

**INSTITUTE
OF SPACE
SCIENCES**

Annual Report 2025

INSTITUTE OF SPACE SCIENCES

Annual Report 2025

An institute of the Spanish National Research Council (CSIC) affiliated with the Institut d'Estudis Espacials de Catalunya (IEEC). A 'María de Maeztu' Unit of Excellence.



Institute of
Space Sciences



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The ICE-CSIC 2025 Annual Report is the result of a collective effort of the ICE-CSIC personnel. We would like to thank everyone that contributed to the report.

For any communication related to this work, please contact:

Institute of Space Sciences (ICE-CSIC)

Campus UAB

Carrer de Can Magrans, 08193

Cerdanyola del Vallès, Barcelona

937 37 97 88

info@ice.csic.es

www.ice.csic.es

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Foreword

Reflecting on 2025, I feel deeply proud of everything that ICE-CSIC has achieved over the past year. Beyond the many scientific results, projects and activities described in this report, this year has represented an opportunity to reflect on who we are as an Institute and the direction in which we want to continue moving forward.

The celebration of the Institute's 25th anniversary in February 2025 was undoubtedly one of the defining moments of the year. Bringing together different generations of ICE-CSIC members reminded us that the Institute we have today is the result of decades of collective effort, ambition and commitment to scientific excellence. It was also an opportunity to recognise the people who have contributed to building a vibrant, international and collaborative research environment.

During 2025, ICE-CSIC continued to grow and evolve. The consolidation of our new scientific structure, the incorporation of new staff members and students, and the strengthening of our technological capabilities all reflect an Institute that remains dynamic and forward-looking.

Scientifically, this has been another outstanding year. Our researchers have continued contributing to major international collaborations, advancing our understanding of the Universe and of our own planet. The increasing relevance of ICE-CSIC in large-scale space missions and international observatories demonstrates the trust that the scientific community places in the expertise, creativity and commitment of our teams.

Equally important has been our continued investment in early-career researchers and in the next generation of scientists and engineers. Welcoming new PhD students, celebrating completed doctoral theses, and maintaining a strong programme of scientific meetings and training activities are essential parts of the Institute's long-term vision.

All these accomplishments are possible thanks to the dedication and talent of the people who make up ICE-CSIC. I would like to sincerely thank our researchers, engineers, technical and administrative staff, students, collaborators and supporters for their work throughout the year.

After celebrating our first 25 years, we look ahead with optimism and ambition. The challenges facing astrophysics, cosmology, and Earth observation are extraordinary, and ICE-CSIC is well positioned to continue contributing at the highest international level in the years to come.



Aldo Serenelli, ICE-CSIC Director.
Credits: Xavier Lapuente/ICE-CSIC.

Aldo Serenelli, ICE-CSIC Director

1. ICE-CSIC at a glance

1.1. Overview and Mission

The Institute of Space Sciences (ICE-CSIC) is a research centre from the Spanish National Research Council (CSIC) that develops cutting-edge research in space sciences.

ICE-CSIC's research is focused on developing theoretical models and technologies to understand the Universe we live in, how it formed and evolved, and how it behaves. In this quest to solve the most challenging mysteries of the Universe, ICE-CSIC also uses space technologies to understand more about our planet Earth, to better model its climate change, and to develop predictive tools that could help avoid the effects of natural disasters.

ICE-CSIC achieved the María de Maeztu seal of excellence for the period 2022-2026, a recognition of its standing among the most important research centres in the country. ICE-CSIC also articulates CSIC's participation in the Institut d'Estudis Espacials de Catalunya (IEEC).

Located at the campus of the Universitat Autònoma de Barcelona in Bellaterra (Barcelona), ICE-CSIC comprises a diverse and international team of over 150 researchers, engineers and support staff.



ICE-CSIC building.

Credits: César Hernández/CSIC Comunicación.

1.2. ICE-CSIC in 2025

2025 was another outstanding year for ICE-CSIC, marked by major scientific achievements, institutional milestones, and continued growth across the Institute.

The year opened with the celebration of ICE-CSIC's 25th anniversary conference in February. Under the theme "25 Years of Discovery and Innovation", members of the Institute gathered for three days at the Residència d'Investigadors in Barcelona to reflect on the past, present, and future of the centre. The conference provided an opportunity to review the Institute's evolution, highlight current research, and discuss future directions across a broad range of topics in astrophysics and space science. As ICE-CSIC looks ahead to the coming decades, the meeting reaffirmed the Institute's commitment to scientific excellence and collaboration.

Explore

ICE-CSIC 25th Anniversary Conference



Group picture of the ICE-CSIC 25th anniversary conference.
Credits: ICE-CSIC.

On 3–5 February 2025, ICE-CSIC commemorated its 25th anniversary with the conference "Institute of Space Sciences: 25 Years of Discovery and Innovation", held at the Residència d'Investigadors in Barcelona. The programme opened with remarks by Director Aldo Serenelli, alongside representatives from ICREA and CSIC, and included contributions from former directors Jordi Isern and Diego F. Torres. Presentations by department heads, the Advanced Engineering Unit and invited speakers highlighted the breadth of research conducted at the Institute, while a dedicated session revisited its early years.

The second and third days focused on the Institute's ongoing research and future challenges. Scientific sessions covered a wide range of topics, including exoplanets, Earth observation, high-energy astrophysics, multi-messenger astronomy, instrumentation and space missions. A round table addressed forthcoming scientific and technological challenges, reinforcing the Institute's forward-looking perspective. The conference concluded with closing remarks by Aldo Serenelli, who acknowledged the contributions of ICE-CSIC members over the past 25 years. Overall, the event highlighted the Institute's strong commitment to excellence, collaboration and innovation, positioning it to continue advancing the frontiers of astrophysics and space sciences.

Following the restructuring of the four ICE-CSIC Departments in 2024, the scientific groups within these departments were reorganised during 2025 into a total of eleven research groups (see Section 2 for further details).

The Institute continued to grow throughout the year, reaching a total of 168 ICE-CSIC personnel as of 31 December 2025. Three new permanent staff members joined the Institute: Daniela Hadasch and Tony Mroczkowski as Faculty members, and David Roma as Tecnólogo in the Advanced Engineering Unit. In July, the Institute's manager, Àngels Benet retired after nine years of dedicated service. Since joining ICE-CSIC in 2016 until her retirement, she was instrumental in the development and consolidation of ICE-CSIC. After a year working alongside her in preparation for the transition, Xavier Mestre assumed the role of Institute Manager.

Research carried out at ICE-CSIC continued to deliver outstanding results across several areas of astronomy and Earth observation, with a total of 527 refereed publications produced by Institute researchers. Among the highlights were the publication of the largest synthetic galaxy catalogue to date by the Euclid Consortium (Castander et al. 2025); the first detection of a long-period transient object in X-rays, potentially pointing to new physics or novel stellar evolution models (Wang et al. 2025); a comprehensive study of the asteroid 2023 CX1 that disintegrated over France in 2023, opening new perspectives for planetary defence (Egal et al. 2025); the detection by the Einstein Probe of an X-ray flash from a massive binary star system, offering new insights into how massive stars interact and evolve (Marino et al. 2025); the application to gamma-ray pulsars of analytical methodologies commonly used in finance and medicine (García & Torres 2025); and new results from the DESI collaboration strengthening indications that dark energy may evolve over time (DESI Collaboration 2025).

The year was also particularly significant for the space missions in which ICE-CSIC participates. In March, the Euclid Consortium, in which the Institute plays a leading role, published its first Quick Release (Q1), accompanied by 34 scientific and technical papers. A second set of seven publications followed in November, based on early Data Release One (DR1) data, presenting important advances including new studies of galaxy morphology and strong gravitational lensing. Meanwhile, LISA, the first gravitational-wave observatory in space, continued its implementation phase with a planned launch in 2035. During 2025 the mission's prime contractor formally began activities and initiated a co-engineering phase with the different subsystems. Among them is the Science Diagnostics Subsystem, responsible for monitoring and characterising environmental disturbances and



Àngels Benet giving a speech at her retirement party.
Credits: ICE-CSIC.

led by ICE-CSIC as part of the Spanish contribution to the mission. ICE-CSIC researchers were also involved in the development of ILIADA (*In-Orbit LISA Diagnostics Demonstrator*), a LISA technology demonstrator selected to fly aboard the GENE0-02 CubeSat, a satellite promoted within the Generalitat de Catalunya's NewSpace strategy and expected to be launched in 2026. The year also witnessed the launch of ESA's HydroGNSS mission, which will provide key observations of humidity, freezing conditions, flooding, and biomass, contributing to a better understanding of the water cycle and the impacts of climate change. Moreover, ICE-CSIC won the tender to develop and implement the first Spanish Earth Observation constellation of satellites, called Atlantic Constellation. ICE-CSIC leads the activity related to the GNSS-R payload.

Important milestones were also reached in the ground-based observatories in which ICE-CSIC participates. In January 2025, the European Commission established the Cherenkov Telescope Array Observatory (CTAO) as a European Research Infrastructure Consortium (ERIC), marking a major step toward becoming the world's most powerful observatory for gamma-ray astronomy. Later in the year, the agreement between the Barcelona-Madrid consortium and Rubin-LSST was formally signed, making all consortium members, including ICE-CSIC, official participants in the LSST collaboration.

The ICE-CSIC Advanced Engineering Unit (AEU) developed in 2025 several improvements of ICE-CSIC's laboratories to offer better services to the engineers and experimental researchers working at the Institute. A major development was the acquisition and installation of a new thermal vacuum chamber

in the Optical Laboratory, enabling controlled simulations of space conditions with pressures down to 10^{-7} mbar and temperatures ranging from -85 to 220 °C, together with a highly dynamic temperature control system. The installation required several modifications to the Optical Laboratory, including the addition of extraction systems in the technical room to dissipate heat generated by the heat exchange systems. These facilities have been essential for the development of the ILIADA project. Additional improvements included the renovation of the humidity control and cooling systems in the building's server room, allowing improved regulation of humidity, temperature and airflow in the Clean Room. In preparation for the calibration work related to the visible sensor of the ARRAKHS mission, both the Clean Room and the Optical Laboratory were renovated. The Payload Laboratory was upgraded with a new four-channel oscilloscope and a thermal camera, while the Mechanical Laboratory acquired a new mechanical lathe capable of polishing resonators and machining pieces in the 5–30 cm size range. Finally, the Institute's

telescope was upgraded with an ASKAR 52M guide tube and a new refrigerated CCD camera.

The technological activities at ICE-CSIC have led to the registration of one software trade secret for a high-precision temperature measurement system at low frequencies.

ICE-CSIC continued to foster the development of international students and early-career researchers through its Master's and PhD training programmes. During 2025 the Institute welcomed 11 new PhD students, bringing the total number of doctoral researchers to 47 as of 31 December. Ten students successfully defended their doctoral theses during the year: Cristian Nery Viglione, Iván Martín, Bo Huang, Carlos Rodríguez, Wei Zhang, Albert Elias, Jilun Peng, Nariman Nakhjiri, Clàudia Soriano and Julen Untzaga. The 8th ICE-CSIC Summer School welcomed 48 students from 17 countries for two weeks of training in observational cosmology delivered by leading experts.

Explore

Highlights New national and European projects



LUNANOVA | ERC Synergy Grant - 2.5 M€ - PI Aldo Serenelli

The LUNANOVA ERC-Synergy project, with a total budget of 14M€ and a 2.5M€ contribution to ICE-CSIC, is focused on studies of nuclear astrophysics for the Sun and solar-like stars. LUNANOVA will install and operate a new, dedicated underground ion accelerator for solar fusion, LUNANOVA, at the INFN Gran Sasso lab. Coupled with additional experiments in Germany and Italy, the LUNANOVA data will be used to develop novel models of the Sun and solar-like stars.



Ópticas y bancos de filtros para cosmología submilimétrica | ATRAE Programme - 998 K€ - PI Tony Mroczkowski

The "Ópticas y bancos de filtros para cosmología submilimétrica" project aims to develop optics, filters, and filter banks applicable to AtLAST and other telescopes operating in submillimeter cosmology. This technology will leverage pulsars to function as a GPS system, with potential applications both within the solar system and in deep space.

The year was also highly successful in terms of research funding. In total, 41 new projects were awarded, representing a total funding of 7.90 million euros. These included an ERC Synergy Grant, an ERC Proof of Concept Grant, an ATRAE Grant, and five projects funded under the Spanish National Plan.

ICE-CSIC hosted six international workshops and scientific meetings during the year, including meetings dedicated to the ARRAKHS, Euclid and LISA missions. The Institute also organised eight colloquia featuring internationally recognised experts. A special highlight was the Christmas Special Seminar Artificial Intelligence: From Myth to Real Impact delivered by Carles Sierra, director of the Artificial Intelligence Research Institute (IIIA-CSIC).

The Institute also maintained its tradition of weekly Pizza Seminars, organising 33 sessions throughout the year with speakers from both inside and outside the Institute, covering a wide range of topics in astronomy and space sciences.

ICE-CSIC researchers received several national and international recognitions in 2025. Francisco. J. Castander was appointed scientific representative for Cosmology on the Spanish National Astronomy Commission, while Nanda Rea was selected to serve on the Senior Science Committee supporting the preparatory phase of the European Southern Observatory's Expanding Horizons programme, which aims to identify the key scientific challenges European astronomers will face in the 2040s and the type of transformational ground-based facilities required to address them. Estel Cardellach was nominated member of the Spanish Space Agency (AEE) Science and Technology Committee, a consultative and advisory collegiate body.

Individual recognitions were also awarded to ICE-CSIC researchers. Estel Cardellach received the Muncunill Award for Honorary Innovation for her contributions to the study of our planet, as well as the Terrassenca of the Year 2025 Prize. Researchers involved in the Fermi and DES collaborations were also honoured with the Giuseppe and Vanna Cocconi Prize and the Berkeley Prize, respectively.



Euclid's view of the Cat's Eye Nebula.

Credits: ESA/Euclid/Euclid Consortium/NASA, image processing by J.-C. Cuillandre, E. Bertin, G. Anselmi.



Group picture science fair in Igalada in June 2025 organised within the framework of the Magnet Alliance activities.
Credits: ICE-CSIC.

From 2021 to 2025, ICE-CSIC partnered with the Gabriel Castellà i Raich school located in Igalada (Barcelona) within the framework of a Magnet alliance. This programme, led by Equitat.org Foundation (formerly BoFill Foundation), aims to fight school segregation in Catalonia. This has been the institute's largest outreach initiative, with an involvement of a quarter of the Institute's personnel.

Inspired by the US model of Magnet schools, the collaboration between an educational centre and a remarkable institution allows the educational centre to develop an innovative and high-quality educational project to become a benchmark educational project in its location, both for the families and for the educational community.

Under the motto "A school, a Universe of learning", the alliance created innovative and engaging scientific projects. ICE-CSIC members acted as advisors and gave specific training for teachers as they contributed to design scientific projects while working alongside the programme's educator and the school staff.

The outcome has been very diverse: talks and workshops at the school, co-creational projects, a theatre performance about the solar system, a podcast, a project about sunspots observation, a project about the life in Mars, etc. In addition, we participated in broader initiatives open to the city like the European Researchers' Night, with talks by the institute's researchers, solar observations and activities prepared by the students, and the International Day of Women and Girls in Science.

In order to reach the local community, the school welcomed families and students from other schools to attend activities. We fostered community engagement in Igalada through public talks by ICE-CSIC researchers at a local bar, inspired by the Pint of Science initiative. Another highlight of the alliance was the online presentation of the book *Viajes espaciales*, by former astronaut and Minister of Science Pedro Duque.

During this collaboration, ICE-CSIC contributed to the design of LAB 2-6, a laboratory offering a range of challenges and scientific experiences for 2-6-year-old children, aiming to awaken interest in science from an early age in a playful environment.

ICE-CSIC also maintained its strong commitment to outreach and public engagement. During 2025 we reached the end of the 4-year Magnet Alliance with the Gabriel Castellà i Raich school in Igalada (Barcelona) to fight school segregation; we opened the Institute to school's visits every month in the framework of the Escolab project; we strengthened our commitment with inclusive actions with a special audiovisual campaign for social media around the International Day of Women and Girls in Science; and participated in major science outreach festivities in the region such as Festa de la Ciència 2025 in Barcelona, and the European Researchers' Night.

Key figures

in 2025

- Members (as of 31 December 2025)
- International members
- New faculty members



527

peer-reviewed publications

85%

of publications in 1st quartile journals

2

publications in Nature

7

publications in Nature Astronomy

4,164

TOTAL CITATIONS

114

Active projects

7.90 Million

EUR funding new projects

33

Pizza seminars

4

AWARDS



23

Press releases



327

Media impacts in Spanish media



274,353

People reached by ICE-CSIC communication actions



1,658 million

People extended reach with media coverage

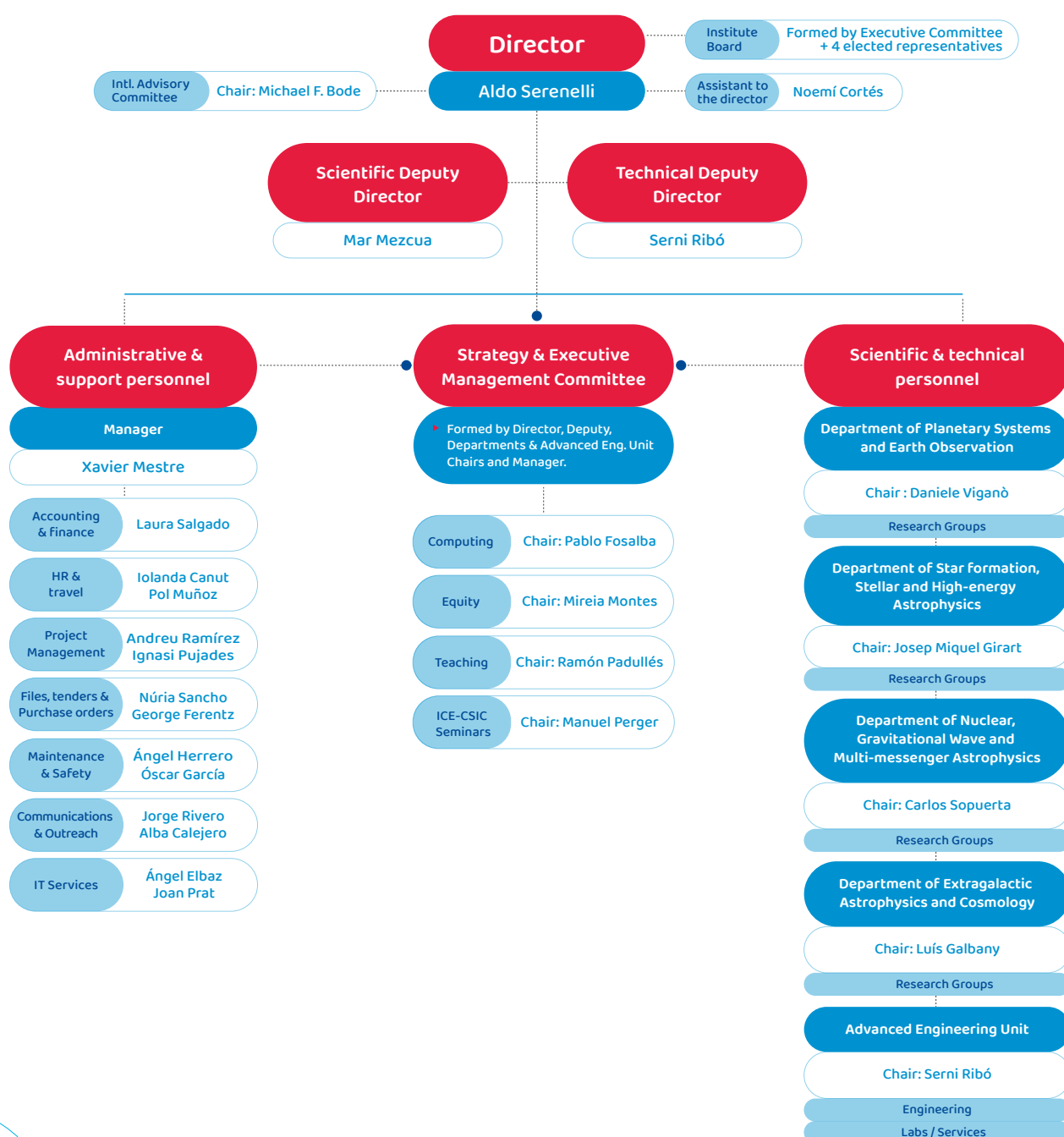
41

New projects

2. Management

ICE-CSIC is organised in four departments: Planetary systems and Earth Observation; Star formation, Stellar and High-energy Astrophysics; the Nuclear, Gravitational Wave and Multi-messenger Astrophysics; and Extragalactic Astrophysics and Cosmology. In addition, there is a technical unit, the Advanced Engineering Unit (AEU), which ensures the development of the Institute's technological research lines and assets and supports the technological needs of the four aforementioned departments. At a formal scientific level, there are about 11 research groups at the Institute, typically composed of about 10+ members, with 2-4 faculty in each of them. Research groups are indeed fluid at ICE-CSIC, and it is common to see cross-interaction among members of different formal groups, even of different departments, as the Institute focuses on around twenty research lines.

Besides these scientific units, three formal bodies structure the centre: the Director's Office, the Board, and the Strategy Committee. Finally, we have several other committees aimed to coordinate different aspects of the Institute.



2.1. Departments

2.1.1. Planetary Systems and Earth Observation

The Planetary Systems and Earth Observation Department works on theoretical, observational and experimental projects and missions the objectives of which span from boosting the knowledge of our planet using spaceborne techniques to the discovery and characterisation of planetary systems around other stars, or the study of the secrets contained in asteroids, comets and meteorites, with clues on the accretionary processes occurred in our planetary system.



Research groups

- Exoplanets and stars
- Earth observation, asteroids, comets and meteorites

2.1.2. Star formation, Stellar and High-energy Astrophysics

The research in the Star Formation, Stellar and High-energy Astrophysics Department is focused on the physical processes associated with stars, from their formation in the densest regions of the interstellar medium, through their evolution and death, including the stellar final remnants (white dwarfs and neutron stars). The research covers the full electromagnetic spectrum, with special focus on the highest (Gamma and X-rays) and lowest (Infrared and Radio) energy regimes. The department is also involved in the development of instrumentation and software solutions for ground- and space-based high energy astrophysical facilities.

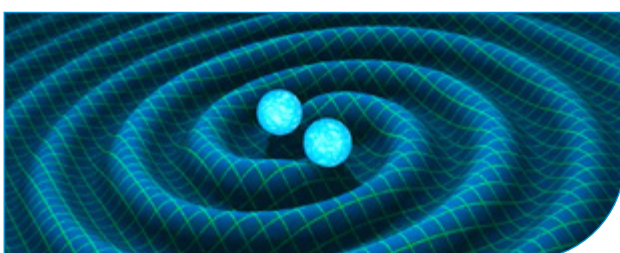


Research groups

- Star and planet formation

2.1.3. Nuclear, Gravitational Wave and Multi-messenger Astrophysics

The primary scientific goal of the Nuclear, Gravitational Wave and Multi-messenger Astrophysics Department is to do research in nuclear physics, gravitational wave physics and in multi-messenger astrophysics with the goal of understanding compact objects like neutron stars, black holes, and the nature of the gravitational interaction. To that end, we carry out observational and theoretical studies that include multi-messenger observations and the development of instrumentation. Regarding observations we mainly use, but are not limited to, X-ray and gravitational waves.



Research groups

- Nuclear and High energy Astrophysics
- Multi-messenger Astrophysics
- Gravitational astronomy - LISA
- Nuclear and Astroparticle Physics
- Extreme compact objects in the transient multi-messenger sky

2.1.4. Extragalactic Astrophysics and Cosmology

The Extragalactic Astrophysics and Cosmology Department investigates the fundamental laws and origins of the Universe, using observational data and models to answer foundational cosmological questions. Our research spans early-Universe evolution, modified gravity, galaxy formation, and large-scale cosmic structure. We study supernovae as both probes for stellar death and as tools for measuring cosmic distances and expansion, and massive black holes, exploring their roles in shaping galaxies and their environments. By combining theoretical and observational approaches, we aim to clarify the complex mechanisms governing the Universe's structure, blending simulations with experimental data for a comprehensive understanding of cosmic evolution.



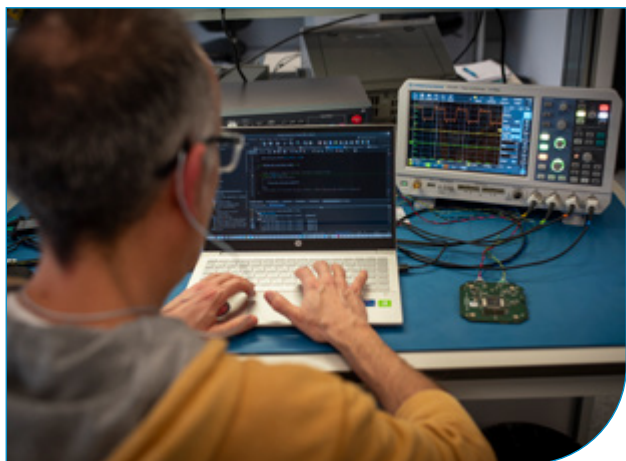
Research groups

- AGN and Galaxy Astrophysics
- Observational and Theoretical Cosmology
- Supernovae and stellar transients

2.2. Advanced Engineering Unit

The Advanced Engineering Unit (AEU) does overall management and supports the development of the Institute's technological research lines and assets. The AEU is responsible for providing ICE-CSIC's technological expertise that allows the Institute to participate in the development of new missions and astronomical observatories.

This unit works together with project's Principal Investigators to support the development of the technological aspects of the project, including the strategic value of keeping the know-how for future projects. Among other tasks, AEU members support ICE-CSIC staff with the design, implementation and testing of electronic hardware, software and mechanical parts. The AEU also runs the laboratories of the Institute.



AEU Laboratories

- Payload Laboratory
- Integration Laboratory
- Astronomy Laboratory
- Clean Room
- Microscopy Clean Room
- Optical Laboratory
- Radiation Laboratory
- Mechanical Laboratory

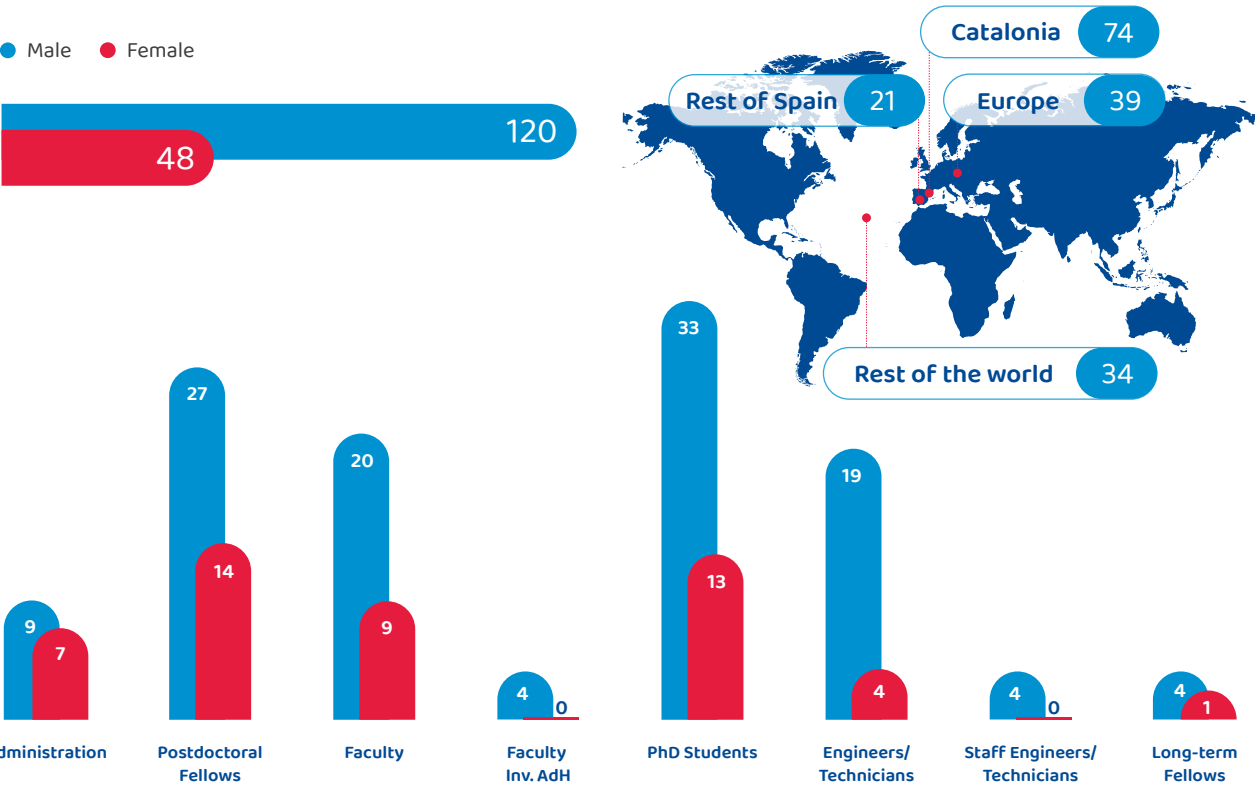
3. People

We are a diverse and international team of researchers, engineers and support staff. As of 31 December 2025, there are 168 people working at ICE-CSIC. This is an increase of 4,3% in comparison with the end of 2024.



ICE-CSIC PhD student Xavier Canalda (left) and ICE-CSIC Vice Director for Technology Serni Ribó (right) working with Project Mirror's drone.
Credits: ICE-CSIC.

