



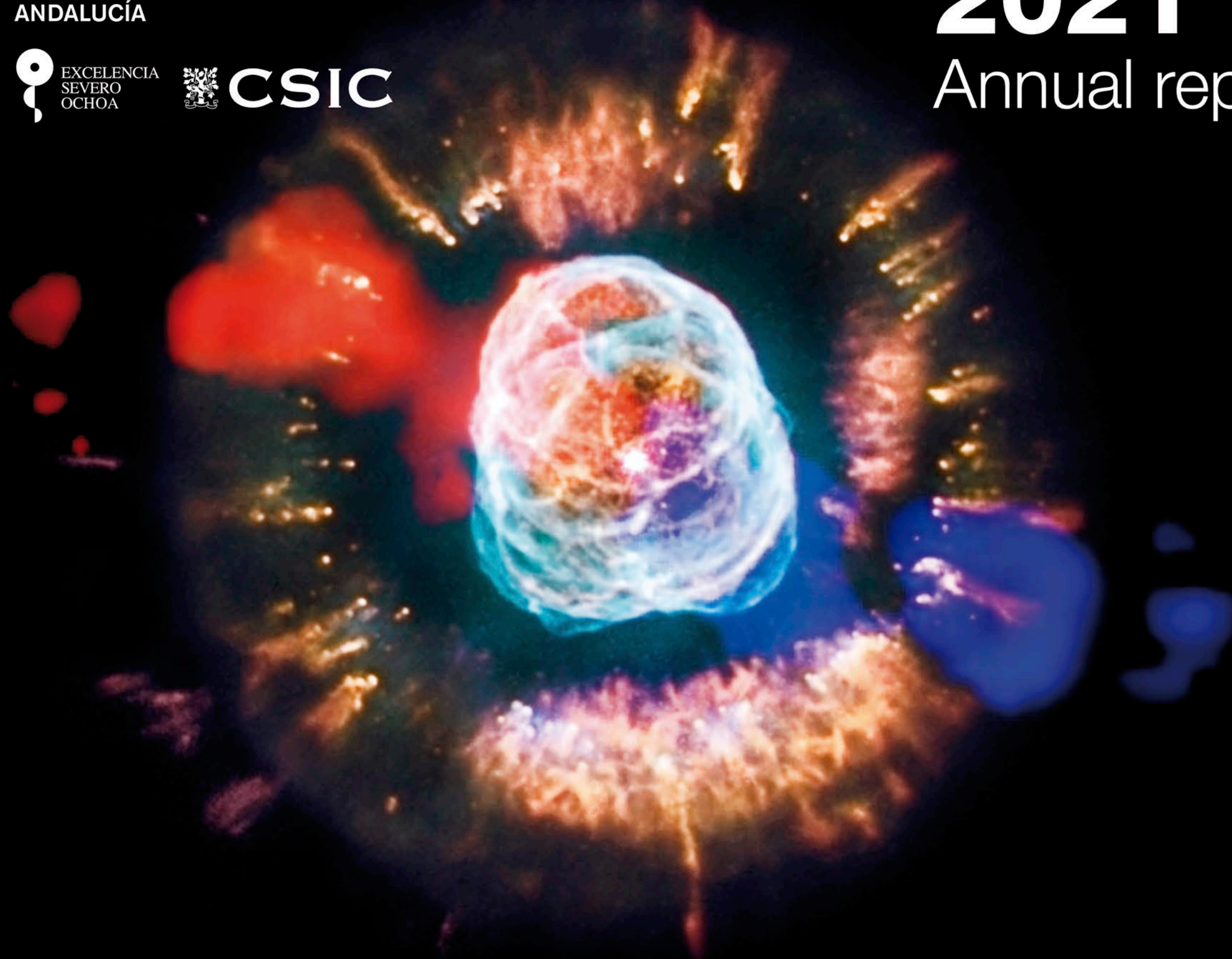
INSTITUTO DE
ASTROFÍSICA DE
ANDALUCÍA



CSIC

2021

Annual report





The **IAA-CSIC 2021 Annual Report** is the result of a collective process of the people who make up the Instituto de Astrofísica de Andalucía. We would like to thank all of them for their dedication and willingness to capture the best possible picture of what we do and what we work for.

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Foreword

Antxon Alberdi

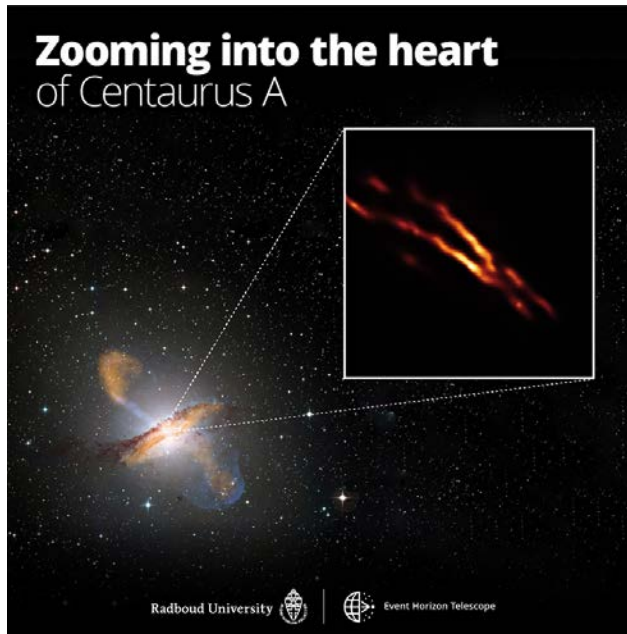
Director IAA-CSIC

Isabel Márquez

Scientific Director SO-IAA Project

The year 2021 offered an excellent opportunity to make a review of the scientific and technical life of the IAA: on the one hand, we were facing the final year of the **“Severo Ochoa – IAA” program** (July 2018 – June 2022). The Severo Ochoa Excellence award has had a transformative impact on the IAA in terms of attracting international talent, rejuvenating our staff, increasing our output, implementing a novel training program, reinforcing work on strategic infrastructure, international visibility and scientific outreach. At the end of 2020, the **mid-term report** was presented obtaining the **highest grade**. On the other hand, it was the time to define the **new strategic plan** for our center, within the framework of the “CSIC Action Plan 2022-2025”. We had a good starting point: the IAA has a strong track record, producing a sustained, large number of high impact work. From a technical side, we contribute to almost every major recent space Solar System mission and participate in state-of-the-art instruments for ground-based telescopes. Moreover, the IAA is recognized as an international center of reference for radio astronomy, with critical involvement in the Event Horizon Telescope and the commitment to establish an SKA Regional Centre (SRC).

We defined a **set of strategic lines** on which we will focus our activity in the coming years: leading multidisciplinary studies of exoplanetary systems and their architecture, deepening the study of the star-planet interaction and exoplanet atmospheres, using our background in radiative transfer models in non-ETL conditions; continuing our leadership in the EHT and in the future ngEHT to obtain the first movies of the supermassive black hole at the center of our Galaxy; exploiting our unique capabilities for the study of star formation and nuclear activity over the full range of relevant physical scales and distances; obtaining an unprecedented 3D map of the universe, via the J-PAS survey, relevant for the study of galaxy formation and evolution; becoming one of the nodes of the SRCs in Europe addressing the most ambitious challenge in radio frequency astronomical observations; leading at IP/co-IP level frontier instrumental projects for space exploration as Comet Interceptor, EnVision, Vigil/Lagrange and SUNRISE 3; strengthening our scientific and technical leaderships in the ESFRI projects in Astronomy; leading the development of the new integral field spectrograph for the CAHA 3.5m



Source: R. Bors; ESO/WFI; MPIFR/ESO/APEX/A. Weiß et al.; NASA/CXC/CfA/R. Kraft et al.; EHT/M. Janßen et al.



Source: Danielle Futselaar (artsource.nl).



Source: Gabriel Pérez Díaz, SMM (IAC).

telescope; consolidating our connections with our most relevant partners such as ESA, ESO, and SKA, among others.

During 2021, the number of publications of high impact increased, with **more than 300 publications** in refereed journals, 85% of which in Q1 journals (7% in D1). We can mention several high impact results, as the public release of the **most detailed star catalogue of the Galactic Center**, a result of the ERC Consolidator Grant GALACTICNUCLEUS, led by researchers from the IAA. For the first time, **a jet of gas emerging from the central star of a planetary nebula** was observed with data from MEGARA/GTC. In the field of exoplanets, the study of **the radio emission of Proxima Centauri**, showing a correlation between the radio light curve and the orbital period, provided a new tool for the study of exoplanetary systems. On the other hand, a system formed by **a white dwarf and a Jovian-type planet** was discovered, providing a glimpse into the possible future of the Solar System. **An eruption of a magnetar** was studied in detail measuring distinct oscillations in its brightness during peak energy, which are a crucial component in understanding giant magnetar flares. With the **EHT**, the structure of the **magnetic fields at the edge of the black hole in M87** was imaged for the first time. Additionally, the EHT pinpointed the **central black hole at the heart of the nearby galaxy Centaurus A**. New results from **SKA precursors** (MeerKAT, ASKAP, LO-FAR, among others) with high resolution studies of

galaxy groups and galaxies in the Local Group were published. IAA researchers led **the study of IZw18**, one of the most metal-poor galaxies, connecting the radiation that produces a Helium halo with the presence of Pop III stars. From the theoretical side, we could mention that the IAA participated in the development of **Uchuu**, the most accurate and complete simulation of the large-scale structure of the Universe.

Regarding **CAHA**, the feasibility studies of the instruments **TARSIS** and **GAMAICA** were presented in Spring 2021 to the Calar Alto Scientific Advisory Committee (SAC). Both are Integral Field Unit (IFU) spectrographs and successfully passed the feasibility study phase, once evaluated by an instrumental and Technical Advisory Committee. A final recommendation by the SAC, after an in-depth review of each project, would be sent to the new CAHA Executive Committee, that would take the final decision on the selected instrument.

The Instrumental and Technological Development Unit (UDIT) develops state-of-the-art instruments for ground-based telescopes and space-borne astrophysical payload instrumentation. During 2021, the final electrical and thermal testing and assembly of the instruments **Tumag** and **SCIP** electronic units, scientific cameras and harness for **Sunrise III** was performed. Sunrise III mission is expected to be launched in June 2022. The flight models of the IAA's contribution to the instruments GALA & JANUS for

for scientific analysis of the data produced at this observatory. For **ELT**, the official start of the two new instrumental projects for the ELT, **ANDES** and **MOSAIC**, both with IAA participation, was approved by the Council of the European Southern Observatory (ESO).

Along 2021 the activity at the institute's headquarters started returning into normal. One aspect that we would like to highlight is that the number of PhD theses defended increased substantially: in 2021, **eleven theses were defended by IAA's predoctoral researchers**. Young researchers were particularly hardly hit by the effects of the pandemic, which made the interaction with their supervisors

difficult, prevented scientific exchange visits, and limited the discussion among the centre's researchers to the screen in many cases. This large increase in the number of theses defended witnesses the return to a more normalised scientific life.

A research institute grows and learns from all those who have worked in it. At the IAA we have incorporated into our year-end meeting a tribute to colleagues reaching retirement age. The combination could not be more interesting: the presentation of all the scientific, technological and outreach activities carried out at the IAA during the year (2021 in this case), together with the tribute to those who have contributed to make the IAA the center it is today. In December 2021 we paid tribute to our fellow scientists José Juan López Moreno and Víctor Aldaya, our UDIT colleagues Miguel Herranz de la Revilla and Luis Costillo, and our administrative colleague Rosa de Castro. This was not a goodbye, it was a see you always.

Enjoy this Report.

the **JUICE mission** were delivered for the integration in the spacecraft. JUICE is expected to be launched in 2023. UDIT also contributed to the instruments COCA, MANIAC, Envis and OPIC for **Comet Interceptor**, VenSpec and VEM for **EnVision**, and PMI for **Vigil (former Lagrange)**, and the MEUs for **PLATO**. With regard to ground-based instrumentation, UDIT contributed to **new instrumentation for CAHA** (CARMENES-PLUS, and the feasibility studies for GAMAI-CA and TARSIS) and **OSN** (MIMA). A number of technical activities were performed at the OSN, including the mirror coating of the 90 cm telescope.

IAA is also playing a relevant role in the **ESFRI infrastructures for Astronomy**. The Spanish Government initiated the necessary steps to become a member of the new IGO SKA. The **IAA is coordinating the Spanish participation in SKA**, with funds granted by a budgetary line from the Spanish Ministry of Science (2021). This reinforces the consolidation of the Spanish SKA office at the IAA. **IAA is prototyping the Spanish node of the international SKA Regional Center (SRC)** network, advocating for the principles of Open Science and reproducibility. For **EST**, our center leads the consortium for **tunable imaging spectropolarimeters**, one of the core instruments, of which three units are planned to be built. For **CTA**, the IAA played an important role in the development of the **Gammapy project**, both from the point of view of software development and project governance. In 2021, CTA adopted the Gammapy software package

IAA Organizational Chart



From left to right, Luis Costillo, Miguel Herranz, José Juan López-Moreno, Rosa Castro, and Víctor Aldaya. All five retired in 2021.

Picture group at the "IAA Day 2021", celebrated on December 17th

IAA overview

The **Instituto de Astrofísica de Andalucía** (IAA) is the largest Astronomy institute of the **Consejo Superior de Investigaciones Científicas** (CSIC)

The IAA research is supported by thirteen active CSIC research groups, covering most of the research topics in modern Astrophysics. This research is carried out within four different departments.

Research Groups

Solar System

- Solar Physics
- Planets and minor bodies
- Terrestrial Atmosphere

Stellar Physics

- Lowmass Stars
- Stellar Variability
- ARAE
- HETH

Radio Astronomy and Galactic Structure

- Stellar Systems
- PISM
- AGN jets

Extragalactic Astronomy

- Galaxy evolution
- Theoretical gravitation
- Observational Cosmology
- Cosmology and Astroparticle Physics

The **Instrumental and Technological Development Unit** (UDIT) and the **Computer Center** (CC) provide technical support to the research lines.

The IAA owns the **Sierra Nevada Observatory** (OSN) and is also the CSIC reference research center for the **Calar Alto Observatory** (CAHA).

Staff

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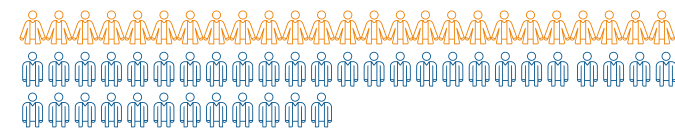
Total member

Category and gender distribution

52 Permanent Staff (10 Female / 42 Male)



62 Postdoc Fellows (25 Female / 37 Male)



46 Predoctoral Researches (15 Female / 31 Male)



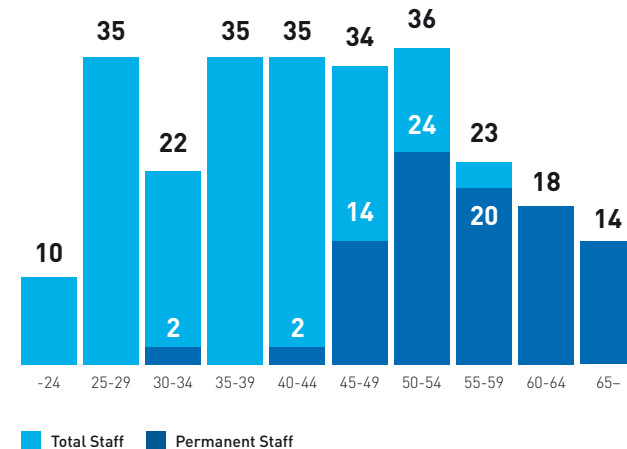
64 Technicians/Engineers (11 Female / 53 Male)



33 Services (17 Female / 16 Male)



Age distribution



Detailed Cientifical and Technical Staff

19 / 4 Scientific researcher / **23 / 5** Senior researcher / **10 / 1** Research professor

57 / 23 Postdoc contract / **4 / 1** Ramón y Cajal / **1 / 1** MSC postdoc

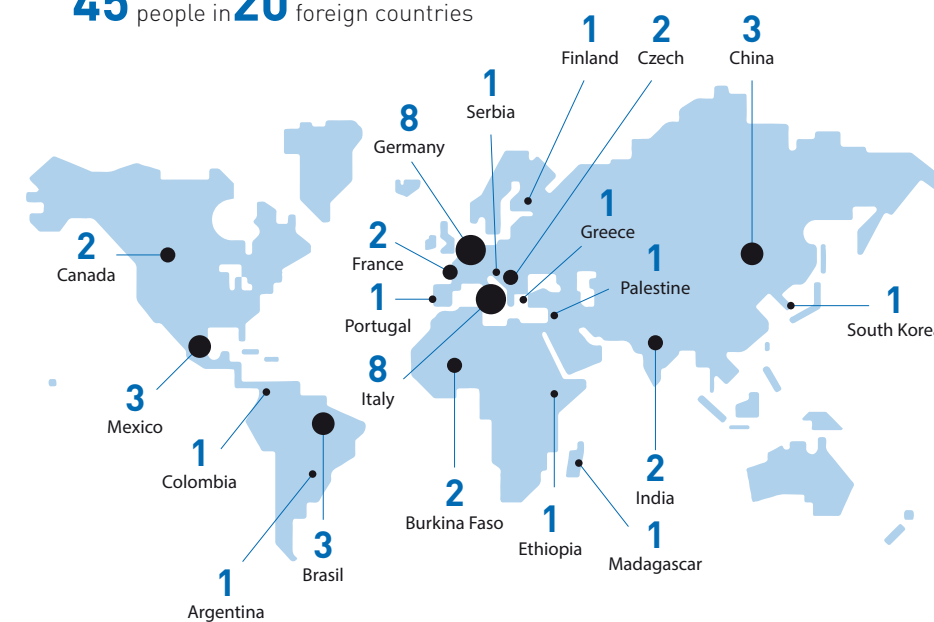
28 / 8 FPI / **6 / 2** PhD contract / **11 / 4** JAE-Intro / **1 / 1** MSC predoc

24 / 3 Electronics / **21 / 4** Software / **8** OSN

6 / 2 Mechanics / **5 / 2** Optics

International Staff

45 people in **20** foreign countries



2021 results

303 SCI publications

47 seminars at the IAA

43 press releases

18 meetings and schools

27 theses (PhD, Master, Degree)

17 courses

4 awards

14.1 M€ total budget

The IAA Severo Ochoa Programme



Isabel Márquez
Scientific Director SO-IAA Project



Straddling the third and final years of the Severo Ochoa IAA award, and in spite of the abnormal normality, the year 2021 came with a number of relevant results in different scientific areas. Among them, we led a number of studies that contributed to the understanding of planetary systems: an ambitious radio observation project that showed that **extrasolar planets can be detected with radio telescopes and follow their variability**; CARMENES allowed the detection of **hot earths and super-earths** around two red dwarf stars; the discovery of a system formed by a **white dwarf and a Jupiter-like planet** showed that planets can survive the death of their stars; from the theoretical side, we first approached the problem of the distribution of temperatures on the surfaces of **distorted white dwarfs**; in our own Solar System, and thanks to the stellar occultation technique, we were able to determine the **characteristics of an elongated centaur** almost 400 km long. In the study of star formation in the Milky Way and the Local Universe, we led both the first evidence of a **jet emerging from the central star of a planetary nebula**, and the **most extensive census of stars in the Galactic Center** recorded to date. We also led a number of results on galaxy evolution and cosmology: we studied the distinct pulses in the giant magnetic flare from a neutron star, **the most distant magnetar flare captured to date**, located in the Sculptor group of galaxies; with EHT, we imaged the magnetic fields at the edge of the **supermassive black hole in M87**; we investigated the origin of the radiation producing the **Helium halo around IZw18** and its eventual connection with PopIII stars; we detected a **gas outflow emanating from the center of the Arp299** merging system with the unprecedented detail provided by LOFAR; we led the **discovery of very low surface brightness galaxies** in the environments of NGC1052, and the **discovery of a possible satellite galaxy of M33**; we strongly participated in the generation of the virtual universe provided by the **numerical simulation UCHUU** (“universe”, in Japanese). All our research produced more than 300 publications in refereed journals, with 85% of them in the first quartile (Q1), more than one third led by IAA scientists. They provide a fair representation on the numerous projects

we are involved in, among which we could highlight GALANTE, CALIFA, ROSSETA, CARMENES, TESS, EHT, J-PLUS, GALACTICNUCLEUS, GAIA, SMASH-ing, OTELO, DESI, SOLAR ORBITER, Mars Express, ExoMars, IPHAS, MEGARA, SITELLE, LeMMINGs, RadioAstron, SKA pathfinders and precursors, etc. Last but not least, contributing to the research on Covid-19 with our skills and tools, we published our results on the **detection of coronavirus in surfaces with our Cosmic Dust Laboratory**, as well as on the impact of the strict confinement on the light pollution levels.

Concerning our **prototype of SKA Regional Center**, in 2021 it hosted 9 research and 9 development projects, together with 8 training activities; we highlight the set-up of the infrastructure to host the SKA Data Challenge 2, and the development of a distributed archive for the ASKAP HII all-sky survey WALLABY. In February 2021, the council of the international Radio Astronomy observatory SKAO (Square Kilometre Array Observatory) intergovernmental organisation (IGO) was formed. The Spanish participation in SKA is led by the IAA-CSIC.

We continued our **Web-loquia program (colloquia in virtual format)**, with more than 30 high standard talks, which were followed by numerous researchers also from another institutions in Spain and abroad. Our **visiting program** started to recover, trying to overcome the difficulties for travelling even within Europe due to the pandemics. Our **training activities**, most of them in the online format, were significantly boosted. Among them I highlight the **two Scientific Advanced Schools**, on “Planets, exoplanets and their systems in a broad and multidisciplinary context” (fully online) and “Star Formation” (hybrid format), together with more than half of the total modules of our **“Advanced School for Instrumentation”**, and the second editions of the schools for Machine Learning, Big Data, and Deep Learning in Astronomy, and Statistics and Data Mining, respectively. Overall, almost 100 teachers and 700 students participated in all the Severo Ochoa IAA training activities during 2021. We also strengthened our actions to recruit master students through the **JAE-intro SOMM program**, thanks to which we could welcome 7 master students who started their projects in the corresponding SO-IAA research fields.

Among our **Gender programme** activities, we highlight the virtual meeting with secondary schools organised for the International Day of Women and Girls in Science (February 11th), and the virtual round table **“Women of excellence: meeting women Scientific Directors of Severo Ochoa Centers”** (March 11th). We also strongly contributed to the design and elaboration of the virtual exhibit “AstronomAs” (www.astronomas.org). Concerning **outreach**, we participated in a number of activities related to the multiformat project **“Hello Earth”**, including a documentary, the edition of a disk-book and several concerts, at IAA, Calar Alto Observatory and CSIC Madrid, where the SO-IAA exhibit **“Perspective”** was shown to the public. The SO-IAA personnel recruited in the previous year could introduce themselves in our IAA (Información y Actualidad Astronómica, nr 66) outreach journal.

