

Instituto de Astrofísica de Andalucía
IAA-CSIC

ANNUAL REPORT
2019



Cover Picture. First image of the Shadow of the Supermassive Black Hole in M87 obtained with the Event Horizon Telescope (EHT)

Credit:

The Astrophysical Journal Letters, 875:L1 (17pp), 2019 April 10

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Foreword

This Report comes later than usual because of the Covid-Sars2 pandemia. Let us use these first lines to remember those who died on the occasion of Covid19 and to all those affected personally. We thank all the people, especially in the health sector, who worked hard for the good of our society.

After having received the Severo Ochoa Excellence award in June 2018, 2019 was the first year to be fully dedicated to our *highly competitive strategic research programme*. Already the first week of April 2019 was a very special one for the IAA life. On the one hand, the **first image ever of the shadow of a black hole** was presented, with a strong participation of IAA researchers in obtaining this fantastic scientific result. A special event was organized at the CSIC headquarters. During the first ten minutes, we were connected with the Press Conference of the European Community in Brussels. For the next hour, a presentation was done for the Spanish community, with the presence of many of our colleagues, showing the results: the central compact radio source in the galaxy M87 had been resolved as an asymmetric bright emission ring with a diameter of $42 \pm 3 \mu\text{s}$. Overall, the observed image was consistent with expectations for the shadow of a Kerr black hole as predicted by general relativity. This discovery has deserved numerous prizes along 2019 and 2020. The image was chosen for instance by the Science Magazine as “Scientific Image of 2019”.

Just in the very same day, the results coming from the **TGO orbiter of the ExoMars mission**, at around four hundred kilometers above the surface of Mars, pointed to a **lack of methane on Mars atmosphere** and showed, studying a dust storm that covered the planet, that the increase of dust affected the atmospheric water vapor, key information to understand the history of water on Mars. This result had also a strong involvement of IAA scientists and engineers.

During 2019, researchers from the IAA published the most extensive catalogue to date of stars in the Galactic Centre. An outstanding result of the “**GALACTICNUCLEUS**” ERC Consolidator Grant

coordinated at the IAA. This project, designed to study the central region of the Milky Way with an unprecedented resolution, unravels the **history of star formation in the galactic center**, showing that it has not been continuous. In fact, an intense episode of star formation that occurred about a billion years ago was detected, where stars with a combined mass of several tens of millions of suns were formed in less than 100 million years.

Many other interesting results were published by IAA researchers in more than 250 publications in refereed journals, a number of those reflecting our participation in large surveys/projects/instruments such as ALHAMBRA, CALIFA, ROSSETA, JUICE, HINODE, CARMENES, TESS, COROT, EHT, CARS, J-PLUS, CTA, MANGA, GAIA, or ALFALFA, among others. To mention some of those results, 31 papers presented observations with **CARMENES**, with up to 28 planets discovered. **Two temperate Earth-mass planet candidates around Teegarden's Star** were unveiled, and a **giant exoplanet orbiting a very-low-mass star** was studied, a system that challenges accepted core-accretion planet formation models. Additionally, **multiband transits observations of hot Jupiters** in the NIR with CARMENES permitted to confirm the **detection of H₂O in those exoplanets**. Researchers from the Solar Physics Group published a **review on the observational characterization of the Quiet-Sun Magnetic Fields**. The study of the very weak afterglow of **one of the closest GRBs** to date allowed the detection of emission surrounding the jet from a **hot cocoon, as predicted by theorists, but never observed before**. In Extragalactic Astronomy, we could mention the search of **intergalactic star forming regions in the Stephan's Quintet**, through the study of ionised gas structures and their kinematics with SITELLE, that deserved the front page of the journal *Astronomy and Astrophysics*, or the study of the spatially resolved **mass-to-light ratio versus colors from the CALIFA galaxies** as a function of the morphology and galaxy stellar mass. Results from the ALHAMBRA and CALIFA surveys continued to pave the way for the **J-PAS survey**, which will be instrumental for studying galaxy evolution. The understanding of **Active Galactic Nuclei** as

fundamental pieces for galaxy evolution was also targeted by studies led by IAA researchers.

The year 2019 was also very important for the IAA Instrumental Development Unit (UDIT): for the instrument **PHI onboard Solar Orbiter**, all the subsystems, pipelines, and the operations coordination and commissioning got ready for its launch on early 2020; concerning the solar telescope **SUNRISE III**, a prototype, flight representative, was manufactured for the whole electronics and cameras for the instruments **TuMag and SCIP**; for the **JUICE** Critical Design Review, both **GALA & JANUS** power supplies Qualification Models and filter wheel pre-QMs were manufactured, tested and delivered to ESA. The proto-flight model manufacturing was also started; for **PLATO**, further advances in the Main Electronic Units and the laboratory Electrical Ground Support Equipment were developed. Looking at the future, the European Space Agency (ESA) selected **Comet Interceptor** as its first Fast mission, with a total development duration from the selection until the launch of about eight years. Comet Interceptor is a technological challenge that seeks to study a new comet, that is, a comet that has not yet been discovered and remains intact since its formation. The IAA will contribute to four of the nine instruments that will travel in the probes. In 2019, for the first time, one of our technicians received the **Prize of the “Spanish Astronomical Society (SEA)” to the best “Instrumental PhD”** in Astrophysics thanks to her work **“PANIC, an infrared wide-field camera for Calar Alto”**.

Continuing with CAHA, the Junta de Andalucía (JA) replaced the Max Planck Society and approved on April 10th its incorporation to the observatory now renamed as **“Centro Astronómico Hispano en Andalucía”**. The IAA is considered as the institute of reference for the agreement between JA and CSIC for the operation of CAHA. The project LUCA (Local Universe from Calar Alto) proposing a new instrument for the 3.5m telescope delivered its feasibility study to the IAA Directorate and CSIC Presidency on July 2019. After a careful consideration of the feasibility study, the CSIC Presidency decided on October 2019 that the

project shouldn't be continued based on a deep analysis of both eventual competitors, and the time-line of the project, specially taking into account the availability of both the funding and the scientific team. A **new call for legacy projects with present or proposed CAHA instrumentation** was released in December 2019, with the corresponding meeting for presenting the proposals scheduled for March 2020. The new proposals have a significant IAA participation.

The IAA kept committed with the **Square Kilometre Array (SKA)** project. Currently in the final stages of design, its construction is expected to start in 2021. The IAA coordinates the 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. The celebration of the **“Spain in SKA!”** workshop at the IAA in June 2019 is clearly in line with our actions. Benefiting from its current expertise in radio-astronomy, its e-Science experience, and its role as coordinator of the Spanish participation in SKA, the IAA seeks getting accredited in the future as the **SKA Regional Center (SRC) node in Spain**, as part of the European SRC network. The work on the SRC was initiated as planned in our Severo Ochoa strategic program.

You will see that, in addition to the new section for “Awards” already started for the 2018 report, a new section is devoted from now on to our “Gender Actions”. This report has been prepared with the aim of showing the reader a panorama of the scientific and technological activity developed at the IAA in 2019. We share with you our satisfaction of working on the frontier of astrophysics, in a Center of Excellence Severo Ochoa, recognized by our Ministry as *being among the best in the world in our scientific area*.

Prof. Antxon Alberdi

Director

Dr. Isabel Márquez

Scientific Director of the project "Severo Ochoa – IAA"

Instituto de Astrofísica de Andalucía, CSIC

August 2020

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 2019 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
- Galaxy Evolution
- HETH
- Low-mass stars and exoplanets
- Physics of the Interstellar Medium
- Planets and Minor Bodies of the Solar System
- Solar Physics
- Stellar Systems
- Stellar Variability
- Terrestrial planets' atmospheres
- Theoretical gravitation and cosmology

AGN JETS

RELATIVISTIC JETS AND BLAZARS

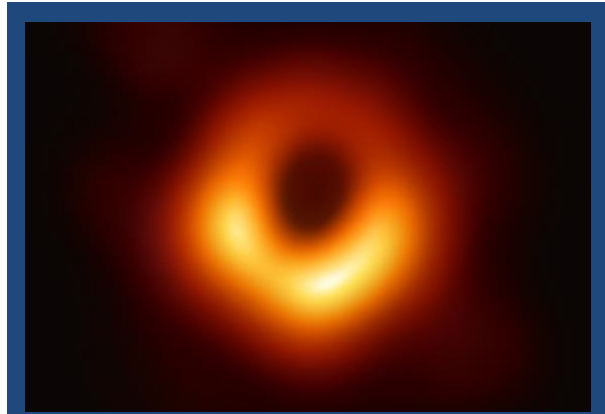
Overview

Our research group is focused on the study of supermassive black holes and their immediate environments, from the innermost accretion disks around their event horizons to the ultra-relativistic jets that are born from them. These jets are commonly present in multiple astrophysical sites, from active galactic nuclei (AGN), to microquasars and GRBs. For AGNs, huge amounts of energy are released as a consequence of mass accretion onto supermassive black holes (SMBHs), lurking in the center of these galaxies. In AGNs 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. Our observational study is based on a multi-instrument and multi-spectral range approach. This includes very long baseline interferometry (VLBI) observations at millimeter wavelengths with the Event Horizon Telescope 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, are also employed by our group to 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 2019

On April 10, 2019, the EHT Collaboration presented the **first image of a black hole** [65, 66, 67, 68,69,70], thus transforming these elusive objects from the realms of science fiction to science fact. The central compact radio source in the radio galaxy M87 was resolved out into an asymmetric bright emission ring with a diameter of 42 μas , consistent in size and shape with the lensed photon orbit encircling a dark shadow caused by photon capture



First image of a black hole shadow obtained by the Event Horizon Telescope (EHT) Collaboration at the center of the elliptical galaxy M87

at the event horizon of a 6.5 billion solar masses black hole, as predicted by general relativity.

EHT observations thus provide confirmation for the presence of supermassive black holes powering active galaxies. It is in this extreme environment of the black hole event horizon that strong-field GR effects become evident and the accretion and outflow processes that govern black hole feedback on galactic scales originate. Imaging black holes on event horizon scales that resolve these effects and processes would enable new tests of general relativity and the extraordinarily detailed study of core AGN physics. In the near future, the EHT will be able to make the first real-time movies of SMBHs (like Sgr A*) and their emanating jets.

MEMBERS

I. Agudo, A. Fuentes, J.L. Gómez, J.E. Ruiz del Mazo, G. Zhao

INVITED RESEARCHERS

Dr. Rocco Lico (Max-Planck-Institut für Radioastronomie, Germany); Dr. Hiroki Okino (National Astronomical Observatory of Japan); Dr. Clemens Thum (IRAM-Granada)

LINES OF RESEARCH

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

ARAE

(ASTROFÍSICA ROBÓTICA Y DE
ALTAS ENERGÍAS)

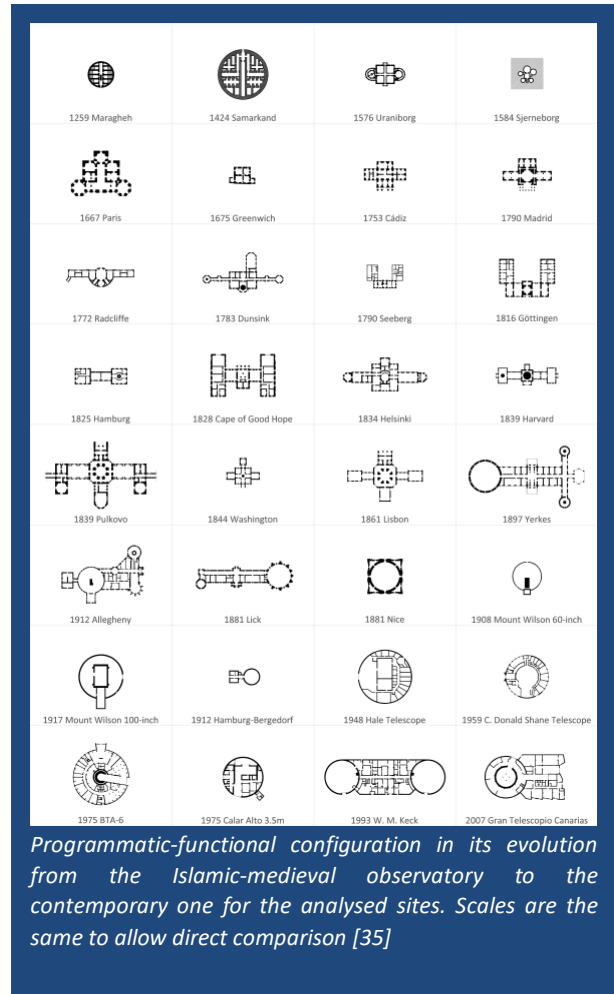
Overview

The ARAE research group was founded in 2001 (under the auspices of the PAI), although some of its members had already started their activity in 1990. 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 such as the BOOTES network of telescopes. We are also involved in space-borne missions. Teaching, public outreach and citizen science are also part of the ARAE activities.

Highlights in 2019

- **GRB 160821B** was a short-duration gamma-ray burst detected in the outskirts of a spiral galaxy at a redshift $z=0.1613$, at a projected physical offset of 16 kpc from the center of that galaxy. We obtained multiwavelength observations and modeled them with two distinct components of emission: a standard afterglow, arising from the interaction of the relativistic jet with the surrounding medium, and a kilonova (KN), powered by the radioactive decay of the sub-relativistic ejecta. Analysis of the KN properties suggested a rapid evolution toward red colors, similar to AT2017gfo (the KN associated to the gravitational wave GW170817), and a low nIR luminosity, possibly due to the presence of a long-lived neutron star (NS). The global properties of the environment, the inferred low mass ($M_{ej}=0.006 M_{\odot}$) and velocities ($V_{ej}>0.05c$) of lanthanide-rich ejecta are consistent with a binary NS merger progenitor [242].

- In order to address the development of astronomical observatories through history, from an architectural point of view, we focused on **32 observatories (in the period 1259-2007)** and carefully analyzed their architectures. Considering the impact of the construction itself or its facilities on the results of the research (thermal or structural stability, poor weather protection, turbulence, etc.). We presented a theoretical-critical contribution that, at least, invites reflection of those involved in the development of astronomical observatories in the future [35]. A classification of astronomical observatories into 10 architectural types was also proposed (Castro Tirado 2019, PhD Thesis).



MEMBERS

A.J. Castro-Tirado, M.A. Castro-Tirado, A. Claret dos Santos and E.J. Fernández-García

INVITED RESEARCHERS

Ayala Gómez, A. (UGR), Caballero García, M. D. (CAS, Rep. Checa); López Casado, M.C. (UMA); Martínez Delgado, D. (MPIA, Germany), Pérez del Pulgar, C. (UMA), Hu, Y., Zhang, B. (Nanjing U., China)

LINES OF RESEARCH

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

GALAXY EVOLUTION

Overview

The group conducts observational and theoretical studies over a wide range of issues on galaxy structure and evolution and cosmology, from the inner stellar and diffuse components to their large-scale cosmic distribution and evolution. This is complemented with 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, teaching, public outreach, and eScience.

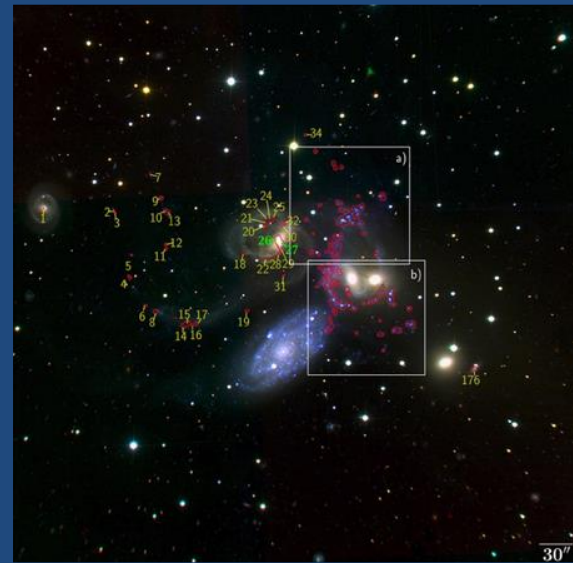
Highlights in 2019

- **Revisiting the hardening of the stellar ionizing radiation in galaxy discs [195].** The equivalent effective temperature of ionizing massive clusters was derived using relative intensities of optical emission lines and a new bayesian-like code developed by us. With this code we analyzed the hardening of the ionizing stellar radiation across the disc of nearby well-characterized galaxies, like M101.

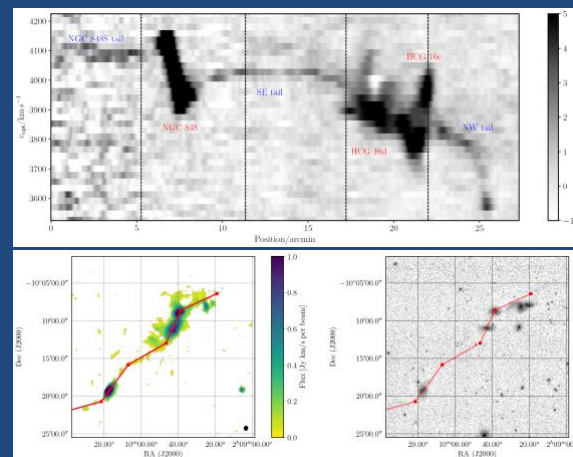
- **A bayesian-like approach to derive chemical abundances in type-2 AGN based on photoionization models [194].** We released a new version of the code HII-CHI-mistry to derive chemical abundances in Narrow-Line Regions in Seyfert 2 galaxies from optical emission lines. Results for a sample from the literature led to both, higher oxygen abundance and ionization parameter as compared to star-forming galaxies.

- **Searching for intergalactic star forming regions in Stephan's Quintet with SITELLE [60].** The spatially resolved kinematics, ionized and diffuse gas of Stephan's Quintet (SQ) was analyzed with the 11'x11' field-of-view of the CFHT imaging Fourier transform spectrograph SITELLE, allowing complete sampling of interactions in the entire galaxy system. Our observations revealed a complex 3D strands system in SQ for the first time.

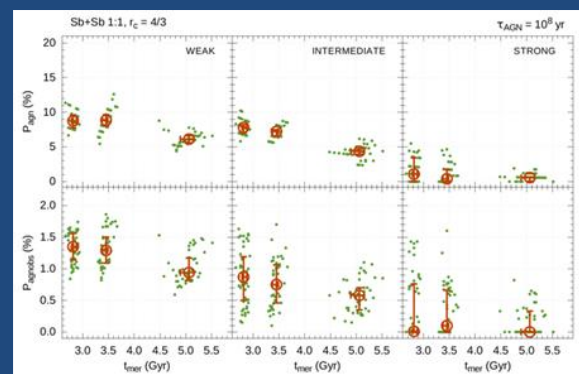
- **Metals and dust content across the galaxies M 101 and NGC 628 [249].** We studied the spatially resolved metal content and dust of the nearby spirals M101 and NGC 628. Abundances of their gas and stars, and dust content were studied within chemical evolution. We derived oxygen effective yield (y_{eff}) and gas-to-dust mass ratio (GDR) across both galaxies; we found the metal budget consistent with the simple model of chemical evolution, for y_{eff} between 0.5 and 1 solar; suggesting some gas flows for outermost M101. The derived GDR vs. metallicity relation shows two slopes, breaking at 12



Stephan's Quintet complex 3D H α strands uncovered with SITELLE. Front page of A&A September 2019 [60]



Top: HI PV diagram of HCG 16. Bottom, left: PV slice as a red line on the moment-zero; right: same line on DECaLS r [115]



Intrinsic (top) and observed (bottom) fractions of DAGN in equal mass mergers of Sb spirals in the nearby universe as a function of merger timescale [230]

+ log(O/H) \approx 8.4, the critical metallicity predicted by dust models.

- **Stellar mass-to-light ratios (M/L) from CALIFA [81].** We applied the fossil record method of stellar population to 450 galaxies, observed with IFS in the CALIFA survey, and derived the radial structure of the M/L. We measured observed and synthetic radial colors in the optical to study the spatially resolved M/L vs. color relations (MLCRs). The sample covers all morphologies and galaxy stellar masses, from $10^{8.4}$ to $10^{12} M_{\odot}$. Our main results were that (a) M/L has a negative gradient, steeper within the central 1 HLR; it is steeper in Sb-Sbc than in early-type galaxies. (b) The MLCRs have a scatter of 0.1 dex; the smallest dispersion found for the combinations (i, g - r) and (R, B - R). Extinction and emission lines do not affect the scatter. Morphology does not have a significant effect, except if the general relation is used for galaxies redder than $(u - i) > 4$ or bluer than $(u - i) < 0$. (c) The IMF has a large effect on MLCRs. (See <http://pycasso.iaa.es/ML>).

- **AMIGA team found that the neutral HI gas in HCG 16 is consumed by tidal encounters and star formation [115].** The workflow is fully reproducible and executable in the cloud. The team studied HI-rich, ultra-diffuse galaxies, finding that their properties cannot be explained by environmental effects [109]. In [29] we made a comprehensive study of the optical morphologies in the AMIGA sample.

SKA coordination activities continued, e.g. the Open RIA meeting "Spain in SKA!", or the negotiation of contracts for SKA construction. As co-chair of SKA HI SWG the P.I. of AMIGA gave talks on the requirements of the HI community for the future SKA regional centres (SRCs).

AMIGA contributed to design a SRCs network for researchers to exploit data according to Open Science (OS) principles, and to the H2020 ESCAPE, that addresses OS challenges shared by ESFRI facilities in Astronomy and Particle Physics. AMIGA's P.I. was designated by the Ministry as Spanish representative in the SRC Steering Committee and leads the development of an SRC prototype at the IAA, with support from the IAA Severo Ochoa programme.

- **Dual AGN fractions from major mergers [230].** We used a suite of 432 collisionless simulations of bound pairs of spirals with mass ratios 1:1 and 3:1, covering a wide range of merger parameters and global properties consistent with lambda CDM, to study the connection between dual AGN (DAGN) and major mergers. A feature of our treatment is that it allows us to obtain large sets of experiments to do statistics on the parameters governing dual activity, including constraints in projected distance and velocity that mimic the limitations of AGN surveys. Our simulations showed

that frequencies of binary systems range up to 15%. These are reduced tenfold when applying observational constraints from the DAGN fraction at low redshift. We demonstrated that the most common limitations in the detection of close active pairs are sufficient to reconcile the intrinsic and observed frequencies.

- **Exploring the MID-infrared SEDs of Six AGN Dusty Torus Models [85, 86].** We analyzed all available torus models and compared them with real data, concluding that discriminating models require mid-infrared spectroscopy if the host galaxy contribution is less than 50%. Hoenig clumpy disk plus wind best represents high luminosity objects, while Nenkova clumpy model is best for low luminosity AGNs.

- **Black Hole Mass Estimates in Quasars at high redshift [156].** We analysed the CIV λ 1549Å and H β profiles to test whether the width of the high-ionization CIV could be used as a virial broadening estimator for high redshift QSOs, as a substitute of H β BH mass estimator. We used high S/N optical and NIR spectra of 76 QSOs covering a wide range in luminosity (10^{43} - 3×10^{48} [erg/s]) and redshift ($z=0-3$). Large blueshifts in CIV indicate that part of the BLR is not virialized, so FWHM(CIV) cannot be used without significant corrections. Once FWHM(CIV) is corrected considering the Eddington ratio and the luminosity of the quasar, we obtained a new CIV-based scaling law that yields unbiased BH masses with respect to those based on H β .

MEMBERS

Castillo, M.T.; Cazzoli, S.; Damas, A.E.; Duarte Puertas, S.; Fernández-Peña, M.; García Benito, R.; Garrido, J.; González Delgado, R.M.; Gutiérrez, J.; Hermosa, L.; Iglesias, J.; Jones, M.G.; Kehrig, C.; Luna, S.; Márquez, I.; Martínez Solaeche, G.; Masegosa, J.; Moldón, J.; del Olmo, A.; Perea, J.D.; Pérez, E.; Pérez Montero, E.; Povic, M.; Rodríguez Martín, J.; Román, J.; Sánchez, S.; Verdes-Montenegro, L.; Vilchez, J.M.

INVITED RESEARCHERS

L.A. Díaz-García (ASIAA, Taiwan); M. Martínez Aldama (Center for Theoretical Physics, Polish Academic of Sciences, Poland); P. Marziani (Osservatorio Astronomico di Padova, INAF, Italy)

LINES OF RESEARCH

Active Galactic Nuclei; Astronomical instrumentation; Cosmic evolution of galaxies; Open Science; Physics of Quasars; Star formation and violent SF in galaxies; Synthesis of stellar populations; The interplay between massive star formation and chemical evolution in galaxies; The influence of the environment on the evolution of galaxies

HETH

(HIGH ENERGY TRANSIENTS AND THEIR HOSTS)

Overview

HETH focuses on the study of explosive transients and their host galaxy environments. We study gamma-ray bursts (GRBs), supernovae (SNe), novae, fast radio bursts (FRBs) and gravitational wave counterparts (GW). For our research we use multi-wavelength data from ORM, OSN, CAHA, VLT, ALMA and NOEMA. Another interest are the environments of stellar explosions to learn more about their progenitors. Finally, we also devote time to develop new astronomical instrumentation. HETH is member of several international collaborations to study GRBs and SNe, their hosts as well as GW counterparts.

Highlights in 2019

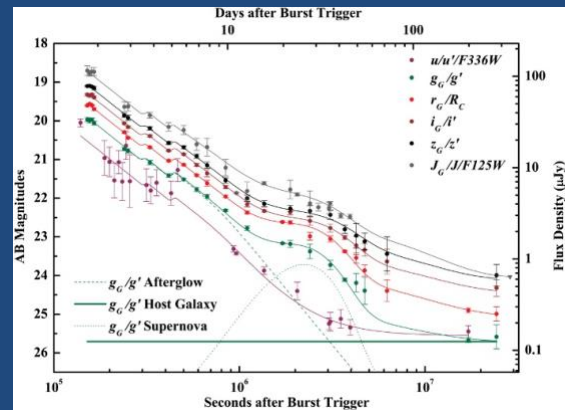
- **Highly luminous supernovae associated with gamma-ray bursts I. GRB 111209A/SN 2011kl in the context of stripped-envelope and superluminous supernovae.**

GRB 111209A was one of the longest GRBs ever discovered, lasting around six hours. It was accompanied by a bright afterglow and an exceptionally luminous SN. This SN resembled superluminous SNe and in Kann et al. we placed SN 2011kl into the context of a large sample of stripped-envelope SNe, showing that it has exceptional properties compared to other GRB-SNe. This also offers strong evidence that this SN must be powered by magnetar central engine instead of classical ^{56}Ni decay [117].

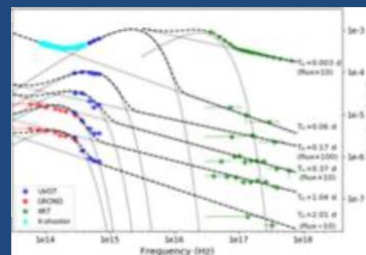
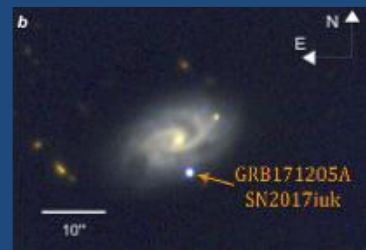
- **Signatures of a jet cocoon in early spectra of a supernova associated with a gamma-ray burst.**

GRB 171205A, one of the closest GRBs to date at only 160 Mpc, had a very weak afterglow. This allowed us, for the first time, to detect emission from a hot cocoon surrounding the jet at less than a day after the explosion, expelling material from the very center of the star. Such a cocoon had been predicted by theorists, but never observed before.

The material in the cocoon moved at speeds up to 100,000 km/s, consisting almost purely of ^{56}Ni and Fe-peak elements. The hot cocoon rapidly decays in time, giving way to the usual afterglow (power-law) and supernova (black-body, BB) emission observed in other long GRBs [108].



Fit to the multi-band light curve of the GRB 111209A afterglow and SN 2011kl, showing the very blue emission. Despite the redshift of $z=0.68$, the SN is clearly detected in the g' band (rest-frame UV) [117]



Top: Color image of the host of GRB 171205A and the GRB/SN in an outer spiral arm. Bottom: SED evolution of the cocoon/SN showing the double BB [108]

MEMBERS

C.J.F. Agüí; K. Bensch; M. Blazek; L. Izzo; D.A. Kann; C.C. Thöne; A. de Ugarte

LINES OF RESEARCH

Gamma-ray bursts; Supernovae (Type IIc, broad-line Ic, SLSNe, GRB-SNe); Supernova progenitors; Novae and nova remnants; Gravitational wave counterparts; GRB/SN host galaxies and GRB/SN environments; Starburst dwarf galaxies in 3D; Astronomical instrumentation

LOW-MASS STARS AND EXOPLANETS

Overview

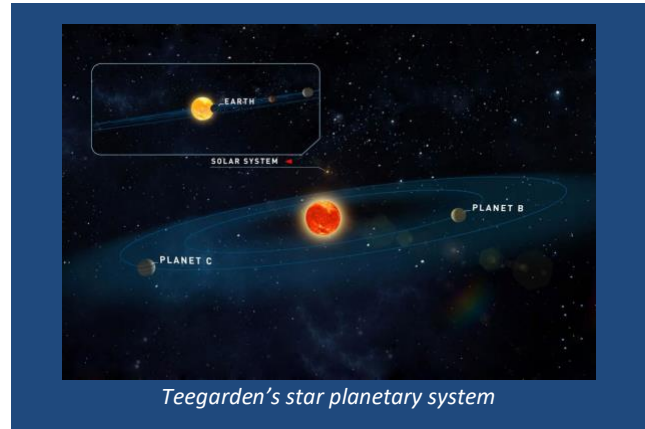
Our group “Physics of low-mass stars, exoplanets and associated instrumentation” studies the physics of planetary systems and their low-mass stars. In the last years, the community has focused on these stars because of the great interest they present for the discovery of temperate rocky planets that 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 theoretical studies 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.

The group hosts the co-PI-ship of the CARMENES consortium. CARMENES (Quirrenbach et al. 2018, SPIE, 10702E, 0W) is a worldwide unique instrument, co-led by the IAA, that started its scientific operation at CAHA observatory in 2016. It is collecting high-precision radial velocity measurements simultaneously in the optical and the near-infrared for a survey of more than 300 M-dwarf stars to search and characterize temperate rocky exoplanets. Furthermore, CARMENES has shown to be a groundbreaking instrument for the study of exoplanet atmospheres opening new lines of research from the ground in this field.

Highlights in 2019

In 2019, we continued collecting data of M dwarfs both with CARMENES and with photometric instruments at the OSN to produce exciting results. CARMENES is already the largest exoplanet survey for M dwarfs to date. It already demonstrated its capabilities: published 31 papers with “CARMENES” in their title and 18 new planets discovered, increasing in 50% the number of planets that existed in the parameter space probed by our instrument.

- **Discovery of two temperate (inside the liquid-water habitable zone), terrestrial ($1.1 M_{\oplus}$) planets around Teegarden’s star, the brightest ultra-cool dwarf (spectral type M7.0V) and one of the closest to our Solar System [255].** These planets constitute, therefore, the fourth closest exoplanetary system with potentially habitable planets. Detected with CARMENES data only, the planets are the smallest ones detected around this type of star with the Doppler technique. Teegarden b is the planet with the highest Earth-similarity index discovered so far. The star is very close to the ecliptic (the plane of Earth’s orbit around the Sun), hence observers who directed their telescopes toward the Sun in 2044 would see the Earth transiting our Sun.



- **“The planet that should not exist”.** CARMENES detected a massive planet, with a minimum mass of 0.46 times the mass of Jupiter, and provided evidence for the presence of a second candidate high-mass planet around the small red dwarf GJ 3512 [167]. The system is unique among those detected so far with RVs and challenges current theories of planet formation and evolution. Furthermore, indications point towards the presence of another giant planet that was ejected when interacting with the other two, making it very difficult to understand how such a small star could have formed three giant planets. Possibly the protoplanetary disk was extremely massive.

- We participate in several collaborations to detect planets in the closest systems to the Sun or to refine the orbital elements, constrain their physical parameters and search for additional planets in known systems. One of the results from one of these collaborations were published in [205], which followed up the transiting planets discovered by CoRoT with ground-based photometry. We refined the ephemeris in all these cases and reduced the uncertainties of the orbital periods by factors between 1.2 and 33. In most cases, our determined physical properties for individual systems are in agreement with values reported in previous studies. However, in one case, CoRoT-27 b, we could not detect any transit event in the predicted transit window.

- In our efforts to understand the planet-hosting M dwarfs, we continue our efforts to understand and detect pulsations in this type of star [see our review paper, 211].

MEMBERS

P.J. Amado, F.F. Bauer, M. Fernández, C.T. Rodríguez López, E. Rodríguez

INVITED RESEARCHERS

M. Oshagh (IAG, Germany), J. Olivares (Diputación de Sevilla), B. Rojas-Ayala (UNAB, Chile), F.J. Pozuelos (University of Liège, Belgium)

LINES OF RESEARCH

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

PLANETS AND MINOR BODIES OF THE SOLAR SYSTEM

Overview

Three are the research areas comprising the group "Planets and minor bodies of the Solar System": 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.

Since 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.

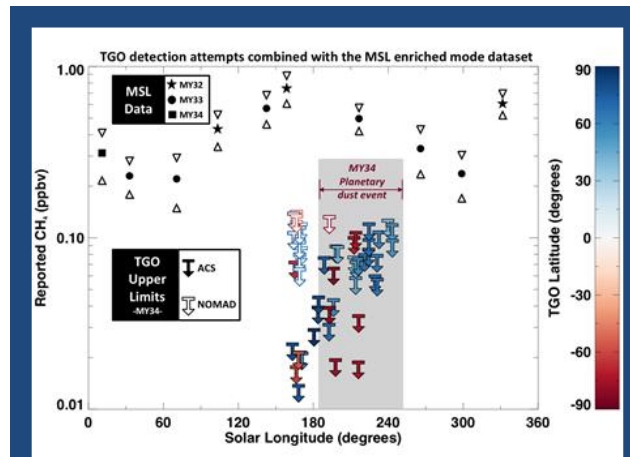
b) Planetary atmospheres and surfaces:

- Origin and evolution of the water content and its derivatives in the atmospheres of the Giant Planets and Titan.

Determination of the turbulent transport 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 strongly 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.



Upper limits for CH₄ obtained by TGO (ACS and NOMAD) compared to seasonally variable background methane as measured by SAM-TLS on Curiosity

- 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).

Highlights in 2019

- Scientific operative phase of **NOMAD** on board Exomars.

- The presence, if any, of the **Methane in the Mars atmosphere** was established under 0.5 p.p.b.v. i.e. **100 times lower than previous published determinations** [123].

- **Photo-polarimetry proved as a useful tool for characterizing cosmic dust grains** [76].

- **Asteroid (6478) Gault is a new member of the Active Asteroids class** of bodies, releasing dust likely as a result of a rotational disruption [168].

MEMBERS

J. M. Castro, R. D. Duffard, J.C. Gómez Martín, D. Guirado, P. J. Gutiérrez, J. Jiménez Ortega, M. Lampon, 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

Prof. A.C. Vandale (BIRA, Belgium)

LINES OF RESEARCH

Planets and minor bodies of the Solar System; Dust in the Solar System; Exoplanets (Exoplanetary atmospheres)

PHYSICS OF THE INTERSTELLAR MEDIUM

Overview

This group studies the formation, evolution and death of stars at different mass and spatial scales across 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 ionized 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.