3.1. Personnel



Administration

Benet, Àngels (until June 2025)
Calejero, Alba
Canut, Iolanda
Cortés, Noemí
Elbaz, Àngel
Ferentz, George Dorin

García, Óscar
Herrero, Àngel
Mestre, Xavier
Pérez, Isabel
Pino, Cristina (until September 2025)
Pujadas, Ignasi

Prat, Joan
Ramírez, Andreu
Rivero, Jorge
Ruiz, Fina
Salgado, Laura
Sancho, Núria

Postdoctoral Fellows

Ashkar, Halim
Casas, Ricard (until July 2025)
Celora, Thomas
De Grandis, Davide
De Sarkar, Agnibha
Estellés, Héctor
Giannini, Giulia
Gomes, Nuno
Goy, Valentín
Gouyou Beauchamps, Sylvain
Gutiérrez, Claudia
Han, Ilseung
Herrera, Yago (until July 2025)
Izquierdo, David
Khurshudyan, Martiros (until April 2025)
Imbrogno, Matteo

Kopsacheili, Maria
Kovlakas, Konstantinos (until March 2025)
Liao, Li Wen
Le Gouellec, Valentin
Marino, Alessio
Martín Vílchez, Iván
Mestre, Enrique
Meyer, Dominique Marc Antoine
Morales, Juan Carlos
Morata, Oscar (until July 2025)
Nèmec, Nina
Noll, Anthony
Parent, Emilie
Parimbelli, Gabriele
Perger, Manuel
Psaridi, Angeliki

Radinovic, Slađana
Ramakrishnan, Sujatha
Ravasio, María
Renard, Pablo
Ronchi, Michele (until April 2025)
Säppi, Saga
Sato, Asako
Sengupta, Soumya
Tabernero, Hugo
Tanious, Maxime
Tutusaus, Isaac
Veresvarska, Martina
Vidal, Verònica
Xu, Yerong
Zennaro, Matteo

Faculty

Anglada-Escudé, Guillem
Cardellach, Estel
Castander, Francisco Javier
Crocce, Martin
Elizalde, Emilio (Inv. AdH)
Fosalba, Pablo
Galbany, Lluís
Gaztañaga, Enrique
Girart, Josep Miquel
Hadasch, Daniela
Hernanz, Margarita

Husa, Sascha
Isern, Jordi (Inv. AdH)
Kemper, Francisca
Li, Weiqiang
Manuel, Cristina
Maury, Anaëlle
Mezcua, Mar
Mroczkowski, Tony (ATRAE Grantee)
Nofrarias, Miquel
Odintsov, Sergei D.
Patruno, Alessandro

Rea, Nanda
Ribas, Ignasi
Ribó, Serni
Rius, Antonio (Inv. AdH)
Serenelli, Aldo
Sopuerta, Carlos
Tolós, Laura
Torrelles, José María (Inv. AdH)
Torres, Diego F.
Trigo-Rodríguez, Josep M.
Viganò, Daniele

Staff Engineers/Technicians

Cirera, Josep Maria	Martín, Víctor
Gálvez, José Luis	Roma, David

Long-term Fellows

Alarcon, Alex	Montes, Mireia	Sánchez-Monge, Álvaro
Coti Zelati, Francesco	Padullés, Ramon	

Engineers/Technicians¹

Aguilar, Eduard (until April 2025)	Chumillas, Alejandro	Pérez, Ana
Álvarez, Daniel	Herencia, Daniel	Salvans, Josep
Ballber, Pau	Karimbu-Vallappil, Arshad (until January 2025)	Serrano, Santiago
Boltà, Helena	Komorowski, Przemyslaw	Serrano, Daniel
Campos, Néstor	Martí, Laura	Sisteré, Sofia
Canal, Miquel (until February 2025)	Montoro, Álvaro	Soldevila, David
Canalda, Xavier	Nakhjiri, Nariman	Tomás, Álex
Carmona, Alex	Oliveras, Santiago	Vallés, Ramon
Costa, Jan Marc		Verderi, Axel

PhD Students

Alburai, Alaa	Fernández de Alarcón Muguruza, Pablo	Phan, Kim
Aleman, Marc	Gambardella, Giosuè	Porqueras, Óscar
Anguera, Alèxia (until November 2025)	Gonzalez Bañuelos, Maider	Pirvu, Rebeca
Baghkhan, Zahra	González, Guillermo	Rodríguez, Carlos
Blanco, Jordi	Grèbol, Pau	Rodríguez, Víctor
Blázquez, Carles	Gualani, Vivek	Sanfeliu, Ramón
Brandoli, Francesco	Hernández, José Luis	Soriano, Clàudia (until November 2025)
Camacho, Gisela	Huang, Bo (until October 2025)	Stucki, Sophie
Chen, Ke	Íñiguez, Daniel	Torki, Maryam
Çoban, Ömer Faruk	Jiménez, Cristina	Untzaga San Vicente, Julen (until February 2025)
Coloma Nadal, Jose María	Kaur, Simranpreet	Wan, Yiqing
D'Onofrio, Simone	Li, Runchuan	Wang, Yilong
Díaz, Pedro	Miao, Hao-Yu	Zhao, Zihao
Díaz, Elena	Moras, Alba	Zhang, Wei (until September 2025)
Du, Hao	Pardo, Celsa	Zhou, Xin
Elias, Albert (until September 2025)	Paz, Antía	Zuleta, Andrés
Eróstegui, Alejandro	Pedretti, Marie	
Fernández, Eloi	Peng, Jilun (until October 2025)	

¹ Xavier Canalda and Daniel Serrano are also doing their PhD theses at ICE-CSIC, see Section 7.2.

3.2. New Faculty Members

Daniela Hadasch

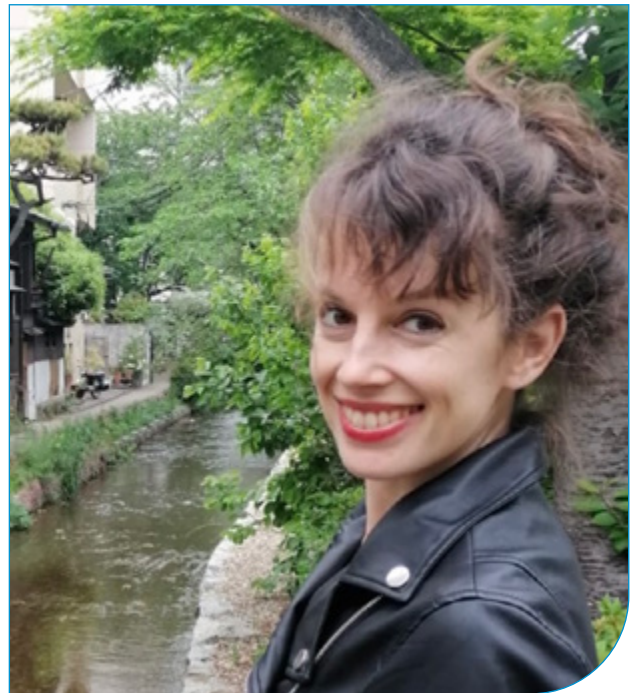
Daniela Hadasch is an observational high-energy astrophysicist whose research focuses on non-thermal processes in Galactic gamma-ray sources, with particular emphasis on transient and variable systems observed at high and very high energies. Her work spans the full chain from instrumentation and operations to data analysis, multi-wavelength coordination, and physical interpretation. She specialises in the study of particle acceleration and radiation mechanisms in environments such as gamma-ray binaries, novae, magnetars, pulsars, and other compact object systems, using both ground-based Cherenkov telescopes and satellite gamma-ray instruments. Her research combines observational diagnostics across energy bands with theoretical modeling to probe the physics of relativistic outflows, shocks, and stellar interaction regions.

Daniela Hadasch received her PhD in Physics from the Universitat Autònoma de Barcelona in 2013, where her thesis established the first discovery of super-orbital variability in gamma-ray binaries and demonstrated the capability of gamma-ray observations to trace the outflows of massive stars in eccentric systems.

Since 2022 she has been Assistant Professor and Excellent Young Researcher at the Institute for Cosmic Ray Research at the University of Tokyo, Japan, following prior positions as Project Assistant Professor and postdoctoral researcher in the same institute, a University Assistant position in Innsbruck, Austria, and earlier research appointments in Spain and Germany.

Her scientific achievements include leading multi-wavelength and multi-collaboration campaigns on gamma-ray binaries, coordinating contemporaneous observations across all operating Cherenkov telescopes worldwide together with major X-ray and optical facilities, and providing benchmark datasets for theoretical modeling.

She has placed the first constraints on magnetars at very-high energies, demonstrating that they are not steady gamma-ray emitters and establishing the framework for ongoing target-of-opportunity programs to follow magnetar flares. She played a key role in the discovery that novae constitute a new class of GeV and later TeV gamma-ray sources, contributing to both the initial Fermi-LAT detection and the first TeV discovery of nova emission with MAGIC.



Daniela Hadasch.
Credits: Daniela Hadasch.

Hadasch has also contributed substantially to the development and preparation of the Cherenkov Telescope Array Observatory (CTAO). She helped classify and evaluate CTA layout performance, work that informed the definition of CTA Key Science Projects and the optimization of observational strategies for transient phenomena.

Since 2018 she has led the setup and management of the CTA-North onsite data center in La Palma, Spain, a critical infrastructure for data processing and telescope operations, integrating large-scale computing and storage systems and coordinating their connection to observatory subsystems.

Her current and future research directions concentrate on transient and variable sources in the CTAO era, including gamma-ray binaries, transitional millisecond pulsars, novae, magnetars, and Galactic plane populations. She is particularly interested in combining CTAO observations with coordinated multi-wavelength and multi-messenger campaigns to investigate particle acceleration, binary evolution, and relativistic outflows in extreme astrophysical environments.

Anthony Mroczkowski

Anthony (Tony) Mroczkowski is a (sub)millimeter instrument scientist and astronomer working to advance instrumentation for studies of clusters of galaxies and the large-scale structures connecting them throughout the cosmic web. Galaxy clusters, which trace the growth of structure across cosmic time, serve as probes of cosmology as well as laboratories for a wide range of astrophysical phenomena such as shocks and the growth of magnetic fields. In studying galaxy clusters, Tony relies primarily on the Sunyaev-Zeldovich (SZ) effect – the inverse Compton scattering of photons from the Cosmic Microwave Background (CMB) by hot electrons in large scale structures. The SZ effect has redshift-independent surface brightness (i.e. does not dim with distance), which allows us to measure the same hot ionized gas from the ground that we would normally have to observe from space using X-ray satellites, with the added benefit that the SZ effect is now probing systems that formed much earlier in the Universe (over 10 billion years ago).

Mroczkowski earned his Bachelor's degree in Engineering from the Cooper Union for the Advancement of Science and Art and his masters and PhD in astronomy from Columbia University, USA, both in the city of New York. From there, he first worked as a postdoc at the University of Pennsylvania (U Penn) in Philadelphia, Pennsylvania, then as an Einstein Fellow at U Penn and NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, and ultimately as a National Research Council Fellow at the US Naval Research Laboratory in Washington, D.C. Through these positions, Mroczkowski has contributed to projects such as the polarization upgrade to the Balloon-borne Large Aperture Submm Telescope, the Multiplexed SQUID/TES Array at Ninety Gigahertz as well as its successor (MUSTANG and MUSTANG-2) on the 100-meter Green Bank Telescope, kinetic inductance detector development for the 25-meter CCAT project, and commissioning of the VLA Ionospheric and Transient Experiment on the Very Large Array. More recently, starting in early 2016,



Tony Mroczkowski.
Credits: Tony Mroczkowski.

he became a faculty-level Astronomer/Instrument Scientist at the European Southern Observatory (ESO) in Garching, Germany, where he oversaw a portion of the development for the Atacama Large Millimeter/Submm Array (ALMA).

In September 2025, he joined ICE-CSIC as a distinguished investigator, Investigador Distinguido according to Law 17/2022 on Science, Technology, and Innovation. He is the first one at ICE-CSIC, and is the first at ICE-CSIC to be funded by the ATRAE programme, which is supported by the Ministry of Science, Innovation and Universities in Spain through the State Research Agency (AEI). At ICE-CSIC, the ATRAE programme enables him to conduct a vigorous research programme in observational cosmology and instrumentation, overseeing major portions of development of the future 50-meter widefield Atacama Large Aperture Submm Telescope (AtLAST) and working on both the science case and future instrumentation suitable for this planned facility.

3.3. Guest researchers

During the year, we have received 36 visiting scientists at ICE-CSIC. Most of them (22) stayed longer than two weeks.

1. **Chen, S.**, Politecnico de Milano, 1/11/2024 - 30/4/2025
2. **Schiavone, T.**, Fondazione Angelo Della Riccia, 1/1/2025 - 31/12/2025
3. **Rodriguez, S. R.**, Instituto de Astronomía Teórica y Experimental (IATE-CONICET), 21/1/2025 - 19/4/2025
4. **Horváth, C.**, Curtin University, 1/2/2025 - 21/2/2025
5. **Solar, M.**, Astronomical Observatory Institute-Adam Mickiewicz University in Poznań, 21/2/2025 - 21/3/2025
6. **Zhao, Z.**, University of Science and Technology of China, 21/2/2025 - 11/3/2025
7. **Wang, Y.**, National Astronomical Observatories, Chinese Academy of Sciences, 28/2/2025 - 27/2/2026
8. **Hwang, J.**, Korea Astronomy and Space Science Institute, 4/3/2025 - 13/3/2025
9. **Regna, T.**, Instituto de Astrofísica de La Plata, 8/3/2025 - 5/4/2025
10. **Bersten, M.**, Instituto de Astrofísica de La Plata, 16/3/2025 - 5/4/2025
11. **Garrison, J.**, Purdue University, 16/3/2025 - 27/3/2025 and 3/6/2025 - 22/6/2025
12. **Rodriguez-Kamenetzky, A.**, Instituto de Astronomía Teórica y Experimental (IATE-CONICET), 1/4/2025 - 31/3/2026
13. **Zholdakhmet, D.**, Al Farabi Nat. University, Almaty, Kasakhstan, 10/4/2025 - 17/5/2025
14. **Toscano, F.N.**, Instituto de Astronomía Teórica y Experimental (IATE-CONICET), 4/5/2025 - 1/8/2025
15. **Gómez Vargas, I.**, Université de Genève, 5/5/2025 - 9/5/2025
16. **Takeishi, R.**, Institute for Cosmic Ray Research, University of Tokyo, 12/5/2025 - 16/5/2025
17. **Zimmermann, B.**, I. Physicalisches Institut, University of Cologne, 1/6/2025 - 10/7/2025
18. **Daspute, M.**, Ariel University, 13/7/2025 - 6/1/2026
19. **Lijo, N.**, Alma Mater Studiorum University of Bologna, 28/7/2025 - 12/9/2025
20. **Li, Y.**, China Earthquake Networks, 1/8/2025 - 31/7/2026
21. **Law, C.Y.**, INAF-Osservatorio Astrofisico di Arcetri, 25/8/2025 - 15/9/2025
22. **Melic, A.**, University of Luxembourg, 1/9/2025 - 30/11/2025
23. **Mesa, V.**, Universidad de la Serena, 6/10/2025 - 24/10/2025
24. **Anastasopoulou, K.**, INAF-Osservatorio Astronomico di Palermo, 20/10/2025 - 25/10/2025
25. **Bose, S.**, Aarhus University, Denmark, 24/10/2025 - 31/10/2025
26. **Stritzinger, M.**, Aarhus University, Denmark, 21/10/2025 - 30/10/2025
27. **Folatelli, G.**, Universidad Nacional de la Plata, 20/10/2025 - 1/11/2025
28. **Dhawan, S.**, University of Birmingham, 14/10/2025 - 17/10/2025
29. **Bersten, M.**, Instituto de Astrofísica de La Plata, 6/10/2025 - 15/10/2025
30. **Gonzalez Gaitan, S.**, Universidade de Lisboa, 27/9/2025 - 26/10/2025
31. **Elias, N.**, INAF-Astronomical Observatory of Padova, 15/11/2025 - 14/11/2026
32. **Gkimisi, K.**, University of Bologna, 3/11/2025 - 1/3/2026
33. **Barrufet de Soto, L.**, University of Edinburgh, 4/11/2025 - 4/2/2026
34. **Murgas, F.**, IAC, 21/11/2025 - 3/12/2025
35. **Spinoso, D.**, Università degli Studi dell'Insubria, 24/11/2025 - 28/11/2025
36. **Mucedola, S.**, Università degli Studi dell'Insubria, 24/11/2025 - 28/11/2025

4. Research highlights

4.1. A virtual Universe for Euclid: the largest cosmological simulations catalogue is now public

The Euclid Consortium published the largest synthetic galaxy catalogue ever built, featuring simulations of more than 3.4 billion galaxies with 400 modelled properties designed to match the 'sharp eyes' of ESA's Euclid mission. Launched in July 2023 to scan a third of the sky over six years, Euclid's mission is preceded by this massive dataset, which was developed by an international team led by ICE-CSIC and the Port d'Informació Científica (PIC). Available on the CosmoHub platform, this catalogue serves as a crucial precursor to the largest 3D map of the Universe ever created.

This synthetic catalogue, known as the 'Flagship 2 galaxy mock', aims to reproduce what the 1.2-m-diameter Euclid telescope will be able to see and capture, mimicking the actual Universe. Due to their very large volume, these simulations allow astronomers to portray very distant galaxies that emitted their light more than 10 billion light years away.

Reproducing the Universe with computational simulations before obtaining the final 3D map will help us understand what Euclid sees and will allow scientists to study the origin of the 'cosmic web' — the large-scale structure of the Universe—, test the standard cosmological model and help us to unravel the nature of dark energy and dark matter. This allows the application of end-to-end software pipelines to constrain cosmological information and carry out galaxy evolution studies to understand how they form across their lifetime.

The team used computational models, produced by the University of Zurich, that simulate the motion of 4 trillion particles under the influence of their mutual gravitational interactions. Of those 4 trillion, 16 billion gravitationally bound objects, called haloes, were identified located within a distance of 18.6 billion light

years from Earth. Haloes were populated with the galaxies that Euclid is expected to observe, calibrating different parameters against the current observed distribution of galaxies.

The galaxy catalogue is produced and analysed using specialised hardware, a Hadoop big data platform located at PIC. Generating a catalogue of these characteristics entails both a scientific and a technical challenge, since it includes the development of computation and statistical strategies, as well as incorporating our up-to-date knowledge of galaxy formation and evolution, and its interplay with the dark components of the Universe.

As observations from previous galaxy surveys, such as the Sloan Digital Sky Survey (SDSS) and the Hubble Space Telescope's Cosmic Evolution Survey (COSMOS) that have been used to calibrate the model's parameters used to assign galaxies to the haloes, the Flagship mock galaxy catalogue will help develop strategies for the scientific exploitation of future galaxy surveys. These simulations may have a further impact and outsmart the catalogue's initial purpose, allowing scientists to test observational techniques in order to recover cosmological information or to carry out studies that connect the visible and the Universe's dark components.

Published in Euclid Collaboration, **Castander, F. J., Fosalba, P.,** Stadel, J., Potter, D., Carretero, J., Tallada-Crespí, P., Pozzetti, L., Bolzonella, M., Mamon, G. A., et al., incl. **Breton, M.-A., Bagkhani, Z., Crocce, M., Serrano, S.** (2025), Euclid: V. *The Flagship galaxy mock catalogue: A comprehensive simulation for the Euclid mission*, Astronomy and Astrophysics, 697, A5, 10.1051/0004-6361/202450853.

Text adapted from the [press release](#) published at the ICE-CSIC website.

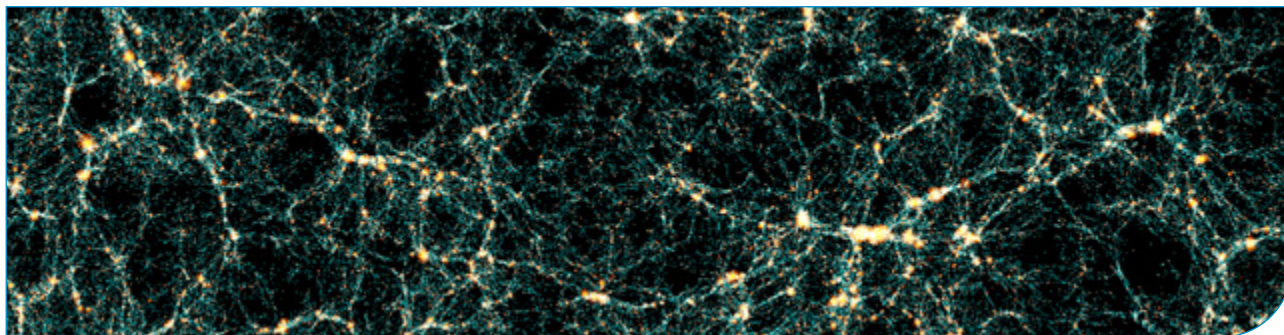


Image extracted from the Euclid Flagship simulations catalogue. Each dot represents a galaxy: blue points mark galaxies at the centers of dark matter clumps, while red points denote satellites within them. Collectively, they trace the large-scale mass distribution of the Universe, forming clumps, filaments, and voids.

Credits: Jorge Carretero & Pau Tallada (Port d'Informació Científica) / Euclid Consortium). Image processed with the software Splotch.

4.2. Detected a transient object emitting pulses in both radio waves and X-rays

An international team of astronomers with ICE-CSIC participation detected a new long-period transient object: a recently discovered type of cosmic phenomenon.

The object, known as ASKAP J1832-0911, emits pulses of radio waves and X-rays for two minutes every 44 minutes. This is the first time objects like these, called long-period transients (LPTs), have been detected in X-rays. It is located in our Milky Way galaxy, about 15,000 light-years from Earth. Astronomers hope it may provide insights into the sources of similar mysterious signals observed across the sky. Detecting these objects using both X-rays and radio waves may help astronomers find more examples and learn more about them.

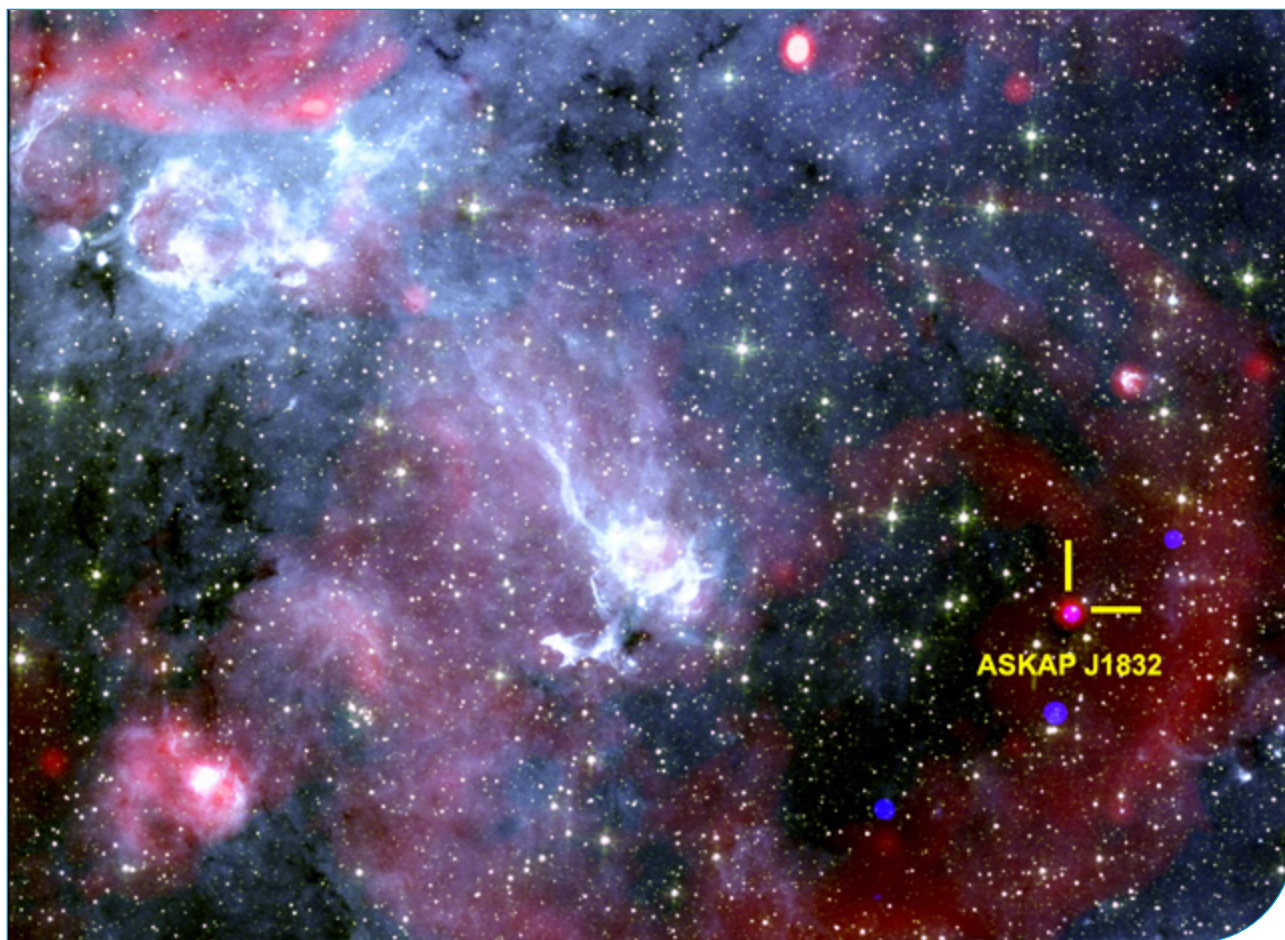
The team discovered ASKAP J1832-0911 by using ASKAP radio telescope on Wajarri Country in Australia, owned and operated by Australia's national science agency, CSIRO. They correlated the radio signals with X-ray pulses detected by NASA's Chandra X-ray Observatory, which was coincidentally observing the same part of the sky.

LPTs, which emit radio pulses that occur minutes or hours apart, are a relatively recent discovery. Since their first detection by ICRAR researchers in 2022, ten LPTs have been discovered by astronomers across the world. Currently, there is no clear explanation for what causes these signals, or why they 'switch on' and 'switch off' at such long, regular and unusual intervals.

The discovery helps narrow down what the objects might be. Since X-rays are much higher energy than radio waves, any theory must account for both types of emissions – a valuable clue, given their nature remains a cosmic mystery.

Published in Wang, L., **Rea, N.**, Bao, T., Kaplan, D. L., Lenc, E., Wadiasingh, Z., Hare, J., Zic, A., Anumalapudi, A., Bera, A., et al. (2025), *Detection of X-ray emission from a bright long-period radio transient*, Nature, 642, 583, 10.1038/s41586-025-09077-w.

Text adapted from the [press release](#) published at the ICE-CSIC website.



An image of the sky showing the region around ASKAP J1832-0911. X-rays from NASA's Chandra X-ray Observatory, radio data from the South African MeerKAT radio telescope, and infrared data from NASA's Spitzer Space Telescope.
Credits: Ziteng (Andy) Wang, ICRAR.

4.3. A comprehensive study of an asteroid disintegrated over France in 2023 opens new horizons for planetary defense

ICE-CSIC participated in the analysis of the asteroid 2023 CX1, detected seven hours before impacting the Earth, as part of an international team, involving nearly one hundred researchers worldwide.

The asteroid 2023 CX1 struck over Normandy (France) on February 13th at 02:59 UTC. Nearly spherical, it measured just under one meter in diameter with an estimated mass of about 650 kg. It caused a catastrophic disruption at an altitude of about 28 km, releasing 98% of its kinetic energy in a fraction of a second. The explosion scattered more than a hundred fragments across Normandy.

Analyses show that 2023 CX1 separated from its parent body in the inner main belt about 30 million years ago. It experienced an atypical fragmentation, as withstanding high dynamic pressures (4 MPa), generating a concentrated spherical shock wave. Hydrodynamic simulations reveal that this type of fragmentation could cause greater ground damage than progressive fragmentations, as observed for the 2013 Chelyabinsk event.

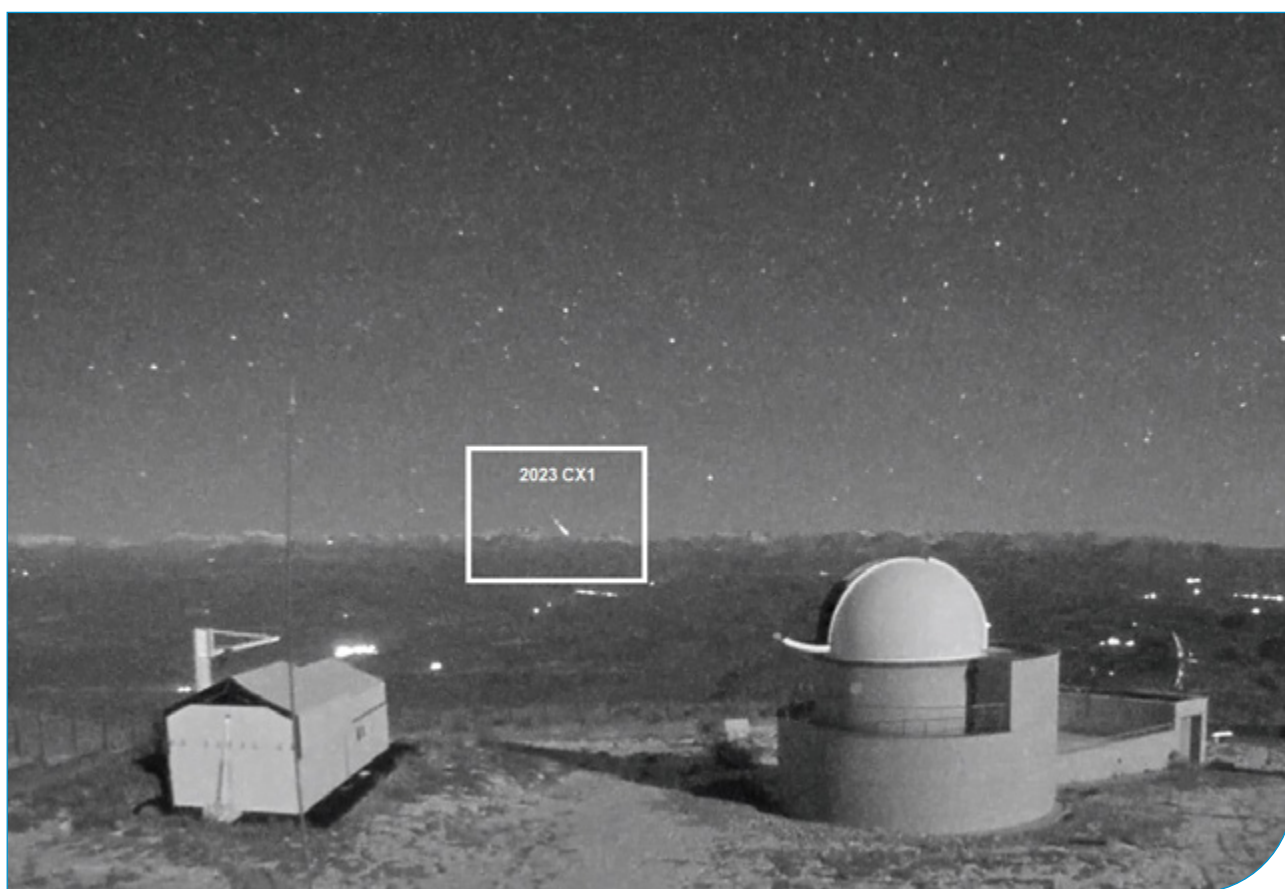
This study highlights the need to integrate spectral,

structural, and dynamical characterisation of pre-impact asteroids into planetary defence protocols.

2023 CX1 is only the 7th asteroid ever detected prior to impact. The accurate prediction, made by ESA and NASA allowed space agencies and the FRIPON/Vigie-Ciel network to mobilize the public to record the asteroid's atmospheric entry, resulting in the first large-scale "targeted" observation of a meteorite-dropping bolide. More than 100 scientists and citizen observers across Europe, America, Africa and Australia joined forces to investigate every aspect of this exceptional fall, demonstrating the power of international cooperation when facing rare and critical celestial events.

Published in Egal, A., Vida, D., Colas, F., Zanda, B., Bouley, S., Steinhäusser, A., Vernazza, P., Ferrière, L., Gattacceca, J., Birlan, M., et al., incl. **Trigo-Rodríguez, J.M.** (2025), Catastrophic disruption of asteroid 2023 CX1 and implications for planetary defence, *Nature Astronomy*, 9, 1624, 10.1038/s41550-025-02659-8.

Text adapted from [press release](#) published at the ICE-CSIC website.



The superbolide produced by the disintegration of asteroid 2023 CX1, captured by the Montsec Observatory, located in Sant Esteve de la Sarga, Lleida.

Credits: OdM/IEEC Team.

4.4. Einstein Probe catches an X-ray burst from an odd stellar couple

The Einstein Probe satellite captured an X-ray flash from a very elusive celestial pair. The discovery, led by ICE-CSIC, opens a new way to explore how massive stars interact and evolve, confirming the unique power of the mission to uncover fleeting X-ray sources in the sky.

The odd celestial couple consists of a big hot star, more than 10 times larger than our Sun, and a small compact white dwarf, with a mass similar to our star. Only a handful of these systems have been found so far, and this is the first time scientists could track the X-ray light coming from such a curious pair from its initial sudden flare-up to its fading away.

Thanks to Einstein Probe catching the novel source right from its initial flash, other telescopes were alerted to the area, enabling scientists to analyse batches of data from different instruments. They examined how the light varied across a range of X-ray wavelengths, and teased out some of the elements present in the exploding material, such as nitrogen, oxygen and neon. The analysis delivered crucial clues.

The unusual duo, consisting of a so-called Be star, a massive and hot object, and a compact and hyper-dense white dwarf, closely orbit each other. The white dwarf's intense gravitational field pulls matter from its companion. As more and more material (mainly hydrogen) rains down on the compact object, its strong gravitation compresses it, until a runaway nuclear explosion is initiated. This creates a bright flash of light across a wide range of wavelengths from visible light to UVs and X-rays.

