Instituto de Astrofísica de Andalucía
IAA-CSIC

ANNUAL REPORT 2015

INSTITUTO de ASTROFISICA de ANDALUCIA
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Cover Pictures

Main picture.

October 2015. The instrument CARMENES (Calar Alto high-Resolution search for M dwarfs with Exoearths with Near-infrared and optical Échelle Spectrographs) is delivered at the 3.5m Calar Alto telescope for its technical and scientifc commisioning. CARMENES near-infrared channelhas been integrated and verified at the IAA clean laboratoriesby ateam led by Dr. Pedro J. Amado.

The operation of this channel in the near-infrared has posed a major technological challenge. Its sensibility and stability demand its operation at a temperature of 133 degrees below zero with a variation range not larger than a thousandth of a degree.

CARMENES capability to observe simultaneously in the optical and near-infrared spectral ranges makes it a world-wide unique instrument for the search of exo-earths around dwarf stars.

The picture shows the CARMENES near-infrared channel and the three meters long and a meter and a half in diameter holding tank at the IAA clean laboratories.

Lower right inset.

Also in October 2015 the IAA was awarded with the 2014 Rodríguez-Acosta Foundation Honour Medal. The IAA relevantastrophysical research and technical achievements and its prominent position among international research centers was recognized by the committee of the Rodríguez-Acosta Foundation for this award.

The Rodríguez-Acosta Foundation Honour Medal is awarded to institutions and individuals with a recognized social, cultural or artistic track. Her majesty the Spanish Queen, Andrés Segovia, Federico Mayor Zaragozaand Enrique Morente, among others, had previously been awarded with the Rodríguez-Acosta Foundation Honour Medal.

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DIRECTOR'S FOREWORD

In 2015 we celebrated the 40th anniversary ofthe original foundation of the Instituto de Astrofísica de Andalucía. Born as a center of the Spanish national research council CSIC. Since then the IAA has been producing research in astrophysics and space science, in parallel with a very substantial technological activity linked to the design and construction of front-line instrumentation for ground-based telescopes and space missions.

The year of the Rosetta mission: during 2015 many exciting results have appeared regarding comet 67P/Churyumov-Gerasimenko. A wealth of new science has been produced to start deciphering the origins of the solar system, leading to a plethora of scientific highlights many of which have been published in Nature and Science journals. This has been an incredible mission indeed, which has demonstrated once again the high level of European space research. The IAA is really proud to be one of the few European centers participating in this amazing project.

CARMENES, the high resolution spectrograph for Calar Alto was delivered to the observatory, and, after the commissioning period, it will be scientifically operational on the mountain in 2016. This is the most complete state-of-the-art, earth-like "planet hunter" to date; CARMENES will observe stars with its two arms simultaneously in the optical and in the near infrared wavelength ranges.

CALIFA, the large Integral Field Spectroscopy survey conceived at the IAA which is carried out with the Calar Alto 3.5m telescope, will provide an unprecedented view of six hundred galaxies of the local Universe. CALIFA is already a reference in the field of galaxy evolution and its data legacy is widely offered to the scientific community of the Calar Alto observatory. Over 8.000 downloads of CALIFA data were carried out by the end of 2015.

The Square Kilometre Array (SKA) is an international effort to build the largest research infrastructure ever developed, and is engaged in the detailed design of the telescope, with the construction starting in 2018. Spain has been positioning for a maximum scientific return and to contribute to SKA work packages of technological relevance and high potential for innovation. IAA-CSIC coordinates the actions for the Spanish participation in SKA at the scientific and technological level since 2011.

Other relevant achievements included in this 2015 annual report of the IAA testify the rich variety and quality of the science produced. The emergence of a stellar jet observed in real time, may exemplify one of these results -published in the Science magazinethis time-, which has been obtained from observations over an eighteen year span of the formation of a massive star.

In 2015 a new ERC Consolidator grant was awarded to one of our young scientists leading an exciting project on *lightning propagation and high-energy emissions within coupled multi-model simulations.* Presently, two ERC Consolidator grant winners are working here. The IAA is coordinator of the H2020 funded Europeannet works for Mars research and also for the ORISON mission, aimed at developing a new infrastructure for stratospheric balloon flights. The ORISON project has continued the experience of the Instituto de Astrofísica in stratospheric flights, gained with the SUNRISE mission and the Huygens probe test flights.

Last but not least, a sad event hit all of us at the IAA last spring, when we lost our colleague Javier Gorosabel who left us suddenly. We have lost a good friend and colleague, and one of the most important astronomers in Spain. Javier passed away last April 2015, and all the IAA staff were shocked because Javier was a well known and beloved member of our scientific family. We accompanied his family in Eibar (Pais Vasco) during the funeral and send them our best wishes from Granada. He will always be remembered.

This report has been prepared with the aim of showing the reader a panorama of the scientific and technological activity developed at the IAA during 2015. We hope you will share the passion for astronomy with us and enjoy all the science presented in this 2015 annual report.

Prof. José Manuel Vílchez

Director

Instituto de Astrofísica de Andalucía

RESEARCH ACTIVITY

The Instituto de Astrofísica de Andalucía is the largest and most productive Astronomy center of the Consejo Superior de Investigaciones Científicas (IAA-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 lines devoted tp 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 these research lines, units and observatory during 2015 are next presented.

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

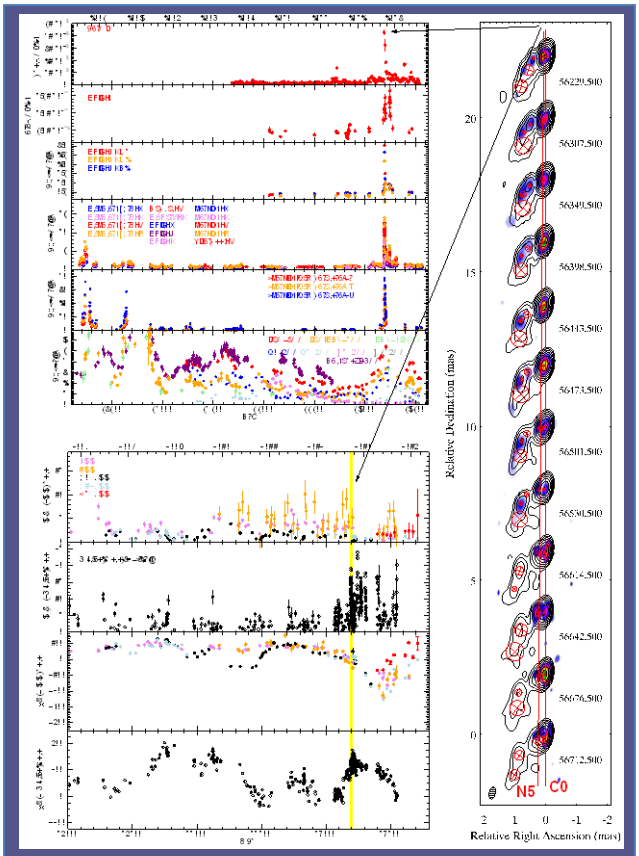
AGN JETS

Our group is focused on the study of relativistic jets, highly collimated fluids containing relativistic particles moving at velocities close to that of the speed of light that are commonly present in active galactic nuclei (AGN). They are powered by the accretion of material onto billion solar masses black holes lurking in the center of these galaxies.

Our research is aimed to address two of the main questions related to AGN jet physics, namely how are jets formed, collimated and accelerated, and what are the sites and mechanisms for the production of very high energy emission. This is carried out through a combination of both, multi-wavelength observations across the electromagnetic spectrum, with special emphasis in VLBI observations, and their comparison with theoretical models based on relativistic MHD and non-thermal emission simulations.

We are leading one of the Key Science Projects of the space VLBI mission RadioAstron aimed to study the magnetic field structure in a sample of AGN to obtain a better understanding of the role played by the magnetic field in the jet formation. Our early results have confirmed the polarization capabilities of this space mission for imaging of the innermost jet regions of AGN with angular resolutions of the order of 20 microarcseconds, unprecedented in astronomy. First 18 cm polarimetric space VLBI observations of the high-redshift quasar 0642+449, with a 4 times improvement in angular resolution over ground VLBI observations, have revealed a magnetic field that is predominantly transverse to the jet in the nuclear region, confirming theoretical expectations.

Multi-waveband observations of the quasar CTA102 and the radio galaxy 3C120 have been analyzed during unprecedented γ-ray flares for both sources. Fermi satellite γ-ray data have been compared with a series of 43 GHz and 15 GHz VLBA images from the VLBA-BU-BLAZAR and MOJAVE programs, respectively, providing the necessary spatial resolution to probe the parsec scale jet evolution during the high energy events. Although these two objects represent very different classes of AGN, we found that the γ-ray flares in both sources are associated with the passage of a new superluminal knot through the millimeter VLBI core of the jet, but not all ejections of new components lead to γ-ray events. Both in CTA102 and in 3C120, γ-ray events occurred only when the new components are moving in a direction closer to our line of sight, which have lead us to conclude that the multi-waveband flares are intimately related to changes in the orientation of the relativistic jet with respect to the observer. We locate the γ-ray dissipation zone a short distance downstream of the radio core but outside of the broad line region, suggesting synchrotron self-Compton scattering as the probable mechanism for the γ-ray production.



Multi-wavelength observations of the quasar CTA102. Flares across the whole spectrum are associated with the passage of superluminal components through the VLBI core of the jet.

Relativistic MHD simulations of over-pressured jets have been used to study the strength of recollimation shocks, commonly associated with the standing features seen in AGN jets, under different configurations of the magnetic field. We find that an axial field introduces a larger effective gas pressure and leads to stronger recollimation shocks and rarefactions, resulting in larger flow variations. On the other hand, a toroidal field leads to weaker recollimation shocks and rarefactions, significantly modifying the jet structure after the first recollimation rarefaction and shock.

MEMBERS

Agudo, I., Casadio, C., Gómez, J. L., Molina. S.

INVITED RESEARCHERS

Maria Rioja (International Center for Radio Astronomy Research, Australia), Richard Dodson (University of Western Australia, Australia), José María Martí (Universidad de Valencia)

LINES OF RESEARCH

Multi-wavelength observations of AGN jets

Relativistic MHD and non-thermal emission simulations

ESTALLIDOS DE FORMACIÓN ESTELAR EN GALAXIAS

Overview

The scientific interest of this group is focused on the study of the interplay between the stars and the interstellar medium in galaxies.

From the technological side, we are also interested on the development of astronomical instrumentation for large telescopes as a tool to make real our scientific ideas and projects.

Highlights in 2015

Digging for clues of the cosmic dawn in our vicinity: PMAS-IFU data of IZw18, the most metal-poor star-forming galaxy in the local Universe, reveals an extended region of highly ionized HeIIλ4684Å. The comparison between current stellar model predictions and our observations points out that only (nearly) metal-free ionizing stars, similar to the first ones briging light to the Cosmos (the so-called PopIII stars), can account for the HeII-ionization budget measured in IZw18.

Extreme Emission-line galaxies (EELGs) out to z=1 in zCOSMOS-20k: A sample of 165 EELGs has ben selected from the zCOSMOS fields in the redshift range 0<z<1. These galaxies were observed with VLT (VIMOS) and HST facilities. They appear to be compact, low-mass, high Star Formation Rate (SFR), metal-poor systems which show in many cases evidences of interactions and are in the process of assembling most of their present-day mass.

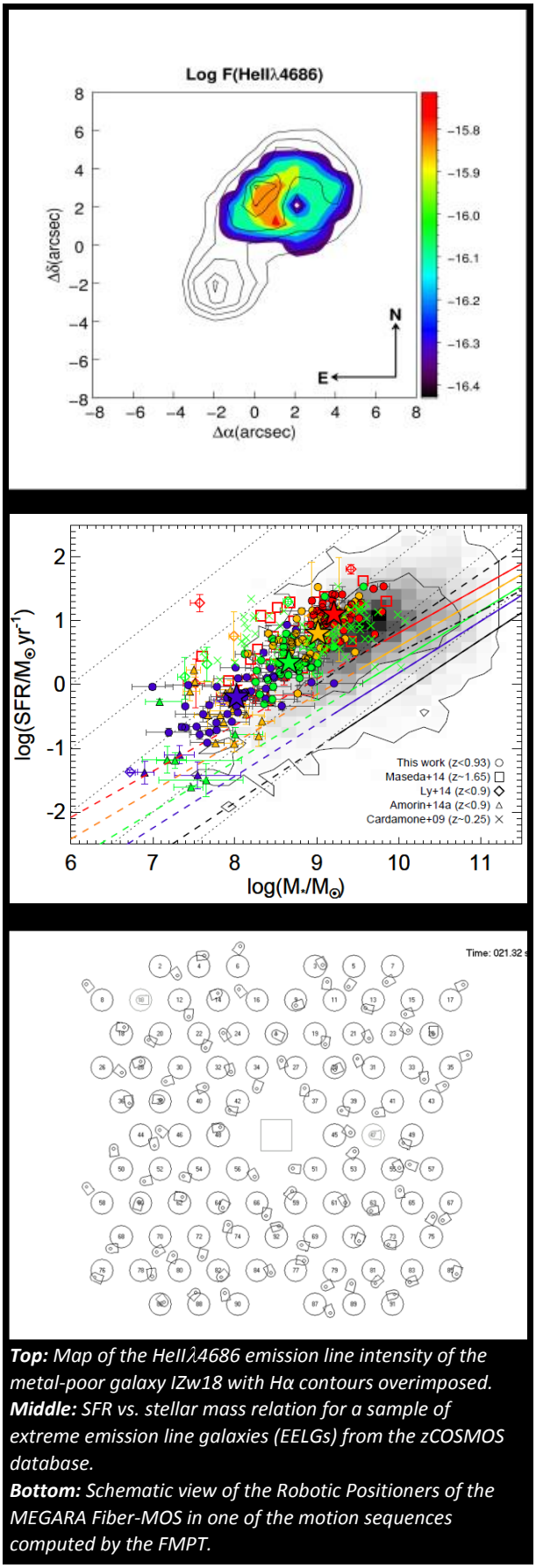
The MEGARA Fiber-MOS Positioning Tool (FMPT): The FMPT is a software suite designed at IAA-CSIC, devoted to generate motion sequences of the MEGARA Robotic Positioners in a quick way and avoiding collisions among them. The Fiber-MOS is one of the most attractive features of MEGARA, the new generation Multi-Object Spectrograph for GRANTECAN, since it will allow observing several objects at once. During 2015 we have finished the first complete version of this software suite, and it is now ready for testing it with the real Fiber-MOS during 2016.

MEMBERS

José Manuel Vílchez Medina,Enrique Pérez Montero, Jorge Iglesias Páramo, Carolina Kehrig, Salvador Duarte Puertas, Isaac Morales Durán

INVITED RESEARCHERS

Manuel Moreno Raya (CIEMAT, Madrid), Martin Roth (AIP, Postdam).



Top: *Map of the HeIIλ4686 emission line intensity of the metal-poor galaxy IZw18 with Hα contours overimposed.*
Middle: *SFR vs. stellar mass relation for a sample of extreme emission line galaxies (EELGs) from the zCOSMOS database.*
Bottom: *Schematic view of the Robotic Positioners of the MEGARA Fiber-MOS in one of the motion sequences computed by the FMPT.*

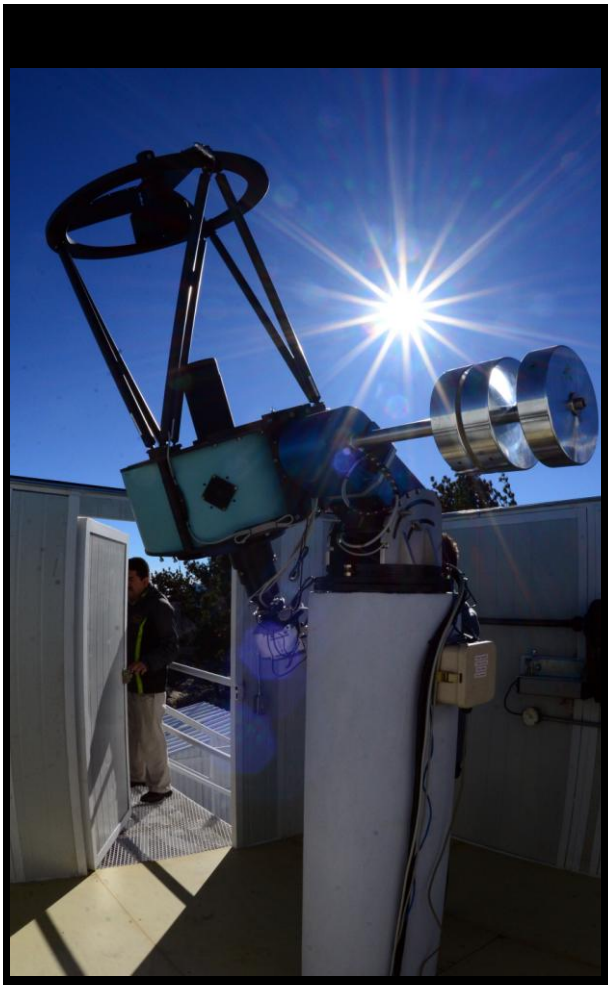
ARAE (Astrofísica Robótica y de Altas Energías)

Overview

The ARAE research group (http://arae.iaa.es) was founded in 2001, although some of its members have already started their activity in 1990, and belongs to the Andalusian Research Plan (PAI). Scientists and engineers are working on a variety of projects, combining their strengths. Half of the members are foreigners from all over the world, what it is also an added value. 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). Public outreach and citizen science are also part of the ARAE activities.

