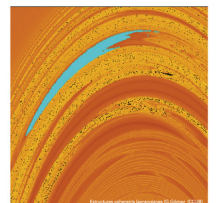
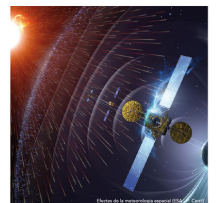
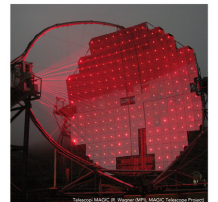
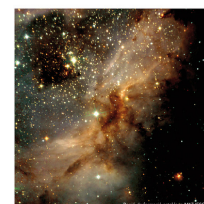
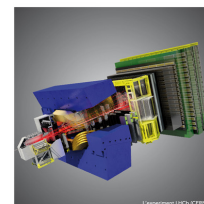
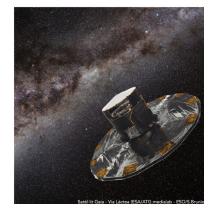
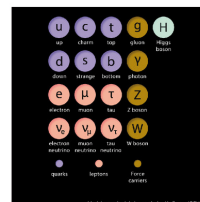
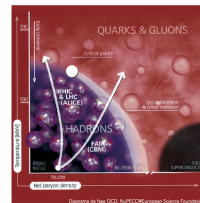
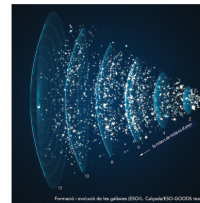
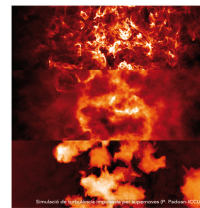


ANNUAL REPORT 2017

INSTITUTE OF COSMOS SCIENCES



Institut de Ciències del Cosmos



<http://icc.ub.edu/>



UNIVERSITAT DE
BARCELONA

Dos campus d'excel·lència internacional:

B:KC Barcelona Knowledge Campus

HUB Health Universitat de Barcelona Campus

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FOREWORD

This year 2017 has been especially important due to some relevant changes in the internal organization and management of the institute, as well as for the new alliances established.

The ICCUB is the first institute of the University of Barcelona (UB) to hold a M&M certificate of excellence. As a result, this year the UB has made a special effort to contribute to its further development by offering 500m² of additional space at the Parc Científic de Barcelona (PCB). This space has been used to install our newly created Technology Unit, which develops instrumentation and big data systems for scientific and technology projects, as well as for companies. This Unit is also in charge of promoting the participation of the ICCUB researchers and engineers in international technological projects by defining an efficient coordination mechanism for technical personnel.



FOREWORD

The Faculty of Physics has also transferred to the ICCUB the laboratory room formerly occupied by our electronics and instrumentation group, who are now part of the Technological Unit. The laboratory room will become a multipurpose meeting room where the ICCUB members can meet and discuss multidisciplinary research topics. Its inauguration is expected at beginning of next year.

The MdM budget, together with the overheads of our three running ERC grants have allowed the ICCUB to increase the human resources at its secretary's office by 40%. This office has been split into two: the Scientific Office and the Administrative Office. The goal of this reorganization is to have specialized personnel for each task, improving efficiency and promoting the present and future growth of the Institute.

Finally, in late 2017 the "Alliance of Severo Ochoa Centres and Maria de Maeztu Units of Excellence" was launched. The ICCUB is a member, which is a step towards boosting the cooperation among the centers.

I think that these changes and alliances mentioned above, are the correct pillars for a more brilliant future of the ICCUB.

LLUÍS GARRIDO BELTRÁN

Director of the ICCUB

ORGANIZATION CHART

Executive Board

Director: Lluís Garrido
Deputy Director: Francesca Figueras
Secretary: Bartomeu Fiol



Scientific Board

Roberto Emparan
David Gascón
Francesca Figueras
Lluís Garrido
Josep Maria Paredes
Assumpta Parreño

Council

Daniel Alsina
Nicola Bellomo
Francesca Figueras
Bartomeu Fiol
Isabel Fernández
Lluís Garrido
Carme Jordi
David Mateos
Jordi Miralda
Paolo Padoan
Josep Maria Paredes
Àngels Ramos
Eduard Salvador
Andreu Sanuy
Enric Verdaguer

International Advisory Council

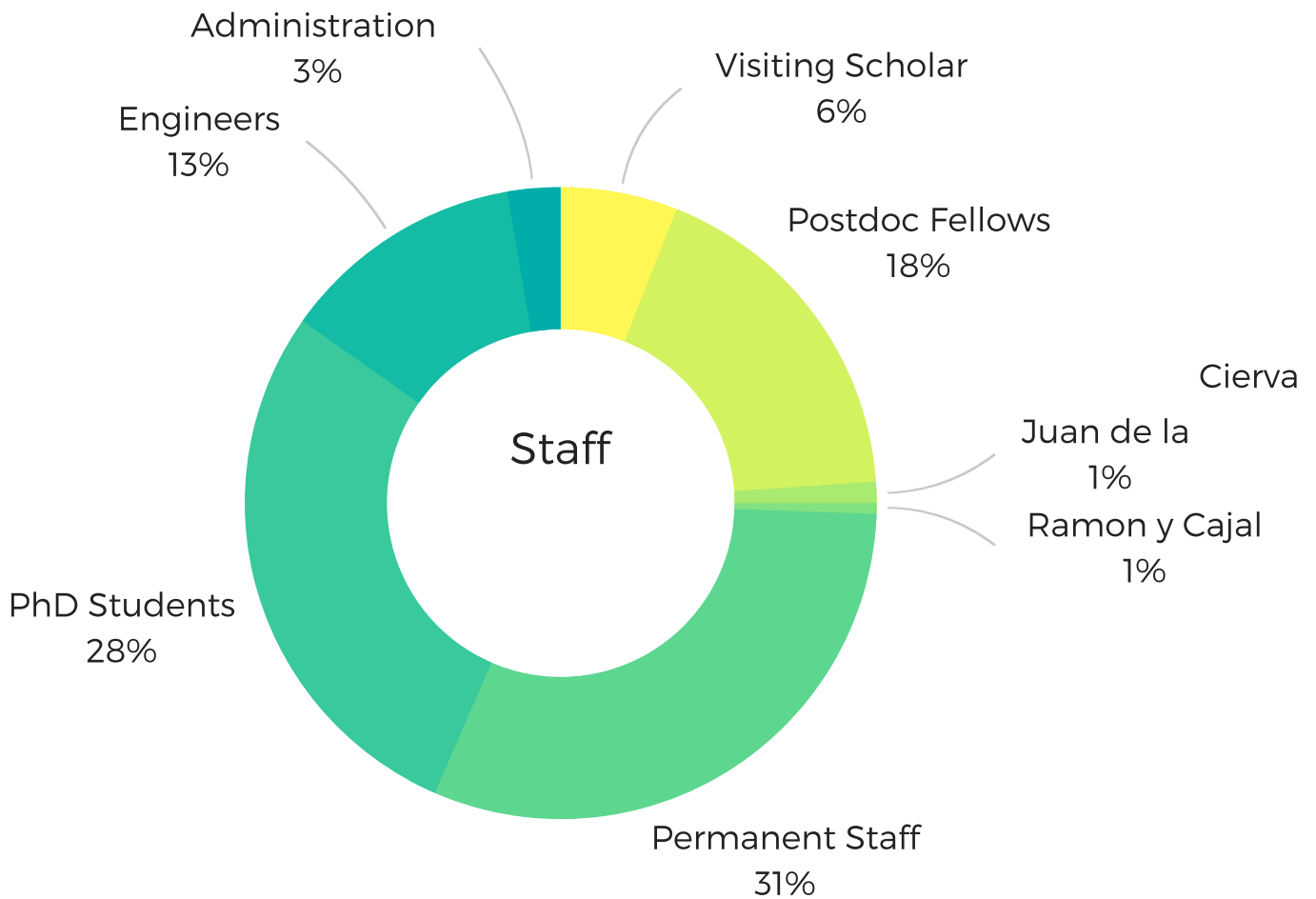
Felix Aharonian, Dublin Institute for Advanced Studies and Max Planck Institute für Kernphysik, Heidelberg (Chair).

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.