We also celebrated an **SO-IAA Conference** in March 2021, together with a gathering of all SO-IAA committees in June and a welcome in-person meeting in September. We actively participated in the meeting **100xCiencia.5** organised by the Severo Ochoa and Maria de Maetzu Alliance (SOMMa), celebrated in Santiago de Compostela in November, and devoted to the **International dimension of Science**. In December we had the kick-off meeting for the preparation of the new Severo Ochoa proposal, to be submitted in February 2022.

Virtually all activities above were supported by the personnel at the SO-IAA Technical Office, hired under the SO-IAA auspices: Alicia Pelegrina, Head of the Office, and Manuel González, whose help was especially instrumental for the SO-IAA monitoring and visitor assistance. Their efforts were joint together with the IAA administrative personnel, with particular emphasis devoted to European projects and technology transfer.

Research groups



CSIC considers the research groups as specific fundamental units which contribute to achieving the scientific objectives of the institution.

During 2021, the IAA had 13 active research groups, which belong to the global area of "Materia". At the IAA we cover all major fields of Astrophysics and Space Science. Our research is based on the three pillars of modern Astrophysics: observation, instrumental development, and theoretical and numerical studies, all of which are firmly established and interconnected. The IAA groups study:

- **The Sun**, via spectropolarimetry, and their magnetic fields from an observational, theoretical and instrumental point of view: "Solar Physics Group".
- **The Earth's atmosphere** and planet atmospheres, including exo-atmospheric studies: "Group of Terrestrial Planet Atmospheres".
- **Planets** and the formation and evolution of minor bodies in the Solar System: "Planets and Minor Bodies Group".
- **The physics of planetary systems** and their low-mass stars: "Physics of low-mass stars, exoplanets and associated instrumentation Group".
- **The variability of stars** and asteroseismology: "Stellar Variability Group".
- **Stellar clusters**, massive stars and the Galactic Center: "Stellar Systems Group".
- **The formation, evolution and death of stars** at different mass and spatial scales and the interstellar medium: "Physics of the Interstellar Medium Group".

- **The structure and evolution of galaxies**, from the inner stellar and diffuse components to their large-scale cosmic distribution and evolution: "Galaxy Evolution Group".
- **Supermassive Black Holes** and their immediate environments, including their associated relativistic jets: "Relativistic Jets and Blazars Group".
- The combination between **General Relativity and Quantum Mechanics** in astrophysical scenarios: "Theoretical Gravitation and Cosmology Group".
- The analysis of **large-scale galaxy clustering mechanisms** and the production of accurate cosmological simulations and galaxy mock catalogs: "Cosmology and Astroparticle Physics Group".
- Multirange observations of **high-energy phenomena** and theoretical stellar evolutionary models: "High Energy Astrophysics and Robotic Astronomy Group (ARAE)".
- **Explosive transients** and their host galaxy environments: "High Energy Transients and their Hosts (HETH) Group".

The following pages present a summary of the results obtained in 2021 by the different research groups. The publications corresponding to the different highlights are identified in brackets, with the corresponding number in the publication list (from page 68 on).

SOLAR SYSTEM

Solar Physics

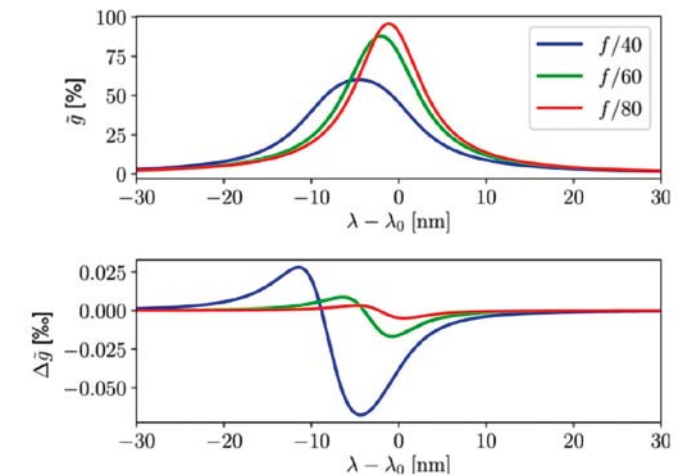
Overview

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

- The radiative transfer equation (RTE) for polarized light in the presence of magnetic fields
- The inversion of the RTE for its use on the interpretation of spectropolarimetric measurements
- The structure and physical nature of all kind of photospheric magnetic structures
- The design, development, and construction of solar instrumentation

Research lines:

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



Top: transmission profiles [expressed in %] of an etalon in telecentric beams with f-numbers $f/40$ (blue), $f/60$ (green), and $f/80$ (red). Bottom: difference between the transmission profile calculated numerically and that obtained with the analytical expressions [expressed in %].

Highlights

Science

The analytical formulation of telecentric, Fabry-Pérot etalons was obtained [24].

Internetwork fields (INs) carry a substantial amount of magnetic flux, and therefore energy, to the solar surface. We used coordinated observations obtained with the Swedish Solar Telescope and the Interface Region Imaging Spectrograph to follow the evolution of IN magnetic loops [116].

We discussed the application of convolutional neural networks (CNNs) as a tool to advantageously initialize Stokes profile inversions. CNNs alone are much faster than assisted inversions, but the latter are more robust and accurate [97].

Instrumentation

SUNRISE III (TuMag & SCIP instruments)

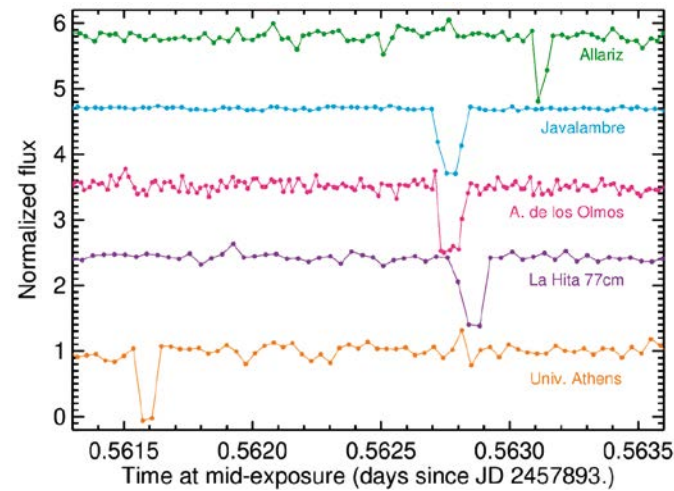
- Final testing of SCIP E-Unit FM (electrical tests and thermal balance test).
- Further development of the SCIP E-Unit software and firmware and support to the NAOJ team for the instrument characterization and optical performance.
- Optical characterization and thermal balance test of the TuMag scientific cameras FM.
- TuMag E-Unit FM assembly and testing (electrical tests and thermal balance tests).
- TuMag E-Unit and O-Unit integration and AIV phase: calibration and end to end testing at INTA.
- TuMag instrument delivered to MPS.

VIGIL (PMI instrument)

- Conclusion of the ESA contracts for the DPU pre-development, bridging phase and fam-phase.
 - Definition of the DPU conceptual design.
 - Kickoff of the B2 phase.
 - Kickoff of the electronics preliminary design and the DPU development model (DM) design.
- SO/PHI
- Several actions on the PHI firmware for data compression.

SOLAR SYSTEM

Planets & minor bodies of the solar system



Overview

The activities of this group are focused on four research lines: planets, minor bodies, exoplanetary atmospheres, and the Cosmic Dust Laboratory (CoDuLab). Broadly speaking, we aim to provide an integrated view of the Solar System and the atmospheres around exoplanets. Observational projects are being conducted from the ground as well as by using instrumentation on board space vehicles. The data interpretation is based on theoretical modeling, numerical simulations, and laboratory studies. We are involved in a number of space missions such as BepiColombo, Exomars, JUICE, Comet Interceptor, and EnVision.

Research lines

- Planets and minor bodies of the Solar System
- Dust in the Solar System
- Exoplanetary atmospheres

Image above: Stellar occultation lightcurves of centaur 2002 GZ32 obtained at the five sites where the occultation was recorded, ordered from the northernmost site (Allariz, Ourense, Spain, top curve) to the southernmost one (University of Athens, Greece, bottom curve). The occulted star is Gaia DR1 4332852996360346368 (UCAC4 385-75921). See reference [261].

Highlights

Retrieval of gas and dust distribution of comet 8P/Tuttle, as a backup target for Comet Interceptor Mission. Comet Interceptor Mission is devoted to explore a dynamically new comet, but in the event that none of those objects becomes available while the spacecraft "waits" in the Sun-Earth Lagrange point L2, a number of short-period comets are being listed as alternative targets. Comet 8P is among those targets, and was characterised in [125].

Scattering matrix measurements of airborne aerosol particles. Mineral aerosols are known to affect climate, while biological aerosol particles as pollen are important as triggers of seasonal allergies. The scattering matrices of volcanic ashes, desert dust, and pollen were obtained using the Cosmic Dust Laboratory (CoDuLab), in the case of pollen for the first time [106].

Characterisation of newly discovered active asteroids. As part of a large program with GTC observations, the dust environment and the dynamical properties of active asteroids P/2019 A4 and P/2021 A5 were inferred [198].

Evidence of energy-, recombination- and photon-limited escape in giant planet H/He atmospheres. Hydrodynamical modeling was used to determine that HD 209458 b, HD 189733 b, and GJ3470 b are in energy-limited, recombination-limited, and photon-limited regimes, respectively [164].

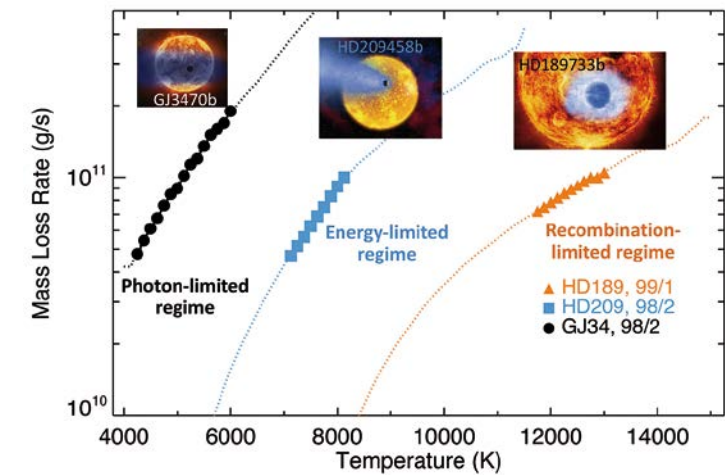
Stellar occultation of elongated centaur (95626) 2002 GZ₃₂. Using the GAIA catalog, a stellar occultation produced by this centaur was predicted, observed, and used to constraint its size, 3D shape, geometric albedo, and lack of rings [261].

Establishing the spatial and temporal variability of iodine in aerosol. Aerosol iodine field observations in the period 1963-2018 were used to discuss its variability on the light of CAM-Chem model simulations [107].

Experimental determination of dust grain sizes from photopolarimetry. The direct comparison of the experimental data with computations for spherical particles showed that the use of the Mie model for analyzing polarimetric observations of cosmic dust clouds prevent locating particles with sizes of the order or larger than the wavelength of the incident light [201].

SOLAR SYSTEM

Terrestrial and planetary atmospheres



Ranges of mass-loss rates and temperatures for the evaporating planets GJ 3470 b, HD 209458 b, and HD 189733 b, derived from He triplet CARMENES data by using hydrodynamical and non-LTE models.

Overview

We investigate the thermal structure, composition, chemistry, dynamics and electricity phenomena of the Earth and planetary atmospheres. About the Earth, we focus on the study of solar particles and radiation effects on atmospheric composition, trends in temperature and species abundances, and the occurrence and impacts on composition of lightning phenomena. About Mars, we study its temperature structure, dynamics, ionosphere and composition. We use a large variety of models and measurements from instruments on satellites, on ground and in the laboratory. More recently we are characterising the giant exoplanets' atmospheres by modelling and analysing ground-based CARMENES data.

Research lines

- Drivers of the Earth's middle atmosphere variability and its impact on climate
- Atmospheric Electricity in Planetary Atmospheres
- Thermal structure and composition of the Terrestrial planetary atmospheres. Remote sensing of planetary atmospheres in IR/UV
- Characterization of exo-atmospheres by modelling and analysis of ground-based and space measurements

Highlights

The installation in 2018 of the Atmosphere-Space Interactions Monitor (ASIM) in the International Space Station (ISS) unveiled the existence of an unsuspectedly high number of blue flashes emanating from thundercloud tops and visible from space. In [166] we analysed a subset of these events that coincide with radio emissions, indicating an upward electric current. We showed that the optical emissions can be explained by the presence of a luminous source extending from the cloud top to a depth of around one kilometre. Our model allowed an estimation of the intrinsic energy of the events, which has implications on the possible global atmospheric impact of this type of electrical discharges.

We studied the seasonal and geographical variation of Mars ionosphere [112]. The data obtained by two different Mars Express instruments over more than 15 years show that the ionospheric peak electron density and peak altitude follow sinusoidal variations with the season. We also found that the presence of crustal magnetic fields increases the peak electron densities, and those peak altitudes are larger during global dust storms.

Atmospheric photo-evaporation is a key mechanism in planetary evolution. The escape in these atmospheres has been studied so far through H Ly- α , but with large uncertainties. The He triplet line offers a new window for studying this hydrodynamic escape mechanism. We analysed He triplet measurements taken by CARMENES of the hot Jupiters HD 209458b and HD 189733b and the warm Neptune GJ3470b with developed hydrodynamic and non-LTE models. We found very outstanding results ([164, 165]. See figure):

- a) we reported, for the first time, observational evidence of the three hydrodynamic escape regimes in H-dominated atmospheres (photon-limited, energy-limited, and recombination limited), as theoretically predicted
- b) the upper atmospheres of these planets are lighter than expected (H/He ratios much larger than that of the Sun); and
- c) we provided unprecedented constraints on their mass loss rates and thermospheric temperatures.

STELLAR PHYSICS

Low-mass stars & exoplanets

Overview

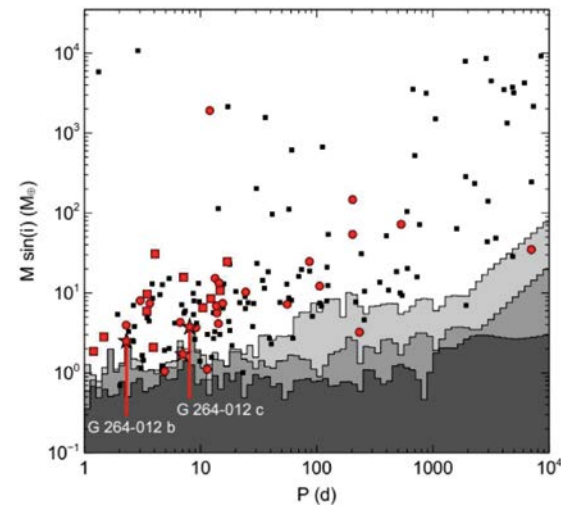
Our group studies the physics of planetary systems and their low-mass host stars. M dwarfs are interesting by themselves and for their potential for the discovery of temperate rocky planets that could sustain liquid water. We work in several aspects of these systems, from the general statistics and observational distribution of their exoplanets to the asteroseismic modelling and magnetic activity of their host stars. The group has expertise in theoretical studies of stellar structure and evolution, magnetic activity, asteroseismology and technical development of new instrumentation. The group hosts the co-PI of the CARMENES consortium and one of the two PIs of the CARMENES Legacy-PLUS project.

Research lines

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

Image above

Minimum mass of the planets detected around M dwarfs by other surveys (black symbols) and CARMENES (red symbols) plotted versus their respective orbital periods. The three star symbols show the planets detected in [13]. The shaded curves show the mass-period regions where it is not possible to detect other smaller or longer-period planets in the same datasets in that paper.



Highlights

CARMENES is a worldwide unique instrument, co-led by the IAA. It is collecting high-precision radial velocities simultaneously by its optical and the near-infrared channels. The latter was designed and built at the IAA and has shown to be a groundbreaking instrument for the study of exoplanet atmospheres, opening new lines of research in this field. It is the largest exoplanet survey of red dwarfs to date. In 2021, the CARMENES Legacy-Plus project continued enlarging and deepening the original survey.

CARMENES has published or submitted 87 papers, 21 of them in 2021, with 40 discovered or confirmed new planets and 15 additional firm candidates. This has allowed us to publish the first and most accurate statistical study on occurrences of exoplanets around M dwarfs to date. The CARMENES results have increased by 50% the number of planets in the parameter space probed by our instrument. In 2021, we continued leading the consortium and contributing to its working groups. We also continued our participation in the other large exoplanet survey in the southern hemisphere (RedDots) and in NASA's mission TESS.

We continued discovering unique systems that deepen our understanding of close-in terrestrial and (super-)Earth planets, such as those in the systems G 264-012 and Gl 393 [13], the latter producing the smallest amplitude yet, which shows the precision we can reach with CARMENES (the paper had the contribution of two of our students). These stars were observed in radio to try to detect the magnetic interaction of the planets with their stars. They were followed up with OSN photometry, which accumulates now around 3000 epochs of observations for the CARMENES survey. This result was published as a Press Release by CSIC in its main web page. To understand different aspects of the host stars, we published a new method to study compact stars deformed by their fast rotation [66]. We continue our participation in the instrumentation projects CARMENES-PLUS for CAHA and ANDES for the ELT.

STELLAR PHYSICS

Stellar variability

Overview

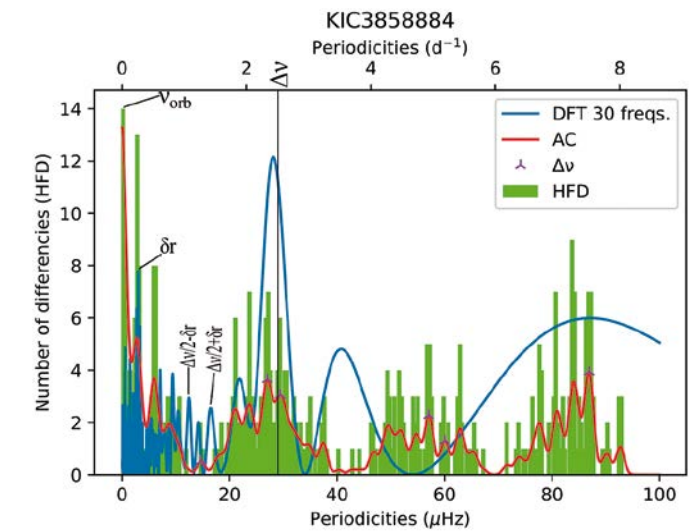
The research at IAA's Stellar Variability Group focuses mainly on the study of stellar structure and evolution and its impact on the characterization of exoplanets, stellar populations and galactic archaeology using asteroseismic techniques.

The group members are involved in the development of theoretical models as well as innovative time series analysis techniques that can be applied to extract information from ultra-precise data, especially observations from space satellites. Instrumental developments are the key part of the work of the group's technical team. The group is also represented in the IAA Sky Quality Office.

In the past we participated in the design and exploitation of the CoRoT space mission and, currently, we are strongly involved in the preparation of the future PLATO 2.0 (ESA) space mission.

Research lines

- Stellar Structure
- Stellar Evolution
- Time Series Analysis
- Open Science



Highlights

Asteroseismology allows to study stellar interiors by analysing how oscillations (manifested at the surface of the star as brightness variations or Doppler shifts) propagate at different depths depending on their frequency.

Delta Scuti stars are intermediate-mass (i.e. between 1.5 and 3 solar masses) pulsating stars which are moderate-to-fast rotators with spectral types ranging from A to F; these stars are very good laboratories to test theories of angular momentum and chemical transport in stellar interiors. The detection and understanding of rotation in stellar interiors is, nowadays, one of the main unsolved questions in stellar physics. Rotation severely hampers an accurate determination of stellar global parameters, such as effective temperatures and surface gravities. Although we have measurements of projected velocities, until now only interferometric techniques for bright and deformed stars may be able to determine the angle of inclination of the star and, therefore, the real rotation velocity.

In [241] we analysed the periodicities found between the pulsation frequencies of a sample of Delta Scuti stars using three well known techniques: the Fourier transform, the autocorrelation function and the histogram of frequency differences. We were able to identify the signature of the rotation (namely, the rotational splitting) in most of the cases, thus paving the way for developing a robust methodology to determine the rotation using asteroseismic data only.

In the figure, we label as "delta r" the rotational splitting, which stands out as a prominent peak in all three analysis techniques.

Technological highlights of PLATO, where IAA is responsible for the MEU (Main Electronic Unit).

- Delivery of 2 units: MEU MTD (Mass Thermal Dummy) at OHB.
- MEU CDR (Critical Design Review) in progress.

STELLAR PHYSICS

ARAE

(Robotic and high-energy Astrophysics)



Artist's view of the NGC 253 magnetar experiencing the giant flare that arrived to the Earth on Apr 15, 2020 [55]. Image courtesy of University of Bergen.

Overview

The ARAE research group was founded in 2001, although some of its members had already started their activity in 1990. Scientists and engineers work on a variety of projects, combining their strengths. Research lines are multi-range observations of high-energy phenomena, theoretical stellar evolutionary models and models of stellar population synthesis. Significant technological developments are also carried out, regarding the robotization of small/medium size observatories and astronomical instrumentation development such as the BOOTES Global network of telescopes. We are also involved at space-borne missions. Teaching, public outreach and citizen science are also part of the ARAE activities.

Research lines

- Compact Objects in the Galaxy
- Cosmic Gamma-Ray Bursts (GRBs)
- Gravitational Waves (GW) electromagnetic counterparts
- Robotic Astronomy
- Astrophysical Transients

Highlights

Study of the nearby ($z = 0.0785$) VHE-detected GRB 190829A/SN 2019oyw [135]

Gamma-ray bursts (GRBs) represent the most powerful explosions in the Universe, with the long-duration ones being related to massive star collapses. GRB 190829A is one of the most energetic events recorded to date. We presented the 10.4 m GTC observations of the afterglow of GRB 190829A and its underlying supernova (SN) and compared to GRB 180728A, similar in behaviour. We concluded that although the prompt emission temporal properties of GRB 190829A and GRB 180728A are similar, the two pulses are different in the spectral domain. The SN 2019oyw associated with GRB 190829A is powered by Ni decay and is a Type Ic Broad-Line SN; its spectroscopic and photometric properties are consistent with those observed for SN 1998bw, but evolved earlier.

