

# Annual Report 2018

Institute  
of Cosmos  
Sciences  
University of  
Barcelona

# Exploring the Universe

Theory, observation, experimentation

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# FOREWORD

## Consolidation & Transition



**Xavier**  
Director

This year 2018 has been a year of consolidation. On the one hand, continuing with the efforts of previous years, the technology unit is fully deployed in the spaces of the Parc Científic de Barcelona (PCB). The unit is not only continuing its technological participation in the existing projects but is also opening new areas of work. On the other hand our administration, structured in the Scientific Office and the Administrative Office, has also been consolidated to provide better support to our researchers.



**Assumpta**  
Deputy Director

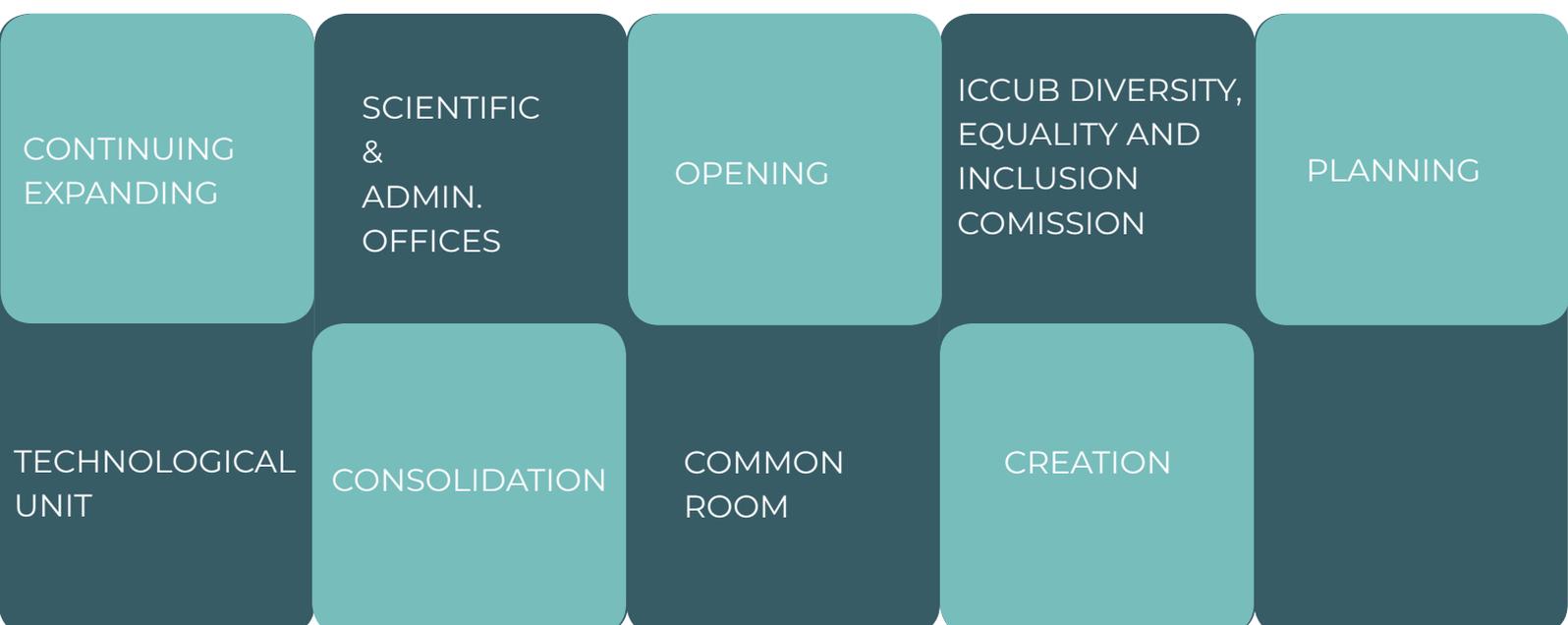
At the same time this has also been a year of transition. Our Maria de Maeztu award is nearing its completion, and we have applied for its renewal. For this we have defined a strategic plan for the next four years where, starting from a thorough review of the status of our institute, we have defined the priority lines and key actions for this period. In this plan we have included new lines aiming to enhance and expand the research fields in two key areas: gravitational waves and quantum technologies. In this respect, it is important to note that our institute has become a member of the Virgo consortium, and that our technological unit has started to actively contribute to this project.

On the infrastructure side, in 2018 we have inaugurated the ICCUB common room, a space where the institute members can meet and interact. We are also in negotiations with the Faculty of Physics and the Faculty of Chemistry to jointly set up a Data Processing Center that will allow a more ordered and better configured space for the installation of racks of computers.

Last but not least, in 2018 we created the Diversity, Equity and Inclusion commission of the ICCUB. This commission, formally approved by the institute's council, has the aim of promoting specific actions to provide a welcoming environment to our members and visitors, regardless of gender, gender identity, sexual orientation, ethnicity, beliefs or disability. The commission will work in cooperation with the Equality Commission of the University of Barcelona and will help us to create a more friendlier working environment for everybody.

**Xavier Luri - Assumpta Parreño**

Director - Deputy Director



# ORGANIZATION CHART

## EXECUTIVE BOARD

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**Deputy Director:** Francesca Figueras – Assumpta Parreño

**Secretary:** Bartomeu Fiol – Federico Mescia

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Xavier Luri  
David Gascón  
Federico Mescia  
Josep M<sup>a</sup> Paredes  
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Gabbanelli	Josep M <sup>a</sup> Paredes
Cristiano Germani	Assumpta Parreño
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Xavier Luri	Eduard Salvador
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## TECHNICAL COORD.