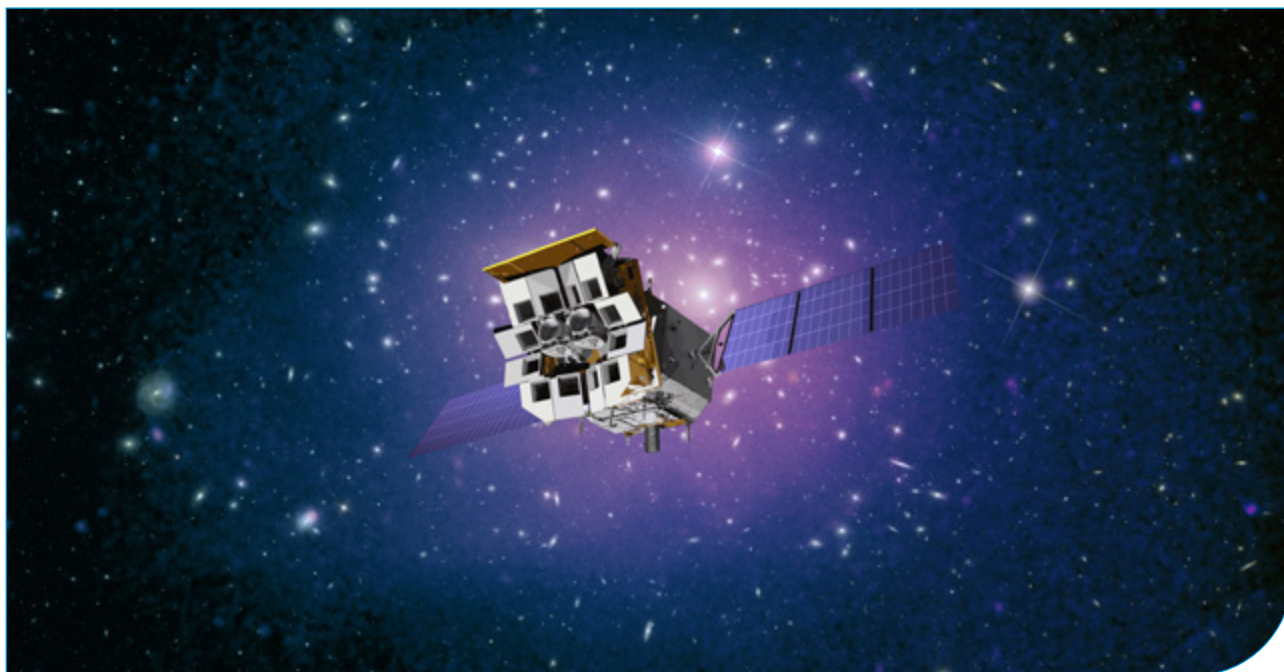
At first sight, the existence of this duo is puzzling. Massive stars of type Be burn fast through their reserve of nuclear fuel. Their lives are fierce and short, spanning about 20 million years. Its companion is (usually) the collapsed remnant of a star similar to our Sun, which in isolation would live for several billions of years.

Scientists think that the couple started off together, as a better-matched binary pair consisting of two rather big stars, six and eight times more massive than our Sun. The bigger star exhausted its nuclear fuel earlier and started to expand, shedding matter to its companion. First, gas in its puffed-up outer layers got pulled in by the companion; then its remaining outer shells got ejected, forming an envelope around the two stars, which later became a disc, and finally dissolved.

By the end of this process, the companion star had grown to be 12 times the mass of the Sun, while the outstripped core of the other had collapsed to become a white dwarf of just over one solar mass. Now, it is the turn of the white dwarf to steal and gobble up material from the outer layers of the Be star.

Published in **Marino, A.**, Yang, H. N., **Coti Zelati, F., Rea, N.**, Guillot, S., Jaisawal, G. K., Maitra, C., Ness, J.-U., Haberl, F., Kuulkers, E., et al. (2025), Einstein Probe Discovery of EP J005245.1-722843: A Rare Be-White Dwarf Binary in the Small Magellanic Cloud?, *The Astrophysical Journal*, 980, L36, 10.3847/2041-8213/ad9580.

Text adapted from the [press release](#) published at the ICE-CSIC website.



Einstein Probe artist impression.
Credits: Chinese Academy of Sciences.

4.5. New method found to compare gamma-ray light curves of around 300 pulsars observed with NASA's Fermi telescope

In 2023, the Third Fermi Large Area Telescope Pulsar Catalogue presented 294 light curves associated with known pulsars, including 143 millisecond pulsars. It provides a wealth of information about the mechanisms that generate pulsar beams. A study, led by ICE-CSIC, introduced a new methodology to compare the whole set of gamma-ray light curves reported in that catalogue.

Gamma rays are the highest-energy form of light, and the gamma-ray sky is spectacularly different from the one we perceive with our own eyes. NASA's Fermi Gamma-ray Space Telescope is a space observatory that allows scientists to answer questions about supermassive black hole systems, pulsars, and the origin of cosmic rays, and search for signals of new physics.

Changes in brightness observed in light curves help astronomers explore how gamma-ray pulsars emit radiation and how their beams sweep across our line of sight. The method applied by ICE-CSIC in this study is based on dynamic time warping (DTW) to compare the whole set of gamma-ray light curves reported in the catalogue mentioned above. Scientists could quantitatively measure the degree of global similarity between two light curves beyond comparing indicators, such as how many peaks there are, their separation, and their width and height.

The DTW method, also employed in different fields, such as medicine, seismology, financial market analysis, and speech recognition, has recently started

to be used in astrophysics, including applications for gamma-ray bursts or gravitational waves studies. This methodology is used for comparing pulsar light curves for the first time providing astronomers with a technique to study whether pulsars having similar light curves (now quantitatively measured) have similarities in other features too. Up to measurements of similarity were mostly done in an artisanal way.

Researchers found surprising that millisecond pulsars -pulsars with a rotational period less than about 10 milliseconds- and young pulsars share detailed light curve morphology up to minute details, despite the many orders of magnitude difference in their physical parameters. This has implications for the understanding of pulsar magnetospheres.

This new method allows astronomers to cluster pulsars according to light similarity. They can study how pulsars with similar light curves behave regarding other aspects, like their spectra. In future studies, this new method can be used to understand and quantify similarities of transitional pulsars or to compare fast radio bursts, gamma radio bursts or magnetar light curves.

Published in **García, C. R., Torres, D. F.** (2025), Quantitative Exploration of the Similarity of Gamma-Ray Pulsar Light Curves, *The Astrophysical Journal*, 982, L51, 10.3847/2041-8213/adbf0f.

Text adapted from the [press release](#) published at the ICE-CSIC website.

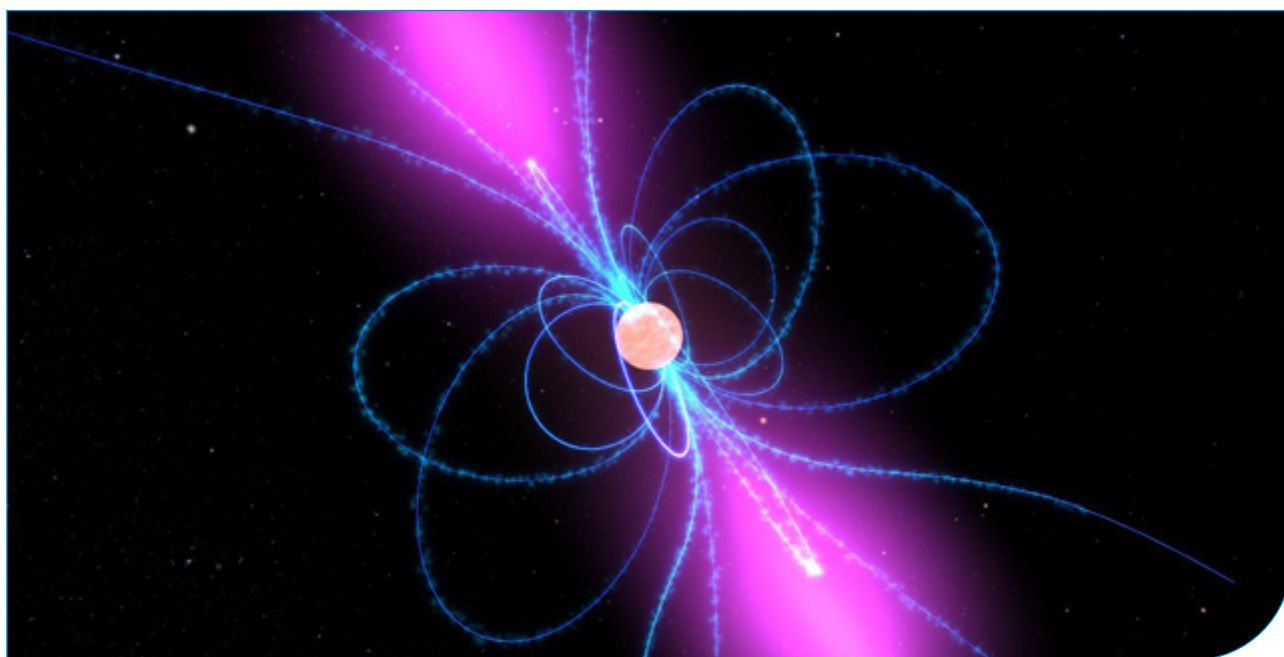


Image extracted from an animation that shows a spinning pulsar, with its strong magnetic field rotating along with it. Clouds of charged particles move along the field lines and their gamma-rays (purple) are beamed like a lighthouse beacon by the magnetic fields.

Credits: NASA/Goddard Space Flight Center Conceptual Image Lab.

4.6. New DESI Results Strengthen Hints That Dark Energy May Evolve

New data from the DESI collaboration, which includes ICE-CSIC, is challenging our fundamental understanding of the universe by using the largest 3D map ever created to track dark energy's influence over the past 11 billion years. After analysing nearly 15 million galaxies and quasars, researchers found hints that dark energy may not be a cosmological constant, but rather evolving over time. This discovery potentially upends the standard model of cosmology.

Taken alone, DESI's data are consistent with our standard model of the universe. However, when paired with other measurements, there are mounting indications that the impact of dark energy may be weakening over time and other models may be a better fit. Those other measurements include the cosmic microwave background, supernovae and weak lensing.

The new analysis uses data from the first three years of observations and includes nearly 15 million of the best measured galaxies and quasars. It's a major leap forward, improving the experiment's precision with a dataset that is more than double what was used in DESI's first analysis, which also hinted at an evolving dark energy.

DESI tracks dark energy's influence by studying how matter is spread across the universe. Events in the very early universe left subtle patterns in how

matter is distributed, a feature called baryon acoustic oscillations. That pattern acts as a standard ruler, with its size at different times directly affected by how the universe was expanding. Measuring the ruler at different distances shows researchers the strength of dark energy throughout history. DESI's precision with this approach is the best in the world.

DESI is one of the most extensive cosmic surveys ever conducted, capable of capturing light from 5,000 galaxies simultaneously. Mounted on the Mayall 4-meter Telescope in Arizona, the instrument involves key Spanish participation from centers like ICE-CSIC. Now in its fourth year, the project has already mapped millions of objects and aims to measure 50 million galaxies and quasars—extremely distant yet bright galactic cores powered by black holes—by its conclusion.

The collaboration will soon begin work on additional analyses to extract even more information from the current dataset, and DESI will continue collecting data. Other experiments coming online over the next several years will also provide complementary datasets for future analyses.

Published in <https://data.desi.lbl.gov/doc/papers/C>.

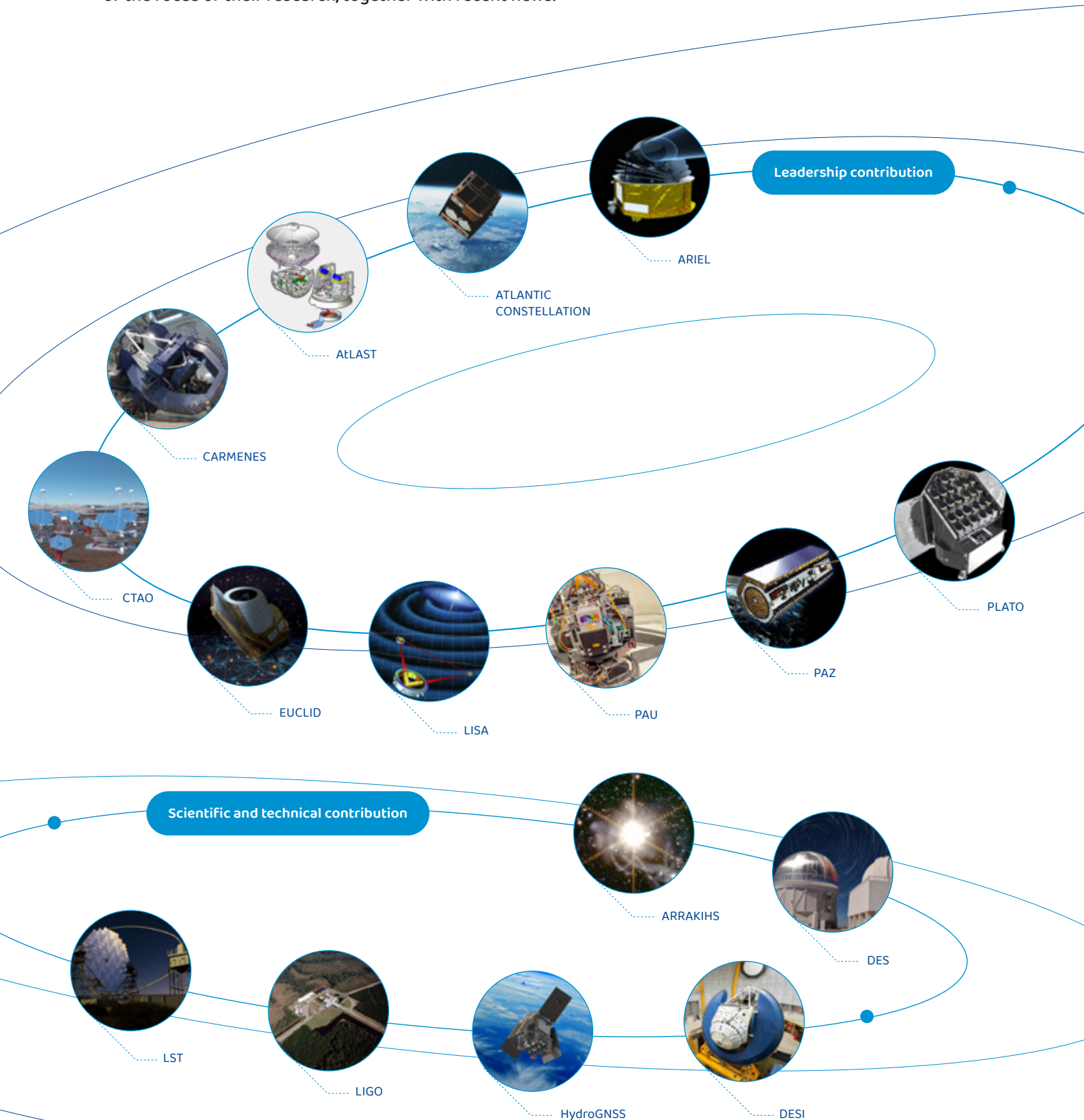
Text adapted from the [press release](#) published at the ICE-CSIC website.

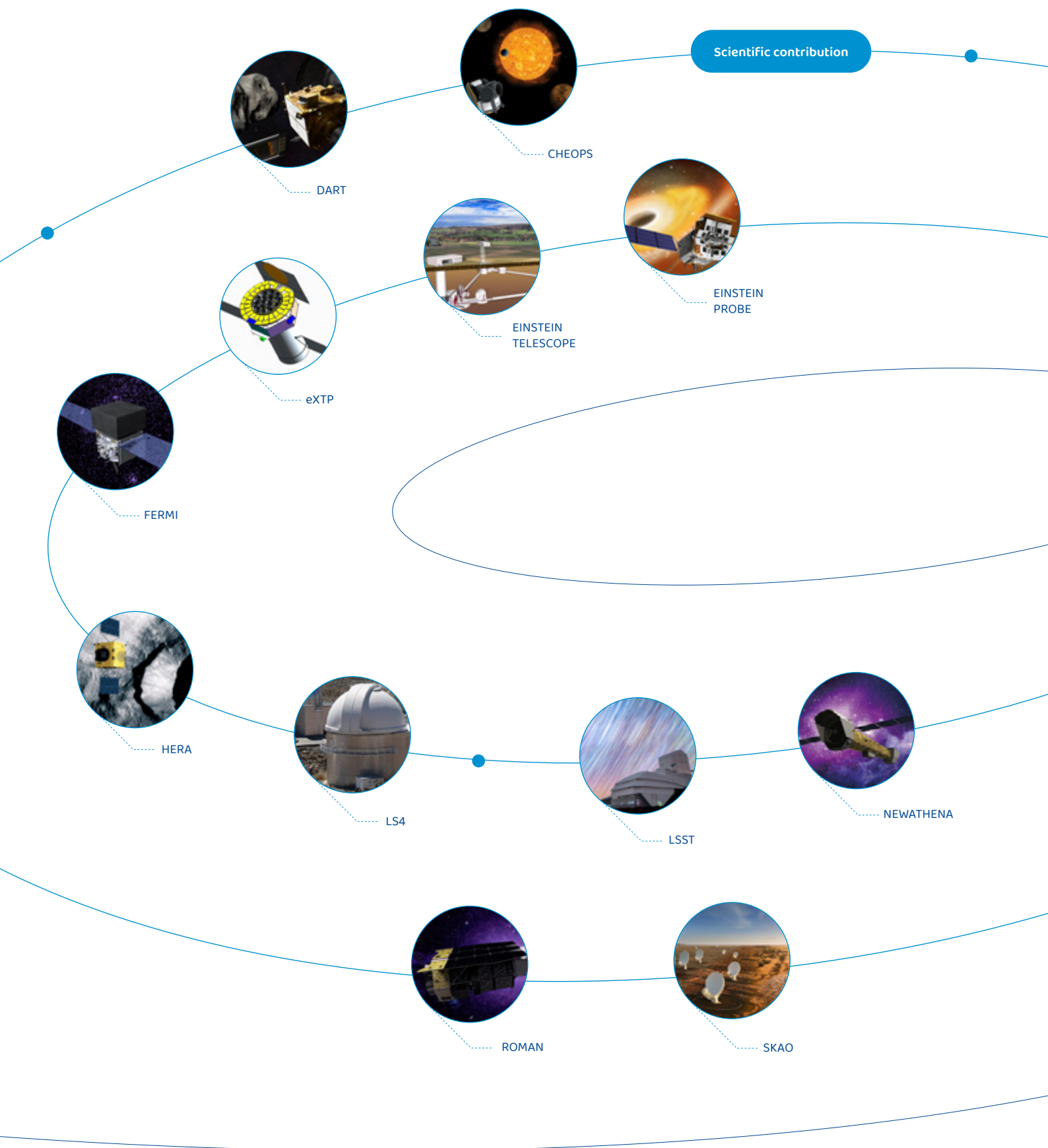


DESI maps distant objects to study dark energy. The instrument is installed on the Mayall Telescope, shown here beneath star trails.
Credits: KPNO/NOIRLab/NSF/AURA/B. Tafreshi.

5. Missions and experiments

ICE-CSIC participates in exciting missions and ground-based experiments that have continued this year. In this section, the senior Institute members leading ICE-CSIC contributions to these projects provide a brief description of the focus of their research, together with recent news.





5.1. Leadership contribution

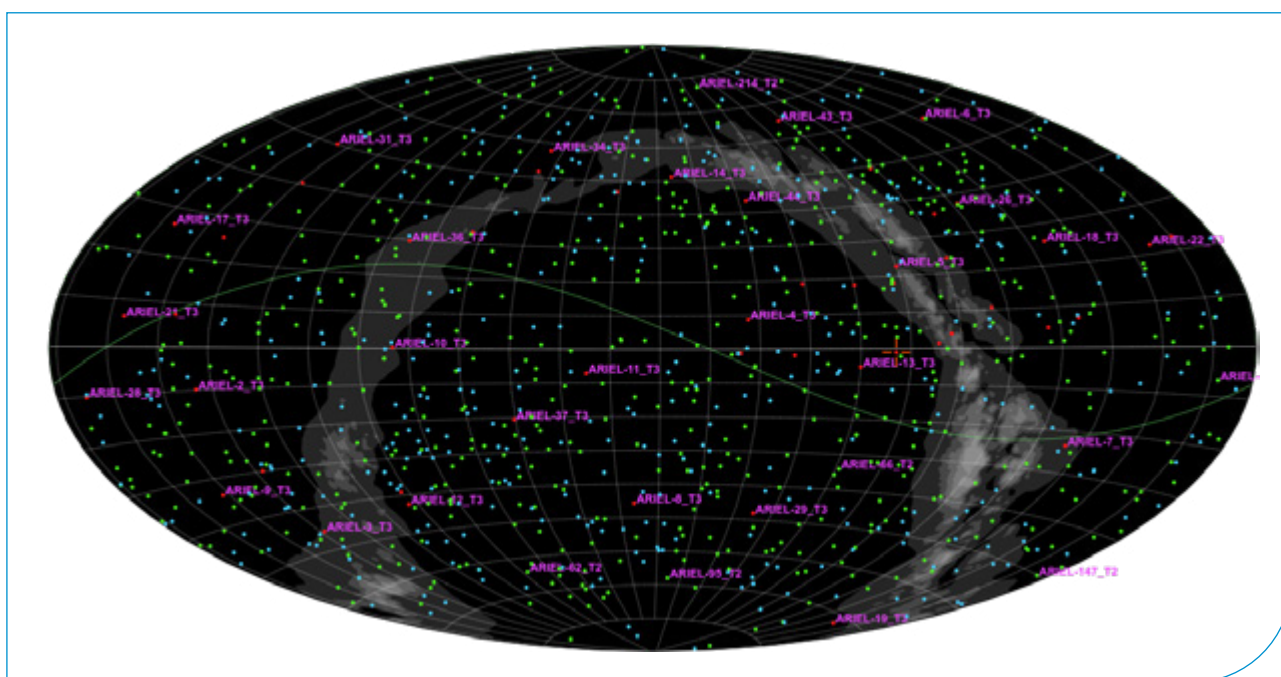
Space missions, observatories and instruments where ICE-CSIC leads an official contribution.

ARIEL

Senior Institute members involved: Ignasi Ribas, Guillem Anglada-Escudé, Juan Carlos Morales

Ariel (Atmospheric Remote-sensing Exoplanet Large-survey) is ESA's fourth medium (or "M-class") mission that was adopted in 2020 and is expected to be launched in 2029. It consists of a 1-metre class telescope equipped with low-resolution spectrographs that will cover the wavelength range from 1.1 μm to 7.8 μm . Ariel will study a complete sample of transiting exoplanets by means of transmission spectroscopy. This means that it will measure the spectra of planets through the follow-up of their transit in front of their host stars or the occultations behind them. This type of observation provides a wealth of information about the atmosphere of the planets such as the chemical composition, the vertical pressure-temperature profile, the dayside-nightside temperature difference, the atmosphere circulation patterns, and the presence of clouds for instance. The goal of this survey, which will characterise a large number of exoplanet atmospheres during its 4 years lifetime, is answering the first of the four ambitious

topics listed in the ESA's Cosmic Vision: "What are the conditions for planet formation and the emergence of life?". The ARIEL mission concept is developed by a consortium of more than 70 institutes from 17 ESA countries. ICE-CSIC is one of the co-PI institutes (co-PI: Ribas) and leads the Spanish contribution (PI: Ribas; National Project Manager: Martí), which also includes the Instituto de Astrofísica de Canarias and the Universidad Politécnica de Madrid. The responsibilities of the groups in Barcelona, coordinated by the PI and ICE-CSIC, are the procurement of the mission planning and scheduling software, which is a critical part of the ground segment of the Ariel mission (provided by the ICE-CSIC) and the design, implementation, assembly and verification of the Telescope Control Unit (developed by UB), which performs the thermal monitoring and control of the telescope, the payload module and commands the secondary mirror refocusing mechanism, which will be developed in collaboration with SENER.



Distribution of the Ariel targets in the sky as shown in the graphical user interface of the Ariel scheduler software.
Credits: Juan Carlos Morales.

Recent developments

During 2025, we continued the development of the Ariel Long Term Planning Tool (LTPT) based on the high-level ground segment requirements and implemented the optimisation algorithms specially designed for the Ariel case (as part of the PhD thesis of Nariman

Nakhjiri, defended in November 2025). Several functionalities have been added to the LTPT, including a calibration figure of merit to consider the calibration strategy. The STARS graphical user interface has been upgraded to allow the execution of the LTPT and the

visualisation of the tool. By the end of 2025, a new release of the tool (version 0.8.0) was delivered to ESA after revision of bugs and vulnerabilities of previous versions. The Ariel scheduling tool was also very useful to assist in the definition of the scientific strategy. By simulating the Ariel mission plans with the LTPT we were able to study the impact on the scientific goals of adding phase curve observations, which are much more demanding than transits and eclipses.

Regarding science, our work basically consists in studying the effects of stellar intrinsic variations, known as stellar activity, on the spectra of planetary atmospheres. In the context of the SPOTLESS ERC Advanced Grant, we are developing methods to correct out such variability and thus keep Ariel's

data free of any bias using the StarSim tool. In the past years, we suggested the use of complementary observations for this purpose (see Rosich et al. 2020) and we are implementing this technique to observations of transiting planets with the James Webb Space telescope (de Wit et al. 2024). In 2025, we conducted pilot observational campaigns to apply the proposed correction methodology to several systems, including Machine Learning. The results are encouraging and first publications are about to be submitted. Photometric and spectroscopic observations from different facilities (TJO, GTC, VLT, CARMENES spectrograph) are being gathered. These activities are being performed in the context of three ongoing PhD theses.

Atlantic Constellation

Senior Institute members involved: Estel Cardellach, Weiqiang Li, Serni Ribó, Antonio Rius

The Atlantic Constellation is a collaboration between Spain and Portugal, each to deploy an independent Earth Observation constellation of low earth orbiters. The constellation will address the growing challenges inflicted by climate disasters affecting Spain, Europe and the world while developing strategic sovereign capabilities in the critical domain of Earth Observation. The Spanish component consists of eight microsatellites. Each of these microsatellites will integrate four onboard instruments for collecting terrestrial data: multispectral optical cameras, which will provide a privileged view of the globe; GNSS (Global Navigation Satellite System) reflectometry sensor, a technology that measures the reflections of terrestrial navigation signals; IoT (Internet of Things), which allows the microsatellites to collect in-situ data in remote areas

and transmitting this information affordably; and an AIS receiver (Automatic Identification System), a technology for locating vessels and monitoring maritime activity beyond visibility limitations.

ICE-CSIC is responsible for one of the four payloads present in every satellite of the constellation: the GNSS reflectometer, a remote sensing technique that uses satellite signals bounced off the Earth's surface to obtain information. In addition, ICE-CSIC also develops the algorithms to extract the geophysical information from the low level data. These algorithms, which will produce surface inundation information, soil moisture, and ocean winds, will run operationally in the mission's ground segment once the satellites are launched into their orbits.

Recent developments

In 2025, ESA – which will manage the development of the mission – issued the Tender for development, implementation and delivery of the eight satellites of the constellation and the operational ground segment. ICE-CSIC was one of the partners of the selected consortium. During this year, the contract was signed and the activity kicked off. The satellites and ground segment shall be delivered in 2027.

AtLAST

Senior Institute members involved: Francisca Kemper, Tony Mroczkowski, Serni Ribó, Álvaro Sanchez-Monge, Josep Miquel Girart, Anaëlle Maury

The Atacama Large Aperture Submm Telescope (AtLAST) is a concept for a 50-meter single-dish submillimeter telescope with a 1–2 degree field-of-view (FoV) to be built on the Chajnantor Plateau in Chile. AtLAST will be fully powered by sustainable energy sources, will be the first large (defined as having a diameter >15 m) mm/submm single-dish telescope in the Southern hemisphere, and the first in either hemisphere to access frequencies >350 GHz. It will cover the 30–950 GHz frequency range, picking up where SKAO leaves off. While this is roughly the same frequency range as ALMA, AtLAST will provide entirely

complementary mapping capabilities, both in terms of speed and angular scales accessible. Interferometers like ALMA and SKAO can have high sensitivity due to their large collecting areas, but they have much poorer wide field mapping speeds than their single dish counterparts. The design of AtLAST is optimised to deliver unprecedented mapping speed, which will be >100,000 times higher than that of ALMA. AtLAST is currently under design by an international consortium consisting of 20 universities, research institutes and industry partners, led by the University of Oslo and including ICE-CSIC.

Recent developments

In 2025, ICE-CSIC contributed to the AtLAST development through several scientific and technical activities. These included contributions to the scientific justification and potential impact of the project, notably through the authorship of white papers for the European Southern Observatory's Expanding Horizons call in support of AtLAST. With the arrival of Tony Mroczkowski, ICE-CSIC assumed a leading and coordinating role in telescope and instrumentation design for the project. The team also

carried out forecasts and instrument configuration simulations using the maria simulator, and initiated electromagnetic simulations for a potential direct-detection spectrometer for AtLAST, alongside the recruitment of an engineering postdoctoral researcher to advance this work. In addition, ICE-CSIC participated in the AtLAST Conceptual Design Review and contributed to the development of remote and distributed operational concepts for the facility.

CARMENES

Senior Institute members involved: Ignasi Ribas, Juan Carlos Morales

CARMENES (Calar Alto high-Resolution search for M dwarfs with Exoearths with Near-infrared and optical Echelle Spectrographs) is an instrument designed and optimised to look for planets around stars smaller than our Sun. ICE-CSIC has a prominent role in CARMENES, being responsible for science preparation and exploitation through the figure of the Project Scientist and, more recently, as co-PI of the CARMENES Legacy-Plus project. In this capacity, the ICE-CSIC team leads the selection of the stars that are being searched for planets, the collection of all the necessary information to guarantee the best precision and the analysis of the data acquired to uncover habitable planets. Besides its scientific role, the ICE-CSIC team was also responsible for key technology packages of the CARMENES spectrograph, which are the Instrument Control System (ICS) and the scheduling system. The ICS is the "brain" of CARMENES and centralises all the subsystems to control the proper working of the instrument, its performance, and environment variables. The scheduler is a complex piece of software factoring in a large number of variables (target properties, prioritisation, environment variables) to find the optimum target to observe at each point in time.

Recent developments

The CARMENES survey entered its second extension phase in 2024, with the primary objective of searching for exoplanets orbiting M-dwarf stars and characterising their occurrence rates and demographics. The scientific productivity of the CARMENES project continues to be outstanding. In 2025 alone, an additional 15 papers were published, bringing the total number of refereed publications since the start of the survey to 142.

While exoplanet detection remains the core focus of CARMENES, the survey is also delivering a wealth of data to advance our understanding of stellar properties and magnetic activity, as well as to characterise exoplanet atmospheres through high-resolution transmission and emission spectroscopy. In particular, the CARMENES spectrograph has played a crucial role in confirming planetary candidates identified by the TESS transiting survey and in accurately measuring their masses.

The main CARMENES survey continues to discover new planets and to demonstrate that planetary systems around M-dwarf stars are both common and diverse in their properties and architectures. In 2025, the ICE-CSIC team led a key publication (Morales et al. 2025) reporting the discovery and detailed analysis of several giant planets orbiting low-mass stars. CARMENES has proven to be unique in uncovering and characterising such systems, some of which challenge current models of planet formation. Another major result from CARMENES this year (Kaminski et al. 2025) revealed that ultracool dwarfs, stars with masses below approximately $0.2 M_{\odot}$, are extremely rich in planetary systems, with nearly all hosting planets and an average of more than two planets per star. Remarkably, the derived planet mass function is very steep, with planets in the $0.5\text{--}3 M_{\oplus}$ range found to be about ten times more abundant than those with masses between 3 and $10 M_{\oplus}$.

