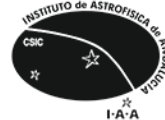


Instituto de Astrofísica de Andalucía
IAA-CSIC

ANNUAL REPORT 2018



Cover and back Picture. M20, Trifid Nebula.

Credit: Observatorio de Calar Alto (CAHA), César Blanco González

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Foreword

The year 2018 was very special for the IAA: the institute was recognized with the “Severo Ochoa Center of Excellence” Award from the Spanish Ministry of Science, Innovation and Universities (MCIU). According to the MCIU, *“the Center of Excellence Severo Ochoa Award, aims to fund and accredit public research centers and units on any areas that demonstrate scientific leadership and impact at global level, as well as active collaboration in their social and business environment. The Centers of Excellence Severo Ochoa are organizational structures with highly competitive strategic research programmes in the frontiers of knowledge. They are among the best in the world in their respective scientific areas”*.

Not only that, on June 2018 Spain became the 11th Member of the Square Kilometre Array (SKA) Organization, culminating several years of work by the Spanish community coordinated by the IAA. Moreover, Beppi Colombo is on its way to Mercury, with the instrument BeLA -with a significant IAA contribution- onboard. Definitely, a good year for the IAA.

The IAA was founded in 1975, and then began to compete in the international league of Astrophysics. Now, it is a Severo Ochoa Research Center. In these years, the IAA has evolved from its first photometers, photon counters that we now look at as museum pieces, to developing first-line instrumentation for both ground and space observatories. And all this has been possible thanks to the intelligence and initiative, the capacity and determination, the effort and loyalty to the IAA of all the people who have been part of its history.

Along these years, science and technology have been evolving continuously, transforming the science challenges into unique achievements in which the IAA has made a very important contribution. Let me mention some examples:

- Planets, satellites and comets have been explored, with an active participation of the IAA in

practically all the space missions of the European Space Agency for the study of the Solar System. The Rosetta mission, which orbited around Comet 67P/Churiomov-Guerasimenko, is a particularly noteworthy example, but along the way has also participated in Cassini-Huygens, Mars Express, Venus Express, ExoMars, Sunrise or the recently launched Beppi Colombo, among others;

- After the discovery of the first exoplanet in 51 Peg in the year 1995, others have been discovered in the habitability zones of many stars. The IAA has played a very important role in this field, with the development and exploitation of the CARMENES instrument, located in the Calar Alto Observatory, dedicated to the detection of exoplanets in M-type stars and the study of their atmospheres;

- The Hipparcos satellite, launched in 1997, provided the first astrometric results for 100,000 stars. Today, the GAIA satellite is capable of studying 1 billion stars, mapping out 8 dimensions of our Galaxy, including the position, speed, metallicity and photometry of stellar objects, a project that has the active participation of IAA research staff;

- The study of the galaxies has evolved from the study of a relatively modest number of them in detail, to lead the CALIFA project, pioneering three-dimensional spectroscopic mapping of more than five hundred galaxies of different morphologies (the most extensive so far), observed in the observatory of Calar Alto. These observations constitute a legacy and reference for the international astronomical community;

- From our first steps in the theoretical study of black holes and the observational study of active galaxies and relativistic jets that emanate from their heart, today we envision the real possibility of obtaining the first direct image of a black hole shadow thanks to the Event Horizon Telescope (EHT) observations, in which the IAA is actively involved;

- Since the first detections of Gamma Ray Bursts, a great variety of transient sources are under study, having achieved a substantial advance in deciphering their nature. In this time, the first

gravitational waves have been detected, a new cosmic messenger that we have only recently begun to receive. The IAA have participated in the first and historical detection of the electromagnetic counterpart of these events in 2017;

The immediate future holds great challenges and opportunities for our Institute. The participation in the ESA missions that will fly in the coming years, such as Solar Orbiter, JUICE or PLATO2.0, the contribution to the instrumental developments in the Calar Alto Observatory, the exploitation of the telescopes of the European Southern Observatory (ESO), together with the most innovative scientific results published by our scientific staff, will strengthen the impact and scientific leadership of the IAA at an international level. The achievement of the Severo Ochoa Award of excellence, which the Ministry grants to the centers that have frontier and highly competitive research programs, and that are among the best in the world in their respective scientific areas, as well as the associated extra-ministerial financing, represent a unique opportunity and a source of hope and commitment. Based on a solid and transversal scientific strategy, our challenge is, through our research, to reach a privileged place in the exploitation of the next generation of astrophysical experiments in the frontier of knowledge.

The IAA remains committed with the SKA project, involving several of our departments and units. We have continued collaborating with CDTI on the revision of industry capacities, and providing support to the Ministry, e.g by attending the SKA Board in representation of the Spanish representative. The IAA is leading the Spanish contribution and hosting the Spanish SKA Office, as well as developing a prototype of the SKA Regional Center as part of its "Severo Ochoa" Strategic Plan. We are entering a new SKA period, in which most SKA consortia have passed the Critical Design Review, with Bridging activities starting that will lead to construction by 2020. Moreover, the Inter-Governmental Organisation (SKA IGO), responsible for delivering the construction and operation, was officially signed on 12th March 2019.

Prof. Antxon Alberdi

Director

Dr. Isabel Márquez

Scientific Director of the project "Severo Ochoa – IAA"

Instituto de Astrofísica de Andalucía

Spanish National Research Council (CSIC)

April 2019

RESEARCH ACTIVITY

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

1. Extragalactic Astronomy

2. Radioastronomy and Galactic Structure

3. Solar System

4. Stellar Physics

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

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

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

This report includes the activities of the following research lines:

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

AGN JETS

Overview

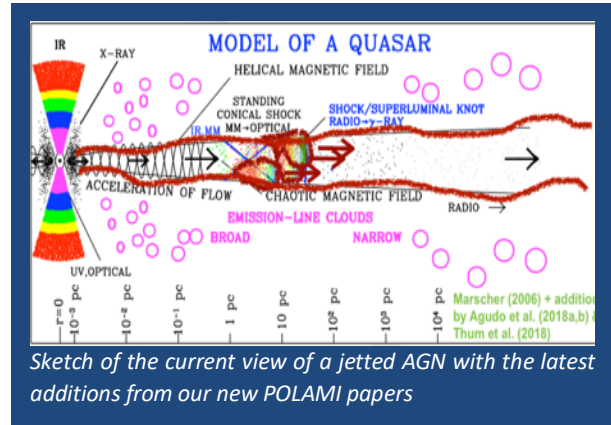
Our research group is focused on the study of relativistic jets, commonly present in multiple astrophysical sites, from active galactic nuclei (AGN), to microquasars and GRBs. For AGN, huge amounts of energy are released as a consequence of mass accretion onto supermassive black holes (SMBH), lurking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

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

Our observational study is based on a multi-instrument and multi-spectral range approach, including very long baseline interferometry observations at mm wavelengths and with the orbiting antenna RadioAstron, which allows the study of the innermost jet regions with an angular resolution of the order of few tens of microarcseconds. Multi-waveband observations across the whole electromagnetic spectrum, including radio, mm, 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 2018

We led the POLAMI (Polarimetric Monitoring of AGN at Millimeter Wavelengths) program. POLAMI is a long-term program to monitor the polarimetric properties (Stokes I, Q, U, and V) of a sample of around 40 of the brightest AGN at 3.5 and 1.3 mm with the IRAM 30m Telescope near Granada. The program is based in a collaboration team formed by 24 researchers in 6 institutions of 5 countries. A series of 3 POLAMI papers were published in 2018. In the first paper of this series [4] we introduced the program and our data, and presented the results of the first 8 years of POLAMI observations. The data obtained from the science targets, as well as the analysis and astrophysical implications of their circular polarization properties and



Sketch of the current view of a jetted AGN with the latest additions from our new POLAMI papers

of their total flux and linear polarization variability were shown [224] and [5], respectively. In particular, we found that circular polarization seems to be present in most AGN at mm wavelengths at levels of 2% or larger, which opened the window for future circular polarization studies of AGN with more sensitive instrumentation. Also, emission at shorter mm wavelength was found to come from smaller regions with progressively better magnetic field order; one-zone models are definitely excluded by the general properties of mm polarization of blazars, and blazar jets are not compatible with axisymmetric geometries in general on which regards to their polarization emission. These findings help to fine tune our current understanding of the innermost regions of relativistic jets in AGN.

The 14th The European VLBI Network (EVN) Symposium and Users Meeting was also organized by our group on behalf of the EVN Consortium Board of Directors. The meeting took place on October 8-11, 2018 at the main auditorium of the "Parque de las Ciencias" of Granada. This biennial meeting, that was attended by 170 participants from 25 countries world-wide, is the main forum for discussion of the latest VLBI scientific results and technical and technological developments within the EVN member countries.

MEMBERS

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INVITED RESEARCHERS

G. Bruni (Max-Planck-Institut für Radioastronomie, Germany);
C. Thum (IRAM-Granada); I. Cho (KASI, South Korea)

LINES OF RESEARCH

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

ARAE (ASTROFÍSICA RO- BÓTICA Y DE ALTAS ENERGÍAS)

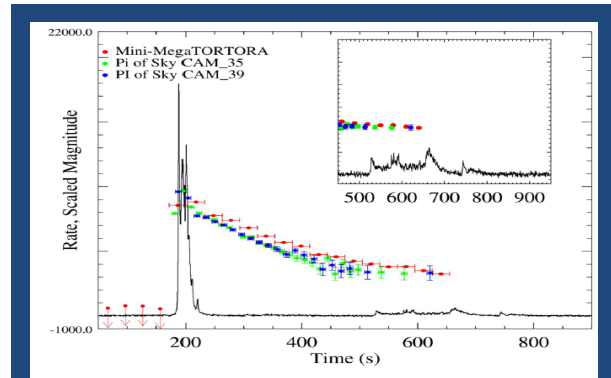
Overview

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

Highlights in 2018

- A gravitational-wave (GW) transient was identified in the electromagnetic spectrum for the first time. The event, was recorded by the LIGO detectors on 2017 Aug 17. This event (GW170817) was identified at other wavelengths with ground- and space-based facilities such as the *Fermi* gamma-ray satellite, when a short gamma-ray burst (sGRB) was recorded 2s after the GW, supporting the double neutron star (DNS) merger as the progenitor. The estimated event rate density above this luminosity is $190 \text{ Gpc}^{-3} \text{ yr}^{-1}$, which is close to the DNS merger event rate density. The event originates from a structured jet viewed from a large viewing angle. There are similar faint soft GRBs in the *Fermi* archival data. A small fraction might belong to this new population of nearby, low-luminosity sGRBs [245].

- Gamma-ray bursts (GRBs) are generated from relativistic jets launched from catastrophic events such as massive star core collapse or binary compact star coalescence. GRB 160625B was simultaneously observed in gamma-ray and optical wavelengths, whose prompt emission consists of three isolated episodes. Its high brightness (with isotropic peak luminosity $L_{p,iso} \approx 4 \times 10^{53} \text{ erg s}^{-1}$) allowed us to conduct detailed time-resolved spectral analysis in each episode, from precursor to main burst and to extended emission. The spectral properties of the first two sub-bursts were distinctly different, allowing us to observe the transition from thermal to non-thermal radiation between well-separated emission episodes within a single GRB, suggesting the change of jet composition from a fireball to a Poynting-flux-dominated jet [243].



GRB 160625B as observed in gamma-rays and optical wavelengths by the Pi-of-the-Sky experiment at our BOOTES-1 astronomical station in INTA-CEDEA (Huelva)

- One problem regarding the limb-darkening coefficients for stellar atmospheric models with spherical symmetry is the difficulty of adjusting both the limb and the central parts simultaneously. Our new method considerably improved the description of both the limb and the central parts and that will allow users to test models of stellar atmospheres with spherical symmetry more accurately in environments such as exoplanetary transits, eclipsing binaries, etc. The resulting coefficients are useful for the photometric systems of the space missions *TESS*, *Kepler*, *CoRoT*, and *MOST*. The new spherical coefficients can easily be adapted to the most commonly used light curve synthesis codes [43].

- The ESA *THESEUS* M5 mission was selected for phase O/A study in June 2018.

MEMBERS

A.J. Castro-Tirado, M.A. Castro-Tirado, M. Cerviño Saavedra, A. Claret dos Santos, I. Carrasco García, E. Fernández-García and, J.C. Tello Salas

INVITED RESEARCHERS

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LINES OF RESEARCH

Robotic Astronomy

High-Energy Astrophysics

Astrophysical Transients

Theoretical Stellar Evolutionary models

Models of stellar population synthesis

GALAXY EVOLUTION

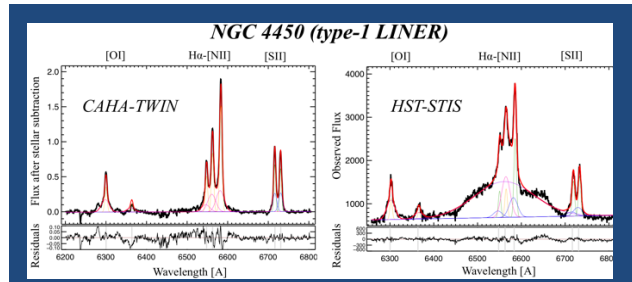
Overview

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

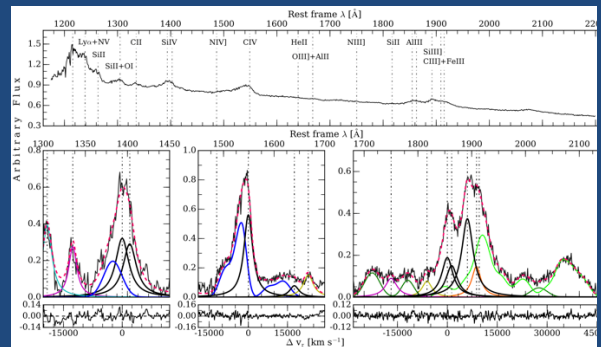
Highlights in 2018

- **Exploration of the AGN nature of nearby type-1 LINERs.** We studied the 22 local ($z < 0.025$) type-1 LINERs from the Palomar survey, on the basis of optical space- (HST) and ground-based (3.5mCAHA and NOT) long-slit spectroscopy. Kinematics and fluxes of a set of emission lines, from $H\beta$ $\lambda 4861$ to $[S II]$ $\lambda\lambda 6716, 6731$, and the absorption NaD $\lambda\lambda 5890, 5896$ were modeled and measured, after subtraction of the underlying starlight. We found that the broad $H\alpha$ component is sometimes elusive in our ground-based spectroscopy, whereas it is ubiquitous for space-based data. The combination of optical diagnostic diagrams, theoretical models [for AGNs, post-asymptotic giant branch stars, and shocks] and the weak/strong-[O I] classification, points to the AGN as the dominant ionization mechanism in these LINERs, with shocks contribution. The emission line kinematics may indicate ionized outflows, preferentially seen in [OI]. However, NaD outflows appear to be less frequent [37].

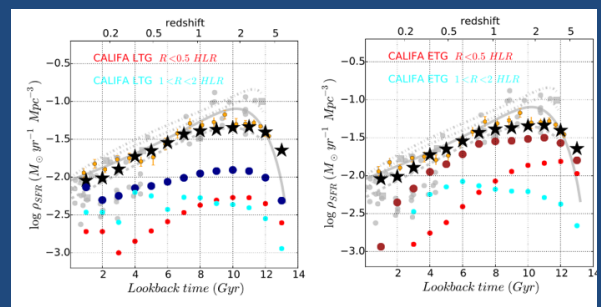
- **Quasars radiating at extreme Eddington ratios** (x_A quasars). Nineteen x_A candidates with redshifts $2 \lesssim z \lesssim 2.9$ were identified using 4DE1 selection criteria applied to SDSS spectra. The emission line spectra were studied using multicomponent fits of deep spectroscopic observations ($S/N \gtrsim 40 - 50$; spectral resolution $\approx 250 \text{ km s}^{-1}$) obtained with OSIRIS@GTC, confirming that almost all of these quasars are x_A sources with very similar properties. The spectra can be characterized as very low ionization ($\log U \approx -3$), which explains the Fe III emission observed in the spectra. x_A show extreme properties in terms of C IV $\lambda 1549$ (median equivalent width 15 \AA , $\lesssim 30 \text{ \AA}$ for most sources) and blueshift amplitudes ($-5000 \lesssim c(1/2) \lesssim -1000 \text{ km s}^{-1}$). A prototypical composite spectrum is presented. The properties of x_A make them easily identifiable in large surveys and potential "standard candles" for cosmological applications. We show that Al III $\lambda 1860$ could be associated with a low-



Ground- and space-based spectra of the type-1 LINER NGC4450. The AGN broad component is visible **only** in the HST-STIS spectrum [37]



Rest-frame composite spectrum of x_A quasars. The blue lines mark the blueshifted components associated to each emission [141]



Evolution of the star formation rate density of the universe as deduced from CALIFA spiral (Left) and elliptical (Right) galaxies [122]

ionization virialized subsystem, supporting previous suggestions that Al III is a reliable virial broadening estimator [141].