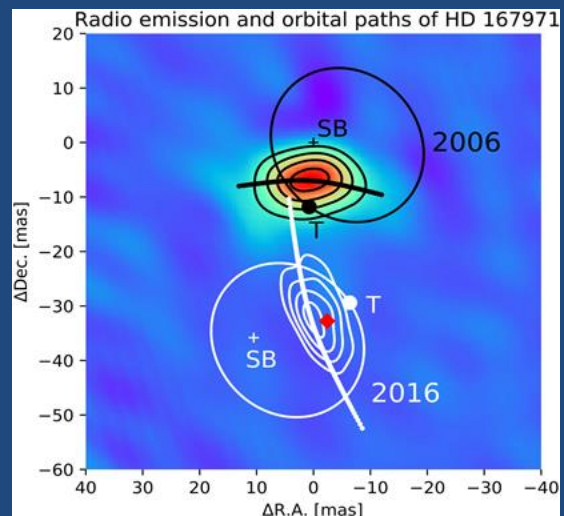
The final stages of a star's life are studied by the multi-wavelength characterization of evolved stars and the wind-blown bubbles around them, to understand the processes that shape planetary nebulae (PNe) and the circumstellar medium around massive stars.

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. High-energy phenomena are studied at different scales.

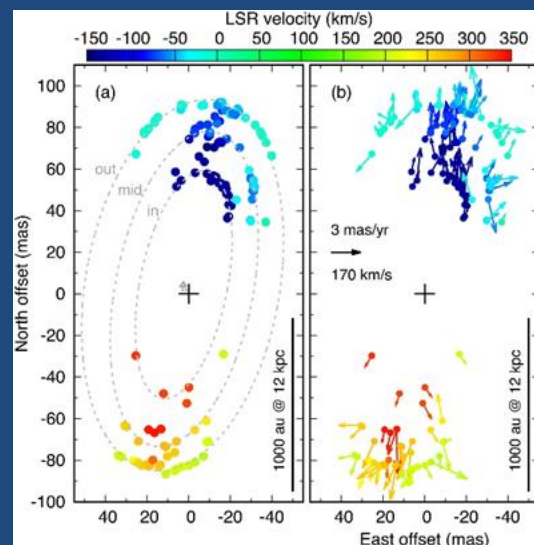
Highlights in 2019

- Within our studies of **massive stars** with radio and NIR interferometry, we observed the triple hierarchical system **HD167971** with VLBI, confirming that the **detected non-thermal radio emission is associated with the wind-wind collision region of the spectroscopic binary and the tertiary component**. The morphology of the emission changes in accordance with the predicted orbital motion of the tertiary around the spectroscopic binary, as determined from NIR interferometric observations. The total intensity also changes between the two observing epochs in a way that is inversely proportional to the separation between the two components, with a negative-steep spectral index typical of an optically thin synchrotron emission. The astrometric solution derived for the stellar system and the wind-wind collision region is consistent with independent Gaia data [216].

- We presented **VLBA observations of the water fountain IRAS 18113–2503, to accurately measure the location and 3-D velocities of its water masers** [181]. Water fountains are evolved stars with high-velocity jets traced by water maser emission, and they may



Astrometric position of the HD167971 system and the C-band radio emission of the 2006 (in black contours and colour scale) and 2016 (in white contours) epochs. The Spectroscopic Binary (SB) is represented by a cross, the tertiary (T) with a dot. The projected orbital path is shown with a solid line. The thick-solid lines represent the 2D bow-shock profile from our geometrical model. The red diamond shows the Gaia astrometric measurement for the system in the 2016 epoch [216]



(a) Location and radial velocities of masers in IRAS 18113–2503. Masers trace three pairs of arcs, tracing episodic events of mass-loss (in, mid, and out). The centers of the fitted ellipses (triangles) nearly coincide with the central star (cross). (b) Radial velocities (color) and proper motions (arrows) of masers. 3-D velocities of the ejections decrease at larger distances from the central star [181]

represent one of the first manifestations of collimated mass loss in the last stages of stellar evolution. IRAS 18113–2503 is the water fountain with the fastest jet

known (~ 350 km/s). Our VLBA observations show three episodes of mass loss, ejected at intervals of 10 yr. This suggests the presence of a binary central star with that period, whereas evidence for binaries with such long periods is very scarce in evolved stars. The decelerating pattern of ejections indicates that they move in a dense medium, which may imply that the secondary is of very low (even substellar) mass.

- The **central star of the planetary nebula NGC 2392, the Eskimo Nebula**, has long been suspected to be binary, but optical data imply two inconsistent periods: a ≈ 1.9 day period derived from N III emission lines and a ≈ 3 hour period derived from N IV absorption lines. A Chandra X-ray observation of NGC 2392 unveiled extremely hard X-ray emission from its central star, which can only be attributed to **accretion onto a compact companion star**. The ≈ 6 hour modulation of the X-ray emission provides key information to understand this system: the 1.9-day period corresponds to the rotation of the central star of the Eskimo, whose atmosphere is irradiated by a hot companion, the 3-hour period to the rotational period of this companion, probed by absorption lines in its atmosphere, and the 6-hour period to the orbital period of the binary system implied by a hot accretion spot [88].

- **The early phases of star formation are characterized by infall motions of ambient material onto a central protostellar object.** In previous works we showed that a signature of this infalling matter is a central blue spot in the intensity-weighted velocity images. In this work we derive an **analytical expression for this velocity as a function of the projected distance to the center**. This method is applied to existing data of several star-forming regions, namely G31.41+0.31 HMC, B335, and LDN 1287, obtaining good fits and deriving values of the central masses onto which the infall is taking place [64].

MEMBERS

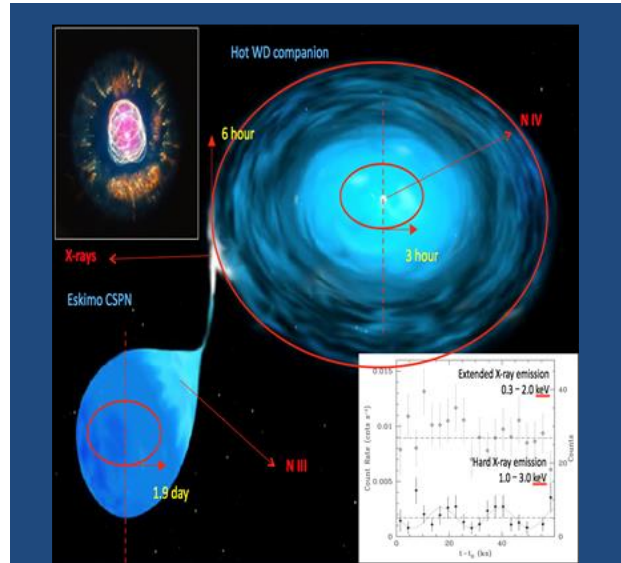
A. Alberdi, G. Anglada, G. Blázquez-Calero, A.K. Díaz-Rodríguez, J.F. Gómez, M.A. Guerrero, L.F. Miranda, M. Osorio, M.A. Pérez-Torres, J. S. Rechy Garcia

INVITED RESEARCHERS

I. de Gregorio (ESO, Chile), G. Niccolini (Université Côte d'Azur, France), J. M. Torrelles (ICE-CSIC), Y.-H. Chu (ASIAA, Taiwan), R. Ortiz Moraes (Univ. Sao Paulo, Brasil), G. Ramos Larios (Univ. de Guadalajara, Mexico), L. Sabin (IA-UNAM, Ensenada, Mexico), J.A. Toalá (IRyA-UNAM, Mexico), L. Zapata (IRyA-UNAM, Mexico), A. López Vázquez (IRyA-UNAM, Mexico), P. V. Almeida (Instituto de Astrofísica e Ciências do Espaço, Portugal), J. Sánchez-Bermúdez (UNAM, Mexico), J. Marcaide (Univ. Valencia, Spain)

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



Artistic view of the binary system at the central star of the Eskimo Nebula. The atmosphere of the central star (CSPN) is irradiated by a hot white dwarf (WD), which accretes material from the stellar wind of the former onto an accretion disk. The top-left inset shows a Chandra and HST composite picture of NGC 2392, where the X-ray emission is shown in purple. The bottom-right inset shows X-ray light-curves of the extended (constant) emission from the hot bubble in NGC 2392 and the point-source (modulated) emission at its central star [88]

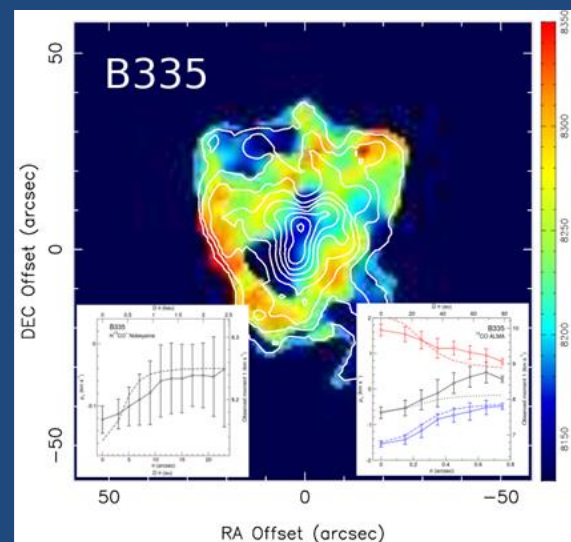


Image of the H13CO+ integrated emission (contours) and intensity-weighted velocity (color scale) of the B335 core showing the central blue spot towards the position of the embedded protostar. The insets show the radial velocity profiles of H13CO+ (from Nobeyama) and 13CO (from ALMA). The dashed lines show the best simultaneous fit to all the data, deriving a central mass of 0.1 solar masses [64]

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 measurements 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.

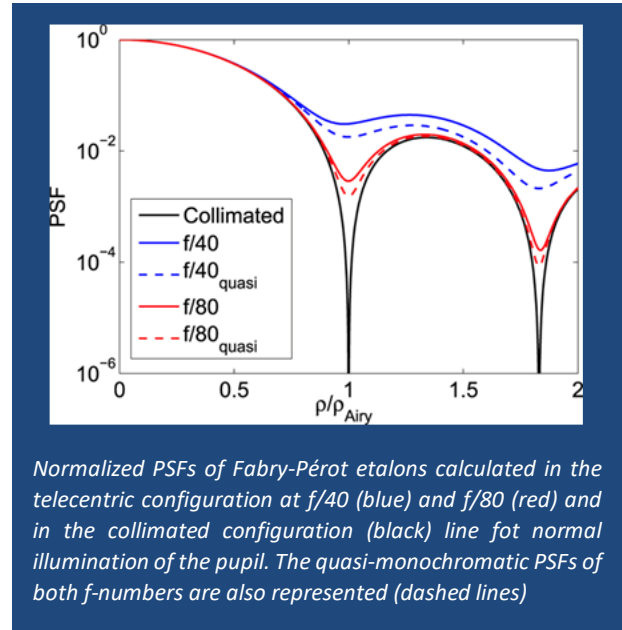
Highlights in 2019

Science

- A **review study** of the quiet-Sun magnetism was published in Living Reviews in Solar Physics [19]. With no more than 100 articles, this high impact (> 12), by-invitation only journal maintains an up-to-date view of most important topics in solar physics. With this 124-page long paper, our team members offer a complete picture of the current observational knowledge in the field.
- A **thorough study on the characterization of both isotropic and anisotropic Fabry-Pérot interferometers** was carried out [13, 14]. We discussed the chosen configuration (collimated or telecentric) for both ideal and real cases. For the real cases, we focused on the effects caused by the polychromatic illumination of the filter by the irregularities in the optical thickness of the etalon and by deviations from the ideal illumination in both setups. The birefringence effects of crystalline etalons were thoroughly studied and the possible consequences in the Stokes profiles of selected spectral lines were discussed.

Instrumentation

- Pre-study of the image stabilization system for the PMI instrument of the ESA's Lagrange mission.



Normalized PSFs of Fabry-Pérot etalons calculated in the telecentric configuration at $f/40$ (blue) and $f/80$ (red) and in the collimated configuration (black) line for normal illumination of the pupil. The quasi-monochromatic PSFs of both f -numbers are also represented (dashed lines)

- Manufacturing and tests of the AMHD and DPU prototypes for the TuMag and SCIP instruments of the Sunrise III mission.
- Thermo-vacuum tests of the TuMag and SCIP, in-house designed and manufactured, cameras.
- Tests of the electronic inverter and data compression systems for the SO/PHI instrument aboard the ESA's Solar Orbiter mission.

MEMBERS

Álvarez, D., Bailén, F. J., Balaguer, M., Bellot, L. R., Cobos, J. P., Del Toro Iniesta, J. C., Dorantes, A., Girela, F., Hernández, D., Herranz, M., Labrousse, P., López Jiménez, A. C., Moreno, A.J., Orozco, D., Ramos Más, J. L., Sánchez, A.

INVITED RESEARCHERS

Campos Rozo, J.I. (University of Graz, Austria), Chian, Abraham (U. Adelaide, Australia and INPE, Brazil), Gosic, M. (LMSAL, Palo Alto, CA, EEUU), Hansteen, V. (University of Oslo, Norway), Murabito, M. (Oss. Astronomico di Roma, INAF, Italia), Ortiz Carbonell, A. (University of Oslo, Norway), Utz, D. (University of Graz, Austria)

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

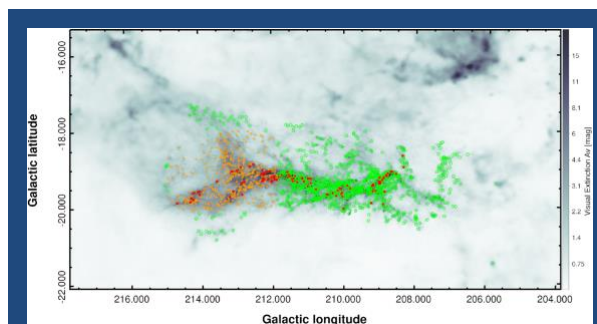
The Stellar Systems Group (SSG) was created in 1988. Since then, our research interests have diversified, even though the group has grown at a slower pace. The group's development is based on the two basic concepts of internationalisation and specialisation. We are leading the study of stellar clusters, 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>), has finished an unprecedented study of the Galactic Centre region (<http://gc.iaa.es>) and is creating the most complete catalogue of Galactic massive stars.

The Galactic Centre is located at only 8 kpc from Earth. It is the only nucleus of a galaxy that can be observed on milli-parsec scales. Therefore, it is fundamental for studying supermassive black holes, nuclear star clusters, or the physics of star formation in conditions that approach those in starburst galaxies and in galaxies at the peak epoch of star formation in the Universe. The IAA Galactic Centre Group (GCG) approaches these questions mainly via high angular resolution infrared observations. It evolved from a one-man team to a real group thanks to an ERC Consolidator Grant (2014-2019; PI Schoedel). The GCG is internationally well known and collaborates with teams in leading international institutes (e.g., N. Neumayer's nuclear cluster group at the German MPIA, or A. Ghez's Galactic Centre Group at UCLA). The next big project of the GCG is an unprecedented proper motion study of stars in the GC to unravel its components and formation history and to study the present-day initial mass function in this emblematic environment.

Highlights in 2019

- Key results obtained under leadership of the GCG in 2019 were: (1) **The first data release of the GALACTICNUCLEUS survey** [177]: The state-of-the-art near infrared survey GALACTICNUCLEUS (JHKs bands, 0.2" angular resolution) supersedes any comparable work by a factor of roughly 100 in the number of measured sources and provides a rich data mine for studying the centre of the Milky Way. (2) **Identification through proper motions measurements of a new candidate for the many "missing" young clusters at the Galactic Centre** [224].

- One of the primary objectives of the Stellar Systems Group is to establish observational constraints that allow us to distinguish between the different models and proposed physical processes that drive the



A dust extinction map of the Orion A molecular cloud derived from Herschel-SPIRE / Planck / 2MASS infrared maps [213]. The symbols indicate the locations of density peaks identified with our technique; orange squares indicate the locations of density peaks in the Tail sub-region, green circles are peaks in the rest of the cloud, and red dots indicate positions of peaks coincident with Young Stellar Objects

formation of stars from a cloud of molecular gas. Analysing the molecular clouds The Pipe and Orion we determined the **primordial nature of spatial segregation by mass of pre-stellar cores**, and as **volume density**, not mass, is the factor that generates a better defined spatial segregation [213]. This result shows that, mass and density, spatial segregation appear in the early stages of cloud collapse and fragmentation, and are not, or not only, due to the later dynamical relaxation of the stellar system. We also performed a **comprehensive analysis of the new GALANTE photometric system** [141], mainly developed for tailoring a homogeneous catalogue of the bright ($V \sim 17$) northern Galactic disk.

MEMBERS

E.J. Alfaro, A.T. Gallego, E. Gallego, E., A. Lorenzo; F. Nogueras, R. Schödel, B. Shahzamanian, A. Sota

INVITED RESEARCHERS

Carlos G. Román Zúñiga (Institute of Astronomy in Ensenada, UNAM, Mexico); - Yuhei Iwata (Keio University, Japan)

LINES OF RESEARCH

Galactic Centre; Massive Stars; Formation and Destruction of Stellar Clusters

STELLAR VARIABILITY

Overview

Research in the stellar variability group has been related with the fractal character of time in the time series describing the light curves of some pulsating stars. This can be the origin of many peaks in the power spectra of several objects which are not yet understood.

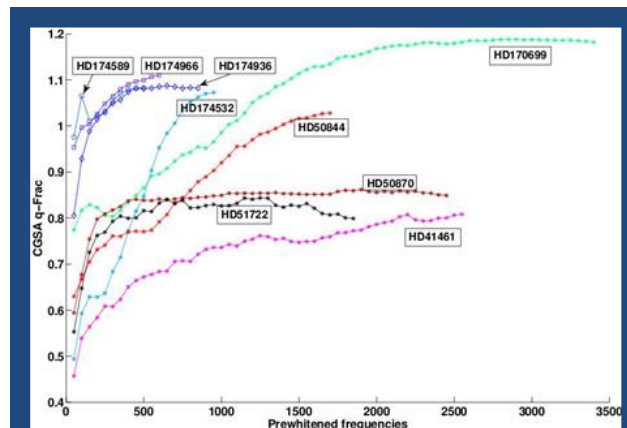
Recently, we have included the effects of rotation on the pulsations of stars and one paper concerning the interplay between Astroparticles and Asteroseismology has been published and within the PLATO2.0 project. Besides, activity related with open science within the project SKA-Link have led the group to participate in the ESCAPE European project.

Highlights in 2019

- We participated in the **asteroseismic analysis of 200 light curves from sector 1 and 2 of the TESS mission**. In this worldwide collaboration, classification of the pulsation content (in δ Scuti, γ Doradus or roAp variable stars), and comparisons with the theoretical models where made. Results allowed us to announce the discovery of the roAp with the shortest period known to date (4,7 min) [44] and to confirm that the mixing processes in the outer envelope of intermediate-mass variable stars are relevant regarding the excitation mechanisms theory [8].

- The Asteroseismology use case is based on the analysis of light curves of pulsating stars in order to derive their internal structure parameters and how they evolve. **Development of specific numerical codes for the treatment and analysis of data generated by the space photometric mission PLATO2.0** is a task assumed by our team. This study includes standard harmonic analyses and non-standard fractal time series analyses. Using these techniques, we found [46] that there is a **fractal background component** determining the frequency content extracted using classical techniques. In addition to this, the innovative application of fractal techniques resulted especially relevant to extract true oscillation modes in iterative harmonic fitting procedures, pointing to a new stop criterion based on the percentage of fractal component that is present in the residuals of the fitting.

- **Implementation and development of the TOUCAN virtual observatory tool**. This tool is a reference of management, comparison and analysis of astrosismic models. Creation of workflows for the processing of observation data following the precepts of reproducibility of the "Open Science" within our



Fractal analysis technique CGSA as a new stop criterion for the frequency extraction from the light curves of pulsating stars [46]

participation in the ESCAPE project funded by the European Community.

MEMBERS

Ayala, A.; Garrido, R.; Jerónimo, J.M.; Lares, M.; Martín, S.; Pascual, J.; Ramón Ballesta, A.; Rodón Ortiz, J. R.; Rodríguez Gómez, J.

LINES OF RESEARCH

*Time Series Analysis; Open Science; Stellar Structure
Fractal analysis*

TERRESTRIAL PLANET'S ATMOSPHERES

Overview

We investigate the Earth's atmosphere by retrieving, processing and analysing data of MIPAS and SABER (space-) and SATI (ground-) based instruments. We focus on the study of the effects of solar particles and radiation on atmospheric composition, and trends in temperature and species abundances. We also study atmospheric electricity in planetary atmospheres and are analysing ASIM and TARANIS data. The ESA ASIM mission was launched in 2018 and its data is being currently analyzed. The GALIUS (Atmospheric Electricity) laboratory was opened in 2018 and has been operating through 2019. The ERC eLightning project continues its development of numerical models of lightning. We are analysing the Martian upper atmosphere using GCM models and Mars Express and IUVS-MAVEN data; and started the analysis of NOMAD/TGO data. We also advanced in exo-atmospheric studies, having detected multiband signals of H₂O in hot Jupiters, and analysed the Helium triplet absorption in the escaping atmospheres of HD 209458 b, HD 189733 b and GJ 3470 b from CARMENES data

Highlights in 2019

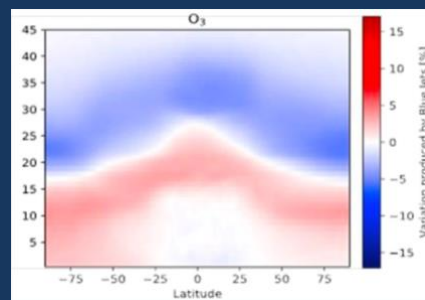
- We developed the **first global atmospheric chemical modeling of stratospheric blue jets** and found that they can have a non-negligible impact on key greenhouse gases as N₂O and O₃ [193].
- The NOMAD and ACS instruments (ExoMars-TGO) captured the **development of Mars global dust storm of 2018** and monitored the increase in atmospheric H₂O and HDO. These data are crucial for understanding Mars' atmospheric escape and its past climate [246].
- We detected **water vapour in the hot Jupiter HD 209458b in the near-IR (0.96-1.06 μm)**. This is the **first detection of H₂O from this band individually**. We also obtained firm evidences of day- to night-side winds at the terminator [218].

MEMBERS

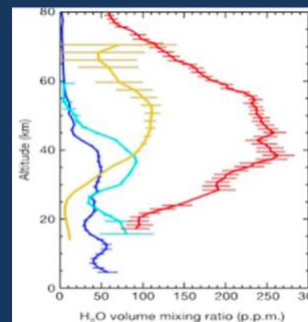
B. Funke, M. García Comas, M. Gomes, F. González Galindo, F.J. Gordillo, B.N. Hill, N. Kieu, D. Li, M.J. López González, M. López Puertas, M.Á. López Valverde, A. Luque, A. Malagón, M. Passas, F.J. Pérez Invernón, A. Sánchez López, J. Sánchez del Río, A. Schmalzried, S. Soler

INVITED RESEARCHERS

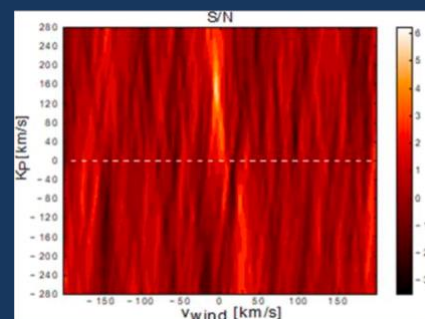
M. Mendillo (Boston Univ.); F. Wunderlich and A. García Muñoz (Tech. Univ. Berlin); K. Molaverdikhani (Heidelberg Univ.); Ruth Lieberman (GSFC, Greenbelt, USA); John Plane



Latitude-altitude(km) zonal mean distribution of the differences in the O₃ annual average between two simulations with and without Blue Jets [193]



NOMAD (blue, red) and ACS (cyan, yellow) measurements of H₂O in Mars' atmosphere before (blue and cyan) and during (red and yellow) the storm [246]



S/N map of H₂O in HD 209458b obtained with the CCF technique in the NIR. Maximum significance is found at the planet velocity (~150 km/s) [218]

(Leeds Univ.), Nikolai Lehtinen (Univ. Bergen, Norway); Javier Navarro-González (Univ. Valencia, Spain)

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; Exo-atmospheres modelling and analysis of ground-based measurements

THEORETICAL GRAVITATION AND COSMOLOGY

Overview

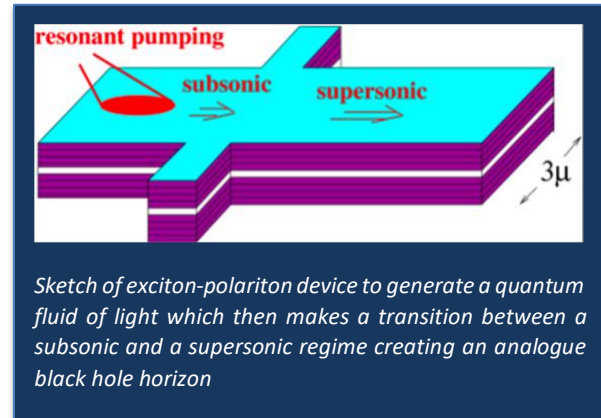
20th-century physics totally changed the way we understood the world by giving birth to two revolutionary theories, General Relativity (GR) and Quantum Mechanics (QM). However, it has left us with a giant puzzle, which might turn to be the seed of a new revolution. Instead of having a single theoretical framework with which to understand nature, we have two, and two that 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 realms 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.

Specifically, our group works on a number of specific subtopics that we briefly describe here.

1. Gravitational collapse in theories of gravity beyond Einstein's GR: 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 analyze 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. Group-theoretical quantization: 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 and Emergent Gravity: Condensed matter systems with emergent geometrical properties have already proved to be 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.

4. The origin of the mass of the particles: One of the biggest problems in physics is to understand what is the origin of the mass of elementary particles. In the standard model of particle physics, the mass emerges owing to the interaction of the Higgs particle with initially massless fermions. 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 2019

-We wrote an **invited review article** for Nature Physics describing the **state of the art of the experimental efforts to create analogue black-hole horizons in laboratory systems**. We also discussed the lessons we are taking from these efforts [16].

-It is common to say that a black hole should be distinguishable from an ultracompact object because the former cannot accommodate any hair while the latter could. However, we showed that **ultracompact stellar objects can accommodate just a tiny amount of hair: they become progressively hairless as its compactness approaches the black hole limit** [17].

MEMBERS

V. Aldaya, J. Arrechea and C. Barceló

INVITED RESEARCHERS

L.J. Garay (UCM), L.C. Barbado (U. Vienna, Austria), R. Carballo-Rubio (SISSA, Italy), S. Liberati (SISSA, Italy)

LINES OF RESEARCH

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

CALAR ALTO OBSERVATORY

Located on the mountain range of Los Filabres, in Almería, at a height of 2167m, the Calar Alto Observatory (CAHA) is, since 2019, operated jointly by the Junta de Andalucía and the Spanish National Research Council (CSIC). The IAA-CSIC is the reference institute of the observatory. CAHA provides three telescopes with apertures of 1.23m, 2.2m and 3.5m to the general community. The ideal atmospheric conditions for astronomical observations and the 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 MICINN (ICTS) for Astronomy.

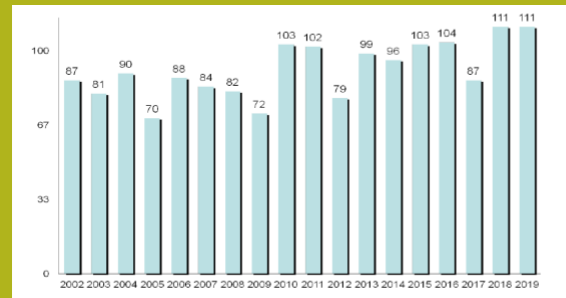
SCIENTIFIC RESULTS IN 2019

The total number of publications in 2019 kept the highest score in all our historic records with 111 papers (see top figure). This represents an extraordinary record considering the total number of telescopes being operated at the mountain.

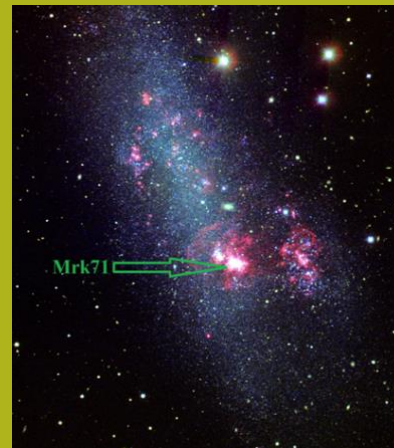
CARMENES FINDS AN ANOMALOUS PLANETARY SYSTEM

CARMENES instrument, co-led by the IAA-CSIC, detected a giant planet around a dwarf star from the Observatory of Calar Alto (Almería). The planet could have been formed by the rupture of the disk around the star, and not by the accumulation of gas around a solid nucleus, as it is believed that gas giants form [167].

CARMENES found a giant gas planet around the red dwarf star GJ3512, as well as indications of the presence of another planet. The finding, published in the journal Science, called into question the most accepted model of formation of the giant planets, which states that they



Historical record of scientific publications in 2018 and 2019



Green pea galaxy NGC2366 resolved in thousands of blue (young) stars



Sunrise telescope mirror aluminizing at Calar Alto observatory

are born from a solid nucleus that accumulates gas, and opens up the possibility of their formation after the rupture into fragments of a protoplanetary disk.

SPACE- AND GROUND-BASED OBSERVATIONS REVEAL A PLANETARY TRIO AROUND A NEARBY STAR

Combining data from the TESS satellite and from various instruments on the ground, CARMENES among others, led to the detection of a multiple planetary system around a nearby star. The work, involving researchers

from IAA-CSIC, opened the door to the detailed study of multiple planetary systems [145]. The combination of data from TESS (Transiting Exoplanet Survey Satellite, NASA) with observations from ground-based facilities, including the CARMENES spectrograph at Calar Alto observatory (CAHA), revealed a triple planetary system around a moderately bright star lying only at 31 light-years from us, making it a favourite target for a detailed study. These new worlds orbit around GJ 357, an M-type dwarf star having approximately a third of the mass and size of the Sun.

CARMENES FINDS TWO TEMPERATE TERRESTRIAL PLANETS AROUND TEEGARDEN'S STAR

CARMENES instrument allowed to find two planets around the Teegarden's star, one of the closest known. With masses similar to Earth's, their temperatures could be warm enough to support liquid water on the surface [255]. Doppler measurements of the Teegarden's star showed the presence of at least two signals, now identified as the two new exoplanets, named Teegarden's star b and c. Researchers deduced that the Teegarden's star b planet has a mass similar to that of the Earth and completes an orbit around the star every 4.9 days at 2.5% of the Earth-Sun distance. On the other hand, Teegarden's star c is also similar to Earth in terms of mass, completes its orbit in 11.4 days and is located at 4.5% of the Earth-Sun distance.

A NEARBY GREEN PEA GALAXY, ANALOG TO THE FIRST GALAXIES, SHOWS HOW THE YOUNG UNIVERSE BECAME ILLUMINATED

PMAS on the 3.5-m telescope was used to study a nearby star-forming galaxy, emitting energetic photons in a similar way to the first generation of galaxies (Micheva et al. 2019). These first galaxies turned the Universe transparent, less than one billion years after the Big Bang. The young Universe was a dark place. A few hundred million years after the Big Bang, the first stars formed, and their ultraviolet radiation ionized the hydrogen atoms that populated the Universe and absorbed the radiation. This is called the Era of Reionization, and marks the time when the Universe became transparent to light. A team of astronomers used the PMAS instrument at Calar Alto Observatory to study a green pea, a local analog to the first galaxies, to better understand how ultraviolet light escapes and ionizes distant areas, in a process similar to that of Reionization (see middle figure, pag. 18).

GALAXIES CO-ROTATE WITH THEIR MOVING NEIGHBORS

Astronomers used CALIFA data to study the rotation of galaxies and found that the direction in which a galaxy rotates is influenced by its moving companions, even distant ones (Lee et al. 2019). Most galaxies rotate: their billions of stars orbit around the center of the galaxy, like a spinning wheel. In the case of spiral galaxies, the rotation and its direction are obvious, thanks to well-visible spiral arms. But even irregular-shaped galaxies like the Large Magellanic Cloud, or "smooth", apparently featureless elliptical and lenticular galaxies show signs of rotation when observed with integral field spectrographs, like the PMAS instrument mounted on the Calar Alto 3.5-m telescope.

TECHNOLOGICAL ACTIVITIES IN 2019

THE MIRROR OF THE SUNRISE MISSION GETS READY AT CALAR ALTO

The SUNRISE mirror, with a diameter of one meter, underwent the aluminizing process as part of the preparations for the next mission flight. SUNRISE, a mission designed to study the Sun's magnetic field from a stratospheric balloon, faces its third flight after its successful trips flying over the Arctic in 2009 and 2013. The instrumentation was recovered in both occasions, and now the mission team focuses on the preparation of the next phase, which will take place in 2021. In late September, the aluminizing of the SUNRISE telescope mirror took place at Calar Alto, a service offered by the observatory that permits to preserve the optimal conditions for observations (see bottom figure, pag. 18).

A MORE EFFICIENT CAFE INSTRUMENT

The last update of the CAFE instrument on the 2.2-m telescope provides a higher accuracy for the studies of stars and exoplanets. The Calar Alto observatory enhanced the accuracy of the CAFE (Calar Alto Fiber-fed Échelle spectrograph) instrument, installed since 2011 on the 2.2-m telescope. The improvement was based on a new temperature control system, the renewal of diffraction grating and a new Calibration unit based on a Fabry Perot design.



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 OSN is operated by the IAA, with the technical and instrument maintenance carried out by the UDIT (Instrumental and Technological Development Unit). The main observatory building hosts two Nasmyth optical telescopes with a 90-cm and a 1.50-m mirror, respectively (hereafter T90 and T150). Each telescope has two instruments: both telescopes have a 2048x2048 CCD camera in the East plane, and while the T90 has a Strömgren-Crawford simultaneous six-channel photometer in the West plane, the T150 has a low-intermediate resolution optical spectrograph, Albireo. Owing to an ongoing upgrading intervention, Albireo has not been available during 2019.

The southernmost high-altitude location in continental Europe, together with the dry climate conditions of Sierra Nevada makes the OSN an excellent place for carrying out other experiments and studies. For this, in addition to the main building, there are other secondary facilities, e.g. the Spectral Airglow Temperature Imager, SATI, a Fabry-Perot spectrometer of the Terrestrial Planets Atmospheres Group, dedicated to the study of the high layers of the Earth's atmosphere.

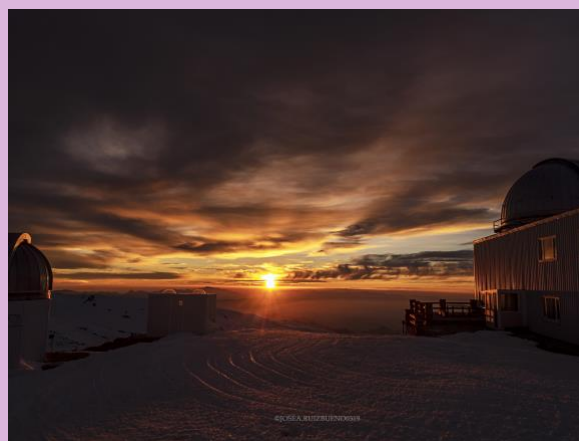
Observations and scientific results in 2019

Nowadays, small to medium size telescopes are increasingly dedicated to follow-up programs needing an extended time baseline and to observations requiring a prompt response (Target of Opportunity programs, ToO) and good time coverage, and the OSN is no exception. Some programs carried out during 2019 and their results were:

- **Follow-up photometry of CARMENES M dwarf targets** was done at the T90 and T150 to characterize their activity and discard false planet positives: 6 papers were published. Among them, 1 in Science: the discovery of a giant planet orbiting a very low mass star that challenges the current planet formation models [167].

