, with outreach activities for children and general public during ten days.

- UPWARDS Project Communication. UPWARDS is a project to build a comprehensive image of Mars. Its Commiunication Unit is located at the IAA, and it developed a documentary, a mobile app, and an exhibition among others. http://upwards.iaa.es

- Desgranando Ciencia. Outreach event celebrated in Granada (14-16 Dec). The IAA-CSIC took part as co-organizer and developed a specific course about techniques to communicate science.

- Calar Alto Observatory Communication. The IAA-CSIC Communication, Education and Public Outreach Unit is in charge of the communication of the Observatory.

- *Astronomía Accesible*. This project aims to emphasize the popularization of astronomy among blind and low vision people. http://astroaccesible.iaa.es/

- Educational activities for primary and secondary schools. We attend two student groups every month.

- PRE-EST project. Project to build the European Solar Telescope. Its Communication Unit is located at the IAA, and the IAA Outrearch Unit helped to develop the work package and assists the EST Communication Officer.

- Bio4SKA, A new generation. Documentary about Biostirling 4 SKA project, to implement a cost effective and efficient new generation of solar dish-Stirling plant. https://vimeo.com/222974045.

- Social Networks. Twitter, facebook and youtube profiles managing.

https://twitter.com/iaaucc
https://www.facebook.com/iaa.comunicacion
https://www.youtube.com/user/iaaudc

PRESS RELEASES

The IAA 2017 scientific achievements attract the media interest producing the media news listed below. They can be also found online in the following link: http://www.iaa.es/en/news

18/12/2017

CARMENES instrument finds its first exoplanet

The planet HD 147379 b, with a mass slightly higher than Neptune, orbits a very close star.

22/11/2017

Artificially lit surfaces on Earth increase more than 2% per year

Light pollution, produced mainly by excessive night lighting or incorrect lighting, is an energy waste that endangers human health and ecosystems. Between 2012 and 2016 artificial night lighting has increased by 9.1%, despite the use of more efficient lighting systems.

20/11/2017

MultiDark-Galaxies: a free access virtual universe

An international team of astronomers has created a theoretical model that allows to recreate, in a broad and detailed way, the formation and evolution of the universe. The work provides an unprecedented test bench for new theories about the cosmos.

03/11/2017

The remains of the formation of a planetary system discovered around the nearest star

Researchers from the Institute of Astrophysics of Andalusia (IAA-CSIC) have discovered a dust belt around Proxima Centauri, the closest star to the Sun, with the ALMA interferometer. Similar to the Kuiper Belt of our Solar System, it represents the finding of remnant material from the formation of the planetary system closest to our own.

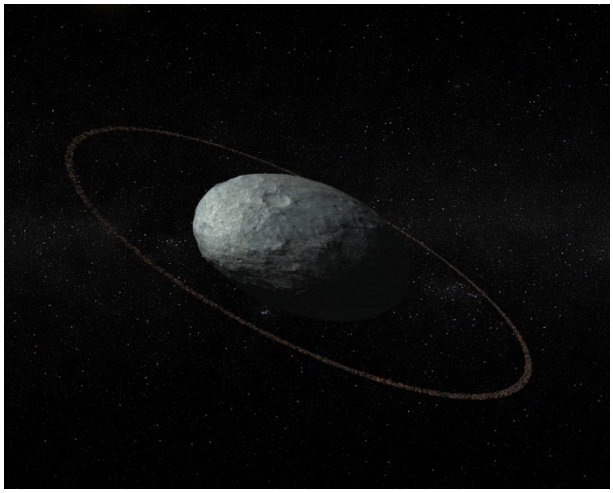
16/10/2017

The merging of two neutron stars allows the first simultaneous study in light and gravitational waves

This is the fifth detection of gravitational waves, but the first in which the counterpart in electromagnetic waves is located and studied. Researchers at the Institute of Astrophysics of Andalusia (IAA-CSIC) take part in several international studies on the phenomenon.

11/10/2017

Haumea, the most peculiar of Pluto companions, has a ring around it



The trans-neptunian belt contains four dwarf planets, among which Haumea stands out for its extremely elongated shape and rapid rotation. A stellar occultation makes it possible to establish main physical characteristics of heretofore this little known body – among which most surprising was presence of a ring.