Very high frequency oscillations in the main peak of a magnetar giant flare [55]

Magnetars are strongly magnetized, isolated neutron stars with high X-ray luminosities and very short rotation periods. Very energetic giant flares (lasting ~ 0.1 s) have been detected in hard X-rays/soft gamma-rays from magnetars, all but one detected from inside our galaxy. During such giant flares Quasi-Periodic Oscillations (QPOs) with low and high frequencies have been observed, their significance been questioned. High frequency QPOs have only been seen during the tail phase of the flare. We reported the observation of two broad QPOs at very high frequencies in the main peak of a giant gamma-ray flare in the direction of the NGC 253 galaxy, disappearing after 3.5 ms. The flare was detected by the ASIM instrument aboard the International Space Station, the only instrument that recorded the main burst phase (0.8–3.2 ms) in the full energy range (50 keV–40 MeV) without suffering from saturation effects. Along with sudden spectral variations, these extremely high frequency oscillations in the burst peak provide a new crucial component to understanding magnetar giant flares.

STELLAR PHYSICS

HETH

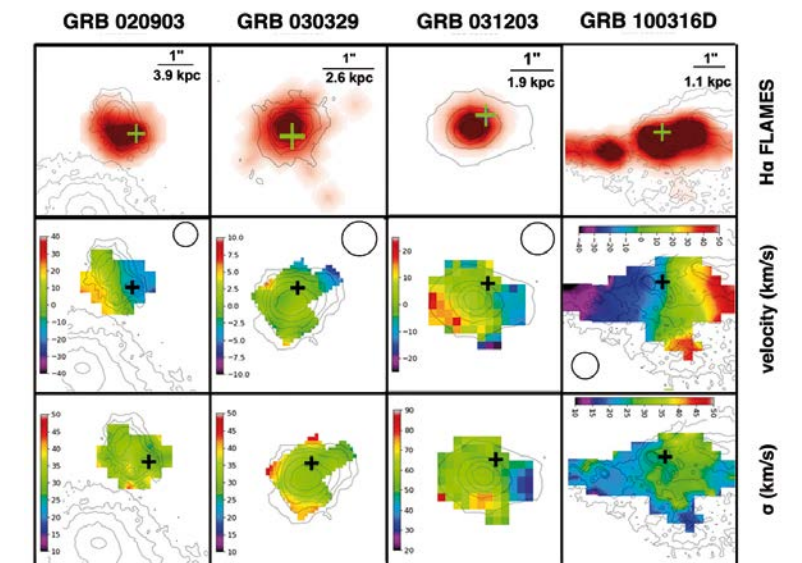
(High energy transients and their hosts)

Overview

The "High-Energy Transients and their Hosts" (HETH) group studies stellar explosions and their environments. The main focus are gamma-ray bursts (GRBs) but the group also studies a wide variety of explosive transients such as supernovae, magnetars or tidal disruption events. HETH also develops new tools and instrumentation to enhance the research capabilities. Group members have been part of the teams developing instruments such as GROND (2.2m telescope, La Silla) or X-shooter (8.2m VLT, Paranal) and have led the OCTOCAM instrument (8.1m Gemini South).

Research lines:

- Explosive transients: Gamma-ray bursts, supernovae, fast radio bursts, unusual objects
- Electromagnetic counterparts of gravitational waves
- Host galaxies of astronomical transients: Spatially resolved with IFU and unresolved
- Starburst galaxies from low to high-redshift
- Very late evolution stages of massive stars
- New instrumentation: OCTOCAM at Gemini, GATOS and EIFIS at GTC



Some of the low-redshift GRB hosts observed with FLAMES. Top row: H α map of the galaxies, Middle row: Velocity field, determined by the peak of the H α emission line, Bottom row: Velocity dispersion measured from the width of the H α emission line [278].

Highlights

Outflows from GRB hosts are ubiquitous: kinematics of $z < 0.3$ GRB-SN hosts resolved with FLAMES [278]

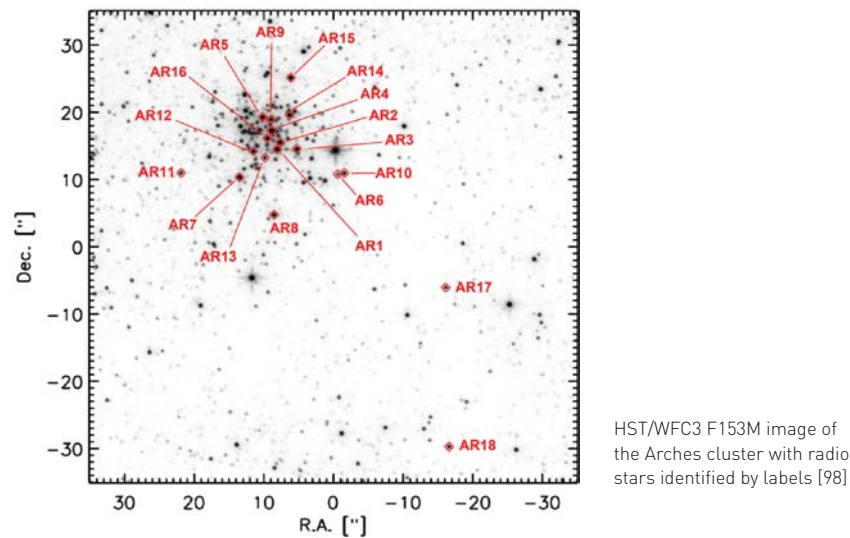
GRB hosts studied with resolved integral field spectroscopy are still rare, due to their low numbers at suited (low) redshifts. This is the first sample of GRB hosts observed not only at high angular but also spectral resolution using the FLAMES/VLT spectrograph at a medium resolution of $\sim 10,000$. Our sample of six dwarf galaxies at $z < 0.3$ all show indications for powerful outflows from star-forming regions, a direct evidence for the massive star-formation happening in GRB hosts. Most galaxies in our sample do not show a regular rotating disk in the narrow component and, in some cases, even show a double component. The outflow component is more metal rich, blue-shifted compared to the narrow emission component and follows a different velocity field. Similar high-resolution studies for other explosive transients would be highly warranted to study resolved star-formation processes and effects on the galaxy.

The Exotic Type Ic Broad-Lined Supernova SN 2018gep: Blurring the Line Between Supernovae and Fast Optical Transients [238]

In the past few years, a new type of transient has emerged, called "fast blue optical transients" (FBOTs), some of which are related to supernovae. SN 2018gep was one of the most extreme of these FBOTs with very fast rise time and high peak magnitude and, after a featureless blue spectrum until peak magnitude, it evolved into a peculiar broadline Type Ic SN. The contribution from HETH was a spatially resolved study of the host galaxy of SN 2018gep through a DDT program at PMAS/CAHA. The galaxy is a star-forming dwarf and the SN located in a star-forming region with 0.4 solar metallicity, much below what has been measured for other BL-Ic SNe and very different from other FBOTs, giving further evidence for a peculiar type of BL-Ic and progenitor system.

RADIO ASTRONOMY
& GALACTIC STRUCTURE

Stellar systems



Overview

The Stellar Systems Group (SSG) was created in 1988. Our research lines cover stellar clusters, massive stars, and the Galactic Centre. Currently, the group is studying the connection between star-forming processes and spatial and kinematic structures at different scales, and continues with the exploitation of large Galactic surveys (including Gaia, GES, OTELO, GALANTE and J-PLUS). The second focus of our work lies on investigating the structure, kinematics, and formation history of the Galactic Center and massive star formation in this emblematic region of the Milky Way. Please visit our website for more information: <https://sbg.iaa.csic.es/>.

Research lines

- Galactic Centre
- Formation, evolution and destruction of Stellar Systems
- Massive Stars

Highlights

The Galactic Centre Team doubled the number of known stars with radio emission originating in ionized stellar winds in the 2-3 Myr-old massive Arches stellar cluster in the Galactic Centre in a combined near-infrared and radio study, that benefits from the high sensitivity of the Very Large Array [98]. The derived mass loss rates of the observed massive post-main sequence stars agree well with those of Wolf Rayet stars, in agreement with their spectral identifications. By comparing the number of detected stars with their expected number inferred from stellar evolutionary models, the Galactic Centre Team found that the observations require that the Arches cluster formed relatively more massive stars than star formation processes in the Galactic disc. This finding of a so-called top-heavy initial mass function is an independent confirmation of theoretical predictions and of the results of previous near-infrared studies.

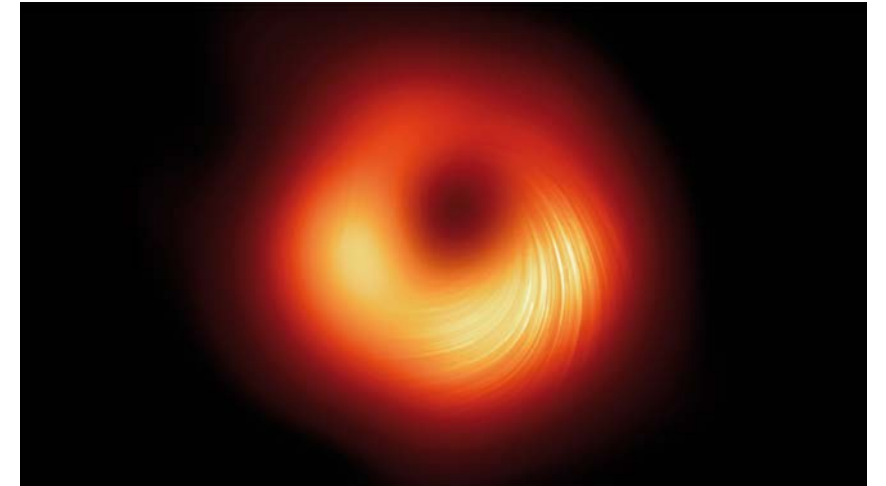
The Stellar System Group has as its main objective the study of the structure, formation and destruction of stellar systems. The astrometric and photometric data provided by Gaia represent the frontier, in quality and quantity, for this kind of studies. In addition, the group is involved in international consortia to obtain complementary data to Gaia that help us to achieve these scientific objectives, such as J-PLUS, GALANTE, WEAVE and 4-MOST to name just a few.

In 2021 we continued with the exploitation of the Gaia releases by analyzing the astrometric data in collaboration with other groups of the IAA, thus reinforcing the cohesion and synergy between the different lines of research of our institute. In particular, we analyzed the kinematics of the planetary nebula Sab 19 and determined its orbit in the Milky Way [120]. Within the GALANTE consortium, we published a paper about the design of the observational strategy, the selection of target fields, and the data reduction pipeline, which was applied to obtain the photometric catalog that we are preparing [181].

RADIO ASTRONOMY
& GALACTIC STRUCTURE

AGN Jets

Relativistic Jets & Blazars



Overview

The main research topic of our group is the study of supermassive black holes (SMBHs) harbored in the nuclear region of active galaxies. Huge amounts of energy are released from their innermost environment in the form of ultra-relativistic jets, as a consequence of mass accretion onto the SMBH and energy extraction through powerful twisted magnetic fields anchored to it. We study these objects at the maximum achievable angular resolution by means of very long baseline radio interferometric observations with the Event Horizon Telescope (EHT) and the space antenna RadioAstron. Thanks to these instruments, we are able to directly image SMBHs and the jets forming close to them.

Research lines

- Imaging supermassive black holes with the Event Horizon Telescope
- Accretion onto supermassive black holes and the formation of relativistic jets
- Blazar jet multi-wavelength phenomenology from the horizon to parsec scales
- AGN, black hole growth and demographics, binary blackholes and gravitational waves

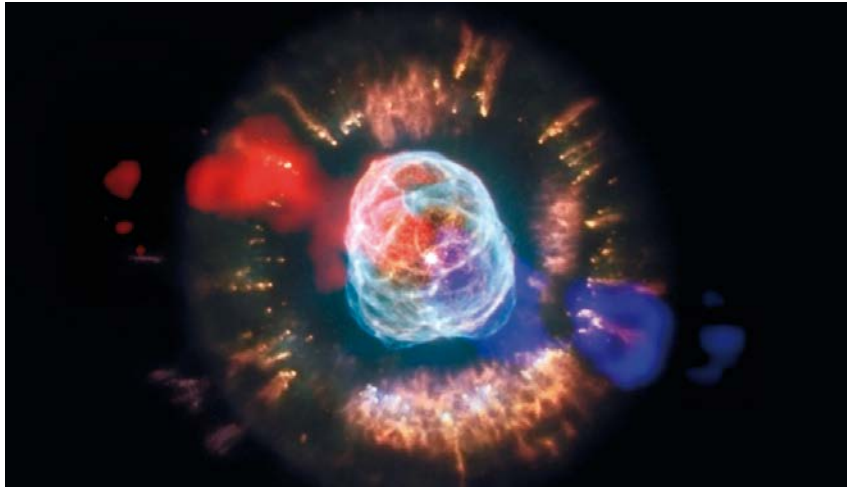
Highlights

In 2017 April, the Event Horizon Telescope (EHT) observed the near-horizon region around the supermassive black hole at the core of the M87 galaxy. These 1.3 mm wavelength observations revealed a compact asymmetric ring-like source morphology. This structure originates from synchrotron emission produced by relativistic plasma located in the immediate vicinity of the black hole. In two subsequent papers, published in 2021, we presented the corresponding linear-polarimetric EHT images of the center of M87 [8] and the theoretical interpretation [7]. This polarized synchrotron radiation probes the structure of magnetic fields and the plasma properties near the black hole. We found that only a part of the ring is significantly polarized. The resolved fractional linear polarization has a maximum located in the southwest part of the ring, where it rises to the level of ~15%. The low fractional linear polarization in the resolved image suggests that the polarization is scrambled on scales smaller than the EHT beam, which we attributed to Faraday rotation internal to the emission region. We showed that the net azimuthal linear polarization pattern may result from organized, poloidal magnetic fields in the emission region. In a quantitative comparison with a large library of simulated polarimetric images from general relativistic magnetohydrodynamic (GRMHD) simulations, we identified a subset of physical models that can explain critical features of the polarimetric EHT observations while producing a relativistic jet of sufficient power. The consistent GRMHD models are all of magnetically arrested accretion disks, where near-horizon magnetic fields are dynamically important.

In [95] we presented our latest RMHD and non-thermal emission simulations aimed to study the role of the magnetic field in the jet dynamics and emission. Models with the highest magnetizations and/or magnetic pitch angles lead to an uneven distribution of the internal energy as a consequence of the larger relative magnetic tension and radial Lorentz force, which translates into a spine brightening in the total and linearly polarized intensity maps. Highly magnetized jets with large toroidal fields tend to have weaker shocks and correspondingly weaker radio knots.

RADIO ASTRONOMY
& GALACTIC STRUCTURE

Physics of the Interstellar medium



HST and GTC MEGARA composite picture of NGC 2392, the Head's Lion Nebula. The blue and red emissions depict the approaching and receding components of the jet as detected in GTC MEGARA observations.

Overview:

We study the formation, evolution, and death of stars at different mass and spatial scales across different environments. The early stages of star and planet formation, as well as star-planet interactions, are studied through radio interferometric observations and modelling of the observed emission. The final stages of the life of stars are studied by the multi-wavelength characterization of evolved stars and the wind-blown bubbles around them, to understand the processes shaping planetary nebulae and the circumstellar medium around massive stars. Radio interferometric monitoring of supernova (SN) explosions and their distribution in ultra luminous infrared galaxies is also carried out to determine the SN and star formation rates.

Research lines

- Massive stars and their surroundings. SN remnants and wind-blown bubbles
- Star and planet formation and interaction
- Planetary nebulae and their precursors
- Luminous and Ultra Luminous Infrared Galaxies
- Prospective Science work for the SKA

Highlights

Planetary nebulae (PNe) are expected to expand and brighten notably in its early formation phases, but the comparison of the images of the Stingray Nebula (aka Hen 3-1357) captured by HST in 1996 and 2016, revealed exactly the opposite: the nebula dimmed drastically in brightness and it seems to have shrunk [27]. This is interpreted as a response to a drop of the surface temperature (and therefore, of ionizing radiation), of its central star, SAO 244567, after a brief flash of helium fusion. These results demonstrate that **nebular changes in PNe can occur on human time-scales.**

The jet in NGC 2392, the Head's Lion Nebula, was the first ever detected in a PN, but an image of the jet was lacking because its terribly weak emission is projected against bright nebular emission. GTC MEGARA observations allowed imaging this jet for the first time [119]. At odds with the fossil jets in other mature PNe, **the jet in NGC 2392 is currently being collimated and launched**, supporting the presence of a double-degenerate system where one component undergoes accretion.

We carried out the most comprehensive radio monitoring campaign towards the closest star to our Sun, Proxima Centauri, using the ATCA [227]. We detected radio emission from the star and its planet, **Proxima b**, showing periodic emission enhancements synchronized with the orbital planetary motion. This radio emission is powered by electron cyclotron-maser, which is able to provide strong, pulsed-like, polarized emission. The data agree very well with the predictions from models of interaction between a host star and its planet. This pioneering work shows, for **the first time, that the presence of an exoplanet can be detected by observing periodic variations of radio emission from the system**, opening a new path for the detection and study of exoplanets. This is a very promising technique given the exceptionally sensitive radio telescopes that are currently under development, such as the SKA.

EXTRAGALACTIC
ASTRONOMY

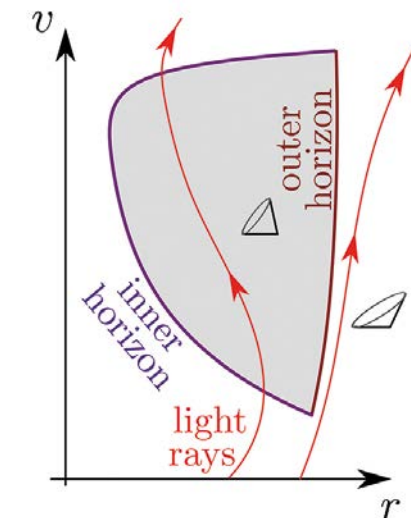
Theoretical Gravitation & Cosmology

Overview

Our group is interested on theoretical gravity, both at the classical level and specially on those situations in which General Relativity (GR) -the best theory of gravity we have- is expected to start failing. The most promising situation in which to observe departures from GR is the physics of gravitational collapse and its end result (black holes in the standard theory). Thus, a large part of our research is centered in analyzing how different situations in standard GR would be modified when going beyond this theory. For instance, we analyze modifications based on semiclassical gravity and those suggested by emergent and analogue gravity scenarios. We study the viability of the new scenarios suggested by these frameworks.

Research lines

- Gravitational collapse and semiclassical gravity
- Black holes and ultracompact objects
- Analogue and emergent gravity
- Group theoretical quantization
- Origin of masses of elementary particle



Sketch of how a black hole with an inner horizon could rapidly eliminate its trapped region from the inside out.

Highlights

Structure of gauge theories [10]. This work contains a complete description of how the crucial notion of gauge symmetry can be most clearly understood embedded into a group theoretical setting. This allows, for example, to fix the Weinberg theta angle algebraically. In addition, it suggests the possibility of a direct non-perturbative quantization of massive non-Abelian Yang-Mills fields without recurring to the Higgs mechanism.

Semiclassical constant-density spheres in a regularized Polyakov approximation [19]. Semiclassical (SC) gravity is a gravitational theory beyond General Relativity which takes into account effects of vacuum polarization. When a stellar configuration approaches the black hole limit, these SC effects become so relevant that they can largely deform the classical geometry. In this paper we proved that SC gravity can lead to relativistic stars so compact that they can be mistaken by black holes.

Black hole inner horizon evaporation in semiclassical gravity [29]. We analyze SC effects at the inner horizon that any realistic black hole contains. We show that the inner horizon has a tendency to move outwards and that this tendency is exponential. This suggests a change of paradigm for black hole evaporation: instead of a slow decay from the outside in, it points towards the possibility of a fast decay from the inside out.

Toward a Mechanism for the Emergence of Gravity [31]. We present a mechanism through which gravity could emerge from an underlying system akin to condensed matter systems. We discover a way to avoid confronting the two most important obstacles faced by emergent gravity: Weinberg-Witten's and Marolf's theorems. Our mechanism relies on making gravity emerge at the same time than the diffeomorphism gauge symmetry characteristic of general relativity.

Interpretations and naturalness in the radiation-reaction problem [32] We revised the one-century-old conceptual problem of understanding when and how a classical charge radiates and how this radiation back-reacts on its trajectory. This revision allowed us to introduce an additional turn in the usual analysis: the natural trajectories of regular extended charges should exhibit an oscillating behaviour.

EXTRAGALACTIC
ASTRONOMY

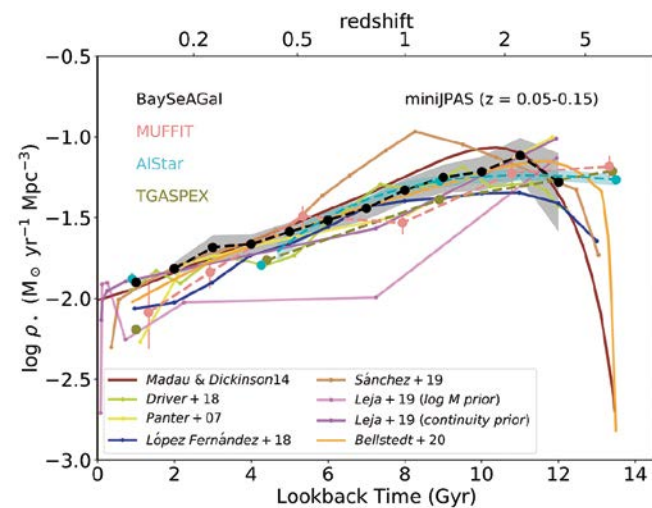
Galaxy Evolution

Overview

The group conducts observational and theoretical studies over a wide variety of issues on galaxy structure and evolution, and cosmology. These range from the inner stellar and gaseous components of galaxies to their large-scale cosmic distribution and evolution. These are complemented with the participation in the research and development of instrumental and technological projects. Observationally, data from 2D spectroscopy, multi-band photometric and HI surveys are used for studies that include the physics of star formation, stellar populations and the diffuse medium in galaxies and galaxy groups and clusters, nuclear activity in galaxies and their interplay with stellar evolution, or the environmental dependence of the structure and evolution of galaxies. These activities include supervising PhD, teaching at master and doctoral level, public outreach conferences, and eScience. Furthermore, we are leading since 2011 the participation of Spain in SKA.

Research lines

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



Cosmic evolution of the star formation rate density obtained from the SED-fitting results of BaySeAGal (black dots), MUFFIT (coral dots), AiStar (cyan dots), and TGASPEX (olive dots), with the nearby galaxies ($0.05 < z < 0.15$). Shaded regions show the uncertainties associated with the results. The different lines represent the star formation rate density obtained in other works (see inset) [112].

