



Institut de Ciències del Cosmos
UNIVERSITAT DE BARCELONA



Institute of Cosmos Sciences

REPORT OF
ACTIVITIES

2016



UNIVERSITAT DE
BARCELONA

FOREWORD

During this year 2016 the institute has entered into a new phase of growth thanks to the María de Maeztu award obtained last year. This award allows us to increase our cosmology research at the highest international level, promote synergies among groups and foster the participation of researchers in technological projects.

As part of our María de Maeztu program, the ICCUB has also launched two international schools to take place on an annual basis, the Barcelona Techno Week and the ICCUB International School. The Barcelona Techno Week is a series of meeting point events between academia and industry, organized around a technological topic of

interest for both worlds. The ICCUB International School is a series of courses on topics relevant to ICCUB priority research topics.

The MdM award is starting to have a positive impact in the evolution of the ICCUB that you can follow in more detail in the next pages.

Lluís Garrido Beltrán
Director

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THE ICCUB



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. In addition, the institute has a strong technology program aimed at fostering its participation in observational astronomy and particle physics international collaborations.

The Institute was created in 2006 as the instrument of the University of Barcelona for the active support of research in theoretical astrophysics and particle physics, focusing on their synergy with cosmology, in order to promote experimental physics and instrument development, to enable a significant participation of the University of Barcelona in large international collaborations, and to attract highly qualified scientific personnel.

Since its creation, the ICCUB has experienced a significant growth, becoming a consolidated research institution with 65 long term scientists, 70 postdoctoral researchers and PhD students and 19 engineers.



EXCELENCIA
MARÍA
DE MAEZTU

The Maria de Maeztu award

In 2016, the ICCUB was chosen as a María de Maeztu unit of excellence by the Spanish Government. Selected institutes stand out for the international impact of their scientific contributions, their innovative power and for their strong relation to the social and economic environment. This award is helping to further strengthen ICCUB's scientific contribution.



Building of the Physics Faculty of the University of Barcelona, headquarters of the ICCUB

ORGANIZATION CHART 2016

Executive Board

Director: Lluís Garrido

Deputy Director: Francesca Figueras

Secretary: Bartomeu Fiol

Council of the Institute

Domènec Espriu

Bartomeu Fiol

Francesca Figueras

Lluís Garrido

Eugeni Graugés

David Mateos

Simone Migliari

Jordi Miralda

Josep Maria Paredes

Àngels Ramos

Blai Sanahuja

Joan Soto

Scientific Board

Francesca Figueras

Bartomeu Fiol

Lluís Garrido

Ricardo Graciani

Simone Migliari

Josep M. Paredes

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.

2016 - THE ICCUB IN FIGURES

Staff

- 057 Permanent Staff
- 005 Ramon y Cajal Members
- 001 Juan de la Cierva Members
- 032 Postdoc Fellows
- 012 Visiting Scholars
- 046 PhD Students
- 022 Engineers and Technicians
- 007 Services and Administration Personnel

Projects and Funds

- 002 ERC Grants
- 014 European Projects
- 001 International projects
- 037 National Plan & Consolider Projects
- 008 Consolidated Groups
- 004 Contracts with the industry

Publications

- 321 SCI Publications
- 089 Non SCI-Publications
- 077 Technical Reports

Theses

- 013 Finished PhD Theses
- 031 Ongoing PhD Theses
- 024 Finished Master Theses

Activities

- 005 ICCUB Colloquia
- 097 Group Seminars
- 026 Event Organization
- 039 Public Talks
- 017 Showings of itinerant exhibitions

RESEARCHERS*

Permanent Staff

Canal, Ramon (UB)
Centelles, Mario (UB)
Crusats, Joaquim (UB)
Diéguez, Ángel (UB)
El-Hachemi, Zoubir (UB)
Emparan García, Roberto A. (ICREA)
Espriu, Domènec (UB)
Estalella, Robert (UB)
Fabricius, Claus Vilhelm (IEEC)
Fernández, José M. (UB)
Figueras, Francesca (UB)
Fiol, Bartomeu (UB)
Garrido, Lluís (UB)
Garriga, Jaume (UB)
Gómez, Gerard (UB)
Gómez, Jose M. (UB)
Gomis, Joaquim (UB)
González- García, M. Concepción (ICREA)
Graciani-Díaz, Ricardo (UB)
Graugés, Eugeni (UB)
Guasch, Jaume (UB)
Guzmán, Rafael (UB & U. Florida)
Iwasawa, Kazushi (ICREA)
Jiménez Tellado, Raúl (ICREA)
Jordi, Carme (UB)
Latorre, José I. (UB)
Llosa, Josep (UB)
López, Rosario (UB)
Luri, F. Xavier (UB)
Magas, Volodymyr (UB)
Manrique, Alberto (UB)
Mateos, David (ICREA)
Mescia, Federico (UB)
Miralda-Escudé, Jordi (ICREA)
Molina, Alfred (UB)
Núñez, Jorge C. (UB)
Padoan, Paolo (ICREA)
Paredes, Josep Maria (UB)
Parreño, Assumpta (UB)

Polls, Artur (UB)
Pons, Josep M. (UB)
Ramos, Àngels (UB)
Ribó, Marc (UB)
Ruiz, Hugo (UB, leave of absence)
Russo, G. (ICREA)
Sala, Ferran (UB)
Salvador, Eduard (UB)
Salvat, Francesc (UB)
Sanahuja, Blai (UB)
Solà, Joan (UB)
Solanes, José M. (UB)
Soto, Joan (UB)
Taron, Josep (UB)
Torra, Jordi (UB)
Verdaguer, Enric (UB)
Verde, Licia (ICREA)
Viñas, Xavier (UB)

Ramon y Cajal Members

Bosch-Ramon, Valentí
Casalderrey, Jorge
Germani, Cristiano
Julià, Bruno
Notari, Alessio

Juan de la Cierva Members

García, Miguel

Postdoc Fellows

Àgueda Costafreda, Neus
Aran, Àngels
Atal, Vicente
Attems, Maximilian
Balaguer, Dolores
Bea, Yago
Bellini, Emilio
Bergström, Johannes

Carrasco, José M.
Cleven, Martin
Coquereau, Samuel
Cuesta, Antonio José
Farrés, Ariadna
Fernández-Faedo, Antón
Frimann, Søren
Gracia, Gonzalo
Haibo, Qiu
Hofer, Lars
Hu, Bin
Izumi, Keisuke
Masana, Eduard
Pantelidou Christiana
Raccanelli, Alvise
Rocha, Jorge
Romero, Mercè
Simpson, Fergus Rae Goalen
Vieyro, Florencia
Voss, Holger
Weiler, Michael
Witek, Helvi
Zambujal Ferreira, Ricardo
Zilhao Miguel

Visiting Scholars

Andrianov, Alexander
Casademunt, Jaume
Gomis Torné, Joaquim
Gotthelf, Eric
Jorba, Ángel
Lizzi, Fedele
Ribó, Josep Maria
Ruiz-Lapuente, M. Pilar
Ruiz, Josep Xavier
Talavera, Pere
Torrelles, Txema
Yun, Joao Lin

PhD Students

Alsina, Daniel
 Arnan, Pere
 Bellomo, Nicola
 Bernal, José Luís
 Casamiquela, Laia
 Cervera, Alba
 Cheng, Yu
 DeCruz, Javier
 Del Ser, Daniel
 Escrivà Mañas, Albert
 Esteban Muñoz, Iván
 Farràs, Martí
 Feijoo, Albert
 Fernández, Gerard
 Fernández, Isabel
 Gabbanelli, Luciano