04/10/2017

CARMENES instrument proves its ability to find Earth-like planets

CARMENES, a visible and infrared spectrograph operating from the Calar Alto observatory (Almeria), is studying a sample of three hundred stars in search of Earth-like planets. The first results of the visible channel, derived from the study of seven planetary systems, show its perfect functioning.

27/09/2017

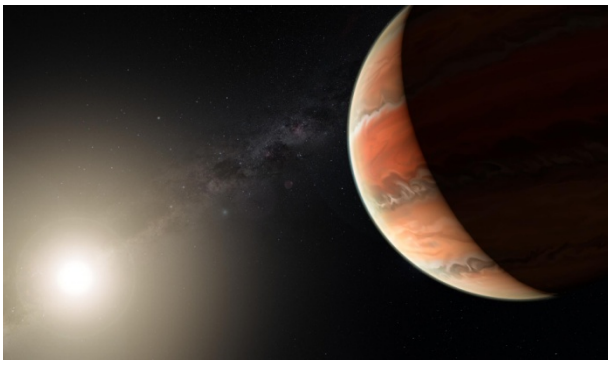
The Cherenkov Telescope Array (CTA), which will observe the most energetic universe from Chile and La Palma, publishes its scientific objectives

With more than a hundred telescopes, the CTA is the largest project of study of the cosmos at high energies conceived. The project, which involves the Institute of Astrophysics of Andalusia (IAA-CSIC), is under construction and will start operating in 2024.

14/09/2017

The unprecedented view of an exoplanet´s atmosphere

Using the FORS2 instrument on ESO's Very Large Telescope, astronomers have detected for the first time the presence of a metal oxide in the atmosphere of an exoplanet. This discovery opens the doors for detailed study of chemistry in exoplanetary atmospheres.



14/08/2017

The IAA will lead two of the five most advanced studies on supermassive black holes in 2018

The 66 antennas of the ALMA observatory join the Horizon of Events (EHT) telescope for the study of supermassive black holes. Five observation proposals have been approved for 2018, two of them coordinated by the Institute of Astrophysics of Andalusia (IAA-CSIC).

21/07/2017

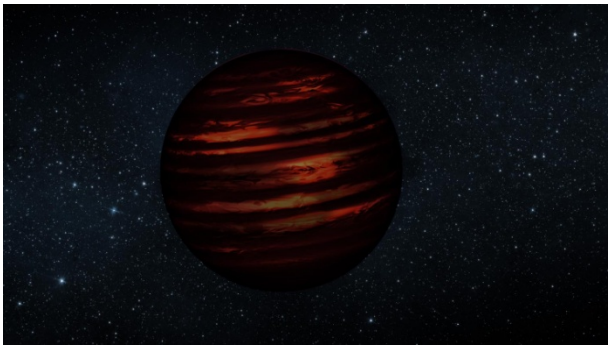
First light for MEGARA instrument on the Gran Telescopio Canarias

The new 3D spectroscopy instrument, in which the IAA-CSIC participates, will make its first observations next Monday.

20/07/2017

Milky Way could have 100 billion brown dwarfs

Brown dwarfs are objects intermediate in mass between stars and planets, with masses too low to sustain stable hydrogen fusion in their core.



04/07/2017

Improved Representation of Solar Variability in Climate Models

New reference data set for model intercomparison studies published

20/06/2017

Red Dots: The Live Search for Terrestrial Planets around Proxima Centauri Continues

The Red Dots campaign will show how astronomers look for planets around Proxima Centauri, Barnard star and Ross 154.

17/05/2017

Levels of light pollution soon to double if color of light is not taken into account

Light pollution – produced by an excess of or incorrect nocturnal lighting – is not just a waste of energy, but it also jeopardizes the health of human beings and ecosystems. Recent studies show the importance of color of lighting, which most widely used sensors are blind to.