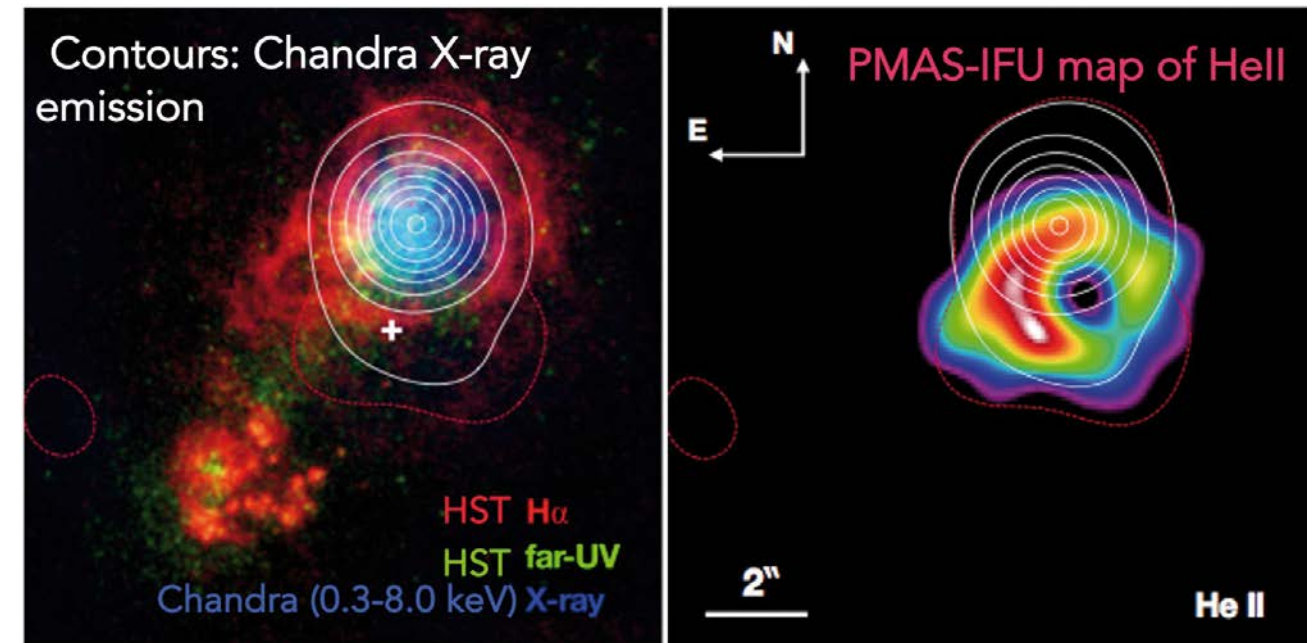
Highlights

Chemical abundances in the nuclear region of nearby galaxies from the Palomar Survey [224].

We have estimated chemical abundances and ionization parameters in the nuclear region of a sample of 143 galaxies from the Palomar Spectroscopic Survey, composed of star-forming galaxies (87), Seyferts 2 (16), and LINERs (40) using the HII-CHI-MISTRY code. We correlated the derived quantities with other different properties of the host galaxies, such as morphology, stellar mass, luminosity, and mass of their supermassive black holes. We find that Seyferts 2 present slightly higher chemical abundances. In contrast, we obtain lower chemical abundances for LINERs than for star-forming galaxies. Our analysis of AGNs (both LINERs and Seyferts) shows that their host galaxy properties are not correlated with our estimated chemical abundances.

J-PAS: Measuring emission lines with artificial neural networks [191].

The Javalambre-Physics of the Accelerated Universe Astrophysical Survey (J-PAS) will observe 8000 deg² of the northern sky with 56 photometric bands, and is ideal for the detection of emission line galaxies. We have developed a new method based on artificial neural networks to measure the equivalent width (EW) of H α , H β , [N II], and [O III] lines up to $z = 0.35$. These lines are essential diagnostics for understanding the evolution of galaxies through cosmic time. We trained and tested artificial neural networks with synthetic J-PAS photometry from CALIFA, MaNGA, and SDSS spectra. We prove the capability of the method by recovering the BPT ([O III]/H β versus [N II]/H α) and WHAN (EW(H α) versus [N II]/H α) diagram reaching a precision of 0.092 and 0.078 dex for the [N II]/H α and [O III]/H β ratios. Furthermore, we show the capability of the method to measure an EW of 10 Å in H α , H β , [N II] and [O III] lines with a signal-to-noise ratio (S/N) of 5, 1.5, 3.5, and 10, respectively, in the photometry. Finally, we compare the properties of emission lines in galaxies observed with miniJPAS and SDSS. Despite the limitation of such a comparison, we find a remarkable correlation in their EWs.



The miniJPAS survey. Identification and characterization of galaxy populations with the J-PAS photometric system [111]

We present the potential of J-PAS by the identification and characterization of a sample of galaxies from the miniJPAS survey (1 deg² on the AEGIS field with the J-PAS photometric system). SED-fitting codes are used to constrain the stellar mass, age, metallicity, extinction, and rest-frame and dust-corrected ($u - r$) colours of a complete flux-limited sample ($r_{SDSS} \leq 22.5$ AB) of galaxies that extends up to $z = 1$. For galaxies with $S/N \geq 10$, we estimate that the J-PAS photometric system will allow us to derive the galaxy properties with precisions that are equivalent to those obtained with spectroscopic surveys of similar S/N. We find: (i) that the fraction of red and blue galaxies evolves with cosmic time, with red galaxies being ~38% and ~18% of the whole population at $z = 0.1$ and $z = 0.5$, respectively, and (ii) at all redshifts, the more massive galaxies belong to the red sequence, and these galaxies are typically older and more metal-rich than their counterparts in the blue cloud. Our results confirm that with J-PAS data we will be able to analyse large samples of galaxies up to $z \sim 1$, with galaxy stellar masses above $\log(M^*/M_{\odot}) \sim 8.9, 9.5,$ and 9.9 at $z = 0.3, 0.5,$ and 0.7 , respectively. The star formation history of a complete sub-sample of galaxies selected at $z \sim 0.1$ with $\log(M^*/M_{\odot}) > 8.3$ constrains the cosmic evolution of the star formation rate density up to $z \sim 3$, in good agreement with results from cosmological surveys.

The challenge of the ionization balance of Helium II in IZw18 [146]

IZw18 is a champion among the most metal-poor ($\sim 4\% Z_{\odot}$) galaxies known in the Universe. We have unveiled the existence of a strong HeII-emitting region in this galaxy, thus representing a unique local analog of the most distant HeII emitters found towards the cosmic dawn. The source of ionization of the observed IZw18 HeII region remains a mystery, since it could not be explained invoking only the conventional stellar sources for this galaxy. This is the first study of the X-ray variability of IZw18, which has been performed in order to evaluate the contribution of the X-ray photons from the dominant high mass binary (HMXB) of IZw18 to the ionization of the region of HeII. The X-ray emission of the galaxy is found to show small variations on timescales from days to decades. The best-fit to the observations using models of HMXB X-ray spectra with photoionization models (Senchyna et al. 2020) cannot explain the HeII ionization budget of IZw18, so the HeII ionization challenge remains.

Image above: Optical image of IZw18 from integral field observations plus the archival HST image and X-ray data sets of this galaxy (left panel). The unveiled HeII region with the X-ray HMXB source (right panel).

UDIT

Instrumental & Technological Development Unit



Flight Models of the JANUS instrument for the JUICE Mission: Filter Wheel

Overview

The Instrumental and Technological Development Unit (UDIT) is focused on the development of state-of-the-art instruments for ground-based telescopes and space-borne astrophysical payload instrumentation. During more than 40 years, the instruments developed at the UDIT have placed the IAA as a reference center for technological research projects.

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

- Analysis, design, integration, and verification of astronomical instruments for ground-based telescopes in Calar Alto Observatory (CAHA), Sierra Nevada Observatory (OSN), ELT (Extremely Large Telescope), etc.
- Analysis, design, integration, and verification of astronomical instruments for interplanetary scientific space missions and stratospheric balloon observatories

Highlights

In the following a summary on the activities performed during 2021 for the instrumentation projects that were developed at the UDIT is provided.

Space projects

JUICE (JUperiter ICy moons Explorer): The Flight Models (FM) of the IAA's contribution to the instruments GALA and JANUS were delivered for integration in the spacecraft; these are the Power Converter Module (PCM) of the instrument GALA and the power supply and mechanisms control module (PSM and MCM respectively) and the filter wheel of the instrument JANUS. The mission is expected to be launched in 2023.

Comet Interceptor: The technical team worked in the design and manufacturing of several prototypes (EBB) to reach the Technology Readiness Level (TRL) 5. The IAA is responsible for developing the power converter modules for the instruments COCA and MANIAC as well as the power-handling unit and the data handling unit for the instruments Envis and OPIC.

EnVision: The IAA worked on the preparation of the CoDR documentation package for the power supply of the suite of instruments Venus Spectroscopy (VenSpec) and VEM (Venus Emission mapper).

PLATO (PLANetary Transits and Oscillation of stars): The technical team was focused on the manufacturing and verification of the Mass Thermal Dummy (MTD) of the two MEU (Main Electronics Unit) that were successfully delivered at the end of 2021. In addition to this, the team worked in the integration of the MEU engineering model with the rest of the subsystems of the instrument. The development of the instrument Qualification Model (QM) and the Critical Design Phase also started during this period.

SUNRISE III. The final electrical and thermal testing and assembly were performed for the instruments TuMag and SCIP electronics units, scientific cameras and harness. Software and firmware development for both instruments also continued. During 2021, calibration and end to end testing of both instruments was carried out with the direct implication of IAA's technical team. Sunrise III mission is expected to be launched in June 2022.

Vigil (former Lagrange): The IAA technical team finished the pre-development study for the PMI instrument Digital Processing Unit (DPU) with the definition of a conceptual design for this subsystem. The design of a DPU Development Model (DM) started, which will be the starting point to reach TRL 6. In addition to this, the definition of the PMI electronics, harness and grounding concept started.

Solar Orbiter: Technical activities were devoted to support PHI Solar Orbiter operations.

Ground-based instruments:

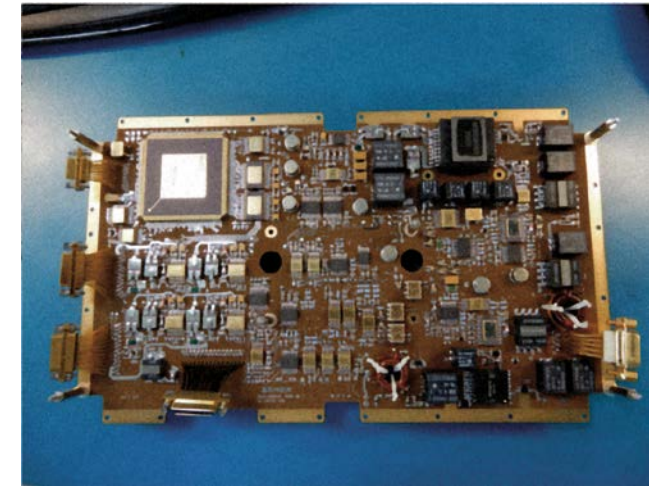
MOSAIC (Multi-object spectrograph for ELT): The first hardware prototype was manufactured to perform the testing of the updated version of the instrument control software. The technical team also worked on the definition of the next step prototype, based on a multi-axes test bench and was focused on management aspects like the development tools definition, budgets, work-packages description, etc.

New instrument for the 3.5m telescope in CAHA. The UDIT concluded in 2021 the feasibility studies of two potential instruments for CAHA observatory next generation instrumentation: **GAMAICA** and **TARSIS**.

GAMAICA: The IAA participated in the instrument concept development including structural and front-end mechanical and opto-mechanical designs, electronics and software designs and spectrograph fiber system unit conceptual design.

TARSIS: The IAA contributed to the instrument concept development with the electronics and instrument control software conceptual designs.

CARMENES-PLUS: In 2021 the following activities were carried out: the integration of the improvements developed during the first phase, which include an automatic vacuum cooling system to avoid thermal drift in the instrument as well as a warmup system for exhaust gas at the exit. The technical team also worked on the second phase improvements developments which are under discussion.



Flight Models of the JANUS instrument for the JUICE Mission: Power Supply Module (PSM) and Mechanism Control Module (MCM)

Other CAHA instrumentation: In 2020 the UDIT had continued to work on the instrument **PANIC** (Panoramic Near Infrared Camera for Calar Alto) through the adaptation of the instrument software to the new detector.

MIMA (Multi-Spectral Imager Mesopause Airglow): The instrument reached its final development phase. The software and electronics were integrated and the AIV phase started. The instrument commissioning and the first light is expected in 2022.

GALIUS (GrAnada Lightning Ultrafast Spectrograph): With the work performed in 2021, two papers were published. One of them describes the experimental analysis of the radial profile of a lightning-like plasma channel through high-speed spectroscopy, which was done for the first time. In addition to this, the group also recorded green signatures of a real sprite.

Data Science: This group's activities were focused on the development of algorithms to be executed in computational clusters for autonomous image calibration, precision astrometry in GAIA EDR3, absolute photometry and light curves generation and cross-correlation between catalogs enabling the use of artificial intelligence.

Calar Alto Observatory (CAHA)



Overview

CAHA is a key institution for the international astronomical community, for its highly competitive astronomical facilities (telescopes and instrumentation). From 2019 on, the Spanish National Research Council (CSIC) and the Junta de Andalucía manage the operation of the observatory with the same percentage. The IAA-CSIC is the research institute of reference of the observatory.

Activities and highlights

Publications and main scientific results

Observations at Calar Alto produced in 2021 a total of 107 publications in international peer-reviewed journals. This includes both scientific projects awarded with open time, and the long-term legacy projects that started in 2021. Calar Alto also continued its activities for the development of new instrumentation, as well as basic infrastructures. We describe below the most relevant of these activities:

Two new planetary systems orbiting G 264-012 and Gliese 393, containing super-Earths, were discovered with the high-resolution spectrograph CARMENES at the 3.5m telescope. This result, reinforces the idea that low-mass stars are susceptible to be orbited by terrestrial planets. Although the high temperatures of the new discovered planets prevent the presence of liquid water in their surface, this discovery has implications for the study of the probability of life in the Universe [13].

CARMENES observations also allowed the characterization of a planet surrounding the star Gliese 486. The combination of the properties of the planet and its distance to the star make it observationally favorable for searches for an atmosphere [284].

Studies of exoplanetary atmospheres with CARMENES led to the first detection of atomic and molecular oxygen in the planet orbiting the star Kelt-9. This is the hottest exoplanet known, thus unsuitable to harbor life [Borsa et al. 2021, Nature Astronomy, 6, 226-231].

The study with CARMENES of the planets orbiting the star V1298 Tauri suggests that the gaseous giant planets could evolve much faster than expected from the current models that point to a slow formation of giant planets [Suárez Mascareño et al. 2021, Nature Astronomy, 6, 232-240].





Three telescopes at Calar Alto (3.5m, 2.2m, and 1.23m) participated in an ambitious observational campaign aimed at studying the clouds of the Venus atmosphere and their relation to its observed variability. This project is being carried out by an international consortium that includes researchers from the País Vasco University; it combines data from different spatial missions and ground telescopes, and among the varied instrumentation used to gather the data, we highlight the camera PlanetCam, available at Calar Alto [Lee et al. 2021, EPSC, 15, 637].

The European Space Agency (ESA) agreed a collaboration with Calar Alto that aims at studying Near Earth Objects including Potentially Hazardous Asteroids. This project not only provides an important

service to the ESA Planetary Defense Office, but also produces relevant results related to other astronomical topics. A good example was the discovery of the cataclysmic and eclipsing type DQ Herculis binary star, a system with a variety of peculiarities that make it unique [Beuermann et al. 2021, *Astronomy & Astrophysics*, 657, A101].

Calar Alto also participated in an interdisciplinary initiative (C-CLEAN) that includes several research institutes. This project is intended to detect viruses on surfaces. A prototype, patented at Sevilla University, applies hyperspectral images to detect the characteristic signal of several microorganisms, like fungi, bacteria and viruses (including SARSCoV-2), as well as their concentration [108].



International collaborations

OPTICON is an European network dedicated to share optical astronomical resources at a European level. During 2021, OPTICON joined RadioNet, its equivalent in Radioastronomy. This resulted in the OPTICON-RadioNet (ORP) network, the largest collaborative network of ground-based astronomy in Europe, which intends to coordinate methods and observational tools, and to provide access to a wider set of astronomical facilities. Calar Alto, previously part of OPTICON, participates now in ORP, together with the IAA-CSIC, Cambridge University (United Kingdom), CNRS (France), and Max-Planck Institute of Radioastronomy (Germany), among others.

The ongoing international long-term observational projects continued during 2021:

- The project SEAMBH (Super-Eddington Accreting Massive Black Hole), in collaboration with Beijing University, is dedicated to the study of supermassive black holes in active galactic nuclei applying the reverberation method, using the CAFOS instrument at the 2.2m telescope.
- The extragalactic survey CAVITY (Calar Alto Void Integral field Treasury survey), devoted to the study of the properties of galaxies in cosmic voids, the loneliest objects in the Universe. This project makes use of the integral field spectrograph PMAS at the 3.5m telescope.
- The KOBE survey is searching for potentially habitable exoplanets orbiting K-dwarfs, and is using the CARMENES spectrograph at the 3.5m telescope.
- CARMENES Legacy+, is an extension of the CARMENES survey, and is intended to the detection and characterization of planets around M-dwarfs, the occurrence of long-period giant planets, and the characterization of exoplanet atmospheres.

New technological developments

The construction of the prototype MARCOT Pathfinder started in 2021. This project proposes to create large optical telescopes by adding the light collected by many small individual telescopes, coupled through innovative technological concepts. The MARCOT collaboration includes Calar Alto, IAA-CSIC, and Potsdam Astronomical Institute (Germany).

During 2021, it started the execution of the first phase for the installation of a Fabry-Pérot calibration unit for the CAFÉ high-resolution spectrograph at the 2.2m telescope. This action will further improve the already excellent performance of this instrument.

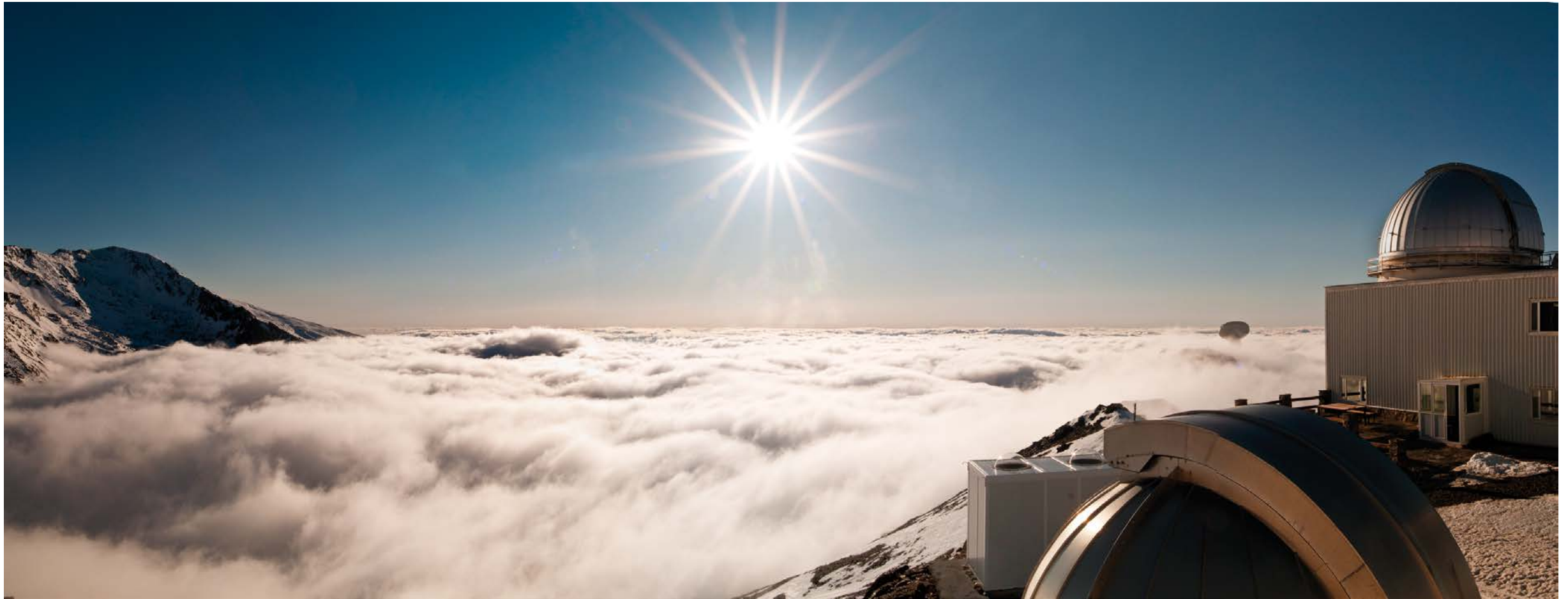
CAHA was searching for a new instrumental concept to be developed for its flagship telescope, the 3.5m. This concept will be selected from the instrumental ideas that were presented during a science workshop for Calar Alto held at IAA-CSIC in March, 2020. Two designs were selected for the viability study phase: TARSIS and GAMAICA. The final decision on the instrument selected to proceed to the construction phase is expected for Spring 2022.

Also related to the CARMENES spectrograph, the CARMENES+ project started the actions on the hardware to improve the thermal stability of the Near Infrared arm of the instrument, which is critical to obtain the optimal spectral resolution that makes this instrument unique.

Finally, regarding basic infrastructures, the project of improving the energy management in the observatory executed most of the civil work during 2021. This initiative was funded by the FEDER program (reference ICTS2017-CAHA-4) and by the Programa de Ayuda a ICTS del subprograma estatal de infraestructuras científicas y técnicas y equipamiento (reference CAHA-16-CE-3978).

OSN

Sierra Nevada Observatory



Overview

OSN is a high mountain observatory located at 2896m in the Sierra Nevada National Park. It belongs to CSIC and it is operated by the IAA. It houses two optical telescopes with 1.5m and 90cm apertures, named T90 and T150. Like many other medium-sized astronomical observatories, the OSN compensates the limited access to observing time at large observatories by providing great flexibility to serve programs that require rapid response or intense temporal coverage, either in terms of sampling or extension. Indeed, OSN focuses on covering long-term follow-up and target of opportunity programs, currently in support of the IAA's research lines. Its privileged location also makes it an ideal site for mid-upper atmosphere sounding and as a test bed for external instrumentation.

Highlights

The T90 and T150 telescopes were equipped with two 4Mp cameras in 2021. The Albireo spectrograph and the Strömgren photometer were undergoing technical actions. OSN also housed the SATI spectrometer, dedicated to the study of the mesopause region, and instrumentation from IAA's Sky Quality Office. OSN also hosted external equipment, namely, a meteoroid detection station and a GPS station. Among the activities, we highlight:

Observation programs

Observations from the OSN have proven very useful for **exoplanetary transits**. Measurements of transit depths of 1.2 mmag at T90 and extraordinary accuracies of 0.73 mmag (rms/min) at T150 were possible. OSN hot Jupiter TrES-5 b transit observation allowed to conclude that its orbital period varies on a long timescale, likely due to the orbital motion induced by a wide-orbiting massive companion [177].