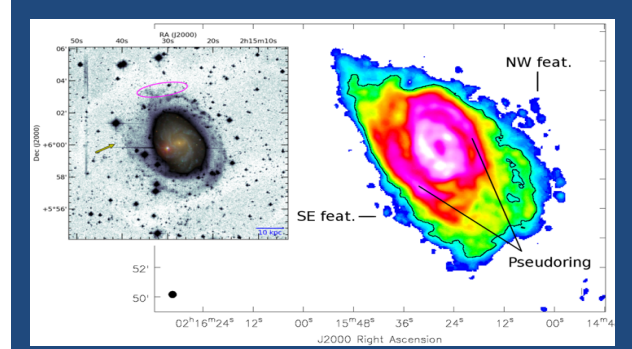
- **Highlights from CALIFA stellar populations.** We studied the cosmic evolution of the stellar mass, and the absolute and specific star formation rate of the Universe as a function of galaxy morphology, combining CALIFA spectra and GALEX images of ~ 400 galaxies. Applying the stellar populations fossil record to inner and outer regions, we derived their contributions to the total stellar mass (ρ_*) and star formation rate (ρ_{SFR}) densities as a function of cosmic time. We find: 1) The specific SFR ($sSFR$) declines rapidly as the Universe evolves, and faster for early- than for late-type galaxies, and for the inner than the outer regions. 2) At low-redshift ($z < 0.5$),

most of the star formation takes place in the outer regions of late spirals, while at $z > 2$, the inner regions of the progenitors of the current E and S0 contribute most to ρ_{SFR} and ρ_* . 3) In agreement with galaxy surveys at different redshifts, the average SFH of CALIFA galaxies shows that galaxies grow their mass mainly in a mode well described by a delayed-tau model, that peaks at $z \sim 2$ and an e-folding time of ~ 3.9 Gyr [122].

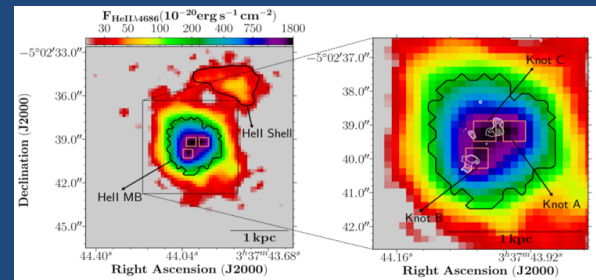
- **AMIGA** team continued working in preparation for SKA, playing a major role in Spain joining the SKA Organization this year. As co-chair of the SKA HI Science Working Group the P.I. of AMIGA presented talks on the requirements of the HI scientific community from future SKA regional centres (SRCs). The study of the isolated, yet highly asymmetric galaxy CIG 96 was published [180]. A first of its kind study of galactic and intra-group magnetic fields as a function of the environment started with a successful JVLA proposal. Data of the polarized emission for a subset of HCGs in well defined evolutionary stages were obtained. Studies of complementary samples included: characterising the galaxy HI mass function [103], constraining the abundance of HI-bearing ultra-diffuse [102], starting the study of the stellar populations of blue, field UDGs, or active involvement in WEAVE-Apertif. As members of SKA Science Data Processor consortium, we contributed to achieve the positive evaluation of its Critical Design, and participated in two deliverables issued by the H2020 AENEAS project, aimed at designing the federated network of European SRCs. In December, the SKA-Link members met at IAA in order to finalise the document with a set of Best Practices for the design of the SRCs.

- **Highlights of the IDILICO project.** A six-dimensional parameter space based on high-resolution numerical simulations of isolated binary galaxy collisions was constructed to investigate the dynamical friction timescales, for major mergers. The experiments followed the gravitational encounters between ~ 600 pairs of similarly massive late- and early-type galaxies with orbital parameters that meet the predictions of the Λ CDM cosmology [216].

- **Highlights from ESTALLIDOS.** From MUSE@VLT IFU data of SBS0335-052E, the most metal-poor starburst in the nearby Universe, we derived the total H α ionizing energy budget from the spatially resolved nebular H α 4686 emission. Comparison with current models indicated that the H α excitation in SBS0335-052E can only be produced by either single, rotating metal-free stars or a binary population with $Z \sim 10^{-5}$ and a top-heavy IMF [106].



Color composite (left) and HI 21 cm (right) maps of the isolated but highly asymmetric galaxy CIG 96 [180]



Spatial distribution of the H α 4686 of the most metal-poor starburst galaxy in the nearby universe SBS0335-052E from MUSE@VLT IFU data [106]

MEMBERS

Cazzoli, S.; Damas, A.E.; Duarte Puertas, S.; Fernández-Peña, M.; García Benito, R.; Garrido, J.; González Delgado, R.M.; Hermosa, L.; Iglesias, J.; Jones, M.G.; Kehrig, C.; Luna, S.; Márquez, I.; Martínez Aldama, M.; Martínez Solaeche, G.; Masegosa, J.; del Olmo, A.; Perea, J.D.; Pérez, E.; Pérez Montero, E.; Povic, M.; Ramírea-Moreta, P.; Sánchez, S.; Verdes-Montenegro, L.; Vílchez, J.M.

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LINES OF RESEARCH

Active Galactic Nuclei; Astronomical instrumentation; Cosmic evolution of galaxies; Open Science; Physics of Quasars; Star formation 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; Violent star formation

HETH

Overview

HETH (High-Energy Transients and their Hosts) 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) or gravitational wave counterparts (GW). For our research we use multiwavelength data from ORM, OSN, CAHA, VLT, ALMA and NOEMA. Another interest are the environments of stellar explosions to learn more about their progenitors.

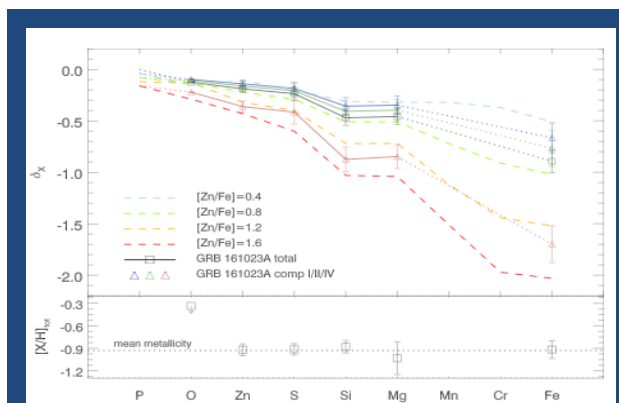
We also devote time to develop new astronomical instrumentation. We presented an instrument concept called "GATOS" for GTC, which issued a call for ideas for a next generation instrument in April 2018. GATOS is a UV-VIS-IR imager and spectrograph with IFU and polarimetry capabilities, supported by a consortium of researchers from Spanish and Mexican institutions. It was presented at the VI Science with the GTC meeting and well received.

Highlights in 2018

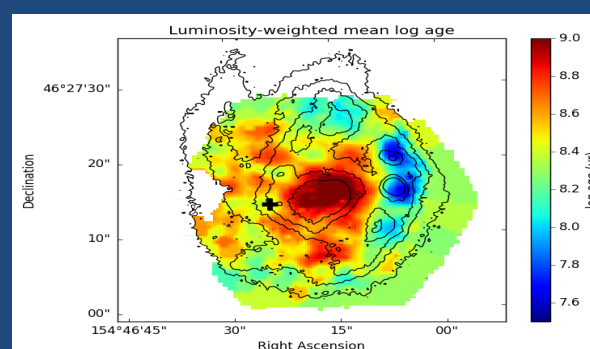
- **GRBs with X-shooter: The host of GRB 100418A and the rich sightline of GRB 161023A [53,52].** The "Stargate" collaboration and its predecessor, of which HETH has been part since the beginning, has collected almost 100 GRB afterglow spectra since 2009. In 2018 we published two papers on individual, out-standing GRBs: 1) GRB 100418A ($z=0.62$) with the weakest GRB-SN so far detected and a compact host that shows a complex double emission line profile. 2) GRB 161023A was the richest sightline in any GRB so far observed. At a redshift of $z=2.7$ we observe a plethora of absorption lines from the host ISM reaching from the Ly-limit to MgII including several fine-structure lines of Fe, Ni, Si and O and a further 9 intervening systems at lower redshifts. Detailed absorption line fitting allows even to disentangle dust depletion in different components in the host.

- **The SN 2017egm host in 3D [97].** SN 2017egm was the closest superluminous SN Type I (SLSN-I) so far detected. Surprisingly, its host is a metal-rich spiral galaxy with an old stellar population while SLSN-I sites are normally metal poor and young. A careful analysis of 3D spectroscopy from MANGA and PMAS/CAHA showed, however, that the population at the SLSN site contained two populations, of which one was young and metal poor (see Fig. below). The galaxy has a close neighbour and both show signs of interactions, providing a possible explanation for a recent starburst giving rise to the SLSN progenitor.

- **Be in the fast nova V407Lup [96].** In 2015, Izzo et al. had discovered ${}^7\text{Li}$ in the spectra of nova V1369Cen. ${}^7\text{Li}$



Dust depletion pattern in the sightline of GRB 161023A separately for three different velocity components and models for different Zn/Fe abundances [53]



Luminosity weighted mean stellar population age map for the host of SLSN 2017egm, data are from the MANGA survey [97]

is produced by the decay of ${}^7\text{Be}$ with a $T_{1/2}$ of 53d, hence the ${}^7\text{Be}$ implies the presence of ${}^7\text{Li}$. ${}^7\text{Be}$ had been previously detected in a carbon-oxygen nova, but Izzo et al. 2018 show the first detection in an oxygen-neon nova, V407Lup, which have less massive ejecta. 30% of Galactic novae are ONe novae hence this confirms the important role of novae in the production of Li. In fact, the estimated Li production is even larger than the one observed, invoking a new "Li problem".

MEMBERS

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INVITED RESEARCHERS

Massimo Della Valle (Obs. di Capodimonte), Ondrej Nentvitch (Univ. of Prague), Renato Martone (Univ. de Ferrara)

LINES OF RESEARCH

Gamma-ray bursts; Supernovae (Type II_n, broad-line I_c, SLSNe, GRB-SNe); 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

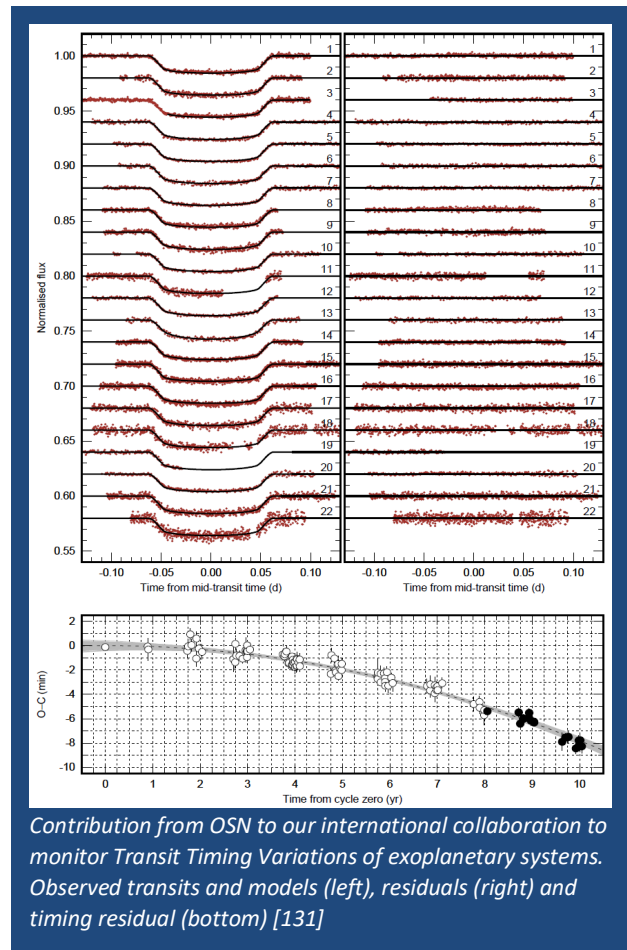
Overview

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 theory of stellar structure and evolution, magnetic activity, asteroseismology, observations with space- and ground-based instruments, technical development of new instrumentation, project management and system engineering.

Highlights in 2018

- CARMENES (Quirrenbach, **Amado** et al. 2018, SPIE, 10702E, 0W) is a world-wide unique instrument, co-led by the IAA (co-PI institution), that started its scientific operation at CAHA observatory in Jan. 1, 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. In 2018, we have continued collecting data of M dwarfs both with CARMENES and with photometric instruments at the OSN, providing exciting results, like the discovery of a candidate super-Earth around the closest single star to our Solar System, Barnard’s star [191]. CARMENES is already the largest exoplanet survey for M dwarfs to date. It has already demonstrated its capabilities by i) building a new and unique catalog of 324 high-resolution M-dwarf spectra in the VIS and NIR [187] and ii) showing tens of possible new exoplanet detections, among them, its first exoplanet, a candidate temperate Neptune [186]. Furthermore, CARMENES has shown to be a groundbreaking instrument for the study of exoplanet atmospheres opening a new line of research from the ground with the detection of excess absorption in the helium triplet at 1083 nanometers during the transit of the Saturn-mass exoplanet WASP-69b [167]. Studies of atmospheric escape from exoplanets had relied, up to now, on space-based observations of the hydrogen Lyman- α line in the far-ultraviolet region, which is strongly affected by interstellar absorption. All these results have contributed to break the record of CAHA publications in one year.

- HIRES is a second-generation instrument for the Extremely Large Telescope (ELT). It is an instrument



conceptually similar to CARMENES. During 2018, our group, belonging to the HIRES consortium and the Project Office, successfully closed with ESO the Phase A of the project (Marconi, Allende-Prieto, **Amado** et al. 2018, SPIE, 10702E, 1Y).

- Brief news: Members of the regional government of Andalucía visited the CAHA to know more about CARMENES and the Observatory.

MEMBERS

P.J. Amado, F.F. Bauer, E. Casal López, M. Fernández, E. Mirabet, D. Pérez Medialdea, C.T. Rodríguez López, E. Rodríguez

INVITED RESEARCHERS

Mahmoudreza Oshagh (IAG, Germany), Julia Olivares (Diputación de Sevilla)

LINES OF RESEARCH

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

PLANETS AND MINOR BODIES

Overview

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

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

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

The main objectives are:

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

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

- b) Planetary atmospheres and surfaces:
 - Origin and evolution of the water content and its 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 directly 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.

- c) IAA Cosmic Dust Laboratory (CODULAB): Experimental study of the angle dependence of the scattering matrices of dust samples of interest for the



Lift-off of the Ariane5 from Kourou carrying the instrument BELA in the Bepi Colombo payload to planet Mercury

Solar System research, i.e. mineral dust particles that are potential candidates for being present in the planetary and cometary atmospheres of the Solar System (e.g. olivines, pyroxenes, basalt, palagonite, calcite, carbon, etc). The CODULAB provides experimental data in support of the research lines described above.

Highlights in 2018

- Scientific operative phase of NOMAD on board Exomars.
- Launching of the instrument BELA in the Bepi Colombo payload to Mercury.
- One member of the group (J.L.Ortiz) was awarded with the La Vanguardia price to the most prominent scientific discovery in Spain in 2017.

MEMBERS

J. M. Castro Marín, R. D. Duffard, J. Escobar, J.C. Gómez Martín, 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

M. Godolt (U. Técnica de Berlín y DLR)

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.

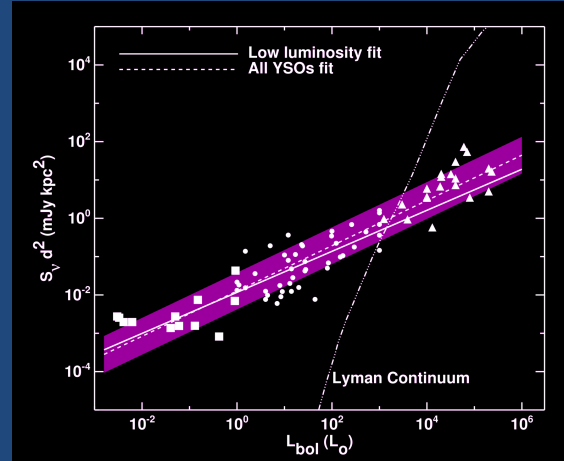
The early stages of star and planet formation are studied through radio interferometric observations and modelling of the observed emission. Infalling molecular envelopes, dusty circumstellar discs and ionised radio jets in young stellar objects are studied. The architecture of nearby exoplanetary systems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

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

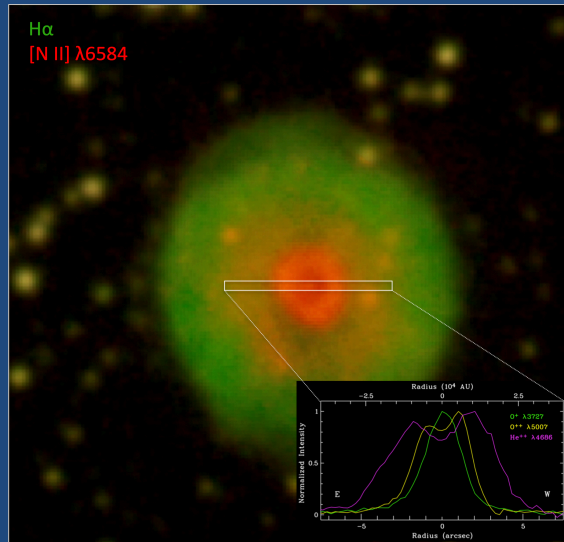
Radio interferometric monitoring of supernova (SN) explosions and their distribution in Ultra Luminous Infrared Galaxies (ULIRGs) is also carried out to determine the SN and star formation rates. We also disentangle the mechanisms for gas and dust heating.