David Gascón  
Jordi Portell

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**Alan Heavens, Imperial Centre for Inference and Cosmology, Imperial College, London.**

**Slava Mukhanov, ASC, Physics Department, LMU, Munich.**

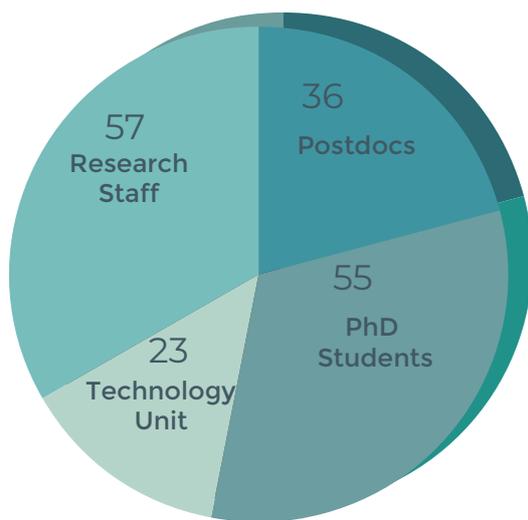
**Tatsuya Nakada, LPHE, École Polytechnique Fédérale de Lausanne, Lausanne.**

**Meghan Urry, Yale Center for Astronomy and Astrophysics, New Haven, United States.**

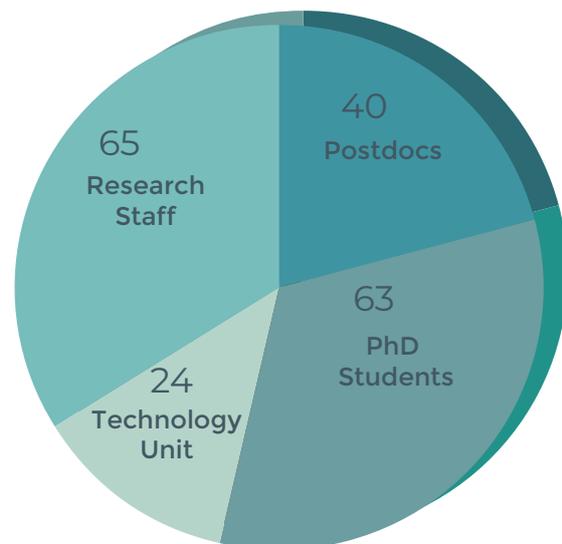
# ICCUB IN FIGURES

## STAFF

Number of ICCUB members

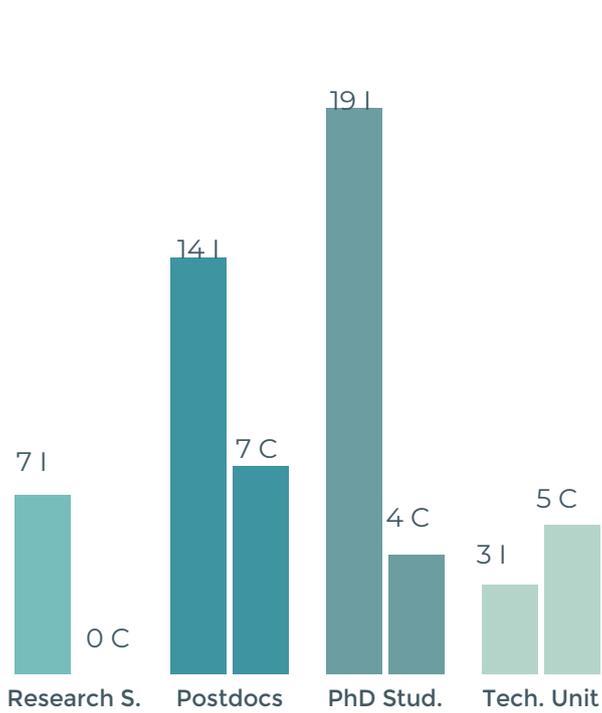


2017



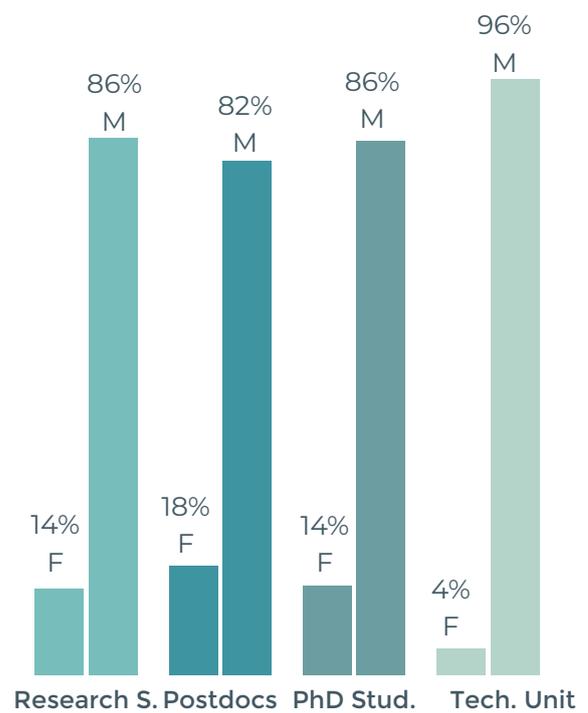
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### Incorporations/Cessations



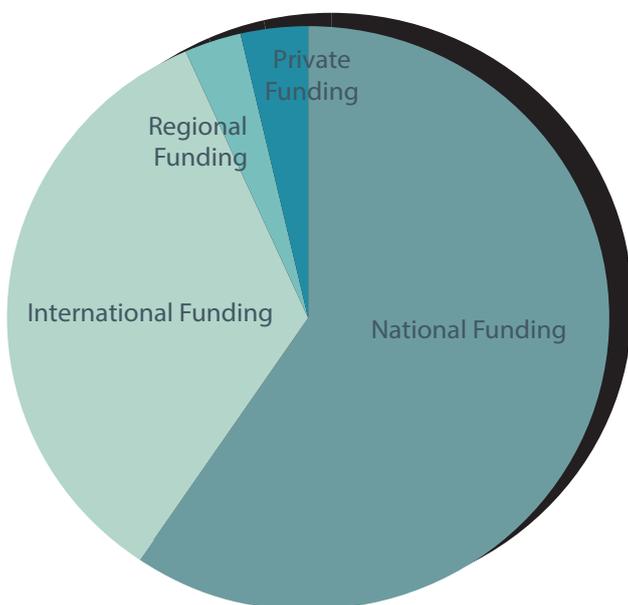
**I - Incorporations**  
**C - Cessations**