ICCUB IN FIGURES

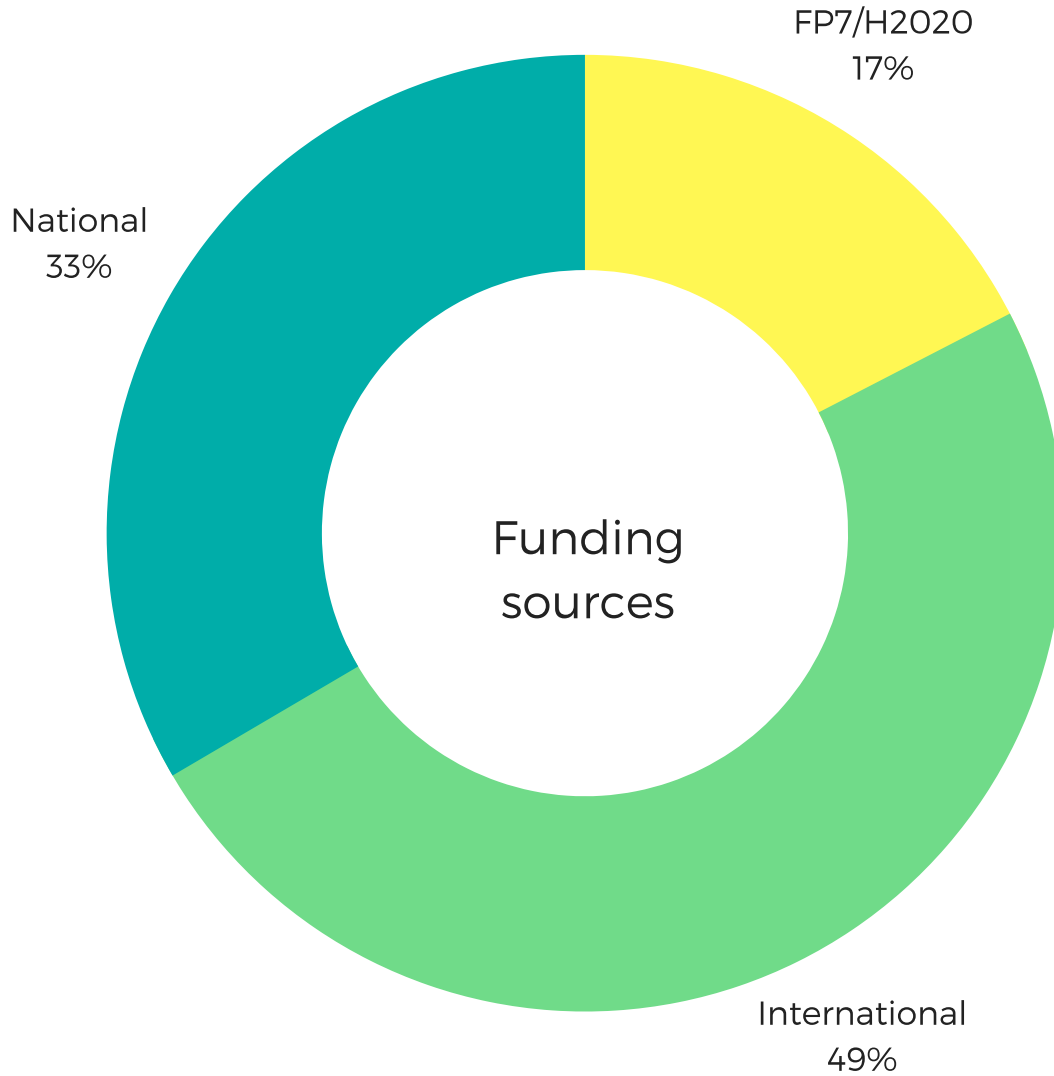


The ICCUB has a total of 184 members with 57 long term scientists, 36 postdoctoral researchers and 52 PhD students and 23 engineers.



People

ICCUB IN FIGURES



5,1M€

International Projects

2,6M€

National Projects

7,7M€

Total Funding Sources



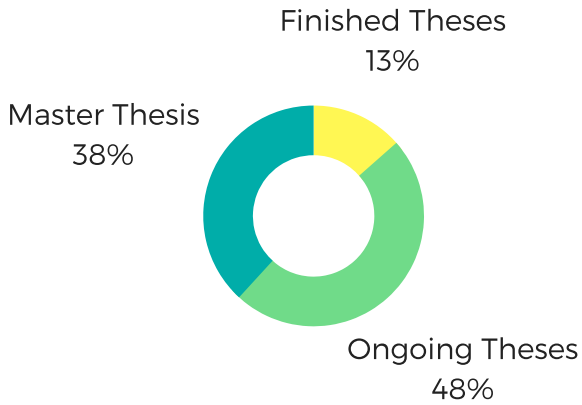
Funding

ICCUB IN FIGURES

Theses



Theses



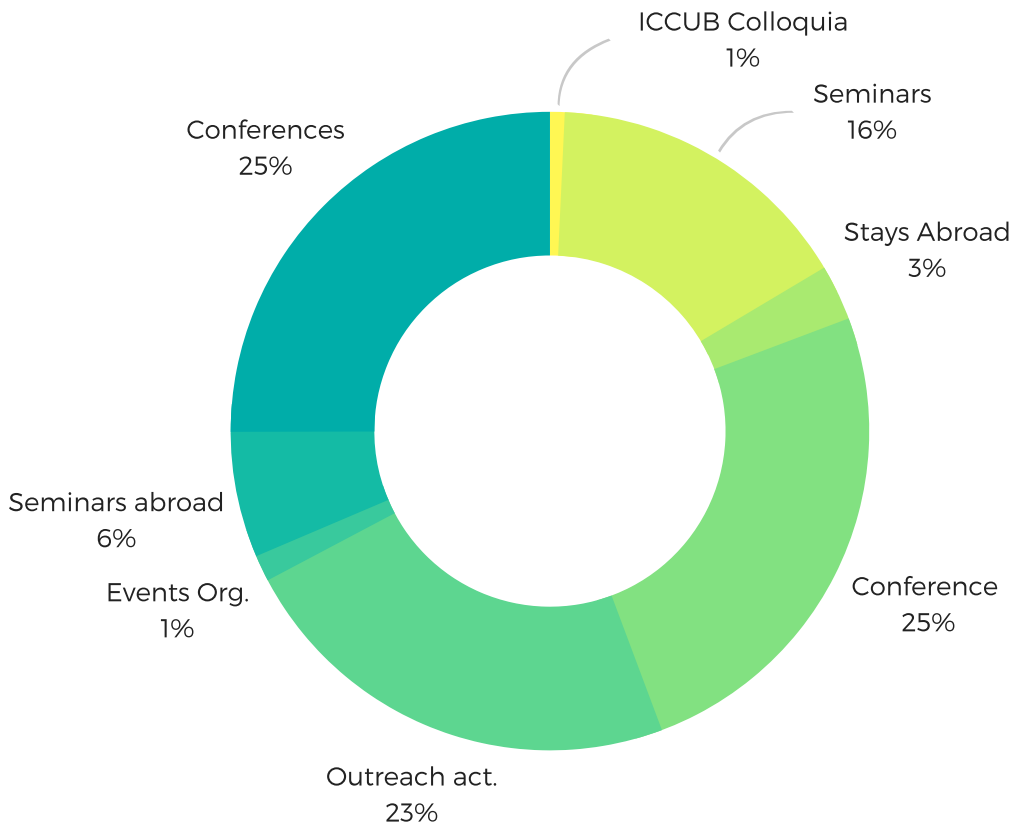
12 doctoral thesis have been read under the direction of our researchers.

52 doctoral students are working side by side with our members.