CTAO/LST

Senior Institute members involved: Diego F. Torres, Daniela Hadasch

The Cherenkov Telescope Array Observatory (CTAO) is an initiative to build the next-generation ground-based very high-energy gamma-ray instrument. ICE-CSIC has been involved in CTAO since its foundation. On the technical side, we worked in the scheduler team. We have also been involved in preparing the scientific exploitation of the observatory. Concerning the scientific exploitation of the observatory, where our Institute is leading a number of the 'Key Science Programs' (KSPs) putting an effort on maximising the physic output of the CTAO. This follows our earlier efforts where Diego F. Torres has been the CTA Physics Coordinator for eight years in the period 2007-2014, having responsibilities in the scientific definition of the experiment, the KSPs, and up to Technical Design Report.

Later on, Emma de Oña, another (former) ICE-CSIC member occupied this post for an additional year.

The Large Sized Telescope (LST) is one of the key components of the CTAO. Four LSTs will be arranged at the Roque de los Muchachos Observatory in La Palma, Spain. The LST-1 is the prototype of the LST, currently under commissioning. Each LST is a giant 23 metre diameter telescope with a mirror area of about 400 square metres and a fine pixelised camera made of 1855 light sensors capable of detecting individual photons with high efficiency. The LST Collaboration comprises over 400 scientists and engineers from 12 countries, ensuring global expertise and innovation.

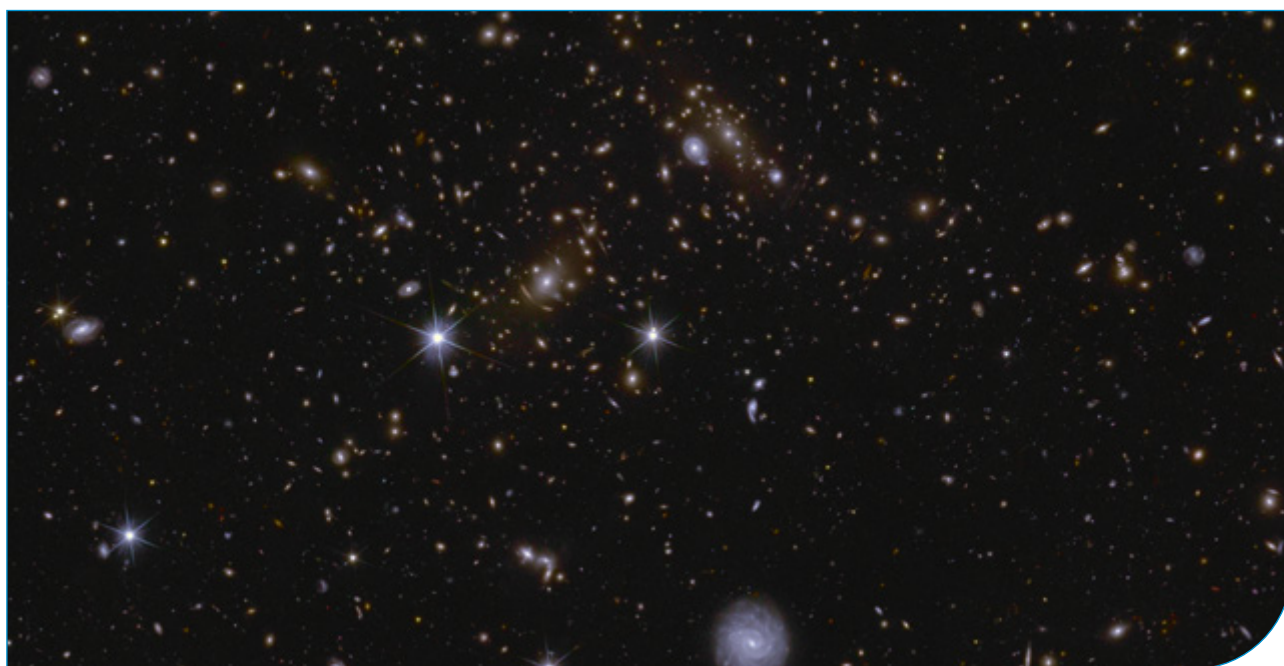
Recent developments

On 7 January 2025, the European Commission established the CTAO as a European Research Infrastructure Consortium (ERIC), furthering its mission to become the world's largest and most powerful observatory for gamma-ray astronomy.

The CTAO ERIC was established with the international support of 11 countries and one intergovernmental organisation that contribute to the technological development, construction and operation of the Observatory. The ERIC not only provides the Central Organisation with a formal framework to accept and operate the current telescope prototypes, but it also allows for the immediate start of construction for

the full array of more than 60 telescopes across both telescope sites in Spain and Chile. On the CTAO-North site, where the Large-Sized Telescope prototype (LST-1) is under commissioning, three additional LSTs and one Medium-Sized Telescope are expected to be built in the next 1-2 years.

At ICE-CSIC we have been helping to install, operate, and observe with the Large Area Telescopes of CTAO in La Palma along the year. Among other early scientific results, we collaborated on the detection of the Geminga pulsar at energies down to 20 GeV, filling in the gap between Fermi-LAT and IACT measurements.



Various huge galaxy clusters as well as intra-cluster light, and gravitational lenses are visible in this image of an area of Euclid's Deep Field South. The cluster near the centre is called J041110.98-481939.3, and is located almost 6 billion light-years away.

Credits: ESA/Euclid/Euclid Consortium/NASA, image processing by J.-C. Cuillandre, E. Bertin, G. Anselmi.

EUCLID

Senior Institute members involved: Francsico Castander, Martin Crocce, Pablo Fosalba, Lluís Galbany, Enrique Gaztañaga, Mar Mezcuca, Mireia Montes

Euclid is an ESA cosmology mission to study the accelerated expansion of the Universe also known as dark energy. ICE-CSIC has leadership roles and visibility in the mission: we belong to the ESA Euclid Science Team, we are part of the Euclid Consortium Board, we lead the simulation effort, we develop software and have contributed to hardware development.

Recent developments

In March 2025, ESA and the Euclid Consortium made available the first Quick Release (Q1). This release included one-pass observations of the Euclid Deep Fields and data from the "Dark Cloud" field, covering around 63 deg². The public release was accompanied by 34 scientific and technical papers submitted to the Astronomy & Astrophysics (A&A) journal. A second wave of seven papers, based on early Data Release One (DR1) data, followed in November, presenting many exciting new results. Notably, galaxy morphology studies and strong-lensing analyses made significant advances thanks to the new Euclid observations.

During 2025, the DR1 content was defined, covering roughly 2000 deg². The processing of the DR1 data took place during the summer and autumn and released internally to the collaboration at the end of the year. DR1 includes a special region of 500 deg² where the blinding strategy is relaxed to enable data-quality validation and analysis pipeline testing. The dataset selected for the Quick Release 2 (Q2) corresponds to the Euclid Galactic Bulge Survey. In September, six members of the Euclid Science Team were replaced by new-appointed members. There was also a renewal of some Euclid Consortium Science Working Group Coordinators and the coordinators of the DR1 Key Projects were selected through open calls. The Euclid Consortium Annual Meeting took place in Leiden, the Netherlands, in March jointly with the ESA ESLAB meeting. In March-April, the mission underwent its Mission Key Point Review, with only a

few items deferred for resolution in a delta review. Overall, the survey progressed nominally, despite episodic periods of high solar activity that resulted in some data loss.

At our Institute, we continued to lead both the Cosmological Simulations working Group and the Simulations Organisation Unit of the Science Ground Segment. The Flagship simulation paper was published in a Euclid Special Issue of the A&A journal. In September, we made the simulations publicly available and announced it in conjunction with a press release. We are now working on preparing for the simulations needed for the DR1 scientific analysis. We were selected as a Barcelona Supercomputing Center strategic project for developing new Euclid simulations and performing cosmological inference. We remain actively involved in coordinating the DR1 Key project focused on deriving cosmological constraints from the joint analysis of weak lensing and galaxy clustering. We have selected the World Trade Center Barcelona as the venue for the Euclid Consortium meeting in 2026 and have been working in its organisation.

This year was marked by the passing of Yannick Mellier, the Euclid Consortium Lead, on 19 December 2025. His death deeply affected the entire collaboration, which now has to adapt to this new situation. Yannick had guided the Consortium since its inception and was instrumental in shaping its scientific vision.

LISA

Senior Institute members involved: Carlos Sopena, Miquel Nofrarias, Sascha Husa

The Laser Interferometer Space Antenna (LISA) will be the first space-based gravitational-wave observatory that will survey the entire observable Universe in the low-frequency band (around the millihertz). In January 2024, LISA successfully passed the Mission Adoption Review, which marks the conclusion of the preliminary design phase and the formal start of the industrial implementation phase. With this milestone, LISA officially became a Large-class (L-class) mission within the ESA Science Programme.

The ICE-CSIC group leads the Spanish contribution to the mission, which contains both instrumental and ground-segment components: (a) The instrumental contribution consists of the Science Diagnostics Subsystem (SDS; M. Nofrarias is the PI leading this effort), responsible for monitoring and characterising environmental disturbances (e.g., temperature, magnetic field, radiation) that could affect the interferometric measurements. (b) The ground segment contribution (C. F. Sopena is the PI leading this effort) is part of the LISA Data Distributed Processing Center (DDPC). This contribution consists of a Data Computing Centre (DCC) and the development of a global-fit data analysis pipeline aimed at producing a comprehensive

catalogue of gravitational-wave sources from the LISA data stream. In addition, ICE-CSIC has a major contribution to waveform modelling within the DDPC framework (led by PI S. Husa), that is, to the production of accurate waveform models that are essential for the global-fit pipelines.



Group picture of the LISA Pathfinder commemoration event.
Credits: ICE-CSIC.

Recent developments

During 2025, the LISA prime contractor (a consortium led by OHB System AG) fully started activities and conducted a co-engineering phase with the different subsystems, including the SDS. This process consolidated the technical requirements and baseline design of this subsystem. The SDS now enters an industrial implementation phase where Elegant BreadBoard Models will be manufactured by industrial partners and subsequently validated through dedicated test campaigns.

In parallel, the group has developed and manufactured Qualification and Flight Models (QMs and FMs) of the In-Orbit LISA Diagnostics Demonstrator (ILIADA), an in-orbit demonstrator carrying prototypes of the main diagnostics on-board LISA (temperature sensors, magnetometers, and a radiation monitor). ILIADA will fly on the forthcoming GENER-02 mission within the framework of the NewSpace programme of the Generalitat de Catalunya. The FM is now fully qualified for flight after passing thermal-vacuum and vibration tests. The launch of GENER-02 is expected in 2026.

On the ground segment front, we have been working on the development of a prototype for the Spanish Data Computing Centre. We have also developed, in the context of the Deep Analysis coordination unit of the

DDPC, new data analysis algorithms for the detection and characterisation of galactic binaries and massive black hole binaries (MBHBs), using both classical Bayesian sampling techniques and simulation-based inference methods based on advanced machine learning techniques. On the other hand, Sascha Husa has served as one of the co-chairs of the waveforms coordination unit of the LISA DDPC, being responsible for the development of quality control procedures for the waveforms code infrastructure that will be developed for the LISA ground segment. Together with Juan de la Cierva fellow Héctor Estellés, he has also been contributed to the sub-project devoted to develop waveforms for the coalescence of MBHBs, in particular in preparing the first data challenge of the DDPC, where their IMRPhenomT waveform model will be used to test LISA global fit algorithms.

Finally, the ICE-CSIC group has been leading the consolidation of the Spanish community interested in the science of LISA, first by creating the LISA Spain meetings (2024 and 2025) and more recently by structuring the community. Most members of the ICE-CSIC group are core members of the new LISA consortium, launched in June 2025, and organised within the LISA-IEEC group, represented on the consortium council by Sascha Husa.

PAU

Senior Institute members involved: Enrique Gaztañaga, Francisco Castander, Martin Crocce, Pablo Fosalba

PAUcam is a unique instrument designed to make high accuracy photometric surveys using 40 narrow-band filters spaced by 100Å in the spectral range of 4500-8500Å. Together with IFAE, we are responsible for building and maintaining the PAUcam in the 4m WHT Telescope in La Palma, Spain. ICE-CSIC is leading the Science and operation of the PAU Survey (PAUS). We also manage the international collaboration and data reduction.

Recent developments

In 2025, PAUS reached several important milestones, including the publication of multiple key collaboration papers and the completion of related PhD theses. These works addressed a broad range of topics, such as intrinsic alignments, photometric redshifts using the estimation algorithm ANNz+, galaxy properties derived through symbolic regression, and the evolution of galaxy luminosity functions up to redshift $z = 2$. A comprehensive list of publications is available at the PAUS website.

In parallel, several additional papers and PhD projects are currently in preparation. These include studies of photometric redshifts based on realistically simulated narrow-band photometry using the Euclid Flagship 2 simulations (in collaboration with Euclid), investigations of cosmic chronometers, and analyses of active galactic nuclei in galaxy pairs.

Together, these results represent a significant contribution to the study of galaxy formation and evolution and further consolidate PAUS's role as a leading project in precision photometry and its applications to cosmology and astrophysics.

PAZ

Senior Institute members involved: Estel Cardellach, Ramon Padullés, Serni Ribó, Antonio Rius

The Radio Occultation and Heavy Precipitation aboard PAZ (ROHP-PAZ) is a proof-of-concept experiment designed and managed at ICE-CSIC. The polarimetric radio occultation measurement concept was conceived at the Institute to measure atmospheric heavy precipitation in addition to the standard radio occultation thermodynamic products. The novelty of the Radio Occultation and Heavy Precipitation experiment aboard PAZ, launched in February 2018 and activated in May 2018, is its capability to quantify the effects suffered by the signals induced by large rain droplets (intense rain) and frozen particles (cloud ice, snow, graupel, etc.). Thanks to the ROHP-PAZ data, ICE-CSIC researchers have confirmed the experiment's hypothesis: the recorded polarimetric signals are sensitive to heavy rainfall and other hydrometeors.

These features are captured through the vertical and horizontal components of the GPS signal, the so-called 'polarimetric observations,' measured for the first time from space. The experiment is also the only one able to jointly sense precipitation and its thermodynamic properties, important pieces of information to understand the conditions underlying intense precipitation, with potential to contribute to improving the modelling/ forecast/ climate projections of these extreme events. The polarimetric data are accessible through the ROHP-PAZ website, hosted at ICE-CSIC, which also contains outreach information. The ROHP-PAZ experiment is funded by the Spanish Ministry of Science and Innovation and led by ICE-CSIC. In addition to NASA Jet Propulsion Laboratory, the experiment is possible through collaborations with the PAZ satellite owner, operator and exploiter, Hisdesat, the National Oceanic and Atmospheric Administration and the University Corporation for Atmospheric Research. The 'traditional' (equivalent to non-polarimetric) radio occultation data are disseminated in near-real time to worldwide weather services through the WMO/UN Global Telecommunications System.

Recent developments

During 2025, ROHP-PAZ continued to provide with Global Navigation Satellite System (GNSS) polarimetric radio occultation data (GNSS PRO), and ICE-CSIC has processed the data into calibrated vertical profiles of polarimetric phase shift. This year, an ESA contract with the European Centre for Medium-Range Weather

Forecasts and ICE-CSIC has kicked off to conduct experiments that will help assessing the impact of assimilating PRO data into the numerical weather prediction models. Furthermore, we have proved the use of PRO data as a diagnosis tool for microphysics schemes in the weather forecast.

PLATO

Senior Institute members involved: Ignasi Ribas, Aldo Serenelli, Juan Carlos Morales

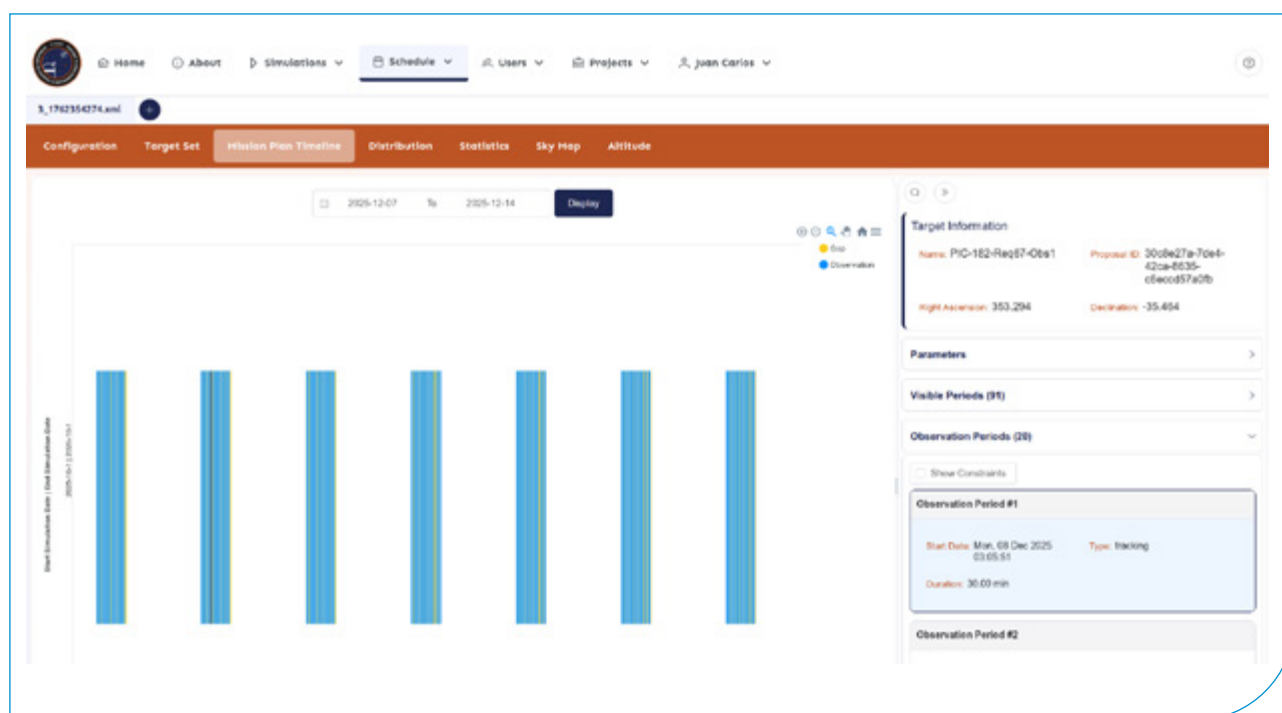
Plato (PLANetary Transits and Oscillations of stars) is the next ESA medium-class mission to be launched in 2026. It consists of 26 cameras that will be staring continuously to a 49x49 deg field on the sky, with the goal of detecting the transits of exoplanets crossing in front of their host stars, and in particular, a Sun-Earth twin. The exoplanets detected by Plato will have to be confirmed with additional photometric and high contrast imaging observations in order to discard false positive scenarios as well as with spectroscopy to provide a measurement of the mass of the exoplanet. The Ground-based Observations Program (GOP) will be in charge of coordinating all these observations. The exoplanet candidates received from the PLATO Data Centre will be distributed among the different facilities according to the relevant parameters and to the observing time availability. At ICE-CSIC, in collaboration with a broader IEEC team, we are contributing to the GOP with a planning software based on the STARS scheduling tools and Artificial Intelligence optimization algorithms that we are developing.

Recent developments

During 2025, we have been developing the Plato-GOP scheduler as per the requirements and design consolidated in 2024, as well as adding new functionalities and parameterisations into the STARS scheduling functions to handle the different observation types and strategies. We have also participated in the preparation of the database used as an interface between the different GOP subsystems. Besides, we have carried out independent tests of the scheduling tool and global tests in coordination with all the other subsystems of the GOP structure. The STARS graphical user interface (STARS GUI) has been adapted and integrated into the observers' interface

developed by the Observatory of Geneva (see Figure below). The main goal of this subsystem is to transfer the observation plans generated by the GOP scheduler to the observers collecting data.

In addition to participating in the GOP, ICE-CSIC is helping to better define the science case of the mission and contributing to the preparation of the data analysis tools. We have been actively participating in the work packages on Stellar Activity and Rotation and Spot Models and we are responsible for the production of the libraries of stellar models that will be used by Plato to determine the fundamental properties of stars in its core programme.



STARS graphical user interface showing one week of the plan of observations of a mock list of Plato exoplanet candidates for one of the instruments defined in Plato GOP and used for testing purposes.

Credits: Juan Carlos Morales.

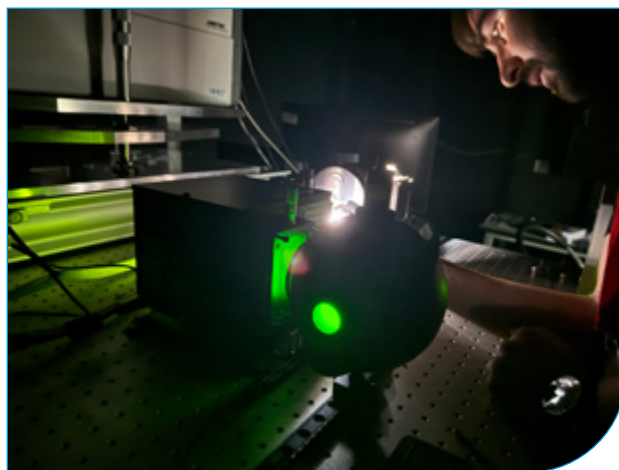
5.2. Scientific and technical contribution

This section comprises missions where ICE-CSIC provides important contributions to the development of space missions and instruments.

ARRAKIHS

Senior Institute members involved: Ricard Casas, Francisco Castander, Pablo Fosalba, Enrique Gaztañaga, Mireia Montes, Santiago Serrano

ARRAKIHS (Analysis of Resolved Remnants of Accreted Galaxies as a Key Instrument for Halo Surveys) is a space mission that was selected in November 2022 as the new fast mission in ESA's Science Programme. ARRAKIHS is designed to study the effects of dark matter on the observed galactic structures exploring the low surface brightness regime. ARRAKIHS will image about one hundred nearby galaxies and their surroundings, using innovative twin binocular assemblies of small telescopes, to characterise the number and nature of galactic substructure and stellar streams in their vicinity. This survey, in visible and infrared wavelengths, will far exceed what is currently possible from ground-based telescopes and will provide the possibility to make tests of the dark matter paradigm of structure formation as well as producing a dataset of significant legacy value.



ICE-CSIC researcher Álvaro Montoro working on the setup for the ARRAKIHS test calibration bench of the visible sensors at ICE-CSIC Optical laboratory.
Credits: Santiago Serrano.

Recent developments

During 2025, the ARRAKIHS mission achieved major progress across its scientific, technical, and organisational activities. The Science Team consolidated the ARRAKIHS Science Committee and produced numerous technical notes supporting ESA's Science Study Team. In parallel, the preparation of the mission Red Book was initiated, a key milestone towards mission adoption.

A major achievement was the installation and commissioning of the On-Ground Demonstrator at the Javalambre Astrophysical Observatory, Spain, where the first images were successfully acquired using the iSIM 170 camera, a replica of the scientific instrument core. At consortium level, the annual ARRAKIHS Consortium Meeting was held in Vienna, Austria, and the consortium expanded to more than 150 members, reflecting the growing scientific and institutional engagement.

As for the instrument, the System Requirements Review was successfully closed early in the year. An internal Intermediate Analysis and Design Review was

conducted to consolidate the instrument design in preparation for the Preliminary Design Review (PDR). Several subsystem breadboards and qualification campaigns were initiated, and a substantial fraction of the PDR documentation was completed, representing another essential step towards mission adoption.

ICE-CSIC researchers played a major role throughout 2025, contributing to the Science Team with support to cosmology and simulation activities. In particular, they actively contributed to the modeling and analysis of realistic simulated images of Milky-Way like galaxies i.e. similar to those that will be observed by ARRAKIHS. The outcome of these analyses has been included in the RedBook and other technical notes that are key to the scientific preparation of the mission.

The ICE-CSIC team also participated in the Science Study Team, commissioning and operating the OGD, leading instrument coordination and calibration activities, and initiating the design and setup for the test calibration bench of the visible sensors at the ICE-CSIC Optical Lab (see image above).

DES

Senior Institute members involved: Enrique Gaztañaga, Francisco Castander, Martin Crocce, Pablo Fosalba, Lluís Galbany

The Dark Energy Survey (DES) is an international astronomical collaboration with more than 400 scientists from 25 institutions. The DES collaboration designed, built and operated a state-of-the-art imaging camera (DECam) to produce the largest survey of galaxies in the Universe, more than 500 million objects over 5000 deg² of the southern sky, and spanning the last 10 billion years of cosmic history. The goal is to trace the large-scale structure of the Universe to study some major issues in observational cosmology, in particular the late time cosmic acceleration. DES last observations were in January 2019 while the collaboration is now concluding the final science analysis with the full dataset, probing the growth of structure by combining clustering and lensing, in addition to baryon acoustic oscillations (BAO), Type Ia supernovae (SNIa), and clusters.

Recent developments

ICE-CSIC researchers have played a central role in several of DES most impactful recent results. A major highlight is the BAO + supernova joint cosmological analysis, which combines DES BAO measurements with the DES supernova sample to deliver competitive constraints on the expansion history of the Universe, with Martin Crocce and Lluís Galbany playing leading roles. In parallel, ICE-CSIC researchers, led by Galbany, contributed to a comprehensive reanalysis of the DES supernova dataset. This work refined the calibration, control of systematic uncertainties, and cosmological interpretation of the supernova sample, reinforcing the robustness of DES supernova constraints.

ICE-CSIC has also been deeply involved in the final batch of DES Key Project cosmological results based on the full six years of data (DES-Y6). M. Crocce has

served as Key Project lead, coordinating the overall cosmological analysis, while Álex Alarcon and Giulia Giannini have led the Redshift Working Group, delivering critical advances in photometric redshift calibration. Giannini has also led the galaxy-galaxy lensing and lensing redshift work, while PhD student Gisela Camacho has led the shear-ratio analyses, and PhD student José María Coloma has contributed to the cosmological inference. The flagship DES-Y6 cosmological analysis is now nearing completion and, for the first time, combines all DES dark-energy probes: 3×2pt (weak lensing and galaxy clustering), supernovae, baryon acoustic oscillations, and galaxy clusters. Its release will mark the culmination of DES's cosmological programme and nearly 20 years of contributions from the ICE-CSIC cosmology group.

DESI

Senior Institute members involved: Francisco Castander, Martin Crocce, Pablo Fosalba, Enrique Gaztañaga, Mar Mezcua

The Dark Energy Spectroscopic Instrument (DESI) collaboration has built a large field of view multi-fibre spectrograph to perform a spectroscopic survey of tens of millions of galaxies to study dark energy using baryon acoustic oscillations (BAO) and redshift space distortions. ICE-CSIC, together with IFAE, has built the guiding and focusing of the Guiding, Focusing and Alignment system (GFAs) units of the instrument. ICE-CSIC also developed the guiding software. We also lead the Image Validation Working Group and participate in the collaboration management in the institutional board, and membership committee.

Recent developments

In 2025, DESI completed its fourth year of observations. Operations have continued routinely. DESI has now gathered around 60 million spectra of galaxies and quasars and around 20 million spectra of stars. DESI is ahead of schedule and the main survey is almost complete. We have started with an extension programme of the survey with further passes in bright and dark time and also covering additional survey area. Plans are also underway for a second part of the DESI survey, focusing on higher redshift tracers of the large scale structure, sampling a higher density sample and mapping local structures to help

constrain dark matter.

In March 2025, DESI published a major set of analyses combining three years of spectroscopic data (Data Release 2, DR2) with observations from the CMB, supernovae, and weak lensing. These studies supported previous DESI results showing that dark energy may not be constant, but instead evolves over cosmic time. DESI also made public the Data Release 1 (DR1) including ~18 million high-confidence redshifts, making it the largest extragalactic redshift sample ever assembled.

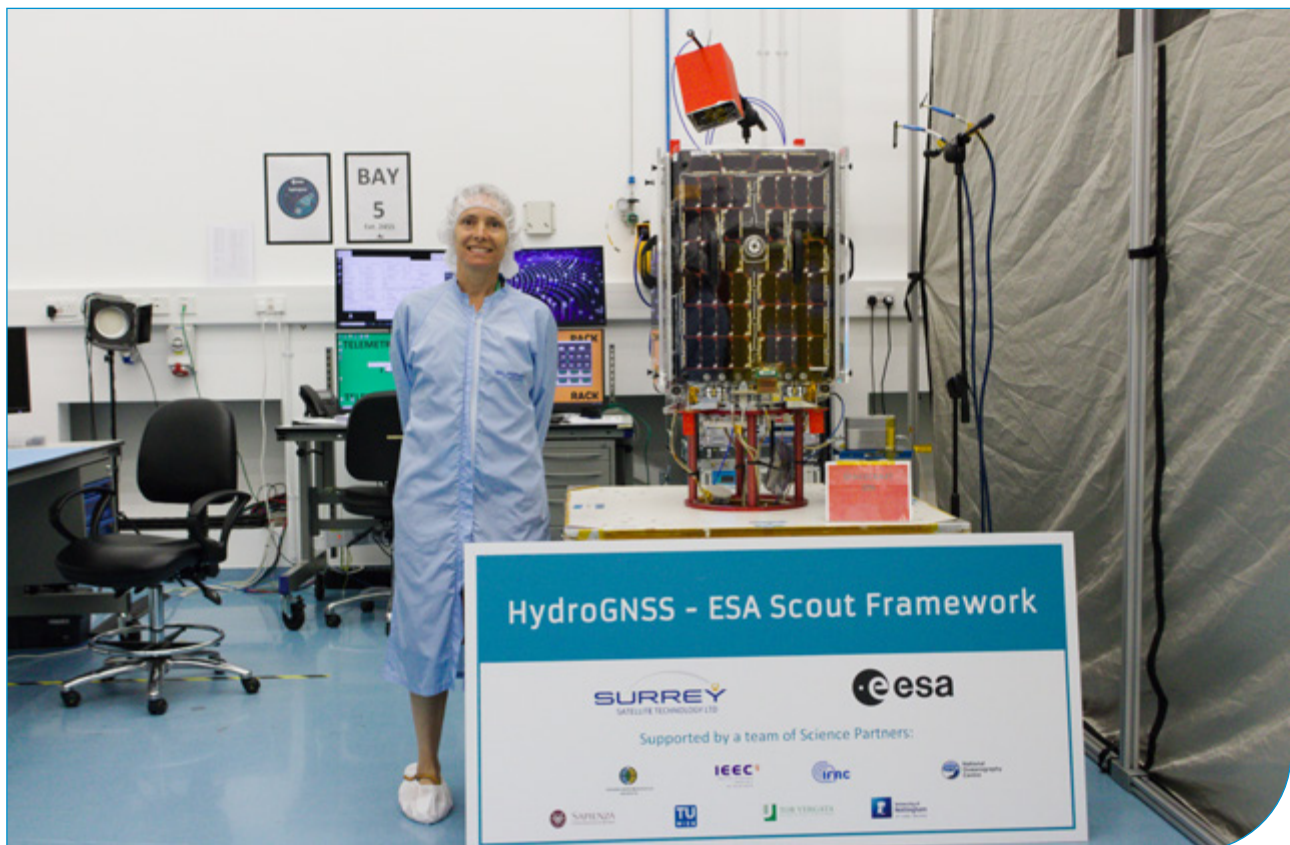
Our ICE-CSIC group continues to be involved in DESI management. In September, Francisco Castander was replaced in his role as deputy chair of the institutional board. In terms of science developments, we have continued with our involvement in the galaxy clustering, galaxies and quasars physics and

Clustering, clusters and cross-correlation science working groups; and participated in some secondary programmes. We have led a paper exploring diagnostics to identify AGN using spectral energy distributions fitting in DESI data.

HydroGNSS

Senior Institute members involved: Estel Cardellach, Serni Ribó, Antonio Rius, Weiqiang Li

HydroGNSS is the second ESA's Scout mission. The HydroGNSS mission, led by the British company Surrey Satellite Technology Ltd, will provide measurements of key hydrological climate variables including soil moisture, freeze– thaw state over permafrost, inundation and wetlands, and above-ground biomass. In order to obtain these measurements, scientists use a technique called 'Global Navigation Satellite System (GNSS) reflectometry'. HydroGNSS paves the way for an affordable future constellation that can offer measurements with a temporal-spatial resolution not accessible to traditional remote sensing satellites, thus offering new capacity to monitor very dynamic phenomena and helping to fill the gaps in our monitoring of the Earth's vital signs for the future.