Galindo, Daniel
 García, Carles
 Gómez, Adrià
 Gontcho A Gontcho, Satya
 González, Clàudia
 Juan, Enric
 Juárez, Carmen
 Katanaeva, Alisa
 Luna Perelló, Raimon
 Maneu, Jordi
 Marín, Carla
 Mariño, Mauricio
 Martínez, Marina
 Menéndez, Lourdes
 Merino, M. Teresa
 Mor, Roger
 Moreno, Víctor
 Mujal, Pere

Oriol, Pablo
 Pablos, Daniel
 Pacheco, Daniel
 Paredes, Xavier
 Pérez, Ignasi
 Pravos, David
 Renau, Albert
 Rives, Vicente
 Rosselló, Martí
 Torrents, Genís
 Torres, Núria
 Triana, Miquel

ENGINEERS AND TECHNICIANS

Antiche, Erika
 Borrachero, Raúl
 Casajús, Adrià
 Casas, Albert
 Castañeda, Javier
 Ciaglia, Dimitri
 Clotet, Marcial
 Garralda, Nora

Gascón, David
 Gómez, Sergio
 González, Juan José
 Julbe, Francesc
 Mauricio, Joan
 Molina, Daniel
 Pérez, Gabriel
 Picatoste, Eduard

Portell, Jordi
 Roma, David
 Sabater, Josep
 Sanuy, Andreu
 Soria, Sergio
 Torra, Ferran

SERVICES AND ADMINISTRATION PERSONNEL

ICCUB Secretariat

Frutos, Ariadna
 Moreno, Ana Belén

Group Support

Bascon, Susana
 Macduff, Kayla
 Olarte, Surinye

Collaborating Students

González, Marta
 Pallarés, Esther

Searching for answers to fundamental questions with a multidisciplinary approach

Research at ICCUB is conducted with the aim of answering some of the most intriguing and fundamental questions in Cosmology:

What are the origin and fate of the Universe?

The Universe underwent an early phase of accelerated expansion, known as inflation, similar to the ongoing phase due to dark energy. Are these two phenomena related? Can they be derived from a fundamental theory?

Which are the ultimate constituents of the Universe?

Dark matter apparently accounts for most of the matter density of the universe. But what is the nature of dark matter and how could the Standard Model of Particle Physics be extended to accommodate it?

Why does the Universe have its present appearance?

Various galaxy properties do not conform to the galaxy formation scenario foreseen in the accelerated flat cold dark matter Universe. Is there something wrong with the models of galaxy formation? Is dark matter warm rather than cold?

These questions reveal the intimate connection between particle physics and astrophysics and therefore demand a multidisciplinary approach. Research at ICCUB intends to tackle them from the theoretical, observational and experimental viewpoints. It is organized in the following areas:

- Cosmology and Large Scale Structure
- Experimental Particle Physics
- Galaxy Structure and Evolution
- Gravitation and Cosmology
- High Energy Astrophysics
- Nuclear and Hadron Physics
- Particle Physics Phenomenology
- Star Formation
- Theoretical Physics
- Additional lines of research

Contributing to international projects to study the macro and the microcosmos

Research in particle physics and astrophysics involve the use of data collected by means of sophisticated instrumentation that cannot be afforded by individual research centers. ICCUB researchers are currently contributing to the following projects:

Space Missions:

Gaia, Solar Orbiter, Euclid, CorE.

Ground-based observatories and telescopes

MAGIC Cherenkov Telescopes, Sloan Digital Sky Survey (SDSS), Cherenkov Telescope Array (CTA), Dark Energy Survey (DES), LSST.

Accelerators and particle detectors

LHCb detector, BABAR detector.

Developing new technology for science applications

Apart from doing fundamental research, the ICCUB has a strong technology program aimed at fostering its participation in observational astronomy and particle physics international collaborations. Its expertise is organized along two transversal technological lines:

- Electronics and Instrumentation Development
- Very Large Data Processing and Analysis

Transferring technology to industry

ICCUB research generates products and technologies transferable to industry and society through licensing of patents and creation of spin-off companies and instrumental services. To date, its technology transfer program has given rise to several applications from medical imaging to space industry.

COSMOLOGY AND LARGE SCALE STRUCTURE

LINES OF RESEARCH

- Large scale structure of galaxies and the intergalactic medium
- Microwave background radiation anisotropies
- Baryonic acoustic oscillations
- Supernova cosmology
- Dark matter and dark energy
- Lyman- α emission from galaxies at high redshifts
- Reionization of the intergalactic medium
- Microcaustics in clusters of galaxies

Research in Cosmology and Large Scale Structure at ICCUB ranges from the inflationary model, the Cosmic Microwave Background and the epoch of reionization, to the formation and evolution of galaxies and the distribution of gas in space, including statistical applications and data analysis. Research is also being carried out into the nature of dark matter and the primordial fluctuations that gave rise to galaxies and larger structures in the universe. ICCUB cosmologists participate in several cosmological projects such as SDSS, EUCLID, LSST and CorE.

Activity 2016

ICCUB researchers continued their research on the cross-correlation of quasars with Lyman- α emission, as well as their work on the metal line properties of Damped Lyman Alpha systems (DLAs). Using the observations from BOSS, a systematic excess of Lyman- α light emission was detected at redshift $z \sim 2.5$ on scales up to 20 Mpc, larger than ever before (Croft et al. 2016). Apart from this, weak absorption systems of triply ionized carbon (CIV) were analyzed by using the largest signal-to-noise absorption spectrum of a quasar that has been achieved up to date (D'Odorico et al. 2016), and a study on measurements of CIV systems with BOSS began to measure the bias factor of these systems through their cross-correlation with quasars. The same measurement of the bias factor for damped Lyman- α systems is also being carried out.

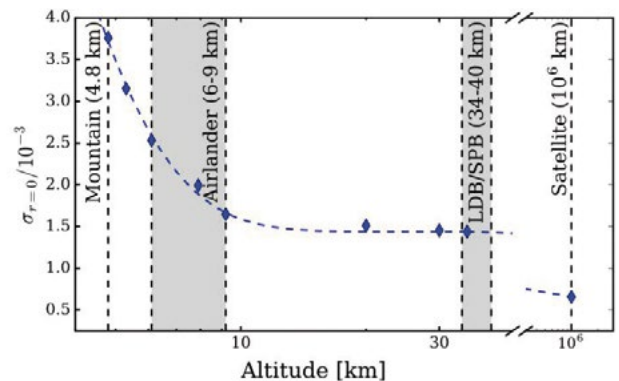
In regard with Cosmic Microwave Background, ICCUB members presented a new way to analyze data to make them independent from assumptions about late time physics. They also explored the application of a new sub-orbital platform to do observations of the polarization

ICCUB MEMBERS

Bellini, E. • Bellomo, N. • Bernal, J. L. • Canal, R. I. Cuesta, A. J. • Gontcho A Gontcho, S. • Guzmán, R. I. Hu, Bin • Jimenez, R. • Juan, E. • Manrique, A. • Miralda, J. • Pérez, I. • Raccanelli, A. • Ruiz, M. P. • Sala, F. • Salvador, E. • Simpson, F. R. G. • Verde, L.