06/06/2017

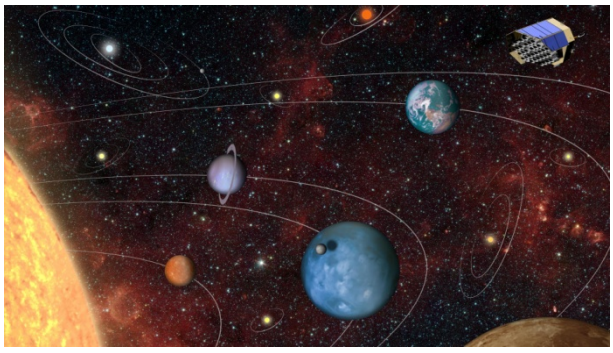
IMaX, an instrument developed in Spain, analyses in detail the behavior of the Sun in full fledged activity

IMaX, a magnetograph developed for the Sunrise mission, observed the Sun from a stratospheric balloon above the Arctic. A precursor to SoPHI, which will equip the Solar Orbiter mission, IMaX has made key breakthroughs to understand the magnetic field which determines the behavior of the Sun.

21/06/2017

Green light to PLATO, ESA's exoearth hunter

With this mission Europe will lead the search for potentially habitable exoplanets. The Institute of Astrophysics of Andalusia participates in the project.



11/04/2017

Rewinding stellar evolution: The last 400,000 years of mass loss from a star

The study of K4-37, a planetary nebula never studied in detail before, allows us to trace back the mass loss

history of its last stages as a star. The study makes use of data from Calar Alto and San Pedro Martir (Mexico) observatories

05/04/2017

OCTOCAM, a project lead by IAA astronomers, will be the next facility instrument of the Gemini observatory

The twin Gemini telescopes, one of the most competitive observatories in the world, consists of two 8.1m telescopes in Hawaii and Chile. OCTOCAM will multiply the power of Gemini South by simultaneously observing in eight different bands

21/03/2017

Rosetta mission describes surface change of comet in transit around the sun

Comparative analysis of comet 67P's surface before and after the perihelion (point on an orbit closest to the sun) reveals numerous changes in its orography, though not on a major scale. Paper published in Science magazine suggests important orographic features of comet 67P date back to previous, more active periods in its history

14/03/2017

SN2015bh: the end of a star or an "impostor" supernova?

Astronomers spot an intense explosion of a massive star, which, according to records, experienced frequent eruptions for at least 20 years. The analysis of the outburst does not allow to discern between a real supernova - an explosive event marks the end of a star - or a giant eruption implying a massive change in the star's evolutionary course

07/03/2017

Astronomers unveil with outstanding detail the first steps of nascent galaxies in the primeval universe

An international team of astronomers have pushed large telescopes to their current limits to discover a population of tiny newborn galaxies, which shed new light into the first stages of galaxy formation. Although rare, these nascent objects reveal with unprecedented detail the extreme physical conditions that have existed in the first galaxies formed right after the Big Bang

28/02/2017

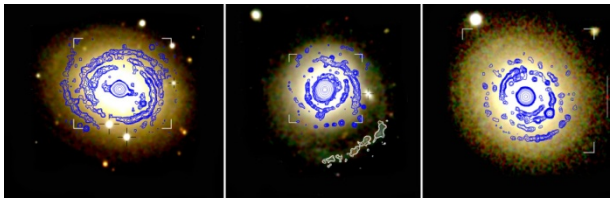
P/2016 J1: an asteroid that split in two and whose fragments, years later, developed tails

Asteroids, unlike comets, do not usually present tails, but there are some twenty exceptions to this rule. P/2016 J1 is a peculiar case, known as an "asteroid pair", resulting from the fracture of a parent asteroid

19/01/2017

Stellar formation is observed in a type of galaxy where, in theory, stars are no longer born

CALIFA project allowed to detect, in three early-type galaxies, a very tenuous arms where stars are being formed. The data, obtained with Calar Alto Observatory 3.5m telescope, contradict the widespread belief that in old galaxies stars are no longer born



29/12/2017

The Institute of Astrophysics of Andalusia launches the app "Let´s go to Mars!"