### Gender

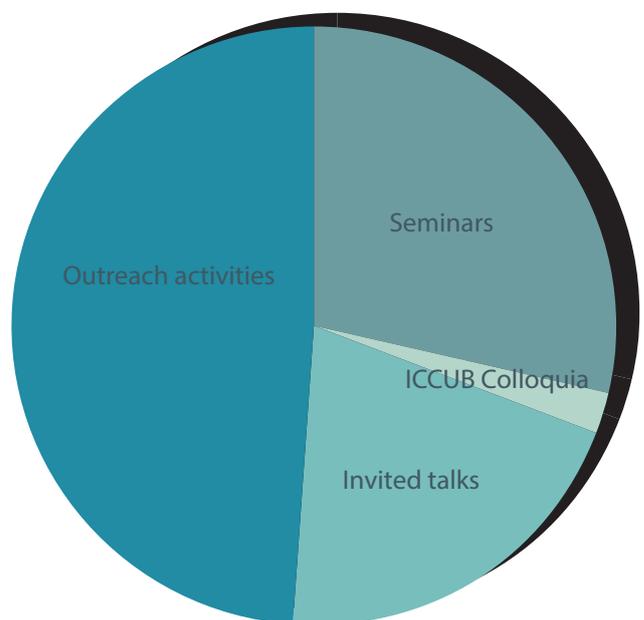


**F - Females**  
**M - Males**

### Funding Sources



### Activities



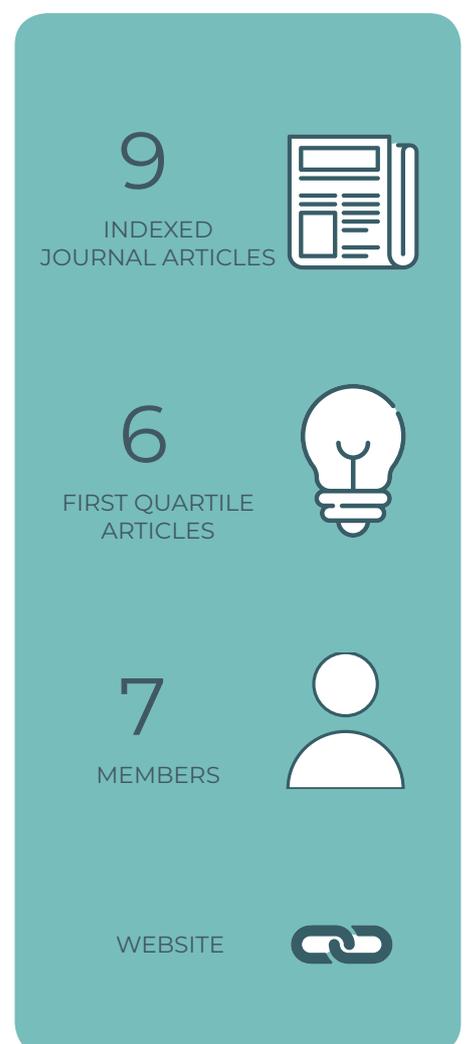
# DISCOVERIES / RESEARCH HIGHLIGHTS

## QUANTUM FIELD THEORY AND STRING THEORY

### **Holography, hydrodynamics and the quark-gluon plasma.**

At low energies quarks and gluons are confined inside the protons and neutrons contained in the atoms that we and the things around us are made of. However, at a temperature of one trillion degrees (a hundred thousand times the temperature at the centre of the Sun) thermal fluctuations are so violent that quarks and gluons become liberated and give rise to a new form of matter known as “Quark-Gluon Plasma” (QGP). The QGP filled the Universe about one microsecond after the Big Bang and it has been recreated on Earth in so-called Heavy Ion Collision experiments (HIC).

One of the main discoveries of these experiments is that the QGP behaves as an almost-perfect fluid that is well described by hydrodynamics. This is crucial because hydrodynamics is the bridge that allows us to connect theory with experiment. We have investigated the applicability of hydrodynamics in a regime that will be

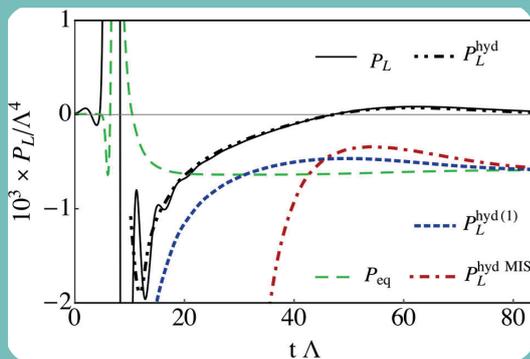


explored by HIC experiments over the next decade. Since this is difficult with conventional methods, we have used a string-theoretical tool known as “holography”, which maps the properties of matter in our four-dimensional world to those of ... gravity in five dimensions! We have discovered that the formulation of hydrodynamics that is almost universally used in hydrodynamic codes, the so-called Muller-Israel-Stewart (MIS) formulation, may not capture correctly the physics of the QGP in the new regime, which could potentially jeopardize our interpretation of the next generation of experiments.

Fortunately, by formulating the problem in terms of five-dimensional gravity, holography also suggests a solution that is currently under investigation.

Reference

Attems M, Bea Y, Casalderrey-Solana J, Mateos D, Triana M & Zilhao M 2018, ‘Holographic Collisions across a Phase Transition’, Phys. Rev. Lett., 121, no. 26, 261601.



Longitudinal pressure at the centre of a HIC as simulated using holography. The continuous black curve is the exact result extracted from the gravitational description. The dotted black curve, which agrees at late times, is the hydrodynamic result in the formulation suggested by holography. In contrast, the MIS formulation of hydrodynamics, shown by the dotted red curve, fails to agree with the exact result.

## COSMOLOGY AND LARGE SCALE STRUCTURE

In 2018 our group entered the arena of primordial Black Holes publishing four articles on the theme. After the discovery in 2016 of the gravitational waves signature of binary black holes merger, the community was left with the open question of whether these black holes were of stellar or primordial origin. If of primordial origin, then not only they could contribute at least in part to the dark matter budget in the Universe, but also they could have specific observational signatures. We have developed what these observational signature would be on the cosmic microwave background, and improved and updated constraints on the possible fraction of dark matter in primordial Black holes from the latest CMB data. Furthermore, we have developed an analytic fast and precise way to make these constraints (usually computed assuming a monochromatic mass distribution) more realistic by converting them into constraints for an extended mass distribution. We have explored signatures of primordial black holes on future 21cm surveys. We have also proposed and developed a statistical way to discriminate between primordial and stellar origin of binary black holes mergers observed from their Gravitational waves emissions.

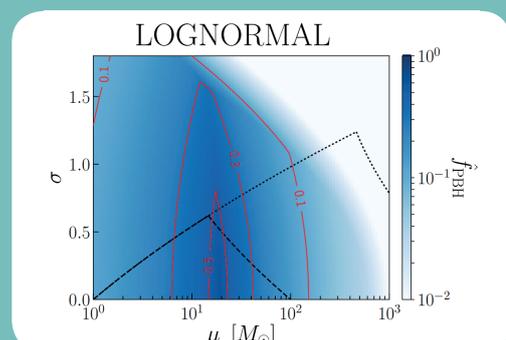
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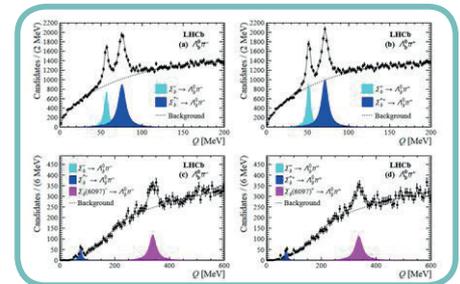
Maximum allowed PBHs fraction for LN distributions for different sets of observables. Microlensing, UFDG and CMB constraints. The black dotted and dashed line corresponds to the  $\delta = 0.001$  curve. Only constraints below these lines can be considered as theoretically consistent.