Activities



Activities



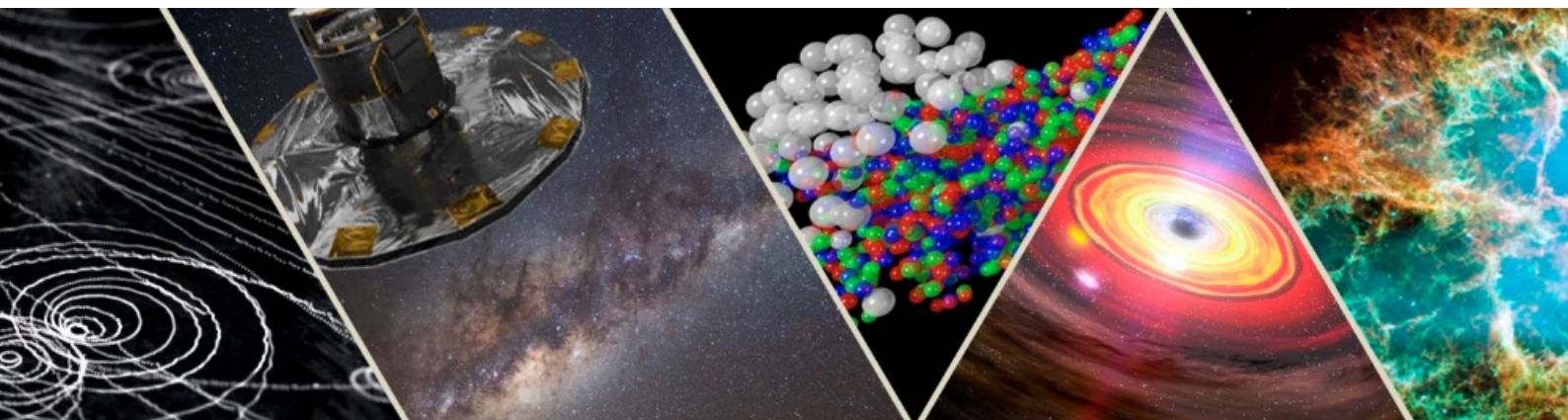
RESEARCH AREAS

The Institute of Cosmos Sciences of the University of Barcelona (ICCUB) is an interdisciplinary center devoted to fundamental research in the fields of cosmology, astrophysics and particle physics. Since its creation in 2006 the ICCUB has been mainly driven by three fundamental questions:

- What are the origin and fate of the Universe?
- What are the ultimate constituents of the Universe?
- Why does the Universe have its present appearance?

The answer to these questions demands the multidisciplinary approach that ICC offers and the recruitment of highly qualified scientists and engineers. In addition, the institute has a strong technology program through its participation in international collaborations in observational astronomy and experimental particle physics.

In 2015, the ICCUB was accredited as a María de Maeztu center of excellence by the Spanish Government. Selected institutes in this programme stand out for the international impact of their scientific contributions, their innovative power and for their strong relation to their social and economic environment.

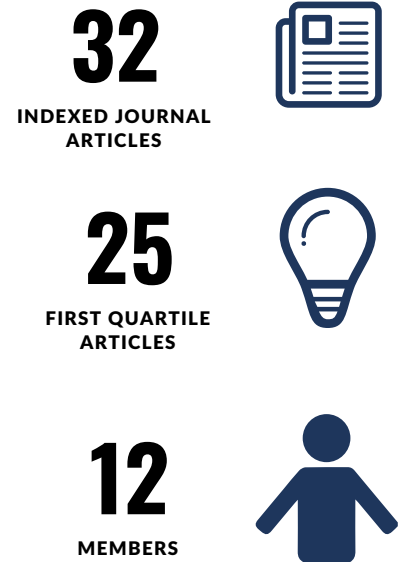


Research

1. COSMOLOGY AND LARGE SCALE STRUCTURE

Summary

We continued to work on the effects of neutrino properties on cosmology: mass, effective number of species and hierarchy. Spurred by the detection of gravitational waves from BH-BH merger, which, it has been suggested, could be of primordial origin, we have also started exploring cosmological implications of primordial black holes and synergies of gravitational waves signals with cosmology. We participate actively in DESI activities.



We explored the use of Lyman-alpha emitting galaxies as a probe to the reionization epoch. We published results from the final analysis of the Lyman alpha forest correlations in quasar spectra in BOSS (SDSS-III) for the Baryon Acoustic Oscillation scale. We have also initiated a study of the gravitational lensing effects of background stars by a cluster of galaxies when extremely high magnifications are reached, as a way to probe the presence of compact objects in the dark matter.

We used of the AMIGA galaxy formation model to constrain reionization and galaxy formation through the properties of the high-z Universe, and applied the model to the interpretation of 21cm line observations. We also performed an analytical study of DM halo properties including substructure.

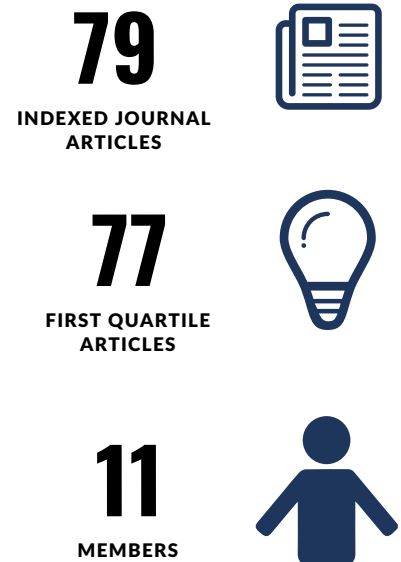
2. EXPERIMENTAL PARTICLE PHYSICS

Summary

In 2017 the research continued its focus on the study of the radiative B meson decays. These b quark to s quark plus a photon transitions offer a unique opportunity to look for new physics beyond the Standard Model by precisely measuring:

- i) the photon polarization of such decays, analyzing the B meson decay time
- ii) the branching ratio of different exclusive channels and the their CP asymmetry and
- iii) the angular distribution of the b meson and baryon decay products

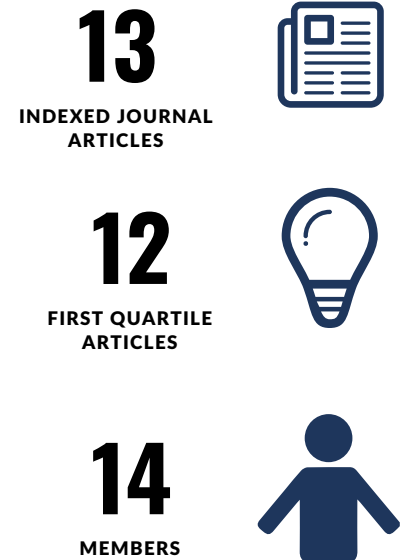
In addition, the ICCUB has contributed to the completion of the design and production of the readout electronics for the calorimeter and the Scintillating Fiber Tracking of the LHCb experiment upgrade. A setup test for the mass Characterization of the LHCb SciFi and CALO application specific integrated circuits (ASIC) has been at the new lab facilities of the PCB. It makes use of a custom build robotized arm fully programmed to automatically perform the mass electronics characterization used for the LHCb experiment sub-detectors, Cerenkov Telescopy Array, etc... The cross-application of the LHCb-generated knowledge in read out electronics has generated the opportunity to explore the possibility to join new experiments (IAXO, etc..) that search new physics beyond the Standard Model of Particle Physics.



3. GALAXY STRUCTURE AND EVOLUTION

Summary

The ICCUB team has continued supporting Gaia space mission operations, spacecraft monitoring and other agreed responsibilities on data processing and validation, meaning astrometry, photometry and archive, within the framework of the Data Processing and Analysis Consortium. The members of the ICCUB have continued their involvement in the managerial bodies of the Gaia mission. The main achievements in 2017 are (1) data production for the 2nd Release planned for April 2018 has successfully concluded, and its validation nearly finished, (2) associated

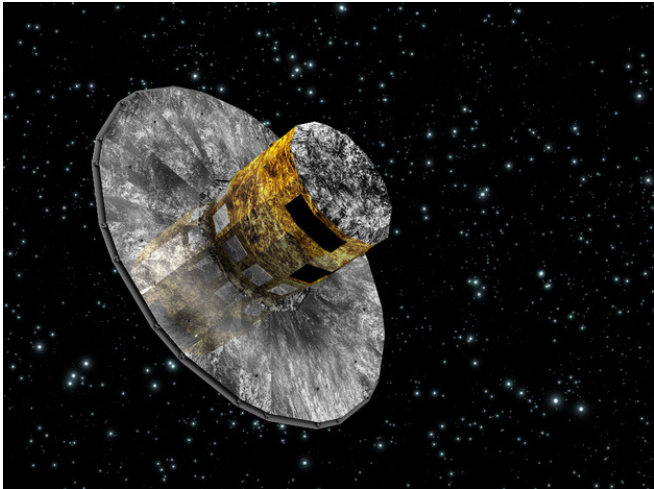


documentation including 12 papers accompanying the release has been prepared, (3) the daily processing of the incoming data from the satellite has routinely continued, and (4) the development and implementation of the software for the Intermediate Data Update and the cross-match of observations into sources for the next Data Release 3 has been finalized.