"Let's go to Mars" is a scientific graphic adventure in which you must land-off in Mars, explore the surface of the planet, build a permanent base for the arrival of your colleagues, collect and analyze Martian samples, and face the many dangers that exist in the red planet

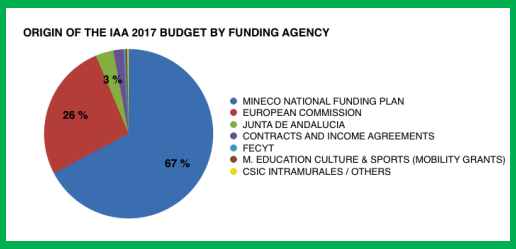
Throughout 2017, the IAA has posted **more than 300 appearances in media**.

FUNDING

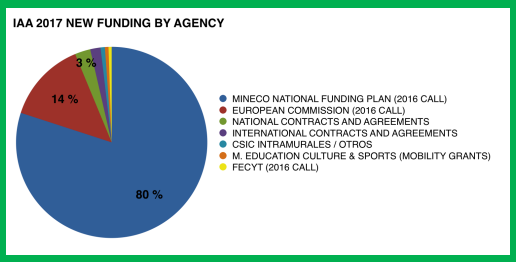
The IAA obtains most of its funding through competitive European and Spanish calls. Below we provide a list of all competitive funding awarded to IAA staff in 2017.

The time evolution of the IAA budget in the last years is shown in the top-right figure. The fraction of the IAA budget (the money used along 2017) and new funding (the money awarded in 2017) by funding agency are shown next.

Time evolution of the IAA budget since 2012



Origin of the IAA 2017 budget by funding agency



IAA 2017 new funding by agency

EUROPEAN RESEARCH COMISSION FP7

Science and Innovation with thunderstorms (SAINT)- H2020-MSCA-ITN-2016
Reference: H2020-MSCA-ITN-2016
PI: **Francisco José Gordillo Vázquez**
Duration: Mar 01, 2017 - Feb 28, 2021
Amount: 495 746 €

Preparatory Phase for the European Solar Telescope (PRE-EST)
Reference: 739500 H2020-INFRA/0287
PI: **Luis Ramón Bellot Rubio**
Duration: Apr 01, 2017 - Mar 31, 2021
Amount: 372 500 €

Advanced European Network of E-infrastructures for Astronomy with the SKA (AENEAS)
Reference: 731016 - H2020-INFRA/0238
PI: **Lourdes Verdes-Montenegro Atalaya**
Duration: Jan 01, 2017 - Dec 31, 2019
Amount: 51 940 €

Optical Infrared Coordination Network for Astronomy (OPTICON)
Reference: 730890 - H2020-INFRA/0243
PI: **José Manuel Vílchez Medina**
Duration: Jan 01, 2017 - Dec 31, 2020
Amount: 6 000 €

MINECO

FASES C/D DE INSTRUMENTOS JANUS Y GALA DE LA MISION JUICE (ESA), CIENCIA CON LA MISION ROSETTA Y ATMOSFERAS EXOPLANETARIAS
Reference: ESP2016-76076-R
PI: **Luisa María Lara López**
Duration: Dec 3, 2016 - Dec 29, 2018
Amount: 3 363 800 €

SPACE SOLAR PHYSICS: PHI FOR SOLAR ORBITER AND IMAX AND SP FOR SUNRISE
Reference: ESP2016-77548-C5-1-R
PI: **José Carlos del Toro Iniesta**
Duration: Dec 30, 2016 - Dec 29, 2019
Amount: 968 000 €

ENTENDIENDO LA ESTRUCTURA INTERNA, LA EVOLUCION Y LA VARIABILIDAD DE ESTRELLAS DE BAJA MASA CON PLANETAS
Reference: AYA2016-79425-C3-3-P
PI: **Matilde Fernández Hernández**
Duration: Dec 30, 2016 - Dec 29, 2019
Amount: 302 500 €

GALAXIAS EN 3D A TRAVES DEL UNIVERSO: SINERGIA ENTRE ESPECTROSCOPIA DE CAMPO INTEGRAL Y CARTOGRAFIADOS MULTIBANDA PANORAMICOS
Reference: AYA2016-77846-P
PI: **Rosa María González Delgado, Enrique Pérez Jiménez**
Duration: Dec 30, 2016 - Dec 29, 2019
Amount: 179 080 €