## EXPERIMENTAL PARTICLE PHYSICS

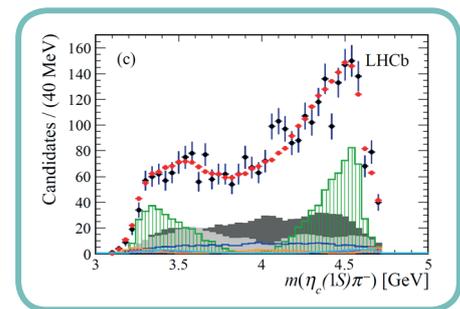
### Observation of two new particles in the $\Lambda_b^0\pi^\pm$ system

LHCb physicists observed and studied two new  $\Sigma_b$  particles—as well as four known ones—in the invariant mass spectrum of the two-body system  $\Lambda_b^0\pi^\pm$ , consisting of a neutral  $\Lambda_b^0$  baryon and a charged  $\pi$  meson. These  $\Sigma_b$  particles manifest as peaks above the smooth background, as shown in the image; on the x-axis,  $Q=m(\Lambda_b^0\pi^\pm)-m(\Lambda_b^0)-m(\pi^\pm)$ . The  $\Lambda_b^0$  baryons are reconstructed via their decay  $\Lambda_b^0 \rightarrow \Lambda_c^+\pi^-$ , with the  $\Lambda_c^+$  baryons in turn decaying to  $pK\pi^+$ .



### Evidence for an exotic particle decaying into $\eta_c(1S)\pi^-$

The first evidence for an exotic particle decaying into another charmonium (cc) meson, the  $\eta_c(1S)$ , plus a  $\pi^-$ . The  $\eta_c(1S)$  was reconstructed through its decay to a proton (p) and an antiproton ( $\bar{p}$ ). Instead of looking for any combination of an  $\eta_c(1S)$  and a pion, the researchers studied those from the decay of a B meson:  $B^0 \rightarrow \eta_c(1S)K^+\pi^-$ . In the absence of exotic resonances, this  $B^0$  decay would proceed predominantly through intermediate kaon resonances, such as  $K^{*0} \rightarrow K^+\pi^-$ . The image shows what happens when contributions from an exotic resonance, the  $Z_c^-(4100)$ , are allowed: a much better description of the data is obtained.



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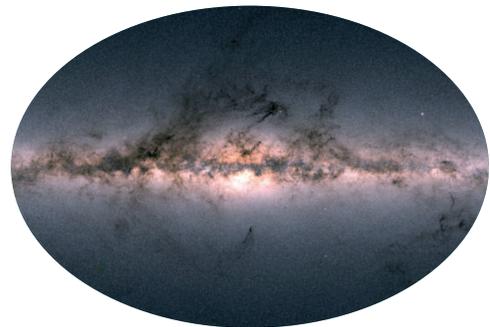


## GALAXY STRUCTURE AND EVOLUTION



### Gaia team detects a shake in the Milky Way

A team led by researchers from the ICCUB and the University of Groningen has found, through the analysis of Gaia data, substructures which were unknown so far in the Milky Way. The findings, which appeared when combining positions and speed of 6 million stars from our galaxy's disk, have been published in the journal Nature. It has been concluded that the disk of our galaxy suffered an important gravitational disturbance about 300 and 900 million years ago.



### New Gaia mission catalogue

On April 25, the European Space Agency (ESA) published the second file for the Gaia mission. This second catalogue, apart from the locations of 1,700 million stars, includes the distance, movement and color of more than 1,300 million stars in the Milky Way and the nearest galaxies. The catalogue has been carried out with data obtained by the satellite over the first twenty-two months of the mission. The file with these data, is open to the world.

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## GRAVITATION AND COSMOLOGY

The cosmic censorship conjecture is one of the deepest open problems in gravitational theory. It asks whether it is possible that classical gravitational dynamics drives a low-energy system into a regime of extremely high-energy densities where quantum-gravitational effects are accessible to observers at asymptotic distances, i.e., without needing to jump inside a black hole.

There are by now a handful of examples where violations of cosmic censorship are well attested. We have recently provided a new one, with a number of appealing properties: it appears in the quintessential phenomenon of General Relativity: the collision of two black holes (in a sufficiently large number of spacetime dimensions, possibly in any  $D$  larger or equal than 6); it does not need any fine-tuning of initial conditions; the singularity is mild, in the sense that it is plausibly resolved by a mechanism with small effects in the evolution of the system. We have performed numerical evolutions of the collisions of these black holes using an effective theory that we recently developed, and have shown that an intermediate unstable state forms -- a rotating black bar -- that then evolves to fragment into two black holes that fly apart from each other.

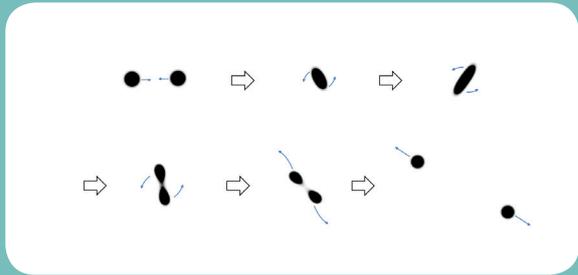
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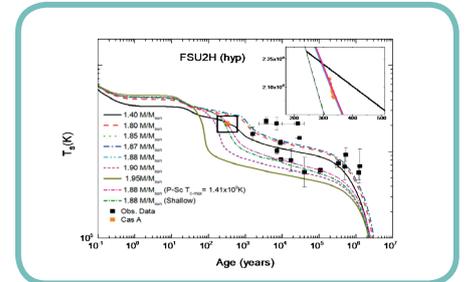
Two spinning black holes collide and form a rotating black bar, which then breaks up into two outgoing black holes (the figures are obtained from the numerical simulation of a collision in the large- $D$  effective theory).