Research on the metal content of damped Lyman alpha systems was completed with former Master student Lluís Mas-Ribas, now a graduate student at University of Oslo, where the average absorption spectrum from metal lines was measured from the BOSS sample of more than 20,000 DLAs. Many average properties of these absorption systems were inferred, including abundances and the relation of high and low-ionization species.

The Lyman alpha emission of galaxies at high redshift continued to be investigated as a way to probe the reionization process of the Universe.

A suite of ~600 simulations of binary galaxy collisions has been built to investigate issues related to galaxy evolution as diverse as the accuracy of the common formulas used to estimate the duration of mergers and the conjecture that mergers can fuel dual AGN. The main finding has been that major-merger timescales are not accurately predicted by existing dynamical-friction models, perhaps due to an incomplete identification of the parameters governing orbital decay.



CREDIT: ESA/Gaia

Spacecraft of the ESA mission Gaia, which was launched in 2013 and it is expected to be operational until 2020.



CREDIT: ESA/Hubble

This image of a pair of interacting galaxies called Arp 273 was released to celebrate the 21st anniversary of the launch of the NASA/ESA Hubble Space Telescope.

4. GRAVITATION AND COSMOLOGY

Summary

Event horizon in black hole collisions

We have given a simple, accurate and very general description of the event horizon in a collision between two black holes in the extreme-mass-ratio limit.

Studies of gravitational duals of quantum field theories

We have analytically constructed the gravitational duals of supersymmetric Yang-Mills $N = 1$ in three dimensions coupled with N_f quark flavors, including the backreaction of these on the color degrees of freedom. We have shown that, for massless quarks, dual gravitational solutions flow in the infrared to a AdS_4 fixed point dual to a Chern-Simons-matter theory. We have also made the first holographic calculation of the geometric polarizability of a plasma at finite temperature.

Holographic investigation of out-of-equilibrium processes in quantum field theory

We have extended the study of transport and holographic collisions to nonconformal theories with baryonic charge. Using numerical techniques, we have analyzed phase transitions with translational symmetry breaking.

Studies of multipoles and distortions of the cosmic microwave background radiation (CMB)

We have analyzed the way in which the subtraction of the kinetic quadrupole of the CMB should be carried out. After performing the correct subtraction, we have improved the agreement between different mapping techniques. We have also

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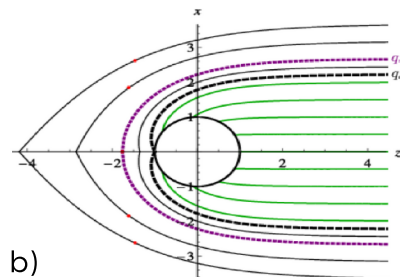
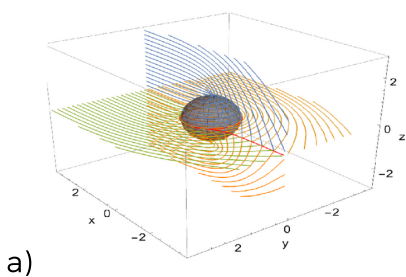
Gravitation

improved the calibration of the Planck satellite detectors. The inclusion of frequency dependent relativistic corrections can be very relevant for future satellite data.

Axion inflation investigated the dynamics of inflationary models in which an inflaton has axionic couplings to gauge fields, and we have obtained predictions within the reach of the next generation of CMB experiments.

Quantum corrections in de Sitter quantum corrections of gravitational potentials in de Sitter space, due to the vacuum polarization of loops of conformal fields and extended the calculation to spinning point particles.

Primordial black hole production and early universe scenarios which may have been produced during inflation. We have shown that these may lead to the formation of a distribution of primordial black holes in the radiation dominated era, with a broad spectrum of masses. We have also considered inflationary scenarios where a strong feature in the density power spectrum leads to the subsequent formation of primordial black holes.



a) Plot from the Exact Event Horizon of a Black Hole Merger.
b) Plot from the Black hole fusion in the extreme mass ratio limit.

5. HADRONIC, NUCLEAR AND ATOMIC PHYSICS

Summary

We have developed an equation of state for neutron star matter with hyperons that fulfils the astrophysical observations of $2M_{\odot}$ neutron stars as well as the recent determinations of stellar radii below 13 km, while reproducing simultaneously the properties of nuclear matter and finite nuclei and the constraints on high-density matter deduced from heavy-ion collisions (Astrophys. J. 834, 3 (2017)).

We have investigated the influence of the symmetry energy on the properties of the transition between the core and the crust of neutron stars using finite-range nuclear interactions of Gogny type. [↔](#)

We have determined the magnetic moments of the octet baryons using Lattice QCD calculations with background magnetic fields. The corresponding analysis enabled for the first extraction of the isovector transition magnetic polarizability. We also explored the possibility that large magnetic fields could stabilize strange matter, but such a scenario was found to be unlikely. [↔](#)

We have studied the quantum correlations of identical bosons in two-dimensional harmonic traps [↔](#) and the saturation properties of helium drops from a Leading Order description. [↔](#)

 Hadronic

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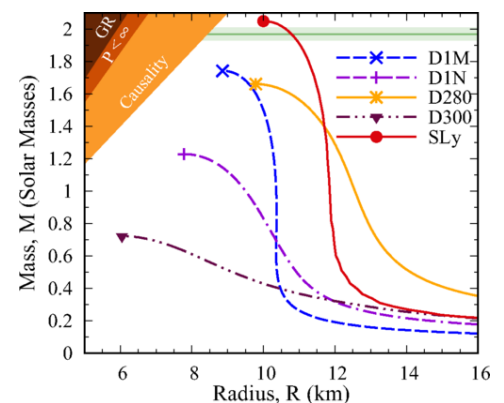
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Mass-radius relation for the neutron stars produced with the four stable Gogny functionals and with the unified SLy EoS. We show physically excluded regions in the upper-left corner as well as the accurate $M \approx 2M_{\odot}$ mass measurement.

6. HIGH ENERGY ASTROPHYSICS

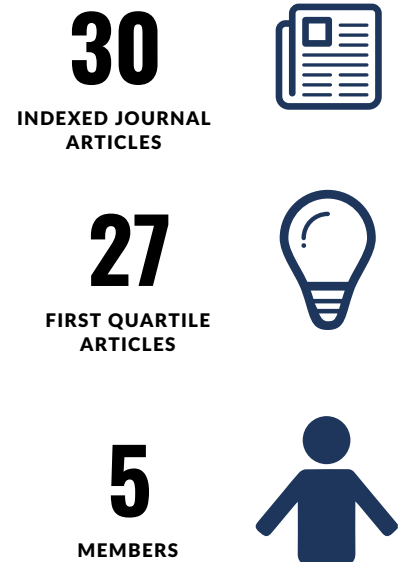
Summary

In 2017 research in High Energy Astrophysics at ICCUB was focused on observations, theoretical modeling and numerical simulations to understand the physics of relativistic astrophysical outflows. ICCUB high energy astrophysicists are active members of the MAGIC Collaboration and they are currently participating, together with experimental physicists and engineers from the ICCUB, in the Cherenkov Telescope Array (CTA) project.

ICCUB researchers reported observational evidence that the parsec-scale radio jets in the Galactic microquasar GRS 1758-258 give rise to a Z-shaped radio emission strongly reminiscent of the X and Z-shaped morphologies found in winged radio galaxies. This is the first time that such extended emission features are observed in a microquasar, providing a new analogy for its extragalactic relatives (Nature Communications 2017).

We participated in the regular MAGIC activities, with a particular incidence in the search for very high-energy gamma-ray emission from the microquasar Cygnus X-1 with the MAGIC telescopes (MNRAS 2017). We also contributed to finding a cut-off in the TeV gamma-ray spectrum of the SNR Cassiopeia A, showing that Cas A is not contributing to the high energy (\sim PeV) cosmic ray sea in a significant manner at the present moment (MNRAS 2017).

HESS J0632+057 is an eccentric gamma-ray Be binary that produces non-thermal radio, X-rays, GeV and very high-energy gamma-rays that is modulated with the orbital period.