OSN **CARMENES target follow-ups** were key to characterizing M dwarf stars and discarding false exoplanet detection positives. It facilitated CARMENES discovery of two planetary systems of Earths and super-Earths orbiting GJ393 and G264-012, allowing to constrain their masses and periods to $1.7M_E$ and 7-day period for the planet around the former, and 2.5 and $3.8M_E$ and 2.3 and 8.1 days period for the planets around the latter [13].

Centaur and TNO occultations observed from OSN were used to constrain the properties and probabilities of rings around Solar System minor bodies. 2002GZ32 centaur occultations resulted in a negative detection of thick rings, as the ones found for Chariklo, but narrower or optically thinner rings could not be ruled out [261].

Other programs running at OSN included the **SN2 project**, focused on building a spectro-photometric sample of type-Ia supernovae; **blazar polarimetry and photometry** to contribute to the MAGIC and WEBT collaborations; the monitoring of **comet 67P/Churyumov-Gerasimenko** to understand its evolutionary processes; the follow-up of **Gamma Ray bursts** to study their temporal evolution; and the contribution to **CoRoT legacy**, to test properties scaling relations of δ Scuti stars.

Main Technical Activities

In a coordinated UDIT and OSN effort, the three **T90 mirrors** were transferred to CAHA for aluminization in September after silver M3 coating removal. After their alignment in record time, the signal on the T90 improved by 80%.

A new low dark noise and high quantum efficiency CCD, identical to and interchangeable with that at T150 and also not requiring liquid N₂, was installed at T90.

External collaborations

- **SMART Project** (Univ. Huelva), analyzing the interplanetary matter impacting our planet with five robotic cameras at OSN.
- **L3AMetSurf Project** (Univ. Granada), testing samples to study material properties and in search for patentable anti-icing solutions.
- **Topo-Iberia station** (Univ. Barcelona), a GPS station used for integrated studies on topography and 4-D evolution.
- **STNS StarTracker Project** (Solar-Mems), a sensor-based pointing subsystem for nano and microsatellites tested at OSN.
- **Master in Astronomy and Astrophysics** (Valencia International Univ.), for which observing practices are carried out under an agreement.

The ESFRI initiatives



The IAA vis-à-vis the ESFRI initiatives in Astronomy

The European Strategy Forum on Research Infrastructures (ESFRI) was established in 2002 at the request of the European Council, with the aim of coordinating a common strategy on scientific facilities and research infrastructures and, in particular, develop a Pan-European Infrastructure Roadmap. The IAA participates actively in all the astronomy-related scientific facilities included in the last updated Roadmap (<https://roadmap2021.esfri.eu/>).

Square Kilometer Array (SKA)

The Square Kilometre Array (SKA) is an international project to build the world's largest radio telescope. Thanks to its extraordinary sensitivity, SKA will be able to conduct transformational science, breaking new ground in astronomical observations. Two relevant events took place in 2021 for the SKA, and the IAA was part of them. The first SKA Observatory's (SKAO) Council meeting was held in February, following the establishment of the SKAO as the world's second intergovernmental organisation (IGO) dedicated to astronomy. IAA is coordinating the Spanish participation in the SKA project, and is part of the Spanish Delegation in this and subsequent Councils. On the other hand, after a historical meeting of its Council, the SKAO Member States approved the start of the construction phase of the SKAO's telescopes. As part of this construction, Spain was pre-allocated several contracts related to band receivers, timing distribution and dish manufacture, with IAA's contributing to the associated negotiations. On the other hand, as one of the strategic projects within our Severo Ochoa grant, IAA is prototyping the Spanish node of the international SKA Regional Center (SRC) network, advocating for the principles of Open Science and reproducibility. The development of the SRC includes aspects such as the development of the necessary hardware and software platform, the scientific and technical support to users from the IAA-CSIC, or the establishment of collaborations with national and international centers.



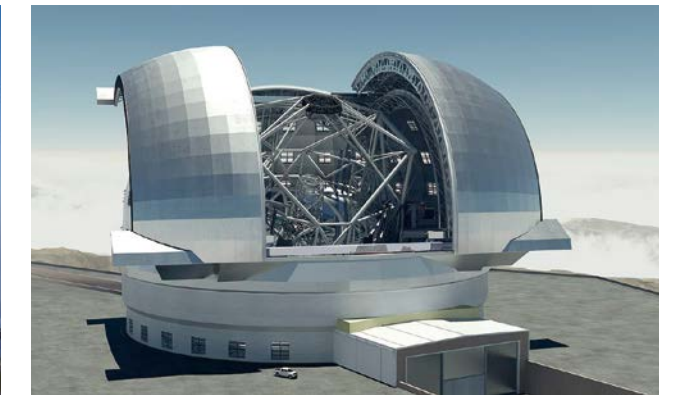
European Solar Telescope (EST)

The European Solar Telescope (EST) will be the largest solar telescope in Europe. With a 4.2-meter primary mirror and state-of-the-art technology, it will provide astronomers with a unique tool to understand the Sun and how it determines near-Earth space weather conditions. In 2021, the project continued preparatory activities for construction, focusing efforts on the design of the telescope and its instruments: the tunable imaging spectropolarimeters, the integral field spectropolarimeters, and the multi-conjugate adaptive optics system. The IAA leads the consortium for tunable imaging spectropolarimeters, one of the core instruments, of which three units are planned to be built. The IAA coordinates the communication office of EST.



Cherenkov Telescope Array (CTA)

The Cherenkov Telescope Array (CTA) will be the global astronomical very-high-energy (VHE) gamma-ray observatory that will exceed the performance of existing instruments in terms of angular resolution, energy coverage and field of view. It will provide a sensitivity improvement of about an order of magnitude over any previous experiment. In June 2021, Gammapy was selected as the CTA (Cherenkov Telescope Array) Science Tool, a software package for the scientific analysis of the CTA data. Moreover, Gammapy plays an integral role in the science operation workflows of the CTA Observatory itself, as part of the pipelines for science verification. For CTA, the IAA had a leading role on the development of the Gammapy project, both by participation in the Coordination Committee (that takes the high level decisions of the project), and by taking part in the group of main Gammapy developers.



European Large Telescope (ELT)

Since 2005, ESO has been developing the Extremely Large Telescope (ELT), a revolutionary ground-based telescope that will have a 39-meter main mirror, making it the world's largest visible-light and infrared telescope. In 2021, the official start of the Phase B of two new instrumental projects for the ELT, ANDES and MOSAIC, both with IAA participation, was approved by the Council of the European Southern Observatory (ESO). ANDES is a very high resolution and high stability spectrograph with several arms or channels covering different wavelength ranges from blue to infrared. MOSAIC is a multi-object spectrograph that will use the widest possible field of view provided by the ELT and will have three modes of operation covering observations in visible and infrared light for more than one hundred sources simultaneously. In 2021, the first MOSAIC hardware prototype was manufactured to perform the testing of the updated version of the instrument control software.

Sky Quality Office

(OCC-IAA)



Measuring night sky brightness. Credits: Máximo Bustamante-Calabria

Overview

The OCC was created in 2016 as an instrument to preserve the astronomical sky quality at the Sierra Nevada and Calar Alto observatories against the threat of light pollution. Due to an increase of night sky brightness in recent years, the office aims at serving as a scientific reference for institutions and agents in the protection and improvement of the dark sky, in addition to advising and promoting the best practices for correct outdoor lighting. Illuminating properly and sustainably is essential to preserve the nocturnal ecosystem and minimize the harmful effects to human health. To monitor the sky brightness, the OCC has installed different types of photometers at the Sierra Nevada Observatory and at the IAA buildings.

Highlights and Activities

Research: Several scientific papers were published in 2021 on the study of light pollution from satellite images and RGB photometry for its calibration [52,53,74,257]. We highlight the article on the effects of the COVID-19 lockdown on urban light pollution in Granada between March and May 2020 [44], which has already more than 25 citations in international journals during the first year of publication. We found a clear decrease in light pollution due both to a decrease in light emissions from the city, and a decrease in anthropogenic aerosol content in the atmosphere which resulted in a decrease of scattered light. Using ground and night-time satellite data, a clear correlation between the abundance of PM10 particles and sky brightness is observed at three different wavelength bands. A more exhaustive analysis of this relationship was presented in a Master thesis in Astronomy and Astrophysics (Bustamante-Calabria).

Institutional collaborations: After carrying out a preliminary study on the feasibility of obtaining a night sky quality certificate in the territory of the Granada Geopark, in March 2021 a collaboration contract was signed with the Granada Provincial Council. At the beginning of the year, the Calar Alto Observatory joined the OCC with the incorporation of a member of the observatory. Representing the Sierra Nevada Observatory and together with Calar Alto, the office submitted a series of allegations for the approval of the new Andalusian regulation for protection against light pollution.

The participation in **educational and outreach activities** is one of the main tasks of the OCC with the aim of raising public awareness on the problem of light pollution. In 2021 we contributed with talks, scientific monologues and radio programs. It was important the participation of office members as teachers at the 2021 summer course on astro-tourism organized by the Andalusian International University.

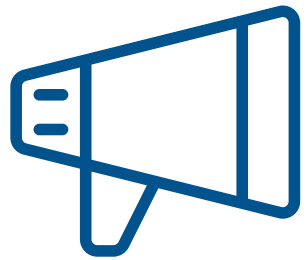
New equipment: A TESS-4C multicolor photometer was acquired to measure the sky brightness at the Sierra Nevada Observatory. This instrument, equipped with GRB filters, serves as complement to the ASTMOM (All-Sky Transmission MONitor) and the 4 SQM (Sky Quality Meters) devices with Johnson-Cousin filters already existing in the observatory building.



Iberian Peninsula at night.
Source: NASA

Public Outreach

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



Popular Science Journal IAA: Información y Actualidad Astronómica. Issued once every four months, it is devoted to high school and university students, as well as general public interested in astronomy. Issues in 2021: 63, 64, 65.



Double urban campaign on the solar system. The campaign in Granada's tram cars "Tenemos cerca lo que está muy lejos" and the street marketing circuit "GRANADA +DESPACIO".

El Radioscopio, a weekly popular-science radio program in collaboration with Canal Sur Radio and broadcasted by Radio Andalucía Información.

Lucas Lara outreach talks. These conferences began in 1995. We celebrate nine talks every year.



Desgranando Ciencia science festival, co-organized by the IAA.

The European Researchers' Night takes place every year all over Europe the last Friday of September. The IAA-CSIC took part in the event in Granada on Friday 24.

PIIISA Project. A multidisciplinary project designed to allow high school students to work with scientists. The IAA-CSIC is the founder of the project.

Course "**Astrophysics in the classroom**" for primary and secondary school teachers in collaboration with the Granada Teacher Training Centre (CEP Granada).

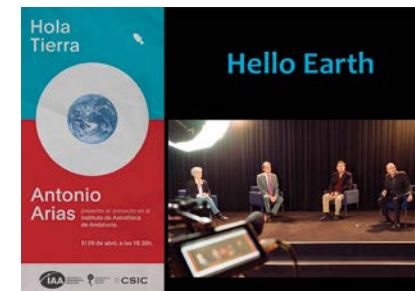
PRE-EST project (European Solar Telescope). Communication support and recording of the documentary "Reaching for the Sun" (in production).

Revista Astronomía. The IAA maintains a monthly collaboration with the magazine, the only one with a commercial circulation specialised in astronomy.

Organization of the **IV course on Science Outreach Techniques** in collaboration with "Hablando de Ciencia" association, and participation in different courses and workshops about science communication.



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



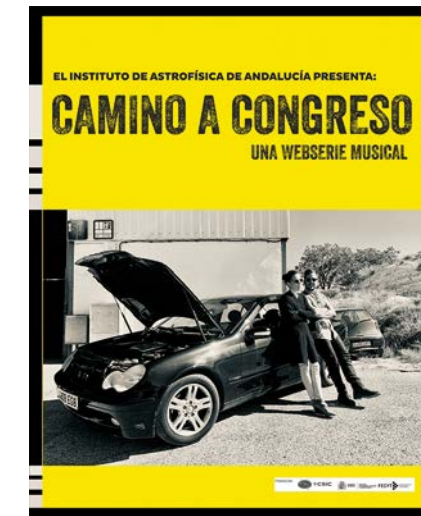
Hola Tierra. A multidisciplinary musical, poetic and humanist project. The project is based on the collection of poems entitled Hello Earth (1974), in which the Apollo 15 astronaut Al Worden described his experience in space, and includes the publication of a book, a CD and a documentary. The IAA participated in this initiative through the "Severo Ochoa - IAA" excellence award.

Perspectiva. Exhibition on Astronomy for the CSIC headquarters in Madrid, related to "Hola Tierra" activities.

Pilares e incertidumbres. IAA-CSIC audiovisual project in which we talk about what we do not know about the universe.

La soledad del navegante. Ciencia y resiliencia. Project that combines science and the performing arts to promote reflection on isolation and adaptation, and their importance in various scientific fields. It targets groups that have suffered particularly badly from confinement during the pandemic.

Calar Alto Observatory Communication. The IAA-CSIC Communication, Education and Public Outreach Unit helps develop communication strategies and press releases for the observatory.

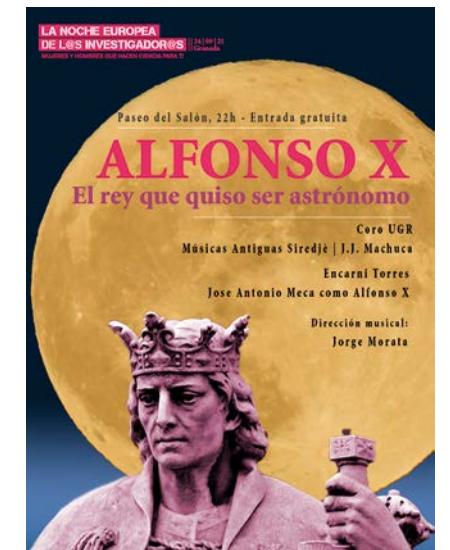


Camino a Congreso. Audiovisual project that is committed to a new format, the music webseries, which combines fiction, science outreach and music. Six episodes.



#TATGranada 2021. International conference on twitter held in Granada every year. The IAA participated as a global partner and speaker.

¿Qué hacen las mujeres ingenieras en ciencia? A roundtable discussion, as an activity for the International Day of Women in Engineering (June 23).



Alfonso X. El rey que quiso ser astrónomo. A show developed by the IAA on Astrophysics and History, with twenty-five voices, six musicians, two actors, and a 6x4 metre projection.

Participation in "**Granada: ciudad de la Ciencia y la Innovación**", a FECYT-funded project of the largest institutions in Granada, to bring science and knowledge closer to citizens.

Astronomía Accesible. This project aims at emphasizing the popularization of astronomy among blind and low-vision people.



Social Networks.

Twitter, facebook, youtube and Instagram profiles managing.

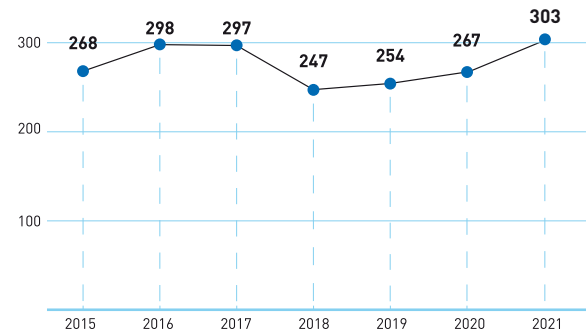
<https://twitter.com/iaauc>

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

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

https://www.instagram.com/iaa_csic

Publications



IAA publications in SCI journals

The research activity carried out at the IAA-CSIC during 2021 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. In 2020, this activity resulted in **303 papers published** in journals of the SCI.

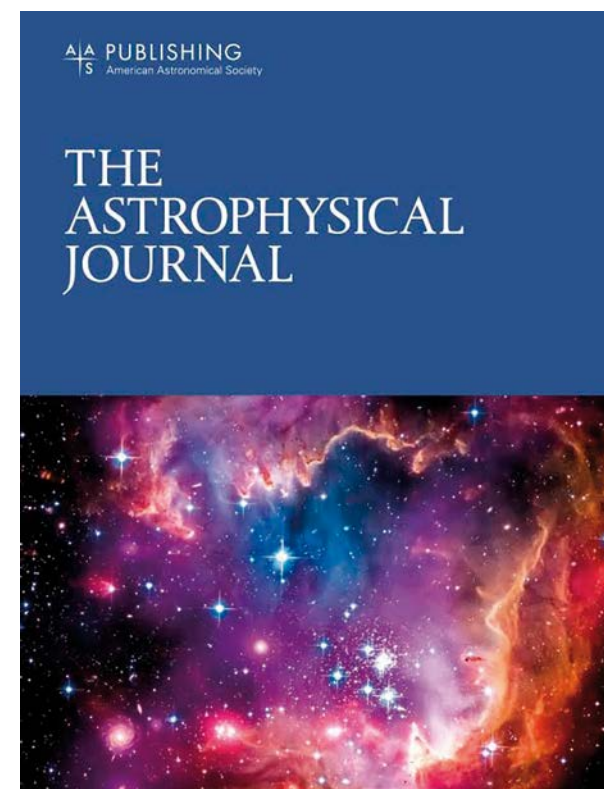
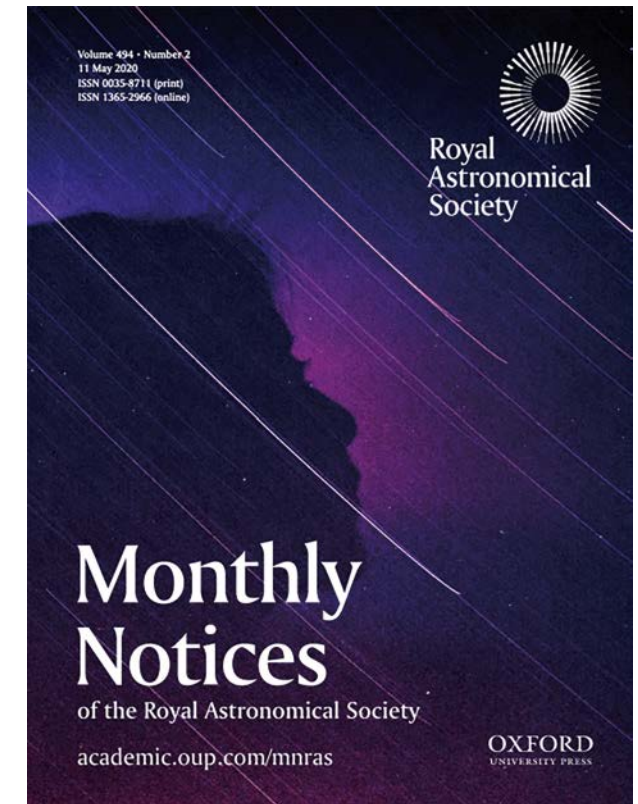
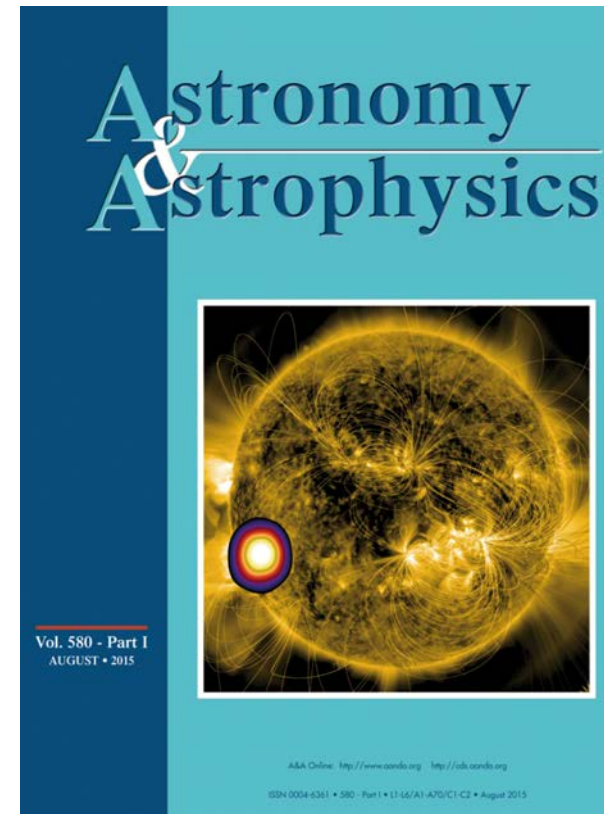
The complete list of the IAA-CSIC publications in 2021 is given in the Annex at the end of this report. The evolution of the number of SCI publications since 2015 is shown below. Along the years, the number of publications fluctuates around an average value of 275 papers per year.

The publications of the IAA-CSIC are mostly distributed in high impact journals. About 85% of our publications appeared in journals of the first quartile (top 25% journals, or Q1). Among these publications, 7% appeared in the first decile (top 10% journals, or D1). Most of the IAA-CSIC scientific results are published in *Astronomy & Astrophysics* and *Monthly Notices of the Royal Astronomical Society*, the main European astronomical journals. A significant fraction of our results is published in *Astrophysical Journal*, the most important American astronomical journal.

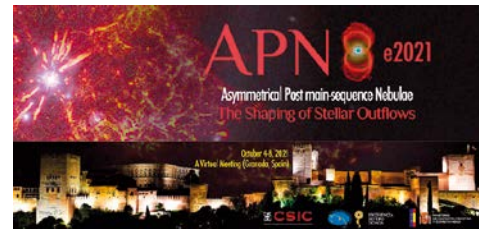
Another aspect of the scientific research of the IAA and its quantitative results is the leadership of these publications. **In about 17% of the IAA SCI 2020 publications their first author belongs to our institute.** This is consistent with the leadership of the IAA in the last 5 years.