# HADRONIC, NUCLEAR AND ATOMIC PHYSICS

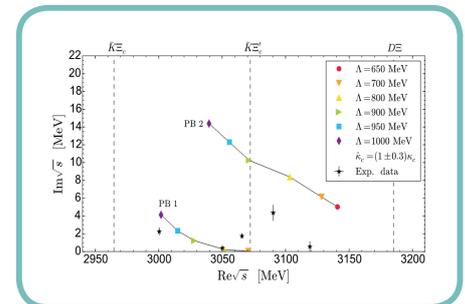
## Cooling of small and massive hyperonic stars

Cooling simulations of isolated neutron stars have been performed, using recently developed equations of state that reproduce the properties of finite nuclei, while fulfilling the restrictions on high-density matter deduced from heavy-ion collisions, neutron stars masses of 2 solar masses and radii below 13 km. A very good agreement with cooling observations is obtained, even without including extensive nucleon pairing. This suggests that neutron star cooling is more compatible with an equation of state that produces a soft nuclear symmetry energy, and generates more compact neutron stars.



## A meson-baryon molecular interpretation for some excited states

We have explored the possibility that some of the five narrow  $\Omega_c$  states recently found by the LHCb collaboration could correspond to exotic pentaquark states, structured as meson-baryon bound molecules. Employing an effective interaction between the low-lying pseudoscalar mesons and the ground-state baryons in s-wave, two resonant structures



in the charm +1, strangeness -2 and isospin 0 sector have been found, having similar masses and widths to those of the observed  $\Omega_c(3050)$  and  $\Omega_c(3090)$ . The identification of these resonances with our predicted meson-baryon molecules would also imply the assignment 1/2- for their spin-parity, contrary to the assignment 3/2- or 5/2- predicted by the quark models for the later state.

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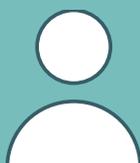
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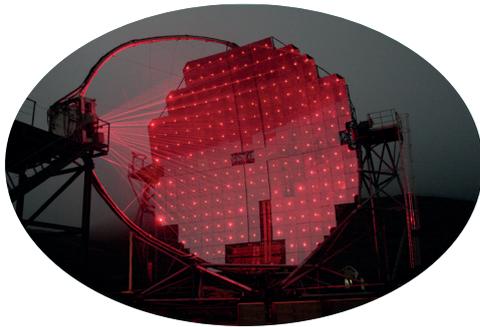
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## HIGH ENERGY ASTROPHYSICS



### MAGIC telescopes identify the origins of a cosmic neutrino

Astrophysicists have found the source of a cosmic neutrino coming from outside the Milky Way which could provide more views to solve a mystery: the origins of primary radiation. The estimation of high energy neutrinos origins is not good in general, and it is hard to identify potential objects in the sky. In this case, the estimation was right, and it coincided with an erupting blazer which can be identified as a potential electromagnetic counterpart”, say M.Ribó and J.M. Paredes.



### Inauguration of the first telescope of a Txerenkov Telescope Array

On 10th October 2018 took place the inauguration of the first prototype Large-Sized Telescope (LST), named LST-1. The telescope is intended to become the first of four LSTs on the north site of the CTA Observatory. The plan for the site also includes 15 Medium-Sized Telescopes (MSTs). Among the participating centers in the construction, the ICCUB has contributed to the design of one of the signal amplification devices.

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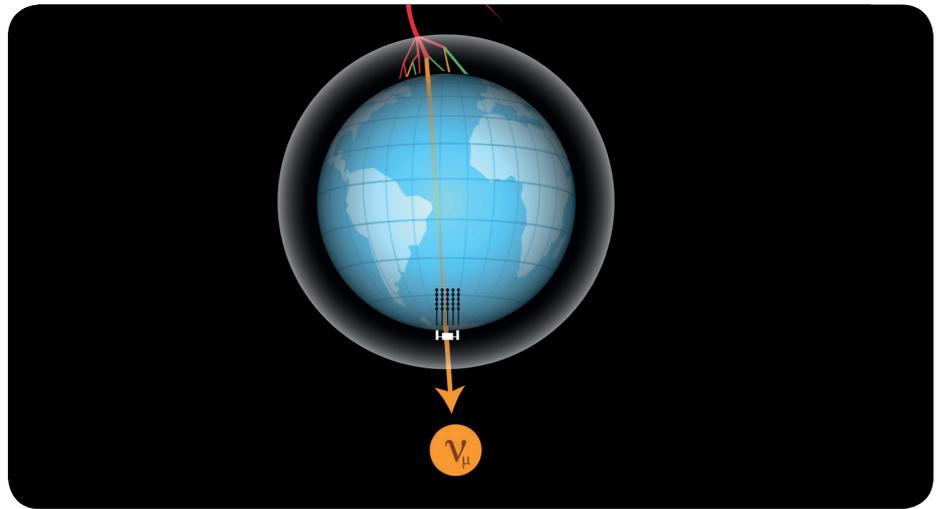


## PARTICLE PHYSICS PHENOMENOLOGY

**ICCUB and IFIC scientists carried out the first Earth tomography with neutrinos**

*Researchers from the ICCUB and the Institute of Corpuscular Physics (UV-CSIC) published in Nature Physics the first study of the density of the planet in which they used the neutrinos.*

Neutrinos are able to cross the planet without flinching, so it can provide valuable information about the distribution of its density, especially in little-known areas such as the inner core, as well as Earth's mass. The study used data from the IceCube experiment (Antartica), the largest neutrino telescope in the world.



CREDIT: Donini, A.; Palomares, S.; Salvadó, J.  
Artistic representation of the Cosmic Ray producing neutrinos.



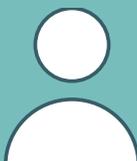
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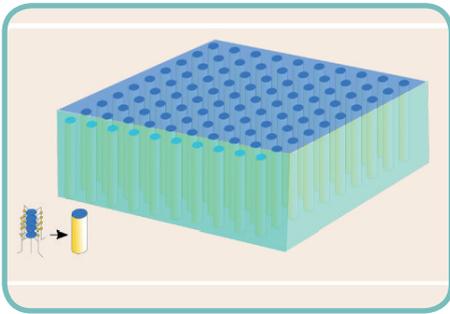


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## QUANTUM PHYSICS

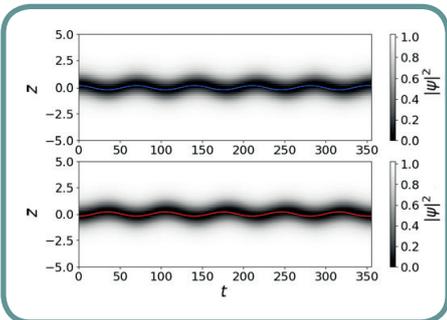
### Finite correlation length scaling with infinite projected entangled-pair states



We show how to accurately study two-dimensional quantum critical phenomena using infinite projected entangled-pair states (iPEPS). We identify the presence of a finite correlation length in the optimal iPEPS approximation to Lorentz-invariant critical states which we use to perform a finite correlation length scaling analysis to determine

critical exponents. This is analogous to the one-dimensional finite entanglement scaling with infinite matrix product states.