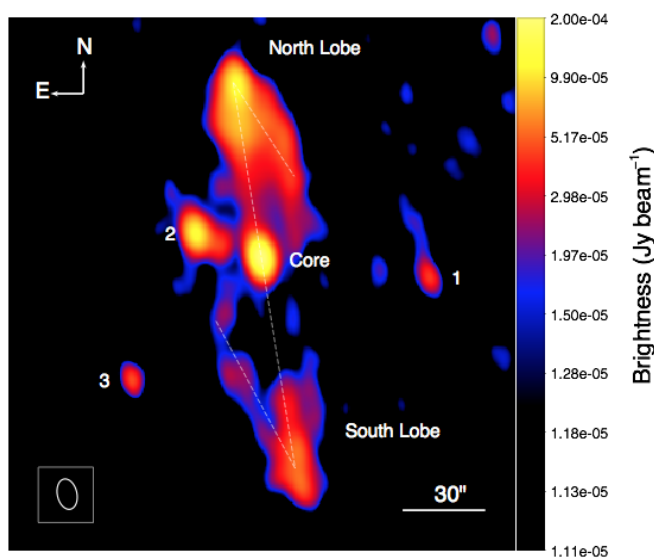


Making use of relativistic hydrodynamics, we propose a novel framework to explain the non-thermal phenomenology of HESS J0632+057, from radio to gamma rays (MNRAS 2017).

We have also published the first simultaneous X-ray/radio observations, obtained with Chandra/VLA, of MWC 656, the first Be/black hole system (ApJ Letters 2017). The results reveal that the accretion/ejection coupling in stellar-mass BHs is independent of the nature of the donor star and the mass transfer channel. We have also conducted simultaneous Chandra/VLA observations of HD 13831, a candidate to be the second Be/black hole system. The data reduction is ongoing.

In the extragalactic area, the active nucleus of the ULIRG IRAS F00183-7111 was observed by NuSTAR. Iwasawa and collaborators present an X-ray study of this ultra-luminous infrared galaxy ($z = 0.327$), using data obtained from NuSTAR, Chandra X-ray Observatory, Suzaku and XMM-Newton. Evidence may point to a central source in this ULIRG accreting close to the Eddington limit (A&A 2017).

In the framework of CTA we participated in the discussions for the study of transient sources and gamma-ray binaries and we produced and tested 10.000 Application Specific Integrated Circuits (ASICs) of the preamplifier PACTA for cameras of the 2nd to 4th Large Size Telescopes of CTA-North.



Z-shaped radio morphology of the microquasar GRS 1758-258. This map was obtained from the concatenation of VLA runs carried out at the 6 cm wavelength in the D and C array configurations conducted in 1992, 1993, 1997 (archival data) and 2016.

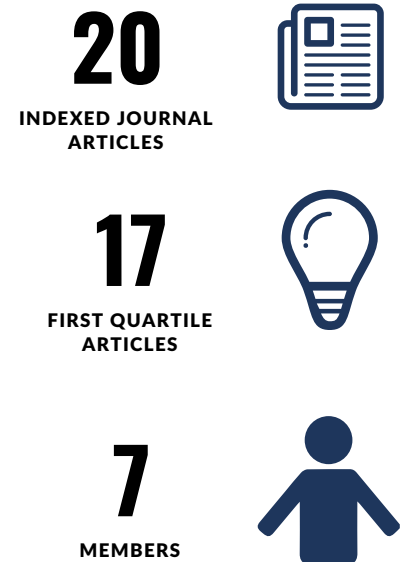
7. PARTICLE PHYSICS PHENOMENOLOGY

Summary

Our activity was influenced to a large extent by recent LHC results. Studies in this area focused on effective theories from the symmetry breaking sector of the Standard Model, some aspects of supersymmetric theories, string phenomenology, flavor physics (particularly b-physics) and physics beyond the Standard Model that the LHC will continue exploring in the years to come. ICCUB members also sharpened their theoretical tools to take adequate stock of run II of the LHC.

In the area of collider physics, we first present an analysis of the relevant di-boson production LHC results to update constraints on triple gauge boson couplings. Our bounds are several times stronger than those obtained from LEP data. Next, we show how in combination with Higgs measurements the triple gauge vertices lead to a significant improvement in the entire set of operators, including operators describing Higgs couplings.

In the area of b-physics, ICCUB researchers have been working to clarify the anomalies from the new results of Lhcb. In particular, recent measurements of $b \rightarrow s\mu^+\mu^-$ processes at Lhcb have revealed tensions at the $2-3\sigma$ level between the Standard Model (SM) prediction and the experimental results in the channels $B \rightarrow K^*\mu^+\mu^-$ and $B_s \rightarrow \mu^+\mu^-$, as well as in the lepton-flavor universality violating observable $R_K = \text{Br}(B \rightarrow K\mu^+\mu^-) / \text{Br}(B \rightarrow Ke^+e^-)$. Combined global fits to the available $b \rightarrow s\mu^+\mu^-$ data suggest that these tensions might have their common origin in New Physics (NP) beyond the SM because some NP scenarios turn out to be preferred over the SM by $4-5\sigma$. The fact that all these anomalies are related to muons further suggests a connection (and a common NP explanation) with the



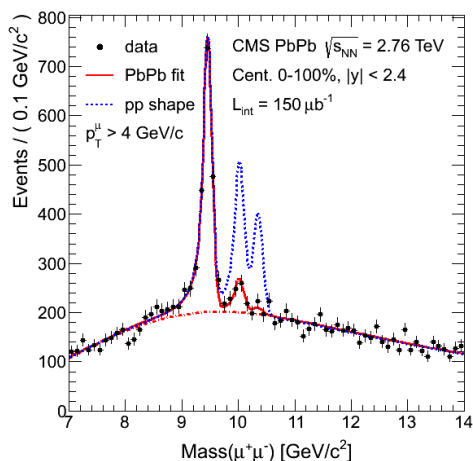
Particle

long-standing anomaly in the anomalous magnetic moment of the muon, $a_\mu = (g-2)_\mu$.

Apart from this, effective theories of QCD, especially in the heavy quark sector, were intensively studied. Several features of heavy ion collisions also received considerable attention. Furthermore, QCD-related research included work on parton distribution functions using neural networks, and jet physics using resummation techniques and effective theories.

Finally, we made very relevant contributions in the field of neutrino physics, mostly in the form of global fits to the data. We performed a combined fit to global neutrino oscillation data available as of fall 2016 in the scenario of three-neutrino oscillations and present updated allowed ranges of the six oscillation parameters. In particular, we quantify for the first time the less precisely known parameters θ_{23} , δCP , and the neutrino mass ordering by performing a Monte Carlo study of the long baseline accelerator and reactor data. We find that the sensitivity to the mass ordering and the θ_{23} octant is below 1σ . Maximal θ_{23} mixing is allowed at slightly more than 90% CL.

As final research, by performing an overall fit to the cosmological observables SNIa+BAO+H(z)+LSS+BBN+CMB (in which the WMAP9, Planck 2013 and Planck 2015 data are taken into account), we find that the class of "running vacuum models" (RVM's) appears significantly more favoured than the ΛCDM , namely at an unprecedented level of $\geq 4.2\sigma$. This issue is quite a hot topic which needs further investigation.



The peaks in red show the measured Υ events in PbPb collisions, with the blue lines showing the expectations if the excited states were not suppressed with respect to the ground state.



8. STAR FORMATION

Summary

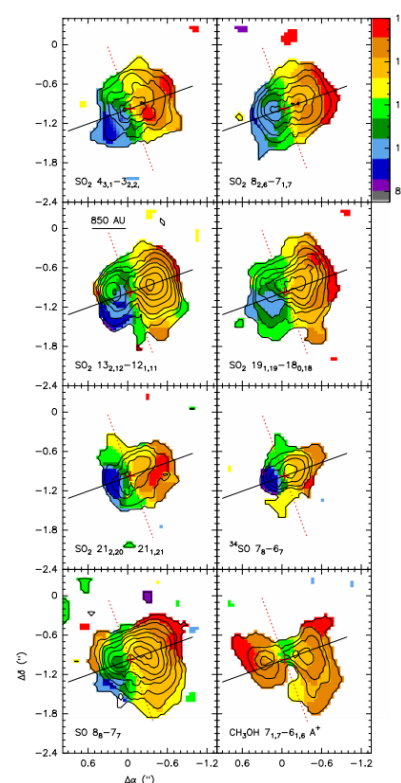
We developed a tool, HfS, to fit the hyperfine structure of spectral lines with multiple velocity components, and, in the case of the ammonia (1, 1) and (2, 2) inversion lines, to fit simultaneously both lines and perform a standard analysis to derive excitation temperature, ammonia column density, rotational temperature, and kinetic temperature. The tool has been used to analyse ammonia observations of a region of low-mass star formation, L1287, with a complex kinematics and several velocity components.