Highlights in 2015

-*Highlight #1*:We further investigated the relationship, between the optical/UV gamma-ray burst (GRB) afterglow luminosity and average afterglow decay rate of long duration GRBs and found significant correlations which are consistent with a common underlying physical mechanism producing GRBs and their afterglows regardless of their detailed temporal behaviour. This led us to discuss alternative more complex models (Oates et al. 2015, MNRAS 453, 4121).
-*Highlight #2*: Observations of DG CVn by the *Swift* satellite and several ground-based observatories (such as the BOOTES network) during its superflare event on 2014 allowed us to perform a complete hard X-ray-optical follow-up of a superflare from the red-dwarf star. This pointed towards a plausible extrapolation between the behaviour from the most active red-dwarf stars and the processes occurring in the Sun (Caballero-García et al. 2015, MNRAS 452, 4195).
-*Highlight #3*: We used a perturbation theory to derive an equation for the gravity darkening exponent (GDE) for neutron and non-relativistic stars as a function of the rotation law, of the colatitude, and of the GDE logarithmic derivatives of the opacity. We used this equation to explore the effects of differential rotation to explain the anomalous values of semi-empirical GDE found in some early-type eclipsing binaries (Claret 2015, A&A 577, A87).
-*Highlight #4*: Complete coverage of the BOOTES Robotic Telescope Network with the deployment of the BOOTES-5 station (including the 60cm diameter Javier Gorosabel Telescope) in México.



The Javier Gorosabel Telescope (JGT) at the BOOTES-5 station in San Pedro Mártir National Observatory (México), opened on 26 Nov 2016

MEMBERS

Cabello Castillo, Juan; Castro-Tirado, Alberto Javier; Cerviño Saavedra, Miguel; Claret dos Santos, Antonio; Cunniffe, Ronan; Espartero Briceño, Francisco; Gorosabel Urkia, Javier María (†); Hu, Youdong; Jeong, Soomin; Oates, Samantha; Pérez-Ramírez, María Dolores (†); Sánchez-Ramírez, Rubén; Tello Salas, Juan Carlos and Zhang, Binbin.

INVITED RESEARCHERS

Caballero García, María Dolores (CAS, CZ); Guziy, Sergey (Nikolaev Univ., Ukraine); Hiriart, David (Univ. Nacional Autónoma, México); Jelínek, Martin (Ondrejov Astronomical Observatory, CZ); and Pandey, Shashi B. (ARIES, India).

LINES OF RESEARCH

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

DARK UNIVERSE

Overview

The work in this research group through 2015 has focused on the preparation of the upcoming J-PAS Survey. We have further refined the software tools that will be necessary to analyze the data and extract the cosmological information.

In addition we have continued work in the scientific exploitaiton of the ALHAMBRA and CLASH surveys.

Highlights in 2015

- Alpha version of the BPZ 3 software
- ALHAMBRA cluster and group catalog
- New version of the CHEFs software
- 12 publications in refereed journals

MEMBERS

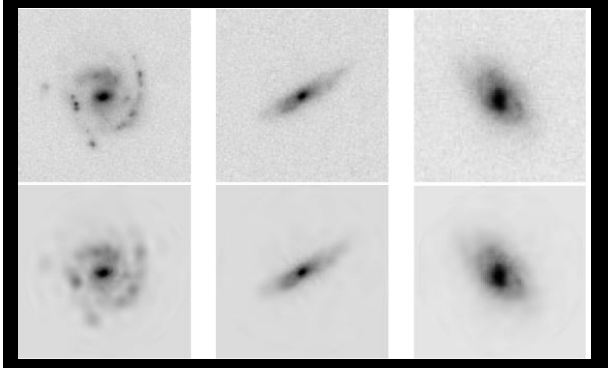
Narciso Benítez

William Schoenell

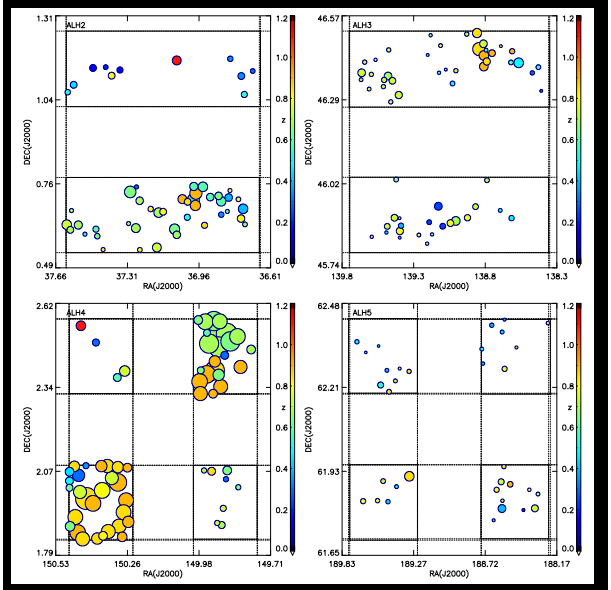
Tom Broadhurst (Ikerbasque)

INVITED RESEARCHERS

Alberto Molino Benito (IAG, Brasil)
Renato Dupke (ON, Brasil)
Carlos López-San Juan (CEFCA, Teruel)



Examples of galaxies modeled with CHEFs. Three real galaxies with different morphologies were selected from the XDF (top row) and modeled to show the efficiency of CHEFs at recovering the radial profiles and thus the total extension of the galaxies (bottom row).



Spatial distribution of level 2 detections in the ALHAMBRA fields #2, #3, #4, and #5. The size of each circle scales with the total stellar mass in the galaxy and its colour refers to its redshift. Solid lines define the limits of each field.

GALACTIC EVOLUTION

Overview

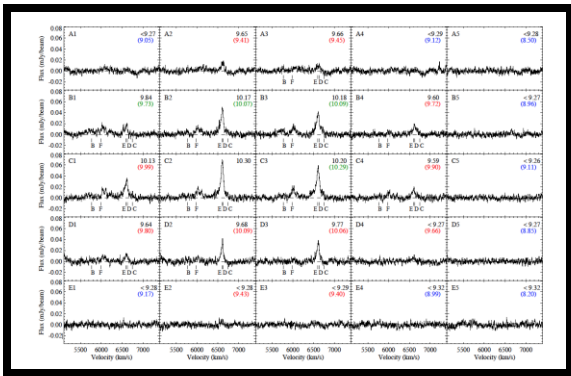
The goals of the Galaxy Evolution group encompass observational and theoretical studies over a wide range of problems of galaxy structure and evolution and cosmology, from their inner stellar and diffuse components to their large-scale cosmological distribution and evolution. This research is complemented 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, the environmental dependence of the structure and evolution of galaxies (isolated, in groups, etc). Additional activities include supervising PhD doctoral studies, teaching Master courses, an active public outreach, and eScience.

Highlights in 2015

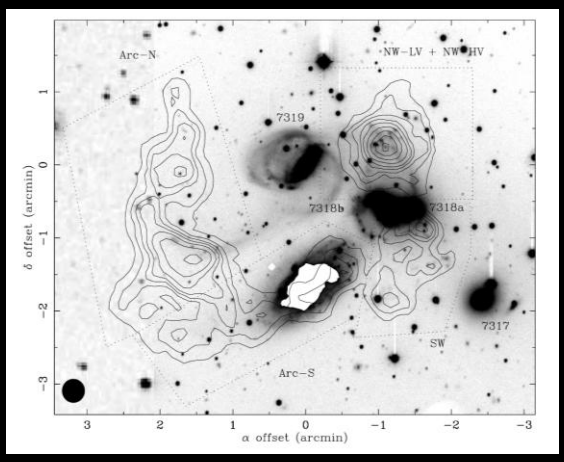
- CALIFA results include the publication of the second public data release DR2 (400 spectral cubes for 200 galaxies). We have analysed the radial distribution of the mass surface density, extinction, light- and mass-weighted ages and metallicity of the stellar populations of 300 galaxies, both as a function of morphology and of total stellar mass. We confirm that more massive galaxies are more compact, older, more metal rich, and less reddened by dust; these trends are preserved with the radial distance to the nucleus. Our main conclusion is that quenching processes act in manners that are independent of mass, while metallicity and galaxy structure are influenced by mass-dependent processes.

- AMIGA has obtained Cycle 3 ALMA P.I. time to observe a subsample of isolated galaxies (to be performed in 2016). The team has mapped the HI emission surrounding several Hickson Compact Groups at large scales (up to 500 kpc), with the Green Bank Telescope. HCG 92 (Stephan's Quintet) deviates significantly from the VLA emission, showing diffuse gas with a distribution suggesting a tidal origin (see Figure). We found that the gas will survive ionization by the cosmic UV background and the escaping ionizing photons from the star forming regions, and stay primarily neutral for at least 500 Myrs.

- We have performed a systematic analysis of the spectral properties and X-ray variations for AGNs, LINERs, and Seyfert 2s. We conclude that the X-ray variations may occur similarly in LINERs and Seyfert 2s, mainly related to the nuclear continuum, although they might have different accretion mechanisms. On the contrary, variations at UV frequencies are detected in LINER nuclei but not in Seyfert 2s. These results might be compatible with the disappearance of the torus and/or the broad line region in AGNs at very low luminosities.



GBT spectra of the HI distribution around HCG 92. The pointings are separated by 4' (107 kpc at the redshift of the group). Borthakur et al (2015).



Total HI column density distribution in HCG 92 superposed on the R image (Williams et al 2002).

MEMBERS

J. Blasco Herrera, C. Cortijo, A. del Olmo, R. García Benito, J. Garrido Sánchez, R.M. González Delgado, L. Hernández García, J. Iglesias, C. Kehrig, R. López Fernández, I. Márquez, M.A. Martínez Carballo, J. Masegosa, J.D. Perea, E. Pérez, E. Pérez Montero, M. Povic, J.E. Ruiz del Mazo, S. Sánchez Expósito, J. Sulentic, L. Verdes-Montenegro, J.M. Vílchez

INVITED RESEARCHERS

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LINES OF RESEARCH

Violent star formation.

Star formation in galaxies.

Stellar population synthesis.

The effects of interaction in the evolution of galaxies.

Modelling the evolution of galaxies in groups.
Active Galactic Nuclei.

Physics of Quasars.

HETH

Overview

At HETH we study several kind of transient sources, from gamma-ray bursts to supernovae to magnetars and X-ray binaries. We focus not only on the transient properties, but also on their environment and host galaxies (for extragalactic sources). By studying the environments of GRBs and supernovae, we want to infer properties of the progenitor stars whenever they cannot be observed directly. To this end, we use a broad range of observations and are particularly interested in resolving the host galaxy and study the immediate environment of the SN/GRB e.g. using IFU data. At high redshifts we use GRBs as probes to study the gas in star-forming galaxies throughout the history of the Universe. In addition, HETH is involved in instrumentation projects, namely OCTOCAM (lead by HETH) and SOXS.

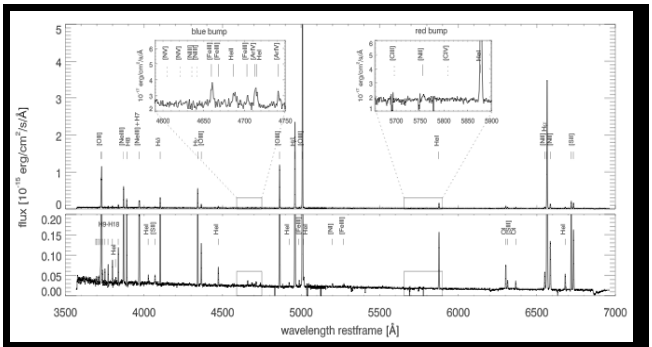
In 2015, HETH was funded by AYA2014-58381P, two RyC fellowships and AURA for the OCTOCAM feasibility study. HETH is part of the collaborations of SUSHIES (SLSN hosts), SHOALS (GRB hosts) and the X-shooter GRB afterglow spectra legacy.

Highlights in 2015

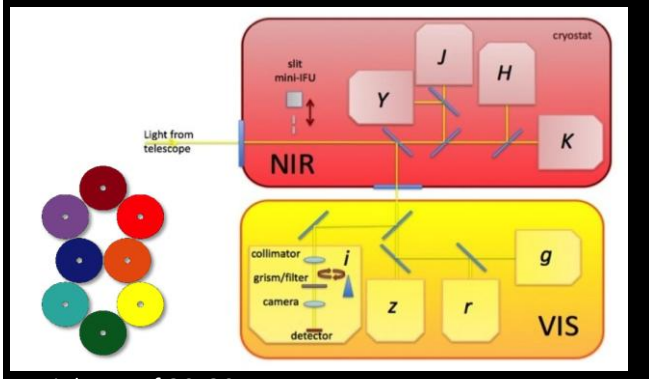
Feasibility study of OCTOCAM for the Gemini Gem4#3 instrumentation call. OCTOCAM is an 8-channel simultaneous imager and spectrograph with additional features (spectro-polarimetry, IFU and high time-resolution). It was one of 4 projects selected for a feasiblility study in a call issued by the Gemini observatory in search for a next generation workhorse instrument. HETH is leading OCTOCAM with A. de Ugarte Postigo as PI and C. Thöne as PM Spain and is done in collaboration with SwRI in San Antonio/Texas and FRACTAL S.R.L. in Madrid. A 2-day presentation of the study was held in Hilo/Hawai'i in September, the final study was delivered to Gemini in October 2015.

Organization of Focus Meeting 10 "Stellar explosions in an ever-changing environment" at the XXIX IAU General Assembly in Honolulu, Hawai'i: In continuation of the "GRBs meet Galaxies at Cabo de Gata" conference in 2013 we organized another cross-disciplinary meeting at the XXIX IAU GA (chair C. Thöne). Participants from any continent, a gender-balanced SOC and invited speakers list, excellent talks and lively discussions made this another success.

A very young stellar population for the host of the SLSN PTF12dam, C. C. Thöne, A. de Ugarte Postigo et al. MNRAS, 451, L65: Super-luminous supernovae are a recently discovered class of core-collapse SNe with brightnesses of <-21 mag and hosted in low-metallicity dwarf galaxies with high star-formation. As part of the SUSHIES collaboration we studied the host of PTF12dam, a low-metallicity tadpole (12+log(O/H)= 8.0), the most extreme example so far. The galaxy has a very young (3 Myr) predominant stellar population responsible for the SLSN but also a much older population. SLSNe could be the first stars exploding after the onset of a star-burst episode in those galaxies.



Spectrum of the host of PTF12dam, a SLSN host showing WR features and a predominantly very young stellar population.



Basic layout of OCTOCAM

SN 2015bh in NGC 2770: NGC 2770 became famous as "SN Ib factory" having hosted 3 Ib SNe between 1999 and 2008. In May 2015, an LBV previously known had a possible core-collapse or major eruption similar to SN 2009ip. We followed this curious object with GTC and OSN throughout 2015 and presented the first results at the "Vth GTC Science" meeting in Puebla.