Estel Cardellach next to the HydroGNSS satellite months before its launch.
Credits: Estel Cardellach.

Recent developments

After ESA selected and approved the mission in 2021, ICE-CSIC's Earth Observation Group has intensively worked as part of the mission consortium towards a quick implementation. The group is responsible for the development, implementation and validation of the operational level-1b processors for signal coherence detection, the level-2 surface inundation processor (operational algorithms for surface water detection), and the 'coherent channel' simulator module, a new

mode of the GNSS reflectometry receiver to be tested in HydroGNSS, whose exploitation is also responsibility of the ICE-CSIC researchers. All these algorithms and processors were already provided to the prime contractor and are part of the operational Payload Data Ground Segment of the mission. The mission was launched on 28 November 2025 and the initial tests are being conducted.

LIGO

Senior Institute member involved: Sascha Husa

The Laser Interferometer Gravitational-Wave Observatory (LIGO) is a groundbreaking scientific facility designed to detect and study gravitational waves, which has opened a new window into the cosmos, allowing scientists to explore phenomena such as black hole mergers, neutron star collisions, and other powerful astrophysical events. LIGO made its first detection of gravitational waves, generated by a pair of colliding black holes some 1.3 billion light years away, in 2015. LIGO operates two large-scale interferometers in the United States of America. These observatories use laser light and precisely aligned mirrors to detect minute distortions caused by passing gravitational waves. By measuring these disturbances, LIGO provides direct evidence of Einstein's theory of general relativity and unveils information about events billions of light-years away. ICE-CSIC participates in LIGO through ICE-CSIC researcher Sascha Husa and his affiliation to the Universitat de les Illes Balears (UIB) Gravitational Physics Group, which is a member of the LIGO Scientific Collaboration (LSC). Husa is leading a team that develops computationally efficient codes for waveform models, which have been used by the LIGO-Virgo-KAGRA collaboration to analyse all events detected to date. Husa is also a member of the LSC Council.

Recent developments

In September 2025, the ICE-CSIC LIGO team doubled in size with the arrival of Juan de la Cierva fellow Héctor Estellés, joining ICE-CSIC staff member Sascha Husa. Both researchers work on waveform modelling and data analysis of spin precession and orbital eccentricity in compact binary coalescences—key signatures of dynamical formation channels such as those in dense stellar environments.

The fourth LIGO–Virgo–KAGRA observing run (O4), which began in May 2023, concluded on 18 November 2025. Its first results have been released in the fourth transient catalog (GWTC-4.0), together with papers on events of special interest. These include GW231123, the most massive merger detected to date,

for which Estellés served as an analysis reviewer. He also contributed to the GWTC-4.0 methods paper, leading the waveform-modelling section, acted as waveform liaison for the catalog, and reviewed parameter-estimation results. Husa contributes to the preparation of GWTC-5.0 and is part of its editorial team. The catalogue will employ the PhenomXPNR waveform model, co-authored by Husa, with Estellés chairing its collaboration review.

Both researchers also contributed to follow-up analyses using public O3 and O4 data, including studies of eccentric black-hole mergers and neutron star–black-hole coalescences, confirming evidence for eccentricity in GW200105.

5.3. Scientific contribution

ICE-CSIC members are part of the scientific teams involved in the following space missions and observatories.

CHEOPS

Senior Institute member involved: Ignasi Ribas

The CHaracterizing ExOPlanet Satellite (Cheops) is the first mission dedicated to studying bright, nearby stars that are already known to host exoplanets, in order to make high-precision observations of the planet's size as it passes in front of its host star. The Cheops mission was launched in December 2019 and it has been on nominal operations since April 2020. The 30-cm telescope is designed to observe a large sample of transiting exoplanets, and to excel at the measurement of the tiny imprint of the planet on the transit and eclipse events, with a precision never attained before. ICE-CSIC is involved in the scientific aspects of the Cheops mission through its participation in the Mission Board and Core Science Team. In addition, the mission control team employs our schedule visualisation tool to allow mission planners evaluate the plans produced by the scheduling algorithm and detect possible alternatives for optimisation.

Recent developments

In 2025, ICE-CSIC continued to play a significant role in the scientific exploitation of the Cheops mission through both leadership and active participation in Guaranteed Time Observations (GTO) programmes. The Institute remains involved in the mission governance via its participation in the Mission Board and Core Science Team, and continues to support mission operations through the use of its scheduling visualisation tools.

A major highlight in 2025 is the strong leadership of ICE-CSIC researchers within Cheops science. Specifically, Angelica Psaridi is the PI of a new Cheops GTO programme dedicated to the precise characterisation of rocky exoplanets orbiting

M-dwarfs, with Ignasi Ribas as co-PI. This programme has successfully started collecting observations and is already delivering high-precision data that will enable improved constraints on the radii, densities, and therefore characterisation of small exoplanets.

In addition, Psaridi is a co-PI in two other Cheops GTO programmes. For all these, she is leading the radial velocity follow-ups using Spanish facilities (CARMENES and HARPS-N). ICE-CSIC scientists also maintain an active participation in the quarterly Cheops science meetings, with two meetings in 2025 taking place in person, at ESTEC and at the Space Research Institute of the Austrian Academy of Sciences (IWF).

DART

Senior Institute member involved: Josep Maria Trigo-Rodríguez

NASA's Double Asteroid Redirection Test (DART) is the first kinetic impact mission dedicated to demonstrating the method of asteroid deflection in a Potentially Hazardous Asteroid. On 22 September 2022, the DART spacecraft collided with asteroid Dimorphos, a 160 metres-in-diameter satellite of the four times larger asteroid Didymos. DART successfully changed the orbit of Dimorphos within the binary system.

Recent developments

During 2025, to end our ICE-CSIC contribution to the DART mission, we participated in a paper by Xiaoyu et al. (2025) dealing with the dynamic aspects associated with the orbital capture of the impact ejecta around the Didymos binary asteroid system. In that article, the ejecta dynamics are described using a bicircular restricted four-body model, incorporating the binary's irregular gravity field and the effect of the

solar radiation pressure induced acceleration. As a result of that study ejecta particles in the range of studied meter to mm-sized particles are unlikely to remain in the vicinity of the orbit and pose a potential hazard to the Hera spacecraft. Consequently, a dust-rich environment surrounding the Didymos system should be considered during Hera approximation at the end of 2026.

EINSTEIN PROBE

Senior Institute member involved: Nanda Rea

The Einstein Probe is an X-ray astronomical space mission led by the Chinese Academy of Sciences in collaboration with ESA and the Max Planck Institute for extraterrestrial Physics aimed at opening a new view of the transient high energy sky. It is a mission dedicated to time-domain astrophysics and it will discover transients and monitor variable objects in the soft X-ray band with an incredible sensitivity. Launched in 2024, Einstein Probe will explore the sky for 3 years looking for new X-ray transients to better understand the most extreme objects in the Universe, in particular high energy flashes of cataclysmic cosmic events. ICE-CSIC is part of the ESA Einstein Probe Science Team, and is chairing the Science Topical Panel 4 on Compact Objects, and part of the Einstein Probe Science Management Committee. Furthermore, we are part of Science Topical Panels on Fast extra-Galactic Transients and Multi-messenger events follow-up.

Recent developments

In 2025, ICE-CSIC strengthened Einstein Probe's impact on time-domain high-energy astrophysics by helping turn rapid soft-X-ray alerts into physical insight.

A headline early-mission result highlighted Einstein

Probe's unique sensitivity to fast, soft-X-ray transients: EP240315a, a long-lasting soft-X-ray signal linked to a high-redshift gamma-ray burst, suggesting that sensitive soft-X-ray monitors can uncover ancient explosions and may force revisions to GRB

prompt-emission scenarios. ICE-CSIC researchers also helped demonstrate Einstein Probe's discovery space for Galactic compact binaries, including a rare Be–white-dwarf system in the Small Magellanic Cloud, revealing an elusive evolutionary stage and showing how Einstein Probe can catch very short, supersoft outbursts that other all-sky monitors would likely miss.

ICE-CSIC members Francesco Coti Zelati and Alessio Marino were central contributors, publishing multiple

analyses that connect Einstein Probe detections to compact-object demographics and accretion physics. Together, these 2025 studies show Einstein Probe is not just an alert machine: it is building statistically meaningful samples of rare transients while catching the faint, early phases of outbursts that were previously missed—key for population studies and for directly testing accretion and explosion models.

Finally, we have collaborated on the first Einstein Probe data release².

EINSTEIN TELESCOPE

Senior Institute members involved: Carlos Sopena, Mar Mezcua, Sascha Husa

The Einstein Telescope (ET) is a proposed underground research infrastructure that will host a third-generation gravitational-wave observatory. It builds upon the achievements of the current second-generation laser-interferometric detectors, the LIGO-Virgo-KAGRA (LVK) collaboration. ET will make it possible, for the first time in the high-frequency band, to explore the Universe through gravitational waves along its cosmic history up to the cosmological dark ages. In doing so, ET will address fundamental open questions in gravitational physics, astrophysics, and cosmology.

ET is currently in its Preparatory Phase following its inclusion in the European Strategy Forum on Research Infrastructures (ESFRI) Roadmap in 2021, with Spain among the four supporting countries. The ET-CSIC Research Unit (RU) played an important role in this milestone of the ET project. The next steps in the development of ET involve the decision about its final configuration (e.g. two L-shaped interferometers versus a single triangular topology) and the selection of its host location in Europe. These key milestones are expected to be achieved during the following next two years.

Recent developments

In 2025, the ET Blue Book, which contains a very detailed description of the rich ET science case has been accepted for publication in the Journal of Cosmology and Astroparticle Physics (JCAP), with significant contributions from scientists affiliated with the ET-CSIC RU.

Moreover, researchers in the ET-CSIC RU are getting more involved in different aspects of the ET science

and associated activities. ICE-CSIC researcher C. F. Sopena is the leader of the ET-CSIC RU of the Einstein Telescope Scientific Collaboration since September 2022. It is a CSIC RU that comprises five CSIC institutes including ICE-CSIC with a total number of 35 ET collaboration members. ICE-CSIC is the one that contributes more scientists to this collaboration, with a total of 20 members, covering a very wide range of topics of interest for the ET project.

eXTP

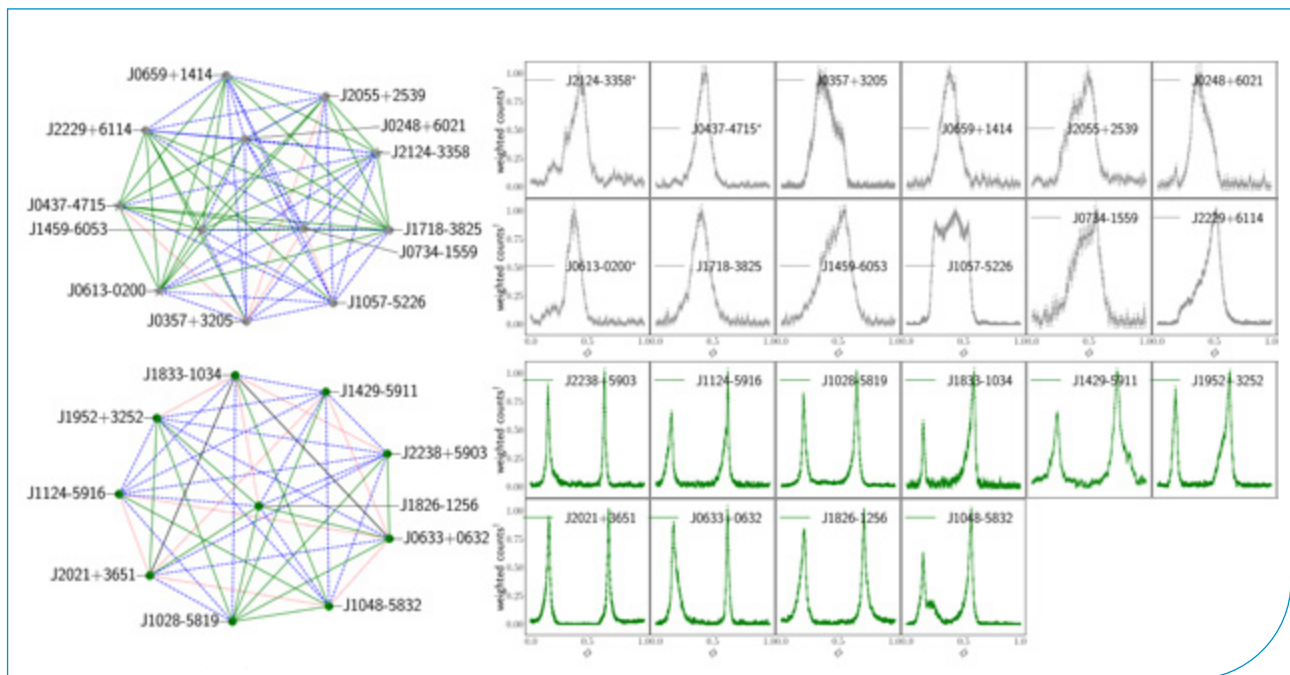
Senior Institute members involved: Margarita Hernanz, José Luis Gálvez, Alessandro Patruno

eXTP is a Chinese X-ray satellite that in its former configuration included four instruments, two led by China (IHEP/CAS) and two by Europe (INAF and ICE-CSIC), with Margarita Hernanz being the PI of the European Wide Field Monitor (WFM). However, there was a de-scoping of eXTP in February 2024 aimed to remove programmatic uncertainties, and now only the two Chinese instruments SFA (Spectral Focusing Array) and PFA (Polarimetry Focusing Array) are kept onboard.

Recent developments

During 2025 we have continued the development of the Demonstration model of a whole WFM camera, in collaboration with the Spanish industries Sener and Tecnia.

² First Einstein Probe data release, available at the ESA's Einstein Probe Science Archive (EPSA): <https://ama.esac.esa.int/ama/#/pages/epsa>



Pulsar clusters and all members are related by at least one similarity at a 3σ significance level. Each node represents a pulsar, and each colored edge connecting the nodes shows the similarity significance of the corresponding light curves (black for $<1\sigma$ and green for $>3\sigma$). Credits: García, C. R., Torres, D. F (2025). Quantitative Exploration of the Similarity of Gamma-Ray Pulsar Light Curves. *The Astrophysical Journal Letters*, 982.

The design, mechanical simulations, manufacturing of the coded mask and other structural parts, like the detectors support plate and collimator (among others), as well as the assembly and precise alignment of the WFM. Thanks to the consulting contracts, it has been possible to optimise the design of the WFM camera itself, as well as its very precise alignment system. An engineering model of the whole camera has been developed.

The alignment and mounting system for the WFM camera has been optimised with the advice of Sener, and the final assembly will be finalized at the Sener company facilities at the beginning of 2026. The design of WFM's detector tray support structure has been optimised with the advice of Tecnalia, which has also manufactured it (in addition to the WFM collimator, already manufactured before).

FERMI

Senior Institute members involved: Diego F. Torres, Daniela Hadasch

NASA's Fermi Gamma-ray Space Telescope, launched in 2008, has two gamma-ray instruments: the Large Area Telescope (LAT) and the Gamma-ray Burst Monitor (GBM). ICE-CSIC hosts a full member (D. F. Torres) in the FermiLAT collaboration (since 2007 before launch), to whom several students and postdocs, as well as an Affiliated Scientist (Nanda Rea) have been associated. The team is devoted to the study of the high-energy Galactic sky, focusing on binaries and the pulsar/pulsar-wind nebula/supernova remnant complex. We participated in the pre-launch activities, simulations and ulterior data analysis, day-to-day running of the experiment, and conducted a variety of tasks. We acted as Flare advocates & daily running checks and participated in the On-orbit calibration & development of responses and the validation of the time-difference analysis technique for radio-quiet pulsars up to helping in the preparations for several NASA Senior Science Reviews.

The highlights of the Institute's contribution to the mission include leading the collaboration work when publishing Fermi's first paper on supernova remnants observations, the first ever detection of orbital GeV variability, the first search for magnetar emission in gamma-rays, the first detection of gamma-ray emission of starburst galaxies, or the first detection of super-orbital variability, among many others. Moreover, we have also had technical involvement such as the definition of a mock population for data challenges and the development of algorithms for source class identification used in the Bright Source List and the First Fermi-LAT Catalogue, or the spectral pipeline of the Second Fermi-LAT Pulsar Catalogue.

Recent developments

This year, we have been actively analysing the pulsars detected in the Third Fermi-LAT catalogue. The Third Fermi Large Area Telescope Pulsar Catalogue presented 294 light curves associated with known pulsars, including 143 millisecond pulsars. It provides a wealth of information about the mechanisms that generate pulsar beams. We have focused on both, understanding the similarity of the lightcurves they have in quantitative ways. For that we pioneered the use of dynamic time warping (DTW) on pulsar physics, an algorithm employed to measure the similarity between two sequences that may vary in speed. DTW is also employed in different fields, such as medicine, seismology, financial market analysis, and speech recognition.

Regarding theoretical models, this year we have achieved, enhancing our code OG-Lightcurve to the ability to produce concurrent fitting of both spectra and lightcurve of the whole catalogue. Our model properly fits all the spectra and reproduces well a considerable fraction of light curves. Light curve fitting itself is something that required innovation and testing.

On the observational side, we have led the Fermi-LAT studies on pulsar wind nebulae (PWNe).

An increasing number of PWNe are being identified in the TeV band by ground-based Imaging Air Cherenkov Telescopes such that they constitute the dominant source class of Galactic TeV emitters. However, MeV–GeV PWN counterparts are still largely lacking. To date, only a dozen PWNe are identified. Most PWNe are located along the Galactic plane embedded within the prominent, diffuse Galactic γ -ray emission, which makes these sources difficult to disentangle from the bright diffuse background. We presented a systematic search for γ -ray counterparts to known PWNe in the 300 MeV–2 TeV energy band using the Fermi-LAT.

We reported on the analysis of 58 regions of interest and classified Fermi-LAT detected sources as either a likely PWN or a candidate PWN counterpart based on their morphological and spectral characteristics across the broadband spectrum. There are nine unidentified Fermi-LAT sources that we consider as likely PWN counterparts, which, if confirmed to be PWNe, would greatly increase the PWN population detected by the Fermi-LAT from 12 to 21.

In the strictly technical part, we have been in charge of several data shifts for flare advocacy.

HERA

Senior Institute member involved: Josep Maria Trigo-Rodríguez

Hera is an ESA mission that will visit the binary asteroid Didymos to map Didymos and Dimorphos at a high resolution while it makes several technological demonstrations under low-gravity conditions. The main goal of Hera is obtaining clues on the nature and structure of both asteroids in order to use that knowledge to mitigate future encounters with hazardous asteroids.

ICE-CSIC participation in the Hera mission involves being part of the investigation team to study Didymos binary asteroid system, with emphasis in the DART-generated impact crater and the surface characteristics of Dimorphos. ICE-CSIC researcher Trigo-Rodríguez belongs to the Data Analysis, Exploitation and Interpretation working group. He is also involved in the Close Operations working group to decide the regions to be specially studied by the diverse instruments and satellites on board the Hera spacecraft. Our expertise in meteorites, and the new VIS-midIR vacuum spectrometer available at ICE-CSIC will allow us to interpret the features of the reflectance spectra received from Hera's sensors.

Recent developments

On 12 March 2025, the Hera probe, ESA's first planetary defense mission, passed 5,000 km from Mars and less than 1,000 km from the moon Deimos, the farthest and most enigmatic of the red planet's satellites. It was an excellent opportunity to test most of the instruments onboard. Probably, the most exciting science will come from the hyperspectral camera Hyperscout H developed at Instituto de Astrofísica de Canarias (IAC), particularly applied to study the face of Deimos opposed to Mars. Some clues on the mineral composition, and the size of the regolith covering Deimos' surface are expected

from these hyperspectral images, probably helping to determine whether it is an asteroid gravitationally captured by Mars or if it could have been ejected at a high velocity following the impact of an asteroid with Mars, as a result of the excavation of a large crater that sent large blocks into Martian orbit.

In addition, another cutting-edge instrument called TIRI provided an amazing sequence of Mars' close encounter, exemplifying the kind of novel data expected when visiting Didymos system. TIRI have mid-infrared spectral bands to map the surface temperature, and it was provided by the Japan

Aerospace Exploration Agency (JAXA). To compare with these results, we obtained some reflectance spectra of Martian achondrites in the ICE-CSIC Meteorites and Sample Return clean laboratory.

In any case, after Mars' close approach, the Hera probe entered interplanetary space on its way to the binary asteroid system Didymos, scheduled

for late December 2026. We will start most of our ICE-CSIC contribution during the phase of study and interpretation of the imagery, once the mission reaches the double asteroid. Hera state-of-the-art instruments will provide new data on the impact consequences of DART, the mineralogy and geology of both asteroids.

LSST

Senior Institute members involved: Lluís Galbany, Francisco Castander, Martin Crocce, Pablo Fosalba

The Vera C. Rubin Observatory is a cutting-edge astronomical facility in Chile, primarily tasked with conducting the Legacy Survey of Space and Time (LSST), a comprehensive synoptic survey across six bands (ugrizY). LSST will cover one-third of the southern sky every night for ten years. To maximise the scientific return from its observations, the LSST community is organised into science collaborations. The Cosmology and Supernova research groups at ICE-CSIC are active members of the Dark Energy Science Collaboration (DESC) and the Transient and Variable Sky Science Collaboration. The Supernova group at ICE-CSIC has been particularly active in the Type Ia supernova modeling topical team.



Image taken by the Vera C. Rubin Observatory in just over seven hours of observing time. Combining many images in this way clearly reveals otherwise faint or invisible details, such as the clouds of gas and dust that comprise the Trifid nebula (top right) and the Lagoon nebula, which are several thousand light-years away from Earth.

Credits: NSF-DOE Vera C. Rubin Observatory.

Recent developments

On 12 December 2025, the agreement between the Barcelona–Madrid consortium and Rubin–LSST was formally signed, and all consortium members (IFAE, CIEMAT, IFT, and ICE-CSIC) are now official members of the LSST collaboration. Lluís Galbany took the role of DESC Publication Manager in November 2025. As part of the preparation for LSST, two recent studies highlight its strong potential for extragalactic astrophysics. Englert et al. (2025) show that imaging with a depth equivalent to eight years of LSST observations enables the detection of faint stellar structures in galaxy clusters, revealing evidence of past interactions. Canepa et al. (2025), in turn, develop machine-learning techniques to automatically measure diffuse light in clusters, a key advance given the large data volume expected from

LSST. Within the DESC cosmology collaboration, ICE-CSIC members made significant contributions to three publications. Open Universe (2025) presents a public simulation suite providing realistic, matched synthetic imaging and catalogues for LSST and Roman over a common simulated sky, aimed at maximising the scientific return of next-generation cosmological surveys. Carreres et al (2025) use simulated Rubin–LSST supernova data to study the growth of cosmic structure, while highlighting potential biases from unmodeled astrophysical effects. Finally, Malz et al (2025) show that light-curve classification metrics are not reliable proxies for cosmological performance in photometric Type Ia supernova analyses, advocating for optimization based on cosmology-driven metrics.

LS4

Senior Institute member involved: Lluís Galbany

The La Silla Schmidt Southern Survey (LS4) is a new time-domain survey to monitor the night sky searching for stellar explosions, stellar variables, and other transients that change brightness on timescales of minutes to years. LS4 utilises the 1m Schmidt Telescope at the La Silla Observatory (Chile) and the upgraded Quest camera, which features 32 Lawrence Berkeley National Laboratory deep-depletion CCDs and provides a total field of view of approximately 20 deg². Half of the focal plane observes in the i band, while the other quarters are dedicated to the g and z bands. ICE-CSIC as an institutional member has participated in the proposal of the project and observing strategy, and has a seat in the Collaboration Council. The Supernova group at ICE-CSIC is actively involved in the supernova physics and supernova cosmology working groups.

Recent developments

LS4 completed commissioning in November 2025, achieving full control of the telescope and camera system and producing science-ready data. Due to a delay in the upgrade of the data-transfer system from La Silla Observatory to La Serena, data have so far been stored on hard drives and analysed on site. Every few days, the collected data are transferred to Berkeley, where they are processed using the official LS4 pipeline and alert stream. As a result,

fully automatic remote observations are not yet in place, and observations must be carried out both on site and remotely for the next few months. The ICE-CSIC supernova group participates in the remote observations and has been awarded telescope time at the Roque de los Muchachos Observatory, Spain, to classify and follow up on particularly interesting discoveries.

NEWATHENA

Senior Institute members involved: Nanda Rea, Francesco Coti Zelati

The NewAthena mission, an ambitious large X-ray observatory developed by ESA, aims to revolutionise our understanding of the cosmos through multi-messenger astrophysics. Scheduled for official adoption in 2027 and a projected launch in 2037, NewAthena is designed to surpass current X-ray observatories in sensitivity and capabilities. The observatory will be equipped with two advanced instruments: a wide-field detector capable of mapping extensive sky regions to identify X-ray sources, and an integral field unit designed to capture images and spectra at each point. This combination will provide critical data on the composition and physical state of cosmic objects, enabling unprecedented precision in observing phenomena such as stellar winds and supernova explosions. The NewAthena mission is poised to open new avenues in astrophysics, offering deeper insights into the fundamental questions of modern astrophysics and the dynamic processes shaping the cosmos.

ICE-CSIC plays a significant role in the NewAthena mission. Notably, Nanda Rea is a member of the NewAthena Science Study Team, the scientific steering committee appointed by ESA to define the mission's scientific requirements and support all aspects related to its scientific return until its adoption. Additionally, approximately ten ICE-CSIC scientists contribute to the NewAthena Topical Panels, reflecting the Institute's active involvement in shaping the mission's scientific objectives.

Recent developments

In 2025, ICE-CSIC contributed to the consolidation of NewAthena (ESA's reshaped flagship X-ray observatory concept) during a key programme phase in which the mission and industrial activities progressed toward major design reviews. ESA and the NewAthena project report had a successful interim review in June 2025, keeping the mission on a path toward adoption around 2027 and a planned launch in 2037. ICE-CSIC also communicated NewAthena's strategic importance for multi-messenger astrophysics and its role in enabling transformational surveys and high-

resolution spectroscopy across compact objects, black holes, and large-scale structure.

A flagship community output underpinning these activities is the Nature Astronomy paper by Cruise et al. 2025, "The NewAthena mission concept in the context of the next decade of X-ray astronomy", which synthesises the mission's science case and explains how NewAthena's leap in sensitivity, survey power and spectral capability will address major questions from compact-object physics and transients to galaxy evolution and cosmology.

ROMAN

Senior Institute member involved: Lluís Galbany

The Nancy Grace Roman Space (Roman) Telescope is a NASA 2.4m wide-field infrared space telescope, scheduled for launch into an L2 orbit by September 2026. Equipped with the Wide-Field Instrument, a 300.8-megapixel multi-band visible and near-infrared camera capable of imaging a 0.28 deg^2 field of view (100 times larger than the Hubble Space Telescope), Roman will investigate the Universe's chronology and the growth of cosmic structures, aiming to measure the effects of dark energy, test the consistency of general relativity, and explore the curvature of spacetime. The ICE-CSIC Supernova group at ICE-CSIC is a member of the Roman Project Infrastructure Team, contributing to the development of the analysis pipeline for supernova cosmology.

Recent developments

The construction and testing of the telescope are progressing at an excellent pace, and the Roman team is working toward a launch date of 28 September 2026, with a contingency plan no later than May 2027. The supernova cosmology Project Infrastructure Team, of which the Supernova ICE-CSIC group is a part, is making steady progress toward delivering a

fully operational pipeline by the time the first Roman images are received, enabling the production of supernova distance measurements and constraints on cosmological parameters. The Supernova ICE-CSIC group participates in both the Characterisation and Spectroscopy Working Groups.

SKAO

Senior Institute members involved: Josep Miquel Girart, Sascha Husa, Mar Mezcuá, Nanda Rea, Álvaro Sánchez-Monge

The Square Kilometre Array Observatory (SKAO) is a next-generation radio astronomy-driven Big Data facility that will revolutionise our understanding of the Universe and the laws of fundamental physics. The SKAO will consist of two cutting-edge arrays: 1) SKA-Low in Western Australia, comprising 131,072 low-frequency antennas, is designed to study the early Universe and the formation of the first stars and galaxies and 2) SKA-Mid in South Africa, featuring 197 mid-frequency dishes, will probe galaxy evolution, cosmic magnetism, and exoplanet systems. Composed of respectively hundreds of dishes and thousands of antennas, the SKAO's arrays will be the two most advanced radio observatories on Earth. Together with other state-of-the-art research facilities, the SKAO will explore the unknown frontiers of science and deepen our understanding of key processes, including the formation and evolution of galaxies, fundamental physics in extreme environments and the origins of life. ICE-CSIC is involved in several scientific working groups, such as the SKA Continuum, SKA-VLBI, SKA-Cradle of life, SKA-Our Galaxy, SKA-Cosmic Magnetism, SKA-Pulsar or SKA-Transients, and is actively contributing to writing multiple chapters of the SKAO Science Book.

Recent developments

In 2025, ICE-CSIC researchers continued their active involvement in the scientific preparation for the SKAO. Several members contributed to the preparation of chapters for the upcoming SKAO Science Book (*Advancing Astrophysics II*), including work on topics such as chemical complexity in the early stages of star formation, the ionised Milky Way, jets and outflows in young stellar objects, the impact of massive stars and stellar clusters, the chemistry of planet-forming disks, pulsars and transient objects. ICE-CSIC also

contributed to the broader SKAO science preparation through participation in the SKAO Science Meeting 2025 held in Görlitz, Germany, which brought together the community to prepare for early science operations and discuss observing capabilities, data products, and analysis challenges. During the meeting, Elena Díaz-Márquez participated in sessions focused on Galactic science and the Cradle of Life theme, and presented the poster "*Characterizing the stellar population in the IRDC G14.225-0.506*", based on VLA observations.

6. Publications

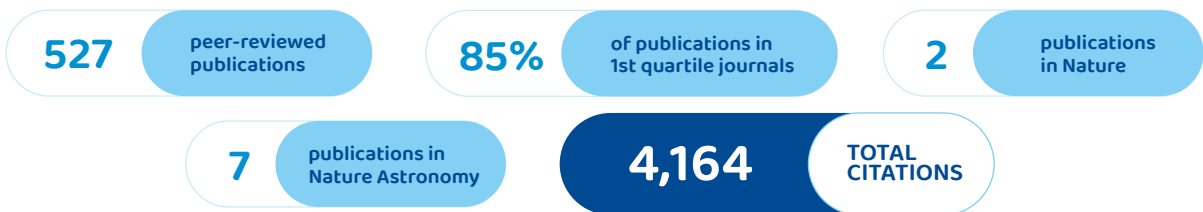
6.1. Peer-reviewed Publications

In 2025, ICE-CSIC personnel participated in a total of 527 peer-reviewed publications, 226 more than the average in the period between 2021 and 2024.