Another result from the research was the study with sub-arcsecond angular resolution, carried out with the Submillimeter Array at 880 μm , of the B0-type protostar GGD27 MM1, the driving source of the parsec scale HH 80-81 jet. We constrained its polarized continuum emission to $< 0.8\%$ at this wavelength. Its submillimeter spectrum is dominated by sulfur-bearing species tracing a rotating-disk-like structure. The resolved SO_2 emission traces the disk kinematics very well and we fit the SMA observations using a thin-disk Keplerian model, which gave the inclination (47 degrees), the inner (170 au) and outer (950-1300 au) radii, and the disk's rotation velocity (3.4 km/s at a putative radius of 1700 au). We roughly estimated a protostellar dynamical mass.

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The image shows the integrated intensity (contours) and centroid velocity (color scale) of different molecular lines in GGD27 MM1.

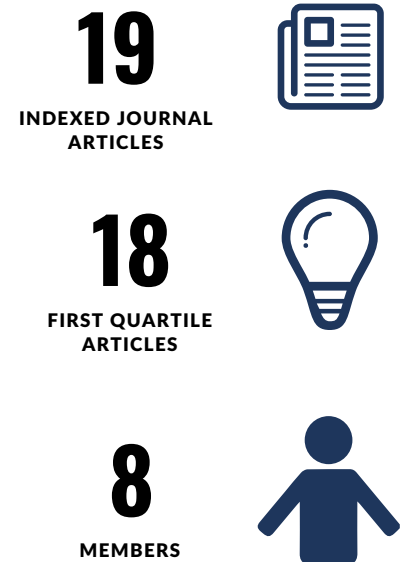
9. THEORETICAL PHYSICS

Summary

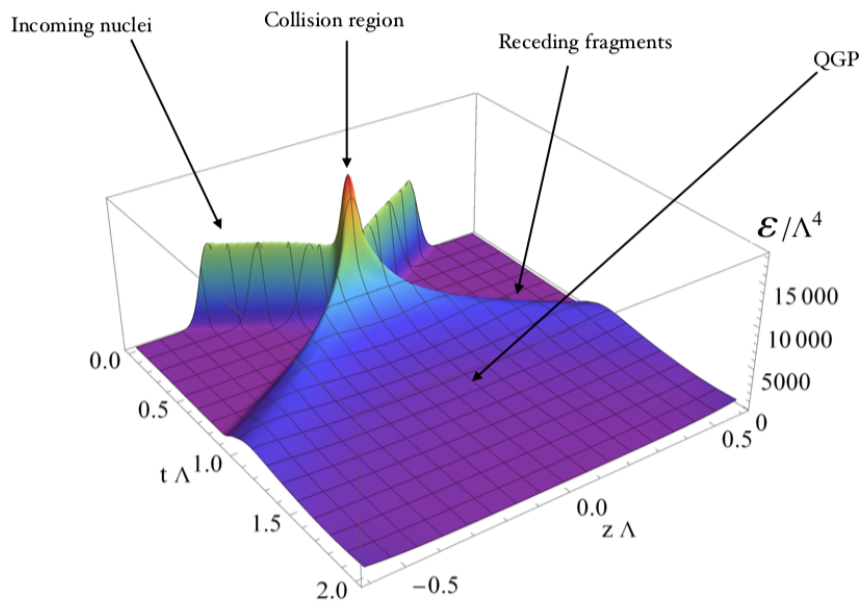
We have used supersymmetric gauge theories as a theoretical laboratory to check standard expectations about the dynamics of quantum chromodynamics in terms of exact results, which include all perturbative and non-perturbative contributions in terms of closed, analytic formulas. A successful tool to explore the strong coupling behavior of supersymmetric gauge theories is localization, with which we have computed exact partition functions, Wilson loop observables and correlation functions in a large class of four-dimensional supersymmetric gauge theories. We have also used localization to perform precision tests of the AdS/CFT duality and, more recently, to establish the existence of a new quantum phase transition in 2+1 dimensional Quantum Electrodynamics.

In the context of applications of the the gauge/string duality, we have extended the success of holographic simulations of heavy ion collisions to the case of non-conformal theories and to theories with phase transitions. In particular, we have simulated for the first time the real-time evolution of strongly coupled gauge theory plasma afflicted by a spinodal instability.

We have studied higher-derivative corrections on the gravity side and we interpreted the result in terms of resurgence and hydrodynamic attractors on the gauge theory side. We have continued our analysis of jet quenching and jet decoherence in hybrid models the Quark-Gluon Plasma. We have constructed the first holographic model of quark matter in which the effects of the flavour degrees of freedom are incorporated, and we have shown how to formulate holography for some UV-incomplete theories, in particular those afflicted by a UV Landau pole.



Motivated by possible applications to condensed matter systems through holography, we have constructed non-relativistic limits of both brane and gravity theories. We have also analysed the possible realizations of the BMS group, which may have implications for holography in flat space and for soft graviton and photon theorems.



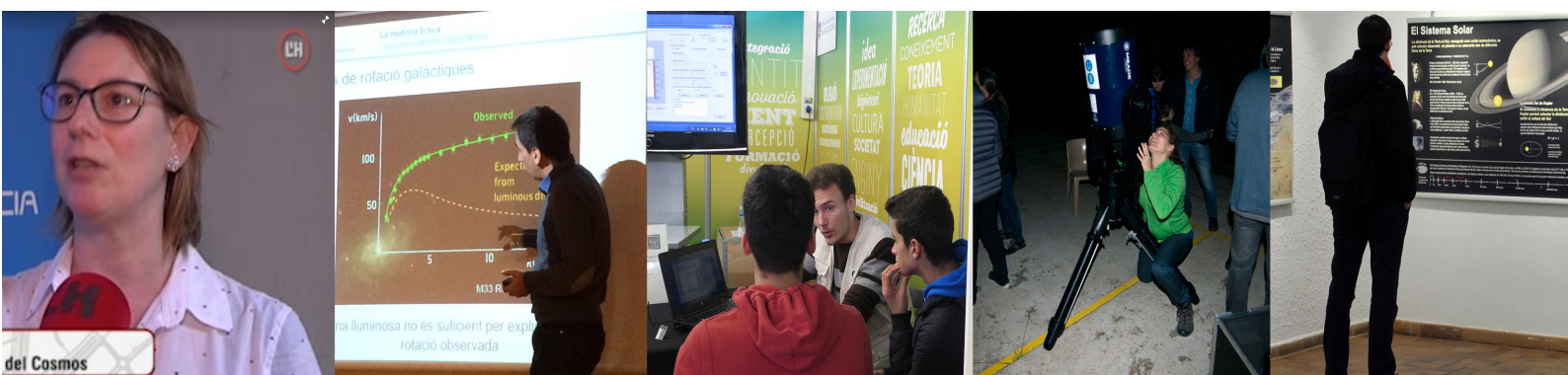
Result of the holographic simulation of a heavy ion collision in a strongly coupled gauge theory with a scale λ . The plot shows the energy density in the gauge theory, extracted from the time evolution of Einstein's equations, as a function of time and of position along the collision direction.

PUBLIC 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 greatest possible extent. Thanks to the Maria de Maeztu award, the institute has been able to significantly expand this support.

The Institute's 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



1. MASTERCLASS ON PARTICLE PHYSICS 2017

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.

147
HIGH SCHOOLS
INVOLVED



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 the LHC. The students also visit the laboratories and attend a presentation about the courses offered at the Faculty of Physics.

152
ATTENDANTS



In 2017 two sessions were held on the 9th of February and the 3rd of March at the Faculty of Physics.