MEMBERS

C. C. Thöne, A. de Ugarte Postigo, R. Sánchez-Ramírez

INVITED RESEARCHERS

M. Blazek (Univ. of Prague), S. Schulze (Univ. Pontificia de Chile), S. Pope (SwRI), P. Roming (SwRI), S. Goodsell (Gemini), Z. Cano (Univ. of Iceland), C. Gall (Univ. of Aarhus)

LINES OF RESEARCH

GRBs, core-collapse SNe and super-luminous SNe
GRB and supernova hosts
Magnetars and X-ray binaries
High redshift galaxies
Resolved spectroscopy of nearby GRB&SN hosts
Chemical evolution of galaxies probed by GRBs
Ground-based VIS-NIR instrumentation

PHYSICS OF LOW-MASS STARS, EXOPLANETS AND ASSOCIATED INSTRUMENTATION

Overview

Our group 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 habitable exo-Earths. 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, observations with space- and ground-based instruments, technical development of new instrumentation and management.

Highlights in 2015

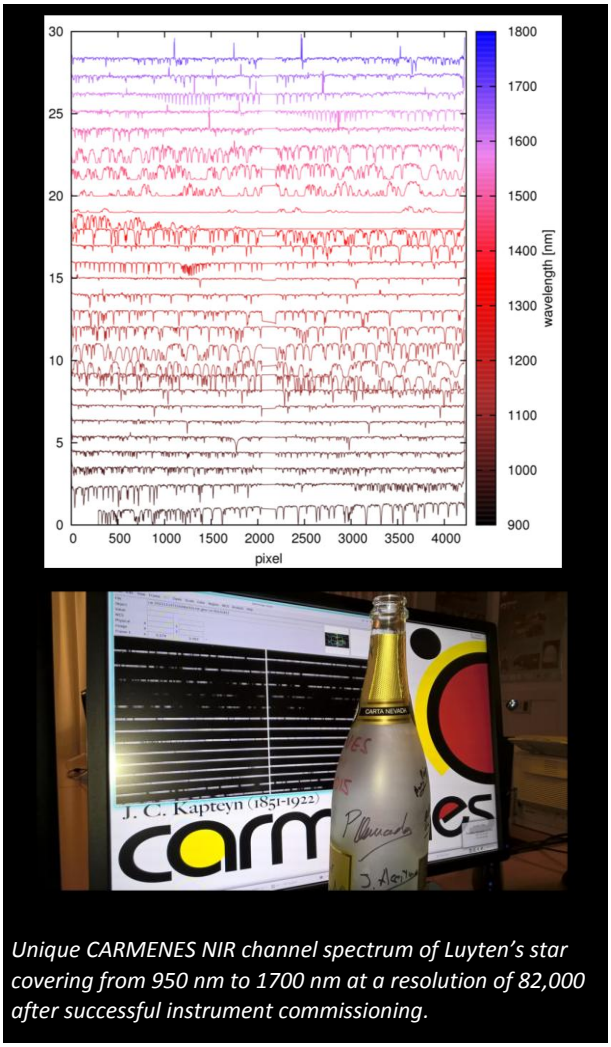
- We finished the construction of CARMENES, a world-wide unique instrument which currently is in operation at CAHA observatory. Its NIR spectrograph (channel) was integrated and verified at the IAA clean labs. The channel was delivered to the observatory in October and was technically and scientifically commissioned in the last two months of 2015, starting operation on Jan 1st, 2016.

- HIRES is a second generation instrument for the European Extremely Large Telescope. It is an instrument conceptually similar to CARMENES. During 2015, our group, the IAA being a member of the HIRES consortium, participated in the writing of its blue book and answered the Request for Information and Call for Phase A studies announced by ESO. Currently, HIRES Phase A is being carried out.

- PANIC, the near infrared wide field camera working at the CAHA 2.2m telescope, is being used in a "shared risks" mode since January 2015.

- We continued with our Cool Tiny Beats (CTB) project. This is a project to search for pulsations, close-in orbiting planets and study activity in M dwarfs. As an example of the results, new observations were awarded in HARPS La Silla (under a pressure factor of 10) to confirm a signal of a possible terrestrial planet in the Habitable Zone of Proxima Centauri.

- The search for what would be the first pulsating M dwarf continued, both from the ground (CTB) and from space with high precision fast photometry obtained by the Kepler spacecraft.



Unique CARMENES NIR channel spectrum of Luyten's star covering from 950 nm to 1700 nm at a resolution of 82,000 after successful instrument commissioning.

- We obtained the last observations and first results of the CARMENES science preparation phase, producing a catalogue of low-resolution spectra for 752 M (and late K) dwarfs. We derived spectral types, studied metallicity and surface gravity and determined activity levels.

- We continued our work in the framework of Transit Timing Variations @ Young Exoplanet Transit Initiative (TTV@YETI). Monitoring for TTVs was performed in six exoplanets from the Observatorio de Sierra Nevada.

MEMBERS

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

INVITED RESEARCHERS

Andreas Quirrenbach (LSW-Heidelberg, Germany), Jean-Louis Lizon (ESO-Garching, Germany), Jürguen H. M. M. Schmitt (HS-Hamburg, Germany), Artie P. Hatzes (TLS-Tauntenburg, Germany), Michael A.C. Perryman (UCD-Dublin, Ireland)

LINES OF RESEARCH

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

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 making use of observational data obtained from ground and space. Moreover, several members of the group are focused on the development of models of planetary and cometary atmospheres in the Solar System.

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

The main objectives are:

Minor bodies: formation and evolution.

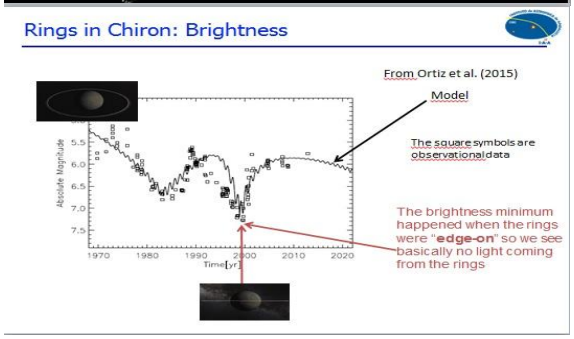
Ground and space observations in multi-spectral ranges.

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.

Planetary atmospheres and surfaces:

- Origin and evolution of the water content and its derivatesin the atmospheres of the Giant Planets and Titan. Determination of the turbulent tranport and chemical schemes controlling the measured vertical profiles by the HIFI instrument on board the Herschel Space Telescope -ESA-.
- We are developing applications for the scientific exploitation of the data provided by the laser altimeter (BeLA) on board the Bepi Colombo mission. This data are related to Mercury geology, geodesy, interior and surface characteristics.
- We are directed involved (CoPI level) from a theoretical and technological point of view in the NOMAD (Nadir and Occultation for Mars Discovery) instrument on board of the ESA ExoMars TGO Orbiter.
- IAA Cosmic Dust Laboratory (CODULAB): Experimental study of the angle dependence of the scattering matrices of dust samples of interest for the



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

- Highlight #1: Rosetta close up at comet Churyumov-Gerasimenko
- Highlight #2: Discovery of rings in Chiron.
- Highlight #3: Integration of NOMAD in TGOEXOMARS

MEMBERS

Benítez Yáñez A.D., Castro Marín J.M., Duffard R.D., Escobar J., Fernández E., González García M., Gutiérrez, P.J., Jiménez Ortega J.,Lampón M., Lara L.M., López Moreno J.J.,MartínezNavajas I., Molina A., Morales Palomino N.F., Moreno F., Muñoz O., Ortiz J.L., Rodrigo Campos J., Santos P.

INVITED RESEARCHERS

Mario Melita, Instituto de Astronomía y Física del Espacio, (Buenos Aires, Argentina)
Adriano Campo Bagatín,Universidad de Alicante
Gonzalo Tancredi, Universidad de Montevideo (Uruguay)
Álvaro Álvarez Candal, Observatorio Nacional de Rio de Janeiro (Brazil)

LINES OF RESEARCH

Planets and minor bodies of the Solar System.

Dust in the Solar System.

PHYSICS OF THE INTERSTELLAR MEDIUM

Overview

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

Early stages ofstar and planet formation are studied through radio interferometric observations and modelling of the observed emission. High angular resolution observations are used for analysing the multiplicity of massive stars.

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

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

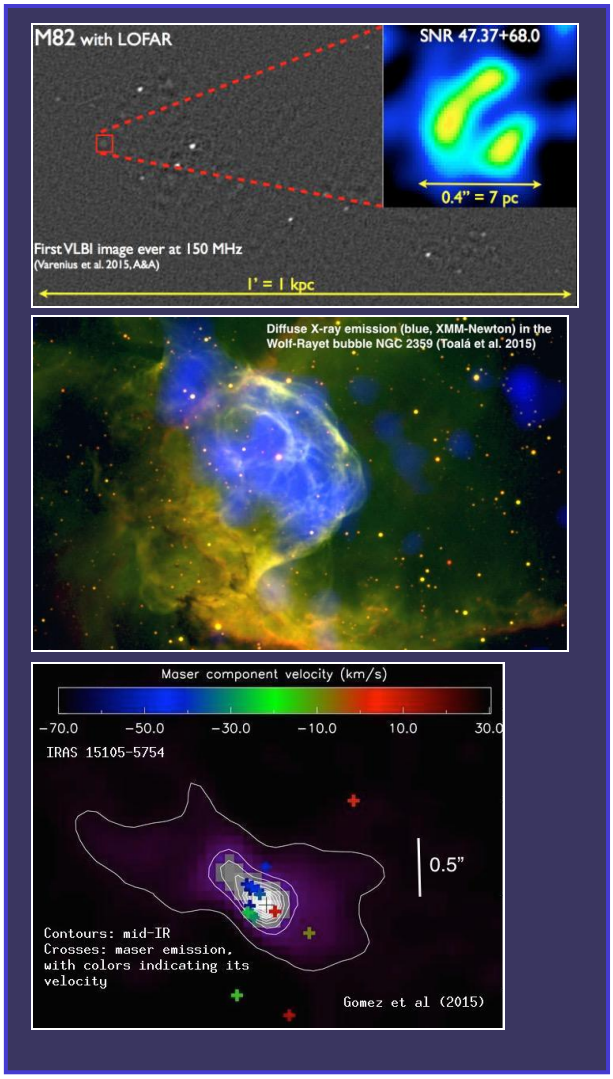
Highlights in 2015

-We observed in “real-time” the onset of the outflow collimation in a jet from a protostar. This is the first time that this process has been observed (Carrasco-González et al. 2015, Science, 348, 114).

-We observed the nearby starburst galaxy M82 with LOFAR at 150 MHz, resulting in the first VLBI image ever at such low frequencies. It shows 16 radio sources, most of them SNRs. The SNR 47.37+68.0 is shown in top panel of the figure (Varenius et al. 2015, A&A, 574, A114).

-The project pursuing the multi-wavelength study of cosmic bubbles hasreported the first detection of diffuse X-ray emission in the Wolf-Rayet (WR) bubble NGC 2359, making it the 4th of its class (see figure, middle panel). Moreover, GTC observations of a sample of PNe in M31 have revealed thehierarchical formation of the substructures observed in this galaxy (Fang et al. 2015, ApJ, 815, 69).

-We confirmed IRAS 15103-5754 as the first PN with non-thermal radio emission and with high-velocity water masers (see figure, bottom panel). These data indicate that the source may be the youngest PN known, and that the beginning of the PN phase is associated with explosive mass-loss (Gómez et al. 2015, ApJ, 799, 186; Suárez et al. 2015, ApJ, 806, 105).



MEMBERS

Alberdi A., Anglada G., Busquet G., Costagliola F., Díaz-Rodríguez A.K., Fang X., Gómez J.F., Guerrero M.A., Herrero-Illana R., Macías E., Manjarrez G., Márquez-Lugo R.A., Mayen-Gijón J.M., Miranda L.F., Osorio M., Pérez-Torres M.A., Ramírez N., Rodríguez M.I., Sánchez-Bermúdez J., Toalá J. A.

INVITED RESEARCHERS

Durán-Rojas M.C. (UNAM, Mexico), González-García, B. (ESAC, Spain), Hummel C. (ESO, Germany), Marcaide J.M. (UV, Spain), Masqué J.M. (U. Guanajuato, Mexico), Ortiz R. (U. Sao Paulo, Brazil), Ros E. (MPIfR, Germany), Rizzo R. (CAB, Spain), Suárez, O. (OCA, France), Torrelles J.M. (ICE-CSIC, Spain), Uscanga L. (Obs. Athens, Greece), Rodríguez L.F. (UNAM, Mexico), Romero-Cañizales C. (PUC, Chile).

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

SOLAR PHYSICS

Overview

The IAA Solar Physics Group's main scientific interests root in solar spectropolarimetry and magnetic fields from all the three points of view: theoretical, observational, and instrumental.

Highlights in 2015

- We continued our efforts to characterize the dynamic and magnetic properties of the solar atmosphere at the highest spatial resolution achievable with current instruments. Using spectropolarimetric observations taken at the Swedish 1m Solar Telescope, we studied the velocity field of sunspot penumbrae on scales of 150 km and confirmed the existence of weak downward motions near the lateral edges of penumbral filaments. For the first time, we observed the evolution of those flows and determined their sizes, shapes, velocities, proper motions and lifetimes. Our results support the view that penumbral filaments are elongated convection cells with hot upflows in the center and cooler downflows at the edges and the tail.

- Also using observations from the Swedish 1m Solar Telescope on La Palma, we discovered instances of small-scale magnetic flux emergence in sunspot light bridges. The newly emerged flux intensifies the light bridge magnetic field and makes it more horizontal. The interaction of this flux with the sunspot field produces chromospheric Ca II 8542 profiles with emission features which have been explained in terms of upflows and strong temperature enhancements of up to 700 K. These perturbations are localized at comparatively low heights, in the upper photosphere. The emerging flux pushes the overlying sunspot field lines together, which may result in magnetic reconnection and heating of the plasma.

- Flux emergence in the quiet Sun was another research topic pursued by the group in 2015. We explained the peculiar chromospheric line profiles observed as cool magnetic bubbles rise from the photosphere into the chromosphere. The emission peak appearing in the red wing of the Ca II 8542 intensity profile is not due to temperature enhancements in this case, but to the coupling of the total source functions of Ca II 8542 and Ca II K, in combination with the presence of upflowing gas. This represents another milestone in our ongoing efforts to understand the formation of the chromospheric Ca II 8542 line.

- A global evolutionary track of the smallest magnetic structures in the internetwork has been obtained from SUNRISE/IMaX observations. Magnetic flux seems to emerge by low-lying loops whose footpoints are advected by convective motions and concentrated and compressed at the vertices of mesogranules. There, the structures oscillate, fragment and coalesce as a whole during the evolution.

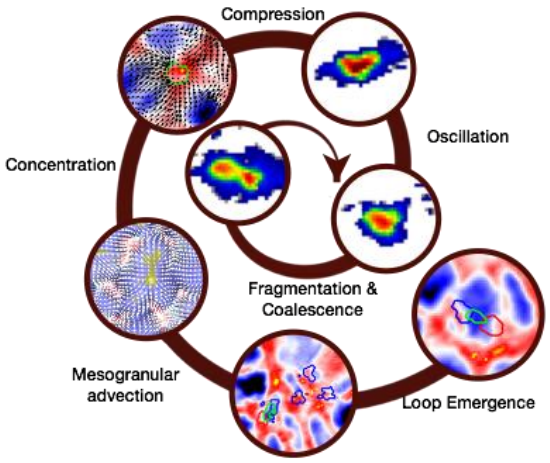


Figure 1: Pictorial view of the evolution of internetwork, small-scale magnetic features as observed by SUNRISE/IMaX.

The results of these investigations have been reported in 6 articles published in major international peer-reviewed journals. The international SOLARNET School and Workshop was organized in Granada, in May.

- Instrumentation highlights related to the SO/PHI magnetograph development:

· Electromagnetic compatibility tests of the Electrical Functional Model (EFM).

· Delivery Review Board for the EFM with MPS, ESA, and Airbus Defence and Space.

· Manufacturing Readiness Reviews of the Qualification Model (QM) sub-systems.

· Fabrication of the Analog, Mechanisms, and Heaters Driver and the Electrical Distribution System boards for the QM.