Number of publications by journal

- 82 Astronomy and Astrophysics
- 72 Monthly Notices of the Royal Astronomical Society
- 26 Astrophysical Journal
- 13 Astrophysical Journal Letters
- 9 Astronomical Journal
- 8 Icarus
- 7 Geophysical Research Letters
- 6 Astrophysical Journal Supplement Series
- 5 Nature Astronomy
Experimental Astronomy
Journal of Cosmology and Astroparticle Physics
- 4 Journal of Geophysical Research, Atmospheres
Journal of Geophysical Research, Planets
Physical Review D
- 3 Atmospheric Measurement Techniques
Journal of Quantitative Spectroscopy and Radiative Transfer
Solar Physics
Universe
- 2 Nature
Science Advances
Atmospheric Chemistry and Physics
Atmospheric Research-Space
Classical and Quantum Gravity
Journal of Geophysical Research, Space Physics
Remote Sensing
Symmetry
- 1 Others



Workshops & meetings

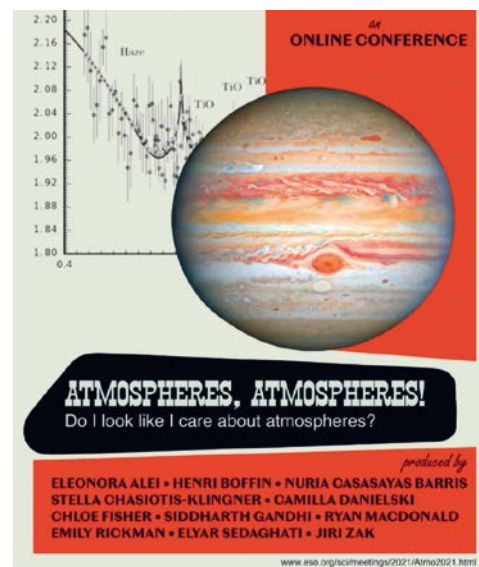


Meetings

Asymmetrical Post-main-sequence Nebulae 8 e2021: The Shaping of Stellar Outflows
INTERNATIONAL CONFERENCE
Granada, Oct 04 - 08, 2021 (virtual format)
IAA MEMBERS OF THE LOCAL ORGANIZING COMMITTEE:
M. Guerrero Roncel
<http://apn8.iaa.csic.es>

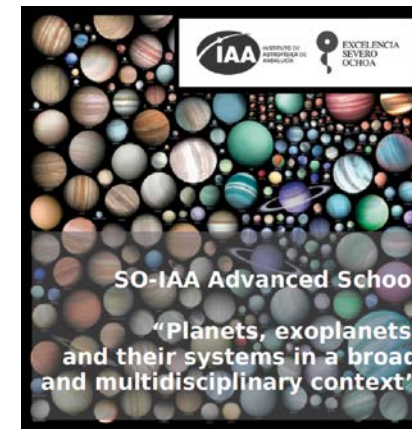


PLATO Mission Conference 2021
INTERNATIONAL CONFERENCE
Granada, Oct 11 - 15, 2021 (virtual format)
IAA MEMBERS OF THE SCIENTIFIC ORGANIZING COMMITTEE:
R. Garrido Haba, J. Suárez Yanes
IAA MEMBERS OF THE LOCAL ORGANIZING COMMITTEE:
J. Suárez Yanes, J. Rodón Ortiz, R. Garrido Haba, J. Rodríguez Gómez, A. Claret dos Santos, M. Lares Martiz, S. Martín Ruiz, M. Mendoza Pérez, J. Pascual Granado, M. Pastor Morales, F. Pozuelos Romero, A. Ramón Ballesta, E. Rodríguez Martínez, M. Sánchez Carrasco, M. Sanz Mesa
<http://platomissionconference2021.iaa.es/>



Horizon Europe: Workshop on RESEARCH INFRASTRUCTURE
NATIONAL WORKSHOP
Granada, Jun 09 - 09, 2021 (virtual format)
<http://www.juntadeandalucia.es/actualidad/eventos/detalle/217675.html>

Atmospheres, Atmospheres! Do I look like I care about atmospheres? (Atmo 2021)
ESO CONFERENCE
August 23-27, 2021 (online)
IAA MEMBERS OF THE ORGANISING COMMITTEES:
Camilla Danielsky
<https://www.eso.org/sci/meetings/2021/Atmo2021.html>



Schools

Planets, exoplanets and their systems in a broad and multidisciplinary context
Granada, Jan 18 - 29, 2021 (virtual format)
https://docs.google.com/forms/d/e/1FAIpQLSe5c_V7n7FSnLXSL-7nIKDI3oQNZ3x2nxvC8AiiHYbE10aB_IA/viewform

IAA Severo Ochoa Advanced School on Star Formation
Granada, Nov 15 - 19, 2021
IAA MEMBERS OF THE ORGANIZING COMMITTEE:
R. Schoedel, A. Pelegrina López, M. González García
IAA MEMBERS OF THE SCIENTIFIC ORGANIZING COMMITTEE:
R. Schoedel
<https://www.granadacongresos.com/starform>

SO instrumentation school
Module I: High level synthesis for Xilinx FPGAs using Vivado HLS
Granada, Apr 28 - 30, 2021 (virtual format)
<https://forms.gle/FgMLANsyVD6zqSTPA>

Module II: Ansys Workbench for Scientific Instrumentation
Granada, Jun 10 - Jul 01, 2021 (virtual format)
<https://forms.gle/p7cwZjndRqftKcf39>

Module III. Beckhoff Motion Control
Granada, Sep 20 - 23, 2021
<https://forms.gle/vyyrVJ5ckXevpvWX9>

Module IV. Vacuum Technology
Granada, Oct 20 - 22, 2021
<https://forms.gle/Ag46jvhSzGheYJ2H9>

Module V. Project management in the 3DExperience environment, including document and requirements management
Granada, Nov 15 - 19, 2021 (virtual format)
https://docs.google.com/forms/d/e/1FAIpQLScpUU-jpRMrscHw1EcuAWEunFjtngng--MqAdQ80TBc9_EhCPA/viewform

Module VI. A practical introduction to Project Management and Earn Value Management for scientists, engineers and new project managers
Granada, Nov 29 - Dec 03, 2021 (virtual format)
<https://forms.gle/gjym896Li2Dsy4QVA>

SOMACHINE 2 Machine Learning, Big Data, and Deep Learning in Astronomy
Granada, Apr 19 - 23, 2021 (virtual format)
IAA MEMBERS OF THE ORGANIZING COMMITTEE: R. Schoedel
IAA MEMBERS OF THE LOCAL ORGANIZING COMMITTEE:
A. Pelegrina López, M. González García
<https://www.granadacongresos.com/somachine2021>

2nd IAA-CSIC Severo Ochoa School on Statistics, Data Mining, and Machine Learning
Granada, Nov 29 - Dec 03, 2021
IAA MEMBERS OF THE ORGANIZING COMMITTEE:
R. Schoedel, A. Pelegrina López, M. González García
<https://www.granadacongresos.com/sostat2021>

Matplotlib for Beginners - A Brief Severo Ochoa Workshop
Granada, Apr 07 2021 (virtual format)
IAA MEMBERS OF THE ORGANIZING COMMITTEE:
A. Díaz Rodríguez, R. Schoedel
<https://forms.gle/sgURZsXr4cPeFbt19>

An Introduction to IFU Spectroscopy
Granada, Jun 14 - 14, 2021 (virtual format)
<https://forms.gle/TeWzd6f5Uta1TMoM8>

Scientific writing and presentation in astronomy
Granada, Jun 09 - 10, 2021 (virtual format)
IAA MEMBERS OF THE ORGANIZING COMMITTEE:
R. Schoedel, M. Pérez Torres
<https://forms.gle/c1BbvV4qTu8ucAxPA>

IV Course on Scientific Dissemination Techniques
Granada, Sep 15 - 16, 2021
<https://granada.hablandodeciencia.com/curso/>

English for Academic Purposes - an online workshop series for young researchers
Granada, Jun 21 - 25, 2021 (virtual format)
<https://forms.gle/9wPU1MfNjKLPARFMA>

Spanish for beginners at the IAA-CSIC
Granada, Oct 21, 2021 - Jan 22, 2022

Gender actions



Overview

The IAA is supporting inclusive initiatives in Gender Equality. This trajectory crystallized in the creation of the Institute's Gender Equality Commission and the preparation and approval of the First Gender Equality Plan of the IAA-CSIC (GEP), in 2018. Here we present the main activities carried out in 2021. The Equality Commission continued its work of advising on the necessary or appropriate measures to actively integrate the principle of gender equality between women and men in the daily life of the centre, as well as organizing events to raise awareness of the role of women in science.

Highlights

In addition to ensuring the gender equality measure, the Gender Equality Commission of the IAA-CSIC acts as the **Gender Working Group** of the gender equality plan drawn up by the Severo Ochoa project. All their governance bodies verify the gender equality, and the following actions have been contemplated:

- 1) **Hypatia of Alexandria Visiting Grant:** 2 visits of the visiting researchers program, out of the 6 offered, were given to female researchers.
- 2) **Vera Rubin Colloquium:** 14 colloquia, out of the 30 offered, were presented by female researchers.

Gender Activities in 2021 in the center

- Production of the annual statistics segregated by gender.
- Organization of activities for the International **Day of Women and Girls in Science** (11 February). Different informal meetings with women researchers, engineers and technicians at the IAA were held for the educational centers in Granada, with the aim of highlighting the role of women in science. These meetings included open discussions, individual reflections and questions about gender roles and the existing stereotypes around science, technology and engineering. We counted with the participation of Isabel Bustamante, Alice Deconto, Carolina Kherig, Luisa Lara, Mariel Lares, Susana Martín, Alicia Pelegrina, Rosario Sanz, and Yolanda Teja, from the IAA, as well as students from 3rd course of ESO of IES Lanjarón and the CEIP Abencerrajes and CEIP Alcazaba (11-12 years old). Both activities were done on-line.

We also collaborated with the students of the Liceo Cervantes of Roma within the activity "¿Esta pregunta es para mí?" producing four videos where Sara Cazzoli, Laura Hermosa, Maria Passas and Mónica Vara answered their questions

- Organization of activities for the International **Women's Day** (8 March): We organized a round table under the title "Mujeres de Excelencia" with the participation of three female researchers who lead the Excellence Severo Ochoa project in their centers, namely María Blasco (CNIO),

Isabel Márquez (IAA-CSIC) and Teresa Moreno (IDAEA-CSIC). It was chaired by Margarita Sánchez, Vicecounselor of the Universidad de Granada

- For the day of **Women and Girls in Engineering** (23 June), a round table was organized with the participation of the female engineers Beatriz Aparicio, María Balaguer, Isabel Bustamante, Carmen Pastor, Susana Sánchez and Rosario Sanz.

• Outreach activities:

Lourdes Verdes-Montenegro participated in a round table on the gender perspective in international R&I, organized by the Vicepresidency of International Relations of the CSIC.

Collaboration with the CSIC delegation in Andalusia in the "Moby Dick" podcast: Mayra Osorio, Alicia Pelegrina, Matilde Fernández and María Passas.

Seven lectures by women researchers from the IAA at the European Researchers' Night 2021 and the "Desgranando Ciencia" event.

Production and distribution of the webseries "Camino a Congreso" in which the personal and working conflicts of women in science are one of the main drivers

We continued to collaborate with scientific outreach magazines and the newspapers El País, Granada Hoy and Ideal. In the IAA magazine *Información y Actualidad Astronómica*, several articles were published with the aim of making visible female scientists who have contributed significantly to the development of Astronomy.

• Gender Equality and COVID-19 Questionnaire:

An online evaluation survey was launched on October 22nd 2020 among IAA-CSIC members to collect data on the impact of the COVID-19 health crisis actions taken at work. The results were published in March 2021.

• CSIC Gender Equality Commission Meetings:

We participated in the second meeting of the CSIC Gender-Equality Commissions in November 17th organized by the IFT-CSIC in coordination with the CSIC Gender Equality Commission and in the meeting 'Los planes de igualdad en los centros de investigación: intercambio de buenas prácticas', organized by ICM in November 23rd.

• SOMMA Gender Equality Commission Meetings:

In 2021 the SOMMA Gender Working Group was re-activated and we participated in the five online meetings organized along the year. As a result of these working meetings, a survey of the SOMMA centers was elaborated. Moreover, the second SOMMA Gender Working Group event took place in a hybrid format on May 26th, with the participation of the CSIC and the Science Ministry.

Awards



The Inaugural 2021 Jocelyn Bell Burnell Inspiration Medal was awarded to **Mirjana Pović** (ESSTI and IAA-CSIC) for "her work on developing astronomy, science and education as a route out of poverty and to improve the quality of life for young people in Africa".



Mirjana Povic
EAS Jocelyn Bell Burnell Inspiration Medal 2021

Rocco Lico, a postdoc hired under the Severo Ochoa IAA project, was recognised with an EHT Early Career Award for "his dedication and positive contribution to the EHTC's management processes and strategy, recognising his unique talent for combining management activities and innovative science".



Rocco Lico
2021 EHT Early Career Award

Isabel Márquez was awarded in the "Women and Science" category of the "Granada City of Science and Innovation" 2021 awards, highlighting the fact that "not only does she embody the overwhelming force of someone researching in truly complex fields of knowledge, but she also combines this professional facet with activities to promote and raise awareness of the role of women in the truly vast field of astronomy".



Isabel Márquez
III edition of the "Granada Ciudad de la Ciencia y la Innovación" Awards Category "Mujer y Ciencia"

The Scientific Culture Unit of the IAA-CSIC (UCC) was awarded in the category of "Scientific Dissemination". The UCC was highlighted for its "experience in pioneering activities in all possible languages and formats, which has undoubtedly contributed to the positioning of the IAA-CSIC as a national reference centre in the field of outreach".

Lourdes Verdes Montenegro
Finalist of the Ada Byron Award of the Faculty of Engineering of the University of Deusto



Unidad de Cultura Científica del IAA
III edition of the "Granada Ciudad de la Ciencia y la Innovación" Awards Category "Divulgación Científica"

Sara Cazzoli
Semifinalist of the FAMELAB scientific monologue contest, organized by the British Council and FECYT.

Funding



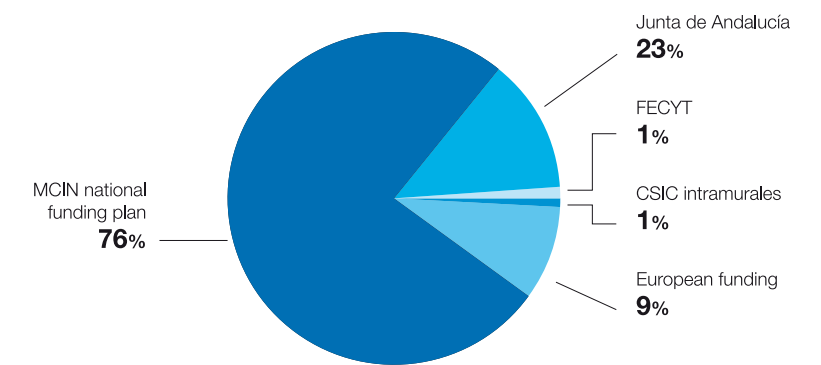
IAA obtains most of its funding through competitive European and Spanish grants (a total of **7,2 million €** was obtained in the 2021 competitive calls).

During 2021, IAA managed a total budget of **14,1 million €**, from which **6,8 million €** (48%) came from competitive projects and CSIC investments; the other **7,3 million €** (52%) corresponded to the permanent staff total cost and common expenses.

The yearly evolution of the IAA budget in the last 5 years is shown below, including the different concepts.

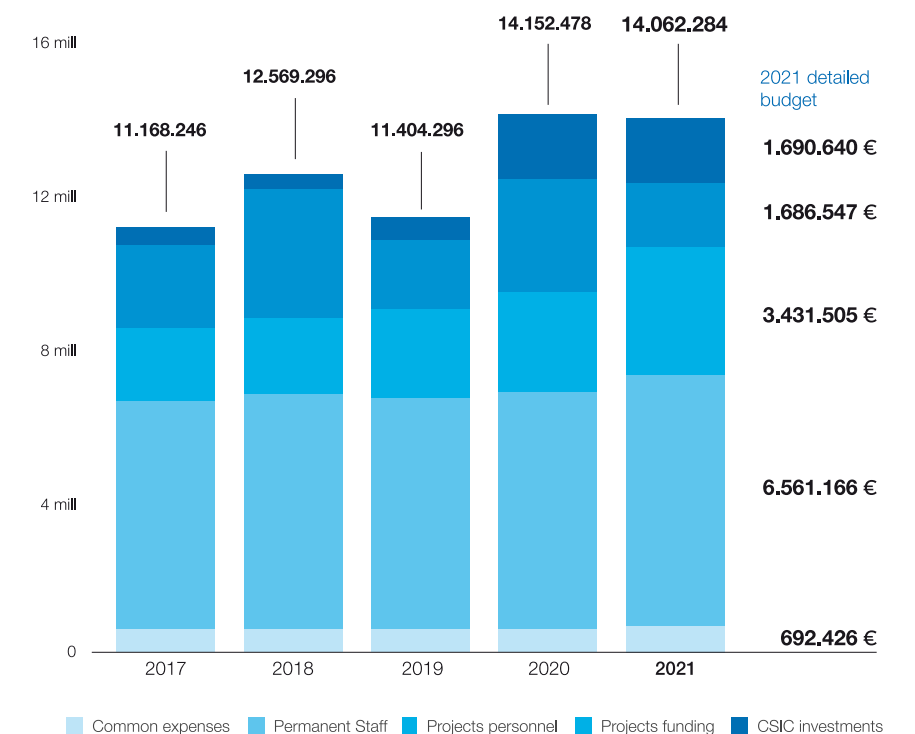
IAA 2020 competitive fundings

Total:
7,2 million €



IAA budget yearly evolution

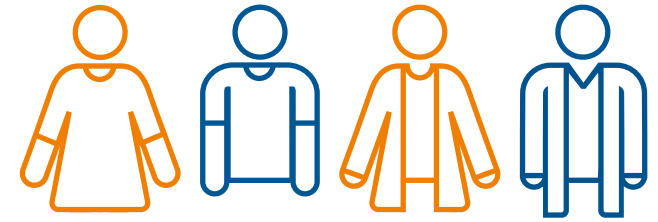
Total 2021:
14,1 million €



Annexes



Staff



Assigned research group

- ^[1] Solar Physics
- ^[2] Planets and minor bodies
- ^[3] Terrestrial atmosphere
- ^[4] Low-mass stars
- ^[5] Stellar variability
- ^[6] ARAE
- ^[7] HETH
- ^[8] Stellar systems
- ^[9] Physics of the interstellar medium
- ^[10] AGN jets
- ^[11] Galaxy evolution
- ^[12] Theoretical gravitation and cosmology
- ^[13] Observational cosmology
- ^[14] Cosmology and particle physics

STAFF RESEARCHERS

Research Professors

Alberdi Odriozola, Antonio María ^[9]
 Castro Tirado, Alberto Javier ^[6]
 del Toro Iniesta, Jose Carlos ^[11]
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 López Puertas, Manuel ^[3]
 Pérez Jiménez, Enrique ^[11]
 Prada Martínez, Francisco ^[14]
 Vílchez Medina, José Manuel ^[11]

Scientific Researchers

Aceituno Castro, Jesús ^[11]
 Alfaro Navarro, Emilio Javier ^[8]
 Anglada i Pons, Guillem Josep ^[9]
 Bellot Rubio, Luis Ramón ^[11]
 Funke, Bernd Rainer ^[3]
 Gómez Fernández, José Luis ^[10]
 Guerrero Roncel, Martín ^[9]
 Lara López, Luisa María ^[2]
 Márquez Pérez, Isabel ^[11]
 Masegosa Gallego, Josefa ^[11]
 Moreno Danvila, Fernando ^[2]
 Ortiz Moreno, José Luis ^[2]
 Pérez Montero, Enrique ^[11]
 Pérez Torres, Miguel Angel ^[9]
 Rodríguez Martínez, Eloy ^[4]
 Schoedel, Rainer ^[8]
 Verdes-Montenegro Atalaya, Lourdes ^[11]

Senior Scientists

Agudo Rodríguez, Juan Iván ^[10]
 Amado González, Pedro José ^[4]
 Barceló Serón, Carlos ^[12]
 Claret dos Santos, Antonio ^[6]
 del Olmo Orozco, Ascensión ^[11]
 Duffard, René Damián ^[2]
 Fernández Hernández, Matilde ^[4]
 García Benito, Rubén ^[11]
 García Comas, Maia Leire ^[3]
 Gómez Rivero, José Francisco ^[9]
 Gordillo Vázquez, Francisco José ^[3]
 Gutiérrez Buenestado, Pedro José ^[2]
 Iglesias Páramo, Jorge ^[11]
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 López Jiménez, Antonio Carlos ^[11]
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 Miranda Palacios, Luis Felipe ^[9]
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 Perea Duarte, Jaime David ^[11]
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Ad honorem

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Research Advisor

Rodríguez Espinosa, José Miguel ^[11]

Associated Doctors

Duarte Puertas, Salvador ^[11]
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Sedaghati, Elyar ^[3]

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Caballero García, María Dolores ^[6]
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Marie Curie Postdocs

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Postdocs

Agís González, Beatriz ^[11]
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Ayala Gómez, Adrián ^[5]
Bonnoli, Giacomo ^[10]
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Cho, Ilje ^[10]
Damas Segovia, Ancor Efren ^[11]
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Ianjamasimanana, Roger ^[11]
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Kehrig Martin dos Santos, Carolina ^[11]

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Lico, Rocco ^[10]
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Martinez Delgado, David ^[6]
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Moldón Vara, Javier ^[11]
Osorio Gutiérrez, Mayra Carolina ^[9]
Parra Royón, Manuel Jesús ^[11]
Pascual Granado, Javier ^[5]
Pereira Breda, Iris ^[11]
Pérez Invernón, Francisco Javier ^[3]
Roche, Nathan ^[11]
Rodríguez López, Cristina Teresa ^[4]
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Sánchez Ramírez, Rubén ^[6]
Santos Sanz, Pablo ^[2]
Shahzamanian Sichani, Banafsheh ^[8]
Shulyak, Denis ^[2]
Siu Tapia, Azaymi Litzi ^[11]
Sorgho, Amidou ^[11]
Stolzenbach, Aurélien ^[3]
Strecker, Hanna Maria ^[11]
Thöne, Christina C. ^[7]
Traianou, Efthalia ^[10]
Van Vliet Wiegert, Theresa Beatrice Veronica ^[11]
Zhao, Guangyao ^[10]

Marie Curie PhD

Kieu, Thi Ny ^[3]

FPI PhD

Agüi Fernández, José Feliciano ^[7]
Álvarez Miranda, Julián ^[3]
Arrechea Rodríguez, Julio ^[12]
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Postdocs

Dorantes Monteagudo, Antonio Jesús ^[11]
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Ramón Ballesta, Alejandro ^[5]
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PhD contracts

Deconto Machado, Alice ^[11]
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JAE-Intro

Dahale, Rohan Arun ^[10]
Domínguez Larrañaga, Isaac ^[3]
Mariana Rodríguez, Rafael ^[8]
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Pastor Gómez, Emilio ^[2]
Prados Abad, Miguel ^[11]
Salas Moreno, Víctor ^[10]
Sánchez Martínez, David ^[14]
Tapia del Moral, Mónica ^[14]
Torres Ríos, Gloria ^[11]
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ENGINEERS & TECHNICIANS

Mechanics

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Varas González, Roberto ^[11]

Electronics

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Rodrigo Campos, Julio ^[2]
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Sanz Mesa, María del Rosario ^[5]
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PhD

Software

Alburai, Alaa R.A. ^[8]
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Morales Fernández, José Miguel ^[11]
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Rodón Ortiz, José Ramón ^[5]
Román García, Javier ^[11]
Ruiz del Mazo, José Enrique ^[10]
Sánchez Expósito, Susana ^[11]