VISITING SCHOLARS

Ruiz-Lapuente, P.



THE AIRLANDER AND THE ADVANTAGE IT OFFERS.

Top: the platform airlander 10 on its first flight on June 17th 2016. Bottom: performance in terms of residual foreground noise on the primordial tensor modes parameter r as a function of altitude. The airlander can perform as well as a long duration Balloon, but offer several logistical and technical advantages

Figures taken from Feeney et al (incl. Verde) MNRAS 2017 arXiv: 1610.07604

cosmic microwave background with the goal of constraining primordial gravity waves via their tensor modes imprint.

Finally, a new mechanism was proposed to resolve the fine tuning involved to explain the cosmological constant value. The mechanism relies on introducing a dark coupling of the dark energy field with the motion of neutrinos. This could have observational consequences.

EXPERIMENTAL PARTICLE PHYSICS

LINES OF RESEARCH

- Physics of beauty and charm mesons
- Charge-Parity symmetry violation
- Search for deviations from the Standard Model in rare B and charm meson decays
- Development of distributed calculation methods using grid and cloud computing
- Simulation and study of the radiation hardness of avalanche photodetectors
- Design, construction, and operation of instrumentation for astrophysics and high energy physics experiments as well as medical imaging techniques
- Design of Application Specific Integrated Circuits for readout electronics for photo-sensors
- Development of time of flight readout electronics for photo-sensors

ICCUB MEMBERS

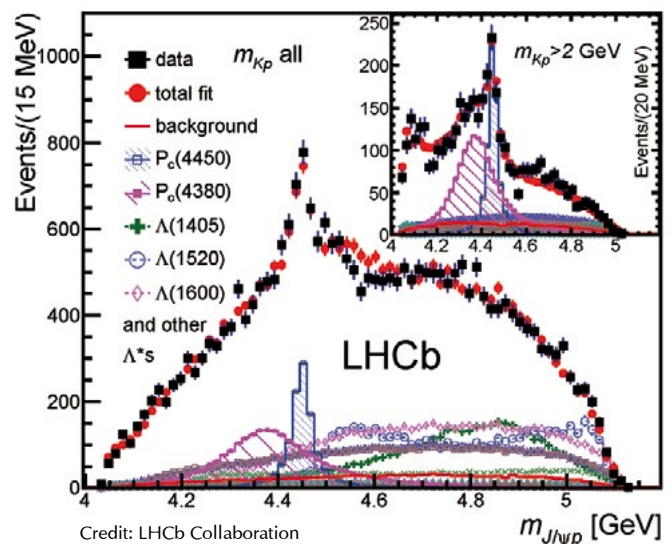
Alfonso, A. • Casajús, A. • Ciaglia, D. • Coquereau, S. • Fernández, G. • Garrido, Ll. • Gascón, D. • Gómez, S. • Graciani, R. • Graugés, E. • Marín, C. • Mauricio, J. • Picatoste, E. • Rives, V. • Ruiz, H. (on leave) • Sanuy, A.

ICCUB's experimental particle physicists are specialized in the study of flavor physics. Specifically, in measuring charge-parity (CP) violation effects and rare decays of particles containing b or c quarks. Currently the group is fully involved in LHCb experiment data analysis and on its upgrade project.

The LHCb detector, one of the four detectors of the Large Hadron Collider (LHC) in CERN, is designed to study this asymmetry through the b and anti-b particle pairs produced in proton collisions. The ICCUB, aside from its participation at a scientific level, undertook the design, production and installation of the electronics of the SPD (Scintillator Pad Detector) part of the calorimeter, and participated in the development of the Worldwide LHC Computing Grid (WLCG) computer network and the DIRAC software. An updated LHCb detector is currently being designed and scheduled to start operation in early 2019. ICCUB researchers participate in the design of the readout electronics of both the calorimeter and the new central tracker, which will be based on scintillating fibers. An important program of technology transfer is being consolidated since 2015, with partnerships with industry, where applications to medical imaging and time of flight measurements of photo-sensor electronics are exploited.

Activity 2016

In 2016 further studies were made on radiative B meson decays, in particular those in which a b quark decays into a s quark plus a photon. In collaboration with members from La Salle, an study was finished about the polarization of one of such decays, $B_s \rightarrow \Phi\gamma$, including



OBSERVATION OF PENTA-QUARKS IN LHCb

In July 2014 the LHCb collaboration reported the discovery of a new class of particle, the “pentaquark”, a particle formed by five quarks. The figure shows a fit to the $J/\psi\pi$ invariant mass spectrum for the $\Lambda_b^0 \rightarrow J/\psi\pi K^-$ decay, with each fit component shown individually. The contribution of the pentaquarks is shown by hatched histograms.

a time-dependent analysis (arXive 1609.02032). Apart from this, further studies were made on the branching ratio of different exclusive channels ($B_d \rightarrow K^*\gamma$, $B_s \rightarrow \Phi\gamma$, $\Lambda_d \rightarrow \Lambda^*\gamma$) and their CP asymmetry; a thesis was read about this issue (Rives 2016). Finally, a study was initiated on the angular distribution of the b meson and barion decay products for the transition $\Lambda_b \rightarrow \Lambda^*\gamma$

GALAXY STRUCTURE AND EVOLUTION

LINES OF RESEARCH

- The stellar constituents of the galactic disk and halo
- The stellar luminosity calibration
- Modeling of galaxy aggregations
- Formation and evolution of galaxies

At present, the research in Galactic Structure and Evolution at the ICCUB is highly focused in the work of exploitation of the First Release of the ESA's Gaia mission, in which ICCUB researchers are deeply involved (see *Very Large Data Processing and Analysis*). Beyond this, research is also being carried out in the modeling of galaxies and their aggregations, the elaboration of methods for the discovery of stellar streams in the galactic halo, the study of stellar constituents of the Milky Way and the calibration of stellar luminosity. Efforts are also aimed to investigate the very complex process of galaxy formation and to explore the physical mechanisms driving their evolution. ICCUB members coordinate the Gaia-REG Network (Red Española de Explotación Científica de Gaia) and are active members of the international networks created for the scientific exploitation of Gaia (GREAT).

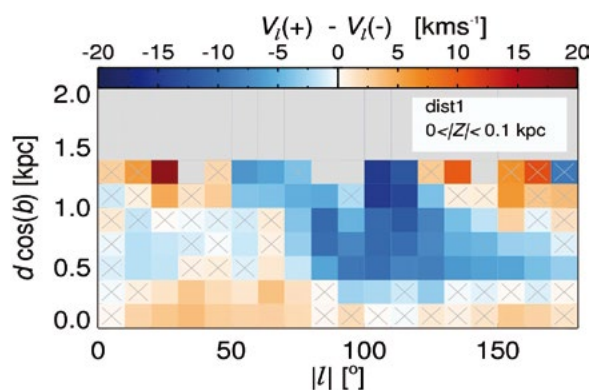
Activity 2016

In September 2016 the first Gaia Catalogue was published (14 month of mission data). The ICCUB members working on Gaia were very active to publish the "Gaia Data Release 1" papers describing the scientific contents on the catalogue. Furthermore, the tools developed during previous years for an innovative scientific exploitation of Gaia started to be applied to this data. In the context of Galaxy Modeling, the kinematics studies of the Galactic disc where undertaken by analyzing the velocity asymmetries in Gaia-TGAS (Gaia DR1) data. This work allowed the characterization of the structure of the spiral arms in the local environment. The computation several high-resolution cosmological N-body with hydrodynamics simulations of Milky Way-sized Galaxies (Garrotxa) continued with the study of its general properties and the Hot-gas Distribution.