ESTALLIDOS DE FORMACION ESTELAR Y EVOLUCION DE GALAXIAS
Reference: AYA2016-79724-C4-4-P
PI: **José Manuel Vílchez Medina, Enrique Pérez Montero**
Duration: Dec 30, 2016 - Dec 29, 2019
Amount: 169 400 €

JETS RELATIVISTAS EN GALAXIAS ACTIVAS
Reference: AYA2016-8089-P
PI: **José Luis Gómez Fernández, Juan Iván Agudo Rodríguez**
Duration: Dec 30, 2016 - Dec 29, 2019
Amount: 135 520 €

AGN, DEL UNIVERSO LOCAL A DISTANCIAS COSMOLOGICAS. DEL MOTOR CENTRAL A LA GALAXIA ANFITRIONA Y SU ENTORNO
Reference: AYA2016-76682C3-1-P
PI: **Isabel Márquez Pérez**
Duration: Dec 30, 2016 - Dec 29, 2019
Amount: 90 750 €

PHOTOMETRIC REDSHIFTS PARA J-PAS
Reference: AYA2016-81065-C2-1-P
PI: **Narciso Benítez Lozano, José Ruedas Sánchez**
Duration: Dec 30, 2016 - Dec 29, 2019
Amount: 89 540 €

CARTOGRAFIANDO EL CIELO: SONDEOS EN EL OPTICO E INFRARROJO DE LA VIA LACTEA II
Reference: AYA2016-75931-C2-1-P
PI: **Emilio Javier Alfaro Navarro**
Duration: Dec 30, 2016 - Dec 29, 2018
Amount: 71 390 €

RED DE EXCELENCIA PARA LA PARTICIPACION CIÉNTIFICA Y TECNOLOGICA ESPAÑOLA EN EL SKA
Reference: AYA2016-82017-REDT
PI: **Lourdes Verdes-Montenegro Atalaya**
Duration: Jul 01, 2017 - Jun 30, 2019
Amount: 20 000 €

CSIC

SKA-Link: combining knowledge to pioneer Big-Data solutions for SKA Data Centres
Reference: i-link 2016 - I-LINK1122
PI: **Lourdes Verdes-Montenegro Atalaya**
Duration: Jan 01, 2017 - Dec 31, 2018
Amount: 27 100 €

The new J-PAS Data Center at the National Observatory of Rio de Janeiro
Reference: COOPB20263
PI: **José Ruedas Sánchez**
Duration: Jan 01, 2017 - Dec 31, 2018
Amount: 17 000 €

FECYT

Buscando a Fotoncita (Un falso documental acerca de la primera divulgadora científica española)
Reference: FCT-16-11172
PI: **Manuel Jesús González García**
Duration: Jan 01, 2017 - Mar 31, 2018
Amount: 22 500 €

La ciencia se cuela (y se queda) en la Feria del Libro de Granada
Reference: FCT-16-11296
PI: **Antonio María Alberdi Odriozola**
Duration: Jan 01, 2017 - May 30, 2017
Amount: 13 600 €

ANNEX

SCI PUBLICATIONS LIST

1. Aartsen M.G. et al. (includes **Cano, Z**.)
"Multiwavelength follow-up of a rare IceCube neutrino multiplet", Astronomy and Astrophysics, Vol. 607, Number A115 (2017)
DOI: 10.1051/0004-6361/201730620

2. Abbott, B. P. et al. (includes **Cano, Z.**; **de Ugarte-Postigo, A.**; **Hodosan, G.**; **Kann, D. A.**; **Castro-Tirado, A. J.**; **Tello, J. C.**; **Hu, Y. -D.**; **Zhang, B. -B.**; **Cunniffe, R.**; **Agudo, I)**
"Multi-messenger Observations of a Binary Neutron Star Merger", Astrophysical Journal, Vol. 848, p. L12 (2017)
DOI: 10.3847/2041-8213/aa91c9