. Acceptance inspection of several QM sub-systems.

· Integration of the Electronic Unit QM.

· First tests of the QM.

MEMBERS

Álvarez García, D. (Engineer), Aparicio del Moral, A. (Engineer), Balaguer Jiménez, M. (Engineer), Bellot Rubio, L.R. (Tenure scientist), Cobos Carrascosa, J.P. (Engineer), Del Toro Iniesta, J.C. (Research scientist; PI), España Navarro, J.(Engineer), Esteban Pozuelo, S. (PhD student),Herranz de la Revilla, M. (Engineer), Girela Rejón, F. (Engineer), Gošić, M. (PhD student), Labrousse, P. (Engineer), López Jiménez, A.C. (Head engineer), Ortiz Gil, A. (Post-doc researcher), Ramos Más, J.L. (Engineer), Requerey, I.S. (PhD student)

INVITEDRESEARCHERS

Ferriz-Mas, A. (University of Vigo)

TERRESTRIAL PLANETS ATMOSPHERES

Overview

Research in our Group is being carried out about the Earth's atmosphere, on retrieving, processing and anlyzing the data of the MIPAS and SABER instruments on-board the ESA ENVISAT and NASA TIMED satellites, respectively. Special focus is put on the study of solar particles and solar radiation and trends in temperature and composition.

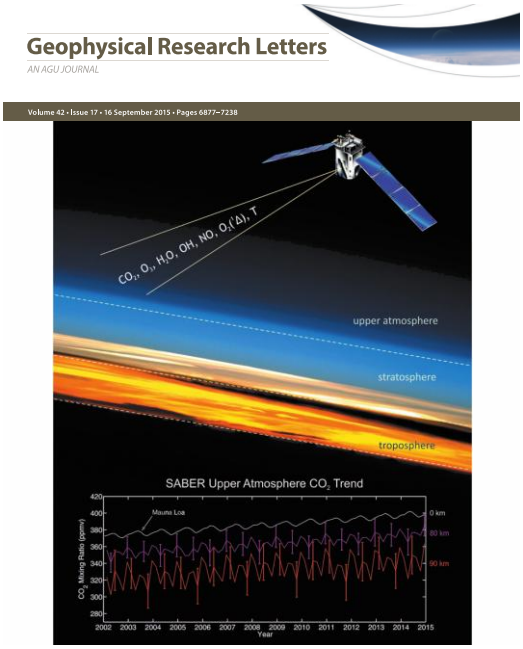
We also continue on the study of atmospheric electricity in planetary atmospheres and preparing for the analysis of the future ASIM and TARANIS missions.

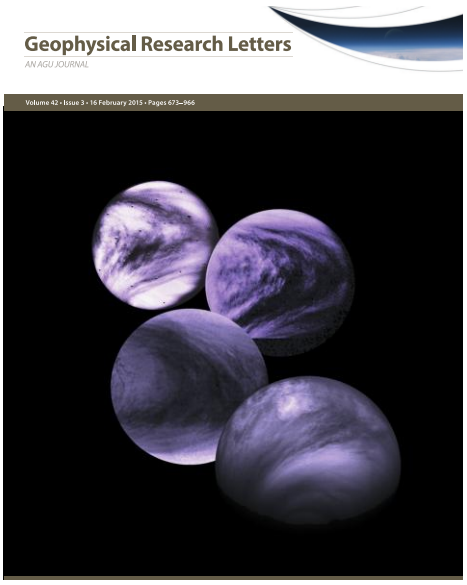
We startedthe project Upwards-H2020, coordinated by our Group, and devoted to the exploitation of Mars Express data and to the development of tools in preparation for Exomars.

We also continued with the analysis of VIRTIS/Venus Express data and the study of the variability of the Martian upper atmosphere using global climate models and ground-based observations.

Highlights in 2015

- SABER/TIMED observed the increase of anthropogenic CO_2 in the middle/upper atmosphere (Yue et al., GRL, 2015; GRL cover, Nature News, NASA Story, top-right figure).
- Explanation of the misterious Y-feature and its 30-day evolution at the Venus clouds as an equatorial Kelvin-like wave (Peralta et al., GRL, 2015; GRL cover; EOS highlight: Calderone, Eos, 96, & Science News, bottom-right figure).
- Gaseous planets may have huge luminous rings caused by lightning, (EOS highlight: Zastrow, *Eos*, 96, 2015; and Luque et al., JGR, 2015).
- First long-term simulations of the Martian upper atmosphere (González-Galindo et al., JGR, 2015).
- High spectral resolution of meteor with GRASSP (Passas et al. *Icarus,* 266, 134, 2015).





MEMBERS

Funke, B., García Comas, M., Gardini, A., González Galindo, F., Gordillo Vázquez, F.J., Jiménez Monferrer, S., Jurado Navarro, Á. A., Luque Estepa, A., López González, M. J., López Puertas, M., López Valverde, M. Á., Passas Varo, M., Pelegrina, A., Peralta, J., Pérez Invernón, F.J., Sánchez López, A., Sánchez del Río, J., Tamayo, A.

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Montanyá J. (UPC, Barcelona, Spain)
Teunissen J. (CWI, The Netherlands)
Ward, W. (University of New Brunswick, Fredericton, Canada)
Winkler H. (University of Bremen, Germany)

LINES OF RESEARCH

- *Thermal structure and composition of the Earth's atmosphere*
- *Atmospheric electricity in planetary atmospheres*
- *Thermal structure and composition of the Terrestrial planetary atmospheres*
- *Remote sensing of planetary atmospheres using IR sensors*

CALAR ALTO OBSERVATORY

The IAA is the reference institute for the **C**alar **A**lto **H**ispano-**A**lemán observatory (CAHA). The observatory 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 four telescopes with apertures of 0.80cm 1.23m, 2.2m and 3.5m to the general community. A 1.5m-telescope is operated under the control of the Observatorio 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.

CAHA telescopes are equipped with state-of-the-art astronomical instrumentation including direct optical and near-infrared imaging cameras, and intermediate- and high-dispersion spectrographs. The observatory 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 also offers aluminizing services as it has the largest aluminizing chamber in Europe, capable to host mirrors with diameters up to 4m.

SCIENTIFIC RESULTS IN 2015

The European Space Agency (ESA) will search for potentially dangerous objects from Calar Alto

The ESA and Calar Alto have signed a collaboration agreement for the exclusive remote use of the 80 cm Schmidt Telescope.NEOs (Near Earth Objects) are comets or asteroids which their orbits, possibly modified by gravitational pull of planets, lead them to regions near to the Earth orbit. Although possibilities of an impact against the Earth are very reduced, the scientific community are developing programs for detecting and studying such objects. NEOs can have very variable sizes, from a few meters to dozens of kilometers. Of the six hundred thousand asteroids discovered about ten thousand came into the category of NEOs. NEOs have to be studied in deep, not only for the information they can give us about the evolution of our Solar System, but because we must know theirphysic properties as better as possible in order to have a future capacity for deviating them and avoid colliding with them.

Night view at CAHA.

The near Earth objet2015TB145, informally designate as "Halloween asteroid".

IZw18: the galaxy that reveals the universe's history

This galaxy stands out for its extreme scarcity of heavy elements, a characteristic typical of primeval galaxies (see page 8).

A group of rearchers observed "The great Halloween pumpkin" from Calar Alto (October 30th, 2015)

Nights of October 30th and 31st are the best opportunity for studying this asteroid, which characteristics points that it could be an extinct comet. The asteroid, with 400 meters wide, will be at about 480.000 km from Earth at its closest approach.

The near Earth object, named as 2015TB145, informally designate as "The great Halloween pumpkin", was studied from the CAHA Observatory by an international group of scientists, coordinated from the IAA.

The interest of this object for the scientific community firstly lies in its cataloging as NEO and secondly, due to

the fact that its orbital characteristics points that this could be an extinct comet.

Observers find two stars so close together that they will end up by merging into 1 very massive star

In our Galaxy a large fraction of the stars are formed in binary systems, and some of these are referred as "eclipsing" which means that the two or more stars observed from Earth undergo eclipses between them because their orbits are edge-on as seen by us. One of these systems is the eclipsing binary MY Camelopardalis (MY Cam), which is one of the most massive of these systems known. A recent article has been published about this binary using observations taken at the CAHA Observatory and authored by astronomers from the University of Alicante, the Astrobiology Centre of the Higher Council for Scientific Research (CAB-CSIC) and the Astrophysics Institute of the Canaries (IAC) together with amateur astronomers. In the article they conclude that MY Cam is the most massive binary yet observed whose components, two stars of spectral type O (blue, very hot, and very luminous) with masses 38 and 32 times that of the Sun, are still on the main sequence (still burning their initial hydrogen fuel), and they are very close together, with an orbital period of less than 1.2 days, which is the shortest period known for stars of this type.

First successful tests of new planet hunter "CARMENES"

CARMENES, an outstanding novel astronomical instrument, which has been designed to look for Earth-like planets, has successfully passed first "on-sky" testsat the telescope. Scientist and engineers of CAHA Observatory have participated in the design and construction of the new "planet hunter". After five years of preparation, the highly complex instrument was for the first time used in November at the 3.5m telescope of the CAHA Observatory, which is operated jointly by the Max-Planck-Society (MPG) and the CSIC.

The instrument consists of two spectrographs to analyze the visible and the infrared light coming from celestial bodies. Both have been optimized for the discovery of planets orbiting nearby stars. Thus, observations with CARMENES will be an important milestone for one of the most exciting areas of space exploration - the search for a second Earth.

The eclipsing binary MY Cam, which is one of the most massive of these systems known.

The panoramic infrared camera PANIC

PANIC is offered by first time

During the second semester of 2015, the Panoramic infrared camera is being used as an standard instrument of the 2.2m telescope, after different commissioning observing runs. Currently, the instrument is attached to the telescope a 20% of the total time.

SIERRA NEVADA OBSERVATORY

AN OBSERVATORY AT 3000M

The Sierra Nevada Observatory (OSN) is a high mountain observatory located at Loma de Dílar (at 2896m height) within the Sierra Nevada National Park (Granada, Spain). The observatory is operated and supplied by the IAA. It consists of a main building which hosts two Nasmyth optical telescopes of 0.9m and 1.5m diameter each (hereafter T90 and T150). The astronomical instruments attached to those telescopes are two similar 2048x2048 CCD cameras and a Strömgren-Crawford simultaneous six-channel photometer. ALBIREO, the low- and intermediate-resolution optical spectrograph, is currently been refurbished. The technical maintenance of the telescopes and instruments is supported by the UDIT (Instrumental and Technological Development Unit) staff belong to IAA.

Due to the size of their telescopes, OSN is especially suited for projects requiring a prompt response (Target of Opportunity, ToO) and/or monitoring observations for long periods of time. The astronomical observations carried out at OSN respond to proposals submitted by IAA research groups, although the number of observing requests by external collaborators is growing with time. In addition to the typical visitor and service observing modes, the OSN offers the possibility to carry out observations in remote mode. Fourteen and twelve proposals have been accepted for the T90 and T150 telescopes for semesters 2015A and 2015B, respectively, in addition to three ToO programs in both semesters. As in previous years, during 2015 the observatory has participated in educational related activities: observing sessions for the Astronomy and Astrophysics Master organized by the Valencia International University and observing sessions for the PIIISA project to introduce Andalucian Secondary students to the research.

Besides the main telescopes, there are secondary astronomical facilities carrying out observations for specific projects: the 60cm IR semi-automated telescope (T60) for early follow-up of gamma-ray bust (GRB), the 35cm telescope (T35) for the observation of variable stars, and the Spectral Airglow Temperature Imager (SATI), and a Fabry-Perot spectrometer dedicated to the study of the high layers of the Earth's atmosphere. Moreover, two seeing-monitors take continuous dome and open-sky measurements in order to characterize the quality of the Sierra Nevada sky. In addition to the instrumentation belonging exclusively to IAA, the OSN hosts astronomical devices in collaboration with other universities and research centers. The OSN Fireball Detection Station is integrated in the SMART project led by Huelva University to monitor the sky in order to analyse the matter interplanetary matter impacting our planet.

Aerial view of the Sierra Nevada Observatory.

OSN observations are to be used frequently by the IAA students to support their PhDs. The most relevant scientific results of the observations are published in international journals. During 2015, observations obtained at OSN have been used in 13 publications (10 ISI publications and 2 proceedings).

The OSN does not only contribute to the scientific production of the IAA and to the formation of its students, but it also participates in multiple outreach activities. It must be particularly emphasized the guided visits, public observations, and talks organized at OSN every summer since 2006.

www.osn.iaa.es/content/visitas-guiadas

MEMBERS

OSN Director: Susana Martín Ruiz

OSN Technical Support Head: Luis Costillo Iciarra

Members: Francisco J. Aceituno Castro, Víctor M. Casanova Escurín, José Luis de la Rosa Álvarez, José Alberto Mirasol Junco, Tomás Pérez Silvente, José Antonio Ruiz Bueno, Alfredo Sota Ballano

UDIT INSTRUMENTAL AND TECHNOLOGICAL DEVELOPMENT UNIT

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

The Instrumental and Technological Development Unit (Unidad de Desarrollo Instrumental y Tecnológico– UDIT) has been in operation at the IAA since its foundation in 1975. State-of-the-art instruments designed and built at the UDIT for balloon and terrestrial rocket payloads in early times and for space missions and ground-based observatoriesnowadays have put the IAA on the map as a reference center for technological-challenging research projects.

The technical production at the UDIT can be split into two major lines:

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

We report next the main technical developmentsfor instrumentation projects achieved in 2015.

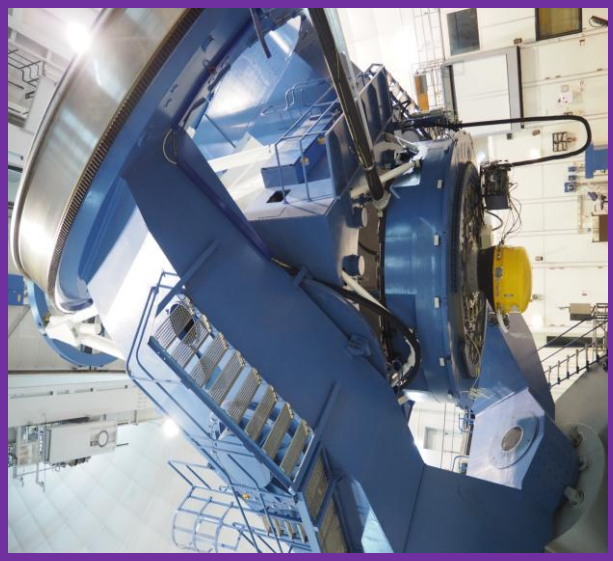
GROUND BASED INSTRUMENTS:

PANIC(PAnoramic Near Infrared Camera) is a general purpose camera for the 2.2mand 3.5m telescopes at CAHA. On November 6th, 2014, we obtained thefirst light of PANIC at the 2.2m telescope, but badweather conditions postponed the commissioning to March 2015, when a successfull Science Verification was carried out at the 3.5m telescope. The Science Verification at the 2.2m was finished in June.

During the second semester PANIC was offered at the 2.2m CAHA telescope in share-risk mode and science observations were obtained.

The IAA has led the optics and high-level software packages. The latter includes the Observation Tool (OT), the PANIC PIpeline (PAPI) and the pipeline for time series (LEMON).

CARMENES(Calar Alto high-resolution search for M dwarfs with Exoearths with Near-infrared and optical Echelle Spectrographs) has been designed and built by a consortium of 11 partners, led by LSW (Heidelberg, Germany) and IAA.



PANIC at the CAHA observatory.

SO/PHI E-UNIT QM model during assembly phase.

IAA was responsible for the integration, verification and commissioning of the NIR channel and, in particular, of the design and manufacturing of its (i) opto-mechanics, (ii) cooling system, (iii) control software and (iv) electronics and exposure meter.

During 2015, the consortium reached all the milestones of the Assembly, Integration and Verification phase. In April, the main first component of CARMENES, its front-end was delivered to, and commissioned at, CAHA. The VIS and NIR channels were sent to the observatory in August and October. "First Light" for both spectrographs simultaneously was achieved on November 9th, 2015, which was a major milestone in the project. The whole instrument was then commissioned until mid December.