### Dark-dark-soliton dynamics in two density-coupled Bose-Einstein condensates



We study the one-dimensional dynamics of dark-dark solitons in the miscible regime of two density-coupled Bose-Einstein condensates having repulsive interparticle interactions within each condensate ( $g > 0$ ). By using an adiabatic perturbation theory in the parameter  $g_{12}/g$ , we show that, contrary to the case of two solitons in

scalar condensates, the interactions between solitons are attractive when the interparticle interactions between condensates are repulsive  $g_{12} > 0$ .

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## STAR FORMATION

The focus of our group on the observational side has been the characterization of the polarization properties of a massive protostellar disk with the ALMA interferometer. We have found that the polarization is mainly from self-scattering, and that dust settling has not occurred yet in the inner disk. We have also been involved in a new molecular-line survey of the Orion cloud with the CARMA interferometer that is providing a wealth of new information on the structure and dynamics of this region. On the theoretical side, we have been able to prove numerically that the physics of isothermal MHD turbulence is sufficient to explain the origin of the stellar mass distribution. We have achieved this with unprecedented star-formation simulations producing up to thousand star particles under realistic molecular cloud conditions (see figure). We have shown that the numerical result is consistent with our theoretical prediction for the peak of the mass distribution and its time evolution. We have also developed a probabilistic approach to investigate the gas-density distribution in supersonic turbulence, which is a crucial ingredient in star-formation model, providing a new test for the accuracy of numerical codes.

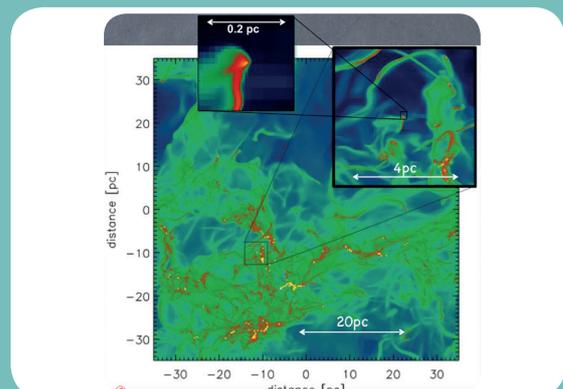
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Projected density from a star-formation simulation with the Ramses adaptive-mesh-refinement code forming hundreds of stars. The simulation covers a range of scales of over five orders of magnitude, from 80 AU to  $10^7$  AU. The two smaller boxes show zoom-in regions of 4 and 0.2 pc, centered on a newborn star formed at the edge of a dense filament.



# LIFE AT THE ICCUB

## WELCOME MARK GIELES



I try to understand the formation and dynamical evolution of globular clusters to shed light on the stellar initial mass function, black hole

dynamics, gravitational waves and the dark matter distribution in galaxies. After an exciting period building a new astrophysics research group in Surrey, I decided that it was time to move on and look for new career opportunities. I was successful with the Icrea Research Professorship to join the ICCUB. It's expertise in galaxy formation and evolution, cosmology and star formation, and the active involvement in Gaia and Virgo make the ICCUB an exciting place to continue my research. I look forward to contribute to keeping and growing the ICCUB as a centre of international research excellence!

## THREE "LA CAIXA" JUNIOR LEADER FELLOWS CHOOSE THE ICCUB FOR THEIR RESEARCH



Anna Ferré, Héctor Gil and Matteo Cerruti are the ICCUB researchers that have been awarded with the "la Caixa" Junior Leader fellowship. Only 22 international postdoctoral researchers have been chosen to benefit from this excellence grant. The primary condition is to perform their research in a Severo Ochoa or María the Maeztu accredited centre, as our institute. We welcome them and wish them a bright future!

## JORDI TORRA AND LICIA VERDE AWARDED THE NARCIS MONTURIOL MEDAL FOR THEIR SCIENTIFIC CONTRIBUTIONS



The President of the Generalitat (Catalan Government), Quim Torra, handed the Narcís Monturiol medal to the nineteen researchers and a institution awarded, among which, Prof. Licia Verde and Àngels Ferrer in behalf of Prof. Jordi Torra. These awards, instituted by the Generalitat in 1982, want to distinguish the people and entities that have contributed significantly to the development of science and technology in Catalonia.

## LICIA VERDE AWARDED THE PREMI NACIONAL DE RECERCA

Licia Verde, ICREA researcher at the Institute of Cosmos Sciences of the University of Barcelona (ICCUB), has been awarded the Premi Nacional de Recerca 2018. This distinction, granted by the Generalitat (Catalan Government) and the Catalan



Foundation for Research and Innovation (FCRI) recognizes the researcher who has recently contributed significantly internationally to the advancement of a scientific discipline in any of its fields. The jury has valued the work of Licia Verde for its pioneering findings on Universe and to contribute decisively to understand how matter and dark energy are distributed in the universe.

## ALBA CERVERA WINNER OF THE TEACH ME QISKIT PRIZE



Alba Cervera has won Teach Me QISKit which offered a \$1.000 prize for the best interactive self-paced tutorial that explains a specific focus topic in quantum computing using QISKit and the IBM Q Experience. IBM has chosen her tutorial “Exact Ising Model simulation: How to simulate time evolution at zero time” because of its creativity, originality, visual appearance and structure.

## PHD STUDENTS MEETINGS

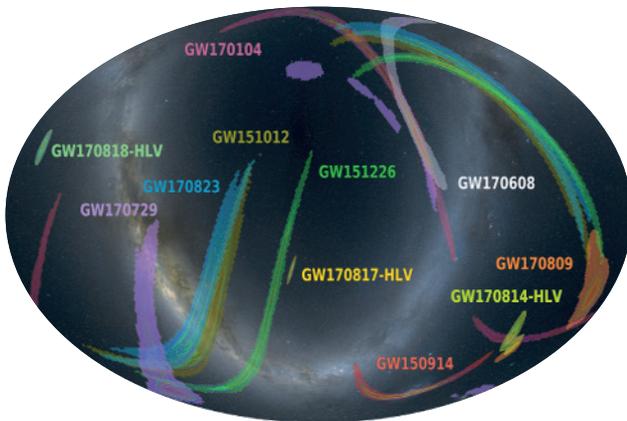
There are weekly meetings addressed to all ICCUB doctoral students. The purpose is to create a community of doctoral students and to encourage collaborations, also between different groups. The topics of these meetings range from presentations of the doctoral students’ research to discussions about recent discoveries or articles published in international journals in the scientific fields researched in the ICCUB. In addition, “soft skills” and aspects of daily life of PhD students are also treated. Collaboration has started between students and seniors to teach different aspects which they will encounter afterwards in their research career. More activities are constantly popping up such as Monthly Beer. They encourage all PhD students to be part of these meetings and collaborate in outreach and improve doctoral life.