Highlights in 2018

- The current status of our knowledge on radio jets from young stellar objects has been reviewed in The Astronomy and Astrophysics Review [14]. These radio jets trace partially ionized material recently (a few years) ejected by the young star. Radio jets are present in young stars across the whole stellar spectrum, from O-type protostars to proto-brown dwarfs. The radio emission is well correlated with the bolometric luminosity, which mostly originates from accretion.
- The discovery of an inside-out shell in HuBi 1, whose ionization structure is inverted with respect to that of classical ionized shells, has led a research team of this group to propose that its central star experienced a born-again event a few decades ago, making this source the missing link between born-again events in solar-like stars and carbon-rich/hydrogen-poor [WC] central stars of PNe [86].
- We directly imaged for the first time the jet produced by a tidal disruption event (TDE), a collimated transient flare theoretically expected to be produced when a star is ripped apart by the gravitational field of a supermassive black hole (SMBH). The TDE jet occurred in the western nucleus of the merging galaxy pair Arp



Radio continuum luminosity at cm wavelengths as a function of the bolometric luminosity from sub-stellar to massive protostars. The dot-dashed line is the expected radio luminosity of a photoionized HII region [14]



NOT ALFOSC composite-colour picture of the planetary nebula HuBi 1 in the H α and [N II] λ 6584 emission lines. The inset shows spatial profiles of relevant emission lines extracted from the East-West aperture. Their spatial distributions unveil an inside-out ionization structure, with the emission from the lower excitation O⁺ peaking inside and that from the higher excitation He⁺⁺ peaking outside [86]

299, and radiated an energy equivalent to that of 15 core-collapse supernova explosions, all of it at infrared and radio wavelengths. The absence of an optical or X-ray counterpart for the TDE implies that most of that emission was reradiated at infrared wavelengths by dust. Efficient reprocessing by dense gas and dust may thus explain the difference between theoretical predictions and observed luminosities of TDEs. Our radio interferometry observations resolve an expanding and decelerating jet, probing the jet formation and evolution around a SMBH [147].

- We reported the first sub-arcsecond angular resolution images at 150 MHz of the A-nucleus in the luminous infrared galaxy Arp 299, using LOFAR. We detected an intriguing two-sided, filamentary structure emanating from the A-nucleus, which we interpret as an outflow extending at least 5 kpc (deprojected size) in the N-S direction. We find that this outflow must be driven by the powerful star-formation activity in this nucleus. Our results open an avenue to the use of low-frequency (150 MHz), sub-arcsecond imaging with LOFAR to detect outflows in the central regions of local luminous infrared galaxies [181].

MEMBERS

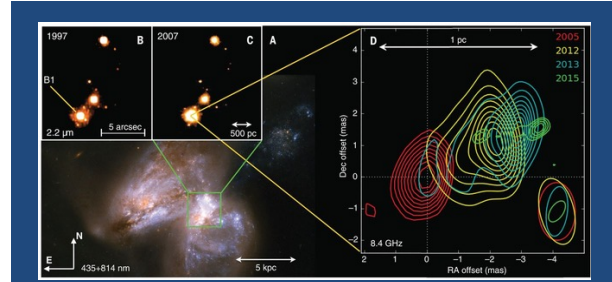
A. Alberdi, G. Anglada, A.K. Díaz-Rodríguez, J.F. Gómez, M.A. Guerrero, L.F. Miranda, M. Osorio, M.A. Pérez-Torres, N. Ramírez-Olivencia

INVITED RESEARCHERS

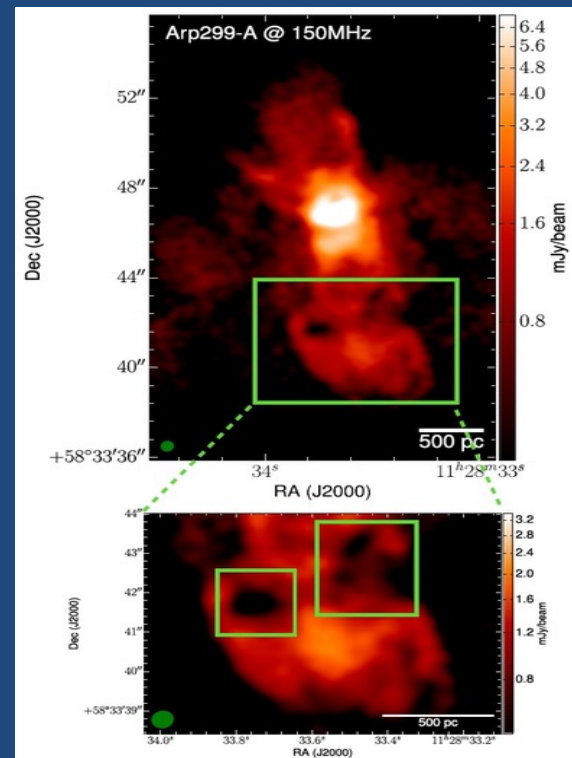
L. Hartmann (University Michigan, USA), P. T. P. Ho (ASIAA, Taiwan), J. I. Añez-López (ICE-CSIC, Spain), B. Balick (University of Washington, USA), R. Ortiz Moraes (Universidade Sao Paulo, Brasil), G. Ramos Larios (Universidad de Guadalajara, Mexico), E.I. Santamaría Domínguez (CUCEI, Universidad de Guadalajara, Mexico), J.A. Toalá (IRyA-UNAM, Mexico).

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



The transient Arp299-B AT1 and its host galaxy Arp299. The VLBI observations show a prominent radio jet expanding at an average speed of about one quarter the speed of light, caused by a tidal disruption event [147]



LOFAR image at 150 MHz (white means brighter) of the nuclear region of the luminous infrared galaxy Arp 299A, showing a filamentary structure in the N-S direction caused by a powerful starburst-driven outflow [181]

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.

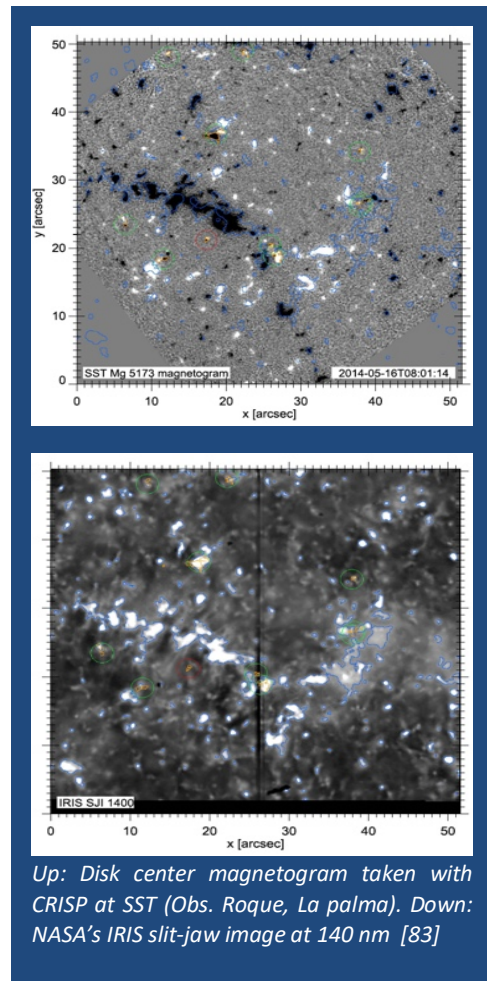
Highlights in 2018

Science

- A study of the polarization produced by the Zeeman effect on the Mg I_b lines on our way for the science to be done with IMAx+ aboard *Sunrise* III [179].
- The algorithms to be carried in the pipeline on board SO/PHI for *Solar Orbiter*.
- The cancellation of opposite polarity magnetic features in the photosphere is found to be associated with localized heating events in the transition regions. The plasma temperature is enhanced by more than 1000 K and therefore flux cancellation is an efficient way to heat the outer solar atmosphere. However, the cancellation rate observed with current instruments is too small to explain the global heating of the chromosphere and transition region, which occurs all over the solar surface [83].
- We have already published SOPHISM, the software end-to-end simulator of SO/PHI [31].
- The "Hinode-12 The many Suns" workshop has been organized from the 10th to the 13th of September (<http://spg.iaa.es/hinode12/>).

Instrumentation

- SO/PHI's RTE firmware flight model delivery.
- SO/PHI's Compression firmware flight model delivery.
- SO/PHI's E-Unit flight spare delivery.
- Conceptual design review of IMAx+ as a whole and of the SCIP electronics and software, for *Sunrise* III.



- Agreement on the participation of technological pre-developments for the PMI instrument aboard the ESA's Lagrange mission.

MEMBERS

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

INVITED RESEARCHERS

Utz, D. (U. Graz, Austria), Campos Rozo, J.I. (U. Graz, Austria), Murabito, M. (Oss. Astronomico di Roma, INAF, Italia), Hansteen, V. (U. Oslo, Norway), Ortiz Gil, A. (U. of Oslo, Norway), Gosic, M. (LMSAL, Palo Alto, CA, EEUU)

LINES OF RESEARCH

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

STELLAR SYSTEMS

Overview

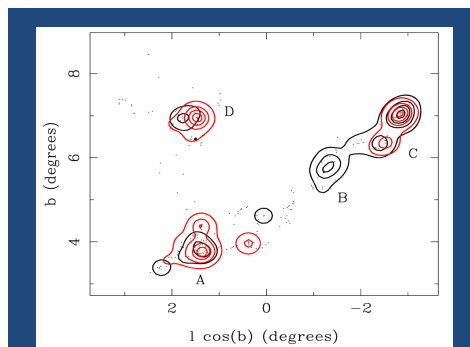
The Stellar Systems Group (SSG) was created in 1988. Since then, our research interests have diversified, even though the group has grown at a lower pace. The group's development departed from two fundamental concepts: (1) Internationalization, understood as the establishment of collaborations with leading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

The ERC Consolidator Grant GALACTICNUCLEUS is still in operation, and we are leading or actively involved in four main surveys connected with stellar clusters, Galactic Centre, Galactic structure and massive stars (Gaia-ESO Survey, GALACTICNUCLEUS Survey, GALANTE, and GOSSS). In 2018, the Galactic Centre Group (GCG) finished the acquisition of the data for the GALACTICNUCLEUS survey (see <http://gc.iaa.es>), and the first target fields of GALANTE survey were reduced and analysed.

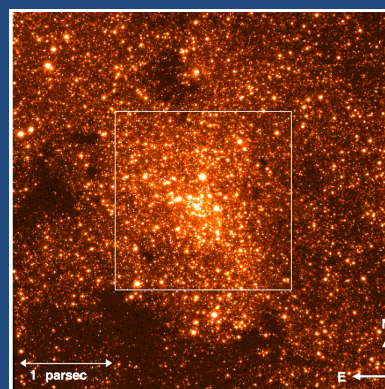
We continue the Gaia-ESO collaboration with the publication of several papers, one of them focussed on stellar cluster in common with Gaia DR-1. In addition, we have proposed for the first time that volume density is the main physical variable driven the spatial segregation observed in the core's distribution of the Pipe nebula.

Highlights in 2018

- Observational and theoretical confirmation of the predicted stellar cusp around the super massive black hole at the centre of the Milky Way in a series of three papers [206].
- Publication of the first paper on the GALACTICNUCLEUS survey, with description of the methodology, data reduction, quality of the data, and an analysis of the near-infrared extinction curve toward the Galactic centre [165].



Surface density map of the peaks of the Pipe Nebula. Black contours: distribution of the 40 more massive cores. Red contours: location of the 40 densest objects. Volume density appears to drive a higher segregation [10]



Ks-band ($2.2 \mu\text{m}$) mosaic of the Galactic centre, observed with NACO/VLT [72; cover image of A&A, January 2018, vol. 609]

- The innermost bulge of the Milky Way, adjacent to the nuclear stellar disc, is very old (~ 12 Gyr) and metal rich (around twice the solar metallicity) [166].
- Primordial mass and density segregation in a young molecular cloud [10].

MEMBERS

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

INVITED RESEARCHERS

J. Alves (Wien U.) A. Ciurlo (UCLA), A. Eckart (University of Cologne), T. Fritz (IAC), M. Hilker (ESO), J. Sánchez-Bermúdez (ESO), M. C. Sánchez-Gil (U. de Cádiz)

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.

Besides, activity related with open science within the project SKA-Link have led the group to participate in the ESCAPE European project.

Highlights in 2018

- Fractal analysis applied to light curves of δ Scuti stars. We developed tools to perform (for the first time) fractal analysis on light curves (time series) of classical pulsators (delta Scuti / gDor / hybrid). This allowed us to find fractal footprints in the light curves of delta Scuti stars, which opens the possibility not only to disentangle different contributions to the observed signal (e.g. pulsation, noise, turbulence, magnetic activity, etc.) [51]

- We showed two important findings for the study of pulsating stars: (1) in contrast to a wide opinion in the field so far, gaps in time series must allays be filled. We showed that the best method (the one better preserving the frequency content) is a non-analytic method based on auto-regresive moving average (ARMA, Pascual-Granado et al. 2015 A&A, 575 (2015) A78); and (2), the pre-whitening method (largely used in the field to obtain stellar oscillation frequencies) is efficient and must be revised [169]

MEMBERS

S. De Franciscis; R. Garrido; M. Lares-Martiz; P. López de Coca; J. Pascual-Granado; J. R. Rodón, S. Martín Ruiz, J.I. Olivares

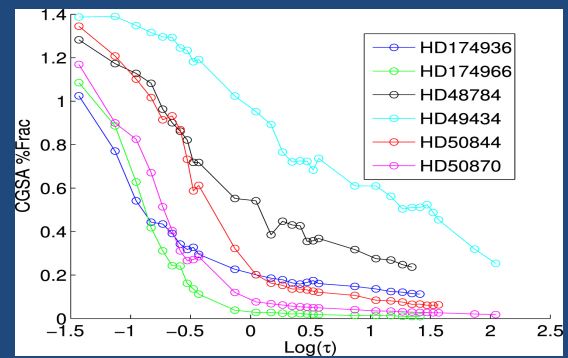
LINES OF RESEARCH

Time Series Analysis

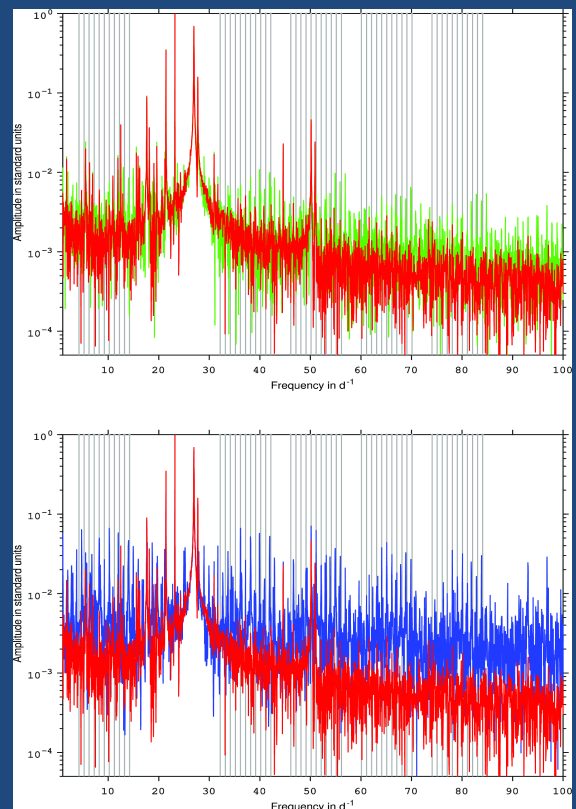
Open Science

Stellar Structure

Fractal analysis



CGSA %Frac versus window size τ for the six Corot δ Scuti stars analysed in this study. For each τ CGSA algorithm analysed the 90% of the total length, performing the cross-spectra orthogonalization among $N_s = 50$ partially overlapping subsets [51]



Powerspectra of the light curves from HD 174966: lower panel shows gapped data in blue and ARMA-interpolated data in red, upper panel shows linearly interpolated data in green and ARMA-interpolated data in red. Vertical gray lines show the main peaks of the spectral window [169]

TERRESTRIAL PLANET'S ATMOSPHERES

Overview

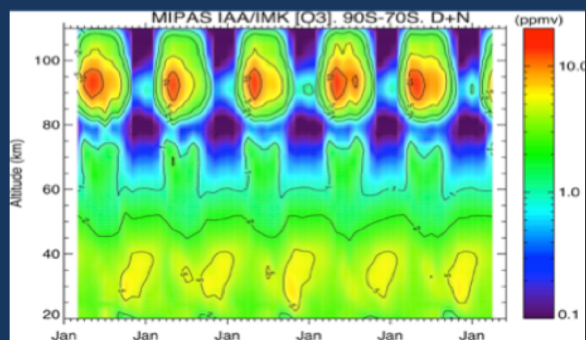
We investigate the Earth's atmosphere by retrieving, processing and analysing data of MIPAS and SABER (space-) and SATI (ground-) based instruments. Special focus is on the study of the effects of solar particles and solar radiation on atmospheric composition, and trends in temperature and species abundances. We also study atmospheric electricity in planetary atmospheres and are preparing for the analysis of the ASIM and TARANIS missions. The ESA ASIM mission was successfully launched in April 2018 and in June data started to be available. The ERC eLightning project continued developing numerical models of atmospheric lightning. The GALIUS laboratory was opened in April. We coordinated the EU H2020 project UPWARDS, devoted to the exploitation of Mars Express data and preparing for Exomars. We continued the analysis of the Martian upper atmosphere using GCM models and Mars Express and IUVS-MAVEN data; and started the analysis of NOMAD/TGO data. In exo-atmospheres studies, we detected a multiband signal of H₂O in HD189733b and analysed the Helium triplet absorption in the escaping atmospheres of HD189733b and WASP 69b from CARMENES data.