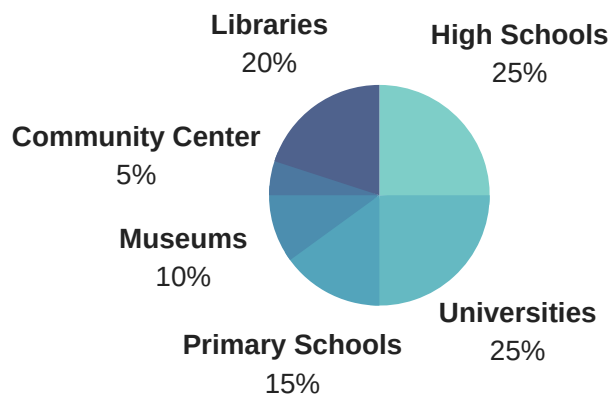
Students of the Masterclass at the lecture class (on the left) and at the laboratory (on the right)

2. TRAVELING EXHIBITIONS

The ICCUB owns seven travelling exhibitions. These exhibitions have different printed versions that are exposed annually in different external centers, like high schools, libraries or community centers. All the exhibitions also have online versions, some of them translated into several languages. In 2017 a new exhibition, "Unraveling the dark universe", has been added, and also a new poster to the exhibition "One thousand eyes to one thousand stars" and a triptych has been edited.



20
DESTINATIONS



EXPOSICIONS DE FÍSICA ITINERANTS

L'Institut de Ciències del Cosmos i el Departament de Física Quàntica i Astrofísica de la Universitat de Barcelona posen a disposició de centres d'ensenyament, institucions i associacions educatives i culturals aquest conjunt d'exposicions itinerants.

Públic: Les exposicions són de caràcter divulgatiu. Poden ser presentades al públic general o treballades amb deteniment en centres educatius. La combinació d'imatges, text i dades tècniques permet adaptar-les a qualsevol nivell.

Preu: Gratuïtes

Requisits: Cal fer-se càrrec del seu transport i muntatge.

INVESTIGADORES EN FÍSICA NUCLEAR


Idioma: català
Pàgina: 16
Pàrqs: 100 cm (32")
Format: Impressions en fulls amb atorgament. Instal·lació: Per pagar.
Embalatge: 1 caixa

Presenta les corajoses experiències vitals de diferents investigadors que han contribuït molt significativament al camp de la Física Nuclear, des de 1943.

© Consorci d'Qualitat de la Facultat de Física UB

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

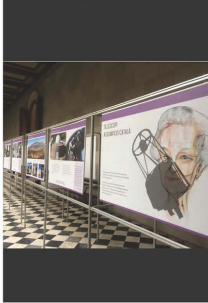
Exposicions gestionades per l'Institut de Ciències del Cosmos i el Departament de Física Quàntica i Astrofísica de la Universitat de Barcelona.



Contacte:
divulgacio@icc.uib.edu

Més informació i versió digital:
<http://serviariu.uib.edu>

EXPOSICIONS DE FÍSICA ITINERANTS



ICCUB **EXPOSICIONS DE FÍSICA ITINERANTS**

VIATGE CAP A L'UNIVERS FOSC

Idioma: català
Pàgina: 17
Pàrqs: 118,8 x 104,1 cm)
Format: Impressions en fulls amb barra superior amb paper de subjecte instal·lació: Per pagar.
Embalatge: 2 tubs cartó

Proposa un recorregut per les fascinants fronteres de la cosmologia i la gravetat, que van des de la matèria fosca i l'energia fosca, als forats negres i les ones gravitacionals.

© ICCUB

DE LA TERRA A L'UNIVERS

Idioma: català
Pàgina: 40
10 cartó (710 x 46 cm)
30 llarg (710 x 46 cm)
Format: Impressions en PVC, amb marca d'aigua instal·lació: Per pagar.
Embalatge: 4 caixes fusta

Mostra l'univers per mitjà d'imatges astronòmiques de gran rellevància científica divulgatives i d'una bellesa inimitable, preses des de diferents observatoris del món.

© D. Galad Gortázar - From the Earth to the Universe

MIL MILIONS D'ULLS PER A MIL MILIONS D'ESTRELLES

Idioma: català, castellà
Pàgina: 10
150 x 100 cm)
Format: Impressions en paper encapçalat amb llapis d'alumini instal·lació: Per pagar.
Embalatge: 4 tubs cartó

Presenta la missió Gaia, un satèl·lit dissenyat i construït per l'Agència Espacial Europea per mesurar les posicions, distàncies i moviments de mil milions d'estrelles, en tres possibles itineraris científic, tecnològic o còsmic.

© ICCUB-EEC

LES DISTÀNCIES CÒSMIQUES

Idioma: català
Pàgina: 2
150 x 100 cm)
Format: Impressions en paper encapçalat amb llapis d'alumini instal·lació: Per pagar.
Embalatge: 2 tubs cartó

Mostra els mètodes per mesurar les distàncies als cossos celestials i el desenvolupament d'aquests mètodes segons les distàncies que s'han de mesurar.

© ICCUB-EEC

TELESCOPI ASSUMPCIÓ CATALÀ

Idioma: català
Pàgina: 14
171,8 x 84,1 cm)
Format: Impressions en fulls amb atorgament a la part superior dels plànols instal·lació: Per pagar.
Embalatge: 1 caixa fusta

Ret homenatge a Maria Assumpció Català, la primera professora numerària astronòmica a la universitat espanyola. El telescopi instal·lat a l'Observatori Aigu de Montseny del Centre d'Observació de l'Univers (Agua, Montseny) duu el seu nom.

© ICCUB-EEC

AMB A D'ASTRONOMA

Idioma: català, castellà, anglès
Pàgina: 18
170 x 100 cm)
Format: Impressions en paper encapçalat amb llapis d'alumini instal·lació: Per pagar.
Embalatge: 3 tubs cartó

Recorre les principals fites de la història de l'astronomia i mostra el paper fonamental desenvolupat per astrònoms d'èpoques i procedències diverses.

© J. Llop i E. Sureda i SGA

Triptych of the ICCUB itinerant exhibitions, edited in 2017



Itinerant exhibitions

Unravelling dark universe

This new exhibition, released in October 2017 and entirely created by ICCUB members consists of 11 posters edited and printed in Catalan and translated to Spanish, English, Italian and Portuguese. Every poster has a link with a web page for further study.

The exhibition proposes a journey towards the fascinating frontiers of cosmology and gravity, ranging from dark matter and dark energy, to black holes and gravitational waves.



Unravelling
the dark
universe

A thousand million eyes for a thousand million stars

This is an exhibition about the Gaia mission produced by the ICCUB in 2013. It consists of 17 informative posters edited and printed in Catalan and Spanish. One new poster has been added in 2017: 'Artificial Intelligence used in order to explore the Milky Way'.



Gaia



Intel·ligència Artificial per explorar la Via Làctia

Per poder processar el petabyte de dades de Gaia calen tècniques de computació distribuïda, com ho és la Intel·ligència Artificial.

Les tècniques d'Intel·ligència Artificial són de gran utilitat per a la cerca de components o patrons i per a la presa de decisions. En el cas de Gaia s'utilitzen per a treballar amb espectres dels milions d'objectes observats amb l'instrument RVS.

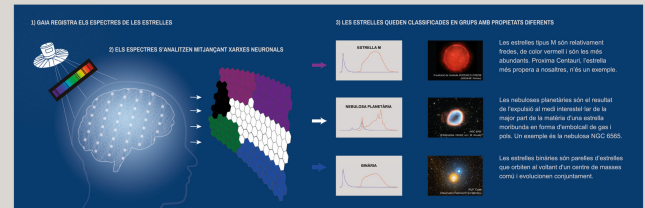


Xarxes Neuronals de Retropropagació

Aquestes xarxes s'entrenen primer amb un conjunt d'informació coneguda de manera que són capaces d'obtenir les propietats d'un objecte nou i desconegut. Amb aquesta tècnica podem determinar la temperatura, gravetat i composició química dels estels.

Mapes Autoorganitzats

Aquestes xarxes (SOM en anglès) són d'especial utilitat quan en conjunt d'objectes desconeguts es poden agrupar en diferents tipus o categories. Objectes propers en el mapa trobaran propietats semblants. Una vegada organitzada la informació, es pot analitzar la base de dades de forma més eficient.