All of these publications are directly accessible from an ADS-library linked from our webpage, and they are also listed below. The majority of the total of publications (around 85%) are in 1st quartile astrophysical journals, based on the SJR quartiles classification of 2024.³

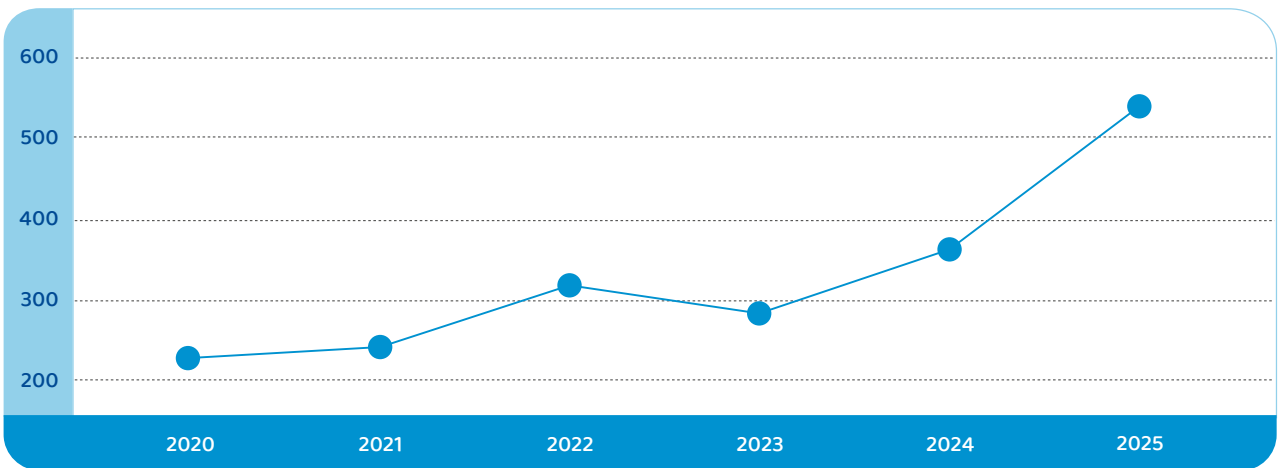
	2020	2021	2022	2023	2024	Average 2021-2024	2025
N° peer-reviewed papers	221	231	313	289	372	301.3	527
ICE-CSIC led papers	38	34	74	63	100	67.8	102
% of papers with ICE-CSIC leadership ⁴	17.2	14.7	23.6	21.8	26.9	22.5	19.4

In 2025



N° peer-reviewed papers

● N° peer-reviewed papers



³ Full list of journals in the first quartile, according to the SJR classification: Astronomy & Astrophysics, Atmospheric Chemistry & Physics, Atmospheric Measurement Techniques, Bulletin of the American Meteorological Society, Classical and Quantum Gravity, European Physical Journal C, Geo-spatial Information Science, Geophysical Research Letters, Geoscience Frontiers, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, IEEE Transactions on Geoscience and Remote Sensing, Journal of Astronomical Telescopes, Instruments, and Systems, Journal of High Energy Astrophysics, Journal of High Energy Physics, Monthly Notices of the Royal Astronomical Society, Nature, Nature Astronomy, Nuclear Physics B, Physical Review D, Physical Review Letters, Physics Letters B, Physics of the Dark Universe, Physics Reports, Publications of the Astronomical Society of the Pacific, Science Advances, Science Bulletin, Science China: Physics, Mechanics & Astronomy, The Astronomical Journal, The Astrophysical Journal, The Astrophysical Journal Letters, The Astrophysical Journal Supplement Series and Universe.

Full list of journals in the second quartile: Astronomy and Computing, Experimental Astronomy, Journal of Cosmology and Astroparticle Physics, Open Research Europe, Publications of the Astronomical Society of Japan, Symmetry, and The Open Journal of Astrophysics.

Full list of journals in the third quartile: Astrophysics and Space Science and Journal of Instrumentation.

Full list of journals in the fourth quartile: Russian Physics Journal.

⁴ Papers with ICE-CSIC researchers as first and/or second author or corresponding author.

379 papers

≥15 Authors

Astronomy &
Astrophysics
160

JCAP
50

MNRAS
43

The Astrophysical
Journal
37

Physical
Review D

26

The Open
Journal
of Astrophysics

13

The
Astrophysical
Journal Letters

11

The
Astronomical
Journal

8

Nature
Astronomy

7

Science China: Physics,
Mechanics & Astronomy

6

The Astrophysical
Journal Series

4

Nature

2

Other
Journals

12

148 papers

<15 Authors

Astronomy &
Astrophysics
53

MNRAS
20

Physical
Review D

12

Physics
Letters B

8

The
Astrophysical
Journal

16

Physics of
the Dark
Universe

6

JCAP

3

IEEE Transactions
on Geoscience
and Remote
Sensing

3

Other Journals
22

The
Astrophysical
Journal Letters

2

European
Physical
Journal C

2

Physical
Review
Letters

1

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7. Training

7.1. Postgraduate Programme in High Energy Physics, Astrophysics & Cosmology

ICE-CSIC co-organises, together with the Institut de Física d'Altes Energies (IFAE), the Postgraduate Programme of High Energy Physics, Astrophysics and Cosmology. This postgraduate programme is part of the UAB doctoral programme that has been awarded with the Spanish Mention of Quality. The master programme has a one-year duration, with 60 ECTS. Its goal is to provide students with the essential tools necessary to start a research career in any of the disciplines taught. During the academic course 2024-2025, a total of 22 students (7 following the astrophysics itinerary coordinated by ICE-CSIC) were enrolled in the programme, from which a total of 5 students obtained their Master's degrees with theses supervised by ICE-CSIC researchers.



ICE-CSIC researcher Daniele Viganò at the Master's presentation.
Credits: ICE-CSIC.

Defended Master's theses

1. **Gual De Torrella Corral, A.**, *Observations on the Magnetic Field on the L1448C(N) protostar*. Supervisor: Josep Miquel Girart. Universitat Autònoma de Barcelona, 4/7/2025.
2. **Juarez Fernandez, D.**, *Gravitational Wave Inspirals in terms of a Dissipative Force*. Supervisor: Carlos Sopena. Universitat Autònoma de Barcelona, 8/7/2025.
3. **Fernandez Puig, E.**, *Gl 710, our future closest neighbour: exoplanet limits and close encounter statistics*. Supervisor: Ignasi Ribas. Universitat Autònoma de Barcelona, 8/7/2025.
4. **Lantzi, L.**, *Characterization of a long-period eccentric detached binary system*. Supervisor: Ignasi Ribas. Universitat Autònoma de Barcelona, 9/7/2025.
5. **Altés Delgado, C.**, *Studying the information content of deep learning methods in the exoplanetary field*. Supervisor: Manuel Perger. Universitat Autònoma de Barcelona, 3/9/2025.

7.2. PhD Programme

ICE-CSIC hosts PhD candidates carrying out a programme of independent research supervised by ICE-CSIC researchers. Over the year, there were a total of 52 PhD students (15 women and 37 men) at the Institute: 18 from Catalonia, 8 from the rest of Spain, 6 from Europe and 20 from the rest of the world. In 2025, eight of them started their PhD and ten PhD students defended their PhD theses.

Defended PhD theses

1. **Cristian Nery Viglione**, *Probing gravity with weak lensing and clustering from mock galaxy surveys*. Supervisor: Pablo Fosalba. Universitat Autònoma de Barcelona, 11/2/2025.

Abstract: The quest for a theoretical explanation of the Universe's observed accelerated expansion has necessitated the inclusion of the cosmological constant (Λ) as a dark energy component. This constant behaves as a negative pressure, or effectively as "repulsive" gravity, on large cosmological scales. Alternatively, several modified gravity models have been proposed to account for this acceleration without relying on a cosmological constant. The proliferation of these gravity theories has highlighted the need to develop robust methods for testing their validity.

As part of the main project of this thesis, we present the first computation of the gravity model testing parameter EG using realistic simulated galaxy mocks. The study focuses on measuring the EG estimator within the framework of General Relativity (GR) and $f(R)$ gravity models, leveraging high-fidelity simulated galaxy catalogs. Our primary aim is to assess the potential of future galaxy surveys to detect deviations from standard gravity using this widely adopted estimator that combines galaxy clustering and weak gravitational lensing. Our findings indicate that, for an all-sky galaxy survey and without accounting for observational systematics, EG can be estimated accurately and with minimal bias for both gravity models across all redshifts. However, the error bars are too large to definitively distinguish between the theories. Alternatively, we propose a straightforward null test of gravity based on redshift-space distortion (RSD) clustering. This test suggests that, with precise modelling of small-scale behaviour in future galaxy surveys, significant departures from standard gravity could potentially be detected.

2. **Iván Martín Vilchez**, *Development of data analysis algorithms and waveform models for the LISA mission*. Supervisor: Carlos F. Sopuerta. Universitat Autònoma de Barcelona, 27/3/2025.

Abstract: LISA is a signal-dominated detector, where many overlapping signals of scientific interest with different properties are present in the data at any given time. To do science, algorithms must be developed to extract the signals emitted by these sources and characterize their properties. In addition, for many of these sources, LISA's high sensitivity drives the need for higher accuracy in the fast template waveform models used in data analysis. This thesis approaches LISA data analysis from three different angles, for three of the major LISA sources. First, we use one of the main current approaches, Markov Chain Monte Carlo algorithms, to successfully find and estimate the parameters of the ten Verification Galactic Binaries present in one of the datasets of the first LISA Data Challenge. We then explore the application of machine learning methods to the analysis of data containing a signal from a Massive Black Hole Binary coalescence. We use Sequential Neural Likelihood, a Simulation-Based Inference algorithm that is able to efficiently request more simulations in the regions of parameter space where more precision is needed. Finally, we develop a modular Fourier-domain framework to model waveforms from Extreme Mass Ratio Inspirals, based on a piecewise Kerr geodesic approximation that allows the incorporation of different radiation reaction prescriptions.

3. **Bo Huang**, *Magnetized Clustered Star Formation in Orion*. Supervisor: Josep Miquel Girart. Universitat Autònoma de Barcelona, 11/4/2025.

Abstract: Interferometric polarization observations have revealed that magnetic fields are crucial in the star formation process. However, their relative importance in different environments and their role in stellar multiplicity remain poorly understood. The B-field Orion Protostellar Survey (BOPS) recently observed 870 μm dust polarization observations of 61 young protostars in the Orion molecular cloud, probing scales from 400 to 3000 au. The observations reveal standard hourglass magnetic field morphologies in collapsing cores, highlighting the interplay between magnetic fields and gravity, while misaligned or twisted fields indicate the growing influence of rotation and turbulence. Our findings suggest that magnetic fields play a key role in regulating fragmentation within dense envelopes: strong magnetic fields suppress fragmentation by stabilizing against gravitational instabilities, whereas weaker fields allow the formation of binary or multiple star systems. We also find that the magnetic field affects disk formation through magnetic braking, that significant misalignment between the magnetic field and outflow axes tends to reduce magnetic braking, leading to the formation of larger disks.

4. **Carlos Rodríguez**, *Application and development of advanced mathematical tools for population and time series analysis in pulsar astrophysics*. Supervisors: Diego F. Torres and Alessandro Patruno. Universitat Autònoma de Barcelona, 4/9/2025.

Abstract: In this thesis, we introduce novel methods for analyzing pulsar populations using advanced mathematical techniques. These tools, particularly graph theory, overcome constraints of conventional visualization. The resulting structures encode similarities that extend beyond standard spin parameters, uncovering relationships not visible in traditional diagrams. This approach enables new interpretations of longstanding problems and a framework for visualizing pulsar populations and categorizing sources. We extend graph theory to the boundary of machine learning, demonstrating its effectiveness for binary separation in an unsupervised context. These topological structures offer transparent and efficient representations in high-dimensional spaces. Finally, we use dynamic time warping, a flexible time-series alignment technique, in the study of gamma-ray pulsar emission processes. The method identifies significant similarities among light curves, frequently irrespective of other properties. Different pulsars can produce similar morphologies. The results are promising, offering new pathways for rigorous mathematical analysis and meaningful alternatives to traditional approaches in high-energy astrophysics.



Wei Zhang (middle) after his PhD Defense with ICE-CSIC researcher Daniela Hadasch (left) and his supervisor Diego Torres (right). Credits: ICE-CSIC.

5. **Wei Zhang**, *Gamma-ray Analysis of Pulsar Environments and Their Theoretical Explanation*. Supervisor: Diego F. Torres. Universitat Autònoma de Barcelona, 5/9/2025.

Abstract: Pulsars and their pulsar wind nebulae (PWNe) are unique laboratories for extreme astrophysical processes. This dissertation combines Fermi-LAT observations with a time-dependent leptonic PWN model (TIDE) to explore their gamma-ray emission. The model was validated on benchmark PWNe and applied to a systematic LAT search, leading to the discovery of new MeV-GeV candidates and the first population-level characterization. Several sources were modeled in detail, and predictions for potential TeV-emitting PWNe were tested against current and future observatories. Ultra-high-energy gamma-ray sources were also examined, revealing limits of standard leptonic scenarios. Beyond PWNe, stringent upper limits were obtained for the binary pulsar 1A 0535+262, and steady emission was detected from the globular cluster M5. Together, these results advance our understanding of pulsar environments and establish a framework for future multi-wavelength and next-generation gamma-ray studies.

6. **Albert Elias**, *Numerical simulations of astrophysical dynamos and applications to giant planets*. Supervisors: Daniele Viganò and Fabio del Sordo. Universitat Autònoma de Barcelona, 15/9/2025.

Abstract: Self-sustaining dynamos provide the most robust framework for explaining the magnetization of planets, stars, and galaxies. This thesis is divided into two parts, both focused on numerical dynamo simulations applied to different astrophysical contexts: the interstellar medium and gas giant (exo)planets.

In the first part, I investigate magnetic field growth in the ISM using 3D MHD simulations in a periodic box with the Pencil Code. I study irrotational subsonic expansion flows as a simplified model for supernova-driven turbulence. The second part of the thesis addresses planetary dynamos using both 1D and 3D approaches. I couple 1D thermodynamic evolutionary profiles from MESA with a 3D spherical-shell dynamo code (MagIC) to explore the long-term evolution of magnetic field properties in cold gas giants giving more information than only dynamo scaling laws. I also investigate inflated hot Jupiters by modeling their 1D convective interiors, examining how their structure affects dynamo behavior.

7. **Jilun Peng**, *Development of innovative land applications for ESA's HydroGNSS mission*. Supervisor: Estel Cardellach. Universitat Politècnica de Catalunya, 31/10/2025.

Abstract: The ESA HydroGNSS mission is a dual-pol, dual-frequency GNSS-R mission, scheduled for launch this year, and this dissertation focuses on developing operational products, including the Level 2 surface inundation product, exploitation of the coherent channel for L1B, and a simplified coherent channel simulator. A global water detection framework incorporating coherence indicators and spatial heterogeneity information, and utilizing either power or complex signals, was introduced, effectively meeting accuracy requirements, with false positives primarily occurring over wetlands and rivers. Analysis of the signal from right-hand circular polarization shows that its normalized power spread ratio more clearly distinguishes land and water surfaces and is more consistent across land types than its left-hand counterpart; combining the normalized power spread ratio with reflectivity further improves surface characterization, thereby reducing dependence on auxiliary data. Exploitation of the coherent channel demonstrates that normalized amplitude exhibits water sensitivity comparable to full entropy and remains stable with integration time, whereas the coherence coefficient is more sensitive to small water bodies but strongly dependent on integration time. A high-rate reflectivity variable derived from normalized amplitude was developed and shows good agreement with CYGNSS L1, raw IF reflectivity, and forward model results, providing higher resolution and improved applicability. The simplified coherent channel simulator reduces modeling complexity and computation time, employing simplifications to generate synthetic signals that, while not reproducing the exact sequence of actual observables, still capture the fundamental behavior of the coherent channel.

8. **Nariman Nakhjiri**, *Astronomical observation scheduling problem: a comprehensive study and novel metaheuristics solutions*. Supervisors: Maria Salamó Llorente, Miquel Sánchez-Marrè. External advisor: Juan Carlos Morales. Universitat de Barcelona, 12/11/2025.

Abstract: The scheduling of astronomical observations is a complex problem. When planning observations on telescopes, different constraints must be fulfilled, the scientific requirements and goals must be met, and the telescope usage shall be optimized. In this thesis we explore Artificial Intelligence techniques based on combinatorial optimization to solve the Astronomical Observations Scheduling (AOS) problem. We use a metaheuristics approach to build scheduling algorithms able to fully explore the broad solution space. The algorithms have been applied in the context of the European Space Agency mission ARIEL, although they can be easily generalized. In the thesis, we demonstrate that the developed algorithms achieve efficient plans at a low computational cost, setting a new benchmark for AOS research.

9. **Julen Untzaga**, *A search for wandering black holes in the Milky Way*. Supervisors: Mar Mezcua and Silvia Bonoli. Universitat Autònoma de Barcelona, 17/11/2025.

Abstract: Intermediate-mass black holes (IMBHs; BH mass of 10^2 – $10^6 M_\odot$) bridge the gap between stellar and supermassive black holes and may represent the “seed” BHs from the early Universe. Some of these seeds likely survived with little growth, now existing as wandering IMBHs within the Milky Way (MW). This thesis combines computational and observational methods to identify and characterize such objects. Using the L-Galaxies model on the Millennium-II simulation, we predict ~ 10 wandering black holes in MW-type galaxies, typically with a BH mass of $\sim 2 \times 10^3 M_\odot$, with merger remnants near the galactic center and ejected wanderers in the outer halo. Observationally, data from HSC, Pan-STARRS, and GAIA were used to detect hyper-compact cluster candidates potentially hosting IMBHs. Follow-up observations with the Gran Telescopio Canarias confirmed three promising MW satellites. This integrated approach refines our understanding of IMBH formation, evolution, and detectability, and improves our knowledge of the high-redshift Universe.



From left to right, Juan Carlos Morales (PhD committee member), Daniele Viganò (PhD supervisor), Claudia Soriano, Rosalba Perna (PhD supervisor), Ludmila Carona (PhD committee member) and Vivien Parmentier (PhD committee member).
Credits: ICE-CSIC.

10. **Clàudia Soriano**, *Atmospheric MHD simulations of Hot Jupiters to study winding, non-ideal effects and turbulence*. Supervisors: Daniele Viganò and Rosalba Perna. Universitat Autònoma de Barcelona, 17/11/2025.

Abstract: Hot Jupiters are highly irradiated gas giants whose extreme conditions make them ideal to study the interaction between atmospheric dynamics and magnetic fields. While hydrodynamical processes have been widely explored, the role of magnetism remains less understood. This thesis investigates the magnetic behaviour of Hot Jupiter atmospheres through local magnetohydrodynamic (MHD) studies. The work progresses from simplified models to complex three-dimensional local approaches to characterise how magnetic induction develops under realistic conditions where non-ideal, such as Ohmic, Hall and ambipolar terms, as well as small-scale turbulence are included. Overall, this research provides a comprehensive framework for understanding magnetic effects in strongly irradiated exoplanetary atmospheres and highlights the importance of incorporating MHD processes into global circulation and evolutionary models.

Ongoing PhD theses

1. **Alburai, Alaa**, *Characterizing underluminous type Ia supernovae at low and high redshift*. Supervisor: Lluís Galbany. Universitat Autònoma de Barcelona.
2. **Alemany, Marc**, *Cartografiado extragaláctico para estudiar la energía oscura, preparación para Euclid*. Supervisors: Pablo Fosalba, Isaac Tutusaus. Universitat Autònoma de Barcelona.
3. **Baghkani, Zahra**, *Simulating the Universe to exploit large cosmological surveys*. Supervisor: Francisco J. Castander. Universitat Autònoma de Barcelona.
4. **Blanco, Jordi**, *Machine learning approaches to high resolution spectroscopy for exoplanets*. Supervisors: Guillem Anglada-Escudé, Manuel Perger. Universitat de Barcelona.
5. **Blázquez, Carles**, *Physical modelling of the activity of the star AU Mic. to reveal planetary signals*. Supervisor: Ignasi Ribas. Universitat Autònoma de Barcelona.
6. **Brandoli, Francesco**, *New inference techniques for the scientific exploitation of the LISA mission*. Supervisors: Carlos Sopena, Sascha Husa. Universitat Autònoma de Barcelona.
7. **Camacho, Gisela**, *Cosmology with galaxy surveys*. Supervisor: Alex Alarcón. Universitat Autònoma de Barcelona.
8. **Canalda, Xavier**, *Root Zone Soil Moisture (RZSM) measurements using signals of opportunity at P and L-band*. Supervisors: Serni Ribó, Weiqiang Li. Universitat Politècnica de Catalunya.

9. **Chen, Ke**, *The universe evolution in entropic and modified gravity*. Supervisor: Sergei D. Odintsov. Universitat Autònoma de Barcelona.
10. **Coloma, José María**, *Cosmología con cartografiados de galaxias*. Supervisor: Martin Crocce. Universitat Autònoma de Barcelona.
11. **Çoban, Ömer Faruk**, *Spectral and Temporal Analysis of Compact Objects with Fermi-LAT*. Supervisors: Diego F. Torres, Jian Li, Daniela Hadasch. Universitat Autònoma de Barcelona.
12. **D'Onofrio, Simone**, *Modified gravity and early-universe cosmology*. Supervisor: Sergei Odintsov. Universitat Autònoma de Barcelona.
13. **Díaz, Elena**, *Characterization of the young stellar population in Orion A*. Supervisors: Gemma Busquet, Josep Miquel Girart. Universitat de Barcelona.
14. **Díaz, Pedro**, *Mixing Processes in Low and Intermediate- Mass Stars on the Age of Asteroseismology*. Supervisor: Aldo Serenelli. Universitat Autònoma de Barcelona.
15. **Du, Hao**, *Innovative processing techniques for operational ocean surface wind measurements from spaceborne GNSS-Reflectometry*. Supervisors: Weiqiang Li, Estel Cardellach. Universitat de Barcelona.
16. **Eróstegui, Alejandro**, *A search for dual AGN in galactic mergers across mass scales*. Supervisor: Mar Mezcuá. Universitat Autònoma de Barcelona.
17. **Fernández, Pablo**, *Testing the Black Hole no-hair conjecture with Extreme-Mass-Ratio Inspirals*. Supervisor: Carlos F. Sopuerta. Universitat Autònoma de Barcelona.
18. **Fernández, Eloi**, *High-performance computational modelling of stellar variability for exo-Earth detection and characterisation*. Supervisors: Ignasi Ribas, Nuno R. C. Gomes. Universitat Autònoma de Barcelona.
19. **Gambardella, Giosuè**, *Galaxy Clustering in redshift surveys: cosmology from Euclid and DESI*. Supervisor: Martin Crocce. Universitat Autònoma de Barcelona.
20. **González, Guillermo**, *Exploitation of GNSS Reflectometry for Innovative Cryosphere Products*. Supervisor: Estel Cardellach. Universitat Politècnica de Catalunya (UPC).
21. **González, Maider**, *Observational studies of stripped-envelope supernovae*. Supervisors: Claudia Gutierrez, Lluís Galbany. Universitat Autònoma de Barcelona.
22. **Grèbol, Pau**, *Physicochemical properties of meteorites and their ablation phases on Earth's atmosphere*. Supervisors: Josep Maria Trigo-Rodríguez, Jordi Ibáñez. Universitat Autònoma de Barcelona.
23. **Gualani, Vivek**, *High stability optical resonator for gravitational astronomy: optical clock and nanokelvin precision thermometry*. Supervisor: Miquel Nofrarias. Universitat Autònoma de Barcelona.
24. **Hernández, José Luis**, *Transport properties in neutron stars and neutron star mergers*. Supervisors: Cristina Manuel, Laura Tolos. Universitat de Barcelona.
25. **Íñiguez, Daniel**, *Spectral and light-curve modelling of the synchro-curvature emission from pulsars*. Supervisors: Diego F. Torres, Daniele Viganò. Universitat Autònoma de Barcelona.
26. **Jiménez, Cristina**, *SNIa environments*. Supervisor: Lluís Galbany. Universitat Autònoma de Barcelona.
27. **Kaur, Simranpreet**, *Radio Emission from exoplanetary systems*. Supervisors: Daniele Viganò, Josep Miquel Girart. Universitat Autònoma de Barcelona.
28. **Li, Runchuan**, *GNSS-R remote sensing of sea ice*. Supervisor: Estel Cardellach. Wuhan University.
29. **Miao, Hao-Yu**, *Exploring extreme transients in the era of time-domain surveys*. Supervisors: Lluís Galbany, Claudia Gutiérrez. Universitat Autònoma de Barcelona.
30. **Moras, Alba**, *Optical based high precision sensing for space missions*. Supervisor: Miquel Nofrarias. Universitat Autònoma de Barcelona.
31. **Pardo, Celsa**, *Exploring neutron-star astrophysics with machine learning*. Supervisors: Vanessa Graber, Nanda Rea. Universitat Autònoma de Barcelona.
32. **Paz, Antía**, *Applications of Polarimetric Radio Occultations for Numerical Weather Prediction modelling*. Supervisors: Ramon Padullés, Estel Cardellach. Universitat de Barcelona.
33. **Pedretti, Marie**, *Constraining the nature of dust and ices during the early stages of star formation with JWST*. Supervisors: Anaëlle Maury, Valentin Le Gouellec. Universitat Autònoma de Barcelona.
34. **Phan, Kim**, *SNIa NIR*. Supervisor: Lluís Galbany. Universitat Autònoma de Barcelona.

35. **Porqueras-León, Óscar**, *Mitigating stellar activity to characterise exoplanet atmospheres*. Supervisors: Juan Carlos Morales, Manuel Perger. Universitat Autònoma de Barcelona.
36. **Pirvu, Rebeca**, *Stellar populations in Local Group galaxies and beyond: observational constraints, population synthesis modeling and the resulting dust production*. Supervisors: Francisca Kemper, Aldo Serenelli. Universitat Autònoma de Barcelona.
37. **Rodríguez, Víctor**, *AGN outflows in dwarf galaxies*. Supervisor: Mar Mezcua. Universitat Autònoma de Barcelona.
38. **Sanfeliu, Ramón**, *The next generation of supernova Hubble diagram*. Supervisor: Lluís Galbany. Universitat Autònoma de Barcelona.
39. **Serrano, D.**, *Magnetic induced forces in LISA*. Supervisor: Miquel Nofrarias. Universitat Autònoma de Barcelona.
40. **Stucki, Sophie**, *StarSim: Modeling Stellar Activity For the Next Era of Exoplanet Detection and Characterization*. Supervisors: Ignasi Ribas, Nina Némec. Universitat Autònoma de Barcelona.
41. **Torki, Maryam**, *Stellar and galactic physics with large-scale surveys*. Supervisor: Aldo Serenelli. Universitat Autònoma de Barcelona.
42. **Wan, Yiqing**, *Advanced GNSS reflectometry instrumental concepts for swarms of nanosatellites*. Supervisors: Estel Cardellach, Serni Ribó. Universitat Politècnica de Catalunya.
43. **Wang, Yilong**, *Theoretical and Observational Studies of X-ray Binaries*. Supervisors: Bifang Liu, Nanda Rea. National Astronomical Observatories, Chinese Academy of Sciences.
44. **Zhao, Zihao**, *Systematic improvement on SED of Gamma-ray Pulsar in 3PC*. Supervisor: Diego Torres. Universitat Autònoma de Barcelona.
45. **Zhou, Xin**, *Research on Satellite-Ground Synergistic GNSS-R for Monitoring the Dynamic Parameters of the Sea Surface During Typhoon Storm Surges*. Supervisors: Qin Zhang, Estel Cardellach. Universitat Autònoma de Barcelona.
46. **Zuleta, Andrés**, *Investigating the evolution of astrophysical dust: constraints from observations at millimeter wavelengths*. Supervisors: Anaëlle Maury, Luca Cacciapuoti. Universitat Autònoma de Barcelona.

External theses

(students not residing in ICE-CSIC, but supervised by ICE-CSIC members)

1. **Anguera, Alèxia**, *Constraining the evolutionary stages of protostellar cores through their chemical and dust properties*. Supervisors: Alvaro Sanchez-Monge, Gemma Busquet Rico. Universitat de Barcelona.
2. **Alibekova, Zhuldyz**, *Gravitating spinor fields in modified gravity theories*. Supervisor: Sergei D. Odintsov. Al Farabi University, Almaty, Kazakhstan.
3. **Berkutbaeva, Raushan**, *Mass gap for a gravitating monopole interacting with a nonlinear spinor field*. Supervisor: Sergei D. Odintsov. Al Farabi University, Almaty, Kazakhstan.
4. **Cross, Dane**, *Sigma8 at high and low z*. Supervisors: Carlos Sanchez, Lluís Galbany. Universitat Autònoma de Barcelona.
5. **Gascón, Carlos**, *Multiwavelength data-analysis techniques for high-contrast imaging of Terrestrial exoplanets*. Supervisors: Guillem Anglada, Ignasi Ribas. Center for Astrophysics, Cambridge, MA.
6. **Kochankovski, Hristijan**, *Strongly coupled matter in neutron star mergers*. Supervisor: Laura Tolós. Universitat de Barcelona.
7. **Montesinos Llácer, Víctor**, *Exotic states. Study at finite density and temperature*. Supervisor: Laura Tolós. IFIC-Universitat de Valencia.
8. **Rakhatov, Dauren**, *Inflation and dark energy in modified gravities*. Supervisor: Sergei Odintsov. Eurasian National University.
9. **Rodríguez, Hilda**, *Wildfire risk assessment with AI and remote sensing data*. Supervisor: Estel Cardellach. Universitat Politècnica de Catalunya.

7.3. Summer School

On 7-18 July 2025, ICE-CSIC received 48 students from 17 countries all over the world who attended the 8th ICE-CSIC Summer School on Observational Cosmology.

The 48 participants were mostly master's and PhD students from a variety of universities and institutions across Europe, Asia, North and South America. They attended a complete programme consisting of lectures and practical hands-on sessions, provided by six invited speakers from research institutions and universities worldwide. This year's school focused on several key themes at the frontier of cosmological research: supernova, weak lensing, galaxy clustering, numerical simulations and galaxy formation, and models beyond Λ CDM.

During the first week, the programme introduced participants to supernova cosmology, exploring how Type Ia supernovae serve as standard candles for measuring cosmic expansion and probing dark energy. Sessions on weak gravitational lensing examined how distortions in galaxy images reveal the distribution

of matter and the role of dark energy, while lectures on beyond- Λ CDM models investigated alternative theories to address current tensions in cosmology. The second week focused on galaxy clustering, using large-scale structure to test cosmological models, alongside numerical simulations and galaxy formation, where students learned to model the evolution of galaxies and cosmic structures across time with high-performance computing. The programme emphasised practical training, preparing participants to engage with the new era of precision cosmology from surveys such as Euclid, LSST, and DESI.

Students were enthusiastic about the experience offered at ICE-CSIC. Moreover, this was a perfect chance to gather experts worldwide and have informal discussions and establish or strengthen collaborations between ICE-CSIC and national, European and international institutions. ICE-CSIC provided lodging expenses for all students, and the LACEGAL programme covered travelling expenses for 4 students coming from Asia/South America.



Group picture ICE-CSIC Summer School 2025 participants.
Credits: ICE-CSIC.