- **Several GRBs were observed**, detecting afterglows and doing their follow-up. We highlight the Nature publication: "Signatures of a jet cocoon in early spectra of a supernova associated with a γ -ray burst" [108].

- **The long-term observational study of the rotational variability of transneptunian objects (TNOs) and Centaurs** proposed, for the first time using the analysis



Sierra Nevada Observatory at twilight. Credit: J.A. Ruiz Bueno

of rotational light-curves, and with observations spanning two decades, that the TNO Varuna has an orbiting satellite [73].

Collaborations in 2019

The OSN hosts a fireball detection station from the University of Huelva, which is 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 from the Topo-Iberia project performs integrated studies on topography and 4-D evolution.

An accurate and complete weather station is a fundamental instrument for an observatory located at very high altitude, as extreme weather, as well as rapid fluctuations, can affect the observations. Thus, the OSN **collaborated with the FT Technologies company in order to test new weather sensors**.

Together with the **IAA Sky Quality Office**, the OSN was present at several meetings for the **defense and protection of the dark sky**. The OSN also performed observations related to educational activities: as observing practices of the **Master in Astronomy and Astrophysics** organized by the Valencia International University, and hosting a **visting program for foreign students**.

Finally, **guided visits for the general public** are traditionally organized in the summer months at OSN.

MEMBERS

OSN Director: C. Rodríguez López. OSN Technical Director: M. Abril

OSN Technical Personnel: L. Costillo, D. Pérez Medialdea, Á. Tobaruela

Support Personnel: F.J. Aceituno, E. Carmona, V. M. Casanova, J.L. de la Rosa, A. López-Comazzi, J. A. Mirasol, T. Pérez, J. A. Ruiz, A. Sota

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 \square UDIT) was founded in 1975 and since its foundation it has been focused on the development of state-of-the-art instruments for ground-based telescopes (OSN, CAHA, GTC) and space-borne astrophysical payload instrumentation (stratospheric balloon observatories and ESA missions). During more than 40 years, the instruments developed at the UDIT have placed the IAA as a reference center for technological 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 space missions.

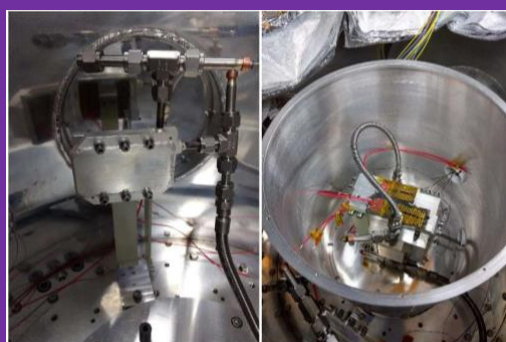
In the following lines we present a summary of the activities performed during 2019 for the instrumentation projects that are being developed at the UDIT.

GROUND BASED INSTRUMENTS

MOSAIC (Multi-object spectrograph for ELT). The IAA contributes to the MOSAIC instrument with the hardware and software control for the cryogenic mechanisms of the IR spectrograph. The activities in 2019 were focused on the simulation and testing of the first version of the instrument control software. The MOSAIC team also worked on the definition of the first hardware prototype.



MIMA instrument. Mechanical design



MUSICA experimental set-up

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 spectrometer with 5 channels for long-term monitoring of mesopause changes. In 2019, the mechanical design of the instrument was finished and the fabrication of the different mechanical parts was started. The development of the control software of the instrument, focused on the filter wheel and power supply control, user graphical interface and the observation planner was almost finished in 2019.

GALIUS (GrAnada Lightning Ultrafast Spectrograph), is a portable, high spectral resolution imaging spectrograph that achieves unprecedented high speeds. It is designed to work in the ultraviolet, visible and near infrared spectral ranges. In 2019, the portable version of the instrument was manufactured at IAA and the complete characterization of the instrument was carried out. Field measurements were performed at an external company

during the second half of 2019. At the end of the year, GALIUS came back to IAA to complement the electrical characterization with additional measurements.

MUSICA-Programa Torres Quevedo. During 2019, a prototype for heat transfer was manufactured and tested with the aim to implement new control strategies for obtaining better thermal stability for cryogenic systems, obtaining a stability of 10 mK in the nitrogen gas flow over 10 h. The improvements obtained for MUSICA are validated for CARMENES upgrade.

HIRES (High Resolution Spectrograph for E-ELT). The IAA is involved in the thermal design of ZYHJ and BVRI channels. IAA worked in the phase B preparation during 2019.

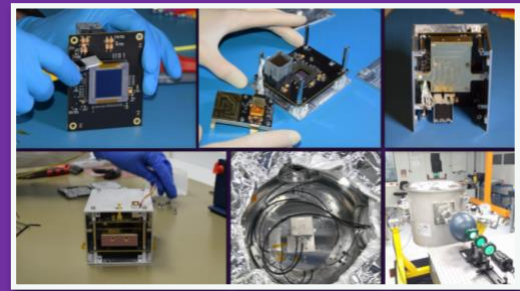
PANIC (Panoramic Near Infrared Camera for Calar Alto) In 2019 IAA was in charge of the update of the low-level software and the pipeline SW to adapt it to the new PANIC's monolithic detectors.

SPACE PROJECTS

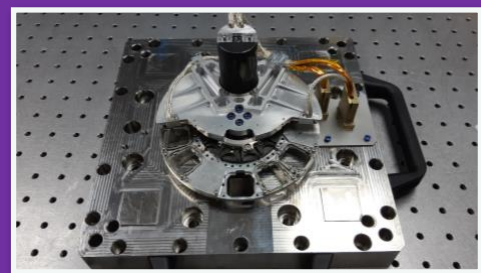
PHI (Polarimetric and Helioseismic Imager for the ESA Solar Orbiter mission). The IAA is the PHI co-PI institution and its Solar Physics group coordinates the Spanish team. The IAA is also responsible for the electronics unit and the harness work packages. During 2019 IAA worked in SO/PHI coordination and commissioning operations as well as supporting the PHI pipeline testing and debugging.

GALA (GANymede Laser Altimeter) and **JANUS** (Jovis, Amorurum 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. In 2019 the CDR (Critical Design Review) for both instruments was successfully passed, the qualification model (QM) was tested and the Flight Model (FM) was manufactured.

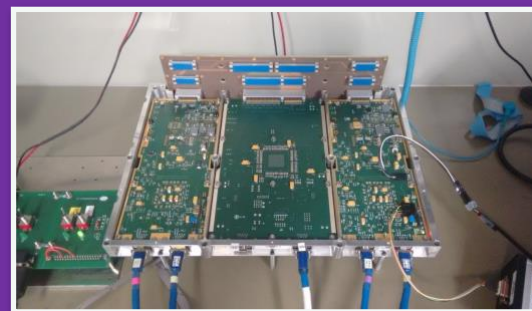
PLATO (PLANetary Transits and Oscillation of stars, ESA). The IAA is responsible for the 2 MEUs (Main Electronic Units) of the instrument. Each MEU is equipped with 6 DPUs (Digital Processing Unit) and 2 SpaceWire routers also under IAA responsibility. In 2019 IAA developed the Laboratory EGSE software, needed to perform some tests with the manufactured HW and the engineering model of the Main Electronics Unit (MEU). Several tests campaigns were performed, with the MEU EM in flight configuration.



SUNRISE SCIP & IMAx+ cameras prototype



JANUS Filter wheel



PLATO Engineering Model (EM)

SUNRISE III. Sunrise III is the third mission of the 1m Sunrise solar telescope. In this new edition, the IAA manages the IMAx+ instrument consortium. It is in charge of the electronics, harness, control software and the electronics and mechanical of the scientific cameras for the **TuMag** and **SCIP** instruments. In 2019 a prototype, flight representative, was manufactured for the whole electronics and cameras. An electrical verification campaign was also carried out with the prototypes.

Lagrange. It is an ESA mission proposal that belongs to ESA's Space Situational Awareness Programme. In 2019, IAA contributed to a pre-development for the Image Stabilization System (ISS) for the instrument PMI (Polarimetric Magnetic field Image).

EnVision. EnVision is a proposed orbital mission to Venus that would perform high-resolution radar mapping and atmospheric studies. In 2019, IAA worked in the conceptual design of the development of the power supply of the suite of instruments Venus Spectroscopy (VenSpec) and VEM (Venus Emission mapper).

Comet Interceptor: Comet Interceptor is an ESA mission that comprises three spacecrafts, to study a pristine comet. IAA worked during 2019 in the conceptual study of the power supply for several instruments in the mission as well as in the digital processing unit of the instrument EnVisS and OPIC

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, A.J. Moreno, J.L. Ramos, N. Robles, J. Rodrigo, J. Sánchez, M. R., Sanz, A. Tobaruela. Mechanics: S. Becerril, I. Bustamante, R. Calvo, E. Álvarez, M.A. Sánchez. Optics: F.J. Bailén. Project Management: M. Balaguer, J.M. Castro, A. López, J.F. Rodríguez. Software: E. Bailón, M. Cabrera, J.P. Cobos, A. García, J.M. Gómez, D. Hernandez, J.M. Ibáñez, J.M. Morales, R. Morales, M. Passas, C. Pastor, A. Sánchez.

GENDER ACTIONS

Overview

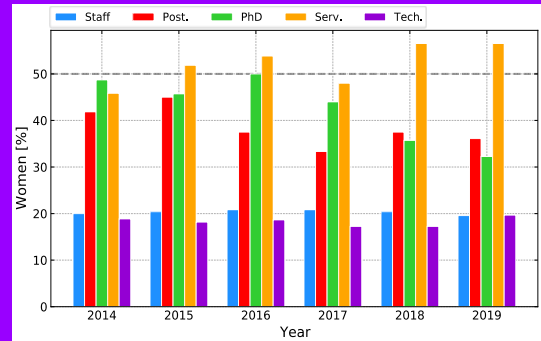
The IAA-CSIC is characterized by its support of inclusive initiatives in Gender Equality. This trajectory crystallized in the creation of the Institute's Gender Equality Commission and the elaboration and approval of the First Gender Equality Plan of the IAA-CSIC in 2018 (GEP). Here we present the gender diagnostic and main activities for the year 2019. (See <https://bit.ly/3hu4DxZ>)

Current diagnostics of gender equality at the IAA

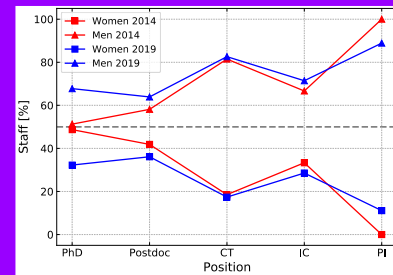
The **first figure** shows that while the presence of women in service activities increased in 2019 compared to 2014 from 46 to 57%, the proportion of women scientists slightly decreased (from 32% to 29%). The decrease in the percentage of female pre-doctoral researchers is significant since 2016 (more than 15% decrease). Considering women in technological activities, the proportion is 20%, only slightly better than in previous years. The **second figure** shows the percentages of women on the different scales of the scientific career in 2019 as compared to those in 2014. In general, the presence of women decreases as you move up in the academic level. This situation improved somewhat with respect to 2014 in the maximum scale, after the promotion of a woman astronomer at the IAA to the level of Research Professor. The proportion of pre-doctoral women decreased, "squeezing" the scissor behavior. The proportion of post-doctoral women researchers also decreased slightly with respect to 2014. The **third figure (left)** shows the evolution of the variation of the number of postdoctoral researchers with respect to 2013. Although the total number of men remained the same, the number of women clearly decreased, with a minimum in 2017. As for the technicians (**third figure, right**), the absolute number of women increased in two in the last year, although the trend during the last 5 years indicates a slower growth than the number of men (1 vs. 5).

Concerning the IAA scientists with permanent positions, the **fourth figure** indicates a similar aging of the both men and women permanent scientists, except for the younger range (reduced from the institute's average of 20% to 14%).

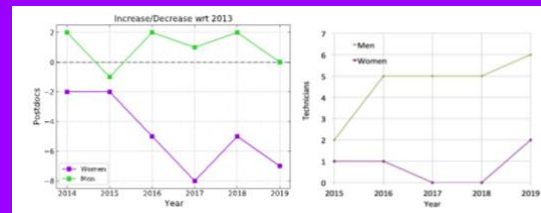
Participation and leadership in research and technological projects and in CSIC groups. The graphs in the **fifth figure** shows the participation in IAA-CSIC research projects in 2019 segregated by gender. 20% of the IAA-CSIC researchers participating in research projects were women. On the other hand, 25% of the principal investigators in the projects led by the IAA in 2019 were female. In the technological projects, 33% were led by women. Only one of the 14 CSIC research groups at the IAA was led by a woman.



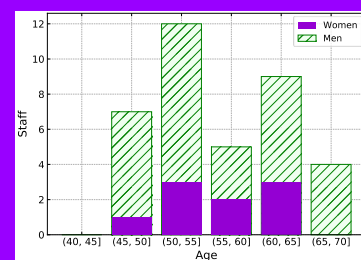
Percentage of IAA women since 2013



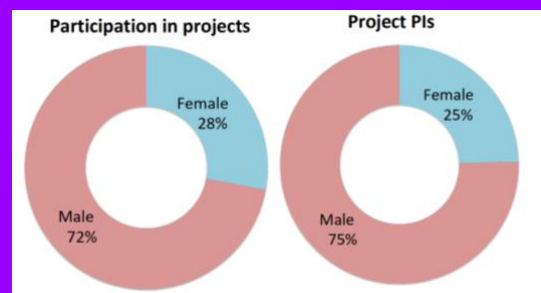
Percentage of IAA women scientists at the different levels in 2014 (red) and 2019 (blue)



Variation in the number of IAA postdocs since 2014 and technicians since 2015



Age of the IAA scientists with permanent positions



Participation in research projects of the IAA personnel (left) and Project leadership (right)

Congresses co-financed by the IAA-CSIC in 2019. The organization of meetings should be gender balanced according to the Spanish *Organic Law 3/2007 for the effective equality of women and men*, which is mandatory for all public administrations. Whereas numbers are right for the composition of Local Organising Committees of the conferences co-financed by the IAA, the composition of their Scientific Organising Committees were unbalanced against women. To ensure that the statistics on women's participation in congresses are taken into account for the definition of their committees, a template was drawn up, which will be *compulsory from 2020 onwards*.

Analysis of Equality measures in the development of the IAA Severo Ochoa excellence project. Five out of the 18 colloquia organized were given by women from the **Vera Rubin** Colloquium program. In the **Hypatia de Alejandria** programme, 4 women participated out of the 24 visits to the centre. Note that in all the 4 cases were the women researchers invited by women. The **Jocelyn Bell** program funded two women researchers from the center to visit other international centers. **Concerning postdoctoral** recruitment, 4 women were hired out of the 10 contracts offered (2 fellows and 2 postdocs). Of the 3 **pre-doctoral positions** offered, all were taken by men. One of these 3 projects offered was led by a female researcher.

All in all, the number for the IAA Severo Ochoa program are, in overall terms, reasonably positive, although the number of visits of the Hypatia de Alexandria will have to be boosted in the coming future.

Gender Activities in 2019

- *Production of the annual statistics segregated by gender.*

- *Organization of activities for the International Day of Women and Girls in Science, 11th February.* An "Open day" was held for the educational centres in Granada city, with the aim of promoting scientific vocations among girls and making visible the role of women researchers, from the youngest to the oldest. Outreach talks were also given to schools in Granada province with the aim of promoting scientific vocations among girls.

- *Organization for March 8th, 2019, of the "presentation of the 1st Gender Equality Plan" to the institute.*

- The Scientific Communication Unit of the IAA continued with the public screening of "*El enigma Agustina*" (<https://bit.ly/3hveyDF>), an audiovisual project of the IAA that addresses the struggle of women to access a scientific career in Spain in the 40s and claims some of the female figures of the time.

- Contribution to the *visibility of women scientists in the Book Fair of Granada 2019*, where the presence of women was very relevant.

- In the YouTube channel of the CSIC delegation in Andalucía, 6 out of the 12 videos of the series "*Yo investigo*" were starred by IAA female researchers (<https://bit.ly/2Zy86Wo>).

- The *librarian of the IAA-CSIC* started the dissemination in open access of the gender activities developed at the IAA (equality plans, articles, IAA magazine, etc). All materials are located in the Institutional Repository of the CSIC, hence guaranteeing its preservation in the long term.

- The female scientists of the IAA actively collaborated by authoring 2 articles in 2019 in the newspaper *El País* "*Las científicas responden*" (https://elpais.com/agr/las_cientificas_responden/).

- We continued to collaborate with the *Scientific Dissemination Magazines* and the newspapers *El País*, *Granada Hoy* and *Ideal*. In the IAA magazine "*Información y Actualidad Astronómica*", articles were published with the aim of making visible women scientists who contributed significantly to the development of astronomy.

Highlights in 2019

The current IAA Directorate is actively promoting the participation of women in the management bodies of the center: the two Deputy Directors, the Head of the Instrumental and Technological Development Unit and the Director of the Sierra Nevada Observatory are all women. Likewise, the Scientific Direction of the Severo Ochoa IAA project is held by a woman.

On 10 September 2019, the IAA received an **accessit from the CSIC in the 2nd edition of the "Gender Equality Accreditation Award"**. The IAA's Directorate considered it essential to submit nominations for women's awards for scientific excellence.

In addition to ensuring the equality measures provided by the GEP, the Equality Commission of the IAA-CSIC acts as the "*Gender Working Group*" of the equality plan drawn up by Severo Ochoa project. All the governance bodies of the Severo Ochoa verify the gender equality. The following actions were contemplated:

- **Hypatia of Alexandria Visiting Grant.** A minimum of 3 visits in the visiting researchers' program, out of the 6 planned, are offered to female researchers.

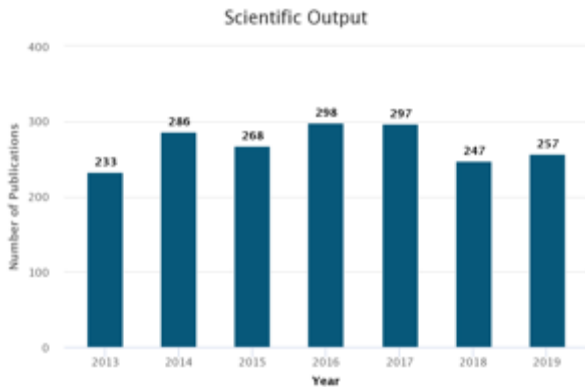
- **Vera Rubin Colloquia.** A minimum of 6 colloquia, out of the 12 planned annually, would be given by female researchers.

- **Jocelyn Bell outgoing program.** As part of the visits by the IAA researchers to prestigious centres, it is envisaged that a minimum of 3 of the 5 planned are offered to female researchers.

SCI PUBLICATIONS

The research activity carried out at the IAA-CSIC during 2019 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 250 papers published in journals of the SCI.

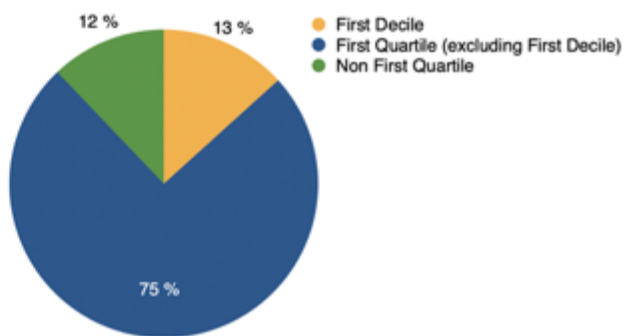
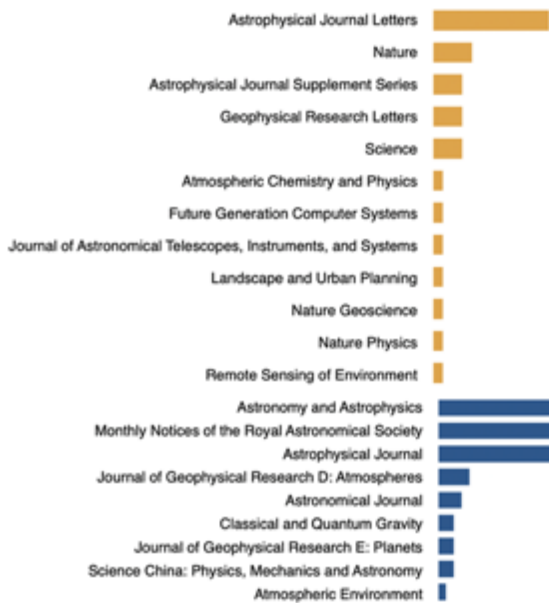
The complete list of the IAA-CSIC publications in 2019 is given in the Annex at the end of this report. The evolution of the number of SCI publications since 2013 is shown below. Along the years, the number of publications fluctuate around an average value of 280 papers per year.



The publications of the IAA-CSIC are mostly distributed in high impact journals (see the figure in the following page). About 75% of our publications appeared in journals of the first quartile (top 25% journals). Among these publications, 13% appeared 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 is 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 18% of the IAA SCI 2019 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, 92% of the IAA publications include authors from international institutions, probing the extraordinary level of internationalization of the IAA research.



AWARDS

AWARDS IN 2019

- **NSF Diamond Achievement Award from the National Science Foundation (USA), May 9th 2019,**

- **American Ingenuity Award in Physical Sciences 2019, from the Smithsonian Institution (USA), Dec 2019**

- **#1 Science Stories of the year, from Science Magazine, 16th December 2019,**

were awarded to the Event Horizon Telescope (EHT) international collaboration, which obtained the first image of a black hole. **J.L Gómez, A. Alberdi** and **G. Zhao** from the IAA-CSIC participate in the collaboration, which brings together 347 researchers. The announcements of the **8th Annual Breakthrough Prize in Fundamental Physics 2020** and the **Einstein Medal 2020** were also released in Sep and Dec 2019, respectively. This result had a huge impact on the media (see page 30).



Delivery of the Severo Ochoa badges to the most recent winners by the Minister of Science, Innovation and Universities in operation, Pedro Duque, who presided the official ceremony. **Isabel Márquez**, Scientific Director of the IAA Severo Ochoa project, receives the distinction, which recognizes the centers that carry out cutting-edge science basic research and are among the best in the world in their area.



Spanish Astronomical Society (SEA) Prize 2019 for the best Spanish Doctoral Thesis in “Instrumentation, Computing and Technological Development in Astronomy and Astrophysics. Awarded to the PhD thesis by **Concepción Cárdenas** entitled “PANIC, a wide-field infrared camera for Calar Alto”, made at the IAA under the supervision of **Julio Rodríguez**. It focuses on the wide-field infrared camera PANIC, covering its theoretical study, optical design, construction and verification, for its operation at Calar Alto 2.2 and 3.5 meter telescopes.



“Granada de Plata 2019” from the City Council of Granada, to the IAA-CSIC. These awards are given to institutions or individuals that are example and model of the best values associated with Granada”, and capable of projecting the good name of the city beyond its borders. The **IAA-CSIC** was selected as a center of reference for the excellence in research, recognised as a Severo Ochoa center.



“Granada City of Science and Innovation 2019” award for “Scientific Career”, devoted to the best recognized and outstanding international trajectory of researchers working in Granada. It was awarded to **José Juan López Moreno**, recognising his pioneering role and excellent scientific contributions to the research line “Space Research” at the IAA-CSIC.



“Distintivo de Igualdad 2019”, these awards granted by the CSIC have the objective of promoting the gender perspective as a cross-cutting category in all aspects of the CSIC's operation and making progress in promoting measures to remove the barriers encountered by women in the exercise of their profession. The **IAA-CSIC** was awarded with an accessit, collected by its Director at the CSIC headquarters in Madrid.



“HEBE” award for “Young researcher” 2019. The Hebe Awards distinguish young local talent. The Science category was won by **Juan Pedro Cobos**, recognizing his scientific trajectory in Astrophysics and Space Science.



“Premio José Luis Comellas de Divulgación Científica 2029” from the Andalusian Network for Astronomy (Red Andaluza de Astronomía, RAdA) was given to **Emilio Alfaro**, who gave a lecture on the "Gaia Catalogue" showing the many tools it offers to an amateur astronomer for doing science.



“Prismas de Divulgación Científica 2019” from the scientific museums in Coruña (Spain) to the best “Singular Project”, was awarded to **“El enigma Agustina”**, on its mixed format as audiovisual, theatre on stage and live radio program, to **Emilio García** and Manuel **González**.





The Black Hole Shadow in M 87 Cover Pages



EDUCATION

PHD THESES

"GALANTE: Photometric System and Galactic Plane Survey"

Author: Antonio Lorenzo Gutiérrez

Supervisors: E.J. Alfaro, J. Maíz

Universidad de Granada

Dec 17, 2019

"Characterization of exo-atmospheres with transmission spectroscopy"

Author: Alejandro Sánchez López

Supervisors: M. López Puertas, B. Funke

Universidad de Granada

Nov 29, 2019

"CO₂ retrievals in the Mars daylight thermosphere from 4.3 μm limb emissions"

Author: Sergio Jiménez Monferrer

Supervisors: M.A. López Valverde, B. Funke

Universidad de Granada

Oct 04, 2019

"The structure and stellar population of the Nuclear Bulge of the Milky Way"

Author: Francisco Noguera Lara

Supervisors: R. Schoedel, A. Alberdi

Universidad de Granada

Sep 23, 2019

"El observatorio astronómico: un diálogo entre ciencia y arquitectura"

Author: Miguel Ángel Castro Tirado

Supervisors: Javier Boned Purkiss, Alberto Castro Tirado

Universidad de Málaga

Jul 19, 2019

"The structure, stellar population, and formation history of the Milky Way's nuclear star cluster"

Author: Eulalia Gallego Cano

Supervisors: R. Schoedel

Universidad de Granada

May 10, 2019

"Study of the chemical and morphological evolution of molecular clouds, using observations of high-density gas tracers"

Author: Guillermo Manjarrez Esquivel

Supervisors: J.F. Gómez Rivero, I. de Gregorio Monsalvo

Universidad de Granada

Jan 11, 2019

TEACHING

IN-HOUSE COURSES



Title: **1st IAA-CSIC Severo Ochoa School on Statistics, Data Mining and Machine**

Organiser: **R. Schoedel (SO-IAA Training Coordinator)**

LOC: A. Pelegrina, M. González

Date: 4 -7 Nov 2019



Title: **III Curso de técnicas de divulgación**

Organisers: **IAA-CSIC & Laniakea**

LOC: E. García, A. Pelegrina, M. González

Date: 20 -21 Nov 2019



Title: Preparation of Proposals to the European Research Council (ERC)

Organisers: **IAA-CSIC**

LOC: R. Castro, A. Pelegrina, M. González

Date: 23 April 2019



Title: Key Aspects in the Preparation of a Competitive Proposal MSCA-IF

Organisers: **IAA-CSIC**

LOC: A. Pelegrina, R. Castro, M. González

Date: 13 June 2019

Undergraduate, Master and PhD Programs

Title: ***Stellar interior and evolution***

Authors: **Mirjana Povic**

Program: Master program in Astronomy and Astrophysics

University: Ethiopian Space Science and Technology Institute (ESSTI), program affiliated to Addis Ababa University, Ethiopia

Hours: 30

Date: November 2018-February 2019, November 2019-February 2020

Title: ***Observational techniques in Astrophysics***

Authors: **Mirjana Povic**

Program: Master program in Astronomy and Astrophysics

University: ESSTI, Ethiopia

Hours: 30

Date: February-June 2019

Title: ***Observational techniques in Astrophysics***

Authors: **Mirjana Povic**

Program: Master program in Physics

University: Mbarara University of Science and Technology (Uganda)

Hours: 42

Date: May 2019

Title: ***Radioastronomía***

Authors: **José Francisco Gómez Rivero, Antonio María Alberdi Odriozola, Guillem Josep Anglada i Pons**

Program: Máster en Física y Matemáticas - FISyMAT

University: Universidad de Granada

Hours: 60

Date: October 2018-February 2019, October 2019-February 2020

Title: ***High Energy Astrophysics***

Authors: **Alberto J. Castro Tirado**

Program: Máster en Física y Matemáticas - FISyMAT

University: Universidad de Granada

Hours: 11

Date: March 2019

Title: ***Cosmología y Galaxias***

Authors: **Emilio J. Alfaro, Mar Basteiro**

Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica

University: Universidad de Granada

Hours: 60

Date: January 2019

Title: ***Origen y evolution de los elementos químicos en el universo***

Authors: **José Manuel Vílchez Medina**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: Universidad de Granada
Hours: 20
Date: March 2019

Title: ***Curso de Astrofísica Estelar***

Authors: **Javier Pascual Granado**
Program: Máster Online en Astronomía y Astrofísica
University: Universidad Internacional de Valencia (VIU)
Hours: 30
Date: January-October 2019

Title: ***Técnicas Observacionales e Instrumentación Astronómica***

Authors: **Martín A. Guerrero Roncel**
Program: Máster en Física y Matemáticas - FISyMAT
University: Universidad de Granada
Hours: 10.5
Date: March-April 2019

Title: ***Física de Detectores***

Authors: **Jorge Iglesias Páramo**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: Universidad de Granada
Hours: 15
Date: October 2019-January 2020

Title: ***Astrofísica Observacional***

Authors: **Miguel A. Pérez Torres**
Program: Máster Universitario en Física Avanzada
University: Universitat de València Estudi General
Hours: 10
Date: January 2019

Title: ***Astrobiología y Planetas Extrasolares***

Authors: **Manuel López Puertas, Miguel A. López Valverde**
Program: Máster en Física, Módulo: Física de Partículas y Astrofísica
University: Universidad de Granada
Hours: 20
Date: April-May 2019

Other Programs

Title: ***New windows to the Universe: Gravitational Waves and MultiMessengers***

Authors: **Alberto J. Castro Tirado**
Program: International School of Astroparticle Physics and Cosmology
University: Universidad Internacional Menéndez Pelayo
Hours: 33 (as co-Director) / 3 (as Lecturer)
Date: July 2019

Title: ***Introduction to python programming***

Authors: **Rubén García Benito**
Program: Training course organized in collaboration with the IAU for the IAU symposium 356
Organizer: Ethiopian Space Science and Technology Institute (ESSTI)
Hours: 10
Date: 5-6 October 2019

Title: ***Iniciación a Python 3***

Authors: **César Husillos, Juan José Guijarro, Manuel Bayo**
Program: Programa de Formación CSIC
Organizer: CSIC
Hours: 25
Date: April 2019

Title: ***Python 3 avanzado orientado a trabajo científico***

Authors: **César Husillos, Juan José Guijarro, Manuel Bayo**
Program: Programa de Formación CSIC
Organizer: CSIC
Hours: 25
Date: September-October 2019

Title 1: ***Galaxias: ¿activas o perezosas?***

Title 2: ***Retos de la astronomía y la exploración espacial: IAA-CSIC*** Authors: **Isabel Márquez Pérez**
Program: XX Curso de Verano, El Universo al alcance de la mano
University: Universidad de Almería
Hours: 2 + 2
Date: July 2019

Title: ***The sky as seen from Sierra Nevada***

Authors: **Alicia Pelegrina López**
Program: MOOC Sierra Nevada
University: Universidad de Granada
Hours: 10
Date: October-November 2019

INTERNATIONAL

SEMINARS

★**Dr. Jeff Wagg** (SKA Observatory)

Title: "The road to the Square Kilometre Array "

Date: Jan 10, 2019

★**Dr. Alice Pasetto** (Centro de Radioastronomía y Astrofísica, UNAM)

Title: "AGN torus detectability at submm wavelengths: what to expect from ALMA continuum data "

Date: Jan 17, 2019

★**Dr. Carlos Carrasco** (UNAM, México)

Title: "Observing Planet Formation with the VLA in the era of ALMA "

Date: Jan 24, 2019

Francisco González Galindo (IAA - CSIC)

Title: "Mars UV atmospheric emissions"

Date: Feb 07, 2019

★**Dr. Andres Moya** (University of Birmingham)

Title: "THOT: Dating stars "

Date: Feb 13, 2019

★**Jon Lawrence** (Australian Astronomical Observatory)

Title: "Instrument development at the AAO "

Date: Feb 19, 2019

★**Prof. Enrique Martinez** (Instituto de Física de Cantabria)

Title: "Planck Cosmological Legacy : the next CMB polarization experiments "

Date: Feb 21, 2019

★**Yuhei Iwata** (Keio University)

Title: "High-velocity Molecular Clouds near the Galactic Center "

Date: Mar 07, 2019

Luca Izzo (IAA - CSIC)

Title: "Signatures of a jet cocoon in early spectra of a supernova associated with a gamma-ray burst "

Date: Mar 13, 2019

Josefa Masegosa Gallego (IAA - CSIC)

Title: "Primer Plan de igualdad del IAA "

Date: Mar 21, 2019

★**Manel Martinez** (Institut de Física d'Altes Energies)

Title: "SO-IAA Colloquia: CTA - The Cherenkov Telescope Observatory for VHE Gamma Ray astronomy "

Date: Mar 28, 2019

Francisco Prada Martínez (IAA - CSIC)

Title: "Is there still hope for discovering new physics in the Euclid era? "

Date: Apr 04, 2019

José Luis Gómez Fernández (IAA - CSIC)

Title: "Imaging a black hole with the Event Horizon Telescope"

Date: Apr 12, 2019

★**John Plane** (University of Leeds)

Title: "Cosmic Dust in Planetary Atmospheres "

Date: Apr 25, 2019

★**Dr. Jose Miguel Rodriguez Espinosa** (Instituto de Astrofísica de Canarias)

Title: "An ionised bubble before the epoch of re-ionisation "

Date: May 03, 2019

★**Prof. Abraham Chian** (University of Adelaide)

Title: "Nonlinear dynamics of space and astrophysical plasmas"

Date: May 09, 2019

★**Dr. Johan Comparat** (Max Planck Institute for Extraterrestrial Physics)

Title: "Active Galactic Nuclei and their large-scale structure: an eROSITA mock catalogue "

Date: May 16, 2019

★**Dr. Ruth Lieberman** (NASA Goddard Space Flight Center)

Title: "TIDES, PLANETARY WAVES, AND ATMOSPHERIC COUPLING "

Date: May 17, 2019

Lourdes Verdes-Montenegro Atalaya, Susana Sánchez Expósito, Michael Gordon Jones (IAA - CSIC)

Title: "A prototype SKA Science Regional Centre at the IAA "

Date: May 24, 2019

★**Dr. Luis Díaz García** (Academia Sinica, Institute of Astronomy & Astrophysics)

Title: "Correlations between the size and the stellar population properties of quiescent galaxies "

Date: Jun 04, 2019

★**Dr. Frank Schinzel** (National Radio Astronomy Observatory)

Title: "The Very Large Array Sky Survey (VLASS) and the next generation Very Large Array (ngVLA) "

Date: Jun 07, 2019

★**Dr. Luis F. Rodríguez** (UNAM, México)

Title: "Back to Orion "

Date: Jun 13, 2019

★**Dr. Li Ji** (Purple Mountain Observatory, Chinese Academy of Sciences)

Title: "Oxygen Line Diagnostics in X-ray spectroscopy "

Date: Jun 18, 2019

★**Dra. Laurence Sabin** (UNAM, México)

Title: "SO-IAA Colloquia: Searching extended line-emission objects in wide-field surveys: The IPHAS experience "

Date: Jun 20, 2019

★**Bruno Rodríguez Del Pino** (Centro de Astrobiología - CSIC)

Title: "Properties of ionized outflows in MaNGA DR2 galaxies"

Date: Jun 25, 2019

★**Dr. David Martínez-Delgado** (University of Heidelberg)

Title: "Stellar Tidal Streams in Nearby Galaxies as Dark Matter Probes"

Date: Jun 27, 2019

Jackeline Suzett Rechy García, Martín Guerrero Roncel (IAA - CSIC)

Title: "The Orientation of the Collimated Outflows of Planetary Nebula: Independence Day "

Date: Jul 09, 2019

★**Dra. Alenka Negrete** (UNAM, México)

Title: "Broad line AGN in the MaNGA survey"

Date: Sep 05, 2019

★**Dr. Isabel Rebolledo** (Universidad Autónoma de Madrid)

Title: "Detection of Exocomets: The gaseous environment of Main-Sequence Stars"

Date: Sep 12, 2019

Rosa María González Delgado (IAA - CSIC)

Title: "JPAS: A survey for Galaxy Evolution studies "

Date: Sep 19, 2019

★**Richard May-Miller** (Cranfield Precision)

Title: "Some aspects of high precision machines for astronomical applications"

Date: Oct 03, 2019

★**Dr. Carlos G. Román Zúñiga** (UNAM, México)

Title: "Cúmulos Jóvenes: eclosionando, moviéndose, volando"

Date: Oct 04, 2019

★**Merodio Codinachs** (European Space Agency)

Title: "SO-IAA Colloquia: FPGAs in space: current experiences, future challenges and opportunities "

Date: Oct 07, 2019

★**Prof. Jon Marcaide** (Universitat de València)

Title: "THE INNER DEBRIS OF SN1987A: MOLECULAR AND DUST EMISSION"

Date: Oct 10, 2019

★**Bárbara Rojas-Ayala** (Universidad Andrés Bello)

Title: "SO-IAA Colloquia: What's is the metallicity of cool dwarf stars?"