Concerning the characterization of the Milky Way constituents, ICCUB researchers made the astrometric

ICCUB MEMBERS

Balaguer, D. • Carrasco, J.M. • Casamiquela, L. • Castañeda, J. • Fabricius, C.V. • Figueras, F. • García, C. • Gracia, G. • Jordi, C. • Luri, F.X. • Masana, E. • Miralda, J. • Miret, N. • Mor, R. • Ribas, A. • Romero, M. • Solanes, J.M. • Torra, J. • Voss, H. • Weiler, M.



TANGENTIAL VELOCITY ASYMMETRIES IN THE SOLAR NEIGHBOURHOOD OBTAINED USING GAIA TGAS

Difference between the median transverse velocity in Galactic longitude as a function of longitude and distance for symmetric Galactic longitudes in the galactic disc (see Antoja et al., 2016)

and photometric analysis of open clusters. Thanks to the work in the spectroscopic OCCASO survey, new radial velocities for 12 Milky Way open clusters were published. The application of the Besançon Population Synthesis Galaxy Model to the Galactic Cepheids allowed to constrain the thin disc IMF of the massive population. A first design of the BGMFast framework to simulate data for Big Data Surveys was completed. ICCUB members took active part in scientific exploitation of the two European consortia created for the acquisition of ground-based spectroscopic measurements complementary to Gaia: Gaia-ESO survey and Open Clusters OCCASO survey. In addition, some members were incorporated to the Survey Working Group of the WEAVE@WHT high resolution spectrographs. Work continued to unveil the formation route of the largest galaxies in the Universe. The obtained results make a strong case for considering hierarchical dissipationless merging a viable route for the formation of the largest galaxies in the Universe. A new and computationally competitive N-body model of a previrialized aggregation of galaxies in a flat Λ cold dark matter Universe was published.

GRAVITATION AND COSMOLOGY

LINES OF RESEARCH

- Dark matter and dark energy in cosmology and in particle physics
- Quantum and semiclassical gravity
- AdS/CFT correspondence and holography
- Black holes

The research done by this ICCUB group focuses on cosmology, gravity and holography. Its members also collaborate with researchers in the Theoretical Physics group to make incursions into particle physics and the gauge/gravity correspondence.

In the area of cosmology, research is focused on models of dark energy, inflationary models, the study of the Cosmic Microwave Background and multiverse scenario, whereas in the area of gravity, research is focused on the study of black holes in string theory and in higher-dimensional spacetimes, on the one hand, and on quantum gravity in de Sitter spaces, on the other hand. In the area of gauge/gravity correspondence, research is devoted to the study of the quark-gluon plasma and the interplay between the gauge/gravity correspondence and supersymmetric localization.

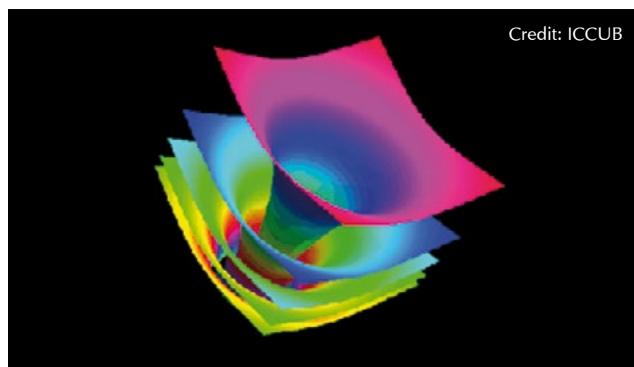
Activity 2016

Concerning cosmology, in 2016 ICCUB researchers of this group extended their work to anomalies and aberrations in the Cosmic Microwave Background. Furthermore, they explored properties of various models of inflation, like axial inflation, scalar-tensor models and holographic inflation. They also discussed possible observational imprints of black holes in multiverse scenarios. Finally, they developed and studied cosmological models with a dynamical vacuum energy.

In regard to gravity, ICCUB researchers continued the development of the inverse-dimensional expansion for black holes which they used to study several of their properties. Additionally, they obtained solutions describing the event horizon of a black hole merger, higher dimensional supercompact stars and certain gravitational

ICCUB MEMBERS

Atal, V. • Emparan, R. A. • Fernández, A. • Fernández, I. • Fiol, B. • Garriga, J. • Germani, C. • Guasch, J. • Izumi, K. • Luna, R. • Llosa, J. • Martínez, M. • Molina, A. • Mateos, D. • Notari, A. • Pantelidou, C. I Pravos, D. • Rocha, J. • Solà, J. • Torrents, G. • Triana, M. • Verdaguier, E. • Witek, H. • Zambujal, R. • Zilhao, M.



Credit: ICCUB

CURVED SPACETIME: FROM BLACK HOLES TO COSMOLOGY

Einstein's theory of gravity tells us that the geometry of space and time gets dramatically distorted in the vicinity of black holes and at the beginning of the universe. This challenges the foundations of Einstein's theory itself and calls for the incorporation of the effects of quantum mechanics.

A surprising spin-off of this research is the possibility of describing a ball of quark-gluon plasma as a black hole in a higher-dimensional space.

instantons. They studied quantum corrections to the gravitational potential in de Sitter spaces, the formation of scalar hair around black holes, and the dynamics of gravitational systems, finding evidence of chaotic behavior.

Lastly, concerning holography, ICCUB researchers analytically constructed gravity solutions dual to three-dimensional and four-dimensional gauge theories with flavor. They used holography to model quantum phase transitions, heavy ion collisions with non-zero baryon charge, and magnetisation density waves. Holography was also used to study non-conformal field theories and to produce large mass hierarchies from strongly coupled dynamics. Finally, ICCUB researchers continued the study of energy loss by radiation of heavy probes coupled to conformal field theories.

HADRONIC, NUCLEAR AND ATOMIC PHYSICS

LINES OF RESEARCH

- Nuclear structure. Nuclear symmetry energy.
- Dense and hot nuclear matter and applications in nuclear astrophysics.
- Hadronic physics. Strangeness and charm in the nuclear medium.
- Relativistic heavy ion collisions.
- Lattice QCD calculations of light nuclear systems.
- Radiation transport and interactions of radiation with matter.
- Ultra-cold atomic gases. Bose-Einstein condensates.

ICCUB MEMBERS

Centelles, M. • Cleven, M. • Escrivà, A. • Feijoo, A. • Fernández, J.M. • González, C. | Julià, B. • Magas, V. • Maneu, J. • Mujal, P. • Parreño, A. • Polls, A. • Ramos, À. • Salvat, F. • Viñas, X.

The group conducts research on the theoretical description of hadron systems, including strangeness and/or charm in the vacuum, in nuclear matter, and in the hot medium generated in relativistic heavy ion collisions. In the atomic sector, models for the numerical study of the interaction of electrons, photons and ions with matter are being improved, while many efforts are also being devoted to the study of ultra-cold atomic gases in various geometrical configurations.