Highlights in 2018

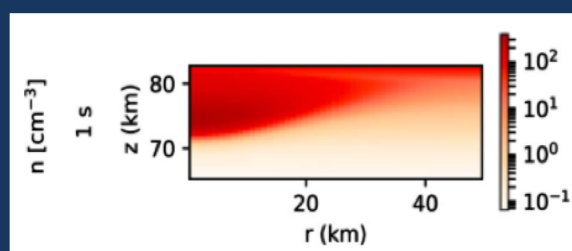
- We retrieved 3D global distributions of ozone (latitude, longitude and height) from MIPAS observations for the 2005-2012 period. This is one of the most comprehensive and complete O₃ datasets so far obtained; being used worldwide including the ESA O3-CCI project [124].
- We modelled the local chemical influence of HALOS and different types of ELVES. We predict that HALOS originated by strong cloud-to-ground lightning produce significant enhancements of the mesospheric electron density, N₂O, and NO [172]. Also, although we found a global production of NO due to HALOS and ELVES of ~10⁻⁷ Tg N/year, this is not significant for global scale chemistry.
- We simulated for the first time with a 3D model the UV atmospheric emissions in the dayside of Mars [81]. The predicted emissions compare well to observations by SPI-CAM/Mars Express and are strongly affected by the atmospheric variability.

MEMBERS

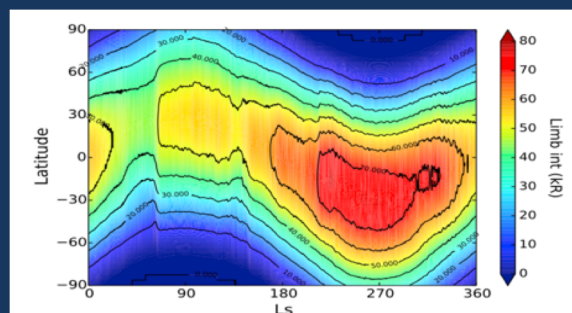
A. Cala, B. Funke, M. García Comas, A. Gardini, M. Gomes, F. González Galindo, M. González, F.J. Gordillo, B.N. Hill, S. Jiménez Monferrer, N. Kieu, D. Li, A. Luque, M.J. López González, M. López Puertas, M.Á. López Valverde, A. Malagón,



Global distribution of ozone at the Southern polar region retrieved from MIPAS spectra [124]



Local enhancement of the mesospheric electron density due to a HALO lasting 1 s and caused by a strong cloud-to-ground lightning with a charge moment change of 560 C km [172]



Seasonal and latitudinal variability of the peak intensity of the CO₂+ UV doublet in the Mars upper atmosphere [81]

M. Passas, F.J. Pérez Invernón, A. Sánchez López, J. Sánchez del Río, A. Schmalzried, S. Soler

INVITED RESEARCHERS

F. Lefèvre (LATMOS, Paris, France), H. Christian (UAH, EEUU), Y. Yair (IDC, Israel), O. van der Velde (UPC, Barcelona), I. Tanarro (IEM-CSIC, Madrid), A. Cardesin (ESAC, Madrid)

LINES OF RESEARCH

Earth's middle atmosphere variability and its impact on climate; Atmospheric Electricity in Planetary Atmospheres; Thermal structure and composition of the Terrestrial planetary atmospheres and exo-atmospheres; Remote sensing of planetary atmospheres in IR and UV

THEORETICAL GRAVITATION AND COSMOLOGY

Overview

20th-century physics totally changed the way we understood the world by giving birth to two revolutionary theories, General Relativity (GR) and Quantum Mechanics (QM). However, it has left us with a giant puzzle which might turn to be the seed of a new revolution. Instead of having a single theoretical framework with which to understand nature, we have two, and two which are mutually inconsistent, at least as far as we can see. In order to describe a system or process in physics we have first to decide which of these two 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.

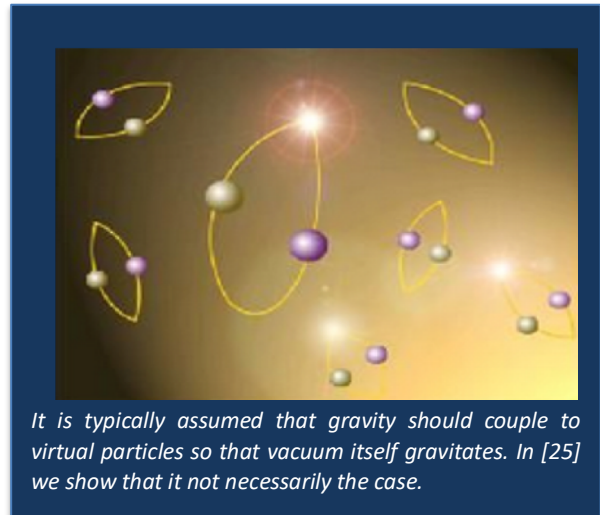
The main activity of our group is to investigate these two situations and to search for ways of combining the gravitational and the quantum realms. For that we use a wide range of techniques: From geometrical techniques in GR to group-theoretical and condensed matter techniques.

This research line of the IAA contains a number of specific subtopics that we pass now to briefly describe.

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 are analyzing the effect that a specific regularization of the classical singularity would have in the process of collapse itself and in the final forms of equilibrium one could attain.

2. 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 Gravity: Condensed matter systems with emergent geometrical properties have already proved 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



It is typically assumed that gravity should couple to virtual particles so that vacuum itself gravitates. In [25] we show that it not necessarily the case.

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 it is the origin of the mass of elementary particles. In the standard model of particle physics the mass emerge 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 2018

We have revised the essential features of the cosmological constant problem for a gravitational theory which is dynamically indistinguishable from standard general relativity. We have shown that this theory circumvents the appearance of a cosmological constant problem. The cosmological constant in this theory is free from radiative corrections making the theory better behaved from an effective field theory perspective [25].

MEMBERS

V. Aldaya and C. Barceló

INVITED RESEARCHERS

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

LINES OF RESEARCH

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

CALAR ALTO OBSERVATORY

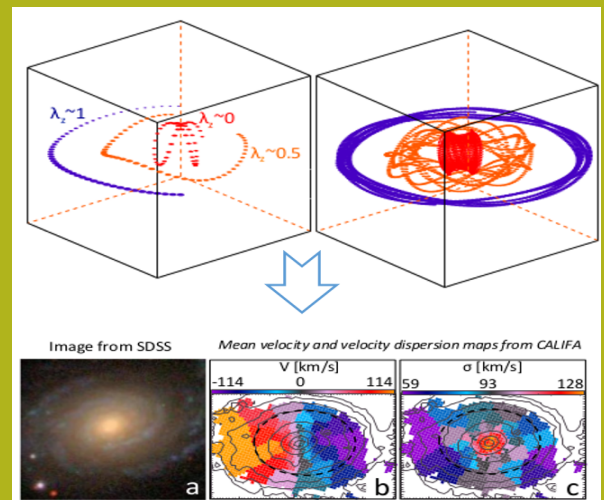
The IAA is also the reference institute for the Calar Alto Hispano-Alemán observatory (CAHA). The German-Spanish Astronomical Center at Calar Alto is located on the mountain range of Los Filabres, in Almería, at a height of 2167m. CAHA is operated jointly by the Max-Planck-Institut für Astronomie (MPIA,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

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

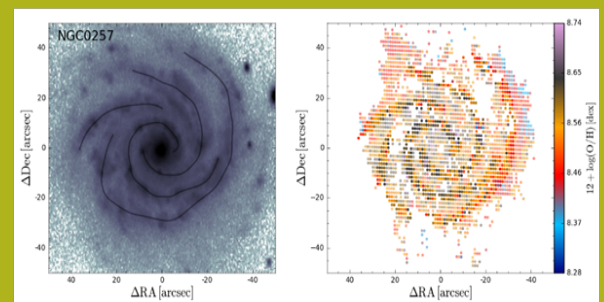
SCIENTIFIC RESULTS IN 2018

LIBRARY OF GALAXY HISTORIES RECONSTRUCTED FROM MOTIONS OF STARS

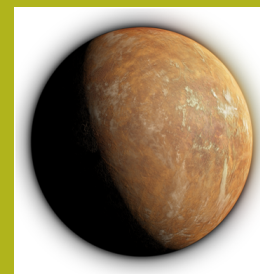
The CALIFA survey allowed to map the orbits of the stars of a sample of 300 galaxies, a fundamental information to know how they formed and evolved. Just like the Sun is moving in our Galaxy, the Milky Way, all the stars in galaxies are moving, but with very different orbits: some of the stars have strong rotations, while others may be moving randomly with no clear rotation. Comparing the fraction of stars on different orbits we can find out how galaxies form and evolve. An international team of astronomers derived directly, for the first time, the orbital distribution of more than 300 galaxies on the local universe. The results, published in Nature Astronomy [247], were based on the CALIFA survey.



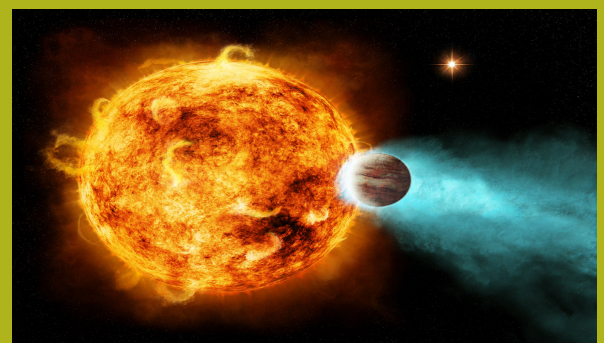
Theoretical orbit superposition models of a galaxy can match CALIFA observations [247]



Grand design Spiral NGC0257. Left: spiral structure over SDSS image. Right: Oxygen abundance map traced using CALIFA data



Artistic view of the Super-Earth around Barnard's star, discovered with CARMENES



Artistic view of a hot Jupiter with an evaporating atmosphere. NASA/Ames/JPL-Caltech

BEST PHD THESIS IN SPANISH ASTRONOMY (SEA) USES CALIFA DATA

Laura Sánchez-Menguiano's thesis got the best 2017 PhD thesis award from the Spanish Astronomical Society. It is based on CALIFA data, taken with the PMAS Integral Field Spectrograph at the 3.5-m Calar Alto telescope, aimed at scrutinizing the spiral structure in disk galaxies. The formation and persistence of spiral arms in galaxies is still not well understood, despite the arms should play a major role in the chemical and dynamical evolution of disk galaxies.

CARMENES SPECTROGRAPH TEAM, LOCATED AT THE CALAR ALTO OBSERVATORY, BEGUN TO RECEIVE THE ALERTS IN FROM TESS

TESS mission (MIT-NASA), with will examine more than two hundred thousand stars along its two years life, constitutes one of the presently most important project for the search of exoplanets, as it will detect planets that can be studied and characterized with instruments that exist today on earth. One of such instruments that will analyze TESS data is CARMENES, whose team already begun receiving TESS planets detections alerts.

SUPER-EARTH DISCOVERED AROUND THE SECOND NEAREST STELLAR SYSTEM

An international team led by researchers from the CSIC found a cold Super-Earth orbiting around the Barnard's star, the second closest star system to Earth, being the first time that astronomers discover this type of exoplanet using the radial velocity method. The results were published in Nature [191]. Observations with CARMENES were decisive for this discovery.

THE "PLANET HUNTER" CARMENES STUDIES EVAPORATING ATMOSPHERES AND WATER VAPOR BEYOND THE SOLAR SYSTEM

Three studies with the infrared channel of the CARMENES instrument, developed at the IAA-CSIC, open a door to the study from the ground of the composition of exoplanetary atmospheres, their escape processes and their clouds and aerosols. The studies, published in the journals "Science" [167] and "Astronomy & Astrophysics" [196], analyzed the proportion of helium and water vapor in the atmospheres of several exoplanets, offering data with better resolution than those of the Hubble Space Telescope and opening new avenues in atmospheric studies.

TECHNOLOGICAL ACTIVITIES IN 2018

CALL FOR LETTERS OF INTENT FOR THE CONSTRUCTION OF THE NEXT GENERATION INSTRUMENT FOR CAHA 3.5M TELESCOPE

In May 2018 Calar Alto solicited letters of intent for a promising science-case/instrument, from proposing teams, to be evaluated by a Scientific Advisory Committee. Junta de Andalucía and University of Almeria (in close collaboration with CAHA and IAA-CSIC) provided 100k€ to fund up a feasibility study. It is expected that the final instrument investment should be predominantly externally funded, in return for extensive (multi-year) telescope access.

The project selected was LUCA (Local Universe from Calar Alto), aimed at unravelling physical processes at small enough scale to study how the star formation and evolution affects the formation and evolution of galaxies in our local universe. The project was conceived at the IAA-CSIC.

CALAR ALTO INSTALLED A NEW INFORMATION TECHNOLOGY (IT) VIRTUALIZATION INFRASTRUCTURE

A new computer infrastructure based on the virtualization of the servers was installed. The control of telescopes and scientific instrumentation, data acquisition, data storage and its efficient management and making them available to the scientific community relay on the IT infrastructure. The optimal exploitation of last generation instruments like CARMENES or PANIC, requires a huge amount of IT resources, as well as the research or administrative activity of the center. The server virtualization was executed by Calar Alto engineering staff and funds from the European Regional Development Funds (ERDF).

CAFE: A MORE ACCURATE AND EFFICIENT INSTRUMENT ON THE 2,2M TELESCOPE

The Calar Alto observatory enhanced the accuracy of the high-resolution spectrograph CAFE (Calar Alto Fiber-fed Échelle spectrograph), installed since 2011 on the 2.2-m telescope. The improvement is based on a new temperature control system and the renewal of a key element of the instrument. This update provides a higher accuracy for the studies of stars and exoplanets.

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 upgrading intervention, Albireo has not been available during 2018.

The southernmost high-altitude location in continental Europe, together with the dry climatic conditions of Sierra Nevada makes the OSN an excellent place for carrying out other kind of 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 2018

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 2018 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: 3 papers were submitted and 6 more are in preparation.
- Follow-up photometry of M dwarf targets of the international *RedDots* program, whose aim is to survey all M dwarfs at less than 5pc, was done at the T90: one of those targets was Barnard star, for which the T90 photometry was used to derive its rotation period, and a planet was discovered and published in Nature [191].
- Two-year observations on WASP-12b were used to publish its refined orbital decay, as part of a larger study to detect companions to hot Jupiters [131].
- Several GRBs were observed, detecting afterglows and doing their follow-up.



Sierra Nevada Observatory. Credit: J.L. de la Rosa

Collaborations in 2018

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 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 visiting program for foreign students.

An episode from Lab24 (outreach program of the national television, RTVE, for science and technology) was filmed at the OSN; it can be watched at the link:

<http://www.rtve.es/alacarta/videos/lab24/lab24-105/4635578/>

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

MEMBERS

OSN Director: C. Rodríguez López; S. Martín (up to March 2018). OSN Technical Director: M. Abril

OSN Technical Personnel: L. Costillo, A. Maza, Á. Tobaruela

Support Personnel: F.J. Aceituno, V. M. Casanova, J.L. de la Rosa, A. López-Comazzi, J. A. Mirasol, T. Pérez, J. A. Ruiz, F. S. Funes, 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, UDIT) is in operation at the IAA since its foundation in 1975. State-of-the-art instruments designed and built at the UDIT for balloon and terrestrial rocket payloads in early times and for space missions and ground-based observatories nowadays, have placed the IAA on the map as a reference center for technological-challenging research projects. The technical production at the UDIT can be split into two major lines:

- Analysis, design, integration, and verification of astronomical instruments for ground-based telescopes, especially for the telescopes at CAHA and OSN.
- Analysis, design, integration, and verification of astronomical instruments for interplanetary scientific missions.

In the following lines we present a summary of the activities performed during 2018 for the instrumentation projects developed at the UDIT.