The official CARMENES survey started on January 1st, 2016.

SPACE PROJECTS:

PHI is a Polarimetric and Helioseismic Imager to be flown onboard the ESA Solar Orbiter mission. IAA is PHI co-PI institution and its Solar Physics group coordinates the Spanish teams involved in PHI. IAA is also responsible for the electronics unit and the harness work packages. During 2015 the EMC tests were done for the EFM model. The QM model has been integrated and verified during this year as well.

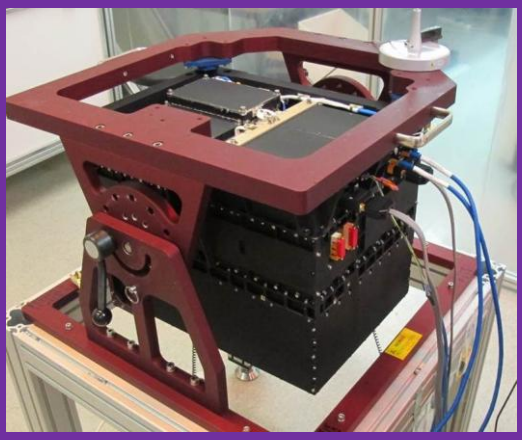
NOMAD (Nadir and Occultation for Mars Discovery) is a 3-channel spectrometer (two IRand one UV) that will fly on-board the ESA ExoMars-TGO mission in 2016. IAA is theco-PI institution of the international consortium led by IASB-BIRA (Belgium). IAA is responsible for SINBAD, the Spacecraft INterface BoArD consisting inCom_Board (CPU and communications with the spacecraft), Pow_Board (powerdistribution filtering and distribution), DC/DCs_module (module with the DC/DCconverters) and SFS (NOMAD onboard SW). During 2015, the SINBAD Flight Spare (FS) model was tested in cleanroom and integrated. Final tests (shock, electrical, vacuum, thermal, vibration) were done to PFM. Finally, NOMAD EIM, SINBAD STM, SINBAD PFM and SINBAD FS models were delivered to ESA.

GALA (GAnymede Laser Altimeter) and **JANUS** (Jovis, Amorum ac Natorum Undique Scrutator) will fly on-board JUICE, an ESA mission that will study the Jovian system. IAA is responsible for the power supply modules of both instruments, and the filter wheel and mechanism controller module (FWM-MCM) of the camera JANUS. At the end of 2015, the JUICE project was at the mid of the preliminary definition (Phase B), with the system requirements review being held in the second semester of the year.

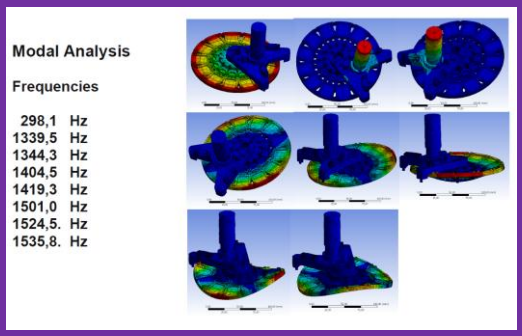
According to this review the design of both instruments (JANUS and GALA) was updated for that milestone. IAA participation were focus in the finite element model (FEM) of the filter wheel (FW) together with the selection of relevant elements of this mechanism like the ball bearings and the sensor position of the filter and the redesign of the Geneva cross mechanism and the cam of the wheel.

As for the electronics, the electrical tests of the different modules continued and the new elegant breadboard model power supply were available at the end of the year.

PLATO (PLAnetary Transits and Oscillation of stars) will be launched by the end of 2025. The payload consists of 28 (TBC) "normal" and 2 "fast" dioptric telescopes with CCD-based focal planes, proximity and remote electronics. The Mission Adoption Review is being studied by ESA until September 2016, and the number of the cameras will be confirmed because the mass exceeded with the original 32 cameras. After that, PDR will start.



NOMAD PFM model being tested during 2015.



JANUS filter wheel Finite Element Model (FEM).

More exciting news at https://udit.iaa.csic.es

IAA is responsible for the MEUs (Main Electronic Units) of the cameras, whereas the coordination responsibility is shared with the Universidad de Granada. During 2015, the PDCR and ISRR documentation was delivered and MEU design was started.

UDIT Members:

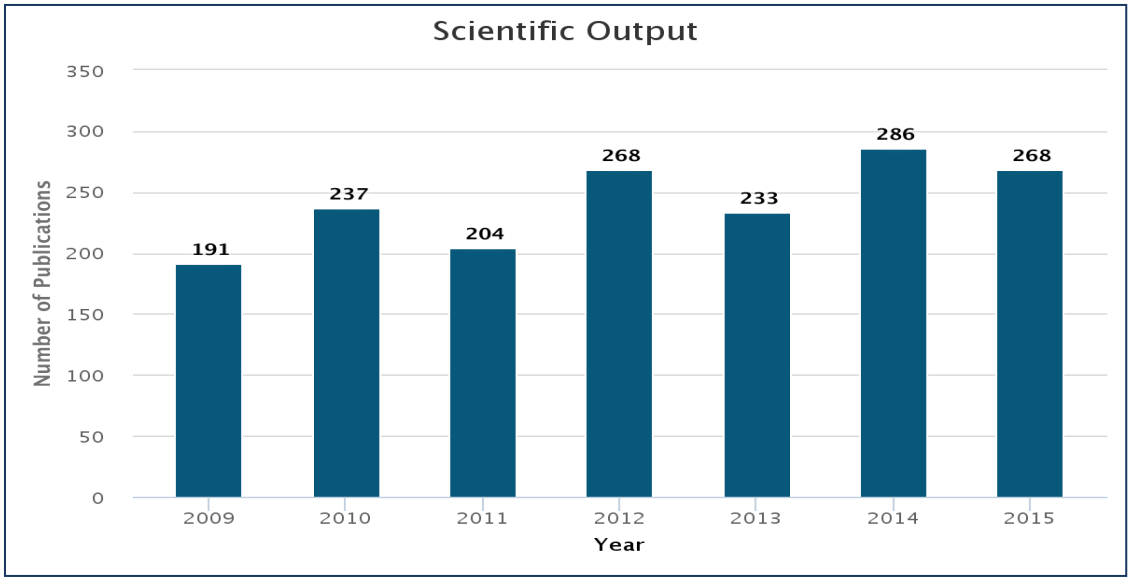
Electronics: M. Abril, D. Álvarez, B. Aparicio, G.P. Candini, J.P. Cobos, L.P. Costillo, J.J. España, F.J. Girela, M. Herranz, J.M. Jerónimo, J. Jiménez, P. Labrousse, H. Magán, I. Martínez, J.L. Ramos, N. Robles, J. Rodrigo, J. Sánchez, M. R., Sanz.

Mechanics: S. Becerril, I. Bustamante, E. Mirabet, M.A. Sánchez. Optics: C. Cárdenas, I. Ferro, D. Pérez, A. Ballesta.
Project Management: M. Balaguer, J.M. Castro, A. López, J.F. Rodriguez
Software: A. García, J.M. Gómez, J.M. Ibáñez, I. Morales, R. Morales, C. Pastor, V. Terrón.

SCI PUBLICATIONS

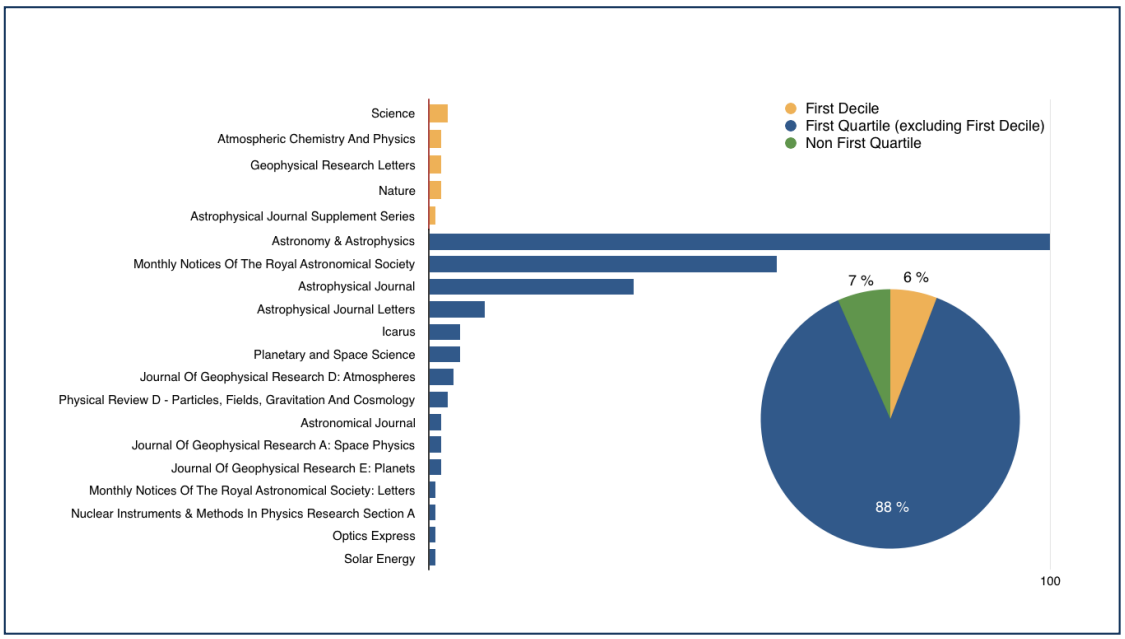
The research activity carried out at the IAA-CSIC during 2015 can be measured by the number of publications in scientific journals included in the Science Citation Index (SCI), i.e., international journals recognized by their quality and impact. This year, this activity has resulted in 268 papers published in journals of the SCI.

The complete list of the IAA-CSIC publications in 2015 is given in the Annex at the end of this report. The evolution of the number of SCI publications in the last 7 years is shown below. The number of publications shows astable increasing trend with time. The IAA-CSIC publications in 2015 exceeds the average of the previous 6 years by 13%.

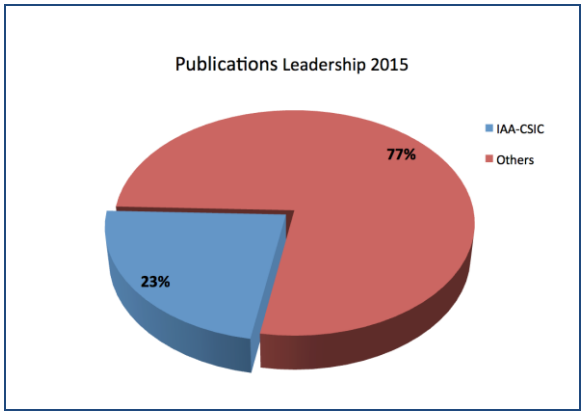


The publications of the IAA-CSIC are mostly made in high impact journals. In 2015, 93% of our publications were made in journals of the first quartile (top 25% journals). Among these, 6% are made in the first decile (top 10% journals). Most of the IAA-CSIC scientific results are published in Astronomy & Astrophysics, the main European astronomical journal.

Monthly Notices of the Royal Astronomical Society and Astrophysical Journal And Astrophysical Journal Letters, the most important British and American astronomical journals, respectively, commonly publish our results. It must be noticed that Icarus, one of the most important journals for planetary sciences, was not included in the first quartile in 2015.

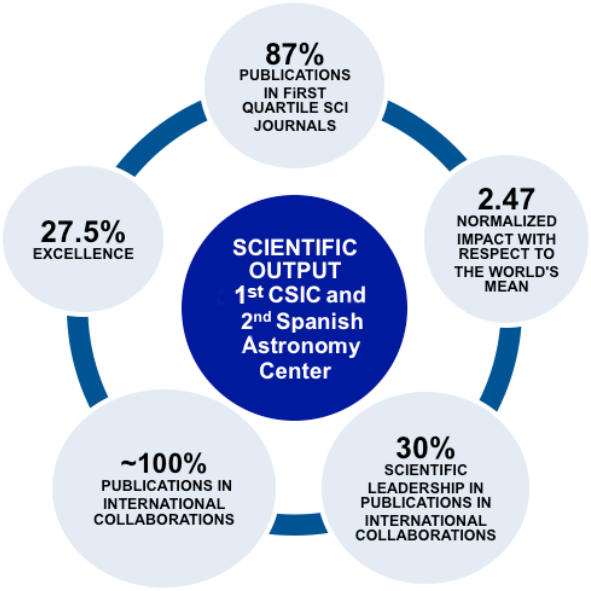


Other aspects of the scientific research of the IAA and its quantitative results are the leadership and internationalization of these publications. Almost a quarter of the IAA SCI 2015 publications are led by IAA scientists, i.e. their first author belongs to the IAA. This is consistent with the leadership of the IAA in the last 5 years.



Furthermore, almost 100% of the IAA publications include authors from international institutions, probing the extraordinary level of internationalization of the IAA research.

According to the WoS Web of Science, the scientific output of the IAA in the period 2011-2015 ranks in the second position among Spanish centers devoted to Astrophysical research. Among all the centers of CSIC the IAA scientific output ranks 7th.



EDUCATION

PHD THESES

"Study of the dynamical and morphological properties of massive stars with high angular resolution techniques"
Author: Joel Sánchez Bermúdez
Supervisors: **Rainer Schödel, Antxon Alberdi Odriozola**
Universidad de Granada Jun 15, 2015

"Electrical discharges in planetary upper atmospheres: thermal and chemical effects"
Author: Francisco Carlos Parra Rojas
Supervisors: **Francisco José Gordillo Vázquez, Alejandro Luque Estepa**
Universidad de Granada Jun 18, 2015

"On the variable nature of low luminosity active galactic nuclei"
Author: Lorena Hernández García
Supervisors: **Josefa Masegosa Gallego, Isabel Márquez Pérez,** Omaira González Martín
Universidad de Granada Jul 21, 2015

"Un sistema de calidad de datos científicos para el instrumento GIADA dentro de la misión espacial ROSETTA"
Author: Rafael Morales Muñoz
Supervisors: Olga Pons Capote, **Julio Federico Rodríguez Gómez**
Universidad de Granada Nov 27, 2015

"Integral Field Spectroscopy of (U)LIRGs and Post-Starburst QSOs: the role of mergers in galaxy evolution"
Author: Clara Cortijo Ferrero
Supervisors: **Rosa María González Delgado**
Universidad de Granada Dec 02, 2015

"The solar internetwork"
Author: Milan Gosic
Supervisors: **Luis Ramón Bellot Rubio**
Universidad de Granada Dec 10, 2015

"Inversión del CO2 y de parámetros colisionales de los espectros de MIPAS en la atmósfera terrestre"
Author: Ángel Aythami Jurado Navarro
Supervisors: **Manuel López Puertas**
Universidad de Granada Dec 11, 2015

"Evolutionary tracks of quiet-Sun magnetic features"
Author: Iker Sánchez Requerey
Supervisors: **José Carlos del Toro Iniesta**
Universidad de Granada Dec 11, 2015

"Observations of small-scale flows in sunspot penumbrae"
Author: Sara Esteban Pozuelo
Supervisors: **Luis Ramón Bellot Rubio**
Universidad de Granada Dec 21, 2015

TEACHING

Master and PhD Programs

Title: ***Astrobiología y Planetas Extrasolares I***
Authors: **Manuel López Puertas**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: Universidad de Granada (UGR)
Hours: 7
Date: November 26, 2015

Title: ***Astrobiología y Planetas Extrasolares II***
Authors: **Miguel AngelLópez Valverde**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: Universidad de Granada (UGR)
Hours: 7
Date: November 26, 2015

Title: ***Astrofísica de Altas Energías***
Authors: **Alberto Javier Castro Tirado, Martín Antonio Guerrero Roncel, Binbin Zhang**
Program: Física y Matemáticas – FISYMAT
University: Universidad de Granada (UGR)
Hours: 60
Date: February 2, 2015

Title: ***Cosmología y galaxias***
Authors: **Emilio Alfaro Navarro**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: Universidad de Granada (UGR)
Hours: 30
Date: April 1, 2015

Title: ***Detectores de radiación***
Authors: **Jorge Iglesias Páramo**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: Universidad de Granada (UGR)
Hours: 6
Date: October 1, 2015