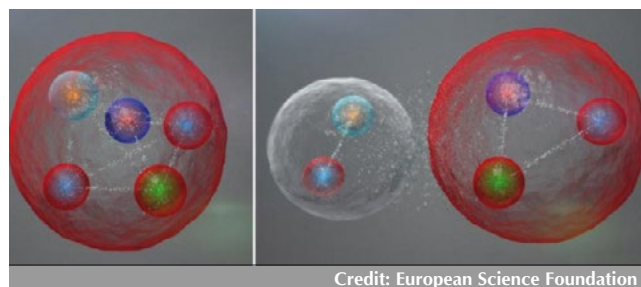
Activity 2016

The investigations in nuclear astrophysics lead to a new equation of state for nucleonic and hyperonic neutron stars that fulfils the observations of 2 solar masses and the recent determinations of radii below 13 km. Besides, the inclusion of short- and long-range nucleon correlations produced a suppression of the pairing gaps in neutron matter, relevant to describe the cooling scenarios.

In the area of nuclear structure, the dependence of the neutron skin thickness of nuclei on the symmetry energy was studied, and the deformation of nuclei with a new effective interaction was calculated.

As part of the hadronic physics research, the properties of the J/Ψ meson in a hot pionic medium were obtained and the importance of connecting them to the properties of the charmed D , D^* mesons was revealed. A careful analysis of the $\bar{K}N$ interaction in the region of $K\Xi$ production was performed, imposing newer constraints on the parameters of the chiral lagrangian based on the interplay of the Born and next-to-leading order terms.

Lattice QCD calculations at large pion masses allowed ICCUB members to study the response of one- and



Credit: European Science Foundation

EXOTIC PENTAQUARK PARTICLES

Illustration of the possible layout of the quarks in a pentaquark particle such as those discovered at LHCb. The five quarks might be tightly bonded (left). They might also be assembled into a meson (one quark and one antiquark) and a baryon (three quarks), weakly bound together.

two-nucleon systems to the large magnetic fields, of strength $|B| \sim 10^{20}$ G, that may exist inside magnetars and in peripheral relativistic heavy ion collisions.

Cross sections for atomic inner-shell ionization and bremsstrahlung emission by electrons were measured at the low-energy beam line of the São Paulo microtron. Models for the full-energy peak efficiency of Si drift detectors employed in x-ray and γ -ray spectrometry were assessed experimentally. The absorbed dose in cell nuclei produced by radionuclides of theranostic importance was simulated.

An effort was made to establish protocols to shortcut the adiabatic evolution of a spin-1 Bose gas in an external magnetic field towards a singlet-spin condensate. Exact diagonalization methods were applied to study the configuration of boson-boson mixtures in a double well potential, modeled by two quantum states and also to establish the excitation spectrum of Bose-Hubbard chains with different geometries.

HIGH ENERGY ASTROPHYSICS

LINES OF RESEARCH

- High-Energy and Very-High-Energy gamma-ray sources in the Galaxy
- Multi-wavelength observations and theoretical modeling
- Microquasars
- Gamma-ray binaries
- Pulsar wind nebulae
- Active galactic nuclei
- MAGIC and Cherenkov Telescope Array

ICCUB MEMBERS

Bosch-Ramon, V. • Galindo, D. • Gotthelf, E. • Iwasawa, K. • Moreno, V. • Paredes, X. • Paredes, J. M. • Ribó, M. • Torres, N. • Vieyro, F.

A general aim of ICCUB researchers working on this field is to achieve a better understanding of the high energy galactic and extragalactic sources, gathering data over a large wavelength range (from radio to TeV energies) as well as modeling emission processes in different scenarios.

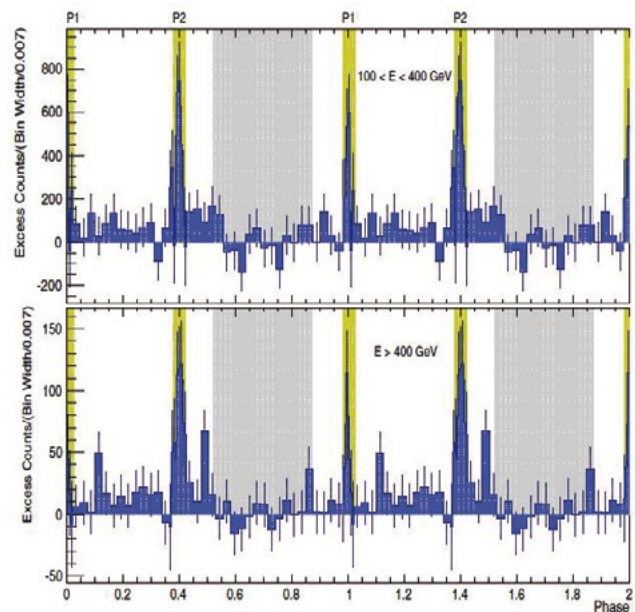
In particular, ICCUB researchers are interested in the observational and theoretical study of microquasars, gamma-ray binaries and active galactic nuclei, as well as in their interactions with their environment, as they are objects that exhibit a non-thermal behavior in the emission from radio to gamma rays related to powerful relativistic outflows generated in a compact object.

ICCUB high energy astrophysicists have been members of the MAGIC Collaboration since February 2006 and they are currently participating, together with experimental physicists and engineers from the ICCUB, in the Cherenkov Telescope Array (CTA) project (see *Electronic and Instrumentation Development*). Some members of the group have been involved in the e-ASTROGAM mission to explore the extreme Universe with gamma rays in the MeV-GeV range.

Activity 2016

In 2016 research in High Energy Astrophysics was focused on observations, theoretical modeling and numerical simulations to understand the physics of relativistic astrophysical outflows.

On the observational side, ICCUB researchers analyzed simultaneous Chandra/VLA observations of MWC 656, the first Be/black hole system, which provided the first simultaneous X-ray/radio detection of the source and revealed that the accretion/ejection coupling in stellar-mass BHs is independent of the nature of the donor star.



Credit: Ansoldi et al. 2016. MAGIC Collaboration

PULSE PROFILE OF THE CRAB PULSAR

Pulse profile of the Crab Pulsar between 100 and 400 GeV (upper panel) and above 400 GeV (bottom panel). The pulse profile, shown twice for clarity, is background subtracted. The bin width around the two peaks is 4 times smaller (0.007) than the rest (0.027) in order to highlight the sharpness of the peaks. Yellow dashed areas identify the phase intervals of the two peaks, whereas the gray areas show the offpulse region.

Using MAGIC telescopes we detected teraelectronvolt pulsed emission from the Crab Pulsar. These results require a revision of the state-of-the-art models proposed to explain how and where gamma-ray pulsed emission from 100 MeV to 1.5 TeV are produced.

The extragalactic group found (among others) a high-velocity ($\sim 0.2 c$) nuclear outflow in the Seyfert galaxy IRAS 18325-5926, which appears/disappears on a few hours time-scale in response to the variable source brightness.

PARTICLE PHYSICS PHENOMENOLOGY

LINES OF RESEARCH

- Standard Model and beyond at the LHC
- Physics of neutrinos, with an emphasis on astrophysics and cosmology
- B-physics, with an emphasis on the analysis and physical reach of the LHCb detector
- QCD in extreme conditions: heavy ion experiments at the LHC, FAIR and other accelerators
- Heavy quark effective theory and other effective theories of QCD
- Perturbative QCD: parton distribution functions. Jet physics
- Axions and other dark matter candidates
- Physics of future colliders

ICCUB MEMBERS

Arnan, P. • Attems, M. • Casalderey, J. • Espriu, D. • Esteban, I. • García, M. • Gómez, A. • González, M. C. • Guasch, J. • Latorre, J. I. • Mescia, F. • Solà, J. • Soto, J. • Taron, J.M. • Hofer, L. • Katanaeva, A.