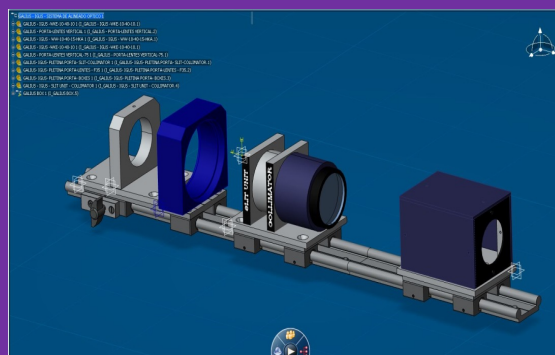
GROUND BASED INSTRUMENTS

MOSAIC (Multi-object spectrograph for ELT). The IAA will contribute with the hardware and software control for the cryogenic mechanisms of the IR spectrograph. The activities in 2018 were focused on the documentation for the Phase A, and on the prototype definition for phases B and C.

MIMA (Multi-Spectral Imager Mesopause Airglow). Based upon a well proven concept of the instrument SATI currently working at OSN, MIMA is a portable ground-based image (2D) VIS-NIR spectrometer with 5 channels for long long-term monitoring of mesopause change. In 2018 the optical design of the instrument was finished and a tolerance and straylight analysis performed. The development of the control software of the instrument was focussed on the filter wheel and



Artificial view of the MIMA instrument



GALIUS mechanical design

power supply control, user graphical interface and the observation planner. The mechanical parts of the mirror as well as the filter wheel were optimized.

GALIUS (GrAnada Lightning Ultrafast Spectrograph), a portable, high spectral resolution imaging spectrograph that achieves unprecedented high speeds, working in the ultraviolet, visible and near infrared spectral ranges. In 2018 the instrument was manufactured and installed at one of the UDIT laboratories. Several tests were performed to calibrate the instrument and to obtain different instrumental functions.

CARMENES UPGRADE. A prototype for heat transfer was designed and manufactured; a set up was also designed and manufactured to perform several tests that will allow characterizing the dissipated power and the efficiency of two types of heaters transfer in several conditions.

HIRES (High Resolution Spectrograph for E-ELT). The IAA is involved in the thermal design of ZYHJ and BVRI channels. The phase A documentation was successfully reviewed. First estimations for the telescope thermal IF were done in 2018.

GREST (Get Ready for EST). The IAA was in charge of the development of large size liquid crystals modulators for EST. This project was successfully finished in 2018 with the fulfillment of the established requirements: to build LCVR cells bigger than 15x15 cm².

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. We are also responsible for the electronics unit and the harness work packages. During 2018 the E-Unit Flight Spare Model was delivered to the PHI consortium. The flight version of the firmware in charge of inverting the Radiative Transfer Equation, the scientific core of the instrument, as well as the flight version of the firmware in charge of performing the image compression were delivered to MPS (PHI PI institution). The launch is foreseen in February 2020.

NOMAD (Nadir and Occultation for Mars Discovery for the ESA ExoMars-TGO mission). In 2018 the mission stated the operation phase, with no incidences detected in the instrument.

GALA (GANymede Laser Altimeter) and **JANUS** (Jovis, Amorurum ac Natorum Undique Scrutator) for the ESA mission JUICE. We are responsible for the power supply modules of both instruments, and the filter wheel and mechanism controller module (FWM-MCM) of the JANUS camera. In 2018 the PDR for both instruments was successfully passed; the Structural and Thermal Model and the Engineering Model of the power supply and the filter wheel were successfully delivered to ESA. The documentation package for the Critical Design Review was elaborated and a pre-qualification model for the filter wheel was designed and manufactured.

PLATO (PLANetary Transits and Oscillation of stars, ESA). The IAA is responsible for the 2 Main Electronic Units (MEUs) of the instrument. Each MEU is equipped with 6 DPUs and 2 SpaceWire routers also under IAA responsibility. In 2018 the BreadBoard Model of the MEU was successfully delivered to ESA. Additional BB models were manufactured for testing purposes with different parts of the instrument. The documentation package for the Instrument PDR was also delivered.

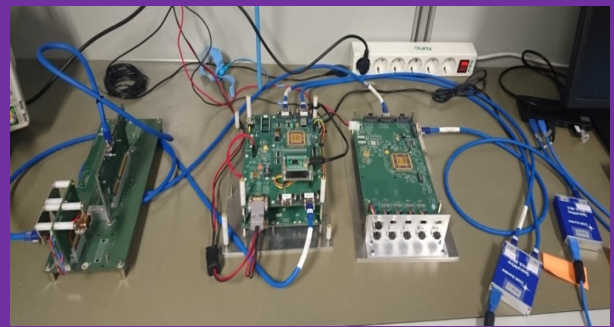
SUNRISE III. Sunrise III is the third mission of the 1m Sunrise solar telescope. The IAA manages the IMAx+ instrument consortium, being in charge of the electronics, harness, control software and the



SO/PHI E-UNIT Flight Spare (FS) model



JANUS Filter wheel Engineering Model (EM)



PLATO Bread Board (BB) Model

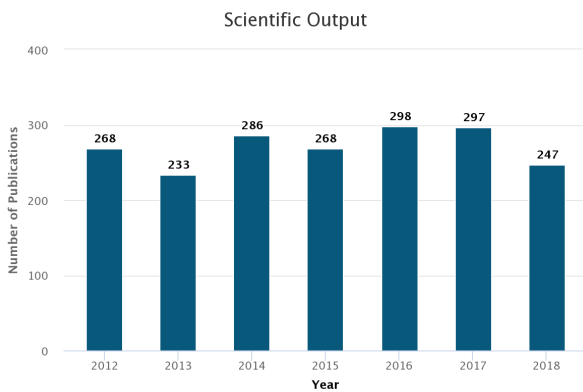
electronics and mechanical of the scientific cameras for the **IMaX+** and **SCIP** instruments. In 2018 the IMAx+ Conceptual Design Review was successfully passed. A first prototype of the scientific camera was designed and built, to be tested beginning 2019. The breadboard models of the different electronics subsystems were also designed.

UDIT Members: **Electronics:** M. Abril, D. Álvarez, B. Aparicio, L.P. Costillo, F.J. Girela, M. Herranz, J.M. Jerónimo, J. Jiménez, P. Labrousse, H. Magán, I. Martínez, J.L. Ramos, N. Robles, J. Rodrigo, J. Sánchez, M. R., Sanz, A. Tobaruela. **Mechanics:** S. Becerril, I. Bustamante, R. Calvo, E. Mirabet, F. Álvarez, M.A. Sánchez. **Optics:** F.J. Bailén, A. Maza. **Project Management:** M. Balaguer, J.M. Castro, A. López, J.F. Rodríguez. **Software:** J.P. Cobos, A. García, J.M. Gómez, D. Hernandez, J.M. Ibáñez, R. Morales, A.J. Moreno, M. Passas, C. Pastor, A. Sánchez.

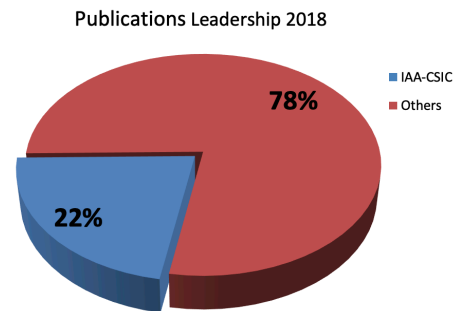
SCI PUBLICATIONS

The research activity carried out at the IAA-CSIC during 2018 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 247 papers published in journals of the SCI.

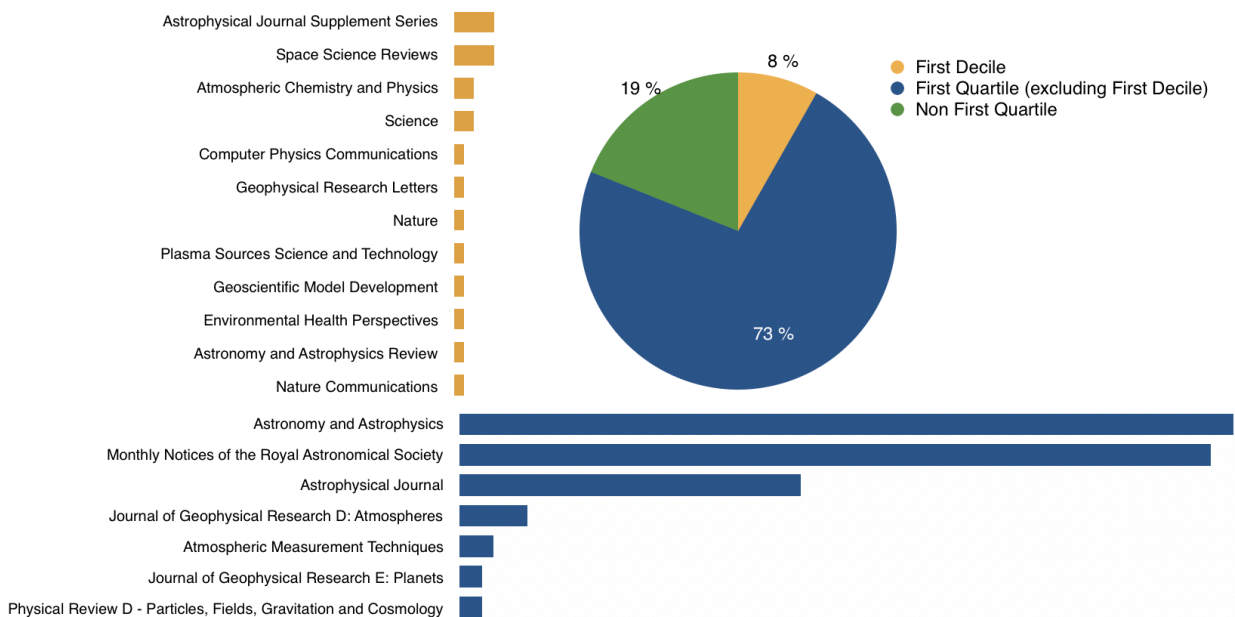
The complete list of the IAA-CSIC publications in 2018 is given in the Annex at the end of this report. The evolution of the number of SCI publications since 2012 is shown below. Along the years, the number of publications fluctuate around an average value of 280 papers per year.



The publications of the IAA-CSIC are mostly distributed in high impact journals (see the figure in the following page). About 73% of our publications appeared in journals of the first quartile (top 25% journals). Among these publications, 8% 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 a quarter (22%) of the IAA SCI 2018 publications are led by IAA scientists, i.e. their first author belongs to the IAA. This is consistent with the leadership of the IAA in the last 5 years. Furthermore, 97% of the IAA publications include authors from international institutions, probing the extraordinary level of internationalization of the IAA research.



AWARDS

AWARDS IN 2018

Center of Excellence “Severo Ochoa” Award. The IAA-CSIC was awarded with this accreditation and support from the Spanish Ministry of Science, Innovation and Universities, deserved to *“organizational structures with highly competitive strategic research programmes in the frontiers of knowledge, among the best in the world in their respective scientific areas”*. IAA-CSIC was the only new center to get this award, which was officially notified on November 2018.



Nature Research Award for Inspiring Science 2018, devoted to celebrate and support the achievements of leading women in science, and of those who have encouraged girls and young women to engage with STEM subjects around the world. **Mirjana Povic**, assistant professor at the Ethiopian Space Science and Technology Institute, Ethiopia, and associated researcher at the IAA-CSIC, won this award in its inaugural call.

<https://www.nature.com/collections/jcpghfmqlz/pastwinners>



First “Granada Ciudad de la Ciencia” award for “Women in research”, devoted to a women researcher working in Granada, with a recognized international career who has also contributed to the visibility of the work of women in science. **Josefa Masegosa** won this award, recognising her excellent scientific contributions together with her commitment to make women visible in Science.



First “Granada Ciudad de la Ciencia” award for “Young researcher”, devoted to young postdocs with an already high impact career. **Juan Pedro Cobos** won this award, recognising his scientific trajectory as an instrumentalist in Astrophysics.



<https://www.iaa.csic.es/noticias/investigadores-iaa-galardonados-con-premios-granada-ciudad-ciencia-y-innovacion>

Award “Vanguardia de la Ciencia”, devoted to provide visibility to excellence research carried out in Spain. **José Luis Ortiz** received this award, recognising his contribution to what the journal “La Vanguardia” considered the most important scientific advance made in Spain in 2017, which showed that the dwarf planets of the outer solar system can have rings.

<https://www.lavanguardia.com/ciencia/20180410/442398485247/premio-vanguardia-de-la-ciencia-planetas-enanos-anillos.html>



“XXXIII Premio Andalucía de Periodismo” from the Junta de Andalucía, in the modality “Radio”, was awarded to the programme **“Radioscopio”**, a collaboration between RTVA and IAA, led at the IAA-CSIC by **Emilio J. García**. The ability to use high quality formats in the radio language of this space broadcast by Radio Andalucía has been highlighted. Its vocation for scientific dissemination supported by Andalusian experts and aimed at the development of its own community has also been valued.

<http://www.juntadeandalucia.es/presidencia/portavoz/sociedad/138557/JuntadeAndalucia/OficinadelPortavozdelGobierno/XXXIIIPremiosAndaluciadePeriodismo/Prensa/Radio/Television/Fotografia/Internet>



“Prismas de Divulgación Científica 2018” from the scientific museums in Coruña (Spain), was awarded for the **“Radioscopio: viaje a Lovaina”**, by Radio Andalucía, as the best work in radio. The programme is broadcasted by Susana Escudero (RTVA), **Emilio J. García (IAA)** and José M. Álvarez (RTVA).

https://www.ivoox.com/radioscopio-n-174-viaje-a-lovaina-audios-mp3_rf_22814008_1.html



“Gran Premio Unicaja Festival Cine Científico BICC Ronda-Madrid-México”, from the “Spanish Association of Scientific Cinema and Image” for the best audiovisual work of the contest, was delivered unanimously by the jury to the audiovisual work **“El Enigma Agustina”** by **Manuel González and Emilio J. García**.

https://cadenaser.com/emisora/2018/11/19/radio_coca_ser_ronda/1542632388_867188.html



EDUCATION

PHD THESES

"PANIC, una cámara infrarroja de gran campo para el observatorio de Calar Alto."

Author: María Concepción Cárdenas Vázquez

Supervisor: Julio Federico Rodríguez Gómez

Universidad de Granada

Dec 12, 2018

"Study of the origin of HI asymmetries of the highly isolated galaxy CIG 96 by means of deep optical and HI observations"

Author: Pablo Ramírez Moreta

Supervisors: Lourdes Verdes-Montenegro Atalaya, Stéphane Leon

Universidad de Granada

Jul 27, 2018

"Sistemas astronómicos de gran campo y su aplicación al estudio de meteoroides en la atmósfera terrestre"

Author: Francisco Espartero Briceño

Supervisor: Alberto Javier Castro Tirado

Universidad Complutense de Madrid

Jun 22, 2018

"Dust in planetary and cometary atmospheres: an experimental and computational study based on the analysis of a lunar dust analog"

Author: Jesús Escobar Cerezo

Supervisors: Olga Muñoz Gómez, Fernando Moreno Danvila

Universidad de Granada

Mar 23, 2018

"Modelling of atmospheric electricity phenomena in the atmospheres of Venus, Earth, Jupiter and Saturn"

Author: Francisco Javier Pérez Invernón

Supervisors: Francisco José Gordillo Vázquez, Alejandro Luque Estepa

Universidad de Granada

Mar 22, 2018

TEACHING

Undergraduate, Master and PhD Programs

Title: **Stellar interior and evolution and Radiation Measurements in Astrophysics, Computational and statistical astrophysics, Galactic and Extragalactic Astronomy, Galactic Dynamics and ISM**

Authors: **Mirjana Povic**

Program: MSc in Astronomy and Astrophysics

University: Ethiopian Space Science and Technology Institute (Ethiopia)

Hours: more than 500

Dates: October 2017 - February 2018, and October 2018 - February 2019

Title: **Observational techniques in Astronomy**

Authors: **Mirjana Povic**

Program: MSc in Astronomy and Astrophysics

University: Mbarara University of Science and Technology (Uganda)

Hours: 90

Date: May 2018

Title: **Astrobiología y Planetas Extrasolares**

Authors: **Manuel López-Puertas y Miguel Ángel López Valverde**

Program: Máster en Física: Física de Partículas y Astrofísica

University: U. Granada

Hours: 20

Title: **Radioastronomía**

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

Program: Máster en Física y Matemáticas (FISYMAT)

University: U. Granada

Hours: 60

Date: Octubre 2018-February 2019

Title: **Física del Cosmos**

Authors: José Ignacio González Serrano, **Enrique Pérez Jiménez**

Program: Máster Universitario en Física de partículas y del Cosmos

University: U. Cantabria & U. Internacional Menéndez Pelayo

Hours: 10

Date: 1 October 2018 to 8 October 2018

Title: **Curso de Astrofísica Estelar**
Authors: **Javier Pascual Granado**
Program: Máster Online en Astronomía y Astrofísica
University: U. Internacional de Valencia
Hours: 30
Date: July-October 2018

Title: **Técnicas Observacionales e Instrumentación Astronómica**
Authors: **Martín Antonio Guerrero Roncel, Alberto Javier Castro Tirado**, Simon Verley
Program: Master en Física y Matemáticas (FISYMAT)
University: U. Granada
Hours: 42
Date: 11 April 2018 – 04 June 2018