### EXTRAORDINARY PHD PRIZE

Adrià Gómez Valent and Ignasi Pérez Ràfols have been awarded with the Extraordinary PhD prize, assessed and selected by a rigorous tribunal composed by Postdoctoral researchers and professors from UB.

## THE ICCUB JOINS THE VIRGO COLLABORATION TO STUDY GRAVITATIONAL WAVES



The Virgo Collaboration is contributing to the detection and analysis of the elusive gravitational waves using the European Gravitational Observatory (EGO), in Cascina (Italy). Virgo can detect gravitational waves in a range similar to the auditive range, so we «listen» to the Universe. Currently, Virgo can detect

gravitational waves generated by binary neutron stars, and by binary black holes. The higher its sensitivity is, the farther it can reach and, thus, more events can be detected and observed.

At the present moment, limitations in the sensitivity only allows to detect phenomena generating the biggest gravitational waves in the universe, such as collisions between black holes or neutron stars.

The ICCUB is contributing to Virgo, taking advantage of the expertise acquired in other projects that also deal with large amounts of data and complex algorithms, such as the Gaia mission of ESA or the LHCb experiment at CERN. Our experts are reviewing the overall computing model, the software management and the data handling approach, aiming at an efficient use of the expensive computing facilities. We also intend to improve some of the data analysis pipelines. Finally, we will also contribute to the electronics and instrumentation upgrades. All this will help Virgo reaching even better sensitivities and, thus, routinely detecting and analysing much more gravitational waves.



## DIVERSITY, EQUITY AND INCLUSION COMMISSION

There are weekly meetings addressed to all ICCUB doctoral students. The purpose is to create a community of doctoral students and to encourage collaborations, also between different groups. The topics of these meetings range from presentations of the doctoral students' research to discussions about recent discoveries or articles published in international journals in the scientific fields researched in the ICCUB. In addition, "soft skills" and aspects of daily life of PhD students are also treated. Collaboration has started between students and seniors to teach different aspects which they will encounter afterwards in their research career. More activities are constantly popping up such as Monthly Beer. They encourage all PhD students to be part of these meetings and collaborate in outreach and improve doctoral life.

**DIEC**



Ombudswoman

Ombudsman



Chair of DIEC

Advisor

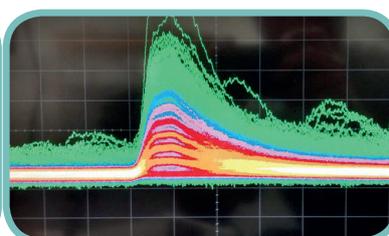
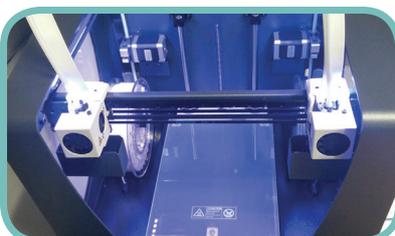
# TECHNOLOGICAL UNIT

## MAIN GOALS

- Provide electronics and data processing services for scientific projects.
- Transfer knowledge to new fields and technology to industry.

## PROJECTS

- LHCb: SPD maintenance and calorimeter upgrade.
- GAIA: data processing and catalogue preparation for the Gaia Data Release 2.
- VIRGO: joined in July 2018. Our experts contributed to the revision of the Virgo Computing Model.
- CTA: The ACTA quality control for the MST-1 telescope with the Nectar CAM camera has been performed. It has been delivered the whole camera with 265 clusters for the NectarCAM.
- The ICCUB is part of many other collaborations such as Solar Orbiter, IAXO and PLATO.



# OUTREACH

The ICCUB research groups are very active in the dissemination of their activity in schools and public centers, and since its establishment, the institute has provided economic and human support to the extent possible. Thanks to the Maria de Maeztu award, the institute has been able to significantly expand this support.

The Institute main outreach activities are:

- Publication of outreach articles
- Astronomy sessions, courses and public talks
- “Taller de Física de Partícules” organization
- Fabrication and management of itinerant exhibitions
- Astronomic events follow-up



# ICCUB LAUNCHED “SERVIPARTÍCULES” A NEW OUTREACH WEBSITE



On November 2018 the ICCUB launched a outreach website on Cosmology, Gravitation, Particle Physics, Atomic Physics and Nuclear Physics.

The new website expands the former dissemination website of the Experimental Group of Particle Physics of the UB “Discovering Particle Physics with the LHC”, and completes the astronomy website “ServiAstro” of the ICCUB and the Department of Quantum Physics and Astrophysics.



<http://serviparticules.ub.edu>

<http://serviastro.ub.edu>



The Outreach Twitter

[@ICCUBdivulga](https://twitter.com/ICCUBdivulga)

The ICCUB created a twitter outreach account extending the Serviastro account.



## MASTERCLAS ON PARTICLE PHYSICS 2018



The Masterclass on Particle Physics is an activity addressed to high school students in their final year, as part of the international activity Hands on Particle Physics. The workshop has taken place at the UB since 2005 and lasts one day, during which students attend talks about Physics and study real data from LHC. The students also visit the laboratories and attend a resenation about the courses offered at the Faculty of Physics.

In 2018 two sessions were held on the 9th and the 16th of March at the Faculty of Physics.

# 162

ATTENDANTS



# 152

HIGH SCHOOLS



**TFP**



### Extra sessions at



#### TECHNOWEEK

16 students selected from the attendants to the Physics Masterclass participated for one week in the special editon of the Masterclas organized in the context of the Technoweeek course.

#### SALÓ DE L'ENSENYAMENT

During three days the students who visited the Saló de l'ensenyament could carry out the practical exercice of the Physics Masterclass.

# TRAVELLING EXHIBITIONS



The ICCUB owns seven travelling exhibitions. These exhibitions have different printed versions that are displayed annually in different external centers, like high schools, libraries or community centers. All the exhibitions also have online versions, some of them translated in several languages.