'Unravelling the dark universe' a new ICCUB travelling exhibition presented in the Physics Faculty on October 2017

From the Earth to the Universe

This is the Catalan version of the exhibition "From the Earth to the Universe", which was translated and edited by the ICCUB in 2009. It shows the Universe through astronomical images of great importance for science dissemination, taken from different observatories around the world, as well as from Spain.



From the Earth to the Universe

Amb A d'AstrònomA

This is the Catalan version of the exhibition Con A de AstrónomA, dedicated to all woman astronomers from different eras and countries, whose contribution to Astronomy has been relevant in a worldwide scale. The ICCUB translated and edited it in 2010.



Amb A d'AstrònomA

Les distàncies còsmiques

This exhibition, which was fully created by ICCUB members in 2012, shows the methods scientists use to calculate the distances to celestial objects, and how these methods have progressively evolved throughout the years depending on how far away observed objects were.



Les distàncies còsmiques



"Amb A d'AstrònomA" al Museu Palau Mercader de Cornellà i "Les distàncies còsmiques" a l'INS La Serra de Mollerussa.

Telescopi Assumpció Català

This exhibition was fully created by ICCUB members who belonged to the former Department of Astronomy and Meteorology of the University of Barcelona. This exhibition is the legacy of Assumpció Català, the first woman Professor of Astronomy at the UB and the first in any Spanish university. The posters show the impressive evolution of Astronomy in Spain in the last decades and are a tribute to a great astronomer, an extraordinary teacher, and the first woman to give name to a telescope in Spain.



Telescopi
Assumpció
Català

Investigadores en Física Nuclear

Exhibition devoted to female researchers who have significantly contributed to the field of Nuclear Physics.



Investigadores
en Física
Nuclear

The exhibition was created by the Equality Commission of the Faculty of Physics of the University of Barcelona, and from now on it will be managed by the ICCUB.

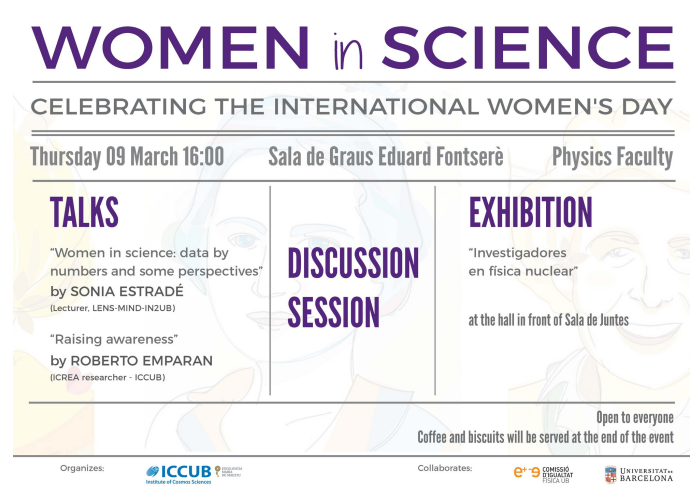
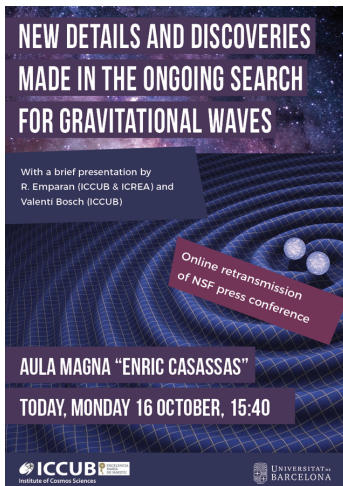
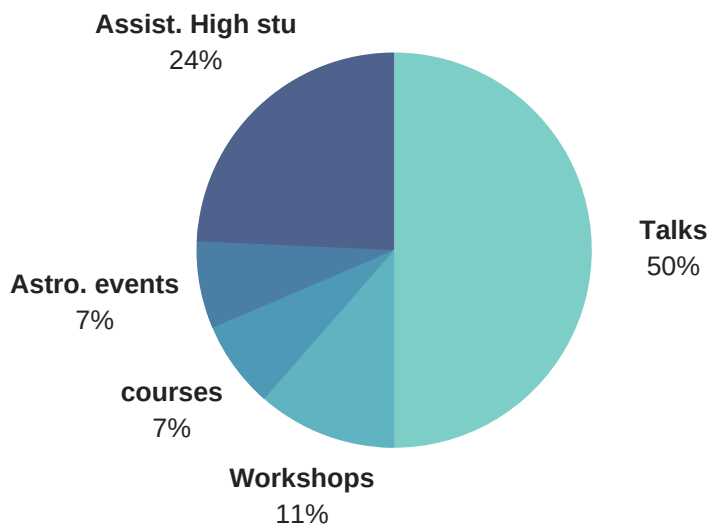


"Telescopi Assumpció Català" in the Mathematics Faculty of the UB (left image). "Investigadores en Física Nuclear" in l'INS Euclides of Pineda de Mar (right image).

3. OTHER OUTREACH ACTIVITIES

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

70
ACTIVITIES

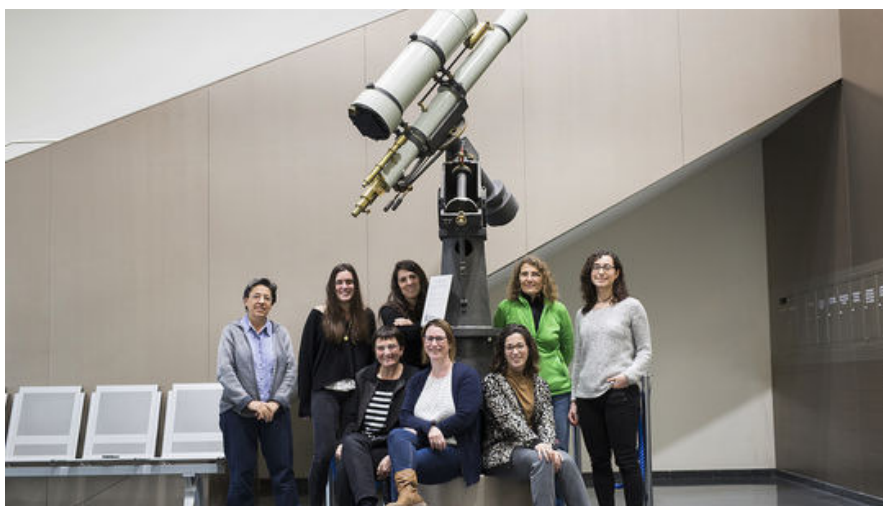
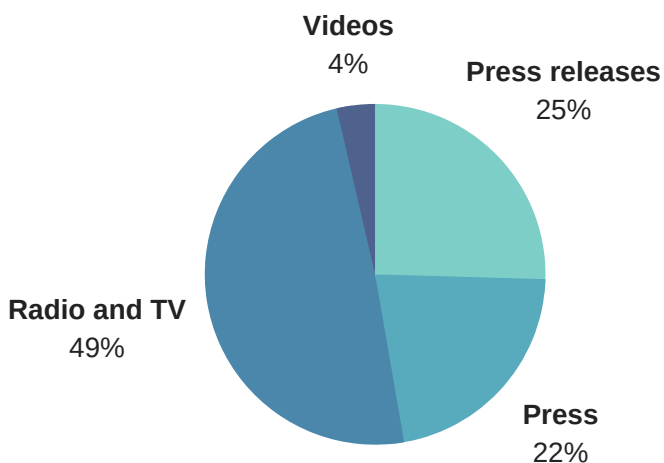


Highlighted talks during 2017: Special session to cover the new discoveries on gravitational waves (left), talk about supernovae in the framework of the 25th anniversary of the Spanish Astronomy Society (center), and the session celebrating the International women's day (right).

4. PRESS AND MEDIA

The ICCUB owns seven travelling exhibitions. These exhibitions have different printed versions that are exposed annually in different external centers, like high schools, libraries or community centers. All the exhibitions also have online versions, some of them translated into several languages. In 2017 a new exhibition, "Unraveling the dark universe", has been added, and also a new poster to the exhibition "One thousand eyes to one thousand stars" and a triptych has been edited.

55
INVOLVEMENTS



Female Gaia researchers at the UB, ARA newspaper, 10/02/2017 (left image). J.M. Carrasco in "Via Lliure" from RAC1 (right image).