Date: Oct 17, 2019

★**Dr. Héctor Cánovas** (ESAC)

Title: "Data mining Gaia DR2: the quest for Pre-Main Sequence Stars (and their discs) "

Date: Oct 22, 2019

★**Dr. Sergio Martín Ruiz** (European Southern Observatory)

Title: "Molecular spectroscopy at high resolution for everyone"

Date: Oct 23, 2019

★**Dr. Ricardo Amorin** (Universidad de La Serena)

Title: "ANALOGUES OF HIGH REDSHIFT GALAXIES: DISENTANGLING THE COMPLEXITY OF THE GREEN PEAS "

Date: Oct 24, 2019

Carolina Kehrig (IAA - CSIC)

Title: "Nebular H α emission from spatially resolved metal-poor star-forming galaxies"

Date: Oct 29, 2019

★**Dr. Raffaella Morganti** (ASTRON)

Title: "SO-IAA Colloquia: Neutral and molecular gas outflows as tracers of the impact of radio jets"

Date: Oct 31, 2019

★**Dr. Karan Molaverdikhani** (University of Heidelberg)

Title: "SO-IAA Colloquia: Characterization of (exo)Planetary Atmospheres"

Date: Nov 07, 2019

★**Dr. Omaira González-Martín** (IRyA-UNAM, México)

Title: "Study of the diversity of AGN dust models"

Date: Nov 12, 2019

★**Dr. Roberto Maiolino** (Cambridge University)

Title: "SO-IAA Colloquia: Outflows and their feedback effect in galaxies"

Date: Nov 14, 2019

★**Dr. Concepción Cárdenas** (Max Planck Institute for Astronomy)

Title: "METIS instrument: the IMAGER and the SCAO "

Date: Nov 19, 2019

★**Dr. Elena Moretti** (Institut de Física d'Altes Energies - IFAE)
Title: "Inverse Compton emission revealed by observations up to TeV energies of GRB 190114C "
Date: Nov 26, 2019

★**Dr. Alejandro López Vázquez** (UNAM, México)
Title: "Molecular outflows: evolution, structure and angular momentum "
Date: Dec 02, 2019

★**Antonio García Muñoz** (Technical University of Berlin)
Title: "SO-IAA Colloquia: Recent advances about the exoplanetary exospheres "
Date: Dec 02, 2019

★**Dr. Daniel Hestroffer** (Observatoire de Paris)
Title: "Gaia mapping mission and science of Solar System Objects "
Date: Dec 05, 2019

★**Dr. Francisco Pozuelos** (Université de Liège)
Title: "SO-IAA Colloquia: Unveiling the nature of planetary systems "
Date: Dec 10, 2019

Sara Cazzoli (IAA - CSIC)
Title: "NGC 7469 as seen by MEGARA: new results from high-resolution IFU spectroscopy"
Date: Dec 12, 2019

★**Dr. Józsa Gyula István Géza** (University of Cape Town)
Title: "The SKA precursor telescope MeerKAT as a galaxy evolution explorer"
Date: Dec 19, 2019

VISITING SCIENTISTS

Invited

Clemens Thum

Instituto de Radioastronomía Milimétrica (IRAM)
01/01/2019 - 31/12/2019

Paola Marziani

INAF
18/11/2019 - 05/03/2020

Mahmoudreza Oshagh

Georg-August-Universität Göttingen
05/11/2019 - 20/01/2020

Igor Zinchenko

Main Astronomical Observatory, Ukraine
06/10/2019 - 20/11/2019

Pedro Viana Almeida

Instituto de Astrofísica e Ciências do Espaço
08/03/2019 - 07/07/2019

Manel Martinez

Institut de Física d'Altes Energies - IFAE
28/03/2019 - 28/03/2019

Roberto Ortiz Moraes

Universidade de São Paulo
28/12/2018 - 06/03/2019

Jack Sulentic

University of Alabama
17/10/2018 - 08/02/2019

SHORT VISITS

Mert Acar

Tubitak Observatory, Turkey
02/09/2019 - 15/12/2019

Alaa Alburai

University of Granada
21/10/2019 - 31/07/2020

Pedro Viana Almeida

Instituto de Astronomía y Física del Espacio (IAFE)
01/10/2019 - 01/12/2019
11/07/2019 - 15/09/2019

Alvaro Alvarez-Candal

Observatorio Nacional de Rio de Janeiro
28/10/2019 - 20/01/2020

Ricardo Óscar Amorín Barbieri

Universidad de La Serena
14/10/2019 - 25/10/2019

Julio Arrechea Rodríguez

Universisty Complutense Madrid
03/06/2019 - 30/06/2019
13/11/2018 - 31/05/2019

Yago Ascasibar

Universidad Autónoma de Madrid
06/06/2019 - 13/06/2019

Denis Belyaev

Russian Space Research Institute
02/10/2019 - 04/10/2019

Guillermo Blázquez Calero

Universidad de Granada
15/07/2019 - 31/08/2019

Daniel Borrajo Gutiérrez

Universidad Complutense de Madrid
03/10/2019 - 05/10/2019

Valentin Boyanov Savov

Universidad Complutense de Madrid
17/06/2019 - 28/06/2019
06/05/2019 - 23/05/2019
11/02/2019 - 08/03/2019

Colin Bradley

University of Victoria
21/10/2019 - 21/10/2019

Joyce Byun

Université de Genève
09/10/2019 - 18/10/2019
24/04/2019 - 03/05/2019
08/01/2019 - 18/01/2019

Héctor Cánovas

ESAC
21/10/2019 - 23/10/2019

Carlos Eugenio Carrasco González

Universidad Nacional Autónoma de México
07/01/2019 - 01/02/2019

Tatiana Cazorla

Universidad de Granada
15/07/2019 - 14/10/2019

Abraham Chian

Instituto Nacional de Pesquisas Espaciais
07/05/2019 - 10/05/2019

You-Hua Chu

Academia Sinica, Institute of Astronomy & Astrophysics
19/07/2019 - 29/07/2019

Johan Comparat

Max Planck Institute for Extraterrestrial Physics
14/05/2019 - 17/05/2019

Itziar de Gregorio Monsalvo

European Southern Observatory
06/09/2019 - 06/09/2019
15/07/2019 - 19/07/2019
10/01/2019 - 11/01/2019

Sylvain de la Torre

Laboratoire d'Astrophysique de Marseille
08/10/2019 - 11/10/2019

Luis Alberto Díaz García

Academia Sinica, Institute of Astronomy & Astrophysics
03/06/2019 - 14/06/2019

Renato Dupke

Observatorio Nacional de Rio de Janeiro
24/11/2019 - 30/11/2019
15/05/2019 - 04/06/2019

Florence Durret

Institut d'Astrophysique de Paris
15/01/2019 - 18/01/2019

Andreas Eckart

University of Cologne
18/02/2019 - 22/02/2019

Guillermo Gonzalez de Rivera Peces

Universidad Autónoma de Madrid
21/10/2019 - 22/10/2019
09/05/2019 - 10/05/2019

Omaira González Martín

Centro de Radioastronomía y Astrofísica, UNAM
10/11/2019 - 16/11/2019
05/05/2019 - 11/05/2019

Murray Graham

Durham University
06/05/2019 - 10/05/2019

Tomoaki Ishiyama

Chiba University, China
09/10/2019 - 19/10/2019

Li Ji

Purple Mountain Observatory, Chinese Academy of Sciences
17/06/2019 - 19/06/2019

Yolanda Jiménez Teja

Observatorio Nacional de Rio de Janeiro
28/10/2019 - 15/01/2020

Gyula István Géza Józsa

South African Astronomical Observatory
16/12/2019 - 20/12/2019

Eric Jullo

Laboratoire d'Astrophysique de Marseille
08/10/2019 - 11/10/2019

Anatoly Klypin

University of Virginia
30/09/2019 - 12/10/2019

Jon Lawrence

Australian Astronomical Observatory
18/02/2019 - 19/02/2019

Nikolai Lehtinen

University of Bergen
15/06/2019 - 20/06/2019

Zongnan Li

Nanjing University
20/01/2019 - 31/01/2019

Ruth Lieberman

NASA Goddard Space Flight Centre
17/05/2019 - 18/05/2019

Patricia López Martínez

Universidad de Sevilla
02/09/2019 - 01/09/2020

Alejandro López Vázquez

Universidad Nacional Autónoma de México
02/12/2019 - 03/12/2019

Guillermo Manjarrez Esquivel

Universidad de Granada
08/01/2019 - 11/01/2019

Mary Loli Martínez Aldama

Polish Academy of Sciences
11/11/2019 - 15/11/2019

David Martinez Delgado

Max Planck Institute for Astronomy
26/06/2019 - 28/06/2019

Michel Mendillo

Boston University
16/05/2019 - 16/05/2019

David Eduardo Millán Calero

Universidad de Granada
13/07/2018 - 13/07/2022

Javier Moldón Vara

University of Manchester
16/01/2019 - 18/01/2019

Elena Moretti

Institut de Física d'Altes Energies - IFAE
26/11/2019 - 26/11/2019

Andrés Moya Bedón

University of Birmingham
11/02/2019 - 13/02/2019

Gilles Niccolini

Université Côte d'Azur
01/04/2019 - 08/04/2019

Shogo Nishiyama

Miyagi University of Education, Japan
04/03/2019 - 08/03/2019

Francisco Noguerras Lara

Max Planck Institute for Astronomy
16/09/2019 - 29/09/2019

Hiroki Okino

National Astronomical Observatory of Japan
21/10/2019 - 25/10/2019

Roberto Ortiz Moraes

Universidade de São Paulo
28/12/2019 - 06/01/2020

Mahmoudreza Oshagh

Georg-August-Universität Göttingen
16/09/2019 - 20/09/2019
24/06/2019 - 28/06/2019
18/03/2019 - 20/03/2019

Benjamin Palmaerts

Université de Liège
28/11/2019 - 05/12/2019

Alice Pasetto

Universidad Nacional Autónoma de México
07/01/2019 - 01/02/2019

Leonid S. Pilyugin

Main Astronomical Observatory, Ukraine
19/06/2019 - 19/07/2019

Venkatessh Ramakrishnan

Universidad de Concepción
03/11/2019 - 10/11/2019

Luis Felipe Rodríguez Jorge

Universidad Nacional Autónoma de México
10/06/2019 - 14/06/2019

Carlos Roman Zúñiga

Universidad Nacional Autónoma de México
01/10/2019 - 10/10/2019

Cristina Romero Cañizales

Universidad Diego Portales
04/11/2019 - 11/11/2019

Jesús Ruiz López

Universitat de València
15/10/2019 - 15/10/2019

Joel Sánchez Bermúdez

Universidad Nacional Autónoma de México
19/03/2019 - 03/04/2019

Nestor Miguel Sánchez Doreste

Universidad de Murcia
18/07/2019 - 20/07/2019

María del Carmen Sánchez Gil

Universidad de Cádiz
03/02/2019 - 09/02/2019

Kang Sincheol

Korea Astronomy and Space Science Institute
26/02/2019 - 24/05/2019

Josep María Solanes Majua

Universitat de Barcelona
27/05/2019 - 30/05/2019
04/02/2019 - 08/02/2019

Amidou Sorgho

University of Cape Town
30/10/2019 - 02/11/2019

Jesús Alberto Toalá Sanz

Universidad Nacional Autónoma de México
12/12/2019 - 07/01/2020

José María Torrelles Arnedo

Institut de Ciències de l'Espai - CSIC
10/01/2019 - 11/01/2019

Josep Tous Mayol

Universitat de Barcelona
27/05/2019 - 30/05/2019
04/02/2019 - 08/02/2019

Arman Tursunov

Silesian University in Opava, Czech Rep.
18/02/2019 - 22/02/2019

Jeff Wagg

SKA Observatory, UK
08/01/2019 - 11/01/2019

Fabian Wunderlich

Technical University of Berlin
21/10/2019 - 25/10/2019
08/01/2019 - 18/01/2019

Iwata Yuhei

Keio University, Japan
04/03/2019 - 08/03/2019

Luis Zapata

Universidad Nacional Autónoma de México
19/10/2019 - 25/10/2019

Shuinai Zhang

Purple Mountain Observatory, Chinese Academy of Sciences
17/06/2019 - 18/06/2019

WORKSHOPS AND MEETINGS



Ciencia presente y futura con CARMENES & 1er encuentro EXONET

Granada, Spain Feb 20 - 22, 2019
 IAA members of the SOC: **P. Amado, M. López Puertas**
 IAA members of the LOC: **P. Amado, F. Bauer, C. Rodríguez López**
<https://bit.ly/3kfubAJ>



PLATO Limb Darkening Meeting #1

Granada, Spain Feb 26 - 27, 2019
 IAA members of the SOC: **J.C. Suárez**
 IAA members of the LOC: **J.C. Suárez, J. Rodón, A. Claret, J. Pascual, A. García Hernández, R. Garrido, M. Lares, S. Martín**
<http://platoldmeeting.iaa.es/>



PLATO MEU PDR Co-location Meeting

Granada, Spain May 07 - 08, 2019
 IAA mem. of the LOC: **M. Sanz, M. Pastor, J.C. Suárez**
<http://platomeupdr.iaa.es>



The Universe in 56 colors. Science with the first J-PAS data

Madrid, Spain May 20 - 23, 2019
 IAA members of the SOC: **J.M. Vilchez**
<https://bit.ly/3hv9Eeq>



Spain in SKA!

Granada, Spain Jun 11 - 12, 2019
 IAA mem. of the SOC: **J. Garrido, L. Verdes-Montenegro**
 IAA mem. of the LOC: **S. Sánchez, A. Damas, A. Díaz, S. Luna, A. Pelegrina**
<http://riastronomia.es/espana-en-ska/>



SOLARIS-HEPPA Working Group meeting

Granada, Spain Sep 18 - 19, 2019
 IAA members of the SOC:
 IAA members of the LOC: **B. Funke**
<https://solarisheppa.geomar.de/granada2019>



6th Workshop on Robotic Autonomous Observatories

Torremolinos, Spain Sep 30 - Oct 04, 2019
 IAA members of the LOC: **A.J. Castro Tirado**



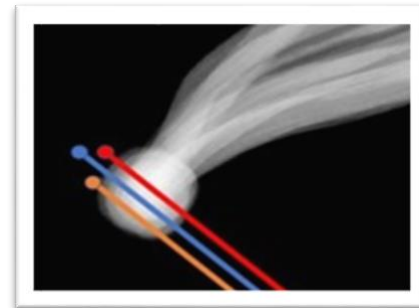
IAU Symposium 356: “Nuclear Activity in Galaxies Across Cosmic Times”
 Addis Ababa, Ethiopia Oct 07 - 11, 2019
 IAA members of the SOC: **M. Povic (chair), I. Márquez**
 IAA members of the LOC: **M. Povic (chair), J. Masegosa**
<http://iau356.essti.gov.et>



10th Gamma PI Coding Sprint
 Granada, Spain Nov 18 - 22, 2019
 IAA members of the SOC & LOC: **J.E. Ruiz del Mazo**
<https://bit.ly/2ZAOJfo>



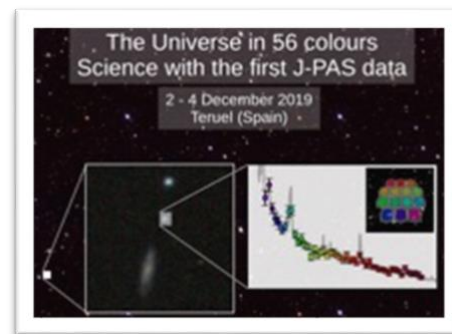
III SUNRISE technical Meeting
 Granada, Spain Nov 11 - 15, 2019
 IAA members of the SOC & LOC: **J.C. del Toro**



Comet Interceptor Full Team Meeting
 Granada, Spain Dec 2 - 3, 2019
 IAA members of the SOC & LOC: **L.M. Lara**



9th ACS Science Team Meeting
 Granada, Spain Nov 14 - 15, 2019
 IAA members of the SOC & LOC: **M.A. López Valverde**



The Universe in 56 colors. Science with the 1st J-PAS data
 Teruel, Spain Dec 2 - 4, 2019
 IAA members of the SOC: **R.M. González Delgado**
<https://bit.ly/3kgCbKY>

STAFF

RESEARCHERS

Permanent Staff

Alberdi Odriozola, Antxon
Aldaya Valverde, Víctor
Alfaro Navarro, Emilio Javier
Amado González, Pedro José
Anglada i Pons, Guillem Josep
Barceló Serón, Carlos
Bellot Rubio, Luis Ramón
Castro Tirado, Alberto Javier
Claret dos Santos, Antonio
del Olmo Orozco, Ascensión
del Toro Iniesta, José Carlos
Duffard, René Damián
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 González, María José
López Jiménez, Antonio Carlos
López Moreno, José Juan
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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
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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

ERC Consolidator Grant

Luque Estepa, Alejandro

Ramón y Cajal Members

Agudo Rodríguez, Juan Iván
de Ugarte Postigo, Antonio
García Comas, Maia Leire
Gómez Martín, Juan Carlos
Orozco Suárez, David
Thöne, Christina

Juan de la Cierva Members

Izzo, Luca
Jones, Michael Gordon
Kann, David Alexander

Postdoc Fellows

Ayala Gómez, Adrián
Bauer, Florian Franziskus
Cazzoli, Sara
Damas Segovia, Ancor Efren
Darriba Pol, Laura
García Benito, Rubén
García Comas, Maia Leire
Garrido Sánchez, Julian
González Galindo, Francisco
Guirado Rodriguez, Daniel
Kann, David Alexander
Kehrig Martin dos Santos, Carolina
Li, Dongshuai
Maranhas Gafeira, Ricardo Jorge
Martín Ruiz, Susana
Moldón Vara, Javier
Osorio Gutiérrez, Mayra Carolina
Pascual Granado, Javier
Pérez Invernón, Francisco Javier
Rechy García, Jackeline Suzett
Rodríguez López, Cristina Teresa
Sánchez Colin, Ángel Enrique
Santos Sanz, Pablo
Shahzamanian Sichani, Banafsheh
Siu Tapia, Azaymi Litzi
Zhao, Guangy

PhD Students

Agüi Fernández, José Feliciano
Arrechea Rodríguez, Julio
Arroyo Polonio, Antonio
Bensch, Katarzyna Anna
Blázquez Calero, Guillermo
Boaventura Teixeira Gomes, Miguel

Castro Tirado, Miguel Ángel
Díaz Rodríguez, Ana Karla
Dorantes Monteagudo, Antonio Jesús
Duarte Puertas, Salvador
Fuentes Fernández, Antonio
Gallego Calvente, Aurelia Teresa
Gallego Cano, Eulalia
Hermosa Muñoz, Laura
Hill, Brittany Nicole
Kieu, Thi Ny
Lampón González-Albo, Manuel
Lares Martiz, Mariel
Lorenzo Gutiérrez, Antonio
Malagón Romero, Alejandro Francisco
Martínez Solaeche, Ginés
Nogueras Lara, Francisco
Ramón Ballesta, Alejandro
Rodríguez Martín, Julio Esteban
Sánchez López, Alejandro
Schmalzried, Anthony
Soler López, Sergio
Vara Lubiano, Mónica

Doctor vinculado

Aceituno Castro, Jesús
García Hernández, Antonio
Madiedo Gil, José María
Molina Cuevas, Antonio
Povic, Mirjana
Suárez Yanes, Juan Carlos

ENGINEERS AND TECHNICIANS

Mechanics

Alvarez Moreno, Fernando
Becerril Jarque, Santiago
Bustamante, 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

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
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 Fernando

Optics

Bailén Martínez, Francisco Javier

OSN Maintenance/Support

Aceituno Castro, Francisco José
Carmona Rodríguez, Enrique
Casanova Escurín, Víctor Manuel
de la Rosa Alvarez, José Luis
Mirasol Junco, José Alberto
Pérez Silvente, Tomás
Ruiz Bueno, José Antonio
Sota Ballano, Alfredo

Software

Blazek, Martin
Cabrera Morales, Manuel
Cobos Carrascosa, Juan Pedro
Fernández García, Emilio Jesús
García Segura, Antonio Jesús
Garrido Sánchez, Julian
Gómez López, Juan Manuel
Husillos Rodríguez, César
Ibáñez Mengual, José Miguel
Luna Valero, Sebastián
Morales Fernández, José Miguel
Morales Muñoz, Rafael
Moreno Mantas, Antonio Jesús
Passas Varo, María
Pastor Morales, Maria del Carmen
Rodón Ortiz, José Ramón
Román García, Javier
Ruiz del Mazo, José Enrique
Sánchez Expósito, Susana

SERVICES AND ADMINISTRATION

Administration Services

Bautisna Navares, Adoración
Cortés Guerrero, María Ángeles
de Castro Díaz, Rosa Irene
Fernandez-Peña Mollá, Marina
Gómez Finnett, Susana Alicia
González Esteva, Alonso M.
González García, Manuel Jesús
Heredia Maldonado, María José
Herrera Jiménez, Eva María
Jiménez Zafrilla, María Isabel
Madrid Gómez, Carmen Elisa
Molina Guerrero, Josefina
Nieto Serrano, Concepción
Pelegrina López, Alicia
Tapia Ruiz, Francisco José
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
Rendón Martos, Francisco

Library

Arco Sarmiento, María Ángeles

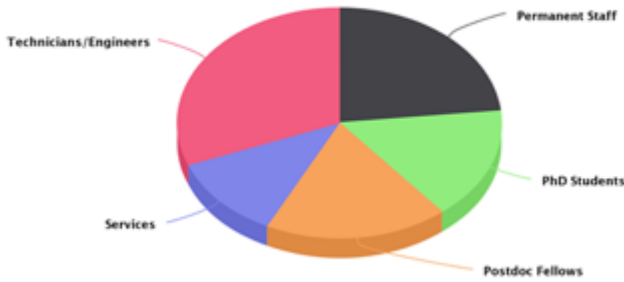
Outreach and Communication Unit

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



IAA Day, December 13th. Presentations of the 2019 Highlights and End-of-year celebration. Our special guest was Prof. Margarita Paneque, Institutional Delegate of the CSIC in Andalucía and Extremadura.

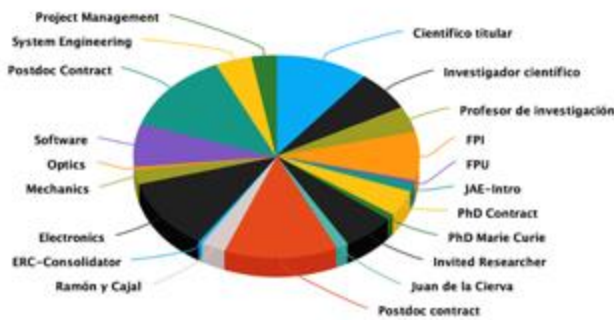
The 2019 IAA staff was distributed among the following general groups. The staff was mainly composed by scientists, with a non-negligible fraction of technicians and engineers.



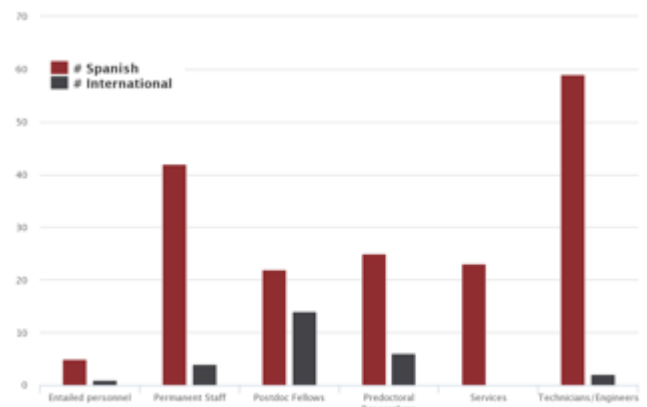
The number of international staff is represented in the following figure.



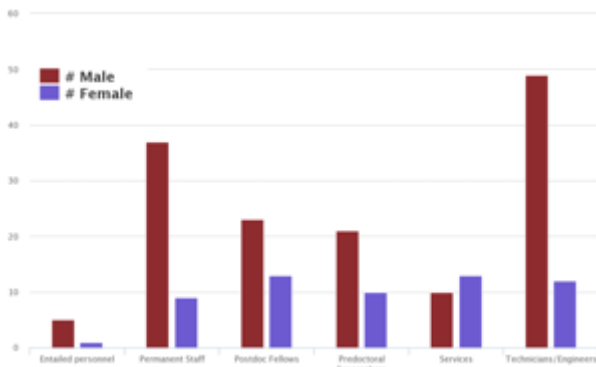
The scientific and technical personnel can be arranged among these overall categories. These can be disaggregated into the different technician, engineer, and scientific groups.



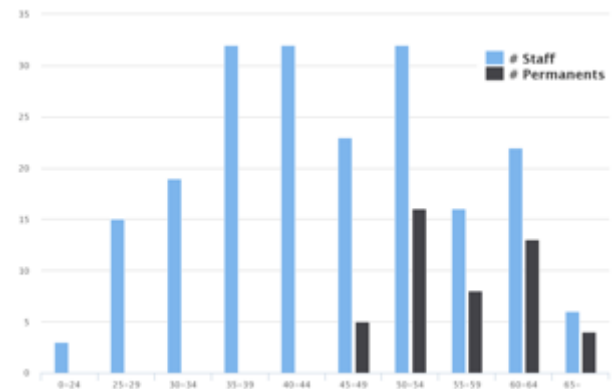
The fraction of international staff was larger among post-doctoral fellows and PhD students.



The gender and nationality distribution of the different groups are shown next. The fraction of women was closer to parity among services (57%), postdocs (36%) and predocs (32%).



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 2019

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

- *IAA Journal: 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. Issues in 2019: 57, 58, 59. <http://revista.iaa.es/>

- *El Radioscopio*, a 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 (Granada). <https://bit.ly/3msbDiT>

- *The European Researchers' Night* takes place every year all over Europe the last Friday of September. The IAA-CSIC took part in the event in Granada on Friday 27 "moving" its research to the center of the city. <https://bit.ly/33ssoBK>

- *PIIISA Project*. A multidisciplinary project designed to allow high school students 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 a general public during ten days. <https://bit.ly/2FsUzs3>

- "El enigma Agustina", science documentary. Presentation, shows and selection in festivals.

- PRE-EST project (European Solar Telescope). Communication support and recording of the documentary "Reaching for the Sun" (in production).

-Desgranando Ciencia science festival. Coorganization and development of the outreach workshop.

- 11 February, International Day of Woman and Girls in Science. Conferences and workshops with students.

- Participation in "Granada Henge", a festival dedicated to the Sun and the winter solstice organized by the city council of Granada. <https://bit.ly/33ssDg8>

ACTIVITIES OF THE COMMUNICATION, EDUCATION AND PUBLIC OUTREACH UNIT



- Participation in "Granada: ciudad de la Ciencia y la Innovación", a FECYT funded project of the largest institutions in Granada to bring science and knowledge close to citizens. <https://twitter.com/granadaciencia>

- 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. The IAA-CSIC attends two student groups every month.

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

https://twitter.com/iaa_csic

<https://www.facebook.com/iaa.comunicacion>

<https://www.youtube.com/user/iaaudc>

- Design and development of corporate material.

PRESS RELEASES

The IAA 2019 scientific achievements attracted 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>

16/01/2019

Observations of a rare hypernova complete the picture of the death of the most massive stars

A work, led by the IAA-CSIC and published in Nature, studies in detail the death of a massive star that produced a gamma-ray burst (GRB) and a hypernova. This work has allowed to find the missing link between these two types of hypernova through the detection of an additional component: a sort of hot cocoon generated around the jet, as it propagates through the outer layers of the progenitor star.

07/02/2019

International Day of Women and Girls in Science

The IAA-CSIC joins the celebration of the International Day of Women and Girls in Science, which seeks to make visible the scientific work of women and promote vocations in girls.

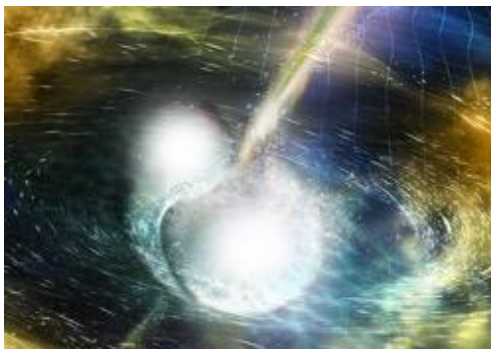
12/02/2019

First formal meeting between the Minister Pedro Duque and the alliance of Severo Ochoa centres and María de Maeztu units, SOMMa

The meeting allowed SOMMa to introduce itself formally to Minister Duque, as well as to establish new communication channels, providing the Minister with first-hand knowledge about the Alliance. The IAA-CSIC obtained in 2018 the distinction as Center of Excellence Severo Ochoa.

21/02/2019

A jet detected from the merging of two neutron stars



The merging of the two stars, which occurred in August 2017, expelled a large amount of material that has been observed so far by radiotelescopes on five continents. These results confirm the existence of a jet of particles that pierced the envelope and propagated at speeds close to that of light

10/04/2019

Astronomers Capture First Image of a Black Hole



A large international collaboration (EHT; Event Horizon Telescope), with the relevant participation of astronomers from the IAA-CSIC, unveiled the first direct visual evidence of a supermassive black hole and its shadow. The image reveals the black hole at the centre of Messier 87. This black hole resides 55 million light-years from Earth and has a mass 6.5-billion times that of the Sun

10/04/2019

The Governing Council of Junta de Andalucía authorizes its Administration to endorse the Hispano-German Astronomical Center (CAHA)

In its sesión of April 9, 2019, The Governing Council of Junta de Andalucía authorizes its Ministry of Economy, Knowledge, Business and University the joining of Junta de Andalucía to the "Economic Interest Group" of the Calar Alto Observatory, in Almería. This decision completes the previous necessary requirements to sign the final agreement.

10/04/2019

First results from the ExoMars misión: absence of methane on Mars and variations in water vapor due to dust storms

After a year in orbit around Mars, the TGO orbiter of the ExoMars mission (ESA-Roscosmos) reveals a surprising absence of methane and a relationship between dust storms and atmospheric water vapor.



The results, published in Nature, were obtained with the ACS and NOMAD instruments. Researchers from the IAA-CSIC participate in the results, as well as in the scientific team that developed NOMAD.

15/04/2019

Hurricane winds in Titan's high atmosphere

Titan, one of Saturn's largest moons, is the only satellite in the Solar System with a complex atmosphere, resembling the primitive Earth. Very strong and confined winds have been detected in the high atmosphere of the satellite, where it seemed to be not enough energy to trigger such fast winds.

30/04/2019

The impact of a rock against the Moon during a total eclipse

The study of the impacts on the lunar surface allows to adjust the predictions of impacts on our planet. A research group with the participation of IAA-CSIC detected a short-lived flash as a meteorite hit the lunar surface and interpret the results assuming that a space rock collided with the Moon at 61,000 kilometres an hour, excavating a crater 10 to 15 metres across.

05/06/2019

TESS first light on stellar physics sheds light on roAp stars, the extreme pulsators

TESS data has allowed to find five roAp, a type of rare stars that shows rapid pulsations, intense magnetic fields and a peculiar chemical composition.

18/06/2019

CARMENES finds two temperate terrestrial planets around Teegarden's star, a small nearby star

CARMENES instrument, co-developed by the IAA-CSIC has allowed to find two planets around the Teegarden's star, the star system number twenty-four closest to ours and one of the smallest red dwarf stars known. With masses similar to Earth's, their

temperatures could be warm enough to support liquid water on the surface.

02/07/2019

Massive stars prefer high-order multiplicity over binarity

MONOS project studies the binary or multiple systems formed by the most massive stars through the study of a catalog of O-type stars. The first results point out that these stellar giants tend to group in multiple systems rather than in pairs.

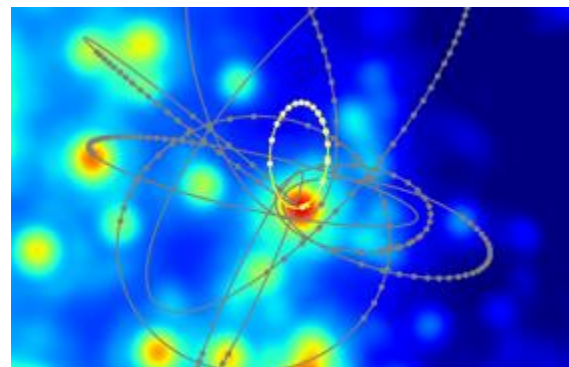
17/07/2019

25th anniversary of the impact of the comet Shoemaker-Levy 9 against Jupiter

Between July 16 and 24, 1994, comet Shoemaker-Levy 9 hit Jupiter. Every observatory in the world was watching this unique event in history. The first image of the impact was recorded at Calar Alto Observatory by IAA astronomers.

25/07/2019

The orbit of a star around the supermassive black hole of the Milky Way confirms the validity of Einstein's theory of relativity



The star S2 draws an ellipse around Sagittarius A *, the black hole of the galactic nucleus, and its monitoring over twenty-six years has allowed studying the gravity in extreme environments. Researchers from the IAA-CSIC participate in the results, published in the journal Science, that confirm the validity of Einstein's theory of relativity through the measurement of the gravitational redshift.