Title: **Cosmología y Galaxias**
Authors: Mar Bastero, **Emilio J. Alfaro**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: U. Granada
Hours: 30
Date: 2017-2018

Title: **Radio Astronomy and Radio Interferometry**
Authors: **Miguel Ángel Pérez Torres**
Program: Máster de Física Avanzada
University: U. Valencia, Estudi General
Hours: 10
Date: January 2018

Title: **Estrellas, Nucleosíntesis, Evolución Química**
Authors: **José Manuel Vilchez Medina**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: U. Granada
Hours: 15
Date: March-June 2018

Title: **Mecánica y Ondas**
Authors: **Francisco Nogueras Lara** and teachers of Departamento de Física Aplicada
Program: Degree in Physics
University: U. Granada
Hours: 15
Date: second semester, term 2017-2018

Title: **Física del Medio Ambiente**
Authors: **Francisco Nogueras Lara** and teachers of Departamento de Física Aplicada
Program: Degree in Physics
University: U. Granada
Hours: 10
Date: second semester, term 2017-2018

Title: **Fundamentos físicos de la ingeniería**
Authors: **Francisco Nogueras Lara** and teachers of Departamento de Física Aplicada
Program: Degree in Engineering of Telecommunication Technology
University: U. Granada
Hours: 15
Date: second semester, term 2017-2018

Title: **Física de los Procesos Biológicos**
Authors: **Francisco Nogueras Lara** and teachers of Departamento de Física Aplicada
Program: Degree in Biology
University: U. Granada
Hours: 10
Date: second semester, term 2017-2018

Title: **Mecánica y Ondas**
Authors: **Francisco Nogueras Lara** and teachers of Departamento de Física Aplicada
Program: Degree in Physics
University: U. Granada
Hours: 50
Date: first semester, term 2018-2019

Title: **School on Long Slit Spectroscopy**
Authors: **Rubén García Benito**
Program: Master of joint program
Universities: Mbarara U. (Uganda) and U. Rwanda
Hours: 44
Date: 26 August - 1 September 2018

Other Programs

Title: **The chemistry of electric discharges and the use of spectral images**
Authors: **Francisco J. Gordillo Vázquez**
Program: First winter school of the Science and Innovation with Thunderstorms (SAINT) network
Organizer: Danish Technical University
Hours: 2 h
Date: 15 January 2018

Title: **Atmospheric Electricity in the Earth and other planets of the Solar System**
Author: **Francisco J. Gordillo Vázquez**
Program: INNOLECT Lectures
Organizer: Masaryk University (Brno, Czech Republic)
Hours: 1.5 h
Date: 5 November 2018

Title: **Parameterization of lightning and blue jets in Atmospheric Chemistry Global Circulation Models (GCM): Global distribution, occurrence and chemical atmospheric effects**

Author: **Francisco J. Gordillo Vázquez**

Program: INNOLECT Lectures

Organizer: Masaryk University (Brno, Czech Republic)

Hours: 1.5 h

Date: 7 November 2018

Title: **Disk models in low and high-mass protostars**

Authors: **Mayra Carolina Osorio Gutiérrez**

Program: ICCUB School: Protoplanetary Disks in Young Stellar Objects

Organizer: Institut de Ciències del Cosmos. Universitat de Barcelona

Hours: 2 h

Date: 25 October 2018

Title: **Jets in Young Stellar Objects**

Authors: **Guillem Anglada Pons**

Program: ICCUB school: Protoplanetary disks in young stellar objects.

Organizer: Institut de Ciències del Cosmos, Universitat de Barcelona

Hours: 3

Date: 22 October 2018

Title: **Introduction to spectropolarimetry**

Authors: **Jose Carlos del Toro Iniesta**

Program: Post-graduate course

Organizer: Mullard Space Science Laboratory, University College (London, UK)

Hours: 20

Date: 2-13 July 2018

Title: **Radiative transfer**

Authors: **Jose Carlos del Toro Iniesta**

Program: 1st School on Solar Spectropolarimetry and Diagnostic Techniques, NCAR Advanced Study Program

Organizer: High Altitude Observatory (NCAR) at Estes Park (USA)

Hours: 10

Date: September 24-October 5, 2018

Title: **Stokes inversions based on response functions**

Authors: **Luis Bellot Rubio**

Program: 1st School on Solar Spectropolarimetry and Diagnostic Techniques, NCAR Advanced Study Program

Organizer: High Altitude Observatory (NCAR) at Estes Park (USA)

Hours: 10

Date: September 24-October 5, 2018

Title: **The Galactic Center and Gravitational Waves**

Authors: **Rainer Schödel**

Program: 2nd Institute of Space Sciences Summer

School: Gravitational Wave Astronomy

Organizer: IEEC-CSIC, Barcelona

Hours: 1.5

Date: 6 July 2018

Title: **Sistemas embebidos para la instrumentación científica**

Authors: **Juan Pedro Cobos Carrascosa, Juan Manuel Gómez López**

Program: Formación de Personal

Organizer: Gabinete de Formación CSIC (Science and Technology)

Hours: 25

Date: May 21-June 2, 2018

Title: **Del rol de la gravedad en las danzas y andanzas de la atmósfera**

Authors: **Maya García Comas**

Program: V Curso de Astrofísica

Organizer: U. de Verano de Teruel, Fundación Universitaria "Antonio Gargallo"

Hours: 2

Date: July 12-14, 2018

Title: **Long Slit Spectroscopy data reduction**

Authors: **Antonio de Ugarte Postigo**

Program: Neutron Star Merger Training Workshop

Organizer: H2020 COST action (PHAROS - CA16214)

Hours: 6

Date: November 14-16, 2018

Title: **La vida secreta de las galaxias (fundamentos y algunas propiedades de las galaxias)**

Authors: **Isabel Márquez Pérez**

Program: Un paseo por el universo: astronomía para disfrutar

Organizer: XIX Curso de verano de la U. de Almería

Hours: 2

Date: July 4, 2018

INTERNATIONAL

SEMINARS

★**Gabriele Bruni** (INAF)

Title: "RESULTS FROM THE RADIOASTRON AGN POLARIZATION KSP: A LIMB-BRIGHTENED JET IN 3C273"
Date: Dec 13, 2018

★**Dr. Jesús Toala** (Centro de Radioastronomía y Astrofísica, UNAM)

Title: "Spirals, rings and arcs around evolved stars "
Date: Nov 29, 2018

★**Dr. Gunther Witzel** (Max Planck Institute for Radioastronomy)

Title: "Time variable processes of Sagittarius A*, the massive black hole at the centre of the Milky Way"
Date: Nov 22, 2018

★**Dra Simona Lombardo** (Laboratoire d'Astrophysique de Marseille)

Title: "Curved focal plane-based pathfinder for ultra-low surface brightness observations"
Date: Nov 21, 2018

★**Dra. Mareike Godolt** (Technical University of Berlin)

Title: "The habitability of stagnant-lid Earths around dwarf stars"
Date: Nov 15, 2018

★**Dr. Alvaro Alvarez-Candal** (Observatorio Nacional de Rio de Janeiro)

Title: "What we (don't) know about the trans-Neptunian objects "
Date: Nov 08, 2018

Miguel Angel Pérez Torres (IAA - CSIC)

Title: "The Arp299B-AT1 puzzle solved: First resolved imaging of a tidal disruption event"
Date: Oct 25, 2018

Maia Leire García Comas (IAA- CSIC)

Title: "An unusual autumn Elevated Stratopause Event (ESE)"
Date: Oct 18, 2018

Martín Guerrero Roncel (IAA- CSIC)

Title: "The planetary nebula HuBi 1, a rebel with a cause"
Date: Oct 11, 2018

★**Dr. Benito Marcote** (Joint Institute for VLBI in Europe (JIVE))

Title: "The European VLBI Network (EVN) and user cases to improve your science"
Date: Oct 04, 2018

★**Baerbel Koribalski** (CSIRO)

Title: "ASKAP and HI in Galaxies"
Date: Sep 27, 2018

Ricardo Jorge Maranhães Gafeira (IAA - CSIC)

Title: "Slender CariiH fibrils observed by SUNRISE II"
Date: Sep 20, 2018

★**Dr. Lorena Hernández-García** (Universidad de Valparaíso)

Title: "The peculiar case of the active galactic nuclei in PBC J2333.9-2343"
Date: Sep 13, 2018

Sara Cazzoli (IAA - CSIC)

Title: "Optical spectroscopy of local type-1 AGN LINERS"
Date: Sep 06, 2018

Mary Loli Martínez Aldama (IAA - CSIC)

Title: "Extreme quasars at high redshift"
Date: Jun 28, 2018

★**Dr. Luis Galbany** (University of Pittsburg)

Title: "What do environments can tell us about supernovae? "
Date: Jun 22, 2018

Juan Iván Agudo Rodríguez (IAA - CSIC)

Title: "Blazar Science with POLAMI: Polarimetric Monitoring of AGN at Millimeter Wavelengths "
Date: Jun 21, 2018

★**Dr. Juan Carlos Suárez** (Universidad de Granada)

Title: "PLATO: de cazar a domesticar sistemas planetarios"
Date: Jun 14, 2018

★**Dr. Lico** (Università di Bologna)

Title: "Physical and statistical properties of High Frequency Peaked blazars"
Date: Jun 07, 2018

★**Dr. Michael Hilker** (European Southern Observatory)

Title: "On the ultra-compact dwarf galaxy-nuclear star cluster connection "
Date: May 24, 2018

★**Prof. Massimo Della Valle** (Osservatorio Astronomico di Capodimonte)

Title: "The Empirical Grounds of Supernova-Gamma-ray Burst connection"
Date: May 17, 2018

★**Dr. Mahmoudreza Oshagh** (Georg-August-Universität Göttingen)
Title: "Stellar activity blurring our insight into the properties of exoplanets"
Date: May 10, 2018

★**Prof. Hugh Christian** (University of Alabama)
Title: "Lightning – from Its Base to Space "
Date: Apr 26, 2018

★**Prof. Bruce Balick** (University of Washington, Seattle)
Title: "Recreating the Early Mass-Loss Histories of pre-Planetary Nebulae"
Date: Apr 18, 2018

★**Dr. Antonio Marín-Franch** (Centro de Estudios de Física del Cosmos de Aragón (CEFCA))
Title: "Observatorio Astrofísico de Javalambre: a dedicated facility for large sky surveys"
Date: Apr 13, 2018

★**Dr. Javier Cenarro** (Centro de Estudios de Física del Cosmos de Aragón (CEFCA))
Title: "The J-PAS and J-PLUS large sky surveys: an unprecedented view of the Universe in multi-colors"
Date: Apr 12, 2018

★**Manuel Roca, Domingo Escutia** (Parque de las Ciencias)
Title: "ESERO Spain, del espacio al aula"
Date: Apr 05, 2018

★**Prof. José Cernicharo** (Instituto de Física Fundamental - CSIC)
Title: "Carbon Chemistry in Carbon-rich AGB stars"
Date: Mar 22, 2018

Jorge Iglesias Páramo (IAA - CSIC)
Title: "MEGARA @ GTC: performance review and commissioning results "
Date: Mar 21, 2018

★**Professor Hélène Courtois** (Université de Lyon)
Title: "Navigating the Universe : « Cosmic Flows » program"
Date: Mar 15, 2018

Josefa Masegosa Gallego (Comisión Igualdad IAA) (IAA - CSIC)
Title: "Mesa redonda: Luces y sombras en la carrera investigadora de las mujeres. Hacia una igualdad efectiva entre hombres y mujeres"
Date: Mar 07, 2018

★ **Prof. Andrea Eckart** (University of Cologne)
Title: "Light and shadow in the Galactic Center"
Date: Feb 22, 2018

Rosa María González Delgado (IAA - CSIC)
Title: "Can CALIFA tell us something about the cosmic evolution of the star formation rate and stellar mass of the Universe?"
Date: Feb 15, 2018

★**Dr. Roberto Cid Fernandes** (Universidade Federal de Santa Catarina)
Title: "Diffuse Ionized Gas in CALIFA (and MaNGA) galaxies"
Date: Jan 25, 2018

Guillem Josep Anglada i Pons (IAA - CSIC)
Title: "Dust belts around Proxima Centauri. First results from a multi-department project at the IAA"
Date: Jan 18, 2018

★**Dr. Anna Ciurlo** (University of California, Los Angeles)
Title: "Dynamics and properties of gas at the Center of the Galaxy"
Date: Jan 11, 2018

VISITING SCIENTISTS

Invited

Clemens Thum

Instituto de Radioastronomía Milimétrica (IRAM)
01/01/2017 - 31/12/2020

Roberto Ortiz Moraes

U. São Paulo
28/12/2017 - 10/03/2018
28/12/2018 - 06/03/2019

Ángel Enrique Sánchez Colín

U. Autónoma de Nuevo León (México),
Facultad de Ciencias Físico Matemáticas
30/07/2018 - 30/10/2018
09/11/2018 - 09/02/2019

Jack Sulentic

U. Alabama
16/03/2018 - 19/05/2018
15/02/2018 - 15/03/2018

Renato Dupke

Observatorio Nacional de Rio de Janeiro
10/04/2018 - 31/10/2018

Yolanda Jiménez Teja

Observatorio Nacional de Rio de Janeiro
22/01/2018 - 24/02/2018

Viggo Hansteen

University of Oslo
01/01/2018 - 31/01/2018

Visiting scientists

Álvaro Álvarez-Candal

Observatorio Nacional de Rio de Janeiro
18/10/2018-16/11/2018
09/05/2018 - 25/05/2018
22/01/2018 - 24/02/2018

Jose Ignacio Añez López

Institut de Ciències de l'Espai - CSIC
26/11/2018 - 14/12/2018

Julio Arrechea Rodríguez

U. Complutense Madrid
13/11/2018 - 31/05/2019

Rebecca Azulay

U. València
15/10/2018 - 26/10/2018

Bruce Balick

U. Wahington, Seattle
14/04/2018 - 19/04/2018

Zelege Beyoro Amado

Ethiopian Space Sciences and Technology Institute
01/12/2018 - 31/12/2018

Jamie Bok

South African Astronomical Observatory
24/10/2018 - 25/10/2018
15/09/2018 - 22/09/2018

Valentin Boyanov Savov

U. Complutense, Madrid
10/12/2018 - 22/12/2018

Gabriele Bruni

INAF
12/11/2018 - 16/11/2018
09/04/2018 - 13/04/2018

Joyce Byun

U. Genève
15/11/2018 - 23/11/2018
28/05/2018 - 01/06/2018
14/04/2018 - 25/04/2018

Roldán Cala Barón

U. Granada
28/08/2018 - 31/08/2018

José Iván Campos Rozo

U. Graz
17/09/2018 - 24/09/2018

Carolina Casadio

Max Planck Institute for Radioastronomy
18/04/2018 - 20/04/2018

Mike Chaffin

Laboratory of Atmospheric and Space Physics, U. Colorado
Boulder (USA)
02/03/2018 - 02/03/2018

Law Chi Yan

U. Concepción
18/07/2018 - 18/07/2018
09/07/2018 - 09/07/2018

James Chibueze

SKA-South Africa
05/10/2018 - 05/10/2018

Ilje Cho

Korea Astronomy and Space Science Institute
11/10/2018 - 22/10/2018

Roberto Cid Fernandes

U. Federal de Santa Catarina
09/01/2018 - 09/02/2018

Anna Ciurlo

U. California, Los Angeles
09/01/2018 - 12/01/2018

María Teresa Costado Dios

U. Cádiz
18/05/2018 - 23/05/2018

Andre Luiz de Amorim

U. Federal de Santa Catarina
09/01/2018 - 09/02/2018

Andreas Eckart

U. Cologne
19/02/2018 - 23/02/2018

Ginevra Favole

ESAC
05/03/2018 - 09/03/2018

Estela del Mar Fernández Valenzuela

University of Central Florida (USA)
23/04/2018 - 27/04/2018
09/04/2018 - 13/04/2018

Marina Fernandez-Peña Mollá

GRANTECAN S.A.
01/06/2018 - 30/06/2018

Tobias Fritz

Instituto de Astrofísica de Canarias (IAC)
10/04/2018 - 13/04/2018

Mareike Godolt

Technical University of Berlin
19/10/2018 - 19/11/2018

Juan Luis Gómez González

Centro de Astrobiología (INTA-CSIC)
02/04/2018 - 18/05/2018

Omaira González Martín

Centro de Radioastronomía y Astrofísica, UNAM
27/11/2018 - 01/12/2018

Milan Gotic

Lockheed Martin Solar and Astrophysics Laboratory (LMSAL)
31/08/2018 - 10/09/2018

Sylvain Graczyk

Institut d'Optique, Graduate School and U. Paris Sud (France)
28/05/2018 - 06/08/2018