3. Abbott, B. P. et al. (includes **Cano, Z.**; **de Ugarte-Postigo, A.**; **Thöne, C. C.**)
"A gravitational-wave standard siren measurement of the Hubble constant", Nature, Vol. 551, p. 85-98 (2017)
DOI: 10.1038/nature24471

4. Adams C., Bourassa A.E., Mclinden C.A., Sioris C.E., Von Clarmann T., **Funke B.**, Rieger L.A., Degenstein D.A.
"Effect of volcanic aerosol on stratospheric NO2 and N2O5 from 2002-2014 as measured by Odin-OSIRIS and Envisat-MIPAS", Atmospheric Chemistry and Physics, Vol. 17, p. 8063-8080 (2017)
DOI: 10.5194/acp-17-8063-2017

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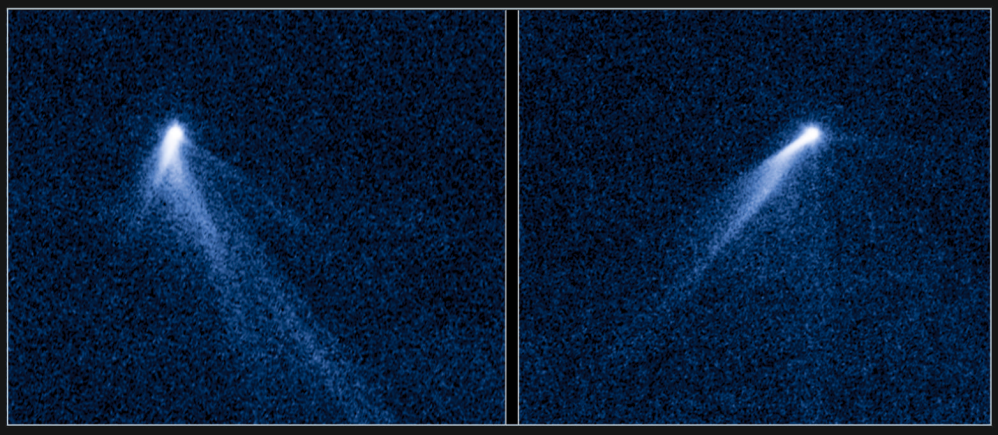
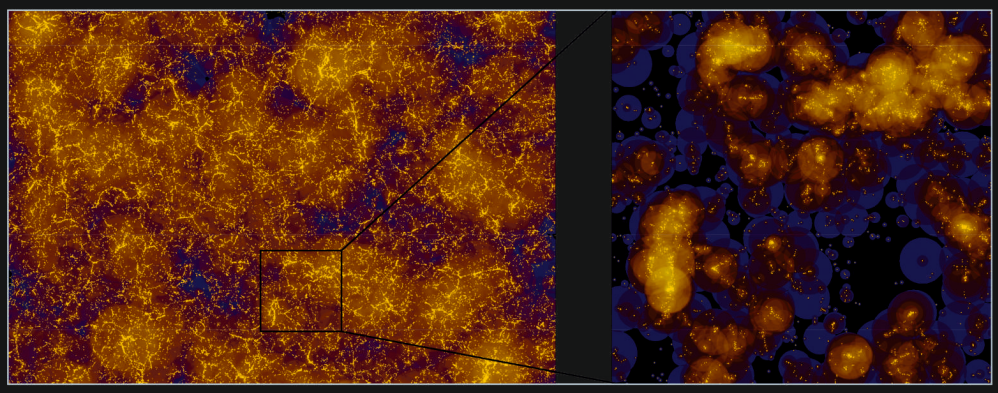
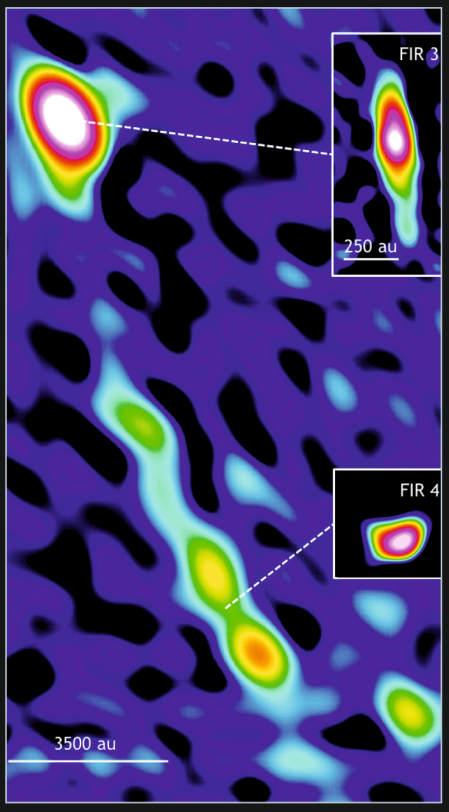