Title: **Estrellas, Nucleosíntesis y Evolución Química**
Authors: **Jose M. Vílchez**
Program: Máster en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
University: Universidad de Granada (UGR)
Hours: 6
Date: March 17, 2015

Title: ***Radioastronomía e Interferometría***
Authors: **José Francisco Gómez Rivero, Antonio Maria Alberdi Odriozola, Guillem Josep Anglada Pons**
Program: Física y Matemáticas – FISYMAT
University: Universidad de Granada
Hours: 40
Date: October 5, 2015

Other Programs

Title: ***De post-AGB a Nebulosas Planetarias***
Authors: **Luis Felipe Miranda Palacios**
Program: Cursos de post-grado del Instituto de Astronomía de la Universidad Nacional Autónoma de México
Organizer: Universidad Nacional Autónoma de México
Hours: 6
Date: November 11, 2015

Title: ***Iniciación a DRUPAL***
Authors: **César Husillos Rodríguez, Aurelia Teresa Gallego Calvente**
Program: Cursos del Gabiente de Formación del CSIC
Organizer: Consejo Superior de Investigaciones Científicas
Hours: 25
Date: March 23, 2015

Title: ***Introducción a la Radioastronomía***
Authors: **Rubén Herrero Illana**
Program: Cursos de Verano de la Universidad Pública de Navarra
Organizer: Universidad Pública de Navarra
Hours: 12
Date: September 22, 2015

Title: ***The Galactic Centre***
Authors: **Rainer Schödel**
Program: School of Astrophysics Francesco Lucchin
Organizer: Istituto Nazionale di Astrofisica INAF
Hours: 5
Date: May 25, 2015

INTERNATIONAL

SEMINARS

★Dr. Dennis Bodewits (University of Maryland)
Title: "Activity and Evolution of Oort Cloud Comets"
Date: Feb 16, 2015

★J. Cernicharo, C. Joblin, J.A. Gago (Centro de Astrobiología - CSIC)
Title: "FORMATION AND EVOLUTION OF COSMIC DUST: THE NANOCOSMOS PROJECT"
Date: Feb 19, 2015

★Almudena Alonso-Herrero (Instituto de Física de Cantabria (CSIC-UC))
Title: "Understanding the obscuring torus and the nuclear star formation of AGN using GTC/CanariCam observations"
Date: Mar 05, 2015

Francisco Manuel Bayo Muñoz (Instituto de Astrofísica de Andalucía - CSIC)
Title: "AirPlay Service"
Date: Mar 12, 2015

★Ryan M. Lau (Cornell University)
Title: "Old Supernova Dust Factory Revealed at the Galactic Center with SOFIA/FORCAST"
Date: Mar 19, 2015

★Prof. Mariano Moles Villamate (Centro de Estudios de Física del Cosmos de Aragón & Instituto de Astrofísica de Andalucía - CSIC)
Title: "FROM ALHAMBRA TO JAVALAMBRE. A SCIENTIFIC PROJECT"
Date: Mar 26, 2015

Sebastián Sánchez (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Ionized gas in the CALIFA galaxies"
Date: Apr 09, 2015

★Raul Michel Murillo (Universidad Nacional Autónoma de México)
Title: "The San Pedro Mártir observatory and its UBVRI photometric survey of Galactic clusters"
Date: Apr 16, 2015

★Javier Díaz Alonso (SEVEN SOLUTIONS S.L.)
Title: "Seven Solutions: industria para las grandes infraestructuras científicas en Granada"
Date: Apr 30, 2015

★Maxim Voronkov (CSIRO)
Title: "ASKAP Commissioning and Early Science"
Date: May 14, 2015

★José María Torrelles (Institut de Ciències de l'Espai - CSIC)
Title: "Observing the onset of outflow collimation in a massive protostar: assembling the puzzle"
Date: May 28, 2015

★Luis F. Rodríguez (Centro de Radioastronomía y Astrofísica, UNAM)
Title: "Massive Star Formation at the Puerto Varas Workshop"
Date: Jun 09, 2015

Ada Ortiz Carbonell (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Ubiquitous magnetic flux emergence in the Sun: a fundamental process"
Date: Jun 11, 2015

★Prof. William Ward (University of New Brunswick)
Title: "The influence of dynamics on airglow and constituents in the terrestrial mesopause region"
Date: Jun 15, 2015

★Pablo Torne (Max Planck Institute for Radioastronomy)
Title: "Into Darkness: the seek for pulsars in the Galactic Centre"
Date: Jun 17, 2015

★Prof. Zhiyuan Li (Nanjing University)
Title: "Untold Stories of Andromeda: A Multi-wavelength View of The Nuclear Environment in M31"
Date: Sep 11, 2015

★A. J. Cuesta, on behalf of the BOSS Collaboration (Universitat de Barcelona)
Title: "Baryon Acoustic Oscillations and the Expansion History of the Universe"
Date: Sep 17, 2015

★Solar MEMS Technologies

Title: "Test In Space, your opportunity to experiment in orbit"
Date: Sep 24, 2015

★Cristina Romero-Cañizales (Pontificia Universidad Católica de Chile)
Title: "Dissecting a rare galaxy merger (the Hummingbird) with radio and mm-observations"
Date: Oct 08, 2015

★Laurie Rousseau-Nepton (Université de Laval)
Title: "High Spatial Resolution 2D Nebular Abundances in Disk Galaxies"
Date: Nov 12, 2015

★Carlos López-Sanjuan (Centro de Estudios de Física del Cosmos de Aragón (CEFCA))
Title: "Following the posterior with the ALHAMBRA survey"
Date: Nov 26, 2015

Rainer Schödel (Instituto de Astrofísica de Andalucía - CSIC)
Title: "Presence and future of adaptive optics at the ESO VLT"
Date: Dec 03, 2015

★Guillem Anglada-Escude (Queen Mary University of London)
Title: "Challenges of the Doppler technique in the presence of stellar noise for the detection of Earth-like exoplanets"
Date: Dec 14, 2015

VISITING SCIENTISTS

Francisco Abellán
Universitat de València
20/09/2015 - 30/09/2015

Jose Ignacio Añez López
Universidad de Granada
15/12/2014 - 15/01/2015

Guillem Anglada Escudé
Queen Mary University of London
14/12/2015 - 15/12/2015

Claire Aubery
Aix-Marseille Université
23/11/2015 - 22/12/2015

Moritz Besser
Max Planck Institute for Chemical Physics of Solids
04/11/2014 - 31/03/2015

Martin Blazek
Czech Technical University
03/02/2015 - 11/03/2015

Juan Manuel Borrero
Kiepenheuer Institut für Sonnenphysik
09/12/2015 - 12/12/2015

Gabriele Bruni
Max Planck Institute for Radioastronomy
08/03/2015 - 20/03/2015

José Cernicharo
Instituto de Ciencias de Materiales de Madrid - CSIC
19/02/2015 - 20/02/2015

Ana Chies dos Santos
Universidade Federal do Rio Grande do Sul
08/04/2015 - 10/04/2015

Roberto Cid Fernandes
Universidade Federal de Santa Catarina
13/01/2015 - 08/02/2015

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Universidade Federal de Santa Catarina
17/09/2014 - 01/10/2015

Laetitia Duret
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23/11/2015 - 22/12/2015

Florence Durret
Institut d'Astrophysique de Paris
23/02/2015 - 27/02/2015

Ute Ebert
Centrum Wiskunde Informatica (CWI)
23/11/2015 - 27/11/2015

Rolando García
National Center for Atmospheric Research
10/12/2015 - 13/12/2015

Beatriz González
ESAC
30/11/2015 - 01/12/2015
27/07/2015 - 29/07/2015

Omaira González Martín
Universidad Nacional Autónoma de México
19/07/2015 - 22/07/2015
03/05/2015 - 08/05/2015

Sanjay Gosain
National Solar Observatory
29/05/2015 - 03/06/2015

Sergiy Guziy
Nikolaev Astronomical Observatory
03/10/2015 - 06/10/2015

Viggo Hansteen
University of Oslo
14/12/2015 - 18/12/2015
13/07/2015 - 17/07/2015
03/05/2015 - 09/05/2015
27/04/2015 - 01/05/2015
30/03/2015 - 04/04/2015

Alexis Helou
Université Paris Diderot
03/02/2015 - 06/02/2015

Ana Herranz Merino
Universidad de Jaén
20/07/2015 - 31/07/2015

Ángel Aythami Jurado Navarro
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09/12/2015 - 11/12/2015
24/11/2015 - 26/11/2015
15/10/2015 - 24/10/2015

Martin Kaufmann
Forschungszentrum Juelich
09/12/2015 - 14/12/2015

Horst Uwe Keller
Institut für Geophysik und extraterrestrische Physik (IGEP)
15/02/2015 - 22/02/2015

Ryan Lau
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18/03/2015 - 21/03/2015

Zhiyuan Li
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09/09/2015 - 12/09/2015

Jean-Louis Lizon
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23/11/2015 - 26/11/2015

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07/01/2015 - 25/02/2015

Pedro Machado
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28/01/2015 - 31/01/2015

Guillermo Manjarrez Esquivel
European Southern Observatory
01/10/2013 - 30/09/2016

José María Martí
Universitat de València
30/06/2015 - 03/07/2015

Paola Marziani
Osservatorio Astronomico di Padova
15/03/2015 - 29/03/2015

Josep Maria Masqué
Universidad de Guanajuato
20/08/2015 - 04/09/2015

Mario Melita
Instituto de Astronomía y Física del Espacio (IAFE)
25/05/2015 - 07/06/2015

Raúl Michel Murillo
Universidad Nacional Autónoma de México
14/04/2015 - 19/04/2015

Juan Pablo Navarro Sánchez
Universidad de Granada
10/03/2015 - 31/07/2015

Shasbi B. Pandey
Aryabhatta Research Institute of Observational Sciences (ARIES)
03/10/2015 - 10/10/2015

Irene Pinos Castro
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18/02/2015 - 20/02/2015

Ricardo Rizzo
Centro de Astrobiología - CSIC
07/07/2015 - 10/07/2015

Luis Felipe Rodriguez
Universidad Nacional Autónoma de México
04/06/2015 - 14/06/2015

Cristina Romero Cañizales
Pontificia Universidad Católica de Chile
04/10/2015 - 13/10/2015

Miguel Sánchez Portal
ESAC
19/02/2015 - 20/02/2015

Walter Santos
Universidade de São Paulo
28/09/2015 - 02/10/2015

Helena Seivane Ramos
Universidad de Granada
15/06/2015 - 30/09/2015

Josep María Solanes
Universitat de Barcelona
04/05/2015 - 08/05/2015

Olga Suárez
Observatoire de la Côte d'Azur
05/05/2015 - 08/05/2015

Jannis Teunissen
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23/11/2015 - 27/11/2015

José María Torrelles
Institut de Ciències de l'Espai - CSIC
26/05/2015 - 28/05/2015

Gian Paolo Tozzi
Osservatorio Astrofisico di Arcetri
27/04/2015 - 22/05/2015

Lucero Uscanga Aguilera
National Observatory of Athens
08/04/2015 - 18/04/2015

William Ward
University of New Brunswick
25/05/2015 - 30/06/2015

Holger Winkler
University of Bremen
21/09/2015 - 02/10/2015

Nataliya Zubko
Finnish Geospatial Research Institute
09/09/2015 - 18/09/2015

WORKSHOPS AND MEETINGS

XXIX IAU General Assembly, Focus Meeting 10: Stellar explosions in an ever-changing environment
Hawaii, USA Aug 11 – 13, 2015
IAA members of the Scientific Organizing Commitee: **C. Thöne**
http://www.iaa.es/iau2015_fm10/

Polarization in the Sun, the Solar System, and Beyond
Granada, SpainMay 25 – 28, 2015
IAA members of the Scientific Organizing Commitee: **L. Bellot Rubio, O. Muñoz Gómez**
IAA members of the Local Organizing Commitee: **S. Esteban Pozuelo, M. Gosic, I. Sánchez Requerey, J. del Toro Iniesta, L. Bellot Rubio**
http://granada-en.congresoseci.com/polarization2015

3rd SOLARNET School on "Solar Magnetic Fields: Modeling and Measuring Techniques"
Granada, Spain May 18 – 23, 2015
http://spg.iaa.es/School

Amazing science with CARMENES
Granada, Spain May 21 - 22, 2015
IAA members of the Scientific Organizing Commitee: **P. Amado González**
IAA members of the Local Organizing Commitee: **P. Amado González, C. Rodríguez López, Z. Modroño Berdiñas**
http://www.riastronomia.es/opencms/opencms/Workshops/R_20150210.html

Workshop estallidos 2015: census and fundamental properties of star-forming galaxies
Not assigned
Granada, Spain May 11 - 13, 2015
IAA members of the Organizing Commitee: **E. Pérez Montero, J. Vílchez Medina, S. Duarte Puertas, C. Kehrig, J. Iglesias Páramo**
http://www.iaa.es/estallidos2015/

STAFF

RESEARCHERS

Permanent Staff

Alberdi Odriozola, Antxon
Aldaya Valverde, Víctor
Alfaro Navarro, Emilio Javier
Anglada i Pons, Guillem Josep
Barceló Serón, Carlos
Bellot Rubio, Luis Ramón
Benítez Lozano, Narciso
Castro Tirado, Alberto Javier
Cerviño Saavedra, Miguel
Claret dos Santos, Antonio
del Olmo Orozco, Ascensión
del Toro Iniesta, José Carlos
Delgado Sánchez, Antonio Jesús
Fernández Hernández, Matilde
Funke, Bernd
Garrido Haba, Rafael
Gómez Fernández, José Luis
Gómez Rivero, José Francisco
González Delgado, Rosa María
Gordillo Vázquez, Francisco José
Gorosabel Urkia, Javier
Guerrero Roncel, Martín Antonio
Gutiérrez Buenestado, Pedro José
Iglesias Páramo, Jorge
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López de Coca Castañer, Pilar
López González, María José
López Jiménez, Antonio Carlos
López Moreno, José Juan
López Puertas, Manuel
López Valverde, Miguel Angel
Márquez Pérez, Isabel
Martín Ruiz Susana
Masegosa Gallego, Josefa
Miranda Palacios, Luis Felipe
Moles Villamate, Mariano Jesús
Moreno Danvila, Fernando
Muñoz Gómez, Olga
Olivares Martín, José Ignacio
Osorio Gutiérrez, Mayra Carolina
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
Verdes-Montenegro Atalaya, Lourdes
Vílchez Medina, José Manuel

Emeriti

Costa Boronat, Víctor
Rolland Quintanilla, Angel

ERC Consolidator Grant

Schödel, Rainer

Ramón y Cajal Members

Agudo Rodríguez, Juan Iván
de Ugarte Postigo, Antonio
Duffard, René Damián
García Comas, Maia Leire
Luque Estepa, Alejandro
Peñarrubia Garrido, Jorge
Sánchez Sánchez, Sebastián Francisco
Thöne, Christina

Juan de la Cierva Members

Binbin, Zhang
Oates, Samantha Rachel

JAE-Doc Fellows

Povic, Mirjana

Postdoc Fellows

Amado González, Pedro José
Anton, Sonia
Blasco Herrera, Javier
Busquet Rico, Gemma
Costado Dios, María Teresa
Dong, Hui
Fang, Xuan
Fernández Lorenzo, Mirian
García Benito, Rubén
Gardini, Angela
González Galindo, Francisco
González García, Marta
González García, Manuel
Guirado Rodriguez, Daniel
Hernández García, Lorena
Herrero Illana, Rubén
Kehrig, Carolina
Mendoza Pérez, María Ángeles

Molina, Sol Natalia
Ortiz Carbonell, Ada
Pascual Granado, Javier
Pozuelos Romero, Francisco José
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Sánchez Doreste, Nestor Miguel
Santos Sanz, Pablo

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Díaz Rodríguez, Ana Karla
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Escobar Cerezo, Jesús
Esteban Pozuelo, Sara
Favole, Ginevra
Fernández Valenzuela, Estela del Mar
Galindo Salgado, Pablo
Gallego Cano, Eulalia Teresa
Gosic, Milan
Hernández García, Lorena
Jiménez Monferrer, Sergio
Jurado Navarro, Ángel Aythami
López Fernández, Rafael
Lorenzo Gutiérrez, Antonio
Macías Quevedo, Enrique
Modroño Berdiñas, Zaira
Parra Rojas, Francisco Carlos
Pérez Invernón, Francisco Javier
Ramírez Moreta, Pablo
Ramírez Olivencia, Naim
Ramos Carmona, Ester
Sampedro Hernández, Laura María
Sánchez López, Alejandro
Sánchez Menguiano, Laura
Sánchez Requerey, Iker
Schoenell, William
Tello Salas, Juan Carlos
Toalá Sanz, Jesús Alberto