Guillermo F. Hägele

U. la Plata (Argentina)
28/01/2018 - 31/01/2018

Lee Hartmann

U. Michigan
23/04/2018 - 26/04/2018

Lorena Hernández García

U. Valparaíso
01/09/2018 - 14/09/2018

Michael Hilker

European Southern Observatory
21/05/2018 - 25/05/2018

Christian Hugh

U. Alabama
15/04/2018 - 30/04/2018

Yolanda Jiménez Teja

Observatorio Nacional de Rio de Janeiro
07/05/2018 - 26/05/2018

Baerbel Silvia Koribalski

CSIRO
12/09/2018 - 11/10/2018

Franck Lefèvre

Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS)
22/10/2018 - 26/10/2018

Rocco Lico

U. Bologna
04/06/2018 - 08/06/2018

Vicent Martinez

U. València
10/07/2018 - 10/07/2018

Paola Marziani

Osservatorio Astronomico di Padova
11/06/2018 - 21/06/2018

Alberto Méndez Gálvez

U. Autónoma de Barcelona
23/07/2018 - 10/09/2018

Antonio David Montero Dorta

U. São Paulo
17/12/2018 - 21/12/2018

Mariarita Murabito

INAF
26/10/2018 - 26/10/2018

Ondrej Nentvich

Czech Technical University
14/09/2018 - 08/10/2018

Kawa Noman

Leibniz Institut für Astrophysik Potsdam
07/09/2018 - 30/09/2018

Mahmoudreza Oshagh

Georg-August-Universität Göttingen
17/12/2018 - 21/12/2018
08/05/2018 - 18/05/2018

Giacomo Pantaleoni

RMIT - Royal Melbourne Institute of Technology
20/09/2018 - 21/09/2018

Javier Peralta Calvillo

Institute of Space and Astronautical Science (ISAS)
29/09/2018 - 13/10/2018

Judit Pérez Romero

Instituto de Física Teórica - UAM/CSIC
19/11/2018 - 23/11/2018

Cristina Prieto Angulo

Trinity College, Dublin
02/07/2018 - 16/07/2018

Gerardo Ramos Larios

U. Guadalajara
08/04/2018 - 23/04/2018

Sergio Rodriguez Torres

U. Autónoma de Madrid
05/03/2018 - 09/03/2018

Javier Román

Instituto de Astrofísica de Canarias (IAC)
26/10/2018 - 29/10/2018

Ana Sagues

Nordic Optical Telescope
09/04/2018 - 13/04/2018

María del Carmen Sánchez Gil

U. Cádiz
16/10/2018 - 27/10/2018

Edgar Ivan Santamaria

U. Guadalajara
29/05/2018 - 12/06/2018

Fernanda Sao Sabbas

Instituto Nacional de Pesquisas Espaciais
09/07/2018 - 13/07/2018

Banafsheh Shahzamanian Sichani

U. Cologne
08/01/2018 - 20/01/2018

Josep María Solanes Majua

U. Barcelona
29/01/2018 - 02/02/2018

Sergio Soler López

U. Cantabria
10/10/2018 - 31/10/2018

Jesús Alberto Toalá Sanz

U.Nacional Autónoma de México
23/11/2018 - 01/12/2018
13/04/2018 - 22/04/2018

Scott Todd

RMIT - Royal Melbourne Institute of Technology
20/09/2018 - 21/09/2018

Josep Tous Mayol

U. Barcelona
21/11/2018 - 29/11/2018

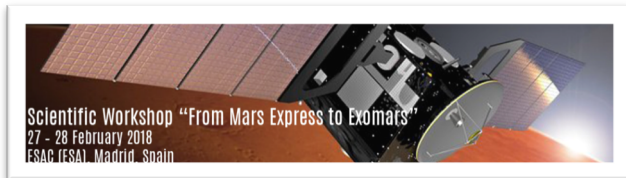
Dominik Utz

U. Graz
17/09/2018 - 24/09/2018

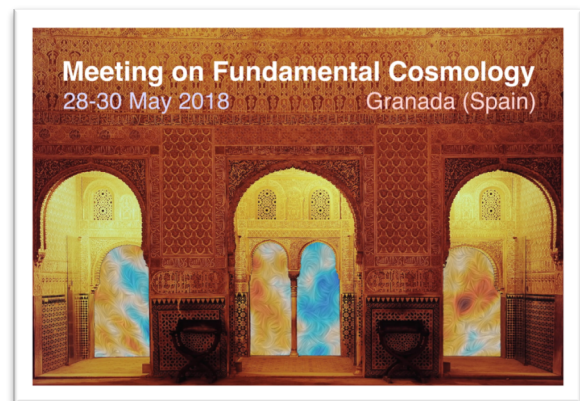
Gunther Witzel

Max Planck Institute for Radioastronomy
19/11/2018 - 23/11/2018

WORKSHOPS AND MEETINGS



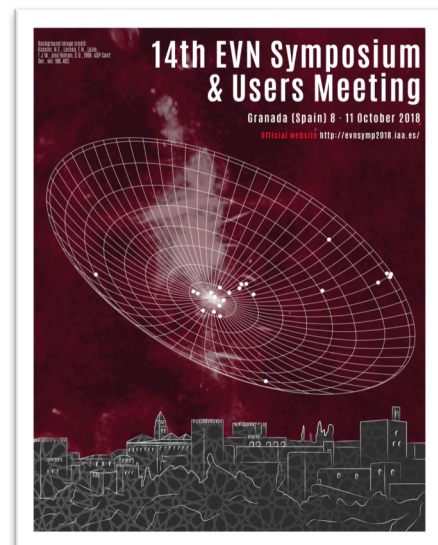
From Mars Express to Exomars
Madrid, Spain
Feb 27 - 28, 2018
IAA members of the SOC: **M. López Valverde, M. López Puertas**



VI Meeting on Fundamental Cosmology
Granada, Spain
May 28 - 30, 2018
IAA members of the SOC: **F. Prada**
IAA members of the LOC: **F. Prada**
<https://cafpe.ugr.es/fcosmology18/>



The 12th MIPAS-IMK/IAA Data User Meeting
Granada, Spain
May 15 - 17, 2018
IAA members of the SOC: **B. Funke, M. López Puertas**
IAA members of the LOC: **B. Funke, M. López Puertas, M. M. García Comas, A. Gardini**
https://www.iaa.csic.es/~puertas/mipas_12dum.html



14th EVN Symposium & Users Meeting
Granada, Spain
Oct 08 - 11, 2018
IAA members of the SOC: **I. Agudo, A. Alberdi**
IAA members of the LOC: **I. Agudo, G. Anglada i Pons, A. Fuentes, A. Gallego, J.L. Gómez, S. Molina, A. Pelegrina, N. Ramírez**
<http://evnsymp2018.iaa.es>



ROSETTA DUST WORKSHOP

Granada, Spain

Oct 1 - 3, 2018

IAA members of the SOC: **F. Moreno, O. Muñoz**

IAA members of the LOC: **F. Moreno, O. Muñoz, D. Guirado, J.C. Gómez**



HINODE -12 THE MANY SUNS

Granada, Spain

Sep 10 - 13, 2018

IAA members of the SOC: **L. Bellot Rubio**

IAA members of the LOC: **L. Bellot Rubio**

<http://spg.iaa.es/hinode12/>

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
Cerviño Saavedra, Miguel
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
Lopez de Coca Castañer, Pilar
López González, María José
López Jiménez, Antonio Carlos
López Moreno, José Juan
López Puertas, Manuel
López Valverde, Miguel Angel
Márquez Pérez, Isabel
Masegosa Gallego, Josefa
Miranda Palacios, Luis Felipe
Moreno Danvila, Fernando
Muñoz Gómez, Olga
Olivares Martín, José Ignacio
Ortiz Moreno, José Luis
Perea Duarte, Jaime David
Pérez Jiménez, Enrique
Pérez Montero, Enrique
Pérez Torres, Miguel Angel
Prada Martínez, Francisco
Rodríguez Gómez, Julio Federico
Rodríguez Martínez, Eloy
Ruedas Sánchez, José
Schoedel, Rainer

Verdes-Montenegro Atalaya, Lourdes
Vílchez Medina, José Manuel

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

Cano, Zachariah Ezekiel Wesley
Izzo, Luca
Jones, Michael Gordon
Kann, David Alexander

Postdoc Fellows

Bauer, Florian Franziskus
Cazzoli, Sara
Damas Segovia, Ancor Eflen
de Franciscis, Sebastiano
Dong, Hui
García Benito, Rubén
Gardini, Angela
González Galindo, Francisco
González García, Manuel Jesús
Guirado Rodriguez, Daniel
Kehrig Martin dos Santos, Carolina
Li, Dongshuai
Maranhas Gafeira, Ricardo Jorge
Marcos Caballero, Airam Eduardo
Martín Ruiz, Susana
Osorio Gutiérrez, Mayra Carolina
Pelegrina López, Alicia
Pérez Invernón, Francisco Javier
Rodríguez López, Cristina Teresa
Santos Sanz, Pablo
Shahzamanian Sichani, Banafsheh
Siu Tapia, Azaymi Litz

PhD Students

Bensch, Katarzyna Anna
Boaventura Teixeira Gomes, Miguel
Castro Tirado, Miguel Ángel
Díaz Rodríguez, Ana Karla
Dorantes Monteagudo, Antonio Jesús
Duarte Puertas, Salvador
Escobar Cerezo, Jesús

Fuentes Fernández, Antonio
Gallego Calvente, Aurelia Teresa
Gallego Cano, Eulalia
Hermosa Muñoz, Laura
Hill, Brittany Nicole
Jiménez Monferrer, Sergio
Kieu, Thi Ny
Lampón González-Albo, Manuel
Lares Martiz, Mariel
Lorenzo Gutiérrez, Antonio
Malagón Romero, Alejandro Francisco
Martínez Solaeche, Ginés
Nogueras Lara, Francisco
Olivares Nadal, Julia del Carmen
Ramírez Olivencia, Naim
Sánchez López, Alejandro
Schmalzried, Anthony
Soler López, Sergio
Tello Salas, Juan Carlos

ENGINEERS AND TECHNICIANS

Mechanics

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

Optics

Bailén Martínez, Francisco Javier
Maza Gutierrez, Antonio

OSN Maintenance/Support

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

Software

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

SERVICES AND ADMINISTRATION

Administration Services

Bordons Mesonero, Fernando
Cortés Guerrero, María Ángeles
de Castro Díaz, Rosa Irene
Fernandez-Peña Mollá, Marina
Gómez Finnett, Susana Alicia

González Esteva, Alonso M.
Heredia Maldonado, María José
Herrera Jiménez, Eva María
Jiménez Zafrilla, María Isabel
Madrid Gómez, Carmen Elisa
Molina Guerrero, Josefina
Nieto Serrano, Concepción
Tapia Ruiz, Francisco José
Torrededia Rodrigo, Cristina

Computer Center

Bayo Muñoz, Francisco Manuel
Parra Garófano, Rafael

General Services

Molero Delgado, José Francisco
Molina Rodrigo, Antonio
Rendón Martos, Francisco

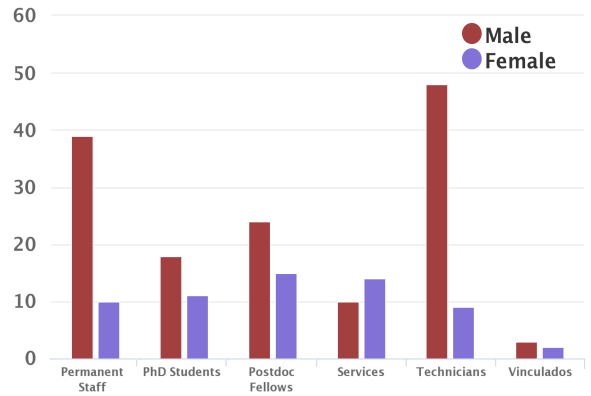
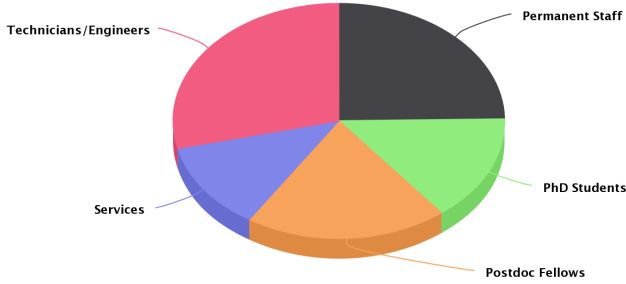
Library

Arco Sarmiento, María Ángeles

Outreach and Communication Unit

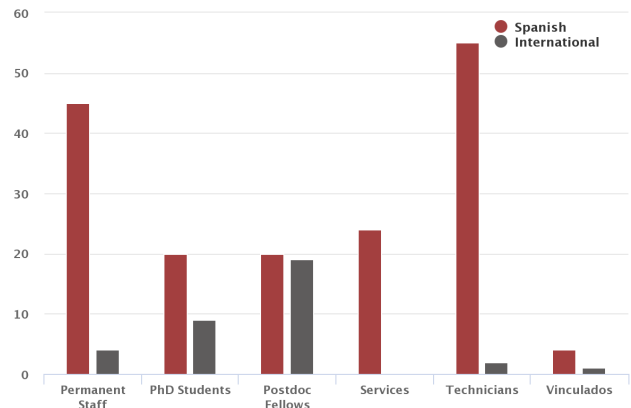
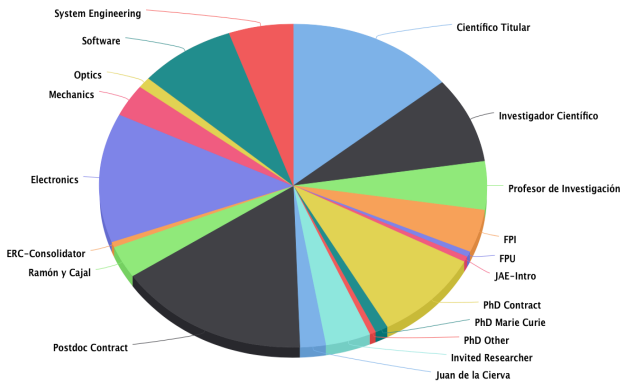
García Gómez-Caro, Emilio José
López de la Calle, Silbia

The 2018 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.



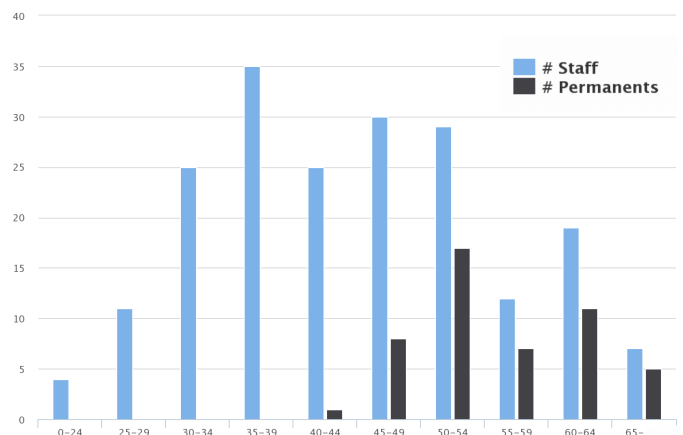
The fraction of international staff was larger among post-doctoral fellows and PhD students.

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



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

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



PUBLIC OUTREACH

PROJECTS HELD DURING 2018

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

- Popular Science Journal IAA: *Información y Actualidad Astronómica*. Issued once every four months, it is devoted to high school and university students, as well as general public interested in astronomy (<http://revista.iaa.es>). Issues in 2018: 54, 55, 56.

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

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

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

- *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 28 "moving" its research to the center of the city.

- *PIISA Project*. A multidisciplinary project designed to allow high school students work with scientists. The IAA-CSIC is the founder of the project. <http://www.piisa.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.

- "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.

- "Las escalas del universo en Caixaforum", astronomy conferences in CaixaForum Sevilla.

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

ACTIVITIES OF THE COMMUNICATION, EDUCATION AND PUBLIC OUTREACH UNIT



- 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/iaaucc>

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

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

- Design and development of corporate material.

PRESS RELEASES

The IAA 2018 scientific achievements attracted the media interest producing the media news listed below (see also <https://www.iaa.csic.es/en/news>)

06/12/2018

The "planet-hunter" CARMENES studies evaporating atmospheres and water vapor beyond the Solar System



Three studies with the infrared channel of the CARMENES instrument, developed at IAA-CSIC, are published in the journals "Science" and "Astronomy & Astrophysics"

27/11/2018

A new instrument for studying galaxies in the local universe from Calar Alto

LUCA is proposed as a new generation instrument for the 3.5 meter telescope of the Calar Alto Observatory (Almería, CAHA).