31/07/2019

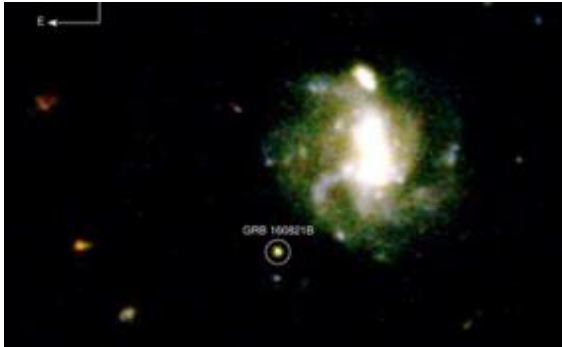
Space and ground-based observations reveal a planetary trio around a nearby star

Combining data from the TESS satellite and from various instruments on the ground, CARMENES among others, leads to the detection of a multiple planetary system around a nearby star. The work, which involves

researchers from the IAA-CSIC, opens the door to the detailed study of multiple planetary systems

27/08/2019

A distant stellar collision with the shine of precious metals



A signature similar to the gold and platinum producing explosion observed in light and gravitational waves in 2017 is found in the data of a 2016 gamma ray explosion. This confirms that heavy elements are produced in kilonovas, bursts that result from the fusion of very compact objects, such as neutron stars or black holes.

06/09/2019

IAA researchers, in the "Oscars of Science"

The "2020 Breakthrough Prize in Fundamental Physics", endowed with three million dollars, has been awarded to the Event Horizon Telescope (EHT) international collaboration, which obtained the first image of a black hole. Two researchers from the IAA-CSIC participate in the collaboration, which brings together 347 researchers from all around the world.

09/09/2019

The Institute of Astrophysics of Andalusia (IAA-CSIC) receives the distinction Center of Excellence Severo Ochoa

The Minister of Science, Innovation and Universities in operation, Pedro Duque, presides the official ceremony of delivery of the Severo Ochoa badges to the most recent winners. Isabel Márquez, Scientific Director of the IAA Severo Ochoa project, receives the distinction, which recognizes the centers that carry out cutting-edge science basic research and are among the best in the world in their area.

19/09/2019

Rediscovering the "Stephan's Quintet"

Researchers from the IAA-CSIC has completed a detailed study of the so-called "Stephan's Quintet", a paradigmatic compact system of galaxies. The large field of view and the spectral ranges of the

observations allowed a thorough study of the entire galaxy system, its interaction history and the main properties of the ionised gas. Compact systems such as the "Stephan's Quintet" are key to understanding the effect of extreme interactions in the evolution of galaxies since the early ages of the universe.

06/10/2019

CARMENES finds an anomalous planetary system that challenges our understanding of how planets form

CARMENES instrument has found a giant gas planet around the red dwarf star GJ3512, as well as indications of the presence of another. The finding calls into question the most accepted model of formation of the giant planets, which states that they are born from a solid nucleus that accumulates gas, and opens up the possibility of their formation after the rupture into fragments of a protoplanetary disk.

14/10/2019

The first results of the GALACTICNUCLEUS project, the most detailed star catalogue of the galactic centre, are published



Researchers at the IAA-CSIC have just published the most extensive catalogue of stars in the Galactic Centre to date. The ERC Consolidator Grant GALACTICNUCLEUS project led by an IAA astronomer has managed to map this area in unprecedented detail. To do this, rapid series of hundreds of short exposures (one second or less) images were taken with VLT/ESO. One of the main objectives of GALACTICNUCLEUS is to be able to reconstruct the stellar formation history of the centre of our galaxy.

28/10/2019

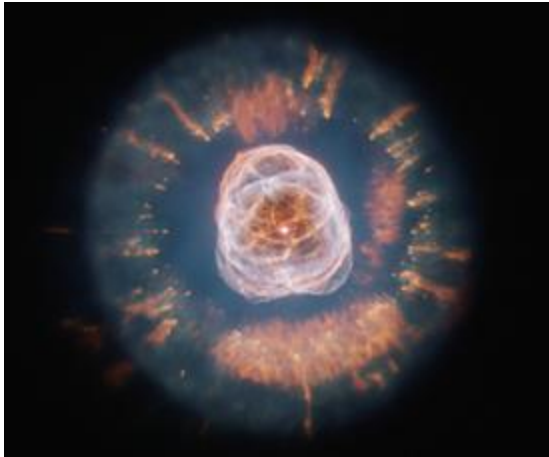
Five thousand "eyes" to capture the colors of the cosmos

The Dark Energy Spectroscopic Instrument (DESI) sees first light. DESI, a project with the participation of the IAA-CSIC, will improve the understanding of the role of dark energy in the history of the expansion of the

universe. The Spanish team has participated in the development of one of DESI's prototypes of robotic fiber optic positioners.

07/11/2019

An invisible companion could explain the strong X-ray emission of the Eskimo Nebula.



An international group of astronomers led by the Instituto de Astrofísica de Andalucía finds a periodic variation in the X-ray emission of the central star of the Eskimo Nebula, confirming that in the center of NGC 2392 there is a multiple system.

20/11/2019

Public Surveys and new instrumentation for Calar Alto Observatory

Calar Alto Observatory opens a new call to the international astronomical community for scientific and technological proposals that will contribute to keep the level of excellence of the observatory.

20/11/2019

Collapsing star breaks the records in very high energy photons production

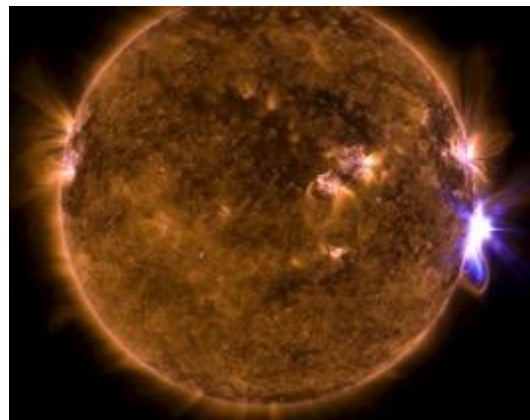


MAGIC telescopes, on the island of La Palma, detect photons in the range of teraelectronvolts in a gamma

ray explosion (GRB), the product of the death of a very massive star. The detection, which requires contemplating new mechanisms in the energy production of GRBs, provides a fundamental perspective to complete our understanding of these events.

02/12/2019

Astronomers find a star that hides, among its pulsations, flares millions of times more intense than those of the Sun



Observations with the Kepler satellite allow surface activity to be found in stars where, according to theoretical models, it should not occur. In the sample highlights the star KIC 9716385, which presents, hidden between its pulsations, flares millions of times more intense than the solar ones.

06/12/2019

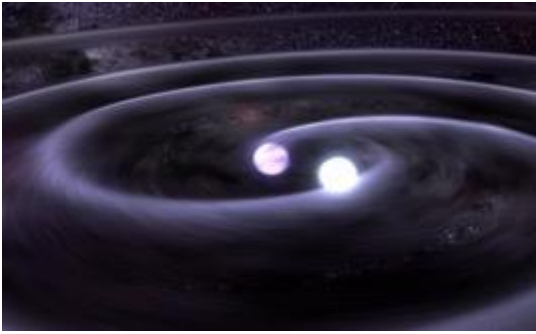
The Institute of Astrophysics of Andalusia (IAA-CSIC) participates in Comet Interceptor, ESA's new mission to study a pristine comet

ESA selected Comet Interceptor as its first Fast mission, or class F (Fast), with a total development duration from the selection until the launch of about eight years. Comet Interceptor is a technological challenge that seeks to study a comet that has not yet been discovered and remains intact since its formation. The IAA-CSIC will contribute to four of the nine instruments that will travel in the probes, providing the power supplies for each of the instruments, as well as a scientific data processing unit shared by two of the instruments.

10/12/2019

Astronomers observe the approach of the stars of a binary system due to the emission of gravitational waves

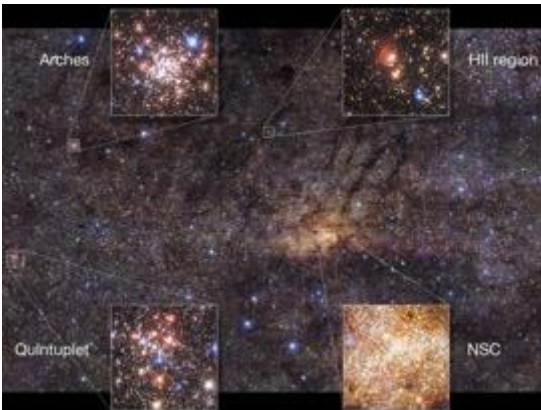
The system is composed of two white dwarf stars that revolve around the common centre of mass every twenty minutes, and which are gradually approaching.



The system is composed of two white dwarf stars that revolve around the common centre of mass every twenty minutes, and which are gradually approaching. The work, in which the IAA-CSIC participates, shows that the stars have “flattened out” and have an ellipsoidal shape due to the tidal forces.

16/12/2019

IAA researchers discover an extremely violent episode in the history of the Milky Way, with over a hundred thousand supernova explosions



This scientific highlight is also a result of the GALACTICNUCLEUS project. A survey with an unprecedented resolution of the central regions of our galaxy reveals its full history of star formation, which presents steep ups and downs in star formation. There are indications of a burst of star formation so intense that it caused more than one hundred thousand supernova explosions.

FUNDING

IAA obtains most of its funding through competitive European and Spanish calls. Below we provide a list of all competitive funding grants awarded to IAA staff and running during 2019.

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 2019) and new funding (the money awarded in 2019) by funding agency are shown next.

NATIONAL RESEARCH AGENCY

Severo Ochoa Excellence Award

Reference: SEV-2017-0709

PI: **Isabel Márquez Pérez**

Duration: Jul 01, 2018 - Jun 30, 2022

Amount: 4 000 000 €

EUROPEAN RESEARCH COMMISSION FP7

e-LIGHTING: Lightning propagation and high-energy emissions within coupled multi-model simulations

Reference: 681257 (ERC-2015-COG)

PI: **Alejandro Luque Estepa**

Duration: Jun 01, 2016 - May 31, 2021

Amount: 1 960 820 €

GALACTICNUCLEUS The Fingerprint of a Galactic Nucleus: A Multi-Wavelength, High-Angular Resolution, Near-Infrared Study of the Centre of the Milky Way

Reference: I-ERC/3311 614922

PI: **Rainer Schoedel**

Duration: Feb 01, 2014 - Jan 31, 2019

Amount: 1 547 660 €

ESCAPE-European Science Cluster of Astronomy & Particle physics ESFRI research infrastructures

Reference: 824064 - H2020-INFRA/0489

PI: Lourdes Verdes-Montenegro Atalaya

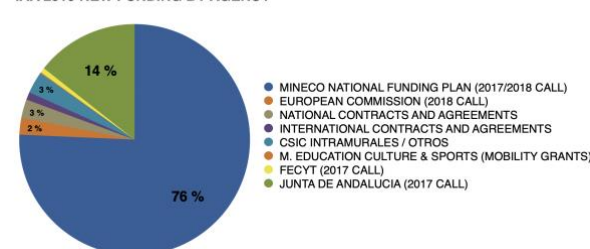
Duration: Feb 01, 2019 - Jul 31, 2022

Amount: 108 375 €



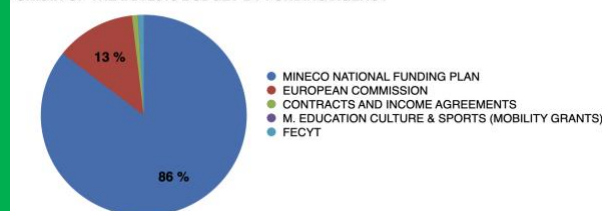
Time evolution of the IAA budget since 2013

IAA 2019 NEW FUNDING BY AGENCY



Origin of the IAA 2019 budget by funding agency

ORIGIN OF THE IAA 2019 BUDGET BY FUNDING AGENCY



IAA 2019 new funding by agency

Science and Innovation with thunderstorms (SAINT)-H2020-MSCA-ITN-2016

Reference: H2020-MSCA-ITN-2016

PI: **Francisco José Gordillo Vázquez**

Duration: Jan 01, 2017 - Jan 01, 2021

Amount: 495 746 €

Preparatory Phase for the European Solar Telescope (PRE-EST)

Reference: 739500 H2020-INFRA/0287

PI: **Luis Ramón Bellot Rubio**

Duration: Jan 01, 2017 - Jan 01, 2021

Amount: 372 500 €

Small Bodies: Near and Far (SBNF)

Reference: H2020-LEITSPACE/ 0140 687378

PI: **René Damián Duffard**

Duration: Apr 01, 2016 - Mar 31, 2019

Amount: 355 000 €

SOLARNET - 824135- Integrating High Resolution Solar Physics - H2020

Reference: 824135

PI: Luis Bellot

Duration: Jan 01, 2019 - Dec 31, 2022

Amount: 109 916 €

Wf4Ever: Advanced Workflow preservation technologies for enhanced science

Reference: 201550E023

PI: Lourdes Verdes-Montenegro Atalaya

Duration: Feb 10, 2015 - Feb 09, 2019

Amount: 63 000 €

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 Vilchez Medina**

Duration: Jan 01, 2017 - Jan 01, 2020

Amount: 6 000 €

MICINN**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 30, 2016 - Dec 29, 2019

Amount: 3 363 800 €

MODELO DE REPUESTO Y DE VUELO DE SUBSISTEMAS DE JANUS Y GALA. FORMACION Y EVOLUCION DE SISTEMAS PLANETARIOS: DESDE CUERPOS MENORES A EXOPLANETAS

Reference: PGC2018-099425-B-I00

PI: **Luisa María Lara López**

Duration: Jan 01, 2019 - Dec 31, 2021

Amount: 2 940 000 €

CONTRIBUCION DEL IAA-CSIC A LA MISION ESPACIAL PLATO2.0: FASES B2/C/D. OPERACION DE NOMAD-EXOMARS

Reference: ESP2017-87676-C5-5-R

PI: **Rafael Garrido Haba, Julio Federico Rodríguez Gómez**

Duration: Jan 01, 2018 - Dec 31, 2020

Amount: 1 899 700 €

FISICA SOLAR ESPACIAL

Reference: RTI2018-096886-B-C51

PI: **Jose Carlos del Toro Iniesta, David Orozco Suárez**

Duration: Jan 01, 2019 - Dec 31, 2021

Amount: 1 573 000 €

SPACE SOLAR PHYSICS: PHI FOR SOLAR ORBITER AND IMAX AND SP FOR SUNRISE

Reference: ESP2016-77548-C5-1-R

PI: **Jose Carlos del Toro Iniesta**

Duration: Dec 30, 2016 - Dec 29, 2019

Amount: 968 000 €

AMIGA6: GAS EN EL INTERIOR Y EN EL ENTORNO DE LAS GALAXIAS. PREPARACION CIENTIFICA PARA SKA Y CONTRIBUCION AL DISEÑO DEL FLUJO DE DATOS

Reference: AYA2015-65973-C3-1-R

PI: **Lourdes Verdes-Montenegro Atalaya**

Duration: Jan 01, 2016 - Dec 31, 2019

Amount: 490 050 €

CARACTERIZACION DE LA ATMOSFERA DE MARTE CON LOS INSTRUMENTOS NOMAD Y ACS A BORDO DE TGO/EXOMARS

Reference: PGC2018-101836-B-I00

PI: **Miguel Angel López Valverde**

Duration: Jan 01, 2019 - Dec 31, 2021

Amount: 356 587 €

Equipamiento computacional para desarrollar el núcleo de un Prototipo de SKA Science Regional Centre en el IAA

Reference: EQC2019-005707-P

PI: **Lourdes Verdes-Montenegro Atalaya**

Duration: Jan 01, 2019 - Dec 31, 2020

Amount: 331 333 €

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 €

SISTEMA DE OBSERVACIÓN DE LA MITAD DE LA BÓVEDA CELESTE EN LA NUEVA ERA DE ASTROFÍSICA DE MULTIMENSAJEROS

Reference: EQC2018-004735-P

PI: **Alberto Javier Castro Tirado**

Duration: Jan 01, 2018 - Mar 31, 2021

Amount: 275 037 €

AMIGA7: GAS Y CAMPOS MAGNETICOS EN ENTORNOS EXTREMOS DE GALAXIAS CON LOS PRECURSORES DE SKA - DESDE EL DISEÑO DEL FLUJO DE DATOS HACIA SU CONSTRUCCION

Reference: RTI2018-096228-B-C31

PI: **Lourdes Verdes-Montenegro Atalaya**

Duration: Jan 01, 2019 - Dec 31, 2021

Amount: 254 100 €

Coordinación de la participación científica y tecnológica de España en el Square Kilometre Array. Oficina española del SKA

Reference: 201950E125

PI: **Lourdes Verdes-Montenegro Atalaya**

Duration: Dec 01, 2019 - Nov 30, 2022

Amount: 250 000 €

ESTRUCTURA, PROCESOS Y CLIMA DE LAS ATMOSFERAS DE LA TIERRA Y EXOPLANETAS

Reference: ESP2017-87143-R

PI: **Bernd Funke, Manuel López Puertas**

Duration: Jan 01, 2018 - Dec 31, 2019

Amount: 239 580 €

JETS ESTELARES, DISCOS Y CAMPOS MAGNETICOS. CIENCIA PARA EL SKA Y CONTRIBUCION AL DISEÑO DE PHASED ARRAY FEEDS

Reference: AYA2017-84390-C2-1-R

PI: **Guillem Josep Anglada i Pons, José F. Gómez Rivero**

Duration: Jan 01, 2018 - Dec 31, 2020

Amount: 222 640 €

LOS GALATICOS DE LA GALAXIA: ESTRELLAS MASIVAS, CUMULOS ESTELARES Y EL CENTRO GALACTICO

Reference: PGC2018-095049-B-C21

PI: **Rainer Schoedel, Emilio Javier Alfaro Navarro**

Duration: Jan 01, 2019 - Dec 31, 2022

Amount: 192 753 €

Adquisición de una infraestructura de

Reference: EQC2018-004366-P

PI: **Francisco Prada Martínez**

Duration: Jan 01, 2018 - Dec 31, 2019

Amount: 191 232 €

Adquisición de una nueva infraestructura de gran capacidad de memoria RAM y almacenamiento para la creación de cielos digitales

Reference: EQC2019-006089-P

PI: **Francisco Prada Martínez**

Duration: Jan 01, 2019 - Dec 31, 2020

Amount: 187 544 €

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 €

CONTRIBUCION DEL IAA A LA EXPLOTACION CIENTIFICA DE ASIM: OBSERVACIONES DESDE EL SUELO Y ANALISIS DE DATOS

Reference: ESP2017-86263-C4-4-R

PI: **Francisco José Gordillo Vázquez**

Duration: Jan 01, 2018 - Dec 31, 2019

Amount: 160 930 €

CIELOS Y UNIVERSOS PARA LOS GRANDES CARTOGRAFIADOS DE GALAXIAS: EXPLOTACION CIENTIFICA

Reference: PGC2018-101931-B-I00

PI: **Francisco Prada Martínez**

Duration: Jan 01, 2019 - Dec 31, 2021

Amount: 157 300 €

ESTUDIO DE OBJETOS TRANSNEPTUNIANOS Y POBLACIONES RELACIONADAS

Reference: AYA2017-89637-R

PI: **José Luis Ortiz Moreno**

Duration: Jan 01, 2018 - Dec 31, 2020

Amount: 152 460 €

HIGH-ENERGY TRANSIENTS AND THEIR HOSTS: LOS COMÚN, LO PECULIAR, EL DETAILLE

Reference: AYA2017-89384-P

PI: **Christina Thöne, Antonio de Ugarte Postigo**

Duration: Jan 01, 2018 - Dec 31, 2019

Amount: 143 990 €

Telescopio extremadamente ligero

Reference: EQC2018-004455-P

PI: **José Luis Ortiz Moreno**

Duration: Jan 01, 2018 - Mar 31, 2021

Amount: 136 625 €

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 €

GRBphot - Base de datos fotométricos de explosiones de rayos gamma

Reference: RTI2018-098104-J-I00

PI: **David Alexander Kann**

Duration: Sep 01, 2019 - Aug 31, 2022

Amount: 133 100 €

LEGADO DEL PROYECTO "SMALL BODIES NEAR AND FAR"

Reference: RTI2018-098657-J-I00

PI: **Pablo Santos Sanz**

Duration: Jan 01, 2019 - Aug 31, 2022

Amount: 133 100 €

EXPERIMENTOS DE LABORATORIO, OBSERVACIONES Y MODELOS DE POLVO COMETARIO: UNA NUEVA ESTRATEGIA

Reference: RTI2018-095330-B-I00

PI: **Olga Muñoz Gómez, Juan Carlos Gómez Martín**

Duration: Jan 01, 2019 - Dec 31, 2021

Amount: 121 000 €

EN CAMINO HACIA SKA: ASTRONOMIA A LA MAS ALTA RESOLUCION ANGULAR Y SENSIBILIDAD

Reference: PGC2018-098915-B-C21

PI: **Miguel Angel Pérez Torres, Antonio María Alberdi Odriozola**

Duration: Jan 01, 2019 - Dec 31, 2020

Amount: 118 580 €

POLVO EN EL SISTEMA SOLAR: EXPERIMENTOS, MODELOS COMPUTACIONALES Y APLICACION AL ESTUDIO DEL COMETA 67PCHURYUMOV-GERASIMENKO, OBJETIVO DE LA MISION ROSETTA.

Reference: AYA2015-67152-R

PI: **Olga Muñoz Gómez**

Duration: Jan 01, 2016 - Jun 30, 2019

Amount: 108 900 €

Caracterización polarimétrica bidimensional del frente de onda en cristales ópticos

Reference: EQC2018-004400-P

PI: **David Orozco Suárez**

Duration: Jan 10, 2018 - Dec 31, 2020

Amount: 106 755 €

ASTRONOMIA GALACTICA Y EXTRAGALACTICA A LA MAXIMA RESOLUCION ANGULAR Y SENSIBILIDAD

Reference: AYA2015-63939-C2-1-P

PI: **Antonio María Alberdi Odriozola, Miguel Angel Pérez Torres**

Duration: Jan 01, 2016 - Dec 31, 2019

Amount: 94 864 €

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 - June 29, 2020

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 - Jun 30, 2019

Amount: 71 390 €

FISICA OCULTA EN LA EVOLUCION EN TIEMPO REAL DE LAS NEBULOSAS GASEOSAS EN TORNO A ESTRELLAS EVOLUCIONADAS DE MASA BAJA E INTERMEDIA

Reference: PGC2018-102184-B-I00

PI: **Martín Guerrero Roncel**

Duration: Jan 01, 2019 - Dec 31, 2022

Amount: 54 450 €

UNIVERSO Y VACIO CUANTICOS

Reference: FIS2017-86497-C2-1-P

PI: **Carlos Barceló Serón**

Duration: Jan 01, 2018 - Dec 31, 2020

Amount: 24 200 €

RED DE EXCELENCIA PARA LA PARTICIPACION CIÉNTIFICA Y TECNOLÓGICA ESPAÑOLA EN EL SKA

Reference: AYA2016-82017-REDT

PI: **Lourdes Verdes-Montenegro Atalaya**

Duration: Jul 01, 2017 - Jun 30, 2019

Amount: 20 000 €

REGIONAL GOVERNMENT JUNTA DE ANDALUCÍA

ACCIONES PARA EL FORTALECIMIENTO DEL INSTITUTO DE ASTROFÍSICA DE ANDALUCÍA-CSIC PARA LA ADQUISICIÓN DEL SELLO "SEVERO OCHOA"

Reference: SOMM17/5208/IAA

PI: **Antonio María Alberdi Odriozola**

Duration: Jan 01, 2019 - Feb 28, 2022

Amount: 1 337 460 €

Contribución andaluza al proyecto espacial CoRoT

Reference: P12-TIC-2469

PI: **Rafael Garrido Haba**

Duration: May 16, 2014 - May 15, 2019

Amount: 259 745 €

La red de Telescopios de Robóticos en Andalucía como parte de una Red a escala planetaria

Reference: P12-TIC-2839

PI: **Alberto Javier Castro Tirado**

Duration: May 16, 2014 - Feb 02, 2019

Amount: 213 959 €

FECYT

Granada. Ciencia para una Ciudad

Reference: FCT-17-12201

PI: **Emilio José García Gómez-Caro**

Duration: Jan 01, 2018 - Mar 31, 2019

Amount: 60 000 €

Documental 'Reaching for the Sun'

Reference: FCT-17-12390

PI: **Emilio José García Gómez-Caro**

Duration: Jan 01, 2018 - Mar 31, 2019

Amount: 45 000 €

INCURSIONES GRAVITATORIAS

Reference: FCT-18-13451

PI: **Carlos Barceló Serón**

Duration: Apr 01, 2019 - Dec 31, 2020

Amount: 35 000 €

Granada, el camino hacia los planetas

Reference: FCT-18-13740

PI: **Luisa María Lara López**

Duration: Oct 01, 2019 - Dec 31, 2020

Amount: 30 000 €

El astrónomo indignado golpea de nuevo

Reference: FCT-17-12547

PI: **Manuel Jesús González García**

Duration: Jan 01, 2018 - Mar 31, 2019

Amount: 20 000 €

ANNEX

SCI PUBLICATIONS LIST

1. Acciari V.A., et al. (includes **Castro-Tirado A.J., Fernández-García E., Hu Y.-D., Izzo L., Kann D.A., Pérez-Torres M.A., Thöne C.C., de Ugarte Postigo A**) MAGIC Collaboration
"Observation of inverse Compton emission from a long γ -ray burst", *Nature*, Vol. 575.0, p. 459-463 (2019)
DOI: 10.1038/s41586-019-1754-6
2. Acharyya A., **Agudo I.**, et al.
"Monte Carlo studies for the optimisation of the Cherenkov Telescope Array layout", *Astroparticle Physics*, Vol. 111.0, p. 35-53 (2019)
DOI: 10.1016/j.astropartphys.2019.04.001
3. Allart, R.; Bourrier, V.; Lovis, C.; Ehrenreich, D.; **Aceituno, J.**; Guijarro, A.; Pepe, F.; Sing, D. K.; Spake, J. J.; Wyttenbach, A.
"High-resolution confirmation of an extended helium atmosphere around WASP-107b", *Astronomy and Astrophysics*, Vol. 623, p. A58 (2019)
DOI: 10.1051/0004-6361/201834917
4. Alonso-Floriano, F. J. et al. (includes **Sánchez-López, A.; López-Puertas, M.; Amado, P. J.; Bauer, F. F.; Lampón, M.; Lara, L. M.**)
"Multiple water band detections in the CARMENES near-infrared transmission spectrum of HD 189733 b", *Astronomy and Astrophysics*, Vol. 621, p. A74 (2019)
DOI: 10.1051/0004-6361/201834339
5. Alonso-Floriano, F. J. (includes **Bauer, F. F.; Lampón, M.; Lara, L. M.; López-Puertas, M.; Sánchez-López, A.; Schmitt, J. H. M. M.**)
"He I λ 10 830 Å in the transmission spectrum of HD209458 b", *Astronomy and Astrophysics*, Vol. 629, p. A110 (2019)
DOI: 10.1051/0004-6361/201935979
6. Alvarez-Candal, A.; Ayala-Loera, C.; Gil-Hutton, R.; **Ortiz, J. L.; Santos-Sanz, P.; Duffard, R.**
"Absolute colours and phase coefficients of trans-Neptunian objects: Correlations and Populations", *Monthly Notices of the Royal Astronomical Society*, p. 1819 (2019)
DOI: 10.1093/mnras/stz1880
7. Amado, Z. B.; **Pović, M.**; Sánchez-Portal, M.; Tessema, S. B.; Bongiovanni, Á.; Cepa, J.; Cerviño, M.; González-Serrano, J. I.; Nadolny, J.; Garcia, A. M. P.; Pérez-Martínez, R.; Pintos-Castro, I.
"A morphological study of galaxies in ZwCl0024+1652, a galaxy cluster at redshift $z \sim 0.4$ ", *Monthly Notices of the Royal Astronomical Society*, p. 1528-1545 (2019)
DOI: 10.1093/mnras/stz427
8. Antoci, V. et al. (includes **García Hernández, A.; Suárez, J. -C.; Martiz, M. Lares; Pascual-Granado, J.; Rodon, J. R.**)
"The first view of δ Scuti and γ Doradus stars with the TESS mission", *Monthly Notices of the Royal Astronomical Society*, p. 2389 (2019)
DOI: 10.1093/mnras/stz2787
9. Aoki S., Vandaele A.C., Daerden F., Villanueva G.L., Liuzzi G., Thomas I.R., Erwin J.T., Trompet L., Robert S., Neary L., Viscardy S., Clancy R.T., Smith M.D., **Lopez-Valverde M.A., Hill B.**, Ristic B., Patel M.R., Bellucci G., **Lopez-Moreno J.-J.**, the NOMAD team
"Water Vapor Vertical Profiles on Mars in Dust Storms Observed by TGO/NOMAD", *Journal of Geophysical Research E: Planets*, Vol. 124, Issue 12, p. 3482-3497 (2019)
DOI: 10.1029/2019JE006109
10. Arsenovic P., Damiani A., Rozanov E., **Funke B.**, Stenke A., Peter T.
"Reactive nitrogen (NO_y) and ozone responses to energetic electron precipitation during Southern Hemisphere winter", *Atmospheric Chemistry and Physics*, Vol. 19.0, p. 9485-9494 (2019)
DOI: 10.5194/acp-19-9485-2019
11. Ashall, C. et al. (includes **Castro-Tirado, A. J**)
"GRB 161219B/SN 2016jca: a powerful stellar collapse", *Monthly Notices of the Royal Astronomical Society*, p. 5824-5839 (2019)
DOI: 10.1093/mnras/stz1588
12. Aznar A., De León J., Popescu M., Serra-Ricart M., Short P., Pravec P., Vaduvescu O., Licandro J., **Ortiz J.L., Sota A., Morales N.**, Lorenzi V., Warner B., Oey J., Groom R.
"Physical properties of PHA 2014 JO 25 from a worldwide observational campaign", *Monthly Notices of*

the Royal Astronomical Society, Vol. 483.0, p. 4820-4827 (2019)

DOI: 10.1093/mnras/sty3250

13. **Bailén, F. J.; Orozco Suárez, D.; del Toro Iniesta, J. C.** "On Fabry–Pérot Etalon-based Instruments. II. The Anisotropic (Birefringent) Case", *Astrophysical Journal Supplement Series*, Vol. 242, p. 21 (2019)
DOI: 10.3847/1538-4365/ab1c57

14. **Bailén, F. J.; Orozco Suárez, D.; del Toro Iniesta, J. C.** "On Fabry–Pérot Etalon-based Instruments. I. The Isotropic Case", *Astrophysical Journal Supplement Series*, Vol. 241, p. 9 (2019)
DOI: 10.3847/1538-4365/aafdb3

15. Bará S., Rodríguez-Arós Á., Pérez M., Tosar B., Lima R.C., **Sánchez de Miguel A.**, Zamorano J.
"Estimating the relative contribution of streetlights, vehicles, and residential lighting to the urban night sky brightness", *Lighting Research and Technology*, Vol. 51.0, p. 1092-1107 (2019)
DOI: 10.1177/1477153518808337

16. **Barceló C.**
"Analogue black-hole horizons", *Nature Physics*, Vol. 15.0, p. 210-213 (2019)
DOI: 10.1038/s41567-018-0367-6

17. **Barceló C.**, Carballo-Rubio R., Liberati S.
"Generalized no-hair theorems without horizons", *Classical and Quantum Gravity*, Vol. 36.0, Number 13LT01, p. 13LT01 (2019)
DOI: 10.1088/1361-6382/ab23b6

18. **Barceló, C.**; Boyanov, V.; Carballo-Rubio, R.; Garay, L. J.
"Semiclassical gravity effects near horizon formation", *Classical and Quantum Gravity*, Vol. 36, p. 165004 (2019)
DOI: 10.1088/1361-6382/ab2e43

19. **Bellot Rubio, L.; Orozco Suárez, D.**
"Quiet Sun magnetic fields: an observational view", *Living Reviews in Solar Physics*, Vol. 16, p. 1 (2019)
DOI: 10.1007/s41116-018-0017-1

20. Beltrán, M. T.; Padovani, M.; Girart, J. M.; Galli, D.; Cesaroni, R.; Paladino, R.; **Anglada, G.**; Estalella, R.; **Osoario, M.**; Rao, R.; Sánchez-Monge, Á.; Zhang, Q.
"ALMA resolves the hourglass magnetic field in G31.41+0.31", *Astronomy and Astrophysics*, Vol. 630, p. A54 (2019)
DOI: 10.1051/0004-6361/201935701

21. Benedetti-Rossi, G.; **Santos-Sanz, P.**; **Ortiz, J. L.**; Assafin, M.; Sicardy, B.; **Morales, N.**; Vieira-Martins, R.; **Duffard, R.** et al.