VISITING SCHOLARS

Andrianov, A.

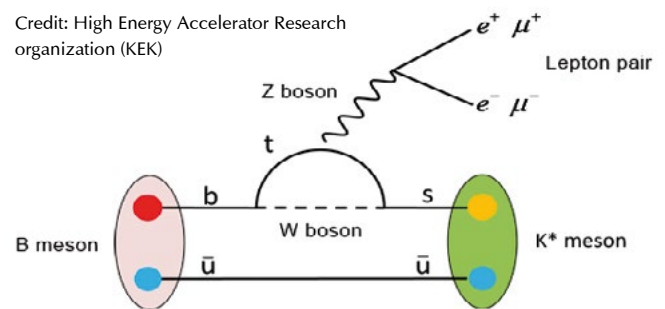
The phenomenological aspects of Particle Physics are central to ICCUB research, covering many aspects of the areas reported in the hep-ph, hep-th and hep-lat archives. The composition of the group reveals this variety of interests, extending to many of the forefront areas of research in Particle Physics.

Several members share their activity in phenomenological aspects with their work in more formal parts of theoretical physics and gravitation. Furthermore, they have an ever-growing interest in the cosmological and astrophysical implications of particle physics phenomenology. There is also a considerable overlap of interests with the Experimental Particle Physics group members from the LHCb experiment in the area of b-physics.

Activity 2016

As in previous years, in 2016 the activity was influenced to a large extent by recent LHC results. In particular, studies 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. ICCUB members also continued sharpening their theoretical tools to take adequate stock of run II of the LHC.

In the area of b-physics, ICCUB researchers worked to clarify the recent anomalies that emerged from the new results of LHCb. The studies were made with a twofold aim: to reduce hadronic uncertainties and to build new physics models.



SCHEMATIC VIEW OF A B DECAY

Weak semileptonic B decays, such as the one in the figure, show some deviations from the Standard Model predictions which are being actively investigated by ICCUB researchers.

This research will allow to address issues relevant for the phenomenology of the Standard Model and its possible extensions within Lattice Quantum Chromodynamics (QCD).

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 lattice field theory, especially in connection with b-physics, parton distribution functions using neural networks, and jet physics using resummation techniques and effective theories.

Very relevant contributions were also made in the field of neutrino and Higgs physics, mostly in the form of global fits to the data. Finally, the ICCUB members realized a new and important theoretical study to constrain the coupling of axion with two photons in view of new experiments.

STAR FORMATION

LINES OF RESEARCH

- High-angular-resolution observations of the first stages of stellar evolution
- Outflows, jets, and accretion disks in young stellar objects, and jets in planetary nebulae
- Computational models of star-forming regions, from large-scale SN-driven turbulence to individual stars

ICCUB MEMBERS

Estalella, R. • Juárez, C. • López, R. • Padoan, P.

VISITING SCHOLARS

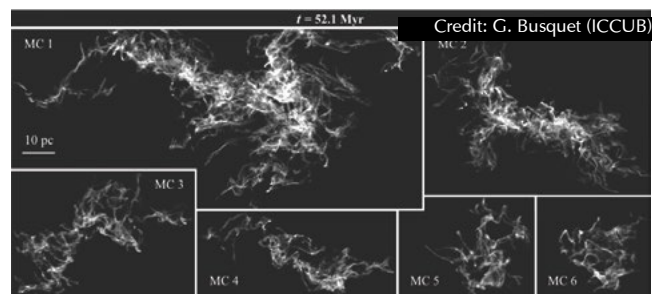
Torrelles, J.M • Yun, J.

ICCUB research in this field focuses on the investigation of the dynamics of star-forming regions in our galaxy and on the study of the first stages of stellar evolution. ICCUB researchers intend to acquire a perspective as wide as possible by pursuing both an observational approach, ranging from the optical to the radio domain, and a theoretical approach, based on state-of-the-art supercomputer simulations of the evolution of star-forming regions.

Specific areas of research include: the characterization of the role of the magnetic field in the star formation process and in the launching and collimation of the astrophysical jets associated with young stellar objects and planetary nebulae; the investigation of the early stages of the formation of massive stars; the search for signatures of planet formation within the protoplanetary disks; the study of the transition from hot molecular cores to bright HII regions; the numerical modeling of the turbulent fragmentation process to understand the origin of the stellar initial mass function and the star formation rate in molecular clouds; and the numerical modeling of the ISM on very large scale to study the role of supernova explosions in the driving of the ISM turbulence and in the formation and disruption of giant molecular clouds.

Activity 2016

We studied the correlation between chemistry, polarization, and dust properties in the Pipe nebula starless Core 109 using IRAM 30 m telescope and the PdBI. This is a prototypical starless core and the most chemically evolved among those isolated, embedded in the bowl. We measured with high precision the velocity field, line widths and opacity and derive the excitation temperature and column density in the core. The core presents a rich chemistry with emission from early and late-time molecules. A Bonnor-Ebert analysis indicates the core



SYNTHETIC MOLECULAR CLOUDS

Examples of molecular clouds selected from a snapshot of a simulation of SN-driven turbulence in a volume of 250 pc size.

is gravitationally unstable and the magnetic field is not strong enough to avoid the collapse. Some molecules exhibit asymmetries in their integrated emission maps, which appear to be correlated with a previously reported submillimetre polarization asymmetry. Additionally, we developed a package to perform a multi-component fit of spectral lines with hyperfine structure (Hfs) and made it available to the community.

The computational effort was focused on the study of the dynamics of molecular clouds (MCs) and their star-formation rate (SFR), using a large-scale simulation of the interstellar medium (ISM). This is the highest-resolution simulation to date of SN-driven turbulence, on a scale of 250 pc, reaching a spatial resolution of 0.007 pc. It was found that the simulated clouds reproduce well the observational properties of real clouds. Other parameters that are very difficult to measure in real clouds were derived from the simulation, such as the compressive ratio of the turbulence. Thanks to the broad dynamic range of the simulation, it was possible to follow the formation of individual massive stars and to show that SN-driven turbulence reproduces the mean SFR of MCs (a few percent per free-fall time), as well as its large scatter from cloud to cloud.

THEORETICAL PHYSICS

LINES OF RESEARCH

- String and superstring theory
- Exact results in supersymmetric field theories
- Applications of the gauge/string duality to strongly coupled systems
- Properties of many-body quantum systems. Quantum phase transitions
- Quantum information
- Quantum simulations

ICCUB activities in theoretical physics cover a wide spectrum of areas reported in the hep-th and quant-ph archives.

Many ICCUB researchers are interested in string theory, a field which has recently been inspired by enormous activity in the gauge/string duality conjecture that allows a treatment of several types of strongly coupled theories in terms of gravity duals. Supersymmetric field theories are studied seeking in an effort to understand the ultraviolet behavior of theories with extended supersymmetries and deriving exact results. Research in quantum information is also active, focusing on several topics such as entanglement entropy, tensor networks, quantum error correction, many-body quantum systems, topological order, ultra-cold gases and quantum simulation. The quantum information researchers at the ICCUB are in close collaboration with some of the groups at ICFO.