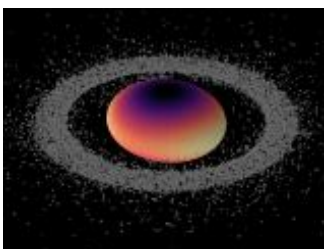
20/11/2018

ESCAPE: Open Science and new paths in the knowledge of the cosmos at all scales

ESCAPE project encompasses some of the world's largest scientific infrastructures in astronomy and particle physics, for the development of a single digital platform for the open use of data

19/11/2018

The complex dynamics of the miniature ring systems of the Solar System



The finding of rings around Solar System bodies that are not planets, such as the dwarf planet Haumea or the centaur Chariklo, showed that these are more common structures than previously thought

16/11/2018

The Institute of Astrophysics of Andalusia obtains the distinction Center of Excellence Severo Ochoa



The objective of the program is to finance and accredit research centers that demonstrate international impact and leadership

14/11/2018

Super-Earth discovered around the second nearest stellar system

An international team of researchers, with the participation of IAA-CSIC finds an exoplanet with three times the mass of the Earth. The exoplanet orbits the red dwarf Barnard, the closest star to the Sun after the Alpha Centauri system

31/10/2018

The researcher Mirjana Povic receives the Nature Research for Inspiring Science Award



Researcher at the Ethiopian Space Sciences and Technology Institute (ESSTI) and associated doctor at the IAA-CSIC, she investigates the formation and evolution of galaxies

07/10/2018

Researchers from around the world debate in Granada the latest advances in the observation of the universe in radio

The European VLBI Network (EVN), a network of radio telescopes distributed throughout Europe and Asia, with additional antennas in South Africa and Puerto Rico, holds its fourteenth symposium in Granada

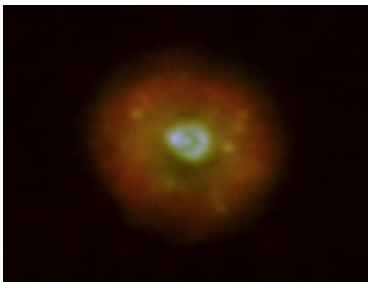
20/09/2018

CARMENES instrument gets the first exoplanet detection alerts from TESS (MIT-NASA) mission

It is expected that the TESS mission, developed at the Massachusetts Institute of Technology (MIT) and NASA, finds about one thousand five hundred planets around other stars in its two years of operation.

06/08/2018

The strange case of HuBi1, an inside-out stellar corpse



The physical structure of a planetary nebula resulting from the final evolution of a solar-like star is contrary to that of all other similar sources. A research led by IAA-CSIC concludes it resulted from a born-again event of its central star

10/07/2018

An extraordinarily dense region tests the theory of structure formation in the universe

A halo of dark matter six times denser than expected has been found around a cluster of galaxies

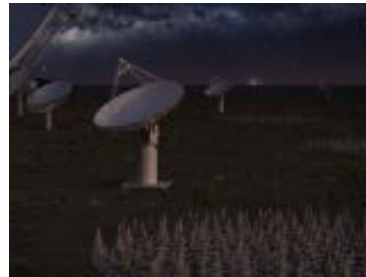
03/07/2018

The atmosphere of Kelt-9b, the hottest known planet, is being dragged towards its star

Similar to Jupiter, Kelt-9 is hotter than some stars. Thanks to the CARMENES instrument at Calar Alto Observatory, astronomers detected an extensive hydrogen envelope around Kelt-9b that escapes and is being captured by the star

19/06/2018

Spain joins the SKA Organisation



SKA is a worldwide scientific and technological project to build the largest radio telescope on Earth. IAA-CSIC leads the Spanish participation

19/06/2018

The star distribution in clusters is established long before stars begin to shine

The analysis of the Pipa nebula, a region of very early star formation, has confirmed that the density of the pre-stellar nuclei determines the geometry of the clusters

14/06/2018

Astronomers See Distant Eruption as Black Hole Destroys Star



First observation of the formation and expansion of a jet of material expelled by a supermassive black hole after destroying a star. The work, led by the University of Turku and IAA-CSIC, is published in the journal Science

07/06/2018

The strange objects at the center of our galaxy: clouds of gas that behave like stars

They could be stars blowed by the extreme gravity conditions around Sagittarius A *, the supermassive black hole at the galactic center.

29/05/2018

The IAA, the only Spanish institution involved in JUICE (ESA), finishes the engineering phase of its contribution to the mission



JUICE, a mission of the European Space Agency (ESA) to be launched in 2022, will study Jupiter and its moons to analyze the possibilities of the development of life around gas giant planets.

15/05/2018

Gigantic gas outflow generated by numerous supernova explosions detected in Arp 299-A galaxy
Arp 299-A galaxy, which is in the process of merging with another galaxy (Arp299-B), is notable for its intense starbursts and its high rate of supernova production.

25/04/2018

A Study Links Night Exposure to Blue Light with Breast and Prostate Cancer
Researchers used images taken by astronauts to evaluate outdoor lighting in Madrid and Barcelona

03/04/2018

SpaceX Launches ASIM mission (ESA), to study electric discharges in the upper atmosphere from the International Space Station



The launch took place on April 2 at 22:30 from the Kennedy Space Center in Florida (USA). The IAA-CSIC participates in the analysis of mission data and through ground support with its own instruments

26/02/2018

From Mars Express to Exomars: a complete review of the red planet

While waiting for the first data from the ExoMars 2016 TGO mission (ESA), international experts on the red planet meet in Madrid to review some current challenges and to prepare for the arrival and scientific exploitation of ExoMars

22/02/2018

POLAMI: a project to unravel the secrets of the supermassive black holes at the center of the galaxies



Coordinated by the IAA-CSIC, it brings together more than twenty researchers from five countries and is the first project of its kind: a long-term study of the active galactic nuclei in polarized light

12/02/2018

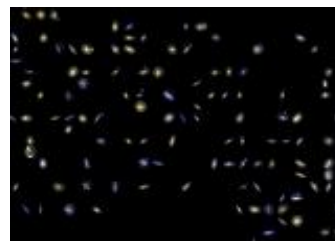
Solving the Dark Energy Mystery: A New Assignment for a 45-Year-Old Telescope
Kitt Peak National Observatory Prepares for the Dark Energy Spectroscopic Instrument

30/01/2018

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

03/01/2018

Library of galaxy histories reconstructed from motions of stars



The CALIFA survey allows to map the orbits of the stars of a sample of 300 galaxies, a fundamental information to know how they formed and evolved

FUNDING

IAA obtains most of its funding through competitive European and Spanish calls. Below we provide a list of all competitive funding awarded to IAA staff in 2018.

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 2018) and new funding (the money awarded in 2018) 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

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 €

Getting Ready for EST (GREST)

Reference: H2020-INFRADEC-1-2014-1 653982

PI: **Jose Carlos del Toro Iniesta**

Duration: Jun 01, 2015 - May 31, 2018

Amount: 194 062 €

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 €

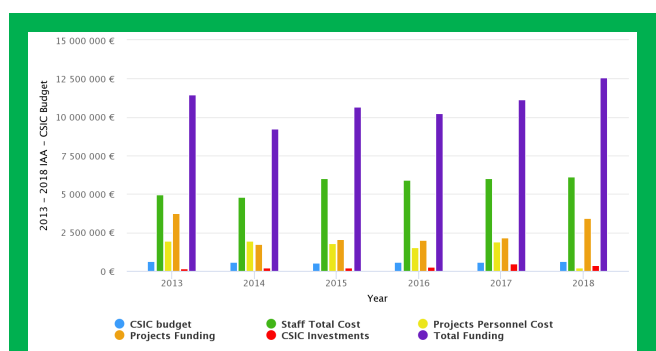
Small Bodies: Near and Far (SBNAF)

Reference: H2020-LEITSPACE/ 0140 687378

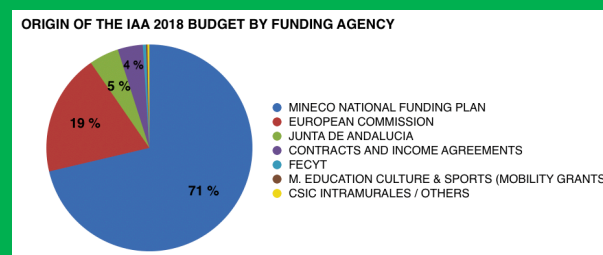
PI: **René Damián Duffard**

Duration: Apr 01, 2016 - Mar 31, 2019

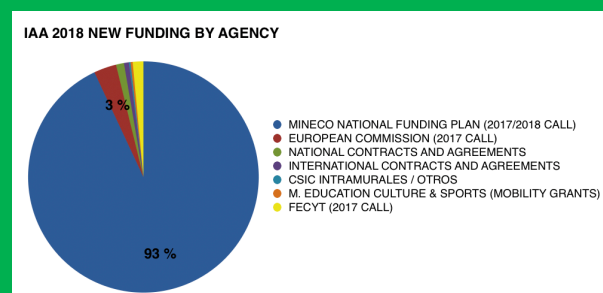
Amount: 355 000 €



Time evolution of the IAA budget since 2013



Origin of the IAA 2018 budget by funding agency



IAA 2018 new funding by agency

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 €

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 €

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 - Jan 01, 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 €

MINECO

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 €

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 €

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 €

UNIVERSO Y VACIO CUANTICOS

Reference: FIS2017-86497-C2-1-P

PI: **Carlos Barceló Serón**

Duration: Jan 01, 2018 - Dec 31, 2020

Amount: 24 200 €

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 €

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 €

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 €

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, 2018

Amount: 3 363 800 €

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

Reference: ESP2016-77548-C5-1-R

PI: **José Carlos del Toro Iniesta**

Duration: Dec 30, 2016 - Dec 29, 2018

Amount: 968 000 €

ENTENDIENDO LA ESTRUCTURA INTERNA, LA EVOLUCION Y LA VARIABILIDAD DE ESTRELLAS DE BAJA MASA CON PLANETAS

Reference: AYA2016-79425-C3-3-P

PI: **Matilde Fernández Hernández**

Duration: Dec 30, 2016 - Dec 29, 2019

Amount: 302 500 €

GALAXIAS EN 3D A TRAVES DEL UNIVERSO: SINERGIA ENTRE ESPECTROSCOPIA DE CAMPO INTEGRAL Y CARTOGRAFIADOS MULTIBANDA PANORAMICOS

Reference: AYA2016-77846-P

PI: **Rosa María González Delgado, Enrique Pérez Jiménez**

Duration: Dec 30, 2016 - Dec 29, 2019

Amount: 179 080 €

ESTALLIDOS DE FORMACION ESTELAR Y EVOLUCION DE GALAXIAS

Reference: AYA2016-79724-C4-4-P

PI: **José Manuel Vilchez Medina, Enrique Pérez Montero**

Duration: Dec 30, 2016 - Dec 29, 2019

Amount: 169 400 €

JETS RELATIVISTAS EN GALAXIAS ACTIVAS

Reference: AYA2016-8089-P

PI: José Luis Gómez Fernández, Juan Iván Agudo Rodríguez

Duration: Dec 30, 2016 - Dec 29, 2019

Amount: 135 520 €

AGN, DEL UNIVERSO LOCAL A DISTANCIAS COSMOLOGICAS. DEL MOTOR CENTRAL A LA GALAXIA ANFITRIONA Y SU ENTORNO

Reference: AYA2016-76682C3-1-P

PI: Isabel Márquez Pérez

Duration: Dec 30, 2016 - Dec 29, 2019

Amount: 90 750 €

PHOTOMETRIC REDSHIFTS PARA J-PAS

Reference: AYA2016-81065-C2-1-P

PI: Narciso Benítez Lozano, José Ruedas Sánchez

Duration: Dec 30, 2016 - Dec 29, 2019

Amount: 89 540 €

CARTOGRAFIANDO EL CIELO: SONDEOS EN EL OPTICO E INFRARROJO DE LA VIA LACTEA II

Reference: AYA2016-75931-C2-1-P

PI: Emilio Javier Alfaro Navarro

Duration: Dec 30, 2016 - Dec 29, 2018

Amount: 71 390 €

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

Reference: AYA2016-82017-REDT

PI: Lourdes Verdes-Montenegro Atalaya

Duration: Jul 01, 2017 - Jun 30, 2019

Amount: 20 000 €

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 €

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 €

POLVO EN EL SISTEMA SOLAR: EXPERIMENTOS, MODELOS COMPUTACIONALES Y APLICACION AL ESTUDIO DEL COMETA 67P-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 €

CARACTERIZACION Y ANALISIS DE LA ATMOSFERA DE MARTE. EXPLOTACION CIENTIFICA DEL INSTRUMENTO NOMAD DE LA MISION TGO-EXOMARS.

Reference: ESP2015-65064-C2-1-P

PI: Miguel Angel López Valverde

Duration: Jan 01, 2016 - Dec 31, 2018

Amount: 35 574 €

LA RED GLOBAL BOOTES PARA INVESTIGACION ASTROFISICA Y DETECCION DE BASURA ESPACIAL Y PARTICIPACION ESPAÑOLA EN LA MISION SVOM

Reference: AYA2015-71718-R

PI: Alberto Javier Castro Tirado

Duration: Jan 01, 2016 - Dec 31, 2018

Amount: 147 620 €

NUCLEOS DE GAS MOLECULAR, DISCOS Y JETS: EL EFECTO DEL CAMPO MAGNETICO

Reference: AYA2014-57369-C3-3-P

PI: Guillem Josep Anglada i Pons

Duration: Jan 01, 2015 - Dec 31, 2018

Amount: 137 940 €

COMPOSICION Y TEMPERATURA EN ATMOSFERAS PLANETARIAS

Reference: ESP2014-54362-P

PI: Manuel López Puertas, Maia Leire García Comas

Duration: Jan 01, 2015 - Dec 31, 2018

Amount: 266 200 €

CONTRIBUCION DEL IAA-CSIC A LA MISION ESPACIAL PLATO2.0: FASES B Y C. OPERACION DE NOMAD-EXOMARS

Reference: ESP2015-65712-C5-3-R

PI: Rafael Garrido Haba, Julio Federico Rodríguez Gómez

Duration: Jan 01, 2016 - Dec 31, 2018

Amount: 1 718 200 €

CONTRIBUCION DEL IAA A LA EXPLOTACION CIENTIFICA DE ASIM

Reference: ESP2015-69909-C5-2-R

PI: Francisco José Gordillo Vázquez, Alejandro Luque Estepa

Duration: Jan 01, 2016 - Dec 31, 2018

Amount: 314 600 €

GRAVEDAD Y UNIVERSO CUANTICO: EMERGENCIA, COLAPSO GRAVITACIONAL Y FISICA TRANSFORMACIONES

Reference: FIS2014-54800-C2-1-P

PI: **Carlos Barceló Serón**

Duration: Jan 01, 2015 - Dec 31, 2018

Amount: 15 125 €

DESCUBRIENDO EL LADO OSCURO DEL UNIVERSO CON LOS GRANDRES CARTOGRAFIADOS ESPECTROSCOPICOS

Reference: AYA2014-60641-C2-1-P

PI: **Francisco Prada Martínez**

Duration: Jan 01, 2015 - Dec 31, 2018

Amount: 90 750 €

Desde las bajas a las altas tasas de acreción en núcleos activos de galaxias. Alimentación y retroalimentación

Reference: AYA2013-42227-P

PI: **Isabel Márquez Pérez, Ascensión del Olmo Orozco**

Duration: Jan 01, 2014 - Jun 30, 2018

Amount: 186 340 €

The Javalambre - Physics of the accelerated universe astrophysical survey

Reference: AYA2013-48623-C2-1-P

PI: **Narciso Benítez Lozano**

Duration: Jan 01, 2014 - Jun 30, 2018

Amount: 119 790 €

CSIC

SKA-Link: combining knowledge to pioneer Big-Data solutions for SKA Data Centres

Reference: i-link 2016 - I-LINK1122

PI: **Lourdes Verdes-Montenegro Atalaya**

Duration: Jan 01, 2017 - Dec 31, 2018

Amount: 27 100 €

The new J-PAS Data Center at the National Observatory of Rio de Janeiro

Reference: COOPB20263

PI: **José Ruedas Sánchez**

Duration: Jan 01, 2017 - Dec 31, 2018

Amount: 17 000 €

REGIONAL GOVERNMENT JUNTA DE ANDALUCÍA

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 €

Objetos Transneptunianos y otros remanentes de la formación del sistema solar. Evolución...

Reference: P12-FQM-1776

PI: **José Luis Ortiz Moreno**

Duration: May 16, 2014 - Oct 30, 2018

Amount: 152 000 €

CALIFA-PopStar: Un legado andaluz universal

Reference: P12-FQM-2828

PI: **Rosa María González Delgado**

Duration: May 16, 2014 - Feb 01, 2018

Amount: 59 050 €

FECYT

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 €

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 €

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. Abeysekara, A. U. et al. (includes **Agudo, I.; Molina, S. N.; Gómez, J. L.**)

"Multiwavelength Observations of the Blazar BL Lacertae: A New Fast TeV Gamma-Ray Flare", *Astrophysical Journal*, Vol. 856, p. 95 (2018)
DOI: 10.3847/1538-4357/aab35c

2. Abolfathi, B. et al. (includes **Prada, F.**)

"The Fourteenth Data Release of the Sloan Digital Sky Survey: First Spectroscopic Data from the Extended Baryon Oscillation Spectroscopic Survey and from the Second Phase of the Apache Point Observatory Galactic Evolution Experiment", *Astrophysical Journal Supplement Series*, Vol. 235, p. 42 (2018)
DOI: 10.3847/1538-4365/aa9e8a

3. Agrawal, Piyush; Rast, Mark P.; **Gošić, Milan; Bellot Rubio, Luis R.**; Rempel, Matthias

"Transport of Internetwork Magnetic Flux Elements in the Solar Photosphere", *Astrophysical Journal*, Vol. 854, p. 118 (2018)
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Cover and back Picture. M20, Trifid Nebula.

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