Invited Researchers

Costagliola, Francesco (Chalmers University of Technology, Onsala Space Observatory, Sweden)
Ferrero, Patrizia (Thueringer Landessternwarte Tautenburg, Germany)
Márquez Lugo, Ramón Alejandro (CONACYT, Mexico)
Rodríguez Martínez, Mónica Ivette (CONACYT, Mexico)
Sulentic, Jack (Junta de Andalucía, Spain)
Thum, Clemens (Instituto de Radioastronomía Milimétrica, IRAM)

ENGINEERS AND TECHNICIANS

Mechanics

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

Electronics

Abril Martí, Miguel
Alvarez García, Daniel
Aparicio del Moral, Beatriz
Balaguer Jiménez, María
Candini, Gian Paolo
Casas Bou, Albert
Castro Marín, José María
Cobos Carrascosa, Juan Pedro
Costillo Iciarra, Luis Pedro
España Navarro, Joaquín José
Girela Rejón, Fernando Javier
Herranz de la Revilla, Miguel
Jerónimo Zafra, José María
Jiménez Ortega, Jaime
Labrousse, Pierre
Martínez Navajas, Ignacio
Molina Farrugia, Berta
Morales Palomino, Nicolás Francisco
Passas Varo, María
Ramos Más, José Luis
Robles Muñoz, Nicolás Francisco,
Rodrigo Campos, Julio
Roma Dollase, David
Sánchez del Río, Justo
Sanz Mesa, María del Rosario

Optics

Cárdenas Vázquez, María Concepción
Ferro Rodríguez, Irene María
Hernández Garay, Mari Paz
Pérez Medialdea, David

System engineering

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

Software

Benítez Yáñez, Alicia Desirée
Cunniffe, Ronan
Gallego Calvente, Aurelia Teresa
García Segura, Antonio Jesús
Garrido Sánchez, Julian
Gómez López, Juan Manuel
Husillos Rodríguez, César
Ibáñez Mengual, José Miguel
Magan Madinabeitia, Héctor
Morales Durán, Isaac
Morales Muñoz, Rafael
Pastor Morales, María del Carmen
Rodón Ortiz, José Ramón
Ruiz del Mazo, José Enrique
Sánchez Expósito, Susana
Terrón Salas, Víctor Francisco

SERVICES AND ADMINISTRATION

Administration Services

Bordons Mesonero, Fernando
Cortés Guerrero, Maria Ángeles
de Castro Díaz, Rosa Irene
Gómez Finnet, Susana Alicia
Heredia Maldonado, Maria José
Herrera Jiménez, Eva María
Madrid Gómez, Carmen Elisa
Molina Guerrero, Josefa
Nieto Serrano, Concepción
Pelegrina, Alicia
Rodríguez Hernández, Adrián
Tapia Ruiz, Francisco José
Torrededía Rodrigo, Cristina
Zaragoza García, Antonia

Computer Center

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

General Services

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

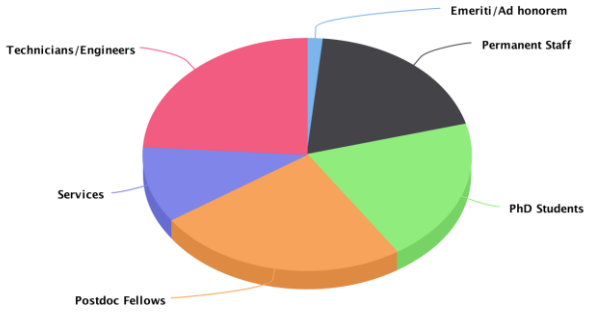
Library

Arco Sarmiento, María Ángeles

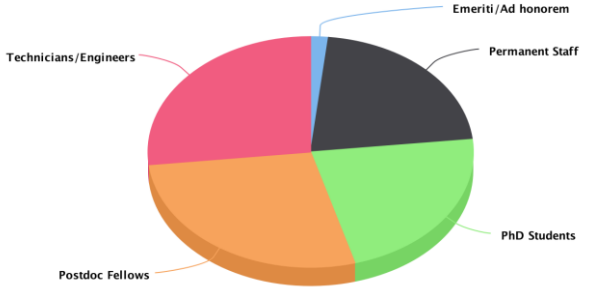
Outreach and Communication Unit

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

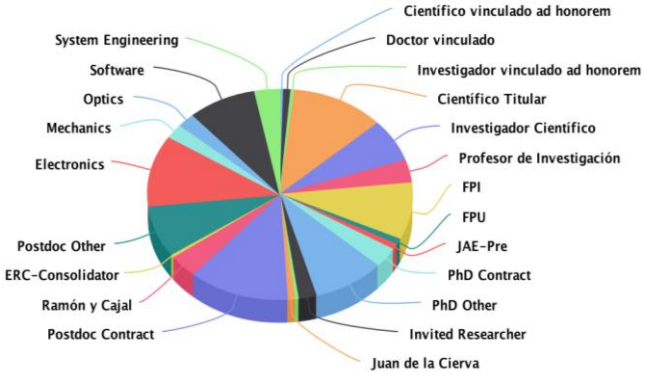
The 2015 IAA staff is distributed among the following general groups. The staff is dominated by scientists, with a non negligible fraction of technicians and engineers.



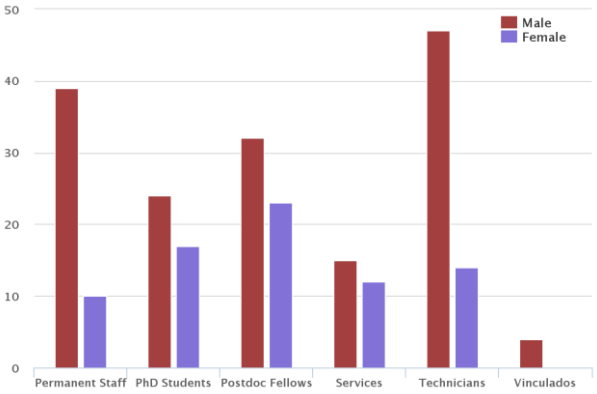
The scientific and technical personnel can be arranged among these overall categories.



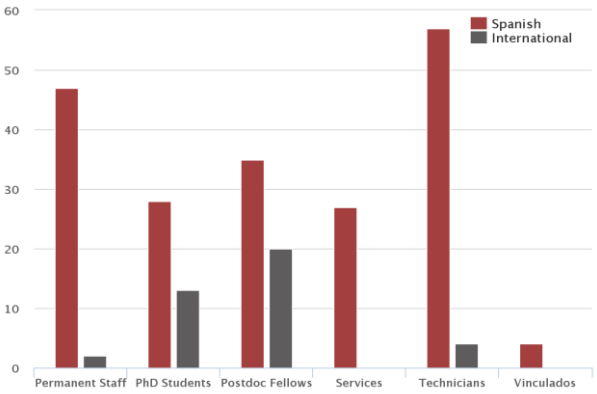
These can be disgregated into the different technician, engineer and scientific groups.



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



This is also the case for international staff, whose fraction is larger among PhD students and post-doctoral fellows.



These figures are indicative of the active actions undertaken by IAA to attract international young talent and incorporate women to the scientific career.

PUBLIC OUTREACH

PROJECTS HELD DURING 2015

TheIAA-CSIC **Communication, Education and Public Outreach Unit**activities cover almost all existing formats to spread science.

- **Popular Science Journal *IAA: Información y Actualidad Astronómica*.** Issued once every four months, it is devoted to high school and university students and general public interested in astronomy (www-revista.iaa.es). Issues in 2015: 45, 46, 47.

- ***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.
http://www-divulgacion.iaa.es/ciclo-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 IRAM 30-meter radioantenna in Sierra Nevada (Granada).
http://www.iaa.es/visitas-OSN-IRAM

- ***The European Researchers' Night*** takes place every year all over Europe on the last Friday of September. The IAA-CSIC contributed to the event on Friday 25 "moving" its research downtown Granada.
http://www.iaa.es/NocheIAA2014

- **40 years of Astronomy.** A whole week of activities celebrating the IAA-CSIC 40th anniversary.
http://www.iaa.es/es/40aniversario

- ***PIIISA Project***(Proyecto de Iniciación a la Investigación de Innovación en Secundaria). A multidisciplinary project designed to allow high school students work with scientists. The IAA-CSIC is the founder of the project.
http://www.piiisa.es

- **UPWARDS Project Communication**. UPWARDS is a cutting-edge project which will build a comprehensive image of Mars, examining everything from the subsoil to the escape into space. The UPWARDS Communication Unit is located at the IAA.

- **Calar Alto Observatory Communication**. The German-Spanish Astronomical Center at Calar Alto is located in north of Almeria. It is operated jointly by the Max-Planck Institut für Astronomie (MPIA) in Heidelberg and the IAA. 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/

- **Square Kilometre Array (SKA) telescope Communication**. The IAA-CSIC is in charge of the Spanish SKA minisite.
http://spain.skatelescope.org/

- **Educational activities**. The IAA-CSIC attends two student groups per month.

- ***La velocidad de nuestros pensamientos*** documentary. Fiction and science united in a film trying to answer an apparently simple question: What is light?
https://vimeo.com/102347401

- **Social Networks**. Twitter, facebook and youtube profiles managing.
https://twitter.com/iaaucchttps://www.facebook.com/iaa.comunicacion
https://www.youtube.com/user/iaaudc

PRESS RELEASES

The IAA 2015 scientific achievements attract the media interest producing the media news listed below. They can be also found online in the following link:http://www.iaa.es/es/prensa

THE WORLD'S LARGEST RADIO TELESCOPE TAKES A MAJOR STEP TOWARDS CONSTRUCTION

Mar 9, 2015

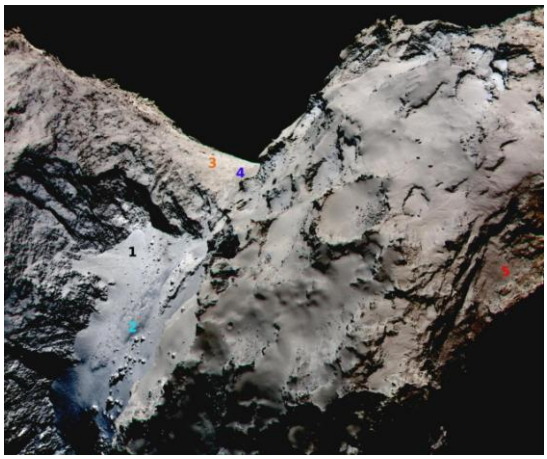
The Square Kilometre Array (SKA), the largest research infrastructure to be ever developed, has already a final design for the first phase of the project. SKA will be the world's largest multi-purpose radiointerferometre with a collecting area of 1 square kilometre, distributed over a distance of at least 3000 km, co-located in Africa and Australia. The IAA-CSIC is leading the Spanish participation in SKA (IP Lourdes Verdes-Montenegro), providing support to I+D centres, companies, MINECO and collaborated with CDTI. Among others, during 2015 it fostered new Spanish memberships to SKA Design consortia and Science Working Groups, filled the SKA Organisation "Survey of SKA Member National Aspirations" and lead the Spanish SKA communication efforts (there was a major update of the Spanish SKA site, http://spain.skatelescope.org). As a result, the Secretary of State established a dialog between Spain and SKA aiming at exploring scenarios for Spain to join the SKA project.

IAA-CSIC has also led the publication of the Spanish SKA White Book (120 researchers from 45 centres) and is involved in SKA precursor science programmes. It has been also actively involved in two SKA design consortia through the AMIGA team (http://amiga.iaa.es) i.e. Infrastructure and Science Data Processor (SDP). In particular, they contributed to the SKA Data and Delivery work packages. They ported software for calibrating LOFAR data in EGI Federated Cloud and were granted in a call jointly coordinated by Amazon Web services and SKA (AstroCompute in the Cloud Grants Program) to port and process LOFAR data using the Amazon cloud.

ROSETTA MISSION YIELDS MOST ACCURATE AND INTEGRAL PICTURE OF A COMET EVER

Jan 22, 2015

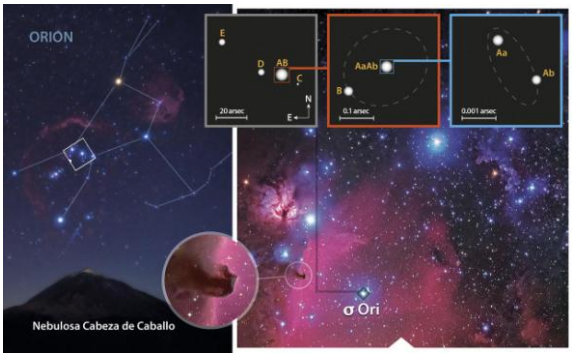
Science magazine publishes special edition on findings of Rosetta, on orbit around comet 67P Churyumov-Gerasimenko since August 2014.



THE CHARACTERISTICS OF THE MULTIPLE STAR 'SIGMA ORIONIS' HAVE BEEN DETERMINED

Jan 27, 2015

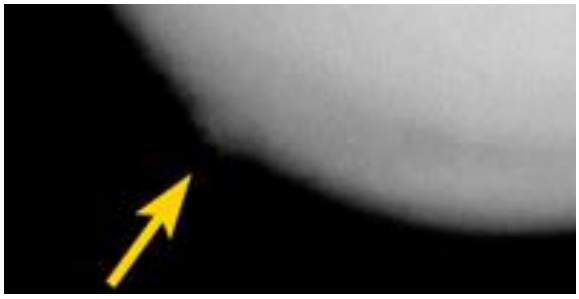
A detailed study on the multiple star system led by Spanish astrophysicists has identified the period, mass and emission of high energy photons of the main stars of the system.



THE HIGHEST PLUME EVER OBSERVED ON MARS

Feb 16, 2015

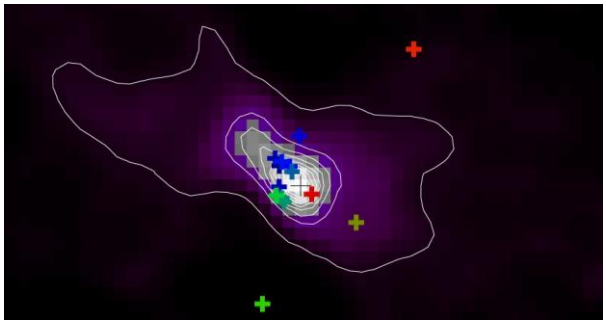
Researchers are studying images of a mysterious bulge that rose up more than 200 km from the surface.



STARS AKIN TO THE SUN ALSO EXPLODE WHEN THEY DIE

Feb 16, 2015

IRAS 15103-5754, a star observed as turning into a planetary nebula, yields new clues of the death of stars similar to the Sun.



JUPITER, A LABORATORY FOR STUDYING EXOPLANETS

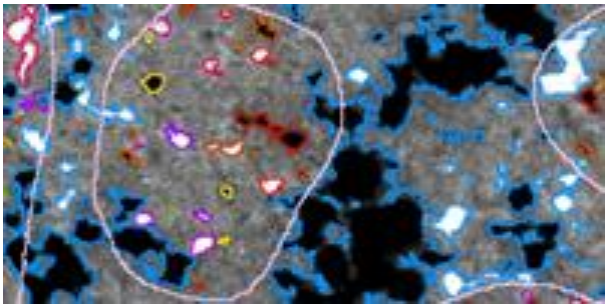
Feb 18, 2015

The atmosphere of Jupiter has been analized during an eclipse of Ganymede, the third satellite of the gas giant.

THE ORIGIN OF THE MAGNETIC FIELD COVERING THE SUN HAS BEEN DISCOVERED

Feb 19, 2015

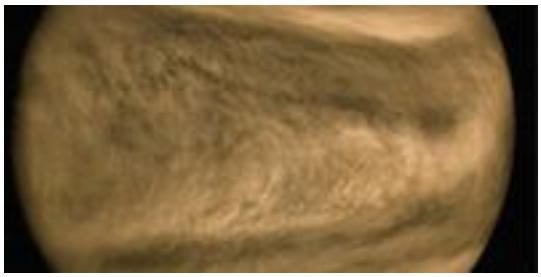
High resolution observations using the HINODE satellite reveal the existence of small magnetic elements inside solar supergranules.