"The Trans-Neptunian Object (84922) 2003 VS2 through Stellar Occultations", *Astronomical Journal*, Vol. 158, p. 159 (2019)
DOI: 10.3847/1538-3881/ab3b05

22. Berg, T. A. M.; Ellison, S. L.; **Sánchez-Ramírez, R.**; López, S.; D'Odorico, V.; Becker, G. D.; Christensen, L.; Cupani, G.; Denney, K. D.; Worseck, G.
"Sub-damped Lyman α systems in the XQ-100 survey I - Identification and contribution to the cosmological HI budget", *Monthly Notices of the Royal Astronomical Society*, p. 1952 (2019)
DOI: 10.1093/mnras/stz2012

23. Bertini, I. et al. (includes **Moreno, F.**; **Munoz, O.**; **Guirado, D.**; **Gutierrez, P. J.**; **Lara, L. M.**; **Lopez Moreno, J. J.**)
"The backscattering ratio of comet 67P/Churyumov-Gerasimenko dust coma as seen by OSIRIS onboard Rosetta", *Monthly Notices of the Royal Astronomical Society*, Vol. 482, p. 2924-2933 (2019)
DOI: 10.1093/mnras/sty2843

24. Bongiovanni, Á. et al. (includes **Cerviño, M.**; **Alfaro, E.**; **Fernández-Lorenzo, M.**; **Pović, M.**)
"The OTELO survey. I. Description, data reduction, and multi-wavelength catalogue", *Astronomy and Astrophysics*, Vol. 631, p. A9 (2019)
DOI: 10.1051/0004-6361/201833294

25. Bosch, G.; Hägele, G. F.; Amorín, R.; Firpo, V.; Cardaci, M. V.; **Vílchez, J. M.**; **Pérez-Montero, E.**; Papaderos, P.; Dors, O. L.; Krabbe, A. C.; Campuzano-Castro, F.
"Integral Field Spectroscopy of Green Peas (I): Disentangling disk-like, turbulence and strong outflow kinematics in SDSSJ083843.63+385350.5", *Monthly Notices of the Royal Astronomical Society*, p. 1787-1796 (2019)
DOI: 10.1093/mnras/stz2230

26. Bosco, F.; Pott, J. -U.; **Schödel, R.**
"SOWAT: Speckle Observations with Alleviated Turbulence", *Publications of the Astronomical Society of the Pacific*, Vol. 131, p. 044502 (2019)
DOI: 10.1088/1538-3873/ab019f

27. Burdge, K. B.; Fuller, J.; Phinney, E. S.; van Roestel, J.; **Claret, A.**; Cukanovaite, E.; Gentile Fusillo, N. P.;

- Coughlin, M. W.; Kaplan, D. L.; Kupfer, T.; Tremblay, P.-E.; Dekany, R. G.; Duev, D. A.; Feeney, M.; Riddle, R.; Kulkarni, S. R.; Prince, T. A.
"Orbital Decay in a 20 Minute Orbital Period Detached Binary with a Hydrogen-poor Low-mass White Dwarf", *Astrophysical Journal Letters*, Vol. 886, p. L12 (2019)
DOI: 10.3847/2041-8213/ab53e5
28. Busquet, G.; Girart, J. M.; Estalella, R.; Fernández-López, M.; Galván-Madrid, R.; **Anglada, G.**; Carrasco-González, C.; Añez-López, N.; Curiel, S.; **Osorio, M.**; Rodríguez, L. F.; Torrelles, J. M.
"Unveiling a cluster of protostellar disks around the massive protostar GGD 27 MM1", *Astronomy and Astrophysics*, Vol. 623, p. L8 (2019)
DOI: 10.1051/0004-6361/201833687
29. Buta R.J., **Verdes-Montenegro L., Damas-Segovia A., Jones M., Blasco J., Fernández-Lorenzo M., Sanchez S., Garrido J., Ramirez-Moreta P., Sulentic J.W.**
"A comprehensive examination of the optical morphologies of 719 isolated galaxies in the AMIGA sample", *Monthly Notices of the Royal Astronomical Society*, Vol. 488.0, p. 2175-2189 (2019)
DOI: 10.1093/mnras/stz1780
30. Cambianica, P. et al. (includes **Gutiérrez, P. J.; López-Moreno, J. J.**)
"Quantitative analysis of isolated boulder fields on comet 67P/Churyumov-Gerasimenko", *Astronomy and Astrophysics*, Vol. 630, p. A15 (2019)
DOI: 10.1051/0004-6361/201834775
31. Campos Rozo, J. I.; **Utz, D.**; Vargas Domínguez, S.; Veronig, A.; Van Doorselaere, T.
"Photospheric plasma and magnetic field dynamics during the formation of solar AR 11190", *Astronomy and Astrophysics*, Vol. 622, p. A168 (2019)
DOI: 10.1051/0004-6361/201832760
32. Carrasco-González, C.; Sierra, A.; Flock, M.; Zhu, Z.; Henning, T.; Chandler, C.; Galván-Madrid, R.; Macías, E.; **Anglada, G.**; Linz, H.; **Osorio, M.**; Rodríguez, L. F.; Testi, L.; Torrelles, J. M.; Pérez, L.; Liu, Y.
"The Radial Distribution of Dust Particles in the HL Tau Disk from ALMA and VLA Observations", *Astrophysical Journal*, Vol. 883, p. 71 (2019)
DOI: 10.3847/1538-4357/ab3d33
33. Casadio, C.; Marscher, A. P.; Jorstad, S. G.; Blinov, D. A.; MacDonald, N. R.; Krichbaum, T. P.; Boccardi, B.; Traianou, E.; **Gómez, J. L.; Agudo, I.**; Sohn, B.-W.; Bremer, M.; Hodgson, J.; Kallunki, J.; Kim, J.-Y.; Williamson, K. E.; Zensus, J. A.
"The magnetic field structure in CTA 102 from high-resolution mm-VLBI observations during the flaring state in 2016-2017", *Astronomy and Astrophysics*, Vol. 622, p. A158 (2019)
DOI: 10.1051/0004-6361/201834519
34. Cassano, R.; Botteon, A.; Di Gennaro, G.; Brunetti, G.; Sereno, M.; Shimwell, T. W.; van Weeren, R. J.; Brüggén, M.; Gastaldello, F.; **Izzo, L.**; Bîrzan, L.; Bonafede, A.; Cuciti, V.; de Gasperin, F.; Röttgering, H. J. A.; Hardcastle, M.; Mechev, A. P.; Tasse, C.
"LOFAR Discovery of a Radio Halo in the High-redshift Galaxy Cluster PSZ2 G099.86+58.45", *Astrophysical Journal Letters*, Vol. 881, p. L18 (2019)
DOI: 10.3847/2041-8213/ab32ed
35. **Castro Tirado, M. A.; Castro-Tirado, A. J.**
"The Evolution of Astronomical Observatory Design", *Journal of Korean Astronomical Society*, Vol. 52, p. 99-108 (2019)
DOI: 10.5303/JKAS.2019.52.4.99
36. Cenarro, A. J. et al. (includes **Alfaro, E. J.; González Delgado, R. M.; Vilchez, J. M.**)
"J-PLUS: The Javalambre Photometric Local Universe Survey", *Astronomy and Astrophysics*, Vol. 622, p. A176 (2019)
DOI: 10.1051/0004-6361/201833036
37. Chen, Z.; **Gallego-Cano, E.**; Do, T.; Witzel, G.; Ghez, A. M.; **Schödel, R.**; Sitarski, B. N.; Becklin, E. E.; Lu, J.; Morris, M. R.; Dehghanfar, A.; Gautam, A. K.; Hees, A.; Hosek, M. W., Jr.; Jia, S.; Mangian, A. C.; Matthews, K.
"Consistency of the Infrared Variability of SGR A* over 22 yr", *Astrophysical Journal Letters*, Vol. 882, p. L28 (2019)
DOI: 10.3847/2041-8213/ab3c68
38. Chian, A. C. -L.; Silva, S. S. A.; Rempel, E. L.; Gošić, M.; **Bellot Rubio, L. R.**; Kusano, K.; Miranda, R. A.; Requerey, I. S.
"Supergranular turbulence in the quiet Sun: Lagrangian coherent structures", *Monthly Notices of the Royal Astronomical Society*, p. 1841 (2019)
DOI: 10.1093/mnras/stz1909
39. **Claret, A.**
"Updating the theoretical tidal evolution constants: Apsidal motion and the moment of inertia", *Astronomy and Astrophysics*, Vol. 628, p. A29 (2019)
DOI: 10.1051/0004-6361/201936007

40. **Claret, A.**; Torres, G.
"The Dependence of Convective Core Overshooting on Stellar Mass: Reality Check and Additional Evidence", *Astrophysical Journal*, Vol. 876, p. 134 (2019)
DOI: 10.3847/1538-4357/ab1589
41. Coe D. et al. (includes **Czakon N.G.**, **Umetsu K.**, **Molino A.**).
"RELICS: Reionization Lensing Cluster Survey", *Astrophysical Journal*, Vol. 884, Number 85, p. 85 (2019)
DOI: 10.3847/1538-4357/ab412b
42. Comparat, J.; Merloni, A.; Salvato, M.; Nandra, K.; Boller, T.; Georgakakis, A.; Finoguenov, A.; Dwelly, T.; Buchner, J.; Del Moro, A.; Clerc, N.; Wang, Y.; Zhao, G.; **Prada, F.**; Yepes, G.; Brusa, M.; Krumpel, M.; Liu, T.
"Active Galactic Nuclei And Their Large-Scale Structure: An eROSITA Mock Catalogue", *Monthly Notices of the Royal Astronomical Society*, p. 1335 (2019)
DOI: 10.1093/mnras/stz1390
43. Costantin, L. et al. (includes **García-Benito, R.**)
"A few StePS forward in unveiling the complexity of galaxy evolution: light-weighted stellar ages of intermediate-redshift galaxies with WEAVE", *Astronomy and Astrophysics*, Vol. 632, p. A9 (2019)
DOI: 10.1051/0004-6361/201936550
44. Cunha, M. S. et al. (includes **Lares-Martiz, M.**; **Pascual-Granado, J.**; **Suárez, J. C.**)
"Rotation and pulsation in Ap stars: first light results from TESS sectors 1 and 2", *Monthly Notices of the Royal Astronomical Society*, Vol. 487, p. 3523-3549 (2019)
DOI: 10.1093/mnras/stz1332
45. D'Ammando, F. et al (includes **Agudo, I.**; **Casadio, C.**; **Fuentes, A.**; **Gómez, J. L.**; **Molina, S. N.**)
"Investigating the multiwavelength behaviour of the flat spectrum radio quasar CTA 102 during 2013-2017", *Monthly Notices of the Royal Astronomical Society*, p. 2393 (2019)
DOI: 10.1093/mnras/stz2792
46. **de Franciscis, S.**; **Pascual-Granado, J.**; **Suárez, J. C.**; **García Hernández, A.**; **Garrido, R.**; **Lares-Martiz, M.**; **Rodón, J. R.**
"A fractal analysis application of the prewhitening technique to δ Scuti stars time series", *Monthly Notices of the Royal Astronomical Society*, p. 4457-4463 (2019)
DOI: 10.1093/mnras/stz1571
47. **de Miguel A.S.**, Bará S., Aubé M., Cardiel N., Tapia C.E., Zamorano J., Gaston K.J.
"Evaluating human photoreceptor inputs from night-time lights using RGB imaging photometry", *Journal of Imaging*, Vol. 5.0, Number 49 (2019)
DOI: 10.3390/jimaging5040049
48. De Rosa A. et al. (includes **Agudo I.**)
"Accretion in strong field gravity with eXTP", *Science China: Physics, Mechanics and Astronomy*, Vol. 62, Number 29504, p. 29504 (2019)
DOI: 10.1007/s11433-018-9297-0
49. De Rosa, A. (includes **Perez-Torres M.**)
"The quest for dual and binary supermassive black holes: A multi-messenger view", *New Astronomy Reviews*, Vol. 86, Number 101525 (2019)
DOI: 10.1016/j.newar.2020.101525
50. Desmars, J.; Meza, E.; Sicardy, B.; Assafin, M.; Camargo, J. I. B.; Braga-Ribas, F.; Benedetti-Rossi, G.; Dias-Oliveira, A.; Morgado, B.; Gomes-Júnior, A. R.; Vieira-Martins, R.; Behrend, R.; **Ortiz, J. L.**; **Duffard, R.**; **Morales, N.**; **Santos Sanz, P.**
"Pluto's ephemeris from ground-based stellar occultations (1988-2016)", *Astronomy and Astrophysics*, Vol. 625, p. A43 (2019)
DOI: 10.1051/0004-6361/201834958
51. Dey, B.; Rosolowsky, E.; Cao, Y.; Bolatto, A.; Sanchez, S. F.; Utomo, D.; Colombo, D.; Kalinova, V.; Wong, T.; Blitz, L.; Vogel, S.; Loeppky, J.; **García-Benito, R.**
"The EDGE-CALIFA Survey: Exploring the Star Formation Law through Variable Selection", *Monthly Notices of the Royal Astronomical Society*, p. 1926-1940 (2019)
DOI: 10.1093/mnras/stz1777
52. Díaz-García, L. A.; Cenarro, A. J.; López-Sanjuan, C.; Ferreras, I.; **Cerviño, M.**; Fernández-Soto, A.; **González Delgado, R. M.**; **Márquez, I.**; **Pović, M.**; San Roman, I.; Viironen, K.; Moles, M.; Cristóbal-Hornillos, D.; López-Comazzi, A.; **Alfaro, E.**; Aparicio-Villegas, T.; **Benítez, N.**; Broadhurst, T.; Cabrera-Cañó, J.; Castander, F. J.; Cepa, J.; **Husillos, C.**; Infante, L.; Aguerri, J. A. L.; Martínez, V. J.; **Masegosa, J.**; Molino, A.; **del Olmo, A.**; **Perea, J.**; **Prada, F.**; **Quintana, J. M.**
"Stellar populations of galaxies in the ALHAMBRA survey up to $z \sim 1$. II. Stellar content of quiescent galaxies within the dust-corrected stellar mass-colour and the UVJ colour-colour diagrams", *Astronomy and Astrophysics*, Vol. 631, p. A156 (2019)

DOI: 10.1051/0004-6361/201832788

53. Díaz-García, L. A.; Cenarro, A. J.; López-Sanjuan, C.; Ferreras, I.; Fernández-Soto, A.; **González Delgado, R. M.**; **Márquez, I.**; **Masegosa, J.**; San Roman, I.; Viironen, K.; Bonoli, S.; **Cerviño, M.**; Moles, M.; Cristóbal-Hornillos, D.; **Alfaro, E.**; Aparicio-Villegas, T.; **Benítez, N.**; Broadhurst, T.; Cabrera-Caño, J.; Castander, F. J.; Cepa, J.; **Husillos, C.**; Infante, L.; Aguerri, J. A. L.; Martínez, V. J.; Molino, A.; **del Olmo, A.**; **Perea, J.**; **Prada, F.**; **Quintana, J. M.**

"Stellar populations of galaxies in the ALHAMBRA survey up to $z \sim 1$. III. The stellar content of the quiescent galaxy population during the last 8 Gyr", *Astronomy and Astrophysics*, Vol. 631, p. A157 (2019)

DOI: 10.1051/0004-6361/201832882

54. Díaz-García, L. A.; Cenarro, A. J.; López-Sanjuan, C.; Peralta de Arriba, L.; Ferreras, I.; **Cerviño, M.**; **Márquez, I.**; **Masegosa, J.**; **del Olmo, A.**; **Perea, J.**

"Stellar populations of galaxies in the ALHAMBRA survey up to $z \sim 1$. IV. Properties of quiescent galaxies on the stellar mass-size plane", *Astronomy and Astrophysics*, Vol. 631, p. A158 (2019)

DOI: 10.1051/0004-6361/201935257

55. Díez Alonso E., Caballero J.A., Montes D., De Cos Juez F.J., Dreizler S., Dubois F., Jeffers S.V., Lalitha S., Naves R., Reiners A., Ribas I., Vanaverbeke S., **Amado P.J.**, Béjar V.J.S., Cortés-Contreras M., Herrero E., Hidalgo D., Kürster M., Logie L., Quirrenbach A., Rau S., Seifert W., Schöfer P., Tal-Or L.

"CARMENES input catalogue of M dwarfs: IV. New rotation periods from photometric time series", *Astronomy and Astrophysics*, Vol. 621, Number 201833316, p. A126 (2019)

DOI: 10.1051/0004-6361/201833316

56. Dinelli B.M., López-Puertas, M., Fabiano F., Adriani A., Moriconi M.L., **Funke B.**, **García-Comas M.**, Oliva F., D'Aversa E., Filacchione G.

"Climatology of CH₄, HCN and C₂H₂ in Titan's upper atmosphere from Cassini/VIMS observations", *Icarus*, Vol. 331.0, p. 83-97 (2019)

DOI: 10.1016/j.icarus.2019.04.026

57. Do T., Hees A., Ghez A., Martinez G.D., Chu D.S., Jia S., Sakai S., Lu J.R., Gautam A.K., O'neil K.K., Becklin E.E., Morris M.R., Matthews K., Nishiyama S., Campbell R., Chappell S., Chen Z., Ciurlo A., Dehghanfar A., **Gallego-Cano E.**, Kerzendorf W.E., Lyke J.E., Naoz S., Saida H., **Schödel R.**, Takahashi M., Takamori Y., Witzel G., Wizinowich P.

"Relativistic redshift of the star s0-2 orbiting the galactic center supermassive black hole", *Science*, p. 664-668 (2019)

DOI: 10.1126/science.aav8137

58. Do, T.; Witzel, G.; Gautam, A. K.; Chen, Z.; Ghez, A. M.; Morris, M. R.; Becklin, E. E.; Ciurlo, A.; Hosek, M., Jr.; Martinez, G. D.; Matthews, K.; Sakai, S.; **Schödel, R.**

"Unprecedented Near-infrared Brightness and Variability of Sgr A*", *Astrophysical Journal Letters*, Vol. 882, p. L27 (2019)

DOI: 10.3847/2041-8213/ab38c3

59. Domínguez, A.; Wojtak, R.; Finke, J.; Ajello, M.; Helgason, K.; **Prada, F.**; Desai, A.; Paliya, V.; Marcotulli, L.; Hartmann, D. H.

"A New Measurement of the Hubble Constant and Matter Content of the Universe Using Extragalactic Background Light γ -Ray Attenuation", *Astrophysical Journal*, Vol. 885, p. 137 (2019)

DOI: 10.3847/1538-4357/ab4a0e

60. **Duarte Puertas, S.**; **Iglesias-Páramo, J.**; **Vilchez, J. M.**; Drissen, L.; **Kehrig, C.**; Martin, T.

"Searching for intergalactic star forming regions in Stephan's Quintet with SIELLE. I. Ionised gas structures and kinematics", *Astronomy and Astrophysics*, Vol. 629, p. A102 (2019)

DOI: 10.1051/0004-6361/201935686

61. Dullo, B. T.; Chamorro-Cazorla, M.; Gil de Paz, A.; Castillo-Morales, Á.; Gallego, J.; Carrasco, E.; **Iglesias-Páramo, J.**; Cedazo, R.; García-Vargas, M. L.; Pascual, S.; Cardiel, N.; Pérez-Calpena, A.; Gómez-Alvarez, P.; Martínez-Delgado, I.; Catalán-Torrecilla, C.

"High-resolution MEGARA Integral-field Unit Spectroscopy and Structural Analysis of a Fast-rotating, Disky Bulge in NGC 7025", *Astrophysical Journal*, Vol. 871, p. 9 (2019)

DOI: 10.3847/1538-4357/aaf424

62. Durret, F.; Tarricq, Y.; **Márquez, I.**; Ashkar, H.; Adami, C.

"Link between brightest cluster galaxy properties and large scale extensions of 38 DAFT/FADA and CLASH clusters in the redshift range $0.2 < z < 0.9$ ", *Astronomy and Astrophysics*, Vol. 622, p. A78 (2019)

DOI: 10.1051/0004-6361/201834374

63. Esparza-Arredondo, D.; González-Martín, O.; Dultzin, D.; Ramos-Almeida, C.; Fritz, J.; **Masegosa, J.**; Pasetto, A.; Martínez-Paredes, M.; Osorio-Clavijo, N.; Victoria-Ceballos, C.

- "Physical Parameters of the Torus for the Type 2 Seyfert IC 5063 from Mid-IR and X-Ray Simultaneous Spectral Fitting", *Astrophysical Journal*, Vol. 886, p. 125 (2019)
DOI: 10.3847/1538-4357/ab4ced
64. Estalella, R.; **Anglada, G.**; **Díaz-Rodríguez, A. K.**; **Mayen-Gijón, J. M.**
"Analysis and test of the central-blue-spot infall hallmark", *Astronomy and Astrophysics*, Vol. 626, p. A84 (2019)
DOI: 10.1051/0004-6361/201834998
65. Event Horizon Telescope Collaboration (includes **Alberdi, A.**; **Gómez, J. L.**)
"First M87 Event Horizon Telescope Results. I. The Shadow of the Supermassive Black Hole", *Astrophysical Journal Letters*, Vol. 875, p. L1 (2019)
DOI: 10.3847/2041-8213/ab0ec7
66. Event Horizon Telescope Collaboration (includes **Alberdi, A.**; **Gómez, J. L.**)
"First M87 Event Horizon Telescope Results. IV. Imaging the Central Supermassive Black Hole", *Astrophysical Journal Letters*, Vol. 875, p. L4 (2019)
DOI: 10.3847/2041-8213/ab0e85
67. Event Horizon Telescope Collaboration (includes **Alberdi, A.**; **Gómez, J. L.**)
"First M87 Event Horizon Telescope Results. II. Array and Instrumentation", *Astrophysical Journal Letters*, Vol. 875, p. L2 (2019)
DOI: 10.3847/2041-8213/ab0c96
68. Event Horizon Telescope Collaboration (includes **Alberdi, A.**; **Gómez, J. L.**)
"First M87 Event Horizon Telescope Results. III. Data Processing and Calibration", *Astrophysical Journal Letters*, Vol. 875, p. L3 (2019)
DOI: 10.3847/2041-8213/ab0c57
69. Event Horizon Telescope Collaboration (includes **Alberdi, A.**; **Gómez, J. L.**)
"First M87 Event Horizon Telescope Results. VI. The Shadow and Mass of the Central Black Hole", *Astrophysical Journal Letters*, Vol. 875, p. L6 (2019)
DOI: 10.3847/2041-8213/ab1141
70. Event Horizon Telescope Collaboration (includes **Alberdi, A.**; **Gómez, J. L.**)
"First M87 Event Horizon Telescope Results. V. Physical Origin of the Asymmetric Ring", *Astrophysical Journal Letters*, Vol. 875, p. L5 (2019)
DOI: 10.3847/2041-8213/ab0f43
71. Falcón-Barroso, J. et al (includes **García-Benito, R.**; **González Delgado, R. M.**; **Márquez, I.**; **Pérez, E.**)
"The CALIFA view on stellar angular momentum across the Hubble sequence", *Astronomy and Astrophysics*, Vol. 632, p. A59 (2019)
DOI: 10.1051/0004-6361/201936413
72. Feller, C. et al. (includes **Lara, L. M.**; **López-Moreno, J. J.**)
"Rosetta/OSIRIS observations of the 67P nucleus during the April 2016 flyby: high-resolution spectrophotometry", *Astronomy and Astrophysics*, Vol. 630, p. A9 (2019)
DOI: 10.1051/0004-6361/201833807
73. Fernández-Valenzuela, E.; **Ortiz, J. L.**; **Morales, N.**; **Santos-Sanz, P.**; **Duffard, R.**; Aznar, A.; Lorenzi, V.; Pinilla-Alonso, N.; Lellouch, E.
"The Changing Rotational Light-curve Amplitude of Varuna and Evidence for a Close-in Satellite", *Astrophysical Journal Letters*, Vol. 883, p. L21 (2019)
DOI: 10.3847/2041-8213/ab40c2
74. Fornasier, S. et al. (includes **Gutierrez, P. J.**; **Lara, M. L.**; **Lopez Moreno, J. J.**)
"Surface evolution of the Anhur region on comet 67P/Churyumov-Gerasimenko from high-resolution OSIRIS images", *Astronomy and Astrophysics*, Vol. 630, p. A13 (2019)
DOI: 10.1051/0004-6361/201834824
75. Fornasier, S. et al. (includes **Gutierrez, P. J.**; **Lara, M. L.**; **Lopez Moreno, J. J.**)
"Linking surface morphology, composition, and activity on the nucleus of 67P/Churyumov-Gerasimenko", *Astronomy and Astrophysics*, Vol. 630, p. A7 (2019)
DOI: 10.1051/0004-6361/201833803
76. Frattin, E.; **Muñoz, O.**; **Moreno, F.**; Nava, J.; Escobar-Cerezo, J.; **Gomez Martin, J. C.**; **Guirado, D.**; Cellino, A.; Coll, P.; Raulin, F.; Bertini, I.; Cremonese, G.; Lazzarin, M.; Naletto, G.; La Forgia, F.
"Experimental phase function and degree of linear polarization of cometary dust analogs", *Monthly Notices of the Royal Astronomical Society*, p. 2198-2211 (2019)
DOI: 10.1093/mnras/stz129
77. Fuhrmeister, B. et al. (includes **Amado, P. J.**; **Bauer, F. F.**)
"The CARMENES search for exoplanets around M dwarfs. The He I triplet at 10830 Å across the M dwarf sequence", *Astronomy and Astrophysics*, Vol. 632, p. A24 (2019)

DOI: 10.1051/0004-6361/201936193

78. Fuhrmeister, B. et al. (includes **Amado, P. J.**)

"The CARMENES search for exoplanets around M dwarfs. Period search in H α , Na I D, and Ca II IRT lines", *Astronomy and Astrophysics*, Vol. 623, p. A24 (2019)

DOI: 10.1051/0004-6361/201834483

79. Fulle, M.; Blum, J.; Green, S. F.; Gundlach, B.; Herique, A.; **Moreno, F.**; Mottola, S.; Rotundi, A.; Snodgrass, C.

"The refractory-to-ice mass ratio in comets", *Monthly Notices of the Royal Astronomical Society*, Vol. 482, p. 3326-3340 (2019)

DOI: 10.1093/mnras/sty2926

80. Ganci V., Marziani P., D'Onofrio M., **Del Olmo A.**, Bon E., Bon N., Negrete C.A.

"Radio loudness along the quasar main sequence", *Astronomy and Astrophysics*, Vol. 630.0, Number A110, p. A110 (2019)

DOI: 10.1051/0004-6361/201936270

81. **García-Benito, R.**; **González Delgado, R. M.**; **Pérez, E.**; Cid Fernandes, R.; Sánchez, S. F.; de Amorim, A. L.

"Spatially resolved mass-to-light from the CALIFA survey. Mass-to-light ratio vs. color relations", *Astronomy and Astrophysics*, Vol. 621, p. A120 (2019)

DOI: 10.1051/0004-6361/201833993

82. García-Bernete, I.; Ramos Almeida, C.; Alonso-Herrero, A.; Ward, M. J.; Acosta-Pulido, J. A.; Pereira-Santaella, M.; Hernán-Caballero, A.; Asensio Ramos, A.; González-Martín, O.; Levenson, N. A.; Mateos, S.; Carrera, F. J.; Ricci, C.; Roche, P.; **Marquez, I.**; Packham, C.; **Masegosa, J.**; Fuller, L.

"Torus model properties of an ultra-hard X-ray selected sample of Seyfert galaxies", *Monthly Notices of the Royal Astronomical Society*, p. 4917-4935 (2019)

DOI: 10.1093/mnras/stz1003

83. Ghirlanda G. et al. (includes **Agudo I.**, **Perez-Torres M.A.**)

"Compact radio emission indicates a structured jet was produced by a binary neutron star merger", *Science*, Vol. 363.0, p. 968-971 (2019)

DOI: 10.1126/science.aau8815

84. **González, M.**; **Gordillo-Vázquez, F. J.**; **Luque, A.**

"Macroscopical model of streamer coronas around a spherical electrode", *Plasma Sources Science and Technology*, Vol. 28, p. 115007 (2019)

DOI: 10.1088/1361-6595/ab4e7a

85. González-Martín, O.; **Masegosa, J.**; García-Bernete, I.; Ramos Almeida, C.; Rodríguez-Espinosa, J. M.; **Márquez, I.**; Esparza-Arredondo, D.; Osorio-Clavijo, N.; Martínez-Paredes, M.; Victoria-Ceballos, C.; Pasetto, A.; Dultzin, D.

"Exploring the Mid-infrared SEDs of Six AGN Dusty Torus Models. II. The Data", *Astrophysical Journal*, Vol. 884, p. 11 (2019)

DOI: 10.3847/1538-4357/ab3e4f

86. González-Martín, O.; **Masegosa, J.**; García-Bernete, I.; Ramos Almeida, C.; Rodríguez-Espinosa, J. M.; **Márquez, I.**; Esparza-Arredondo, D.; Osorio-Clavijo, N.; Martínez-Paredes, M.; Victoria-Ceballos, C.; Pasetto, A.; Dultzin, D.

"Exploring the Mid-infrared SEDs of Six AGN Dusty Torus Models. I. Synthetic Spectra", *Astrophysical Journal*, Vol. 884, p. 10 (2019)

DOI: 10.3847/1538-4357/ab3e6b

87. **Gordillo-Vázquez F.J.**, **Pérez-Invernón F.J.**, Huntrieser H., Smith A.K.

"Comparison of Six Lightning Parameterizations in CAM5 and the Impact on Global Atmospheric Chemistry", *Earth and Space Science*, Vol. 6, Issue 12, p. 2317-2346 (2019)

DOI: 10.1029/2019EA000873

88. **Guerrero, M. A.**; Toalá, Jesús A.; Chu, You-Hua

"Variable Hard X-Ray Emission from the Central Star of the Eskimo Nebula", *Astrophysical Journal*, Vol. 884, p. 134 (2019)

DOI: 10.3847/1538-4357/ab4256

89. Günther M.N. et al. (includes **Suárez J.C.**)

"A super-Earth and two sub-Neptunes transiting the nearby and quiet M dwarf TOI-270", *Nature Astronomy*, p. 1099-1108 (2019)

DOI: 10.1038/s41550-019-0845-5

90. Güttler, C. et al. (includes **Moreno, F.**)

"Synthesis of the morphological description of cometary dust at comet 67P/Churyumov-Gerasimenko", *Astronomy and Astrophysics*, Vol. 630, p. A24 (2019)

DOI: 10.1051/0004-6361/201834751

91. Handler, G. et al. (includes **Pascual-Granado, J.**)

"Asteroseismology of Massive Stars with the TESS Mission: The Runaway β Cep Pulsator PHL 346 = HN Aqr", *Astrophysical Journal Letters*, Vol. 873, p. L4 (2019)

DOI: 10.3847/2041-8213/ab095f

92. Hasselmann, P. H. et al. (includes **Gutierrez, P. J.; Lara, L. M.; López-Moreno, J. J.**)
 "Pronounced morphological changes in a southern active zone on comet 67P/Churyumov-Gerasimenko", *Astronomy and Astrophysics*, Vol. 630, p. A8 (2019)
 DOI: 10.1051/0004-6361/201833940
93. Hatzidimitriou, D. et al. (includes **Alfaro, E. J.**)
 "The Gaia-ESO Survey: The inner disc, intermediate-age open cluster Pismis 18", *Astronomy and Astrophysics*, Vol. 626, p. A90 (2019)
 DOI: 10.1051/0004-6361/201834636
94. Heintz, K. E.; Bolmer, J.; Ledoux, C.; Noterdaeme, P.; Krogager, J. -K.; Fynbo, J. P. U.; Jakobsson, P.; Covino, S.; D'Elia, V.; De Pasquale, M.; Hartmann, D. H.; **Izzo, L.**; Japelj, J.; **Kann, D. A.**; Kaper, L.; Petitjean, P.; Rossi, A.; Salvaterra, R.; Schady, P.; Selsing, J.; Starling, R.; Tanvir, N. R.; **Thöne, C. C.**; **de Ugarte Postigo, A.**; Vergani, S. D.; Watson, D.; Wiersema, K.; Zafar, T.
 "New constraints on the physical conditions in H₂-bearing GRB-host damped Lyman- α absorbers", *Astronomy and Astrophysics*, Vol. 629, p. A131 (2019)
 DOI: 10.1051/0004-6361/201936250
95. Hernández-García, L.; Panessa, F.; Bassani, L.; Bruni, G.; Ursini, F.; Chavushyan, V.; González-Martín, O.; **Cazzoli, S.**; Jiménez-Andrade, E. F.; Arévalo, P.; Díaz, Y.; Bazzano, A.; Ubertini, P.
 "A young and obscured AGN embedded in the giant radio galaxy Mrk 1498", *Monthly Notices of the Royal Astronomical Society*, p. 4049-4062 (2019)
 DOI: 10.1093/mnras/stz2265
96. **Herrero-Illana, R.**; Privon, G. C.; Evans, A. S.; Díaz-Santos, T.; **Pérez-Torres, M. Á.**; U, V.; **Alberdi, A.**; Iwasawa, K.; Armus, L.; Aalto, S.; Mazzarella, J.; Chu, J.; Sanders, D. B.; Barcos-Muñoz, L.; Charmandaris, V.; Linden, S. T.; Yoon, I.; Frayer, D. T.; Inami, H.; Kim, D. -C.; Borish, H. J.; Conway, J.; Murphy, E. J.; Song, Y.; Stierwalt, S.; Surace, J.
 "Molecular gas and dust properties of galaxies from the Great Observatories All-sky LIRG Survey", *Astronomy and Astrophysics*, Vol. 628, p. A71 (2019)
 DOI: 10.1051/0004-6361/201834088
97. Hergiv M.E., Marshall B.T., Bailey S.M., Siskind D.E., Russell J.M., III, Bardeen C.G., Walker K.A., **Funke B.**
 "Validation of Solar Occultation for Ice Experiment (SOFIE) nitric oxide measurements", *Atmospheric Measurement Techniques*, Vol. 12.0, p. 3111-3121 (2019)
 DOI: 10.5194/amt-12-3111-2019
98. Hinode Review Team; Al-Janabi, K.; Antolin, P.; Baker, D.; **Bellot Rubio, L. R.** et al
 "Achievements of Hinode in the first eleven years", *Publications of the Astronomical Society of Japan*, Vol. 71, p. R1 (2019)
 DOI: 10.1093/pasj/psz084
99. Hintz, D. et al. (includes **Amado, P. J.**)
 "The CARMENES search for exoplanets around M dwarfs. Chromospheric modeling of M 2-3 V stars with PHOENIX", *Astronomy and Astrophysics*, Vol. 623, p. A136 (2019)
 DOI: 10.1051/0004-6361/201834788
100. Hromakina, T. A.; Belskaya, I. N.; Krugly, Yu. N.; Shevchenko, V. G.; **Ortiz, J. L.**; **Santos-Sanz, P.**; **Duffard, R.**; **Morales, N.**; Thirouin, A.; Inasaridze, R. Ya.; Ayvazian, V. R.; Zhuzhunadze, V. T.; Perna, D.; Romyantsev, V. V.; Reva, I. V.; Serebryanskiy, A. V.; Sergeev, A. V.; Molotov, I. E.; Voropaev, V. A.; Velichko, S. F.
 "Long-term photometric monitoring of the dwarf planet (136472) Makemake", *Astronomy and Astrophysics*, Vol. 625, p. A46 (2019)
 DOI: 10.1051/0004-6361/201935274
101. **Hu, Y. -D.**; **Oates, S. R.**; Lipunov, V. M.; **Zhang, B. - B.**; **Castro-Tirado, A. J.**; **Jeong, S.**; **Sánchez-Ramírez, R.**; **Tello, J. C.**; **Cunniffe, R.**; Gorbovskoy, E.; **Caballero-García, M. D.**; Pandey, S. B.; Kornilov, V. G.; Tyurina, N. V.; Kuznetsov, A. S.; Balanutsa, P. V.; Gress, O. A.; Gorbunov, I.; Vlasenko, D. M.; Vladimirov, V. V.; Budnev, N. M.; Balakin, F.; Ershova, O.; Krushinski, V. V.; Gabovich, A. V.; Yurkov, V. V.; **Gorosabel, J.**; Moskvitin, A. S.; Burenin, R. A.; Sokolov, V. V.; Delgado, I.; Guziy, S.; **Fernandez-García, E. J.**; Park, I. H.
 "Multiwavelength observations of GRB 140629A. A long burst with an achromatic jet break in the optical and X-ray afterglow", *Astronomy and Astrophysics*, Vol. 632, p. A100 (2019)
 DOI: 10.1051/0004-6361/201834959
102. Husemann, B.; Scharwächter, J.; Davis, T. A.; **Pérez-Torres, M.**; Smirnova-Pinchukova, I.; Tremblay, G. R.; Krumpe, M.; Combes, F.; Baum, S. A.; Busch, G.; Connor, T.; Croom, S. M.; Gaspari, M.; Kraft, R. P.; O'Dea, C. P.; Powell, M.; Singha, M.; Urrutia, T.
 "The Close AGN Reference Survey (CARS). A massive multi-phase outflow impacting the edge-on galaxy HE 1353-1917", *Astronomy and Astrophysics*, Vol. 627, p. A53 (2019)
 DOI: 10.1051/0004-6361/201935283