Activity 2016

In 2016, ICCUB researchers used the AdS/CFT duality to study various Yang-Mills theories at finite heavy-quark density and their renormalization group flows. For the first time, this was done by numerical simulation of general relativity. Moreover, the Mare Nostrum super computer was used for this activity. Results have been highly cited in the community.

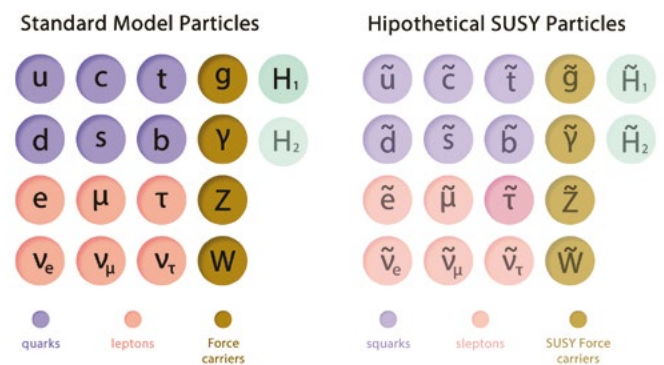
Concerning quantum information theory, research focused on maximally entangled states, quantum simulations, quantum statistical systems and other related issues. In particular, we analyzed how maximal entanglement is generated at the fundamental level in

ICCUB MEMBERS

Bea, Y. • Casalderrey, J. • Cervera, A. • Emparan, R.A. • Espriu, D. • Fernández-Faedo, A. • Fiol, B. • Gabbanelli, L. • Gomis, J. • Katanaeva, A. • Latorre, J.I. • Lizzi, F. • Luna, R. • Mateos, D. • Pantelidou, C. • Pons, J.M. • Rocha, J. • Russo, J.G. • Solà, J. • Subils, J. • Talavera, P. • Zilhao, M.

VISITING SCHOLARS

Lizzi, F. • Talavera, P.



Credit: ICCUB

THE STANDARD MODEL AND BEYOND

Supersymmetry (SUSY) is one of the possible extensions of the Standard Model in which ICCUB members are working. It predicts a partner for each particle of the Standard Model, and it could solve a major problem of this model: fixing the mass of the Higgs boson. For SUSY theories to work, a second Higgs particle must be also introduced in the Minimal Standard Model

QED by studying correlations between helicity states in tree-level scattering processes at high energy. Our results were a first step towards understanding the connections between maximal entanglement and the fundamental symmetries of high-energy physics.

A very active research line also searched for exact results in nonabelian gauge theories. Using supersymmetric localization, matrix integrals and resurgence techniques, various aspects of supersymmetric gauge theories in three and four dimensions were studied.

Finally, there was also important activity in the areas of black hole physics.

ELECTRONIC AND INSTRUMENTATION DEVELOPMENT

ACTIVITIES

- Cameras
- Radiation detectors and photo detectors
- Microelectronics
- Radiation hard design and qualification
- Hardware for Instrumentation and Communications
- Embedded Software and Firmware
- Signal processing

ICCUB MEMBERS

Casas, A. • Ciaglia, D. • Diéguez, A. • Fernández, G. • Garrido, L. • Gascón, D. • Gómez, J.M. • Gómez, S. • Graciani, R. • Graugés, E. • Mauricio, J. • Núñez, J.C. • Oriol, P. • Picatoste, E. • Ribó, M. • Roma, D. • Ruiz, H. • Sabater, J. • Sánchez, D. • Sanuy, A.

ICCUB members develop instrumentation, front-end electronics, read-out and real-time processing systems, application-specific integrated circuits (ASICs) and signal processing algorithms/tools for astrophysics, space projects, high energy physics and medical imaging among other fields. At the moment, the ICCUB is participating in the following projects:

CTA: The CTA (Cherenkov Telescope Array) project is an initiative to build the next generation ground-based very high energy gamma-ray instrument. The instrument will consist of an array of more than 100 Imaging Atmospheric Cherenkov Telescopes (IACTs) located in the northern and southern hemispheres. In addition to physics case studies, the ICCUB is involved in the design and prototyping of the CTA telescopes' cameras. In particular, the ICCUB has developed several ASICs for fast optical sensors readout. These high-speed photodetectors were photomultiplier tubes (PMTs) at the beginning of the project, but some of the related subprojects are now pointing to silicon photomultiplier (SiPM, MPPC, GAPD, ...) sensors in order to avoid ageing problems. The ICCUB has also developed an ASIC dedicated to the SiPM readout for the level 0 trigger system of the Large and Medium Size Telescopes.

LHCb: LHCb is one of the four general purpose detectors of the Large Hadron Collider (LHC) at CERN, designed to study CP violation through the analysis of b and anti-b particle pairs produced in proton collisions. The ICCUB undertook the design, production and installation of the electronics of the SPD (Scintillator Pad Detector) part of the calorimeter. An updated LHCb detector is currently being designed and scheduled for late 2018 to start operation. The ICCUB participates in the design of the readout electronics of both the calorimeter and the new

central tracker.

MIRADAS: MIRADAS instrument is a near-infrared multi-object echelle spectrograph for Gran Telescopio de Canarias (GTC) operating at spectral resolution $R=20,000$ over the $1-2.5\mu\text{m}$ bandpass. The instrument selects targets using 12 deployable probe arms with pickoff mirror optics, each feeding a 4.0×1.2 -arcsec field of view to the spectrograph. The ICCUB is responsible of the software that controls the probe arms. It determines the targets of each arm, and the sequence followed to reach those targets while avoiding collisions.

Solar Orbiter: The ICCUB is part of the Polarimetric and Helioseismic Imager instrument for the Solar Orbiter mission (SO/ PHI). ICCUB's responsibility is the development and implementation of an Image Stabilization System (ISS) that will provide the highly stable mechanical environment that the instrument demands. The ISS includes a camera, a controller for a piezo-electric based Tip-Tilt mirror and the control firmware for the FPGA that controls the whole system. The system has been optimized to minimize the power consumption while reaching the required performance.

Telescope Fabra-ROA: ICCUB researchers have been working for more than ten years on the Telescope Fabra-ROA Montsec (TFRM), a remote operated Baker-Nunn Camera located at the Observatori Astronomic del Montsec (OAdM). Since the beginning of science TFRM operations, ICCUB researchers have been conducting two specific and distinct surveys: super-Earths transiting around M-type dwarfs stars and geostationary debris in the context of Space Situational Awareness / Space Surveillance and Tracking (SSA/SST) programs. In parallel other programs the search for near earth objects

(NEO) and the observations of high energy sources are carried out regularly.

PET Imaging: The experience gained in the development of scientific instrumentation, particularly in the design of ASICs for high speed photodetectors like photomultiplier tubes (PMTs) or Silicon photomultipliers (SiPM, MPPC, GAPDs, etc.) is now being applied to the medical imaging field. The ICCUB has developed several ASICs for Positron Emission Tomography (PET) with Time of Flight (ToF) capabilities.

Activity 2016

CTA: In 2016, the work has focused on two main activities. First, since the designs using PMTs have been selected as a baseline for the IACTs, ICCUB engineers, in collaboration with other research centers, have prepared the instrumentation to test the trigger mezzanines that include the level 0 and level 1 trigger system for the first Large Size Telescope. Printed Circuit Boards (PCBs) that operate with a robot which will conduct massive testing of ASICs in the context of CTA have also been designed. Secondly, a new Multi-purpose Integrated Circuit (MUSIC) ASIC design has been prototyped and evaluated by several research groups inside the CTA community. This new design replaces the PMT based focal plane electronics with a SiPM based one while maintaining the remaining electronic parts (front end and back planes), and also replaces the discrete preamps used in the current SiPM based AICTs designs.