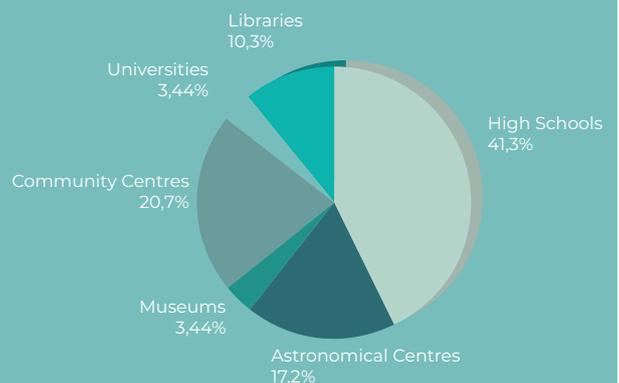
In 2018 five new posters were added to the exhibition “One thousand eyes to one thousand stars” on the occasion of the second data release of the Gaia Mission.

## Exhibitions

- De la Terra a l'Univers
- Amb A d'Astrònoma
- Les distàncies còsmiques
- Mil milions d'ulls per a mil milions d'estrelles
- Viatge cap a l'univers fosc
- Telescopi Assumpció Català
- Investigadores en Física Nuclear

29

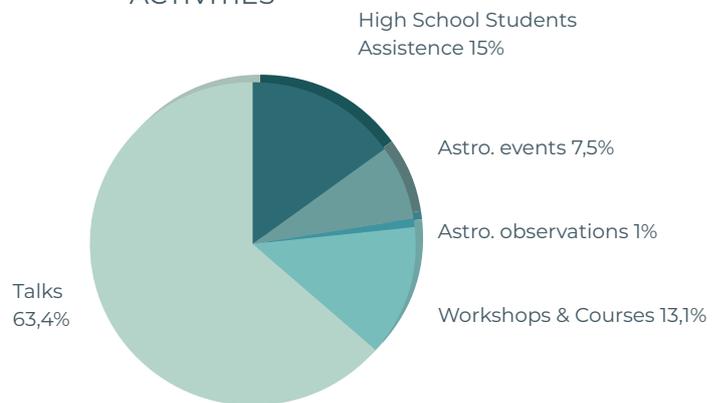
DESTINATIONS



## OTHER OUTREACH ACTIVITIES

ICCUB members give outreach talks addressed either to students or to general public, give courses and participate in workshops in the framework of science festivals or student fairs, assists high school students on their final projects, organize astronomical observations, and give coverage to remarkable astronomical ephemeris.

145  
ACTIVITIES



### Remarkable outreach activities

#### Nobel Prize Panel: “Atomic Physics: past, present and future”



A Nobel prize panel with five physics Nobel prizes conducted by ICCUB researcher Bruno Julià was organized as the outreach event of the ICAP 2018. The ICCUB members Bruno Julià, Jose Ignacio Latorre and Artur Polls participate in the committees of this event.

#### Nobel Prize Talk: “Gravitational Waves: From Einstein to a New Science”



In the context of SEWM 2018 was held an outreach talk by Prof. Barry C. Barish, Nobel Laureate 2017, about gravitational waves and his personal implication on this historical episode of Physics. The ICCUB members Joan Soto and Jorge Casalderrey-Solana participate in the organisation of this event.

## Sónar Calling



To celebrate its 25th anniversary, Sónar launched a message in search of extraterrestrial intelligence in the potentially habitable exoplanet GJ273b, 12.5 light-years from us. The ICCUB researcher Jordi Portell taken part in this project.

Framed within the international conference Sonar+D, there was a discussion by the researchers who took part in the project. Besides ICCUB researcher Xavier Luri carried out a workshop on the analysis of astronomical data for creative applications. There was a great impact of the project and the activities in the press, shooting a documentary with the participation of the researchers and making several interviews for the Radio and the newspapers.

## Activities at Brians2



Our researchers have carried on two different activities in the Centre de Formació d'adults Victor Català for the inmates of the penitentiary Brians 2. On 8th March, Carme Jordi participated in a round table for the commemoration of the

Women's day. On June Alfred Castro, Eduard Masana and Mercè Romero conducted a telescope session with an astronomical introduction.

## Hay Festival Perú - Chile



The ICREA-ICCUB researcher Roberto Emparan participated in the Hay Festival, in the Peru and the Chile editions. He gave three talks and some interviews to the press, radio and TV from both countries.

Gaia DR2



The Second Data Release of the Gaia Mission was on April and an open presentation act was held at the Physics University. In the act participated the rector of the University of Barcelona, the director of the Institute of Space Studies of

Catalonia, the director of the ICCUB and some members of the GaiaUB team. For this occasion were added five posters with the new achievements of the Gaia mission to its exhibition.

Dark Matter Day

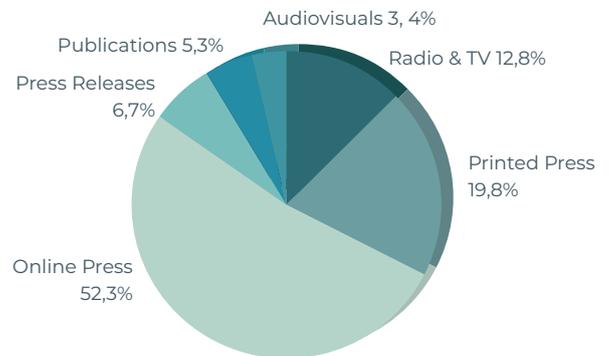


Celebrating the Dark Matter Day on October ICCUB organized a round table on this concept with the researchers Roberto Emparan, Héctor Gil, José Luís Bernal, and Nicola Bellomo.

## PUBLICATIONS, PRESS & MEDIA

In 2018 ICCUB members have actively participated in the dissemination of science through the publication of popular science books and articles and also through a lot of interviews in the press and media about remarkable news and on their own research.

298  
INVOLVEMENTS



### Remarkable News

#### Tribute to Stephen Hawking



Stephen Hawking, renowned cosmologist and science divulgator, died in Cambridge on 14 March. Some ICCUB researchers pay tribute to him in the press.

#### Publication of the book “Iluminando el Universo Oscuro” by Roberto Emparan



On February Roberto Emparan published his first book of popular science “Iluminando el Universo Oscuro” and give some interviews to the press about it.

#### Publication of the book “Democracias robotizadas ” by R. Jimenez and L. Moreno



On May Raul Jiménez published this book on the role that machine learning, artificial intelligence, bayesian statistics and quantum computing will have on our societies.

#### Astronomical section in “El Periódico” by E. Masana and S. Ribas



Eduard Masana published 9 astronomical articles during 2018 in the Astronomica Section of the newspaper “El Periódico” that shares with our collaborator Salvador Ribas (PAM).