103. Hussmann, H., et al. (includes **Lara, L. M.**; **Castro-Marin, J. M.**; **Herranz de la Revilla, M.**; **Jiménez-Ortega, J.**; **Martínez-Navajas, I.**; **Rodrigo, J.**)
 "The Ganymede laser altimeter (GALA): key objectives, instrument design, and performance", CEAS Space Journal, p. 381-390 (2019)
 DOI: 10.1007/s12567-019-00282-8
104. in 't Zand J.J.M., et al. (includes **Agudo I.**, **Izzo L.**, **Pérez Torres M.A.**)
 "Observatory science with eXTP", Science China: Physics, Mechanics and Astronomy, Vol. 62, Number 29506, p. 29506 (2019)
 DOI: 10.1007/s11433-017-9186-1
105. Irwin J., **Damas-Segovia A.**, Krause M., Miskolczi A., Li J., Stein Y., English J., Henriksen R., Beck R., Wiegert T., Dettmar R.-J.
 "CHANG-ES: XVIII-The CHANG-ES survey and selected results", Galaxies, Vol. 7.0, Number 42 (2019)
 DOI: 10.3390/galaxies7010042
106. Irwin, J.; Wiegert, T.; Merritt, A.; Weźgowiec, M.; Hunt, L.; Woodfinden, A.; Stein, Y.; **Damas-Segovia, A.**; Li, J.; Wang, Q. D.; Johnson, M.; Krause, M.; Dettmar, R.-J.; Im, J.; Schmidt, P.; Miskolczi, A.; Braun, T. T.; Saikia, D. J.; English, J.; Richardson, M.
 "CHANG-ES. XX. High-resolution Radio Continuum Images of Edge-on Galaxies and Their AGNs: Data Release 3", Astronomical Journal, Vol. 158, p. 21 (2019)
 DOI: 10.3847/1538-3881/ab25f6
107. Issaoun, S., et al. (includes **Gómez, J. L.**)
 "The Size, Shape, and Scattering of Sagittarius A* at 86 GHz: First VLBI with ALMA", Astrophysical Journal, Vol. 871, p. 30 (2019)
 DOI: 10.3847/1538-4357/aaf732
108. **Izzo L.**, **de Ugarte Postigo A.**, Maeda K., **Thöne C.C.**, **Kann D.A.**, **Della Valle M.**, Sagues Carracedo A., Michałowski M.J., Schady P., Schmidl S., Selsing J., Starling R.L.C., Suzuki A., **Bensch K.**, Bolmer J., Campana S., **Cano Z.**, et al.
 "Signatures of a jet cocoon in early spectra of a supernova associated with a γ -ray burst", Nature, Vol. 565, p. 324-327 (2019)
 DOI: 10.1038/s41586-018-0826-3
109. Janowiecki, Steven; **Jones, Michael G.**; Leisman, Lukas; Webb, Andrew
 "The environment of H I-bearing ultra diffuse galaxies in the ALFALFA survey", Monthly Notices of the Royal Astronomical Society, p. 566-577 (2019)
 DOI: 10.1093/mnras/stz1868
110. Jelínek M., **Kann D.A.**, Štrobl J., Hudec R.
 "Applying weighted image coaddition to observations of GRB optical afterglows at the D50 telescope in Ondřejov", Astronomische Nachrichten, Vol. 340.0, p. 622-628 (2019)
 DOI: 10.1002/asna.201913666
111. Jenkins, J. S.; Pozuelos, F. J.; Tuomi, M.; Berdiñas, Z. M.; Díaz, M. R.; Vines, J. I.; **Suárez, J. C.**; Peña Rojas, P. A.
 "GJ 357: A low-mass planetary system uncovered by precision radial-velocities and dynamical simulations", Monthly Notices of the Royal Astronomical Society, p. 2544 (2019)
 DOI: 10.1093/mnras/stz2937
112. Jenkins, J. S.; Harrington, J.; Challener, R. C.; Kurtovic, N. T.; Ramirez, R.; Peña, J.; McIntyre, K. J.; Himes, M. D.; **Rodríguez, E.**; Anglada-Escudé, G.; Dreizler, S.; Ofir, A.; Rojas, P. A. P.; Ribas, I.; Rojo, P.; Kipping, D.; Butler, R. P.; **Amado, P. J.**; **Rodríguez-López, C.**; Kempton, E. M.-R.; Palle, E.; Murgas, F.
 "Proxima Centauri b is not a transiting exoplanet", Monthly Notices of the Royal Astronomical Society, p. 268-274 (2019)
 DOI: 10.1093/mnras/stz1268
113. Jia, Siyao; Lu, Jessica R.; Sakai, S.; Gautam, A. K.; Do, T.; Hosek, M. W., Jr.; Service, M.; Ghez, A. M.; **Gallego-Cano, E.**; **Schödel, R.**; Hees, Aurelien; Morris, M. R.; Becklin, E.; Matthews, K.
 "The Galactic Center: Improved Relative Astrometry for Velocities, Accelerations, and Orbits near the Supermassive Black Hole", Astrophysical Journal, Vol. 873, p. 9 (2019)
 DOI: 10.3847/1538-4357/ab01de
114. **Jiménez-Teja, Y.**; **Dupke, R. A.**; Lopes de Oliveira, R.; Xavier, H. S.; Coelho, P. R. T.; Chies-Santos, A. L.; López-Sanjuan, C.; Alvarez-Candal, A.; Costa-Duarte, M. V.; Telles, E.; Hernandez-Jimenez, J. A.; **Benítez, N.**; Alcaniz, J.; Cenarro, J.; Cristóbal-Hornillos, D.; Ederoclite, A.; Marín-Franch, A.; Mendes de Oliveira, C.; Moles, M.; Sodr e, L.; Varela, J.; Vázquez Rami o, H.
 "J-PLUS: Analysis of the intracluster light in the Coma cluster", Astronomy and Astrophysics, Vol. 622, p. A183 (2019)
 DOI: 10.1051/0004-6361/201833547
115. **Jones, M. G.**; **Verdes-Montenegro, L.**; **Damas-Segovia, A.**; Borthakur, S.; Yun, M.; **del Olmo, A.**; **Perea, J.**; **Román, J.**; **Luna, S.**; Lopez Gutierrez, D.; Williams, B.;

- Vogt, F. P. A.; **Garrido, J.**; **Sanchez, S.**; Cannon, J.; **Ramírez-Moreta, P.**
 "Evolution of compact groups from intermediate to final stages. A case study of the H I content of HCG 16", *Astronomy and Astrophysics*, Vol. 632, p. A78 (2019)
 DOI: 10.1051/0004-6361/201936349
116. Jullo, E.; de la Torre, S.; Cousinou, M. -C.; Escoffier, S.; Giocoli, C.; Metcalf, R. B.; Comparat, J.; Shan, H. -Y.; Makler, M.; Kneib, J. -P.; **Prada, F.**; Yepes, G.; Gottlöber, S.
 "Testing gravity with galaxy-galaxy lensing and redshift-space distortions using CFHT-Stripe 82, CFHTLenS, and BOSS CMASS datasets", *Astronomy and Astrophysics*, Vol. 627, p. A137 (2019)
 DOI: 10.1051/0004-6361/201834629
117. **Kann, D. A.**, et al
 "Highly luminous supernovae associated with gamma-ray bursts. I. GRB 111209A/SN 2011kl in the context of stripped-envelope and superluminous supernovae", *Astronomy and Astrophysics*, Vol. 624, p. A143 (2019)
 DOI: 10.1051/0004-6361/201629162
118. Kim, J. -Y.; Krichbaum, T. P.; Marscher, A. P.; Jorstad, S. G.; **Agudo, I.**; Thum, C.; Hodgson, J. A.; MacDonald, N. R.; Ros, E.; Lu, R. -S.; Bremer, M.; de Vicente, P.; Lindqvist, M.; Trippe, S.; Zensus, J. A.
 "Spatially resolved origin of millimeter-wave linear polarization in the nuclear region of 3C 84", *Astronomy and Astrophysics*, Vol. 622, p. A196 (2019)
 DOI: 10.1051/0004-6361/201832920
119. Klimenko V.V., Klimenko M.V., Bessarab F.S., Sukhodolov T.V., Koren'kov Y.N., **Funke B.**, Rozanov E.V.
 "Global EAGLE Model as a Tool for Studying the Influence of the Atmosphere on the Electric Field in the Equatorial Ionosphere", *Russian Journal of Physical Chemistry B*, Vol. 13.0, p. 720-726 (2019)
 DOI: 10.1134/S1990793119040079
120. Klimenko, M. V.; Klimenko, V. V.; Bessarab, F. S.; Sukhodolov, T. V.; Vasilev, P. A.; Karpov, I. V.; Korenkov, Y. N.; Zakharenkova, I. E.; **Funke, B.**; Rozanov, E. V.
 "Identification of the mechanisms responsible for anomalies in the tropical lower thermosphere/ionosphere caused by the January 2009 sudden stratospheric warming", *Journal of Space Weather and Space Climate*, Vol. 9, p. A39 (2019)
 DOI: 10.1051/swsc/2019037
121. Klose, S.; Schmidl, S.; **Kann, D. A.**; Nicuesa Guelbenzu, A.; Schulze, S.; Greiner, J.; Olivares E., F.; Krühler, T.; Schady, P.; Afonso, P. M. J.; Filgas, R.; Fynbo, J. P. U.; Rau, A.; Rossi, A.; Takats, K.; Tanga, M.; Updike, A. C.; Varela, K.
 "Four GRB supernovae at redshifts between 0.4 and 0.8. The bursts GRB 071112C, 111228A, 120714B, and 130831A", *Astronomy and Astrophysics*, Vol. 622, p. A138 (2019)
 DOI: 10.1051/0004-6361/201832728
122. Klypin, A.; **Prada, F.**
 "Effects of long-wavelength fluctuations in large galaxy surveys", *Monthly Notices of the Royal Astronomical Society*, p. 1684-1696 (2019)
 DOI: 10.1093/mnras/stz2194
123. Korabiev O., et al. (includes **López-Moreno J.-J.**, **Funke B.**, **García-Comas M.**, **González-Galindo F.**, **López-Puertas M.**, **López-Valverde M.**, **Martin-Torres J.**), The ACS and NOMAD Science Teams
 "No detection of methane on Mars from early ExoMars Trace Gas Orbiter observations", *Nature*, p. 517-520 (2019)
 DOI: 10.1038/s41586-019-1096-4
124. Kubátová, B.; Szécsi, D.; Sander, A. A. C.; Kubát, J.; Tramper, F.; Krtička, J.; **Kehrig, C.**; Hamann, W. -R.; Hainich, R.; Shenar, T.
 "Low-metallicity massive single stars with rotation. II. Predicting spectra and spectral classes of chemically homogeneously evolving stars", *Astronomy and Astrophysics*, Vol. 623, p. A8 (2019)
 DOI: 10.1051/0004-6361/201834360
125. Kundu, E.; Lundqvist, P.; Sorokina, E.; **Pérez-Torres, M. A.**; Blinnikov, S.; O'Connor, E.; Ergon, M.; Chandra, P.; Das, B.
 "Evolution of the Progenitors of SNe 1993J and 2011dh Revealed through Late-time Radio and X-Ray Studies", *Astrophysical Journal*, Vol. 875, p. 17 (2019)
 DOI: 10.3847/1538-4357/ab0d81
126. Lai, I. -L. et al. (includes **Gutiérrez, P. J.**; **Lara, L. M.**; **López-Moreno, J. J.**)
 "Seasonal variations in source regions of the dust jets on comet 67P/Churyumov-Gerasimenko", *Astronomy and Astrophysics*, Vol. 630, p. A17 (2019)
 DOI: 10.1051/0004-6361/201732094
127. Lalitha, S. et al. (includes **Bauer, F. F.**; **Amado, P. J.**; **López-González, M. J.**; **Rodríguez, E.**; **Rodríguez-López, C.**)
 "The CARMENES search for exoplanets around M dwarfs. Detection of a mini-Neptune around LSPM

J2116+0234 and refinement of orbital parameters of a super-Earth around GJ 686 (BD+18 3421)", *Astronomy and Astrophysics*, Vol. 627, p. A116 (2019)
DOI: 10.1051/0004-6361/201935534

128. Lamb, G. P. et al. (includes **de Ugarte Postigo, A.; Izzo, L.; Kann, D. A.; Thöne, C. C.**;) "Short GRB 160821B: A Reverse Shock, a Refreshed Shock, and a Well-sampled Kilonova", *Astrophysical Journal*, Vol. 883, p. 48 (2019)
DOI: 10.3847/1538-4357/ab38bb

129. **Lara L.M.**, Rodrigo R., Moreno R., **Lampón M.** "Analysis of the origin of water, carbon monoxide, and carbon dioxide in the Uranus atmosphere", *Astronomy and Astrophysics*, Vol. 621, Number A129, p. A129 (2019)
DOI: 10.1051/0004-6361/201732123

130. Lellouch, E.; Gurwell, M. A.; Moreno, R.; Vinatier, S.; Strobel, D. F.; Moullet, A.; Butler, B.; **Lara, L.**; Hidayat, T.; Villard, E. "An intense thermospheric jet on Titan", *Nature Astronomy*, p. 614-619 (2019)
DOI: 10.1038/s41550-019-0749-4

131. Li X., Lu G., Fan Y., Jiang R., Zhang H., **Li D.**, Liu M., Wang Y., Ren H. "Underground Measurement of Magnetic Field Pulses During the Early Stage of Rocket-Triggered Lightning", *Journal of Geophysical Research D: Atmospheres*, p. 3168-3179 (2019)
DOI: 10.1029/2018JD029682

132. **Li, D., Luque, A.**, Rachidi, F., Rubinstein, M., Azadifar, M., Diendorfer, G., Pichler, H. "The Propagation Effects of Lightning Electromagnetic Fields Over Mountainous Terrain in the Earth-Ionosphere Waveguide", *Journal of Geophysical Research D: Atmospheres*, Vol. 124, Issue 24, p. 14198-14219 (2019)
DOI: 10.1029/2018JD030014

133. Li, Zongnan; Li, Zhiyuan; Zhou, Ping; Gao, Yu; Jiang, Xue-Jian; **Dong, Hui** "JCMT Mapping of CO(3-2) in the Circumnuclear Region of M31", *Monthly Notices of the Royal Astronomical Society*, p. 43 (2019)
DOI: 10.1093/mnras/stz040

134. Lillis R.J., Fillingim M.O., Ma Y., **Gonzalez-Galindo F.**, Forget F., Johnson C.L., Mittelholz A., Russell C.T., Andersson L., Fowler C.M.

"Modeling Wind-Driven Ionospheric Dynamo Currents at Mars: Expectations for InSight Magnetic Field Measurements", *Geophysical Research Letters*, p. 5083-5091 (2019)
DOI: 10.1029/2019GL082536

135. Liuzzi G., Villanueva G.L., Mumma M.J., Smith M.D., Daerden F., Ristic B., Thomas I., Vandaele A.C., Patel M.R., **Lopez-Moreno J.-J.**, Bellucci G., the NOMAD team "Methane on Mars: New insights into the sensitivity of CH₄ with the NOMAD/ExoMars spectrometer through its first in-flight calibration", *Icarus*, Vol. 321, p. 671-690 (2019)
DOI: 10.1016/j.icarus.2018.09.021

136. Logroño-García, R. et al. (includes **González Delgado, R. M.**) "J-PLUS: Measuring H α emission line fluxes in the nearby universe ", *Astronomy and Astrophysics*, Vol. 622, p. A180 (2019)
DOI: 10.1051/0004-6361/201732487

137. López-Casado C., Pérez-del-Pulgar C., Muñoz V.F., **Castro-Tirado A.J.** "Observation scheduling and simulation in a global telescope network", *Future Generation Computer Systems*, Vol. 95, p. 116-125 (2019)
DOI: 10.1016/j.future.2018.12.066

138. López-Cobá, C.; Sánchez, S. F.; Bland-Hawthorn, J.; Moiseev, A. V.; Cruz-González, I.; **García-Benito, R.**; Barrera-Ballesteros, J. K.; Galbany, L. "Systematic study of outflows in the Local Universe using CALIFA: I. Sample selection and main properties", *Monthly Notices of the Royal Astronomical Society*, Vol. 482, p. 4032-4056 (2019)
DOI: 10.1093/mnras/sty2960

139. López-Sanjuan, C.; Díaz-García, L. A.; Cenarro, A. J.; Fernández-Soto, A.; Viironen, K.; **Molino, A.; Benítez, N.**; Cristóbal-Hornillos, D.; Moles, M.; Varela, J.; Arnalte-Mur, P.; Ascaso, B.; Castander, F. J.; **Cerviño, M.; González Delgado, R. M.; Husillos, C.; Márquez, I.; Masegosa, J.; Del Olmo, A.; Pović, M.; Perea, J.** "The ALHAMBRA survey: tight dependence of the optical mass-to-light ratio on galaxy colour up to $z = 1.5$ ", *Astronomy and Astrophysics*, Vol. 622, p. A51 (2019)
DOI: 10.1051/0004-6361/201833402

140. López-Sanjuan, C. et al. (includes **Alfaro, E.; Vílchez, J. M. Alcaniz, J.**)

- "J-PLUS: photometric calibration of large-area multi-filter surveys with stellar and white dwarf loci", *Astronomy and Astrophysics*, Vol. 631, p. A119 (2019)
DOI: 10.1051/0004-6361/201936405
141. **Lorenzo-Gutiérrez, A.; Alfaro, E. J.**; Apellániz, J. Maíz; Barbá, R. H.; Marín-Franch, A.; Ederoclite, A.; Cristóbal-Hornillos, D.; Varela, J.; Vázquez Ramió, H.; Cenarro, J.; Lennon, D. J.; García-Lario, P.
"The Galante Photometric System", *Monthly Notices of the Royal Astronomical Society*, p. 966-980 (2019)
DOI: 10.1093/mnras/stz842
142. Lossow, S. et al. (includes **García-Comas, M.**)
"The SPARC water vapour assessment II: profile-to-profile comparisons of stratospheric and lower mesospheric water vapour data sets obtained from satellites", *Atmospheric Measurement Techniques*, Vol. 12, p. 2693-2732 (2019)
DOI: 10.5194/amt-12-2693-2019
143. Lucchetti A. et al. (includes **Gutiérrez P., Lara L., Moreno J.L.**)
"The Rocky-Like Behavior of Cometary Landslides on 67P/Churyumov-Gerasimenko", *Geophysical Research Letters*, Vol. 46, Issue 24, p. 14336-14346 (2019)
DOI: 10.1029/2019GL085132
144. Luque, R. et al. (includes **Bauer, F.; Amado, P. J.**)
"Detection and characterization of an ultra-dense sub-Neptunian planet orbiting the Sun-like star K2-292", *Astronomy and Astrophysics*, Vol. 623, p. A114 (2019)
DOI: 10.1051/0004-6361/201834952
145. Luque, R. et al. (includes **Rodríguez-López, C.; Amado, P. J.; Bauer, F. F.**)
"Planetary system around the nearby M dwarf GJ 357 including a transiting, hot, Earth-sized planet optimal for atmospheric characterization", *Astronomy and Astrophysics*, Vol. 628, p. A39 (2019)
DOI: 10.1051/0004-6361/201935801
146. Macías, E.; Espaillet, C. C.; **Osorio, M.; Anglada, G.**; Torrelles, J. M.; Carrasco-González, C.; Flock, M.; Linz, H.; Bertrang, G. H. -M.; Henning, T.; **Gómez, J. F.**; Calvet, N.; Dent, W. R. F.
"Characterization of Ring Substructures in the Protoplanetary Disk of HD 169142 from Multiwavelength Atacama Large Millimeter/submillimeter Array Observations", *Astrophysical Journal*, Vol. 881, p. 159 (2019)
DOI: 10.3847/1538-4357/ab31a2
147. Madiedo, J. M.; **Ortiz, J. L.; Morales, N.; Santos-Sanz, P.**
"Multiwavelength observations of a bright impact flash during the 2019 January total lunar eclipse", *Monthly Notices of the Royal Astronomical Society*, Vol. 486, p. 3380-3387 (2019)
DOI: 10.1093/mnras/stz932
148. MAGIC Collaboration; Acciari, V. A. et al. (includes **Agudo, I.**)
"A fast, very-high-energy γ -ray flare from BL Lacertae during a period of multi-wavelength activity in June 2015", *Astronomy and Astrophysics*, Vol. 623, p. A175 (2019)
DOI: 10.1051/0004-6361/201834010
149. Mahoro, A.; **Pović, M.**; Nkundabakura, P.; Nyiransengiyumva, B.; Väisänen, P.
"Star formation in far-IR AGN and non-AGN galaxies in the green valley. II. Morphological analysis", *Monthly Notices of the Royal Astronomical Society*, p. 452-463 (2019)
DOI: 10.1093/mnras/stz434
150. Maíz Apellániz, J.; Trigueros Páez, E.; Negueruela, I.; Barbá, R. H.; Simón-Díaz, S.; Lorenzo, J.; **Sota, A.**; Gamen, R. C.; Fariña, C.; Salas, J.; Caballero, J. A.; Morrell, N. I.; Pellerin, A.; **Alfaro, E. J.**; Herrero, A.; Arias, J. I.; Marco, A.
"MONOS: Multiplicity Of Northern O-type Spectroscopic systems. I. Project description and spectral classifications and visual multiplicity of previously known objects", *Astronomy and Astrophysics*, Vol. 626, p. A20 (2019)
DOI: 10.1051/0004-6361/201935359
151. **Malagón-Romero A., Luque A.**
"Spontaneous Emergence of Space Stems Ahead of Negative Leaders in Lightning and Long Sparks", *Geophysical Research Letters*, p. 4029-4038 (2019)
DOI: 10.1029/2019GL082063
152. **Malagón-Romero A., Pérez-Invernón F.J., Luque A., Gordillo-Vázquez F.J.**
"Analysis of the Spatial Nonuniformity of the Electric Field in Spectroscopic Diagnostic Methods of Atmospheric Electricity Phenomena", *Journal of Geophysical Research D: Atmospheres*, p. 12356-12370 (2019)
DOI: 10.1029/2019JD030945

153. Marciniak, A. et al. (includes **Duffard, R.**)
 "Thermal properties of slowly rotating asteroids: results from a targeted survey", *Astronomy and Astrophysics*, Vol. 625, p. A139 (2019)
 DOI: 10.1051/0004-6361/201935129
154. Martínez-García S., Lopez-Colino F., Garrido J., Glez-De-Rivera G., **Sanchez J., Prada F.**
 "Comparison of communication architectures for a fiber-positioning spectrograph", *Journal of Astronomical Telescopes, Instruments, and Systems*, Vol. 5.0, Number 014007 (2019)
 DOI: 10.1117/1.JATIS.5.1.014007
155. Marziani P., Bon E., Bon N., **del Olmo A., Martínez-Aldama M.L., D'Onofrio M., Dultzin D., Alenka Negrete C., Stirpe G.M.**
 "Quasars: From the physics of line formation to cosmology", *Atoms*, Vol. 7.0, Number 18 (2019)
 DOI: 10.3390/atoms7010018
156. Marziani, P.; **del Olmo, A.**; Martínez-Carballo, M. A.; Martínez-Aldama, M. L.; Stirpe, G. M.; Negrete, C. A.; Dultzin, D.; D'Onofrio, M.; Bon, E.; Bon, N.
 "Black hole mass estimates in quasars. A comparative analysis of high- and low-ionization lines", *Astronomy and Astrophysics*, Vol. 627, p. A88 (2019)
 DOI: 10.1051/0004-6361/201935265
157. Masoumzadeh, N. et al. (includes **Gutiérrez, P. J.; Lara, L. M.; López-Moreno, J. J.**)
 "Phase-curve analysis of comet 67P/Churyumov-Gerasimenko at small phase angles", *Astronomy and Astrophysics*, Vol. 630, p. A11 (2019)
 DOI: 10.1051/0004-6361/201834845
158. Matonti C., et al. (includes **Gutiérrez, P. J.; Lara, L. M.; López-Moreno, J. J.**)
 "Bilobate comet morphology and internal structure controlled by shear deformation", *Nature Geoscience*, p. 157 (2019)
 DOI: 10.1038/s41561-019-0307-9
159. Melandri, A. et al. (includes **Izzo, L.; de Ugarte Postigo, A.; Cano, Z.; Kann, D. A.; Thöne, C. C.**)
 "GRB 171010A / SN 2017htp: a GRB-SN at $z=0.33$ ", *Monthly Notices of the Royal Astronomical Society*, p. 2495 (2019)
 DOI: 10.1093/mnras/stz2900
160. Melandri, A. et al. (includes **Castro-Tirado, A. J.; Hu, Y. -D.; Della Valle, M.**)
 "Unveiling the enigma of ATLAS17aeu", *Astronomy and Astrophysics*, Vol. 621, p. A81 (2019)
 DOI: 10.1051/0004-6361/201833814
161. Mendes de Oliveira, C. et al. (includes **Cano, Z.; Izzo, L.; Kann, D. A.; Thöne, C.; de Ugarte Postigo, A.**)
 "The Southern Photometric Local Universe Survey (S-PLUS): improved SEDs, morphologies and redshifts with 12 optical filters", *Monthly Notices of the Royal Astronomical Society*, p. 2048 (2019)
 DOI: 10.1093/mnras/stz1985
162. Meza, E. et al. (includes **Ortiz, J. L.; Tirado, A. Castro; Duffard, R.; Morales, N.; Santos-Sanz, P.**)
 "Lower atmosphere and pressure evolution on Pluto from ground-based stellar occultations, 1988-2016", *Astronomy and Astrophysics*, Vol. 625, p. A42 (2019)
 DOI: 10.1051/0004-6361/201834281
163. Michałowski, Michał J.; Kamphuis, P.; Hjorth, J.; **Kann, D. A.; de Ugarte Postigo, A.**; Galbany, L.; Fynbo, J. P. U.; Ghosh, A.; Hunt, L. K.; Kuncarayakti, H.; Le Floch, E.; Leśniewska, A.; Misra, K.; Nicuesa Guelbenzu, A.; Palazzi, E.; Rasmussen, J.; Resmi, L.; Rossi, A.; Savaglio, S.; Schady, P.; Schulze, S.; **Thöne, C. C.**; Watson, D.; Józsa, G. I. G.; Serra, P.; Smirnov, O. M.
 "Nature of the unusual transient AT 2018cow from HI observations of its host galaxy", *Astronomy and Astrophysics*, Vol. 627, p. A106 (2019)
 DOI: 10.1051/0004-6361/201935372
164. Mignoli, M.; Feltre, A.; Bongiorno, A.; Calura, F.; Gilli, R.; Vignali, C.; Zamorani, G.; Lilly, S. J.; Le Fèvre, O.; Bardelli, S.; Bolzonella, M.; Bordoloi, R.; Le Brun, V.; Caputi, K. I.; Cimatti, A.; Diener, C.; Garilli, B.; Koekemoer, A. M.; Maier, C.; Mainieri, V.; Peng, Y.; **Pérez Montero, E.**; Silverman, J. D.; Zucca, E.
 "Obscured AGN at $1.5 < z < 3.0$ from the zCOSMOS-deep Survey . I. Properties of the emitting gas in the narrow-line region", *Astronomy and Astrophysics*, Vol. 626, p. A9 (2019)
 DOI: 10.1051/0004-6361/201935062
165. **Molino, A.** et al. (includes **Sampedro, L.; Benítez, N.**)
 "J-PLUS: On the identification of new cluster members in the double galaxy cluster A2589 and A2593 using PDFs", *Astronomy and Astrophysics*, Vol. 622, p. A178 (2019)
 DOI: 10.1051/0004-6361/201731348
166. Moral-Castro, I. del; García-Lorenzo, B.; Almeida, C. Ramos; Ruiz-Lara, T.; Falcón-Barroso, J.; Sánchez, S. F.; Sánchez-Blázquez, P.; **Márquez, I.; Masegosa, J.**

"Spotting the differences between active and non-active twin galaxies on kpc-scales. A pilot study.", *Monthly Notices of the Royal Astronomical Society*, p. 3794-3815 (2019)

DOI: 10.1093/mnras/stz637

167. Morales J.C., et al. (includes **Bauer F.F., Rodríguez E., López-González M.J., Rodríguez-López C., Amado P.J., Abril M., Aceituno J., Aceituno F.J., Antona R., Becerril-Jarque S., Berdiñas Z.M., Calvo-Ortega R., Casal E., Casanova V., Claret A., Fernández M., Ferro I.M., Lampón M., Lara L.M., Magán Madinabeitia H., Martín-Ruiz S., Mirabet E., Pascual J., Pérez Medialdea D., Rabaza O., Ramón Ballesta A., Rodríguez Trinidad A., Sánchez Carrasco M.A., Sánchez-López A., Sota A., Suárez J.C.**)

"A giant exoplanet orbiting a very-low-mass star challenges planet formation models", *Science*, Vol. 365.0, p. 1441-1445 (2019)

DOI: 10.1126/science.aax3198

168. **Moreno, F.**; Jehin, E.; Licandro, J.; Ferrais, M.; Moulane, Y.; Pozuelos, F. J.; Manfroid, J.; Devogèle, M.; Benkhaldoun, Z.; Moskovitz, N.; Popescu, M.; Serracart, M.; Cabrera-Lavers, A.; Monelli, M.

"Dust properties of double-tailed active asteroid (6478) Gault", *Astronomy and Astrophysics*, Vol. 624, p. L14 (2019)

DOI: 10.1051/0004-6361/201935526

169. Mostajabi A., **Li D.**, Azadifar M., Rachidi F., Rubinstein M., Diendorfer G., Schulz W., Pichler H., Rakov V.A., Pavanello D.

"Analysis of a bipolar upward lightning flash based on simultaneous records of currents and 380-km distant electric fields", *Electric Power Systems Research*, Vol. 174.0, Number 105845 (2019)

DOI: 10.1016/j.epsr.2019.04.023

170. Müller T., Kiss C., Alí-Lagoa V., **Ortiz J.L.**, Lellouch E., **Santos-Sanz P.**, Fornasier S., Marton G., Mommert M., Farkas-Takács A., Thirouin A., Vilenius E.

"Haumea's thermal emission revisited in the light of the occultation results", *Icarus*, Vol. 334.0, p. 39-51 (2019)

DOI: 10.1016/j.icarus.2018.11.011

171. Mužić, K.; Scholz, A.; Peña Ramírez, K.; Jayawardhana, R.; **Schödel, R.**; Geers, V. C.; Cieza, L. A.; Bayo, A.

"Looking Deep into the Rosette Nebula's Heart: The (Sub)stellar Content of the Massive Young Cluster NGC 2244", *Astrophysical Journal*, Vol. 881, p. 79 (2019)

DOI: 10.3847/1538-4357/ab2da4

172. Nagel, E. et al. (includes **Rodríguez, E.; Amado, P. J.; Aceituno, J.; López-González, M. J.; Rodríguez-López, C.**)

"The CARMENES search for exoplanets around M dwarfs. The enigmatic planetary system GJ 4276: one eccentric planet or two planets in a 2:1 resonance?", *Astronomy and Astrophysics*, Vol. 622, p. A153 (2019)

DOI: 10.1051/0004-6361/201834569

173. Neumann J., Gadotti D.A., Wisotzki L., Husemann B., Busch G., Combes F., Croom S.M., Davis T.A., Gaspari M., Krumpke M., **Pérez-Torres M.A.**, Scharwächter J., Smirnova-Pinchukova I., Tremblay G.R., Urrutia T.

"The Close AGN Reference Survey (CARS): Comparative analysis of the structural properties of star-forming and non-star-forming galaxy bars", *Astronomy and Astrophysics*, Vol. 627.0, Number A26, p. A26 (2019)

DOI: 10.1051/0004-6361/201834441

174. Nigro, C.; Deil, C.; Zanin, R.; Hassan, T.; King, J.; **Ruiz, J. E.**; Saha, L.; Terrier, R.; Brügge, K.; Nöthe, M.; Bird, R.; Lin, T. T. Y.; Aleksić, J.; Boisson, C.; Contreras, J. L.; Donath, A.; Jouvin, L.; Kelley-Hoskins, N.; Khelifi, B.; Kosack, K.; Rico, J.; Sinha, A.

"Towards open and reproducible multi-instrument analysis in gamma-ray astronomy", *Astronomy and Astrophysics*, Vol. 625, p. A10 (2019)

DOI: 10.1051/0004-6361/201834938

175. Nishikawa K.-I., Mizuno Y., **Gómez J.L.**, Dutan I., Meli A., Niemiec J., Kobzar O., Pohl M., Sol H., MacDonald N., Hartmann D.H.

"Relativistic jet simulations of the weibel instability in the slab model to cylindrical jets with helical magnetic fields", *Galaxies*, Vol. 7.0, Number 29 (2019)

DOI: 10.3390/galaxies7010029

176. Noda, C. Quintero; Iijima, H.; Katsukawa, Y.; Shimizu, T.; Carlsson, M.; de la Cruz Rodríguez, J.; Cobo, B. Ruiz; **Suárez, D. Orozco**; Oba, T.; Anan, T.; Kubo, M.; Kawabata, Y.; Ichimoto, K.; Suematsu, Y.

"Chromospheric polarimetry through multi-line observations of the 850 nm spectral region III: Chromospheric jets driven by twisted magnetic fields", *Monthly Notices of the Royal Astronomical Society*, p. 4203-4215 (2019)

DOI: 10.1093/mnras/stz1124

177. **Nogueras-Lara, F.; Schödel, R.; Gallego-Calvente, A. T.; Dong, H.; Gallego-Cano, E.; Shahzamanian, B.**; Girard, J. H. V.; Nishiyama, S.; Najarro, F.; Neumayer, N.

"GALACTICNUCLEUS: A high-angular-resolution JHKs imaging survey of the Galactic centre. II. First data

release of the catalogue and the most detailed CMDs of the GC", *Astronomy and Astrophysics*, Vol. 631, p. A20 (2019)

DOI: 10.1051/0004-6361/201936263

178. **Nogueras-Lara, F.; Schödel, R.;** Najarro, F.; **Gallego-Calvente, A. T.; Gallego-Cano, E.; Shahzamanian, B.;** Neumayer, N.

"Variability of the near-infrared extinction curve towards the Galactic centre", *Astronomy and Astrophysics*, Vol. 630, p. L3 (2019)

DOI: 10.1051/0004-6361/201936322

179. **Oates, S. R.;** Motta, S.; Beardmore, A. P.; Russell, D. M.; Gandhi, P.; Kuin, N. P. M.; De Pasquale, M.; Altamirano, D.; Breeveld, A. A.; **Castro-Tirado, A. J.;** Knigge, C.; Page, M. J.; Steeghs, D.

"Swift UVOT observations of the 2015 outburst of V404 Cygni", *Monthly Notices of the Royal Astronomical Society*, p. 1940 (2019)

DOI: 10.1093/mnras/stz1998

180. Obuljen, Andrej; Alonso, David; Villaescusa-Navarro, Francisco; Yoon, Ilsang; **Jones, Michael**

"The HI content of dark matter halos at $z \approx 0$ from ALFALFA", *Monthly Notices of the Royal Astronomical Society*, p. 5124-5138 (2019)

DOI: 10.1093/mnras/stz1118

181. Orosz, G., **Gómez, J.F.,** Imai, H., Tafoya, D., Torrelles, J.M., Burns, R.A., Frau, P., **Guerrero, M.A.,** **Miranda, L.F.,** **Perez-Torres, M.A.,** Ramos-Larios, G., Rizzo, J.R., Suárez, O., Uscanga, L.

"Rapidly evolving episodic outflow in IRAS 18113-2503: Clues to the ejection mechanism of the fastest water fountain", *Monthly Notices of the Royal Astronomical Society*, Vol. 482, p. L40-L45 (2019)

DOI: 10.1093/mnras/sly177

182. Ortiz, R.; **Guerrero, M. A.;** Costa, R. D. D.

"Ultraviolet and optical spectroscopy of AGB stars showing UV excess", *Monthly Notices of the Royal Astronomical Society*, Vol. 482, p. 4697-4712 (2019)

DOI: 10.1093/mnras/sty3076

183. O'Donoghue, A. A.; Haynes, M. P.; Koopmann, R. A.; **Jones, M. G.;** Giovanelli, R.; Balonek, T. J.; Craig, D. W.; Hallenbeck, G. L.; Hoffman, G. L.; Kornreich, D. A.; Leisman, L.; Miller, J. R.