8. Conferences and Seminars

8.1. Pizza Seminars

1. **Pasquato, M.**, *Causality and the supermassive black hole: Galaxy coevolution conundrum*, 10/01/2025
2. **Huang, B.**, *Magnetized envelope in Orion*, 24/01/2025
3. **Némec, N.**, *The Sun as a guide to detecting exoplanets*, 31/01/2025
4. **Rivero, J.**, *Astronomy for peace*, 07/02/2025
5. **Sato, A.**, *Initial magnetized environment and dust evolution around Taurus protostellar twins*, 14/02/2025
6. **Elias, A.**, *Planetary dynamos in evolving cold gas giants*, 21/02/2025
7. **Torres, D.**, *On pulsar similarity: a novel look at their light curves*, 28/02/2025
8. **Le Gouellec, V.**, *Accretion properties of embedded protostars studied with submillimeter and near-infrared observations*, 07/03/2025
9. **Chen, S.**, *Autonomous spacecraft navigation based on X-Ray pulsar signals*, 14/03/2025
10. **Solar, M.**, *Supernova environments: An alma + muse approach*, 21/03/2025
11. **Maury, A.**, *Protoplanetary disks, magnetic fields and dust evolution: a journey with the youngest protostars of our Milky Way*, 28/03/2025
12. **D. Odintsov, S.**, *Modified gravity: Unifying inflation with dark energy*, 04/04/2025
13. **Tabernero, H.**, *Automatic determination of stellar parameters and its applications to exoplanet science*, 11/04/2025
14. **Izquierdo-Villalba, D.**, *A multimessenger view of massive black hole binaries through the lens of semi-analytical models of galaxy formation*, 25/04/2025
15. **Gómez, I.**, *Machine learning for small astrophysical datasets: applications in cosmology and exoplanet detection*, 09/05/2025
16. **Viganò, D.**, *Hot, puffy Jupiters and their peculiar magnetism*, 16/05/2025
17. **Barrufet, L.**, *Massive dusty high-redshift galaxies: insights from JWST and future prospects*, 30/05/2025
18. **Peña, L.**, *Radio signatures of magnetic star-planet interaction: observations and modelling*, 06/06/2025
19. **Cardellach, E.**, *Five-week in a tallship: sailing adventures for satellite oceanography*, 13/06/2025
20. **Noll, A.**, *The asteroseismology of red clump stars*, 20/06/2025
21. **Trigo-Rodríguez, J.**, *How will the Vera Rubin Survey discover thousands of new asteroids per day?*, 27/06/2025
22. **Li, Y.**, *From Space to ground: Using GNSS to understand our dynamic earth*, 26/09/2025
23. **González, S.**, *Dust extinction towards supernovae and their host galaxies*, 03/10/2025
24. **Mesa, V.**, *When galaxies meet: Interactions, black holes and the promise of data science*, 10/10/2025
25. **Dhawan, S.**, *The role of strong gravitationally lensed supernovae in constraining the hubble constant and dark energy*, 17/10/2025
26. **Shapiro, A.**, *Looking for exoplanets and finding stellar magnetism instead*, 24/10/2025
27. **Estellés, H.**, *Listening to the Universe: Results from the latest Ligo-Virgo-Kagra observing run*, 31/10/2025
28. **Sanjuan, J.**, *Measuring gravity in space*, 07/11/2025
29. **Xu, Y.**, *X-Ray High-Spectral-Resolution view of ultra-fast outflows in active galactic nuclei*, 14/11/2025
30. **Vallés, R.**, *Stars scheduling systems in the CTA observatory*, 21/11/2025
31. **Spinoso, D.**, *Massive black holes formation and evolution in cosmological environments*, 28/11/2025
32. **F. Sopena, C.**, *One hundred and ten years of general relativity: Still resisting the challenges*, 05/12/2025
33. **Senior PhD students at ICE-CSIC**, *Bullet #PizzaSeminar-Senior PhD edition*, 12/12/2025

8.2. ICE-CSIC Colloquia and Invited Seminars

1. **Jonker, P.**, *The origin of fast X-Ray transients*, ICE-CSIC Colloquia, 29/01/2025
2. **Blum, J.**, *Comets as clues to the formation and evolution of planetesimals*, ICE-CSIC Colloquia, 26/02/2025
3. **L. Garrison, J.**, *Exploiting signals of opportunity: A new approach to microwave remote sensing*, ICE-CSIC Colloquia, 19/03/2025
4. **Jean, P.**, *Observation of the High-energy emission from novae with LAT/Fermi*, ICE-CSIC Colloquia, 30/04/2025
5. **Iodice, E.**, *Looking into the faintest with muse: Integral-Field spectroscopy of Ultra-diffuse galaxies in a cluster environment*, ICE-CSIC Colloquia, 28/05/2025
6. **Hatch, N.**, *Euclid's view of intracluster light*, ICE-CSIC Colloquia, 02/07/2025
7. **Kamp, I.**, *A new window into planet formation with JWST*, ICE-CSIC Colloquia, 25/09/2025
8. **Fernández, J.**, *X-Ray binary accretion states in AGN? Sensing the accretion disc of supermassive black holes with IR nebular lines*, ICE-CSIC Colloquia, 27/11/2025
9. **Sierra, C.**, *Artificial intelligence: From myth to real impact*, ICE-CSIC Colloquia, 18/12/2025
10. **Camprubí, E.**, *On wet rocky worlds: How does origin of life research impact space exploration efforts at ocean worlds?*, ICE-CSIC Special Seminar, 09/01/2025
11. **Vink, J.**, *The heaviest stars and black holes in the Universe*, ICE-CSIC Special Seminar, 13/01/2025
12. **Scaringi, S.**, *Eavesdropping on accreting white dwarfs through timing and gravitational waves*, ICE-CSIC Special Seminar, 11/02/2025
13. **Renard, P.**, *Lyman-Alpha intensity mapping with optical imaging surveys: Future prospects*, ICE-CSIC Special Seminar, 12/02/2025
14. **Lovell, C.**, *High-fidelity mocks From the Flamingo simulations*, ICE-CSIC Special Seminar, 07/03/2025
15. **De la Macorra, A.**, *Dynamical dark energy and DESI*, ICE-CSIC Special Seminar, 10/09/2025
16. **Gomblitz, J.**, *Applications of deep learning in astroparticle physics*, ICE-CSIC Special Seminar, 10/09/2025
17. **Anastasopoulou, K.**, *Unveiling the High-energy phenomena of massive stars in Westerlund 1 with EWoCS*, ICE-CSIC Special Seminar, 23/10/2025
18. **Kipping, D.**, *Bayesian Introspection*, ICE-CSIC Special Seminar, 27/10/2025
19. **Potapov, A.**, *Bridging earth and heaven: Laboratory and observational astrochemistry*, ICE-CSIC Special Seminar, 30/10/2025
20. **Parmentier, V.**, *Understanding giant exoplanetary atmospheres with low and high-spectral resolution*, ICE-CSIC Special Seminar, 18/11/2025



IIIA-CSIC Director Carles Sierra during the ICE-CSIC Christmas Colloquium.
Credits: ICE-CSIC.

8.3. Workshops and meetings organised at ICE-CSIC

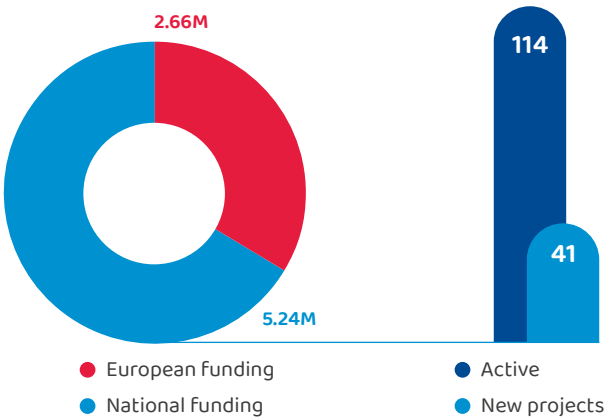
1. **ICE-CSIC 25th Anniversary**
03-05/02/2025
2. **Euclid Cosmological Simulations SWG Meeting 2025** 05-07/03/2025
3. **6th Barcelona Initiative for Gravitation (BIG) Meeting**
04/07/2025
4. **Arrakihs Detector Task Force**
22-23/09/2025
5. **Arrakihs Calibration & Data Processing** 24-26/09/2025
6. **From LISA Pathfinder to LISA: Celebrating 10 years of the LPF Launch** 03-04/12/2025



Group picture of the 6th Barcelona Initiative for Gravitation (BIG) meeting.
Credits: ICE-CSIC.

9. Projects

In 2025, ICE-CSIC received competitive funding for 41 new scientific projects for a total of around 7.90 million euros, distributed in 5.24 million euros from national funding and 2.66 million euros from European funding. Another 73 projects were for a total of 114 active projects in 2025.



9.1. New projects

1. **Project code:** 202550E282
Title: Supporting research at ICE after the Maria de Maeztu Grant
PI: Serenelli, A.
Funding source: CSIC

2. **Project code:** 202550E271
Title: Simulaciones Cosmológicas
PI: Castander, F. J.
Funding source: CSIC

3. **Project code:** 20245Y787
Title: Caracterizando la emisión de la luz intracumular para formas
PI: Montes, M.
Funding source: AEI

4. **Project code:** 20245Y513
Title: Conectando el Universo local con el Universo a alto redshift
PI: Mezcuá, M.
Funding source: AEI

5. **Project code:** 20245Y278
Title: Astrofísica de pulsares sinérgica: de avances teóricos a software crítico para el Cerenkov Telescope Array Observatory
PI: Torres, D.F.
Funding source: AEI

6. **Project code:** 20245Y184
Title: Cosmología con Cartografiados de Galaxias
PI: Croce, M.
Funding source: AEI
7. **Project code:** 20245RD015
Title: Red española de física de ondas gravitacionales
PI: Sopuerta, C.
Funding source: AEI

8. **Project code:** 20245I223
Title: Observations Soop extendidas para aplicaciones downstream
PI: Cardellach, E.
Funding source: AEI

9. **Project code:** OTR15632
Title: Becas postdoctoral junior leader de La Caixa 2025
PI: Brandoli, F.
Funding source: LA CAIXA

10. **Project code:** OTR15631
Title: Becas posdoctoral junior leader de La Caixa 2025
IP: Ravasio, M.
Funding source: LA CAIXA

11. **Project code:** OTR15630
Title: Becas posdoctoral junior leader de La Caixa 2025
PI: Izquierdo, D.
Funding source: LA CAIXA

12. **Project code:** OTR15629
Title: Becas posdoctoral junior leader de La Caixa 2025
PI: Zennaro, M.
Funding source: LA CAIXA

13. **Project code:** OTR15369
Title: Ayudas personal técnico de apoyo 2024
PI: Mestre, E.
- Funding source:** AEI

14. **Project code:** OTR15167
Title: Ayudas empleo juvenil 2025
PI: Ramirez, A.
Funding source: SEPE

15. **Project code:** OTR14340
Title: Ayudas Juan de la Cierva 2023
PI: Giannini, G.
Funding source: AEI

16. **Project code:** IMOVE25177
Title: Soil Moisture Sensing using Signals of Opportunity at P & L band
PI: Ribó, S.
Funding source: CSIC

17. **Project code:** FUNDS25133
Title: Distintivo FUNDS Stg-2026 en el ICE
PI: Serenelli, A.
Funding source: CSIC

18. **Project code:** FUNDS25111
Title: Physics at the Limits: Advanced Gravitational-Wave Detectors Probing Black Holes and Beyond
PI: Serenelli, A.
Funding source: CSIC

19. **Project code:** FUNDS25048
Title: Distintivo FUNDS STG/COG/ADG/SYG 2025 en el ICE
PI: Serenelli, A.
Funding source: CSIC

20. **Project code:** AGAIN25005
Title: Distintivo again en el ICE - AdG 2024
PI: Kemper, F.
Funding source: CSIC
21. **Project code:** AGAIN25002
Title: Distintivo again en el ICE - AdG 2024
PI: Sopuerta, C.
Funding source: CSIC
22. **Project code:** 2025ICT173
Title: Ayudas extraordinarias a la incorporación de científicos titulares oep 2022
PI: Li, W.
Funding source: CSIC
23. **Project code:** 2025ICT172
Title: Ayudas extraordinarias a la incorporación de científicos titulares oep 2022
PI: Patruno, A.
Funding source: CSIC
24. **Project code:** 2025ICT048
Title: Ayudas extraordinarias a la incorporación de científicos titulares oep 2022
PI: Hadasch, D.
Funding source: CSIC
25. **Project code:** 202550E150
Title: Teledetección de la Tierra y otros cuerpos del sistema solar con Fuentes de oportunidad
PI: Padulles, R.
Funding source: CSIC
26. **Project code:** 202550E104
Title: High-energy astrophysics of Galactic compact objects: observations, simulations and new techniques
PI: Padulles, R.
Funding source: CSIC
27. **Project code:** CNS2024-154731
Title: Radio Occultaciones Polarimétricas y Microondas pasivo colaborando para la mejora de predicción de precipitación
PI: Padulles, R.
Funding source: AEI
28. **Project code:** CNS2024-154592
Title: Cosmología usando la emisión de la luz intracumular
PI: Montes, M.
Funding source: AEI
29. **Project code:** FCT-24-20593
Title: ECLIPSE INCLUSIVO: Camino al eclipse solar total del 2026
PI: Rivero, J.
Funding source: FECYT
30. **Project code:** JDC2023-051934-I
Title: Ayudas Juan de la Cierva 2023
PI: Estellés, H.
Funding source: AEI
31. **Project code:** 101189496
Title: A new X-ray pulsar navigation system for Deep Space Exploration
PI: Rea, N.
Funding source: EU
32. **Project code:** JDC2023-052168-I
Title: Ayudas Juan de la Cierva 2023
PI: De Sarkar, A.
Funding source: AEI
33. **Project code:** 2023 BP 00063
Title: BP-2023
PI: Ashkar, H.
Funding source: AGAUR
34. **Project code:** 101188037
Title: Consolidating plans for the Atacama Large Submillimeter Telescope
PI: Kemper, F.
Funding source: EU
35. **Project code:** JAEPR23048
Title: Exploring extreme transients in the era of time-domain surveys
PI: Serenelli, A.
Funding source: CSIC
36. **Project code:** ATR2024-154740
Title: Ópticas y bancos de filtros para cosmología submilimétrica
PI: Mroczkowski, T.
Funding source: AEI
37. **Project code:** RYC2023-045531-I
Title: Ayudas Ramón y Cajal 2023
PI: Tutusaus, I.
Funding source: AEI
38. **Project code:** MOV-TEC 2025-047
Title: Ayuda extraordinaria de movilidad para estancias formativas de personal técnico del CSIC 2068
PI: Elbaz, A.
Funding Source: CSIC
39. **Project code:** 20255FAS069
Title: Vacío mejorado, termómetro más datos, nevera
IP: Serenelli, A.
Funding Source:
40. **Project code:** IEEC/75/2025
Title: MESURES d'HUMITAT DEL SÒL PER AGRICULTURA DE PRECISIÓ (MEDHUSA)
IP: Ribó, S.
Funding Source: IEEC
41. **Project code:** ERC-Synergy
Title: Laboratory Underground for Nuclear Astrophysics New Observatory for Solar Neutrino Reactions
PI: Serenelli, A.
Funding source: EU

9.2. Ongoing Projects

1. **Project code:** CEX2020-001058-M
Title: Unidades de Excelencia María de Maeztu
PI: Serenelli, A.
Funding Source: AEI
2. **Project code:** PID2023-153099NA-I00
Title: Einstein Probe: una nueva mirada al universo transitorio en rayos X
PI: Coti-Zelati, F.
Funding source: AEI
3. **Project code:** RYC2021-032892-I
Title: Ayudas Ramón y Cajal 2021
PI: Sánchez-Monge, Á.
Funding source: AEI
4. **Project code:** 202250E071
Title: The nano-physics of interstellar silicates
PI: Kemper, F.
Funding source: CSIC
5. **Project code:** 20215AT016
Title: Cornering the hubble tension using supernovae in the local universe
PI: Galbany, L.
Funding source: CSIC
6. **Project code:** PID2021-128989NB-I00
Title: Cosmología con cartografiados de galaxias
PI: Crocce, M.
Funding source: AEI
7. **Project code:** PID2021-128062NB-I00
Title: Propiedades físico-químicas de asteroides y cometas a partir del estudio en el laboratorio de meteoritos y muestras retornadas
PI: Trigo-Rodríguez, J.M.
Funding source: AEI
8. **Project code:** 948582
Title: Imprints of Magnetic fields in Exoplanets
PI: Viganò, D.
Funding source: EU
9. **Project code:** 20245PRC05
Title: Machine learning methods for analysis of X-ray timing data
PI: Serenelli, A.
Funding source: CSIC
10. **Project code:** CNS2023-145240
Title: Exploración de las condiciones prístinas para transformar el polvo interestelar en planetesimales
PI: Maury, A.
Funding source: AEI
11. **Project code:** PRE2021-096988
Title: Contrato predoctoral para la formación de doctores 2021
PI: Jiménez, C.
Funding source: AEI
12. **Project code:** PRE2021-098098
Title: Contrato predoctoral para la formación de doctores 2021
PI: Crocce, M.
Funding source: AEI
13. **Project code:** PRE2021-097623
Title: Contrato predoctoral para la formación de doctores 2021
PI: Hidalgo, C.
Funding source: AEI
14. **Project code:** 202350E189
Title: Potenciando la Unidad de Ingeniería Avanzada en el ICE (Boosting the Advanced Engineering Unit at ICE)
PI: Serenelli, A.
Funding source: CSIC
15. **Project code:** 101149286
Title: Mitigating stellar magnetic activity contamination in transmission spectroscopy
PI: Ribas, I.
Funding source: EU
16. **Project code:** OTR11043
Title: Ayuda otorgada por la F. La Caixa en relación con el desarrollo del prog. de becas de postdoctorado junior leader 2023, para un proy. en univ. y centros de inv. españoles
PI: Alarcon, A.
Funding source: LA CAIXA
17. **Project code:** PRE2021-100290
Title: Contrato predoctoral para la formación de doctores 2021
PI: Íñiguez, D.
Funding source: AEI
18. **Project code:** JDC2023-052264-I
Title: Ayudas Juan de la Cierva 2023
PI: De Grandis, D.
Funding source: AEI
19. **Project code:** IMOVE24276
Title: Improving Tropical Cyclone forecast using Polarimetric Radio Occultations
PI: Padullés, R.
Funding source: CSIC
20. **Project code:** IMOVE24223
Title: Assessing the activity of Active Galactic Nuclei (AGN) in galaxy mergers across mass scales in the DESI survey
PI: Mezcua, M.
Funding source: CSIC
21. **Project code:** IMOVE24043
Title: Observational characterization and modelling of the most detailed sample of under-luminous Type Ia supernovae
PI: Galbany, L.
Funding source: CSIC
22. **Project code:** FUNDS24091
Title: NDS STG/COG/ADV/SYG-01 2024 en el Instituto de Ciencias del Espacio - V2
PI: Serenelli, A.
Funding source: CSIC
23. **Project code:** FUNDS24073
Title: Distintivo FUNDS STG/COG/ADV/SYG-01 2024 en el Instituto de Ciencias del Espacio
PI: Serenelli, A.
Funding source: CSIC
24. **Project code:** PID2023-153229NA-I00
Title: Paleta Cósmica: Un modelo físico para entender los colores y la estructura cosmológica en el Universo

- PI:** Alarcon, A.
Funding source: AEI
25. **Project code:** 101086388
Title: Latin American Chinese European Galaxy Formation Network
PI: Fosalba, P.
Funding source: EU
26. **Project code:** 202450E110
Title: Exploración de las condiciones prístinas para transformar el polvo interestelar en planetesimales
PI: Maury, A.
Funding source: CSIC
27. **Project code:** PTA2022-022158-I
Title: Ayudas personal técnico de apoyo 2022
PI: Salvans, J.
Funding source: AEI
28. **Project code:** PRE2022-104802
Title: Contrato predoctoral para la formación de doctores 2022
PI: Coloma, J.M.
Funding source: AEI
29. **Project code:** PRE2022-101957
Title: Contrato predoctoral para la formación de doctores 2022
PI: González, G.
Funding source: AEI
30. **Project code:** PRE2022-104624
Title: Contrato predoctoral para la formación de doctores 2022
PI: Grèbol, P.
Funding source: AEI
31. **Project code:** PRE2022-101942
Title: Contrato predoctoral para la formación de doctores 2022
PI: Blanco, J.
Funding source: AEI
32. **Project code:** PRE2022-104649
Title: Contrato predoctoral para la formación de doctores 2022
PI: Rodríguez, V.
Funding source: AEI
33. **Project code:** PRE2022-101913
Title: Contrato predoctoral para la formación de doctores 2022
PI: Fernández, P.
Funding source: AEI
34. **Project code:** PRE2022-102836
Title: Contrato predoctoral para la formación de doctores 2022
PI: Croce, M.
Funding source: AEI
35. **Project code:** RYC2021-030888-I
Title: Ayudas Ramón y Cajal 2021
PI: Coti-Zelati, F.
Funding source: AEI
36. **Project code:** PID2023-151307NB-I00
Title: Facilitando la siguiente generación de cosmología con supernovas
PI: Galbany, L.
Funding source: AEI
37. **Project code:** PID2023-150491NB-I00
Title: Aprendizaje de Máquina para mitigar actividad estelar en la investigación de Exoplanetas
PI: Anglada-Escudé, G.
Funding source: AEI
38. **Project code:** PID2023-146675NB-I00
Title: Formación Estelar en la Galaxia: Un Enfoque Estadístico
PI: Sánchez-Monge, A., Girart, J.M.
Funding source: AEI
39. **Project code:** PID2023-149918NB-I00
Title: Propiedades, evolución, vientos y remanentes de estrellas de masa baja e intermedias
PI: Serenelli, A.
Funding source: AEI
40. **Project code:** RYC2021-033309-I
Title: Ayudas Ramón y Cajal 2021
PI: Padulles, R.
Funding source: AEI
41. **Project code:** 101120117
Title: Gns-s-r satellite earth observation
PI: Cardellach, E.
Funding source: EU
42. **Project code:** 101098309
Title: Exploring the pristine conditions for transforming interstellar dust into planetesimals
PI: Maury, A.
Funding source: EU
43. **Project code:** MMT24-ICE-01
Title: AI optimization techniques for astronomical scheduling tools: Supporting the transversal ICE effort in the development of a versatile, multi-facility scheduler
PI: Viganò, D.
Funding source: CSIC
44. **Project code:** 101126626
Title: Artificial intelligence in sustainable development goals
PI: Serenelli, A.
Funding source: EU
45. **Project code:** 101140786
Title: Physical modelling of stellar activity effects to discover and measure exoearths
PI: Anglada-Escudé, G.
Funding source: EU
46. **Project code:** RYC2022-036949-I
Title: Ayudas Ramón y Cajal 2022
PI: Montes, M.
Funding source: AEI
47. **Project code:** CEX2020-001058-M
Title: Unidades de Excelencia María de Maeztu
PI: Serenelli, A.
Funding Source: AEI
48. **Project code:** OTR13046
Title: AYUDAS DE INCORPORACIÓN DEL PROFESORADO DE INVESTIGACIÓN ICREA 2023
PI: Maury, A.
Funding Source: ICREA
49. **Project code:** COOPB23040
Title: Modelos y Observaciones de Supernovas en el proyecto Precision Observations of Infant Supernova Explosions (POISE)

- PI:** Galbany, L.
Funding Source: CSIC
50. **Project code:** ILINK23001
Title: The La Silla Southern Supernova Survey (LS4): a network to exploit the data and enable synergies for the future
PI: Galbany, L.
Funding Source: CSIC
51. **Project code:** ILINK23028
Title: Optomechanical resonators for high precision space experiments
PI: Nofrarias, M.
Funding Source: CSIC
52. **Project code:** JDC2022-049447-I
Title: Ayudas Juan de la Cierva 2022
PI: Kopsacheili, M.
Funding Source: AEI
53. **Project code:** JDC2022-049957-I
Title: Ayudas Juan de la Cierva 2022
PI: Parent, E.
Funding Source: AEI
54. **Project code:** CA26273
Title: Tecnologías avanzadas para la exploración del universo
PI: Serenelli, A.
Funding Source: Ministerio de Ciencia e Innovación
55. **Project code:** CA26273
Title: Tecnologías avanzadas para la exploración del universo
PI: Serenelli, A.
Funding Source: Generalitat de Catalunya
56. **Project code:** OTR08994
Title: Fundación La Caixa postdoctorado Junior Leader 2022
PI: Carles Sánchez, C.
Funding Source: La Caixa
57. **Project code:** 101008324
Title: Chemical Elements as Tracers of the Evolution of the Cosmos - Infrastructures for Nuclear Astrophysics
PI: Serenelli, A.
Funding Source: EU
58. **Project code:** 817661
Title: Magnetar Census: the impact of highly magnetic neutron stars in the explosive and transient Universe
PI: Rea, N.
Funding Source: EU
59. **Project code:** TED2021-129812B-I00
Title: Medición de humedad del suelo a profundidad utilizando drones
PI: Ribó, S.
Funding Source: AEI
60. **Project code:** 20215AT007
Title: Spaceborne Coherent GNSS Reflectometry: Model, Processing and Applications
PI: Li, W.
Funding Source: CSIC
61. **Project code:** IJC2020-042690-I
Title: Ayudas Juan de la Cierva - Incorporación 2020
PI: Khurshudyán, M.
Funding Source: AEI
62. **Project code:** 2024ICT070
Title: Ayudas Extraordinarias a la Incorporación de Científicos Titulares OEP 2020-2021
PI: Nofrarias, M.
Funding Source: CSIC
63. **Project code:** 2024ICT026
Title: Ayudas Extraordinarias a la Incorporación de Científicos Titulares OEP 2020-2021
PI: Galbany, L.
Funding Source: CSIC
64. **Project code:** 2024ICT025
Title: Ayudas Extraordinarias a la Incorporación de Científicos Titulares OEP 2020-2021
PI: Anglada-Escudé, G.
Funding Source: CSIC
65. **Project code:** 2024ICT024
Title: Ayudas Extraordinarias a la Incorporación de Científicos Titulares OEP 2020-2021
PI: Viganò, D.
Funding Source: CSIC
66. **Project code:** PID2020-120375GB-I00
Title: Aprendizaje automático con datos y modelos para la detección de exoplanetas cercanos parecidos a la Tierra (DMLEXO)
PI: Anglada-Escudé, G.
Funding Source: AEI
67. **Project code:** 2021 SGR 00426
Title: MAP: Enfoque multimensajero de la física de astropartículas
PI: Torres, D.F.
Funding Source: AGAUR
68. **Project code:** CNS2022-136050
Title: Machine Learning for Extreme precision Doppler spectroscopy
PI: Anglada-Escudé, G.
Funding Source: Ayuda CNS2022-136050 financiada por MICIU/AEI/10.13039/501100011033 y por la Unión Europea NextGenerationEU/PRTR
69. **Project code:** 202250E103
Title: Cosmología con Cartografiados Extragalácticos
PI: Castander, F.J.
Funding Source: CSIC
70. **Project code:** PRE2020-093336
Title: Contrato Predoctoral para la Formación de Doctores 2020 (anteriormente BES)
PI: Díaz, P.
Funding Source: AEI
71. **Project code:** PID2021-124581OB-I00
Title: Investigación Fundamental e Innovación Tecnológica para Avanzar la Ciencia de Púlsares
PI: Torres, D.F.
Funding Source: AEI
72. **Project code:** PID2021-124243NB-C22
Title: Agujeros negros en crecimiento: desde las primeras semillas hasta los núcleos activos de galaxia
PI: Mezcua, M.
Funding Source: AEI
73. **Project code:** PID2021-126436OB-C22
Title: GNSS Environmental and Societal Missions - Parte CSIC
PI: Cardellach, E.
Funding Source: AEI

10. Awards and Distinctions

10.1. Awards

The Fermi Gamma-ray Space Telescope collaboration, awarded the Giuseppe and Vanna Cocconi Prize

The European Physical Society (EPS) awarded the Fermi-LAT and Fermi-GBM collaborations the 2025 Giuseppe and Vanna Cocconi Prize in recognition of their groundbreaking contributions to the fields of particle astrophysics and cosmology. The pioneering work of the two groups has revolutionised our understanding of the high-energy Universe and enabled fundamental discoveries that will impact the field for decades to come.



Estel Cardellach, on board the tall ship Statsraad Lehmkuhl as part of the lecturers of the ESA Ocean Synergy Training Course 2025.
Credits: Joël Marc.

DESI Collaboration Receives 2026 Berkeley Prize

The DESI collaboration received the 2026 Lancelot M. Berkeley–New York Community Trust Prize for Meritorious Work in Astronomy. Established in 2011 by the American Astronomical Society (AAS), the Berkeley prize includes a monetary award and an invitation to give the closing plenary lecture at the AAS winter meeting. The DESI collaboration is being honored with the 2026 Berkeley prize for their work creating the largest 3D map of the universe, enabling the study of the effects of dark energy over cosmic time, and particularly for precise measurements of baryon acoustic oscillations as a function of redshift all the way to $z = 2.3$, when the universe was less than three billion years old.

Researcher Estel Cardellach receives the Muncunill Award for Honorary Innovation and the Terrassenca of the Year 2025 Prize

ICE-CSIC and IEEC researcher Estel Cardellach received the Muncunill Award for Honorary Innovation for her contributions to the study of our planet. The award was presented on 8 May 2025 at an event at the Principal Theatre of Terrassa. This is the 9th edition of the ceremony, organised by Terrassa's City Council, with the support of the Provincial Deputation of Barcelona, with the goal of both bringing the innovation closer to the citizenship and recognising the companies who work in this field, as well as contributing to reinforcing Terrassa's position as an innovation referent.

Cardellach was also one of the three winners of the "Terrassenca of the Year 2025 Prize". The purpose of this award is to appoint every year between one and three people from Terrassa who, due to their civic and/or professional careers, have uplifted the city in the fields of culture, art, sports, business and charity, among others.

10.2. Distinctions

Clàudia Soriano was selected one of the 100 Women TIC role models in Catalonia 2025

These awards Premis Inspiració Women Approved 2025 are organised by Instituto Más Mujeres with the support of the Generalitat of Catalonia.

Within the 100 previously selected role-models, 10 of them were selected in different categories to keep on celebrating female talent in the Catalan technologic sector. Among these 10 women, Clàudia Soriano received the Inspiration Award for Emergent Talent.

11. Communication and Outreach

The ICE-CSIC Communication and Outreach Office is responsible for coordinating and implementing a wide range of communication and public engagement initiatives aimed at enhancing the visibility of the Institute's scientific and institutional activities. These efforts are directed towards diverse audiences, including the general public, national and international communities of astronomers and engineers, students and educators, families, journalists and policymakers.

11.1. Communication

Throughout 2025, ICE-CSIC published a total of 46 communication pieces (21 scientific news items, 18 institutional announcements and 7 outreach articles) [see Section 12 for further details]. Among these, 23 press releases were prepared in coordination with the CSIC, the CSIC Delegation in Catalonia and the IEEC Communication Offices, along with other corresponding institutions, ensuring their dissemination to regional and national media. These actions resulted in 327 media appearances.

The Communication and Outreach Office also oversees ICE-CSIC's digital presence, managing the institutional website and social media channels, including X, YouTube, LinkedIn, Instagram, as well as the newly launched BlueSky and TikTok accounts. In addition, four editions of the ICE-CSIC newsletter were published during 2025. Altogether, the Institute's central communication activities reached approximately 274,353 people (see infographic for detailed figures), with an extended audience of around 1,658 million when considering media coverage⁵.

To mark ICE-CSIC's 25th anniversary, an institutional video presenting the Institute was launched in February for use at events and public activities. The video was produced in three languages: [English](#), [Catalan](#) and [Spanish](#).

Among the most significant outreach initiatives of the year were targeted actions designed to engage broader audiences. On the occasion of the International Day of Women and Girls in

Science (February 11th), the Office continued the #HowItAllStarted social media campaign, originally launched in February 2024. The campaign showcases the women working at the Institute across research, engineering and administrative roles, sharing their professional paths, responsibilities and motivations for pursuing careers in science. The campaign came to an end in 2025 after the International Day of Women.

During the year, the Communication and Outreach Office coordinated media requests addressed to ICE-CSIC researchers and hosted 3Cat at the Institute to record interviews. The scientific podcasts *TransmediaLab Mandarin* and *Vida Ajenas*, also recorded interviews with ICE-CSIC researchers on site.