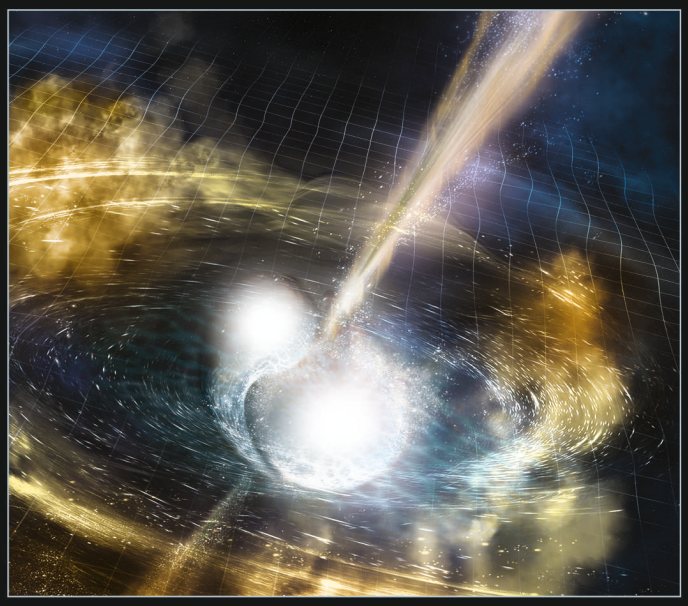
P/2016 J1: an asteroid that split in two and whose fragments, years later, developed tails. Asteroids do not usually present tails, but there are some exceptions. P/2016 J1 is a peculiar case, known as an "asteroid pair".



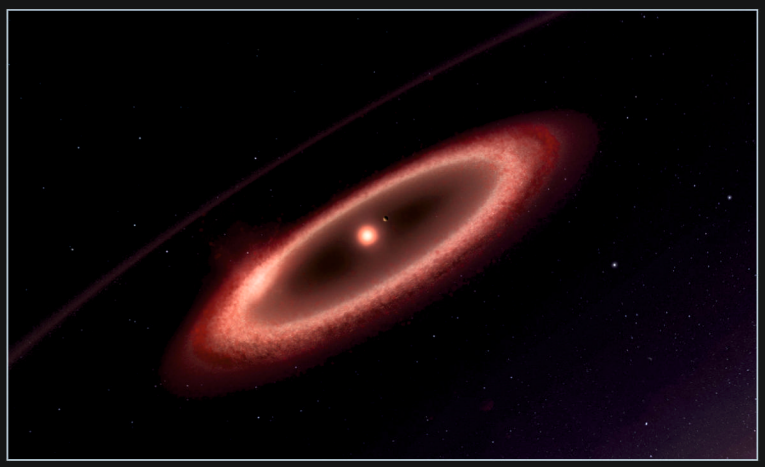
MultiDark-Galaxies: a virtual universe of free access. An international team of astronomers has created a theoretical model that allows to recreate, in a broad and detailed manner, the formation and evolution of the universe.



Can a star trigger the formation of another? The star FIR4, in the molecular cloud of Orion, could owe its origin to the jet ejected by a nearby star.



The first study in light and gravitational waves, devoted to the merging of two neutron stars. The IAA-CSIC took part in several international studies on the phenomenon.



The remains of the formation of a planetary system discovered around the nearest star. Discovered a dust belt around Proxima Centauri. It represents the finding of remnant material from the formation of the planetary system closest to our own.

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