OSN maintenance/support

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
Sánchez Funes, Fernando
Sota Ballano, Alfredo

PhD

SERVICES & ADMINISTRATION

Administration and project support

Blanca Gámez, Ana Belén
Bustamante Calabria, Máximo
Castro Díaz, Rosa Irene de
Cortés Guerrero, María Ángeles
Cosano Mañas, José Rufino
Fernández Torres, María Lourdes
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González García, Manuel Jesús
Heredia Maldonado, María José
Herrera Jiménez, Eva María
Jiménez del Río, Yrene ^[11]
Jiménez Zafrilla, María Isabel
López Fernández, Víctor Aníbal ^[11]
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Martínez Fortes, Natalia
Molina Guerrero, Josefina
Pelegrina López, Alicia
Sánchez Castro, Lorena
Tapia Ruiz, Francisco José
Torrededia Rodrigo, Cristina
Villaverde Aparicio, Marcos ^[11]

Computer center

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

General services

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

Library

Arco Sarmiento, María Ángeles

Outreach and communication

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

Ongoing projects



AGENCIA ESTATAL DE INVESTIGACIÓN

Title: Apoyo a Centros de Excelencia Severo Ochoa

Ref.: SEV-2017-0709

Pl: Isabel Márquez Pérez

Dur.: Jul 01, 2018 - Jun 30, 2022

Title: Modelo de repuesto y de vuelo de subsistemas de JANUS y GALA. Formación y evolución de sistemas planetarios: Desde cuerpos menores a exoplanetas

Ref.: PGC2018-099425-B-I00

Pl: Luisa María Lara López

Dur.: Jan 01, 2019 - Sep 30, 2022

Title: Participación del IAA-CSIC en la misión espacial PLATO2.0. Fases C/D-1. Operación NOMAD-EXOMARS

Ref.: PID2019-107061GB-C63

Pl: Rafael Garrido Haba, Julio Federico Rodríguez Gómez

Dur.: Jun 01, 2020 - May 31, 2024

Title: Física solar espacial

Ref.: RTI2018-096886-B-C51

Pl: Jose Carlos del Toro Iniesta, David Orozco Suárez

Dur.: Jan 01, 2019 - Dec 31, 2022

Title: Un nuevo instrumento de campo integral para el espectrografo OSIRIS en el Gran Telescopio Canarias

Ref.: EQC2021-007105-P

Pl: Francisco Prada Martínez

Dur.: Jun 01, 2021 - Dec 31, 2023

Title: Caracterización de la atmósfera de Marte con los instrumentos NOMAD y ACS a bordo de TGO/EXOMARS

Ref.: PGC2018-101836-B-I00

Pl: Miguel Angel López Valverde

Dur.: Jan 01, 2019 - Sep 30, 2022

Title: Sistema de observación de la mitad de la bóveda celeste en la nueva era de astrofísica de multimensajeros

Ref.: EQC2018-004735-P

Pl: Alberto Javier Castro Tirado

Dur.: Jan 01, 2018 - Mar 31, 2021

Title: Amiga7: Gas y campos magnéticos en entornos extremos de galaxias con los precursores de SKA - desde el diseño del flujo de datos hacia su construcción

Ref.: RTI2018-096228-B-C31

Pl: Lourdes Verdes-Montenegro Atalaya

Dur.: Jan 01, 2019 - Dec 31, 2022

Title: Agujeros negros supermasivos y Jets relativistas

Ref.: PID2019-108995GB-C21

Pl: José Luis Gómez Fernández, Juan Iván Agudo Rodríguez

Dur.: Jun 01, 2020 - May 31, 2023

Title: Jets estelares, discos y campos magnéticos. Ciencia para el SKA y contribución al diseño de Phased Array Feeds

Ref.: AYA2017-84390-C2-1-R

Pl: Guillem Josep Anglada i Pons, José Francisco Gómez Rivero

Dur.: Jan 01, 2018 - Sep 30, 2021

Title: Los galácticos de la galaxia: Estrellas masivas, cúmulos estelares y el centro galáctico

Ref.: PGC2018-095049-B-C21

Pl: Rainer Schoedel, Emilio Javier Alfaro Navarro

Dur.: Jan 01, 2019 - Dec 31, 2022

Title: Detección y caracterización de los sistemas planetarios en estrellas enanas M: Entendiendo su estrella y sus planetas

Ref.: PID2019-109522GB-C52

Pl: Pedro José Amado González

Dur.: Jun 01, 2020 - May 31, 2023

Title: Atmósfera y clima de la Tierra y exo-planetas

Ref.: PID2019-110689RB-I00

Pl: Bernd Rainer Funke, Manuel López Puertas

Dur.: Jun 01, 2020 - May 31, 2023

Title: Contribución del IAA a la explotación científica de ASIM: Experimentos, observaciones desde suelo, análisis de datos y modelización

Ref.: PID2019-109269RB-C43

Pl: Francisco José Gordillo Vázquez

Dur.: Jun 01, 2020 - Dec 31, 2023

Title: Comprensión de la actividad nuclear en galaxias: De las bajas a las altas tasas de acreción

Ref.: PID2019-106027GB-C41

Pl: Isabel Márquez Pérez, Ascensión del Olmo Orozco

Dur.: Jun 01, 2020 - May 31, 2023

Title: Galaxias en 3D y sus propiedades integradas: sinergia entre J-PAS/J-PLUS e IFS

Ref.: PID2019-109067GB-I00

Pl: Rosa María González Delgado

Dur.: Jun 01, 2020 - May 31, 2023

Title: Cielos y universos para los grandes cartografiados de galaxias: Explotación científica

Ref.: PGC2018-101931-B-I00

Pl: Francisco Prada Martínez

Dur.: Jan 01, 2019 - Aug 31, 2022

Title: Estallidos de formación estelar a lo largo de la evolución del universo

Ref.: PID2019-107408GB-C44

Pl: José Manuel Vilchez Medina, Jorge Iglesias Páramo

Dur.: Jun 01, 2020 - May 31, 2023

Title: Telescopio extremadamente ligero

Ref.: EQC2018-004455-P

Pl: José Luis Ortiz Moreno

Dur.: Jan 01, 2018 - Mar 31, 2021

Title: Legado del proyecto Small bodies near and far

Ref.: RTI2018-098657-J-I00

Pl: Pablo Santos Sanz

Dur.: Jan 01, 2019 - Dec 21, 2022

Title: GRBphot - Base de datos fotométricos de explosiones de rayos gamma

Ref.: RTI2018-098104-J-I00

Pl: David Alexander Kann

Dur.: Sep 01, 2019 - Aug 31, 2022

Title: Experimentos de laboratorio, observaciones y modelos de polvo cometario: Una nueva estrategia
Ref.: RTI2018-095330-B-I00
Pl: Olga Muñoz Gómez, Juan Carlos Gómez Martín
Dur.: Jan 01, 2019 - Sep 30, 2022

Title: En camino hacia SKA: Astronomía a la más alta resolución angular y sensibilidad
Ref.: PGC2018-098915-B-C21
Pl: Miguel Angel Pérez Torres, Antonio María Alberdi Odriozola
Dur.: Jan 01, 2019 - Jun 30, 2021

Title: Astronomía de rayos gamma con MAGIC y CTA-NORTE - contribución del IAA-CSIC
Ref.: PID2019-107847RB-C44
Pl: Juan Iván Agudo Rodríguez
Dur.: Jun 01, 2020 - May 31, 2023

Title: AGN, del universo local a distancias cosmologicas. Del motor central a la galaxia anfitriona y su entorno
Ref.: AYA2016-76682C3-1-P
Pl: Isabel Márquez Pérez
Dur.: Dec 30, 2016 - Mar 29, 2021

Title: Física oculta en la evolución en tiempo real de las nebulosas gaseosas en torno a estrellas evolucionadas de masa baja e intermedia
Ref.: PGC2018-102184-B-I00
Pl: Martín Guerrero Roncel
Dur.: Jan 01, 2019 - Dec 31, 2022

Title: Universo y vacío cuánticos
Ref.: FIS2017-86497-C2-1-P
Pl: Carlos Barceló Serón
Dur.: Jan 01, 2018 - Sep 30, 2021

Title: Red temática para la participación científica y tecnológica española en el SKA
Ref.: RED2018-102587-T
Pl: Lourdes Verdes-Montenegro Atalaya
Dur.: Jan 01, 2020 - Dec 31, 2022

Title: Sistemas planetarios a lo largo de la evolución estelar
Ref.: PID2020-114461GB-I00
Pl: Guillem Josep Anglada i Pons
Dur.: Sep 01, 2021 - Aug 31, 2024

Title: Física de los objetos transneptunianos y poblaciones relacionadas
Ref.: PID2020-112789GB-I00
Pl: José Luis Ortiz Moreno
Dur.: Sep 01, 2021 - Aug 31, 2024

Title: Detección de fenómenos transitorios haciendo uso de instrumentacion robótica con alta resolucion temporal
Ref.: PID2020-118491GB-I00
Pl: Alberto Javier Castro Tirado
Dur.: Sep 01, 2021 - Aug 31, 2024

Title: De los exoplanetas a los agujeros negros supermasivos: La exploracion de las fronteras
Ref.: PID2020-117404GB-C21
Pl: Miguel Angel Pérez Torres
Dur.: Sep 01, 2021 - Aug 31, 2024

Title: Búsqueda de corrientes estelares de marea en el universo local con cartografiados de imagen
Ref.: PID2020-114581GB-C21
Pl: David Martinez Delgado
Dur.: Sep 01, 2021 - Aug 31, 2023

Title: El universo cuántico gravitacional: Espaciotiempos efectivos y sus fluctuaciones cuánticas
Ref.: PID2020-118159GB-C43
Pl: Carlos Barceló Serón
Dur.: Sep 01, 2021 - Aug 31, 2024

Title: Una perspectiva planetaria sobre cambio climático: Marte y la evolución del agua
Ref.: RTI2018-100920-J-I00
Pl: Francisco González Galindo
Dur.: Oct 01, 2019 - Sep 30, 2022

REGIONAL GOVERNMENT JUNTA DE ANDALUCÍA

Title: Acciones para el fortalecimiento del IAA-CSIC para la adquisición del sello "Severo Ochoa"
Ref.: SOMM17/5208/IAA
Pl: Antonio María Alberdi Odriozola
Dur.: Jan 01, 2019 - Feb 28, 2022

Title: Excelencia científica y tecnológica en el IAA-CSIC: OSN, UDIT y Centro de Cálculo
Ref.: IE19_242_C SIC-I AA
Pl: Antonio María Alberdi Odriozola
Dur.: Dec 28, 2020 - Dec 27, 2022

Title: Stellar Tidal Streams in the Local Universe as Cosmological Diagnostic
Ref.: TASE-136
Pl: David Martinez Delgado
Dur.: Oct 01, 2020 - Sep 30, 2023

Title: Acciones para la optimización de observatorios astronómicos en Andalucía
Ref.: IE-2017-5298
Pl: Antonio María Alberdi Odriozola
Dur.: May 01, 2020 - Apr 30, 2022

Title: LUCA: Revelando la estructura fina de las galaxias del Universo Local con espectroscopía 3D
Ref.: P18-FRJ-2595
Pl: Rubén García Benito
Dur.: Dec 01, 2020 - Nov 30, 2023

Title: Supermassive black holes and blazar jets
Ref.: P18-FR-1769
Pl: José Luis Gómez Fernández
Dur.: Jan 01, 2020 - Jun 30, 2023

Title: Propiedades físicas del polvo cometario y aplicaciones biomédicas
Ref.: P18-RT-1854
Pl: Fernando Moreno Danvila, Olga Muñoz Gómez
Dur.: Jan 01, 2020 - Dec 31, 2022

Title: IAA4SKA. Contribution of the Instituto de Astrofísica de Andalucía to the Square Kilometre Array (SKA): Open Science and Engineering to reinforce the leadership of the Spanish participation in the SKA.
Ref.: P18-RT-3082
Pl: Lourdes Verdes-Montenegro Atalaya, Antonio María Alberdi Odriozola
Dur.: Jan 01, 2020 - Dec 31, 2022

Title: Estudiando galaxias jóvenes con tecnología de vanguardia: piezas clave de la evolución del Universo
Ref.: P18-FR-2664
Pl: Jorge Iglesias Páramo
Dur.: Jan 01, 2020 - Dec 31, 2022

Title: Objetos Transneptunianos y otros remanentes de la formación del sistema solar
Ref.: P20_01309
Pl: José Luis Ortiz Moreno
Dur.: Oct 05, 2021 - Dec 31, 2022

Title: Descifrando la Vía Láctea: Minería de datos y herramientas numéricas para la explotación de grandes cartografiados galácticos
Ref.: P20_00753
Pl: Emilio Javier Alfaro Navarro
Dur.: Oct 05, 2021 - Dec 31, 2022

Title: Imaginología y polarimetría en el ultravioleta cercano para aplicaciones espaciales (NUVIP)
Ref.: P20_01307
Pl: David Orozco Suárez
Dur.: Oct 05, 2021 - Dec 31, 2022

Title: Detección y caracterización de los sistemas planetarios en estrellas enanas. M: Entendiendo su estrella y sus planetas
Ref.: P20_00737
Pl: Pedro José Amado González
Dur.: Oct 05, 2021 - Dec 31, 2022

Title: Construction of the Calar Alto Schmidt-Lemaître Telescope (CASTLE), a technology demonstrator for curved detectors
Ref.: P20_00737
Pl: Francisco Prada Martínez
Dur.: Oct 05, 2021 - Dec 31, 2022

Title: Explorando la formación y supervivencia planetaria en condiciones extremas
Ref.: P20_00880
Pl: Mayra Carolina Osorio Gutiérrez
Dur.: Oct 05, 2021 - Dec 31, 2022

Title: Aprendizaje artificial aplicado a simulaciones de transporte Montecarlo: aplicación a la producción de rayos X en descargas eléctricas
Ref.: P20_00831
Pl: Alejandro Luque Estepa
Dur.: Oct 05, 2021 - Dec 31, 2022

EUROPEAN PROGRAM FUNDS

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

Ref.: 681257 (ERC-2015-COG)

Pl: Alejandro Luque Estepa

Dur.: Jun 01, 2016 - May 31, 2021

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

Ref.: 739500 H2020-INFRA/0287

Pl: Luis Ramón Bellot Rubio

Dur.: Apr 01, 2017 - Dec 31, 2021

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

Ref.: H2020-MSCA-ITN-2016

Pl: Francisco José Gordillo Vázquez

Dur.: Mar 01, 2017 - Feb 28, 2021

Title: ROle and impAct of Dust and clouds in the Martian Atmosphere: from lab to space (ROADMAP)

Ref.: 01004052 H2020-LEIT-SPACE/0753

Pl: Olga Muñoz Gómez

Dur.: Nov 01, 2020 - Oct 31, 2023

Title: CICLE -- Unveiling the formation and evolution of galaxy clusters through the intracluster light and multidisciplinary techniques of image processing and big data analysis

Ref.: H2020-MSCA-IF-2019 -- 898633

Pl: Yolanda Jiménez Teja

Dur.: Apr 01, 2020 - Mar 31, 2022

Title: SOLARNET - 824135- Integrating High Resolution Solar Physics - H2020

Ref.: 824135

Pl: Luis Ramón Bellot Rubio

Dur.: Jan 01, 2019 - Dec 31, 2022

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

Ref.: 824064 - H2020-INFRA/0489

Pl: Lourdes Verdes-Montenegro Atalaya

Dur.: Feb 01, 2019 - Jul 31, 2022

MINISTERIO DE CIENCIA E INNOVACIÓN

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

Ref.: 201950E125

Pl: Lourdes Verdes-Montenegro Atalaya

Dur.: Dec 01, 2019 - Nov 30, 2022

Title: Ayuda del MICIIN para la coordinación de la participación en SKA-españa

Ref.: OTR07653

Pl: Lourdes Verdes-Montenegro Atalaya

Dur.: Jan 01, 2021 - Dec 31, 2021

FECyT

Title: Horizontes de Luz

Ref.: FCT-20-15889

Pl: Emilio José García Gómez-Caro

Dur.: Jul 01, 2021 - June 30, 2022

CDTI

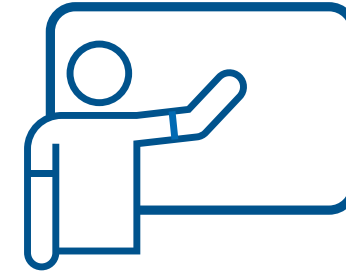
Title: Convenio CSIC-CDTI para la ejecución del Proyecto «Modelos de Vuelo para la MEU (Unidad de la Electrónica Principal) de PLATO»

Ref.: ICTP-20210005

Pl: Julio Federico Rodríguez Gómez

Dur.: Dec 06, 2021 - Dec 05, 2026

Education & teaching



PhD Theses

Title: Disk and jets in the formation of multiple stellar systems

Author: Ana Karla Díaz Rodríguez

Sup.: Guillem Josep Anglada i Pons

Univ.: Universidad de Granada

Date: Feb 10, 2021

Title: Numerical investigation on the advance of leader channels in lightning and long sparks

Author: Alejandro Francisco Malagón Romero

Sup.: Alejandro Luque Estepa

Univ.: Universidad de Granada

Date: Mar 23, 2021

Title: Characterisation of exoplanetary upper atmospheres undergoing hydrodynamic atmospheric escape

Author: Manuel Lampón González-Albo

Sup.: Manuel López Puertas

Univ.: Universidad de Granada

Date: Mar 24, 2021

Title: Properties of galaxies in galaxy clusters up to a redshift of $z \sim 1$

Author: Zeleke Beyoro Amado

Sup.: Solomon Tessema Belay, Mirjana Povic,

Miguel Sánchez Portal

Ethiopian Space Science and

Technology Institute (ESSTI)

Date: May 31, 2021

Title: Non-linear terms in Delta Scuti stars power spectra

Author: Mariel Lares Martiz

Sup.: Rafael Garrido Haba, Javier Pascual Granado

Univ.: Universidad de Granada

Date: Jun 11, 2021

Title: Spectropolarimetric and imaging properties of Fabry-Perot etalons. Applications to solar instrumentation

Author: Francisco Javier Bailén Martínez

Sup.: Jose Carlos del Toro Iniesta,

David Orozco Suárez

Univ.: Universidad de Granada

Date: Jun 25, 2021

Title: Position on the Hertzsprung-Russell diagram of magnetically active young stars

Author: Estefania Casal López

Sup.: Matilde Fernández Hernández

Univ.: Universidad de Granada

Date: Jul 02, 2021

Title: High angular resolution radio observations of luminous infrared galaxies

Author: Naim Ramírez Olivencia

Sup.: Antxon María Alberdi Odriozola,

Miguel Angel Pérez Torres

Univ.: Universidad de Granada

Date: Jul 05, 2021

Title: New windows onto the stellar population at the Galactic Centre: multi-wavelength and time-domain studies

Author: Aurelia Teresa Gallego Calvente
Sup.: Rainer Schoedel
Univ.: Universidad de Granada
Date: Jul 08, 2021

Title: Multi-wavelength study of GRBs detected by Fermi and Swift

Author: Youdong Hu
Sup.: Alberto Javier Castro Tirado, Binbin Zhang
Univ.: Universidad de Granada
Date: Jul 21, 2021

Title: Ultra-fast time-resolved spectroscopy lightning-like discharges with GALIUS

Author: Thi Ny Kieu
Sup.: Francisco José Gordillo Vázquez, Alejandro Luque Estepa
Univ.: Universidad de Granada
Date: Oct 14, 2021

MASTER Theses

Title: Densidad y temperatura en la media-alta atmósfera de Marte: comparación de las medidas por ocultación estelar con un Modelo Climático Global

Author: Raúl Marcos Orzaes
Sup.: Francisco González Galindo
Univ.: Valencia International University
Date: 25/5/2021

Title: Estudio de la variación radial de la temperatura efectiva de los cúmulos ionizantes en los discos de las galaxias espirales del muestreo CHAOS

Author: Aitor Elorrieta Alberdi
Sup.: Enrique Pérez-Montero (IAA) & Rubén García-Benito (IAA)
Univ.: Valencia International University
Date: 26-05-2021

Title: Planetary nebula around PG1159-type central stars: properties and characteristics

Author: José Francisco López Herrera
Sup.: Luis F. Miranda
Univ.: Valencia International University
Date: 6 September 2021

Title: Variability of the planetary nebula M3-27

Author: David Enrique Rodríguez Granados
Sup.: Luis F. Miranda and Lorenzo Olguín
Univ.: Valencia International University
Date: 8 November 2021

Title: The History of the Galactic Center told by its Brightest Stars

Sup.: Prof. Andreas Eckart, Dr. Rainer Schödel
Univ.: University of Cologne, Germany
Date: 18/11/2021

Title: Detección de eventos transitorios mediante procesamiento de imágenes astronómicas

Author: Ignacio Pérez-García
Sup.: Alberto J. Castro-Tirado
Univ.: Valencia International University
Date: 11 November 2021

Title: Catálogo HOPS sobre discos y jets asociados a estrellas muy jóvenes en Orión

Author: Florin Placinta Alexandru
Sup.: Mayra Osorio, Guillermo Blazquez (mentor)
Univ.: Granada
Date: 21 September 2021

Title: Evolución Estelar en Tiempo Real

Author: Francisco Peraza
Sup.: Javier Pascual Granado
Univ.: Valencia International University
Date: 06/2021

Title: Subestructuras en el espacio-fase de la región de formación estelar de Mon OB1

Author: Llanos Martínez Fernández
Sup.: Emilio J. Alfaro
Univ.: Valencia International University
Date: April 14th, 2021

Title: Light Scattering en discos protoplanetarios

Author: María de la Concepción Jiménez Serrano
Sup.: Daniel Guirado Rodríguez
Univ.: Valencia International University
Date: June 30th

Title: Stellar Tidal Streams around Milky Way analog galaxies

Author: Silvia Farrás Aloy
Sup.: Dr. David Martínez Delgado
Univ.: Valencia International University
Date: 10 Noviembre 2021

Title: Búsqueda de galaxias de bajo brillo superficial en el entorno de galaxias masivas cercanas

Author: Antonio Paradell Bondia
Sup.: Dr. David Martínez Delgado
Univ.: Valencia International University
Date: 10 Noviembre 2021

Title: Búsqueda de cúmulos globulares en la corriente estelar de la galaxia del Sombrero M104

Author: Francisco Javier Riquel Castilla
Sup.: Dr. David Martínez Delgado
Univ.: Valencia International University
Date: 10 Noviembre 2021

Title: "Clasificación morfológica de corrientes estelares"

Author: Juan Emiliano Vejarano Bolívar
Sup.: Dr. David Martínez Delgado
Univ.: Valencia International University
Date: 28 Junio 2021

Title: Estudio de la relación entre el brillo del cielo nocturno y la contaminación por aerosoles en un entorno urbano.