THE HUGE 'Y' IN THE ATMOSPHERE OF VENUS DUE TO A WAVE DISTORTED BY THE WIND

Feb 24, 2015

When observed in ultraviolet light, Venus' atmosphere reveals to be covered by a dark Y-shaped cloud whose origin and evolution have remained unexplained up to date.



IZw 18: THE GALAXY THAT REVEALS THE HISTORY OF THE UNIVERSE

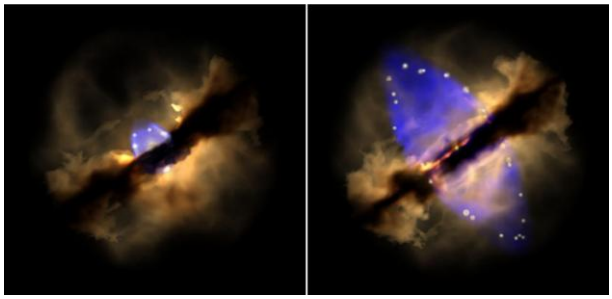
Mar 23, 2015

A map of ionized helium in the galaxy has just been published which indicates the presence of peculiar stars similar to the first that ever shone in the universe.

REAL TIME EMERGENCE OF A STELLAR JET

Mar 25, 2015

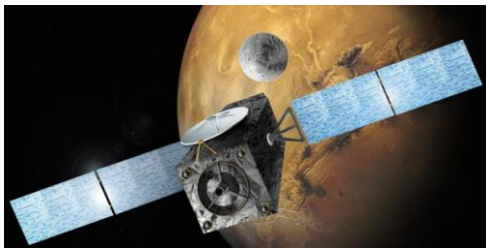
The observation over an eighteen year span of the formation of a massive star has unveiled the birth of a bipolar jet which ejects matter and regulates the star's growth.



IAA COLEADS NOMAD, AN INSTRUMENT THAT MAY SOLVE THE ENIGMA OF METHANE ON MARS

May 13, 2015

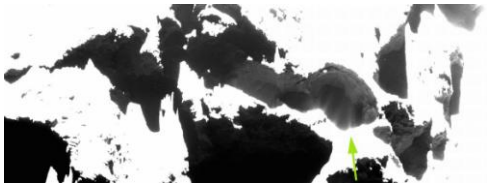
In eight months'time, an instrument called NOMAD will fly to Mars aboard the ExoMars mission of the European Spatial Agency (ESA).



ACTIVITY INSIDE PITS OF COMET 67P OBSERVED BY THE ROSETTA MISSION HELPS TO EXPLAIN THEIR ORIGIN

Jul 1, 2015

The origin of circular depressions found in comets has finally been unveiledby observations acquiered by the OSIRIS camera on board the Rosetta ESA mission.



UPWARDS, A CUTTING-EDGE PROJECT FOR GLOBAL UNDERSTANDING OF MARS

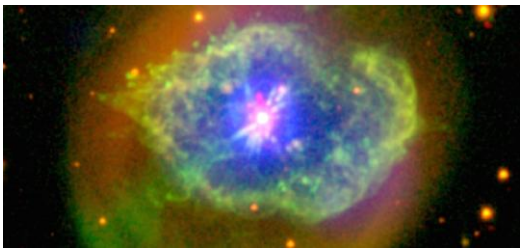
Jul 09, 2015

Co-ordinated by the Instituto de Astrofísica de Andalucía (IAA-CSIC), the project involves seven European scientific institutions which are developing new analytical techniques to exploit the Mars Express and the future ExoMars missions.

ABELL 78: THE BORN-AGAIN STAR

Jul 27, 2015

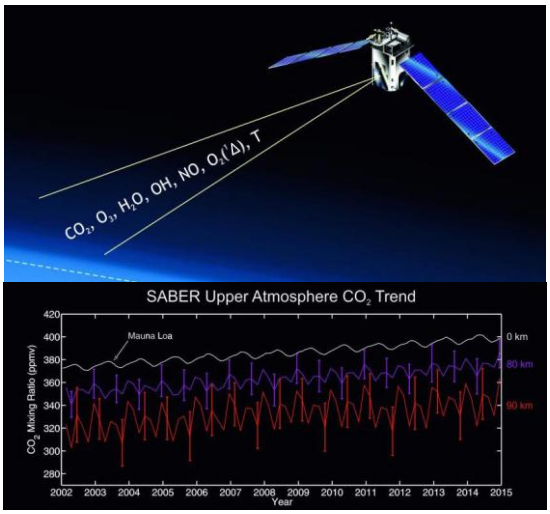
The central star of the planetary nebula Abell 78 suffered a late thermonuclear blast that took it back for a while to the early phases of the post-AGB evolution.



CONCENTRATION OF CARBON DIOXIDE ON THE RISE IN UPPER LAYERS OF EARTH'S ATMOSPHERE

Sep 15, 2015

SABER, an instrument aboard the NASA satellite TIMED, has measured a 5%-12% increase per decade in the CO_2concentration in the upper atmospheric layers.



ROSETTA MISSION CONFIRMS COMET 67P TO BE PRODUCT OF FUSION OF TWO INDEPENDENT OBJECTS

Sep 27, 2015

Cometary lobes collided together very slowly during the formation of the Solar System.

THE INSTITUTE OF ASTROPHYSICS OF ANDALUSIA RECEIVES THE MEDAL OF HONOR OF THE FOUNDATION RODRíGUEZ-ACOSTA

Oct 8, 2015

The Medal of Honor Foundation Rodríguez-Acosta 2014 has been awarded to the IAA during a ceremony in the hall of the Museum of Gómez-Moreno Institute.

INFRARED 'EYE' ARRIVAL COMPLETES CARMENES INSTRUMENT, WHICH WILL SEE ITS FIRST LIGHT IN NOVEMBER

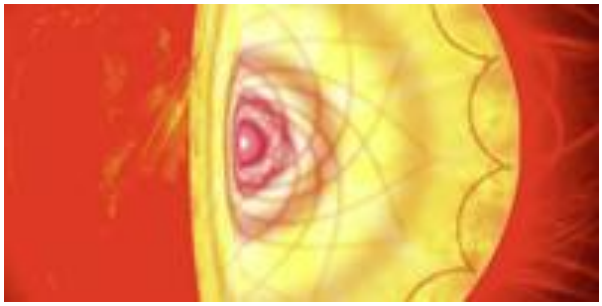
Oct 18, 2015

The infrared channel, developed at the Instituto de Astrofísica de Andalucía (IAA-CSIC), will be placed tomorrow in its final location, at the 3.5m Calar Alto Observatory telescope.

RESEARCHERS FROM THE IAA AND THE UGR QUESTION RESULTS OBTAINED SO FAR IN THE STUDY OF PULSATING STARS

Nov 30, 2015

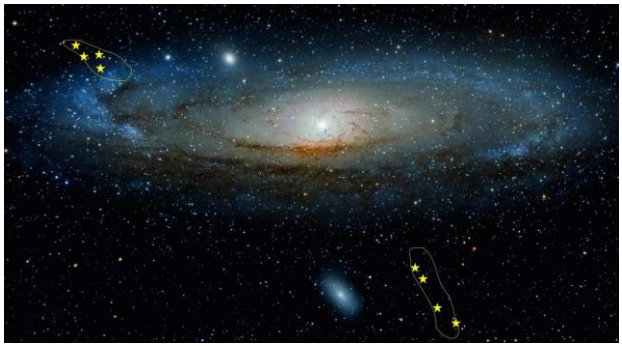
A study using the high precision satellites CoRot and Kepler has pointed to two examples which put in question the use of a tool common to most studies of stellar oscillations.



HISTORY OF ANDROMEDA GALAXY STUDIED THROUGH STELLAR REMAINS

Dec 11, 2015

Planetary nebulae, stars similar to the Sun which have burnt up their fuel and ejected their external layers, make it possible to study two main substructures of the Andromeda galaxy.



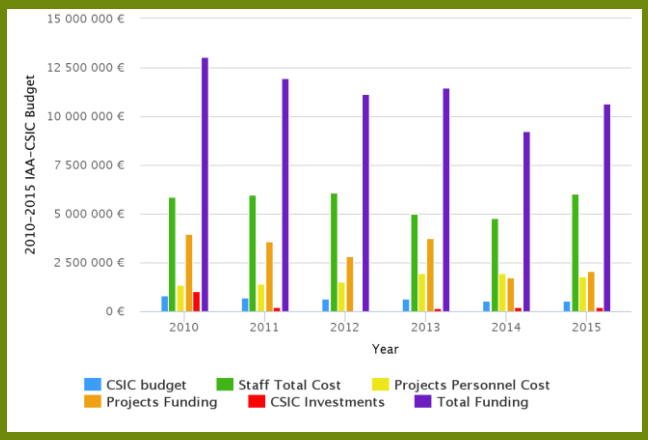
Throughout 2015, the IAA has posted more than 125 appearances in media.

FUNDING

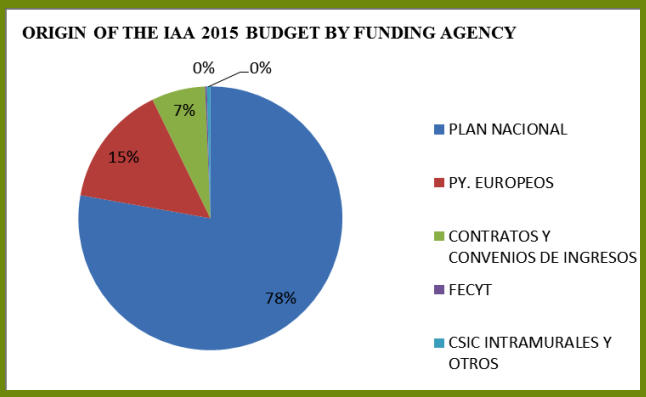
The IAA obtains most of its funding through competitive Andalucian, Spanish, and European calls. Here we provide a list of all competitive funding awarded to IAA staff in 2015.

The time evolution of the IAA budget in the last years is shown in the top-right figure. There is a notable decline the total funding level throughout the 2010-2014 period which is leveled in 2015 by the new projects funded by the European Union.

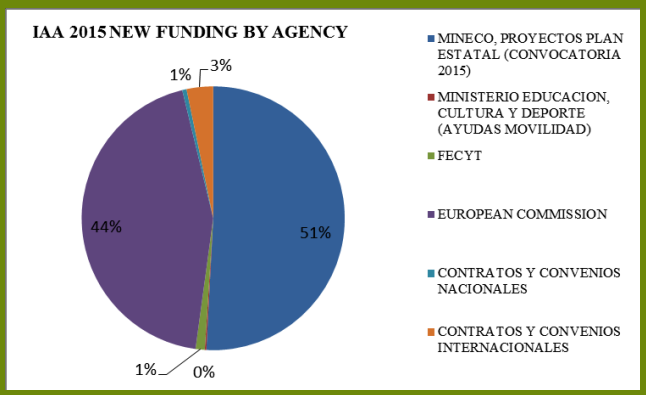
The fraction of the IAA budget and new funding in 2015 by funding agency are shown next.



Time evolution of the IAA budget in the last 5 years.



Origin of the IAA 2015 budget by funding agency.



IAA 2015 new funding by agency.

EUROPEAN RESEARCH COMISSION FP7

Getting Ready for EST (GREST)
Reference: H2020-INFRADEC-1-2014-1 653982
PI: **José Carlos del Toro Iniesta**
Duration: June 1, 2015 – May 31, 2018
Amount: 194.062,50

Understanding Planet Mars With Advanced Remote-sensing Datasets and Synergistic Studies (UPWARDS)
Reference: H2020-COMPET-2014 633127
PI: Miguel Angel López Valverde
Agency: European Comission FP7
Duration: Jan 01, 2015 - Jan 01, 2018
Amount: 594.516

MICINN

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 1, 2015 - Dec31, 2017
Amount: 137.940

GRAVEDAD Y UNIVERSO CUANTICO: EMERGENCIA, COLAPSO GRAVITACIONAL Y FISICA TRANSFORMACIONES
Reference: FIS2014-54800-C2-1-P
PI: **Carlos Barceló Serón**
Duration: Jan 1, 2015 - Dec31, 2017
Amount: 15.125

ESTUDIO MULTIDISCIPLINAR SOBRE PLANETAS ENANOS Y PEQUEÑOS CUERPOS DEL SISTEMA SOLAR III
Reference: AYA2014-56637-C2-1-P
PI: **René Damián Duffard, José Luis Ortiz Moreno**
Duration: Jan 1, 2015 - Dec31, 2017
Amount: 123.420

FABRICACION E INTEGRACION DE LOS MODELOS QM, FM Y FS DE SO/PHI (POLARIMETRIC AND HELIOSEISMIC IMAGER FOR SOLAR ORBITER)
Reference: ESP2014-56169-C6-1-R
PI: **José Carlos del Toro Iniesta**
Duration: Jan 1, 2015 –Dec 31, 2017
Amount: 1.209.400

BÚSQUEDA DE PLANETAS DE TIPO TERRESTRE EN ESTRELLAS FRÍAS EMPLEANDO INSTRUMENTOS ASTRONÓMICOS DE NUEVA TECNOLOGÍA
Reference: AYA2014-54348-C3-1-R
PI: **Matilde Fernández Hernández**
Duration: Jan 1, 2015 – Dec 31, 2016
Amount: 471.900 □

RESOLVIENDO LAS GALAXIAS EN ESPACIO Y TIEMPO: CLAVES PARA LA FORMACIÓN Y EVOLUCIÓN DE LAS GALAXIAS
Reference: AYA2014-57490-P
PI: **Rosa González Delgado, Enrique Pérez Jiménez**
Duration: Jan 1, 2015 – Dec 31, 2016
Amount: 129.470 □

BURBUJAS COSMICAS: UNA VISION PANCROMATICA
Reference: AYA2014-57280-P
PI: **Martín Antonio Guerrero Roncel**
Duration: Jan 1, 2015 - Dec31, 2017
Amount: 123.420 □

CIENCIA CON LA MISION ROSETTA, TECNOLOGIA PARA LA MISION JUICE Y ATMOSFERA EXOPLANETARIAS
Reference: ESP2014-54062-R
PI: **Luisa María Lara López**
Duration: Jan 1, 2015 - Dec31, 2017
Amount: 808.280 □

COMPOSICION Y TEMPERATURA EN ATMOSFERAS PLANETARIAS
Reference: ESP2014-54362-P
PI: **Manuel López Puertas, Maia Leire García Comas**
Duration: Jan 1, 2015 - Dec 31, 2017
Amount: 266.200 □

LA PROPAGACIÓN DE RAYOS COMO UN PROBLEMA DE FORMACIÓN DE PATRONES
Reference: FIS2014-61774-EXP
PI: **Alejandro Luque Estepa**
Duration: Sep 1, 2015 - Aug 31, 2017
Amount: 48.400 □

EXPLOSIONES ESTELARES MASIVAS: SU ORIGEN, MUERTE Y CONSECUENCIAS
Reference: AYA2014-58381-P
PI: **Christina Thöne, Antonio de Ugarte Postigo**
Duration: Jan 1, 2015 - Dec 31, 2017
Amount: 135.520 □

AMIGA5: GAS EN EL INTERIOR Y EN EL ENTORNO DE LAS GALAXIAS. PREPARACION CIENTIFICA Y TECNOLOGICA PARA EL SKA
Reference: AYA2014-52013-C2-1-R
PI: **Lourdes Verdes Montenegro**
Duration: Jan 1, 2015 - Dec31, 2016
Amount: 158.510 □

ANNEX

SCI PUBLICATIONS

1. Aalto S., Garcia-Burillo S., Muller S., Winters J.M., Gonzalez-Alfonso E., Van Der Werf P., Henkel C., **Costagliola F.**, Neri R.
"High resolution observations of HCN and HCO + J = 3-2 in the disk and outflow of Mrk 231: Detection of vibrationally excited HCN in the warped nucleus"
Astronomy and Astrophysics, Vol. 574, Number A85
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