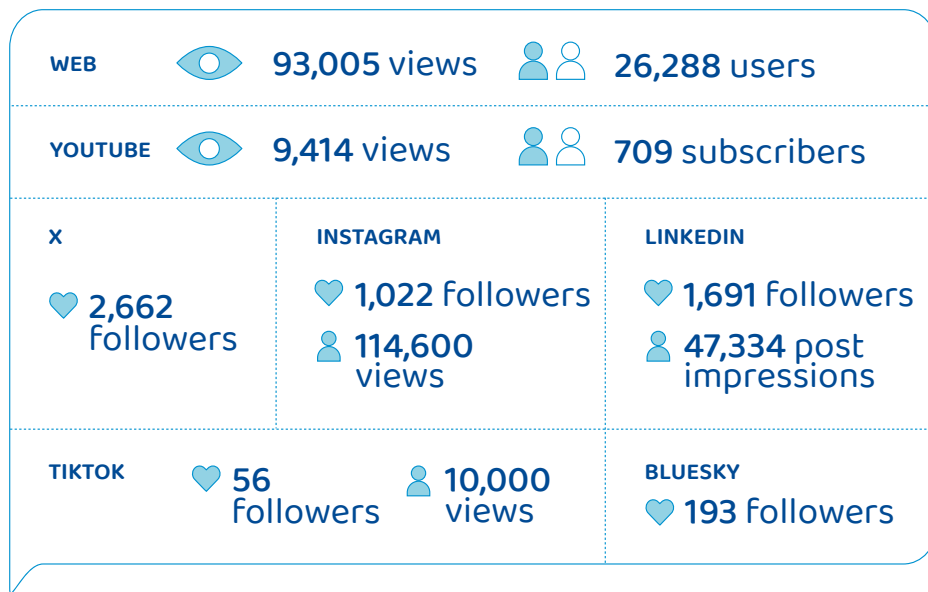
To commemorate the 10th anniversary of the first detection of gravitational waves, an interactive article⁶ was published highlighting both the scientific milestone and ICE-CSIC's key contribution to ESA's LISA Pathfinder mission. The article was featured on the CSIC website and distributed to the media.

Finally, the Office served as the Spanish Communication contact point for the Euclid Consortium, supporting coordinated communication efforts among Spanish institutions. This role led to the preparation of a press release and a series of social media videos announcing the publication of the Euclid Flagship simulations. The coordinated communication campaign was launched simultaneously in six countries.

⁵ The data related to press impacts and audience only accounts for media in Spain, as indicated by the information compiled through the press clipping service provided by CSIC.

⁶ It was written by Aitana C. Bonfill as part of her scientific journalism internship.

ICE-CSIC Communication Channels Impacts



11.2. Outreach

In 2025, we continued our commitment to bring astronomy closer to society through our public engagement actions.

Educational activities

Magnet alliance

In June 2025, the Institute concluded its fourth year of the Magnet Alliance with the school Gabriel Castellà i Raich in Igualada, Barcelona, see Section 2.1 for an account of the successful alliance. During this year, our activities involved the participation of 28 ICE-CSIC members (9 women and 19 men) who brought astronomy topics to the classrooms and organised visits to perform hands-on activities with the students.

Final activities to highlight include the commemoration of the International Day of Girls and Women in Science on February 11th when the school organised an event called Talk GC held at the Igualada Central Library. The 4th Primary Education class interviewed ICE-CSIC researchers Margarita Hernanz, Mar Mezcuà, Claudia Gutiérrez, and Cristina Jiménez about what took them to start a career in science, their childhood and what they used to like, as well as their work and current interests.

⁷ This figure is the result of the addition of the ICE-CSIC website views, YouTube views, Instagram post impressions, LinkedIn post impressions, TikTok views and BlueSky post impressions. X post impressions were not included, as access to this metric is restricted under the platform's analytics offering.

⁸ The number of press impacts and audience only takes into account media outlets in Spain, as this is the information available through the press clipping service provided by CSIC.



Amanar activity with Sahrawi children at the Planetari Municipal de Barcelona.
Credits: ICE-CSIC.

From January to April, the 5th and 6th Primary Education class conducted a research project related to the Sun. Using a solar educational telescope, they made periodic observations of the Sun, tracing the sunspots on its surface and using them to measure the solar rotation. Finally, the last activity of the Magnet Alliance took place in Igualada: a science fair open to all where students from the Gabriel Castellà i Raich school took the lead. With the support from teachers and

ICE-CSIC researchers, they presented different hands-on activities focusing on topics such as galaxies, planets, black holes, magnetism, lenses, stars and many more. The event, organised at the courtyard of the Museu de la Pell to both end the alliance and to celebrate the end of the school year, was attended by over 100 people who enjoyed an eventful afternoon.

ESA CESAR

We continued our collaboration with the ESA CESAR project, co-organising three online training courses for teachers on topics related to space sciences that reached over 500 teachers in Spain and Argentina. Additionally, we co-organised the ESA-GTTP 2025

– The Sun and Eclipses teacher training on 21-25 July 2025 at ESAC, based in Villanueva de la Cañada (Madrid). This course was attended by 30 in-person and over 100 online teachers.

CSIC Ciencia en el barrio

Another CSIC educational initiative we continued our involvement in was Ciencia en el Barrio. Our activities within the project comprised two visits from high-schools to ICE-CSIC and the three scientific talks and

three educational workshops in high-schools and civic centres. As a highlight, one high-school replicated our educational workshop The Dark Universe at the Feria de la Ciencia in Sevilla.

Escolab

ICE-CSIC is participating for the first time in the Escolab programme from Barcelona's municipality. This is a project that aims to give students the opportunity to visit scientific institutions to learn and experience scientific research firsthand. During the

2025-2026 academic course, we offered two activities including an educational workshop and visits to our laboratories, telescope and meteorite collection. In November-December seven high-schools visited ICE-CSIC, with 11 more visits programmed until June 2026.

A course on didactic tools for CSIC personnel

As part of the CSIC Scientific Education Group, the ICE-CSIC Communication and Outreach Office co-organised the second edition of the course "Didactic tools to bring science closer to the classrooms", which is offered by the CSIC training office to the personnel of all CSIC centres across Spain. The online course took place in March 2025 and was addressed to scientific and technical personnel involved in outreach and educational activities.

Taught by experts in didactics, CSIC professionals close to the educational field and teachers from different educational levels that had previously collaborated with CSIC, the course offered a global view of education nowadays and provided the CSIC personnel with tools to address outreach activities in the classroom. Working in groups, the 50 attendees designed an educational activity addressed to students from a specific educational level, guided by a teacher of the course and a member of the CSIC Scientific Education Group.

Inclusive activities

Eclipse Inclusivo

In October 2025, we launched Eclipse Inclusivo, a science outreach project that takes advantage of the unique opportunity presented by the total solar eclipse that will cross the Iberian Peninsula on 12 August 2026 to bring science closer to the general public, school children, people with visual impairments and/or blindness, and vulnerable groups during the year prior to the eclipse in an inclusive way. The project received €30,000 funding by the Spanish Foundation for Science and Technology (FECYT). Even though most of the project will be implemented in 2026, we started planning the educational workshops for visually-impaired people co-organised with the Spanish National Organization of the Blind (ONCE) that

will be held in 2026 to motivate them to experience the solar eclipse. For that purpose, we will produce 100+ LightSound devices, a tool that allows you to experience an eclipse through sound and that we will distribute through solar eclipse events around the country. Finally, we started the teacher training co-organised with the Catalan Education Department, where around 40 primary and secondary teachers enrolled to learn about the Sun and Eclipses and how to introduce the topic in schools in an inclusive way. The teachers that will complete the training in 2026, will have access to take on loan for a week one of the two solar telescopes provided by ICE-CSIC.



ICE-CSIC engineer Josep Maria Cirera gives a presentation during the Eclipse Inclusivo teacher training at ICE-CSIC premises.
Credits: ICE-CSIC.

Amanar

At the end of July, ICE-CSIC organised an outreach astronomy activity within the Amanar project for Sahrawi children who spend the summer with host families around Barcelona in the framework of the 'Vacaciones en Paz' programme. The activity was

at the Planetari Municipal de Barcelona welcoming around 30 people, including Sahrawi children and host families who enjoyed a planetarium session and learnt about astronomical objects, constellations and mythologies around them.

International Day of Women and Girls in Science

In addition to the #HowItAllStarted campaign and the Talk GC event within the Magnet Alliance described above, on the occasion of the International Day of Women and Girls in Science February 11th, several ICE-CSIC female researchers joined the #100tífiques

initiative, by giving face-to-face and online talks to Primary and High school students in Catalonia about the work of a scientist and their experience as women in science.

Activities for under-represented groups

To extend our inclusive actions, we performed a pilot activity for visually impaired people using astronomy 3D tactile materials. Organised together with the Vil·la Urània civic centre and the Instituto Municipal

de Discapacidad de Barcelona, 12 visually impaired people of all ages and their accompanying persons were able to learn about planets, stars and galaxies.

Local and national outreach festivities

To reach out to the general public, we organised educational workshops and telescope observations in major science outreach festivities in the region:

On February 1st, we participated in the Matinal astronòmica in Les Franqueses del Vallès with the organisation of the hands-on workshop *L'Univers a les teves mans* where the children and families participating learnt about the solar system, stars and galaxies through tactile models.

On May 31st and June 1st, ICE-CSIC participated on Barcelona's Science Festival 2025 with the organisation of four workshops where hundreds of attendees could learn how scientists use GPS to study our planet; how stars live and die; experience a journey through the Universe with 3D tactile materials; and learnt about traditional astronomy of the Sahrawi people in a virtual reality experience.

On September 26th, ICE-CSIC joined the European Researchers' Night celebrations at the UAB campus. We organised two educational workshops with participations of our researchers Margarita Hernanz, Cristina Jiménez, Simone D'Onofrio and Pau Grèbol; talks by our researchers Mireia Montes and Pau Grèbol; and a final talk by our laboratories manager Josep Maria Cirera who conducted remote observations with our rooftop telescope to close the festivities. All activities were enjoyed by hundreds of students, families and children.

Within the framework of CSIC's Science and Technology Week in November, we organised a full week of events, including a guided tour to our facilities; 2 school visits within the Escolab project; and an activity about the solar eclipse at a high-school in the neighboring region of Sant Cugat.



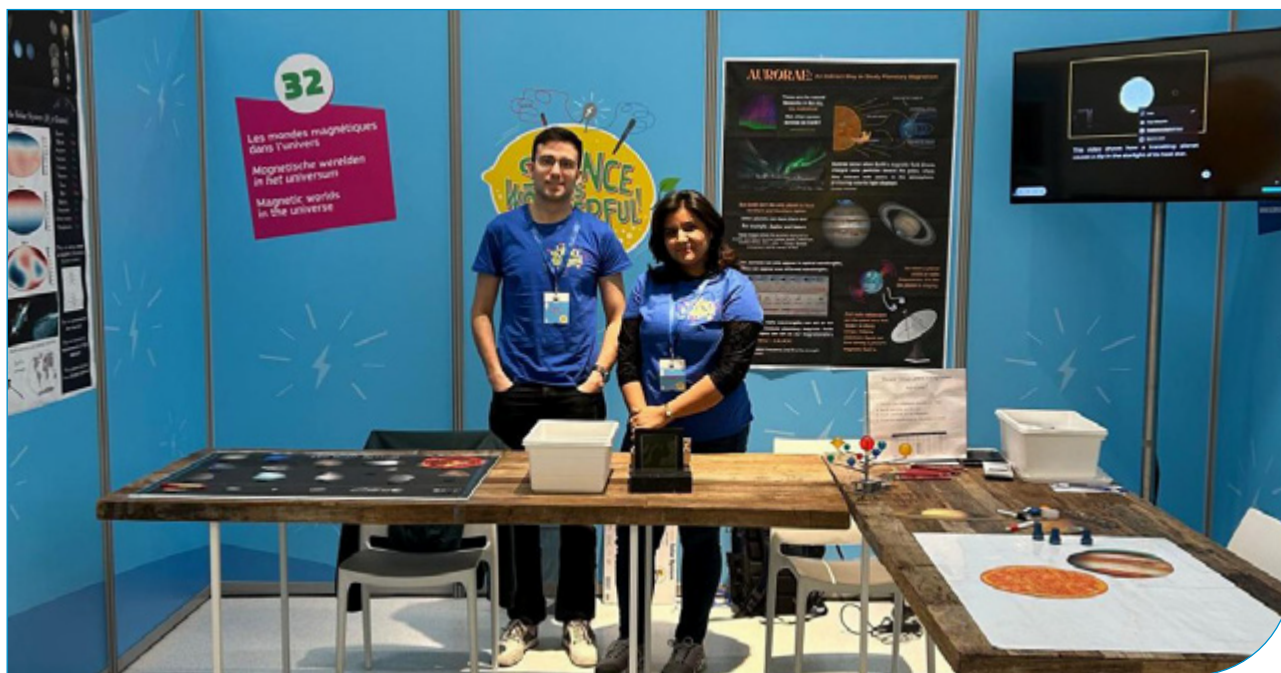
ICE-CSIC members Jose Luis Hernández, Alba Calejero and Simone D'Onofrio at Barcelona's Science Festival 2025.
Credits: ICE-CSIC.

Education fairs

On 13-14 March, ICE-CSIC PhD students Albert Elías and Simranpreet Kaur participated in the Science is Wonderful event, together with former ICE-CSIC researcher Fabio del Sordo, in Brussels (Belgium). They showcased the wonders of space to hundreds of students through hands-on activities at their stand "Magnetic Worlds in the Universe".

To promote the Institute's activities and especially the opportunities for students, we were present

at two student fairs. In March, we attended Saló de l'Ensenyament, the largest fair for high-school students in Catalonia, where we interacted with over 100 high-school students through an educational workshop on the Life and Death of Stars. In May, we participated with a stand on the XVIII Fira de Ciències i Enginyeries UB, interacting with over 300 astronomy/science students.



Albert Elías (left) and Simranpreet Kaur (right) at the Science is Wonderful event in Brussels (Belgium).
Credits: Fabio del Sordo.

11.2.1. Outreach initiatives by ICE-CSIC researchers

ICE-CSIC researchers are quite active developing their own outreach projects and collaborating with researchers from other institutions to reach a greater audience.

The Spanish Meteor Network (SPMN)

During 2025 our professional-amateur (ProAm) initiative involved >40 different stations providing data on bright meteors and fireballs over the Iberian peninsula, Balears and Canary islands. Here is a brief summary of the most relevant meteor detections by the SPMN network.

During the first half of the year we had relevant sporadic fireballs, but others produced by several meteor showers like the Quadrantids, Kappa Draconids, Mu Orionids, and Lirids. In particular, on January 24th, the North Cancrids produced an extremely bright bolide catalogued as SPM240125F

(see Figure below). After that, in the second half of the year, the activity of fireballs during the summer was dominated by Alpha Capricornids, Aquarids and Perseid showers. Miguel Furones, Miguel García, Jordi Gil, Fernando Gómez, Cèsar Guasch, Sensi Pastor, José A. Reyes, and Antonio J. Robles participated in the detection of most of these bright bolides.

The last quarter of the year was particularly impressive, summarising about one third of all fireballs recorded last year. The activity of bright fireballs was dominated by some fireball-producing meteoroid streams. On October 9th Joan Figueras,

a collaborator using his forward-scatter detector in Riudellots de la Selva (Girona) was able to clearly record the peak of echoes associated with a dense cloud of Giacobini-Zinner meteoroids. That outburst of meteors happened at 7h UTC, in broad daylight for Europe, and it was recognized by a Minor Planet Center circular.

On October 16th an artificial bolide SPMN161025ART was imaged by Ramón López from Lanzarote plus the all-sky cameras of Telescope Nazionale Galileo (TNG) from La Palma and Enol Matilla from Tenerife. We identified that event as produced by the decay of the 3 tones in mass XYJ-7 Chinese satellite. The shock wave produced by the reentry was recorded by 13 seismic stations of the Instituto Geográfico Nacional (IGN) that we are studying for its implications to human hazard.

On November we had an unusual display of extremely bright bolides associated with the Taurid resonant swarm, a possible concentration of bodies with diameters of several tens of meters in diameter located in the interior of the Taurid meteoroid stream produced by 2P/Encke and dynamically associated with

the 7:2 mean motion resonance with Jupiter has been recently tested telescopically, and predicted to return in 2025 (Quanzhi Y. et al. 2025, Acta Astron. 238, 285). We detected extremely bright Taurid fireballs from November 3 to 20 radiating from a distinctive radiant. These extremely bright events were produced by 2P/Encke meteoroids few tens of cm sized meteoroids in diameter, clearly distinguishable from the two main branches and consistent with the radiant location of the 2015 resonant Taurid outburst detected by Pavel Spurný et al. (2017). The mere presence of these components of large meteoroids deserves consideration because it could be a consequence of the continuous disruption of meter-sized meteoroids, or even larger bodies, already in the category of asteroids. In November we also had a great display of Leonids, including a very bright bolide listed in our online catalogue as SPMN181125P.

Finally, during December we had a great display of Geminid meteors, with some events brighter than the Moon. That meteor display completed an extraordinary year of ProAm cooperation where 20,500 video files of bright meteors and fireballs were recorded and saved, involving a total disk size of 112 Gb.



The extremely luminous SPM240125F event recorded from Barx-La Visteta.
Credits: Jordi Donet / SPMN.

Blogs

[Dark Cosmos](#), a blog by the ICE-CSIC by Enrique Gaztañaga.

[Articles](#) by Josep Maria Trigo-Rodríguez at The Conversation España.

Researcher Josep M. Trigo-Rodríguez is the Scientific Director and promoter of [DivulCat](#), a scientific outreach project (a blog of blogs) maintained by scientists from Catalan-speaking territories. Several ICE-CSIC researchers collaborate with their own blog:

- [Obrint els ulls...](#), a blog by Emilio Elizalde on *Divulcat*.
- [La deu de l'únic vers](#), a blog by Lluís Galbany on *Divulcat*.
- [Ciències planetàries i meteorits](#), a blog by Josep M. Trigo-Rodríguez on *Divulcat*.

12. News

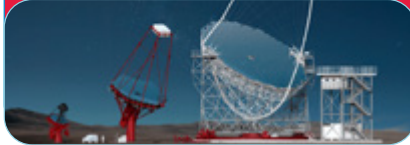
08/01/2025

A new study points to a universal mechanism for jet collimation



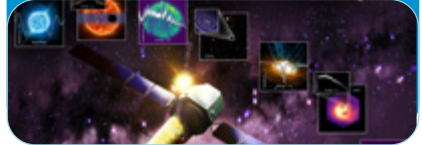
13/01/2025

The CTAO Becomes a European Research Infrastructure Consortium



16/01/2025

The NewAthena mission plans an ambitious multi-messenger X-ray observatory to study the cosmos



23/01/2025

Einstein Probe detects puzzling cosmic explosion



31/01/2025

ICE-CSIC celebrates its 25th anniversary with a commemorative conference



14/02/2025

A sample of more than 3600 Ia supernovae could change how to measure the expansion history of the Universe



18/02/2025

Einstein Probe catches an X-ray burst from an odd stellar couple



19/02/2025

DESI uncovers 2500 new active black holes in dwarf galaxies, of which 300 are new intermediate-mass black holes



24/02/2025

Astronomer Tony Mroczkowski receives a grant from the ATRAE programme



10/03/2025

The ALMAGAL survey observes a thousand stellar factories to uncover the origin of stars



11/03/2025

A super-Earth discovered in the habitable zone of a nearby red dwarf



19/03/2025

Euclid opens data treasure trove to study the Dark Universe



20/03/2025

New DESI Results Strengthen Hints That Dark Energy May Evolve



26/03/2025

Nanda Rea, appointed member of the Senior Science Committee of ESO's Expanding Horizons



15/04/2025

Hubble telescope investigates a magnetar's birthplace



16/04/2025

New method found to compare gamma-ray light curves of around 300 pulsars observed with NASA's Fermi telescope



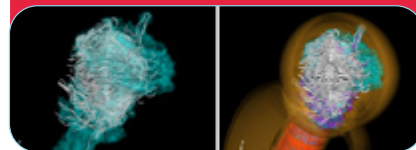
05/05/2025

A team of astronomers resolve the mystery of massive star formation with the Very Large Array telescope



16/05/2025

New simulations hint pulsar nebulae are influenced by the evolution of their progenitor stars



28/05/2025

Detected a transient object emitting pulses in both radio waves and X-rays



23/06/2025

The first images of the most complete 'movie' of the night sky ever made are published



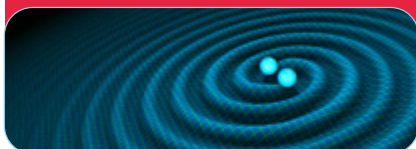
04/07/2025

Francisco Castander, appointed scientific representative for cosmology at the Spanish National Astronomy Committee



09/07/2025

REDONGRA: a network to propel Spain's role in gravitational wave astronomy



15/07/2025

NASA's IXPE imager reveals mysteries of a rare pulsar



25/07/2025

ICE-CSIC holds the 6th Barcelona Initiative for Gravitation meeting



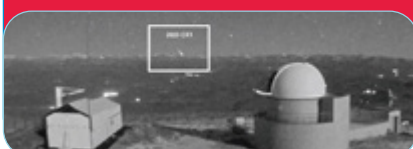
19/08/2025

A team of astronomers present a new method to detect supernovae hours after the explosion



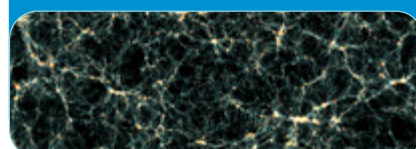
17/09/2025

A comprehensive study of an asteroid disintegrated over France in 2023 opens new horizons for planetary defense



22/09/2025

A virtual Universe for Euclid: the largest cosmological simulations catalogue is now public



24/10/2025

ICE-CSIC participates in the Atlantic Constellation, a project for observing the Earth from space



03/11/2025

A team of astronomers use cosmological data to test if dark matter behaves like ordinary matter



06/11/2025

ICE-CSIC is co-leading an ERC Synergy project that aims to revolutionize our current understanding of the Sun



28/11/2025

CSIC participates in the ESA mission that will study Earth's hydrological properties from space



10/12/2025

ICE-CSIC leads a pioneering study on the feasibility of asteroid mining



11/12/2025

Celebrating 10 years of LISA Pathfinder's launch, the mission that paved the way for gravitational wave astronomy in space



Image Credits

ICE-CSIC participation in Missions and Experiments Infographic (pages 28 and 29)

1. **ARIEL**
Ariel telescope. Credits: ESA/STFC RAL Space/UCL/UK Space Agency/ATG Medialab.
2. **Atlantic Constellation**
Atlantic Constellation. Credits: Open Cosmos.
3. **AtLAST**
AtLAST. Credits: AtLAST.
4. **CARMENES**
The 3.5-metre telescope of the Calar Alto Observatory, from where the CARMENES instrument operates. Credits: IAA-CSIC.
5. **CTAO**
CTAO-South site. Credits: CTAO ERIC.
6. **Euclid**
Illustration of the Euclid space mission. Credits: ESA/Euclid/Euclid Consortium/NASA. Background galaxies: NASA, ESA, and S. Beckwith (STScI) and the HUDF Team.
7. **LISA**
The three LISA spacecraft will be placed in orbits forming a triangular configuration, with the center 20° behind the Earth and each side measuring 5 million km. (The figure showing the formation is to scale). Credits: NASA.
8. **PAU**
PAUCam. Credits: PAUCam.
9. **PAZ**
Artistic view of the PAZ Low Earth Orbiter, launched in February 2018. This satellite hosts the Radio Occultation and Heavy Precipitation experiment aboard PAZ (ROHP-PAZ), testing the capability of polarimetric radio occultation signals to sense precipitation events. Credits: Hisdesat.
10. **PLATO**
Artist's impression of ESA's PLATO spacecraft. Credits: ESA/ATG Medialab.
11. **ARRAKIHS**
Simulation of the halo of one of the galaxies that will be observed in the ARRAKIHS mission. Credits: Alex Camazón (ARRAKIHS Consortium).
12. **DES**
Blanco Telescope located at the Cerro Tololo Inter-American Observatory. Credits: Andreas Papadopoulos.
13. **DESI**
Blanco Telescope at the Cerro Tololo Inter-American Observatory in Chile. Credits: Reidar Hahn, Fermilab.
14. **HydroGNSS**
Artist's impression of the HydroGNSS satellite in orbit. Credits: SSTL.
15. **LIGO**
LIGO. Credits: LIGO.
16. **LST**
LST. Credits: LST.
17. **CHEOPS**
Artist's impression of Cheops, the Characterising Exoplanet Satellite, with an exoplanet system in the background. Credits: ESA/ATG Medialab.
18. **DART**
Illustration of the DART mission. Credits: NASA/Johns Hopkins APL.
19. **Einstein Probe**
Einstein Probe. Credits: CAS/ESA/Max Planck Society.
20. **Einstein Telescope**
Einstein Telescope artist's impression. Credits: Einstein Telescope Collaboration.
21. **eXTP**
Baseline design of the eXTP satellite. The payload includes 9 (SFA) and 4 (PFA) X-ray telescopes, 40 LAD modules, and 3 WFM camera pairs. Credits: eXTP.
22. **Fermi**
Illustration of the Fermi Gamma-ray Space Telescope, which has been studying the extreme universe for a decade. Credits: NASA's Goddard Space Flight Center/Conceptual Image Lab.
23. **HERA**
Hera scans DART's impact crater. Credits: ESA. Image taken from the video "Hera: ESA's Planetary Defence Mission".
24. **LSST**
LSST. Credits: LSST.
25. **LS4**
LS4. Credits: LS4.
26. **NewAthena**
An artistic view of the NewAthena space observatory. Credits: ESA/IRAP/CNRS/UT3/CNES/Fab&Fab. Composition: ACO.
27. **ROMAN**
Spacecraft visualization of the Nancy Grace Roman Space Telescope. Credits: GSFC/S.
28. **SKAO**
SKAO. Credits: SKAO.

ICE-CSIC News infographic (pages 109 and 110)

1. **8/1/2025**
Artistic view of a protostar driving a bipolar jet within a helical magnetic field. Credits: Wolfgang Steffen, UNAM A new study points to a universal mechanism for jet collimation.
2. **13/1/2025**
Three classes of telescope types are required to cover the full CTA energy range (20 GeV to 300 TeV). Credits: Gabriel Pérez Díaz, IAC
3. **16/1/2025**
NewAthena, the next-generation large X-ray observatory. Credits: Athena Community Office-ACO.
4. **23/1/2025**
Representation of the Einstein Probe spacecraft. Credits: OPENVERSE/Einstein Probe Science Center.
5. **31/1/2025**
ICE-CSIC personnel, December, 2024. Credits: ICE-CSIC.
6. **14/2/2025**
Samuel Oschin Telescope. Credits: Palomar Observatory/California Institute of Technology.
7. **18/2/2025**
Einstein Probe artist impression. Credits: Chinese Academy of Sciences.
8. **19/2/2025** Artist's illustration of a dwarf galaxy with active galactic nuclei. Credits: NOIRLab/NSF/AURA/J. da Silva/M. Zamani.
9. **24/2/2025** Tony Mroczkowski in the Atacama Desert. Credits: Patricio Gallardo.
10. **10/3/2025**
The ALMA antennas observing the Milky Way, high up in the Chajnantor Plateau in Chile's Atacama desert. Credit: ESO/Y. Beletsky.
11. **13/3/2025**
Artistic recreation of GJ 3998 d, a super-Earth in its star's habitable zone. Credit: Gabriel Pérez Díaz (SMM, IAC) Credits: Gabriel Pérez Díaz (SMM, IAC)
12. **19/3/2025**
Various huge galaxy clusters as well as intra-cluster light, and gravitational lenses are visible in this image of an area of Euclid's Deep Field South. The cluster near the centre is called J041110.98-481939.3, and is located almost 6 billion light-years away. Credits: ESA/Euclid/ Euclid Consortium/NASA, image processing by J.-C. Cuillandre, E. Bertin, G. Anselmi.
13. **20/3/2025**
DESI maps distant objects to study dark energy. The instrument is installed on the Mayall Telescope, shown here beneath star trails. Credit: KPNO/NOIRLab/NSF/AURA/B. Tafreshi
14. **26/3/2025**
ICE-CSIC researcher Nanda Rea. Credits: ICE-CSIC.
15. **15/4/2025**
Artist impression of a neutron star. Credits: ESA.
16. **16/4/2025**
Image extracted from an animation that shows a spinning pulsar, with its strong magnetic field rotating along with it. Clouds of charged particles move along the field lines and their gamma-rays (purple) are beamed like a lighthouse beacon by the magnetic fields. Credits: NASA/ Goddard Space Flight Center Conceptual Image Lab.
17. **5/5/2025**
Artist interpretation of accretion disk and jets. Credits: NSF/AUI/NSF NRAO/B. Saxton
18. **16/5/2025**
Rendering of the 3D magnetohydrodynamic pulsar wind nebula models, considered without and with their complex environments shaped by their progenitor star before the explosion. The various colors highlight the stellar wind bubble created by the pulsar's massive progenitor star throughout its life and the materials therein. The white tubes trace the magnetic field lines in the pulsar wind. Credits: Meyer, et al. (2025). 3D magnetohydrodynamic simulations of runaway pulsars in core-collapse supernova remnants. A&A, 696, L9.
19. **28/5/2025**
An image of the sky showing the region around ASKAP J1832-0911. X-rays from NASA's Chandra X-ray Observatory, radio data from the South African MeerKAT radio telescope, and infrared data from NASA's Spitzer Space Telescope. Credits: Ziteng (Andy) Wang, ICRAR.
20. **23/6/2025**
Vera C. Rubin Observatory's first light images of the Trifid and Lagoon nebulae. This image combines 678 separate images taken by NSF-DOE Vera C. Rubin Observatory in just over seven hours of observing time. Combining many images in this way clearly reveals otherwise faint or invisible details, such as the clouds of gas and dust that comprise the Trifid nebula (top right) and the Lagoon nebula, which are several thousand light-years away from Earth. Credits: NSF-DOE Vera C. Rubin Observatory.

21. **4/7/2025**
Researcher Francisco Castander at Cape Canaveral Space Force Station in Florida during the launch of the Euclid space mission on June 30, 2023. Credits: Francisco Castander.
22. **9/7/2025**
An artist's impression of gravitational waves generated by binary neutron stars. Credits: R. Hurt/Caltech-JPL.
23. **15/7/2025**
Artist's impression of the central regions of the system PSR J1023+0038, showing the pulsar, the inner accretion disc and the pulsar wind. Credits: Marco Maria Messa (University of Milan and INAF-OAB) and Maria Cristina Baglio (INAF-OAB).
24. **25/7/2025**
Group picture of the 6th Barcelona Initiative for Gravitation (BIG) meeting. Credits: ICE-CSIC.
25. **19/8/2025**
Composite image of the Tycho Supernova in the constellation Cassiopeia. Chandra's X-ray data have been combined with an optical image of the stars in the same field of view from the Digitized Sky Survey. Credits: X-ray: NASA/CXC/RIKEN & GSFC/T. Sato et al; Optical: DSS
26. **17/9/2025**
The superbolide produced by the disintegration of asteroid 2023 CX1, captured by the Montsec Observatory, located in Sant Esteve de la Sarga, Lleida. Credits: OdM/IEEC Team.
27. **22/9/2025**
Image extracted from the Euclid Flagship simulations catalogue. Each dot represents a galaxy: blue points mark galaxies at the centers of dark matter clumps, while red points denote satellites within them. Collectively, they trace the large-scale mass distribution of the Universe, forming clumps, filaments, and voids. Credits: Jorge Carretero & Pau Tallada (Port d'Informació Científica) / Euclid Consortium). Image processed with the software Splotch.
28. **24/10/2025**
Credits: Open Cosmos
29. **3/11/2025**
Map of the distribution of galaxies observed by the DESI collaboration, from which it is possible to accurately measure the velocities of galaxies. Credits: Claire Lamman/DESI collaboration; custom colormap package by cmastro.
30. **6/11/2025**
Aldo Serenelli, director of the Institute of Space Sciences (ICE-CSIC).
31. **28/11/2025**
Illustration of HydroGNSS, one of ESA's new Scout missions being developed within the Earth Observation FutureEO programme. Credits: ESA/ Mlabspace
32. **10/12/2025**
Reflected light image of a thin section of carbonaceous chondrite CV3 from NASA's Antarctic collection, analyzed in the study. Several chondrules with bright olivine crystals embedded in a carbonaceous matrix can be seen. Credits: J.M.Trigo-Rodríguez/ICE-CSIC.
33. **11/12/2025**
Group picture of the LISA Pathfinder commemoration event. Credits: ICE-CSIC.