Author: Máximo Bustamante Calabria
Sup.: Susana Martín Ruiz and Alejandro Sánchez de Miguel
Univ.: Valencia International University
Date: 05/07/2021

DEGREE Thesis

Title: Gradientes de metalicidad del gas en galaxias barradas de baja masa

Author: Silvia García Soto
Sup.: Isabel Pérez & Rubén García-Benito
Univ.: Universidad de Granada
Date: 21-07-2021

Courses

Title: Analysis of integral-field spectroscopic data

Teach.: Rubén García-Benito
Prog.: Seminarios de Investigación del Master de Astrofísica
Univ.: Universidad Autónoma de Madrid
Hours: 2
Date: 05-11-2021

Title: Medio interestelar

Teach.: Enrique Perez Jimenez, Angeles Díaz, Elena Terlevich
Prog.: Máster en Física Teórica
Univ.: Universidad Autónoma de Madrid
Hours: 20
Date: January-June 2021

Title: Modern Observational Techniques in Astronomy

Teach.: Mirjana Povic
Prog.: PhD
Org.: Ethiopian Space Science and Technology Institute, Ethiopia
Hours: 6 credit hours (12 ECTS)
Date: Dec/2020-March/2021 and Nov/2021 - Feb/2022

Title: Stellar interior and evolution, and radiation measurements in astrophysics

Teach.: Mirjana Povic
Prog.: MSc
Org.: Ethiopian Space Science and Technology Institute, Ethiopia
Hours: 3 credit hours (6 ECTS)
Date: Dec/2020-March/2021

Title: Observational Techniques in Astronomy

Teach.: Mirjana Povic
Prog.: MSc and PhD
Org.: Ethiopian Space Science and Technology Institute, Ethiopia
Hours: 3 credit hours each (6 ECTS each)
Date: Apr/2021-June/2021

Title: Introduction to Astrophysics

Teach.: Mirjana Povic
Prog.: MSc/PhD
Org.: African School of Physics (ASP)
Hours: 6
Date: July/2021

Press releases



Acces to all news at:

<https://www.iaa.csic.es/en/news>

Title: Técnicas Observacionales en Astrofísica

Teach.: Simon Verley, Alberto Javier Castro
Tirado, Martín Guerrero Roncel
Prog.: Master en Física y Matemáticas (FISyMAT)
Univ.: Universidad de Granada
Hours: 30
Date: February-June 2021

Title: The XXI century radio observatory: the Square Kilometer Array (SKA)

Teach.: Javier Moldón
Prog.: Máster Universitario en Astronomía y Astrofísica
Univ.: Valencia International University
Hours: 2
Date: 02/12/2021

Title: Astrobiología y planetas extrasolares.

Teach.: M. López Puertas
Prog.: Máster Universitario en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
Univ.: Universidad de Granada
Hours: 10
Date: May 2021

Title: Radioastronomía

Teach.: Jose Francisco Gomez, Guillem Anglada, Antonio Alberdi, Angela Gardini
Prog.: Máster en Física y Matemáticas (FISYMAT)
Univ.: Universidad de Granada
Hours: 60
Date: September 2020-March 2021; September 2021-March 2022

Title: Otros Sistemas Solares: Nacimiento planetario

Teach.: Mayra Osorio
Prog.: El sistema solar y la exploración espacial en el aula: potenciando nuevas vocaciones científicas
Org.: Consejería de Educación y Deporte, Junta de Andalucía
Hours: 2
Date: 5 April 2021- 30 May 2021

Title: Origen y evolución de los elementos químicos en el Universo. Parte II.

Teach.: Jose Manuel Vilchez Medina
Prog.: Máster Universitario en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
Univ.: Universidad de Granada
Hours: 10
Date: 7-21 March 2021

Title: Física de detectores

Teach.: Jorge Iglesias Páramo
Prog.: Máster Universitario en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
Univ.: Universidad de Granada
Hours: 15
Date: November 2021

Title: El Cielo desde Sierra Nevada

Teach.: Jose Manuel Vilchez Medina
Prog.: Sierra Nevada: naturaleza y recursos
Univ.: Universidad Internacional de Andalucía, UNIA
Hours: 6
Date: 6-9 September 2021

Title: Aproximación a la Astronomía

Teach.: Miguel Pérez-Torres
Prog.: Programa de formación para mayores de 55 años y jubilados
Univ.: Universidad de la Experiencia de Zaragoza
Hours: 20
Date: March-May 2021

Title: Cosmología y Galaxias

Teach.: Mar Basteiro and Emilio J. Alfaro
Prog.: Máster Universitario en Física: Radiaciones, Nanotecnología, Partículas y Astrofísica
Univ.: Universidad de Granada
Hours: 10
Date: January 2021

Title: Astrofísica Extragaláctica

Teach.: David Martínez Delgado
Prog.: Master Universitario en Astronomía y Astrofísica
Univ.: Valencia International University
Hours: 14
Date: July- October 2021

Oxygen found in the atmosphere of the hottest known exoplanet

22/12/2021

A team with the participation of the IAA-CSIC published the discovery of oxygen atoms in KELT-9b, the first detection of this compound in an exoplanetary atmosphere

Distinct pulses captured in the giant magnetic flare from a neutron star

22/12/2021

In just a tenth of a second, a magnetar -a particularly strongly magnetized neutron star- released energy equivalent to that produced by the Sun in 100,000 years. Its detailed study revealed multiple pulses at the peak of the eruption, which will make it possible to understand these still little-known giant magnetic flares

The dramatic final dance of stars with shared envelope

16/12/2021

The IAA-CSIC participated in the study of fifteen peculiar stars; they turned out to be double stars that, after sharing an envelope, lost a large part of their mass

Double helix structure observed in the jet emanating from the black hole in M87 galaxy

07/12/2021

Produced by the magnetic field, it is the first time that this structure was observed at such far distances from the black hole. The IAA-CSIC participated in the discovery

Giant planets could reach maturity sooner than expected

02/12/2021

The IAA-CSIC participated in the study of the giant planets of the V1298 Tau system, which in just twenty million years already reached their final size. The finding was possible thanks to radial velocity measurements from the HARPS-N spectrograph, at the Roque de los Muchachos Observatory (ORM), and from CARMENES, at the Calar Alto Observatory (CAHA)

The researcher Isabel Márquez and the Outreach Department at the IAA-CSIC, received "Granada Ciudad de la Ciencia y la Innovación" awards"

01/12/2021

The aim of these awards is to recognise and disseminate the excellent scientific activity in the area of Granada.

On fire and in the process of breakind up by its star companion

25/11/2021

Found a system formed by a white dwarf star and a small object, possibly a planet, so close that the second is scorched by the star's radiation, causing its atmosphere to evaporate

Discovery of a possible satellite galaxy of M33, a neighbouring Local Group galaxy

17/11/2021

M33, also known as the Triangle galaxy, is the third largest galaxy in the Local Group, after Andromeda and the Milky Way. The finding was part of the search for the "lost satellites", which tries to resolve the discrepancy between the galaxy formation models and the observations of the Local Group galaxies

New perspectives on the problem of galaxies without dark matter

11/11/2021

The discovery of numerous very low surface brightness galaxies in the environment of NGC 1052 provided a crucial clue to the debate about the lack of dark matter in some galaxies of this group. The new data pointed to the existence of a group of galaxies closer than NGC 1052, to which these anomalous galaxies would belong, and the proximity would solve the problem

Rocco Lico awarded with a 2021 EHT Early Career Award

23/10/2021

Rocco Lico's outstanding contributions to the EHT was recognised in the second annual EHT Early Career and Outstanding PhD Awards for "his dedication and positive contribution to the EHTC's management processes and strategy, recognising his unique talent for combining management activities and innovative science"

Planetary system found similar to the future of the Solar System after the Sun's death

13/10/2021

Scientists from the IAA-CSIC were involved in the discovery of a system formed by a white dwarf star and a planet similar to Jupiter. The discovery, published in Nature, showed that planets can survive the death of their star

Light pollution increased by at least 49% in the last 25 years

27/09/2021

The study only included data from satellites, very limited for the detection of blue light (the most polluting), so that the real increase could amount to 270% globally. The investigation revealed the seriousness of a problem that, according to experts, would worsen if the draft Royal Decree for energy efficiency were approved favouring the use of blue light

Remnants of the historic supernova of 1181 suggested it originated from the merger of two stars

22/09/2021

Chinese and Japanese texts documented the appearance of a supernova in the year 1181, and in 2021 the remnant of that explosion was located

The IAA participated in the development of 'Uchuu', the most accurate and complete simulation of the universe.

14/09/2021

An international team of researchers developed the most realistic simulation of the universe to date. The creation, named Uchuu (which means universe in Japanese) was made possible thanks to ATERUI II (Japan), the most powerful supercomputer in the world, built by the National Astronomical Observatory of Japan (NAOJ) to facilitate the understanding of different astronomical phenomena from a theoretical point of view.

The most detailed images of galaxies were obtained thanks to LOFAR, a network of 70,000 antennas

27/08/2021

The IAA-CSIC headed one of the eleven articles that made up a special issue of the journal Astronomy & Astrophysics on the results of LOFAR. This paper shows the structure of the system Arp 299, which stands out for its high rate of supernova production

New technique to detect, without contact, viruses on surfaces

10/08/2021

Based on the use of hyperspectral images and data processing with advanced statistics and artificial intelligence, it was successfully applied in two synthetic models of SARS-CoV-2. The research, which continues in humans, was funded by the Carlos III Health Institute and made it possible to patent a technique capable of simultaneously analyzing numerous samples without the need for contact or reagents

The Perseid meteor shower arrived

02/08/2021

The Perseids are produced by the impact in our atmosphere of fragments of the meteoroid cloud of Comet 109P / Swift-Tuttle, and are also recorded on the surface of the Moon. During the peak, around August 11, up to fifty perseids per hour could be observed in places away from light pollution

Small force, big effect: how planets can affect the Sun

29/07/2021

The IAA-CSIC is involved in developing a theory that supports the hypothesis that planets affect the Sun's magnetic activity. It shows how the small influence of the planets could set a rhythm in a system like the Sun that, if confirmed, would allow events such as solar storms to be predicted more accurately

The massive star that barely shone upon death

26/07/2021

The IAA-CSIC participated in two articles that disseminated the discovery of the shortest gamma ray burst (GRB) produced by the death of a massive star ever detected

The enigmatic assembly process of the Sombrero galaxy

21/07/2021

The Sombrero galaxy, a strange hybrid between a spiral and an elliptical galaxy, was observed in detail to look for clues about its formation process. Unless a large elliptical structure surrounding the galaxy, probably the result of a minor merger with another galaxy, was characterised, the origin of its shape remains unknown

The Event Horizon Telescope (EHT) pinpointed the central black hole of the galaxy Centaurus A

19/07/2021

The EHT collaboration, in which the IAA-CSIC participates, showed in unique detail the heart of Centaurus A, from which gigantic jets of matter emerge.

MeerKAT discovered a group of galaxies hidden in a well-studied region

15/07/2021

Its abundance of neutral hydrogen suggests that it is a group of galaxies in the process of formation.

CARMENES instrument found two new planetary systems formed by Earths and super-Earths

30/06/2021

The IAA-CSIC led the detection of what, according to the data, is the most common type of planetary systems around dwarf stars, the most common stars in the Milky Way

Noctilucent clouds observed from the Observatory of Sierra Nevada

24/06/2021

Noctilucent clouds were observed from the Sierra Nevada Observatory (OSN) The presence of this type of cloud is considered as an indicator of climate change and for years they have been observed at increasingly lower latitudes. This is one of the first times that they were observed from Granada.

CAIRT mission, with the participation of the IAA-CSIC, candidate for ESA's Earth Explorer 11 programme

18/06/2021

The mission will focus on processes combining atmospheric circulation, composition, space weather and regional climate change, and will provide critical observations not available with existing or planned satellites

IAA researchers published the most detailed star catalogue of the Galactic Centre

08/06/2021

The GALACTICNUCLEUS project makes it possible to study the stellar population surrounding the super-massive black hole at the Galactic Centre in unprecedented detail. The work, led by the IAA-CSIC, offered the most extensive census of stars in the Galactic Core recorded to date

Juice mission prepared for its extreme environmental test

24/05/2021

JUICE, a European Space Agency (ESA) mission to be launched in September 2022, will study Jupiter and its moons to analyse the possibilities for the development of life around gas giant planets. The IAA-CSIC participates in two of the mission's instruments, the GALA laser altimeter and the JANUS camera

Presentation of the project "Hello Earth"

30/04/2021

The IAA-CSIC welcomed the presentation of the project of the musician Antonio Arias based on the poems of the astronaut Al Worden. The project, which had the participation of the Cervantes Institute and the IAA-CSIC, includes an album, a book and a documentary

A method to study distorted white dwarf stars was developed

26/04/2021

The IAA-CSIC led a study to determine the properties of stars that, either because of rapid rotation or because they are in a very compact double system subject to strong tidal forces, showed a flattened shape

OPTICON-Radionet PILOT (ORP), the largest astronomy network in Europe, was born

16/04/2021

Two astronomy networks came together to form the largest collaborative ground-based astronomy network in Europe

What ignites the helium halos of early galaxies remains a mystery

12/04/2021

A study led by IAA-CSIC targetted the galaxy IZw18, an analogue of the first galaxies that appeared in the universe, for understanding the origin of the radiation that produces a helium halo around it

MAAT: new "eyes" for the OSIRIS instrument of the Gran Telescopio Canarias (GTC)

30/03/2021

MAAT, a visiting GTC instrument in the preliminary design phase, planned to bring the technique known as integral field spectroscopy to the OSIRIS instrument

Astronomers Imaged Magnetic Fields at the Edge of M87's Black Hole

24/03/2021

The Event Horizon Telescope (EHT) reached a new milestone in astronomical observation by analyzing M87's supermassive black hole in polarized light

Observed for the first time a jet of gas as it emerges from the central star of a planetary nebula

10/03/2021

Thanks to MEGARA instrument of the Gran Telescopio Canarias, researchers from the IAA-CSIC observed and analyzed the jet of NGC 2392, which points to the existence of a companion star

A Super-Earth well suited for atmospheric studies was found

04/03/2021

The IAA-CSIC participated in the discovery of a planet around the red dwarf star Gliese 486, a system placed at 26 light years from us

Researcher Mirjana Povic received the Jocelyn Bell Burnell Award from the European Astronomical Society

02/03/2021

Researcher at the Ethiopian Institute of Space Science and Technology and a vinculated doctor to the IAA-CSIC, she investigates the formation and evolution of galaxies. She works in the development of science and education in Africa, with a special focus on the role of women, with projects in Ethiopia, Uganda, Rwanda, Tanzania, South Africa, Kenya and Ghana

The Exoplanet Revolution

23/02/2021

Didier Queloz, 2019 Nobel Prize in Physics for the discovery of the first exoplanet around a star similar to the Sun, will give a seminar on the planetary systems found to date and their implications for our vision of the universe

The IAA Advanced School of Planetary Systems, open to the public

15/02/2021

Organized within the framework of the IAA Severo Ochoa-IAA project, it addresses our knowledge of exoplanetary systems from a broad and updated context

ExoMars mission discovered new gas and tracks water loss on Mars

10/02/2021

The ExoMars-TGO orbiter, from the European Space Agency and Roscosmos, found hydrogen chloride in the Martian atmosphere, produced by the release of salt embedded in the planet's surface. The ExoMars data also allowed quantifying the loss of water on the red planet and establishing the mechanisms that contribute to the process

The largest radioastronomy observatory in the world, SKAO, was born

04/02/2021

Spain is among the participating countries in the SKA Observatory (SKAO), an intergovernmental organization that will open a new era in radioastronomy. The Minister of Science, Pedro Duque, highlighted it as a milestone that will revolutionize astronomy and other scientific and technological fields. Spanish participation in SKA is led by the IAA-CSIC

A "magnifying glass" looked at one of the largest known centaurs

03/02/2021

Thanks to a stellar occultation, a research led by IAA-CSIC was able to determine the characteristics of 2002 GZ32, a centaur with a diameter of almost 400 km on its major axis. Known for more than forty years, little information is available about this group of icy objects orbiting the Sun between the orbits of Jupiter and Neptune

The IAA developed a study showing a decrease in light pollution in Granada during confinement

19/01/2021

Although similar studies were carried out in other countries, this is the only one that obtained results thanks to the combination of observations from satellite and from the ground

A study of the radio emission of Proxima Centauri, the closest planetary system, opened a new path for the study of exoplanets

14/01/2021

Researchers from the IAA-CSIC led an ambitious radio observation project showing that extrasolar planets can be detected with radio telescopes

List of publications



Acces to all entries at:

<https://www.iaa.csic.es/en/publications>

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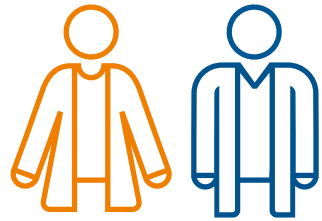
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Visiting scientists



INVITED

Dmitry Blinov

Foundation for Research and Technology Hellas. Greece
12/11/2021 - 14/12/2021

Carolina Casadio

Foundation for Research and Technology Hellas. Greece
12/11/2021 - 14/12/2021

Arianna Cortesi

Observatório do Valongo. Brasil
08/11/2021 - 08/02/2022

Ana Karla Díaz Rodríguez

University of Manchester. UK
12/07/2021 - 20/08/2021

Rubén López Coto

Istituto Nazionale di Fisica Nucleare. Italy
01/12/2021 - 31/05/2022
01/04/2021 - 30/06/2021

Joel Sánchez Bermúdez

Universidad Nacional Autónoma de México. Mexico
25/10/2021 - 15/12/2021

LONG VISITS

Vieri Bartolini

Università di Bologna. Italy
02/03/2021 - 02/07/2021

Valentin Boyanov Savov

Universidad Complutense de Madrid. Spain
04/08/2021 - 27/08/2021
28/06/2021 - 21/07/2021
12/04/2021 - 12/05/2021
22/02/2021 - 31/03/2021

Michael James Francis

University of Exeter. UK
01/09/2021-31/08/2022

Gerardo García Moreno

Universidad Complutense de Madrid. Spain
20/12/2021 - 23/12/2021
03/11/2021 - 19/11/2021
18/10/2021 - 29/10/2021
16/09/2021 - 15/10/2021
10/05/2021 - 31/05/2021

Angela Gardini

Universidad de Granada. Spain
21/10/2019 - 31/08/2021

Valentin Michel

ENSTA - Institut Polytechnique de Paris, France
18/05/2021 - 08/08/2021

David Eduardo Millán Calero

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

Sabela Reyero Serantes

Univ. de Salamanca. Spain
12/04/2021 - 20/07/2021

Flavia Rommel

Observatorio Nacional de Rio de Janeiro. Brasil
14/09/2021 - 31/12/2021

David Rosado Belza

Instituto de Astrofísica de Canarias (IAC). Spain
18/11/2021 - 09/04/2022

Tianrui Sun

University of Shanghai. China
05/04/2021 - 04/04/2022

Shimeles Terefe Mengistue

Ethiopian Space Science and Technology Institute. Ethiopia
28/08/2021 - 25/12/2021

SHORT VISITS

Roldán Alonso Cala Barón

Universidad de Granada. Spain
18/05/2021 - 18/05/2021

Miguel Cano González

Universidad de Oviedo. Spain
07/12/2021 - 15/01/2022

Alejandro Manuel Cardesin Moinelo

ESAC. Spain
02/11/2021 - 02/12/2021
06/09/2021 - 24/09/2021

Aline Chu

Institut d'Astrophysique de Paris. France
14/10/2021 - 24/10/2021

Miriam Cisneros

Royal Belgian Institute for Space Aeronomy. Belgium
13/10/2021 - 21/10/2021

Gabriele Columba

Università di Padova. Italy
05/11/2021 - 24/11/2021

Ana Karla Díaz Rodríguez

Universidad de Granada. Spain
23/12/2020 - 10/01/2021

Carlos Humberto Domínguez Tagle Paredes

Instituto de Astrofísica de Canarias (IAC). Spain
24/05/2021 - 28/05/2021

Chi An Dong Paez

University of Cambridge. UK
08/07/2021 - 30/07/2021

Ruben Fedriani

Chalmers University of Technology. Sweden
13/12/2021 - 17/12/2021

Gabriella Gilli

Instituto de Astrofísica e Ciências do Espaço. Portugal
27/05/2021 - 31/05/2021

Lorena Hernández García

Universidad de Valparaíso. Chile
05/09/2021 - 10/09/2021

Kelley Michelle Hess

ASTRON. Netherlands
04/10/2021 - 11/10/2021

Steffen Hess

ASTRON. Netherlands
11/07/2021 - 17/07/2021

Ángel Luis Huelmo Iglesias

Central nuclear de Almaraz. Spain
06/03/2021 - 14/03/2021

Luca Izzo

Dark Cosmology Centre - Univ. of Copenhagen. Denmark
28/06/2021 - 01/07/2021

Santiago Jiménez Corral

Universitat de València. Spain
21/05/2021 - 21/05/2021

Guillermo Manjarrez Esquivel

Universidad de Granada. Spain
04/06/2021 - 04/06/2021

Paola Marziani

INAF. Italy
31/10/2021 - 15/11/2021

Alejandro Mus Mejías

Universitat de València. Spain
27/09/2021 - 01/10/2021

Francisco Noguerras Lara

Max Planck Institute for Astronomy
08/11/2021 - 12/11/2021

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Centro de Astrobiología, INTA-CSIC. Spain
01/12/2021 - 03/12/2021

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Istituto Astrofisica e Planetologia Spaziali. Italy
28/06/2021 - 02/07/2021

Conrad Schwanitz

ETH Zurich. Switzerland
04/10/2021 - 08/10/2021

Efthalia Traianou

Max Planck Institute for Radioastronomy. Germany
12/05/2021 - 15/05/2021

Huib Van Langevelde

Joint Institute for VLBI in Europe. Netherlands
09/11/2021 - 11/11/2021

Maciek Wielgus

Max Planck Institute for Radioastronomy. Germany
13/12/2021 - 21/12/2021

In memoriam



José María Jerónimo, Chema in the IAA and Pepe for his family, has been and is an inseparable part of the IAA since his incorporation in 1981. His knowledge in electronics and his good manners of working have been collected in successive space exploration projects among which it is worth mentioning from the development of rocket payloads for the study of the upper atmosphere to his participation in NOMAD-Exomars, through HASI in Huygens and in GIADA, on board Rosetta, and the PLATO mission.

The results of his work are physically present on Earth, Titan, the surface of comet Churyumov-Gerasimenko and on two spacecraft orbiting Mars, but above all they are and will continue to be among those of us who have had the good fortune to have known him and shared a multitude of experiences over these almost 40 years.

Who can offer so much?

José Juan López Moreno
Ad Honorem Professor (IAA-CSIC)