"The Arecibo Pisces-Perseus Supercluster Survey. I. Harvesting ALFALFA", *Astronomical Journal*, Vol. 157, p. 81 (2019)

DOI: 10.3847/1538-3881/aaf890

184. Pajola, M. et al. (includes **Gutierrez, P. J.; Lara, L. M.; Lopez Moreno, J. J.**)

"Multidisciplinary analysis of the Hapi region located on Comet 67P/Churyumov-Gerasimenko", *Monthly Notices of the Royal Astronomical Society*, Vol. 485, p. 2139-2154 (2019)

DOI: 10.1093/mnras/stz446

185. Palle, E. et al. (includes **Amado, P. J.**)

"Detection and Doppler monitoring of K2-285 (EPIC 246471491), a system of four transiting planets smaller than Neptune", *Astronomy and Astrophysics*, Vol. 623, p. A41 (2019)

DOI: 10.1051/0004-6361/201834001

186. Pandey, S. B.; **Hu, Y.; Castro-Tirado, A. J. et al. (Sánchez-Ramírez, R.; Gorosabel, J.; Guziy, S.; Jelinek, M.; Tello, J. C.; Jeong, S.; Oates, S. R.; Zhang, B. -B.; Caballero-García, M. D.; Ayala, A.)**

"A multi-wavelength analysis of a collection of short-duration GRBs observed between 2012-2015", *Monthly Notices of the Royal Astronomical Society*, p. 5294-5318 (2019)

DOI: 10.1093/mnras/stz530

187. **Passas-Varo M., Sánchez J., Kieu T.N.,** Sánchez-Blanco E., **Gordillo-Vázquez F.J.**

"Galios: An ultrafast imaging spectrograph for the study of lightning", *Applied Optics*, Vol. 58.0, p. 8002-8006 (2019)

DOI: 10.1364/AO.58.008002

188. Passegger, V. M. et al. (includes **Amado, P. J.; Bauer, F. F.**)

"The CARMENES search for exoplanets around M dwarfs. Photospheric parameters of target stars from high-resolution spectroscopy. II. Simultaneous multiwavelength range modeling of activity insensitive lines", *Astronomy and Astrophysics*, Vol. 627, p. A161 (2019)

DOI: 10.1051/0004-6361/201935679

189. Pastorello, A. et al. (includes **Cano, Z.; Kann, D. A.; de Ugarte Postigo, A.; Izzo, L.; Thöne, C. C.**)

"The evolution of luminous red nova AT 2017jfs in NGC 4470", *Astronomy and Astrophysics*, Vol. 625, p. L8 (2019)

DOI: 10.1051/0004-6361/201935511

190. Pastorello, A. et al. (includes **Cano, Z.; de Ugarte Postigo, A.; Kann, D. A.; Thöne, C. C.**)

- "A luminous stellar outburst during a long-lasting eruptive phase first, and then SN IIn 2018cnf", *Astronomy and Astrophysics*, Vol. 628, p. A93 (2019)
DOI: 10.1051/0004-6361/201935420
191. Pauwels J., Le Viol I., Azam C., Valet N., Julien J.-F., Bas Y., Lemarchand C., **Sanchez de Miguel A.**, Kerbiriou C.
"Accounting for artificial light impact on bat activity for a biodiversity-friendly urban planning", *Landscape and Urban Planning*, Vol. 183, p. 12-25 (2019)
DOI: 10.1016/j.landurbplan.2018.08.030
192. Peiřker, F.; Zajaček, M.; Eckart, A.; Sabha, N. B.; **Shahzamanian, B.**; Parsa, M.
"New bow-shock source with bipolar morphology in the vicinity of Sgr A*", *Astronomy and Astrophysics*, Vol. 624, p. A97 (2019)
DOI: 10.1051/0004-6361/201834947
193. **Pérez-Invernón F.J.**, **Gordillo-Vázquez F.J.**, Smith A.K., Arnone E., Winkler H.
"Global Occurrence and Chemical Impact of Stratospheric Blue Jets Modeled With WACCM4", *Journal of Geophysical Research D: Atmospheres*, p. 2841-2864 (2019)
DOI: 10.1029/2018JD029593
194. **Pérez-Montero, E.**; Dors, O. L.; **Vílchez, J. M.**; **García-Benito, R.**; Cardaci, M. V.; Hägele, G. F.
"A bayesian-like approach to derive chemical abundances in type-2 active galactic nuclei based on photoionization models", *Monthly Notices of the Royal Astronomical Society*, Vol. 489, p. 2652-2668 (2019)
DOI: 10.1093/mnras/stz2278
195. **Pérez-Montero, E.**; **García-Benito, R.**; **Vílchez, J. M.**
"Revisiting the hardening of the stellar ionizing radiation in galaxy discs", *Monthly Notices of the Royal Astronomical Society*, Vol. 483, p. 3322-3335 (2019)
DOI: 10.1093/mnras/sty3330
196. Perger, M. et al. (includes **Amado, P. J.**; **Bauer, F. F.**; **López-González, M. J.**; **Rodríguez, E.**; **Rodríguez-López, C.**)
"Gliese 49: activity evolution and detection of a super-Earth. A HADES and CARMENES collaboration", *Astronomy and Astrophysics*, Vol. 624, p. A123 (2019)
DOI: 10.1051/0004-6361/201935192
197. Petrov, P. P.; Grankin, K. N.; Gameiro, J. F.; Artemenko, S. A.; Babina, E. V.; Albuquerque, R. M. G. de; Djupvik, A. A.; Gahm, G. F.; Shenavrin, V. I.; Irsmbetova, T. R.; **Fernandez, M.**; Mkrtychian, D. E.; Gorda, S. Yu
"Dynamics of wind and the dusty environments in the accreting T Tauri stars RY Tauri and SU Aurigae", *Monthly Notices of the Royal Astronomical Society*, Vol. 483, p. 132-146 (2019)
DOI: 10.1093/mnras/sty3066
198. Pettit J.M., Randall C.E., Peck E.D., Marsh D.R., van de Kamp M., Fang X., Harvey V.L., Rodger C.J., **Funke B.**
"Atmospheric Effects of >30-keV Energetic Electron Precipitation in the Southern Hemisphere Winter during 2003", *Journal of Geophysical Research A: Space Physics*, p. 8138-8153 (2019)
DOI: 10.1029/2019JA026868
199. Piatti, A. E.; **Alfaro, E. J.**; Cantat-Gaudin, T.
"Two kinematically distinct old globular cluster populations in the Large Magellanic Cloud", *Monthly Notices of the Royal Astronomical Society*, Vol. 484, p. L19 (2019)
DOI: 10.1093/mnras/sty240
200. Pilyugin, L. S.; Grebel, E. K.; Zinchenko, I. A.; Nefedyev, Y. A.; **Vílchez, J. M.**
"Relations between abundance characteristics and rotation velocity for star-forming MaNGA galaxies", *Astronomy and Astrophysics*, Vol. 623, p. A122 (2019)
DOI: 10.1051/0004-6361/201834239
201. Porth, O. et al. (includes **Alberdi, A.**; **Fromm, C. M.**; **Gómez, J. L.**) (The Event Horizon Telescope Collaboration)
"The Event Horizon General Relativistic Magnetohydrodynamic Code Comparison Project", *Astrophysical Journal Supplement Series*, Vol. 243, p. 26 (2019)
DOI: 10.3847/1538-4365/ab29fd
202. Pravec P. et al. (includes **Ortiz J.L.**, **Morales N.**)
"Asteroid pairs: A complex picture", *Icarus*, Vol. 333.0, p. 429-463 (2019)
DOI: 10.1016/j.icarus.2019.05.014
203. Prisinzano, L. et al. (includes **Alfaro, E. J.**)
"The Gaia-ESO Survey: Age spread in the star forming region NGC 6530 from the HR diagram and gravity indicators", *Astronomy and Astrophysics*, Vol. 623, p. A159 (2019)
DOI: 10.1051/0004-6361/201834870
204. Raetz, St.; Heras, A. M.; Gondoin, P.; **Fernández, M.**; **Casanova, V.**; Schmidt, T. O. B.; Maciejewski, G.

- "CoRoT-18 b: Analysis of High-Precision Transit Light Curves with Starspot Features", *Acta Astronomica*, Vol. 69, p. 205-226 (2019)
DOI: 10.32023/0001-5237/69.3.1
205. Raetz, St; Heras, A. M.; **Fernández, M.**; **Casanova, V.**; Marka, C.
"Transit analysis of the CoRoT-5, CoRoT-8, CoRoT-12, CoRoT-18, CoRoT-20, and CoRoT-27 systems with combined ground- and space-based photometry", *Monthly Notices of the Royal Astronomical Society*, Vol. 483, p. 824-839 (2019)
DOI: 10.1093/mnras/sty3085
206. Raiteri, C. M. et al. (includes **Agudo, I.**; **Gómez, J. L.**; **Molina, S. N.**)
"The beamed jet and quasar core of the distant blazar 4C 71.07", *Monthly Notices of the Royal Astronomical Society*, p. 1837-1849 (2019)
DOI: 10.1093/mnras/stz2264
207. Ramón-Pérez, M.; Bongiovanni, Á.; Pérez García, A. M.; Cepa, J.; Lara-López, M. A.; de Diego, J. A.; **Alfaro, E.**; Castañeda, H. O.; **Cerviño, M.**; **Fernández-Lorenzo, M.**; Gallego, J.; González, J. J.; González-Serrano, J. I.; Nadolny, J.; Oteo Gómez, I.; Pérez Martínez, R.; Pintos-Castro, I.; **Pović, M.**; Sánchez-Portal, M.
"The OTELO survey. II. The faint-end of the H α luminosity function at $z \sim 0.40$ ", *Astronomy and Astrophysics*, Vol. 631, p. A10 (2019)
DOI: 10.1051/0004-6361/201833295
208. Ramón-Pérez, M.; Bongiovanni, Á.; Pérez García, A. M.; Cepa, J.; Nadolny, J.; Pintos-Castro, I.; Lara-López, M. A.; **Alfaro, E. J.**; Castañeda, H. O.; **Cerviño, M.**; de Diego, J. A.; **Fernández-Lorenzo, M.**; Gallego, J.; González, J. J.; González-Serrano, J. I.; Oteo Gómez, I.; Pérez Martínez, R.; **Pović, M.**; Sánchez-Portal, M.
"The OTELO survey. III. Demography, morphology, IR luminosity and environment of AGN hosts", *Astronomy and Astrophysics*, Vol. 631, p. A11 (2019)
DOI: 10.1051/0004-6361/201833296
209. Ren H., Tian Y., Lu G., Zhang Y., Fan Y., Jiang R., Liu M., **Li D.**, Li X., Qie X.
"Examining the influence of current waveform on the lightning electromagnetic field at the altitude of halo formation", *Journal of Atmospheric and Solar-Terrestrial Physics*, Vol. 189.0, p. 114-122 (2019)
DOI: 10.1016/j.jastp.2019.04.010
210. Rodríguez Del Pino, Bruno; Arribas, Santiago; Piqueras López, Javier; Crespo Gómez, Alejandro; **Vílchez, José M.**
"Extreme gas kinematics in an off-nuclear HII region of SDSS J143245.98+404300.3", *Astronomy and Astrophysics*, Vol. 630, p. A124 (2019)
DOI: 10.1051/0004-6361/201936140
211. **Rodríguez-Lopez, Cristina**
"The Quest for Pulsating M Dwarf Stars", *Frontiers in Astronomy and Space Sciences*, Vol. 6, p. A76 (2019)
DOI: 10.3389/fspas.2019.00076
212. Roeten K.J., Bougher S.W., Benna M., Mahaffy P.R., Lee Y., Pawlowski D., **González-Galindo F.**, **López-Valverde M.Á.**
"MAVEN/NGIMS Thermospheric Neutral Wind Observations: Interpretation Using the M-GITM General Circulation Model", *Journal of Geophysical Research E: Planets*, Vol. 124, Issue 12, p. 3283-3303 (2019)
DOI: 10.1029/2019JE005957
213. Román-Zúñiga, C. G.; **Alfaro, E.**; Palau, A.; Hasenberger, B.; Alves, J. F.; Lombardi, M.; Sánchez, G. P. S.
"Not so different after all: Properties and Spatial Structure of Column Density Peaks in the Pipe and Orion A Clouds", *Monthly Notices of the Royal Astronomical Society*, p. 4429-4443 (2019)
DOI: 10.1093/mnras/stz2355
214. Rousseau-Nepton, L. et al. (includes **Duarte Puertas, S.**; **Iglesias-Páramo, J.**; **Vílchez, J. M.**)
"SIGNALS: I. Survey description", *Monthly Notices of the Royal Astronomical Society*, Vol. 489, p. 5530-5546 (2019)
DOI: 10.1093/mnras/stz2455
215. **Sánchez de Miguel A.**, Kyba C.C.M., Aubé M., Zamorano J., Cardiel N., Tapia C., Bennie J., Gaston K.J.
"Colour remote sensing of the impact of artificial light at night (I): The potential of the International Space Station and other DSLR-based platforms", *Remote Sensing of Environment*, Vol. 224.0, p. 92-103 (2019)
DOI: 10.1016/j.rse.2019.01.035
216. Sanchez-Bermudez, J.; **Alberdi, A.**; **Schödel, R.**; Brandner, W.; Galván-Madrid, R.; Guirado, J. C.; Herrero-Illana, R.; Hummel, C. A.; Marcaide, J. M.; **Pérez-Torres, M. A.**
"A VLBI study of the wind-wind collision region in the massive multiple HD 167971", *Astronomy and Astrophysics*, Vol. 624, p. A55 (2019)

DOI: 10.1051/0004-6361/201834659

217. **Sánchez-Gil, M. C.; Alfaro, E. J.; Cerviño, M.; Pérez, E.**; Bland-Hawthorn, Joss; Jones, D. Heath
"Hierarchical Bayesian approach for estimating physical properties in nearby galaxies: Age Maps (Paper II)", *Monthly Notices of the Royal Astronomical Society*, Vol. 483, p. 2641-2670 (2019)
DOI: 10.1093/mnras/sty3106

218. **Sánchez-López, A.** et al. (includes **López-Puertas, M.; Funke, B.; Bauer, F. F.; Amado, P. J.; Lampón, M.; Lara, L. M.**)
"Water vapor detection in the transmission spectra of HD 209458 b with the CARMENES NIR channel", *Astronomy and Astrophysics*, Vol. 630, p. A53 (2019)
DOI: 10.1051/0004-6361/201936084

219. Santamaría, E.; **Guerrero, M. A.**; Ramos-Larios, G.; Sabin, L.; Vázquez, R.; Gómez-Muñoz, M. A.; Toalá, J. A.
"Measuring the expansion and age of the nova shell IPHASX J210204.7 + 471015", *Monthly Notices of the Royal Astronomical Society*, Vol. 483, p. 3773 (2019)
DOI: 10.1093/mnras/sty3364

220. Sato-Polito, G.; Montero-Dorta, A. D.; Abramo, L. R.; **Prada, F.**; Klypin, A.
"The dependence of halo bias on age, concentration and spin", *Monthly Notices of the Royal Astronomical Society*, p. 1570-1579 (2019)
DOI: 10.1093/mnras/stz1338

221. Schöfer, P.; Jeffers, S. V.; Reiners, A.; Shulyak, D.; Fuhrmeister, B.; Johnson, E. N.; Zechmeister, M.; Ribas, I.; Quirrenbach, A.; **Amado, P. J.**; Caballero, J. A.; Anglada-Escudé, G.; **Bauer, F. F.**; Béjar, V. J. S.; Cortés-Contreras, M.; Dreizler, S.; Guenther, E. W.; Kaminski, A.; Kürster, M.; Lafarga, M.; Montes, D.; Morales, J. C.; Pedraz, S.; Tal-Or, L.
"The CARMENES search for exoplanets around M dwarfs. Activity indicators at visible and near-infrared wavelengths", *Astronomy and Astrophysics*, Vol. 623, p. A44 (2019)
DOI: 10.1051/0004-6361/201834114

222. Schweitzer, A. et al. (includes **Amado, P. J.; Aceituno, J.; Bauer, F. F.**)
"The CARMENES search for exoplanets around M dwarfs. Different roads to radii and masses of the target stars", *Astronomy and Astrophysics*, Vol. 625, p. A68 (2019)
DOI: 10.1051/0004-6361/201834965

223. Selsing, J. et al. (includes **Cano, Z.; de Ugarte Postigo, A.; Kann, D. A.; Thöne, C. C.**)
"The X-shooter GRB afterglow legacy sample (XS-GRB)", *Astronomy and Astrophysics*, Vol. 623, p. A92 (2019)
DOI: 10.1051/0004-6361/201832835

224. **Shahzamanian, B.; Schödel, R.; Noguerras-Lara, F.; Dong, H.; Gallego-Cano, E.; Gallego-Calvente, A. T.; Gardini, A.**
"First results from a large-scale proper motion study of the Galactic centre", *Astronomy and Astrophysics*, Vol. 632, p. A116 (2019)
DOI: 10.1051/0004-6361/201936579

225. Shulyak, D.; Reiners, A.; Nagel, E.; Tal-Or, L.; Caballero, J. A.; Zechmeister, M.; Béjar, V. J. S.; Cortés-Contreras, M.; Martin, E. L.; Kaminski, A.; Ribas, I.; Quirrenbach, A.; **Amado, P. J.**; Anglada-Escudé, G.; **Bauer, F. F.**; Dreizler, S.; Guenther, E. W.; Henning, T.; Jeffers, S. V.; Kürster, M.; Lafarga, M.; Montes, D.; Morales, J. C.; Pedraz, S.
"Magnetic fields in M dwarfs from the CARMENES survey", *Astronomy and Astrophysics*, Vol. 626, p. A86 (2019)
DOI: 10.1051/0004-6361/201935315

226. Sicardy, B., Leiva, R., Renner, S., Roques, F., El Moutamid, M., **Santos-Sanz, P.**, Desmars, J.
"Ring dynamics around non-axisymmetric bodies with application to Chariklo and Haumea", *Nature Astronomy*, Vol. 3, Issue 2, p. 146-153 (2019)
DOI: 10.1038/s41550-018-0616-8

227. Sierra, A.; Lizano, S.; Macías, E.; Carrasco-González, C.; **Osorio, M.**; Flock, M.
"An Analytical Model of Radial Dust Trapping in Protoplanetary Disks", *Astrophysical Journal*, Vol. 876, p. 7 (2019)
DOI: 10.3847/1538-4357/ab1265

228. **Siu-Tapia A.**, Lagg A., Van Noort M., Rempel M., Solanki S.K.
"Superstrong photospheric magnetic fields in sunspot penumbrae", *Astronomy and Astrophysics*, Vol. 631.0, Number A99, p. A99 (2019)
DOI: 10.1051/0004-6361/201834083

229. Smirnova-Pinchukova, I.; Husemann, B.; Busch, G.; Appleton, P.; Bethermin, M.; Combes, F.; Croom, S.; Davis, T. A.; Fischer, C.; Gaspari, M.; Groves, B.; Klein, R.; O'Dea, C. P.; **Pérez-Torres, M.**; Scharwächter, J.; Singha, M.; Tremblay, G. R.; Urrutia, T.

- "The Close AGN Reference Survey (CARS). Discovery of a global [C II] 158 μm line excess in AGN HE 1353-1917", *Astronomy and Astrophysics*, Vol. 626, p. L3 (2019)
DOI: 10.1051/0004-6361/201935577
230. Solanes, J. M.; **Perea, J. D.**; Valentí-Rojas, G.; **del Olmo, A.**; **Márquez, I.**; Ramos Almeida, C.; Tous, J. L.
"Intrinsic and observed dual AGN fractions from major mergers", *Astronomy and Astrophysics*, Vol. 624, p. A86 (2019)
DOI: 10.1051/0004-6361/201833767
231. Solano E. et al. (includes **Dupke R.A.**, **Alfaro E.**)
"J-PLUS: Discovery and characterisation of ultracool dwarfs using Virtual Observatory tools", *Astronomy and Astrophysics*, Vol. 627.0, Number A29, p. A29 (2019)
DOI: 10.1051/0004-6361/201935256
232. Stoppacher, D.; **Prada, F.**; Montero-Dorta, A. D.; Rodríguez-Torres, S.; Knebe, A.; Favole, G.; Cui, W.; Benson, A. J.; Behrens, C.; Klypin, A. A.
"A semi-analytical perspective on massive galaxies at $z \sim 0.55$ ", *Monthly Notices of the Royal Astronomical Society*, p. 1316-1331 (2019)
DOI: 10.1093/mnras/stz797
233. Suárez, G.; Downes, J. J.; Román-Zúñiga, C.; **Cerviño, M.I.**; Briceño, C.; Petr-Gotzens, M. G.; Vivas, K.
"System initial mass function of the 25 Ori group from planetary-mass objects to intermediate/high-mass stars", *Monthly Notices of the Royal Astronomical Society*, Vol. 486, p. 1718-1740 (2019)
DOI: 10.1093/mnras/stz756
234. Takey, A.; Durret, F.; **Márquez, I.**; Ellien, A.; Molham, M.; Plat, A.
"The 3XMM/SDSS Stripe 82 Galaxy Cluster Survey II. X-ray and optical properties of the cluster sample", *Monthly Notices of the Royal Astronomical Society*, p. 4863-4879 (2019)
DOI: 10.1093/mnras/stz1097
235. Tanvir, N. R. et al. (includes **de Ugarte Postigo, A.**; **Kann, D. A.**; **Cano, Z.**; **Izzo, L.**; **Sánchez-Ramírez, R.**; **Thöne, C. C.**)
"The fraction of ionizing radiation from massive stars that escapes to the intergalactic medium", *Monthly Notices of the Royal Astronomical Society*, Vol. 483, p. 5380-5408 (2019)
DOI: 10.1093/mnras/sty3460
236. Thomas N., Hussmann H., **Lara L.M.**
"The BepiColombo Laser Altimeter (BELA): a post-launch summary", *CEAS Space Journal*, p. 371-380 (2019)
DOI: 10.1007/s12567-019-00270-y
237. Toalá, J. A.; Ramos-Larios, G.; **Guerrero, M. A.**; Todt, H.
"Hidden IR structures in NGC 40: signpost of an ancient born-again event", *Monthly Notices of the Royal Astronomical Society*, p. 3360-3369 (2019)
DOI: 10.1093/mnras/stz624
238. Tobin, J. J. et al. (includes **Díaz-Rodríguez, A. K.**; **Osorio, M.**; **Anglada, G.**)
"The VLA/ALMA Nascent Disk and Multiplicity (VANDAM) Survey of Orion Protostars. I. Identifying and Characterizing the Protostellar Content of the OMC-2 FIR4 and OMC-2 FIR3 Regions", *Astrophysical Journal*, Vol. 886, p. 6 (2019)
DOI: 10.3847/1538-4357/ab498f
239. Tognon, G. et al. (includes **Lara, L. M.**; **López-Moreno, J. J.**)
"Spectrophotometric variegation of the layering in comet 67P/Churyumov-Gerasimenko as seen by OSIRIS", *Astronomy and Astrophysics*, Vol. 630, p. A16 (2019)
DOI: 10.1051/0004-6361/201834884
240. Toledo-Padrón, B. et al. (includes **Rodríguez-López, C.**; **Amado, P. J.**; **Rodríguez, E.**; **Morales, N.**; **López-González, M. J.**; **Aceituno, F. J.**; **Casanova, V. M.**; **Martín-Ruiz, S.**; **Ortiz, J. L.**; **Sota, A.**)
"Stellar activity analysis of Barnard's Star: Very slow rotation and evidence for long-term activity cycle", *Monthly Notices of the Royal Astronomical Society*, p. 1981 (2019)
DOI: 10.1093/mnras/stz1975
241. Treviño-Morales, S. P.; Fuente, A.; Sánchez-Monge, Á.; Kainulainen, J.; Didelon, P.; Suri, S.; Schneider, N.; Ballesteros-Paredes, J.; Lee, Y. -N.; Hennebelle, P.; Pilleri, P.; **González-García, M.**; Kramer, C.; García-Burillo, S.; Luna, A.; Goicoechea, J. R.; Tremblin, P.; Geen, S.
"Dynamics of cluster-forming hub-filament systems. The case of the high-mass star-forming complex Monoceros R2", *Astronomy and Astrophysics*, Vol. 629, p. A81 (2019)
DOI: 10.1051/0004-6361/201935260
242. Troja, E. et al. (includes **Castro-Tirado, A. J.**; **Hu, Y.**; **Márquez, I.**)

- "The afterglow and kilonova of the short GRB 160821B", *Monthly Notices of the Royal Astronomical Society*, Vol. 489, p. 2104-2116 (2019)
DOI: 10.1093/mnras/stz2255
243. Tubiana, C. et al. (includes **Gutiérrez, P. J.**; **Lara, L. M.**; **López-Moreno, J. J.**)
"Diurnal variation of dust and gas production in comet 67P/Churyumov-Gerasimenko at the inbound equinox as seen by OSIRIS and VIRTIS-M on board Rosetta", *Astronomy and Astrophysics*, Vol. 630, p. A23 (2019)
DOI: 10.1051/0004-6361/201834869
244. Ucci, G., Ferrara, A., Gallerani, S., Pallottini, A., Cresci, G., **Kehrig, C.**, Hunt, L.K., Vilchez, J.M., Vanzi, L.
"The interstellar medium of dwarf galaxies: new insights from Machine Learning analysis of emission-line spectra", *Monthly Notices of the Royal Astronomical Society*, Vol. 483, p. 1295-1313 (2019)
DOI: 10.1093/mnras/sty2894
245. van Putten M.H.P.M., **Valle M.D.**
"Observational evidence for extended emission to GW170817", *Monthly Notices of the Royal Astronomical Society: Letters*, Vol. 482, p. L46-L49 (2019)
DOI: 10.1093/mnrasl/sly166
246. Vandaele A.C. et al. (includes **López-Valverde M.**, **Funke B.**, **García-Comas M.**, **Gonzalez-Galindo F.**, **López-Puertas M.**, **López-Moreno J.-J.**, **López-Moreno J.-J.**, **Funke B.**, **García-Comas M.**, **Gonzalez-Galindo F.**, **López-Puertas M.**, **López-Valverde M.**, **López-Valverde M.**, **Martin-Torres J.**), NOMAD Science Team, ACS Science Team
"Martian dust storm impact on atmospheric H₂O and D/H observed by ExoMars Trace Gas Orbiter", *Nature*, p. 521-525 (2019)
DOI: 10.1038/s41586-019-1097-3
247. Varenus, E.; Conway, J. E.; Batejat, F.; Martí-Vidal, I.; **Pérez-Torres, M. A.**; Aalto, S.; **Alberdi, A.**; Lonsdale, C. J.; Diamond, P.
"The population of SNe/SNRs in the starburst galaxy Arp 220. A self-consistent analysis of 20 years of VLBI monitoring", *Astronomy and Astrophysics*, Vol. 623, p. A173 (2019)
DOI: 10.1051/0004-6361/201730631
248. Vercellone, S. et al. (includes **Agudo, I.**; **Gómez, J. L.**; **Molina, S. N.**)
"AGILE, Fermi, Swift, and GASP/WEBC multi-wavelength observations of the high-redshift blazar 4C +71.07 in outburst", *Astronomy and Astrophysics*, Vol. 621, p. A82 (2019)
DOI: 10.1051/0004-6361/201732532
249. **Vilchez, J. M.**; Relaño, M.; Kennicutt, R.; De Looze, I.; Mollá, M.; Galametz, M.
"Metals and dust content across the galaxies M 101 and NGC 628", *Monthly Notices of the Royal Astronomical Society*, Vol. 483, p. 4968-4983 (2019)
DOI: 10.1093/mnras/sty3455
250. Wang, L. J.; Wang, X. F.; **Cano, Z.**; Wang, S. Q.; Liu, L. D.; Dai, Z. G.; Deng, J. S.; Yu, H.; Li, B.; Song, L. M.; Qiu, Y. L.; Wei, J. Y.
"Broad-lined type Ic supernova iPTF16asu: A challenge to all popular models", *Monthly Notices of the Royal Astronomical Society*, p. 2109 (2019)
DOI: 10.1093/mnras/stz2184
251. Wang, S.-Q.; **Cano, Zach**; Li, L.; Liu, L.-D.; Wang, L.-J.; Zheng, W.; Dai, Z.-G.; Liang, E.-W.; Filippenko, A. V.
"Modeling the Light Curves of the Luminous Type Ic Supernova 2007D", *Astrophysical Journal*, Vol. 877, p. 20 (2019)
DOI: 10.3847/1538-4357/ab1903
252. Werle, A.; Cid Fernandes, R.; Vale Asari, N.; Bruzual, G.; Charlot, S.; **Gonzalez Delgado, R.**; Herpich, F. R.
"Simultaneous analysis of SDSS spectra and GALEX photometry with STARLIGHT: method and early results", *Monthly Notices of the Royal Astronomical Society*, Vol. 483, p. 2382-2397 (2019)
DOI: 10.1093/mnras/sty3264
253. Wright, N. J. et al. (includes **Alfaro, E. J.**)
"The Gaia-ESO Survey: Asymmetric expansion of the Lagoon Nebula cluster NGC 6530 from GES and Gaia DR2", *Monthly Notices of the Royal Astronomical Society*, p. 2477-2493 (2019)
DOI: 10.1093/mnras/stz870
254. Yan, F. et al. (includes **Amado, P. J.**; **Bauer, F. F.**; **Lara, L. M.**; **López-Puertas, M.**; **Sánchez-López, A.**)
"Ionized calcium in the atmospheres of two ultra-hot exoplanets WASP-33b and KELT-9b", *Astronomy and Astrophysics*, Vol. 632, p. A69 (2019)
DOI: 10.1051/0004-6361/201936396
255. Zechmeister, M. et al. (includes **Bauer, F. F.**; **López-González, M. J.**; **Rodríguez, E.**; **Rodríguez López, C.**; **Anglada-Escudé, G.**; **Amado, P. J.**; **Abril, M.**; **Aceituno, F. J.**; **Aceituno, J.**; **Antona Jiménez, R.**; **Becerril, S.**; **Calvo Ortega, R.**; **Casal, E.**; **Casanova, V.**; **Claret, A.**;

Fernández, M.; Lampón, M.; Lara, L. M.; López-Puertas, M.; Martín-Ruiz, S.; Mirabet, E.; Pascual, J.; Pérez Medialdea, D.; Rabaza, O.; Ramón Ballesta, A.; Rodríguez Trinidad, A.; Sánchez Carrasco, M. A.; Sánchez-López, A.; Sota, A.; Suárez, J. C.)

"The CARMENES search for exoplanets around M dwarfs. Two temperate Earth-mass planet candidates around Teegarden's Star", *Astronomy and Astrophysics*, Vol. 627, p. A49 (2019)

DOI: 10.1051/0004-6361/201935460

256. Zinchenko, I. A.; Pilyugin, L. S.; Sakhibov, F.; Grebel, E. K.; Just, A.; Berczik, P.; Nefedyev, Y. A.; **Vílchez, J. M.**; Shulga, V. M.

"Peculiar motions of the gas at the centre of the barred galaxy UGC 4056", *Astronomy and Astrophysics*, Vol. 628, p. A55 (2019)

DOI: 10.1051/0004-6361/201935897

257. Zubko N., **Muñoz O.**, Zubko E., Gritsevich M., Escobar-Cerezo J., Berg M.J., Peltoniemi J.

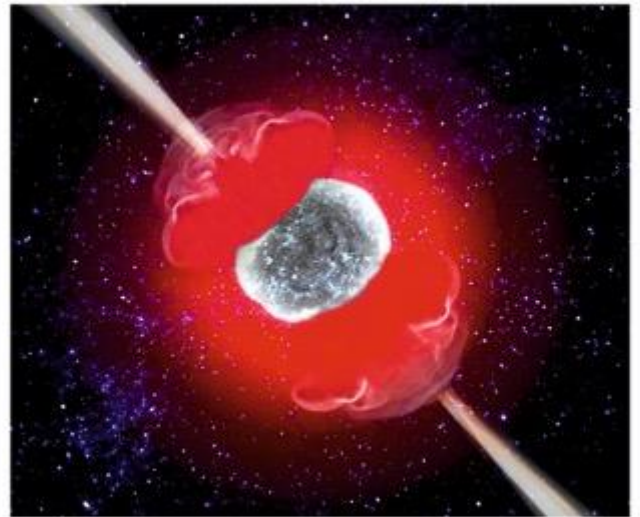
"Light scattering from volcanic-sand particles in deposited and aerosol form", *Atmospheric Environment*, Vol. 215.0, Number 116813, p. 116813 (2019)

DOI: 10.1016/j.atmosenv.2019.06.051



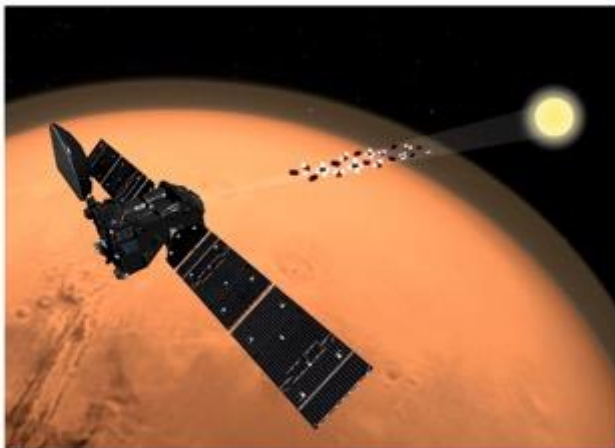
Rediscovering the "Stephan's Quintet"

A study by researchers from the IAA-CSIC offers new results on the "Stephan's Quintet", one of the most paradigmatic compact systems of galaxies. The work was chosen as the cover for the journal *Astronomy and Astrophysics*.



Observations of a rare hypernova complete the picture of the death of the most massive stars

A work, led by the IAA-CSIC and published in *Nature*, studies in detail the death of a massive star that produced a gamma-ray burst (GRB) and a hypernova.



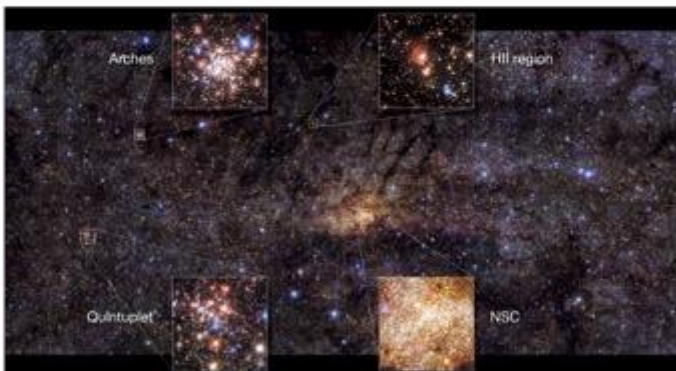
First results from the ExoMars mission: absence of methane on Mars and variations in water vapor due to dust storms

The results, published in *Nature*, were obtained with the ACS and NOMAD instruments. Researchers from the IAA-CSIC participate in the results, as well as in the scientific team that developed NOMAD.



CARMENES finds two temperate terrestrial planets around Teegarden's star, a small nearby star

CARMENES is a visible and infrared spectrograph that operates from the Calar Alto Observatory. Researchers from the Institute of Astrophysics of Andalusia (IAA-CSIC) participate in the research, which collected data from different astronomical facilities, including the Sierra Nevada Observatory (OSN).



IAA researchers discover an extremely violent episode in the history of the Milky Way, with over a hundred thousand supernova explosions

A survey with an unprecedented resolution of the central regions of our galaxy reveals its full history of star formation, which presents steep ups and downs in star formation.