LHCb: In regard to the upgrade of the LHCb calorimeter, first, the design of the analog chip ICECAL has been validated for the irradiated environment at the LHCb detector and two designs of the chip (ICECALv3.1 and ICECALv3.2) have been prepared for production to launch in 2017. Apart from this, a model for the new SiPM from Hamamatsu was developed in the Cadence environment to analyze if the new sensor works with the PACIFIC4b and to check if the new sensor and the updated analog chain were verifying specifications. In addition, due to petition from the reviewers in the PACIFIC EDR 2016, a Baseline Holder has been designed.

MIRADAS: In 2016 ICCUB members revised the algorithms that compute the trajectory of the probe arms and implemented the base algorithms for the assignment of the different objects to a probe-arm. Results were presented in the SPIE conference.

Solar Orbiter: In 2016 the Correlation Camera Flight Model and the Tip-Tilt Controller Flight Model have been manufactured and delivered to the Kiepenheuer Institute for Solar Physics (KIS) and the Instituto Astrofísica Andalucía (IAA), respectively.

PET: The work has progressed in several directions: (1) In collaboration with the industry new improvements have been included in a new version of the high-resolution multi-purpose 4-channel time to digital converter (TDC) ASIC based on a patented circuit, (2) a new collaboration has been established with CERN to develop a new generation of ultra-fast electronics for photo-detector readouts for multiple applications, and (3) in collaboration with CIEMAT a new extended version of the FlexToT ASIC is in preparation to improve the performance of designs based on monolithic crystals.

Telescope Fabra-ROA: In the context of space debris, the TFRM collaborating in the ISON network, participated in the final part of the Test-Bed for the Remote Control of an Automated Follow-Up Telescope and in the New European Program of Space Surveillance and Tracking (SST-UE) organized directly by the European Union. During 2016, the total number of observations reported was 260.899, corresponding to 38.078 objects (tracks) with a mean of 273 objects per useful night. About a 10% objects per night without TLE (not in the Space-Track catalog) were observed. Regarding the exoplanet survey, ICCUB researchers continued observing 48 selected fields detecting hundreds of new variable stars and studying the possibility of new exoplanets in them using newly implemented algorithms. Also, the optical counterparts of four high-energy sources were systematically observed to establish the variations of their light curves and the models to explain them. During 2016, a new program to search for Trojan asteroids of the Earth-Moon system was initiated. As well as an instrumental modification in order to be able to observe, Low Earth Orbit objects (LEOs).

VERY LARGE DATA PROCESSING AND ANALYSIS

LINES OF RESEARCH

- Star tracker algorithms
- Onboard real-time data processing
- High-performance data compression
- Massive data processing pipelines
- Clustering and cross-matching algorithms
- Data mining techniques
- Grid Computing

ICCUB MEMBERS

Antiche, E. • Balaguer, D. • Borrachero, R. • Carrasco, J. M. • Casajús, A. • Castañeda, J. • Clotet, M. • Fabricius, C. • Farràs, M. • Figueras, F. • Garralda, N. • González, J.J. • Graciani, R. • Jordi, C. • Julbe, F. • Luri, F.X. • Masana, E. • Molina, D. • Portell, J. • Torra, J. • Voss, H. • Weiler, M.

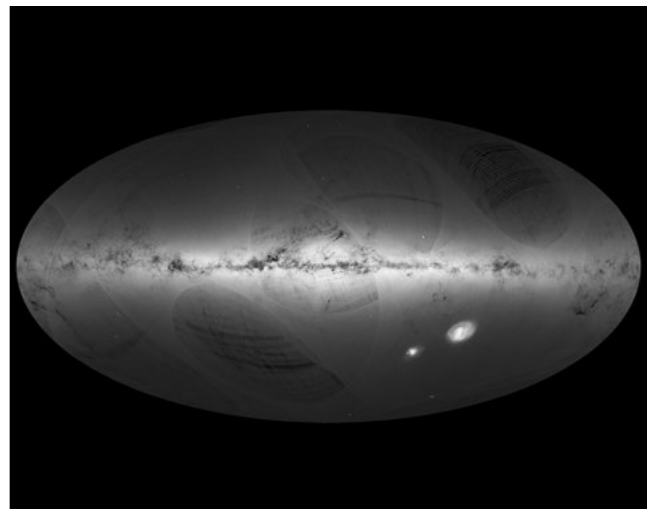
The ICCUB provides massive data processing algorithms and software which are essential for the success of large international projects. Expertise of ICCUB members is applicable to ground and space. The institute is currently participating in the following projects:

Gaia DPAC: ICCUB researchers have a leading role at the highest technological, scientific and management levels of the Gaia Data Processing & Analysis Consortium (DPAC). They have responsibilities in the Simulations, Core Processing and Photometry units, and they manage the Data Processing Center of Barcelona. The ICCUB leads the Gaia Archive unit, funded through an EU project (GENIUS). The knowledge gained on data compression has allowed ICCUB to patent a SW/HW solution and to create a spin-off, DAPCOM.

DIRAC: The DIRAC (Distributed Infrastructure with Remote Agent Control) project is a complete grid solution for a community of users developed by CERN, CNRS and ICCUB. It was created to handle the distributed computing of the LHCb experiment, and now other communities, such as CTA, have begun to use it. The ICCUB is now responsible of the continuous updates. During 2015, the Consortium decided to allow access to new partners, and by the end of 2015 these new partners included the Institute of High Energy Physics, IHEP at Beijing, China, and the High Energy Accelerator Research Organization, KEK at Sukuba, Japan.

Activity 2016

Gaia DPAC has achieved a very important milestone: on 14 September 2016, the first Gaia catalogue was released



GAIA DATA RELEASE 1

Gaia 's first sky map based on the first year of observations from esa's gaia satellite,

(known as "Gaia Data Release 1" or simply DR1). It includes the sky position and brightness for 1.1 billion stars, also providing proper motions and parallaxes for 2 million stars. Despite its known limitations, Gaia DR1 has been a worldwide astronomical revolution. The ICCUB researchers have played a key role on its preparation and validation, from the very first daily processing systems (remarkably IDT), the cyclic processing systems (remarkably IDU and its cross-matching), up to the catalogue validation and preparation (where our institute has a leading role). Beyond DR1, during 2016 the ICCUB has continued working on the Gaia data processing towards the second release, planned for Q1 2018. Remarkably, we have improved the observations-sources cross-matching (ultimately defining the catalogue contents), and for the first time, we have re-determined with IDU the image parameters for accumulated raw observations.

ADDITIONAL AREAS OF RESEARCH

ASTRODYNAMICS AND CELESTIAL MECHANICS

ICCUB researchers on Astrodynamics are devoting their efforts to address some fundamental issues concerning the problems related to orbit and attitude control in formation flying of swarms of spacecraft; the development of some dynamical indicators to determine regions and structures that separate different dynamic regimes in autonomous and non-autonomous dynamical systems; the optimal transfer to polar orbits around the Moon; the analysis of the phase space in the vicinity of an irregular asteroid; and the study of mass transport mechanisms in the Solar System.

Activity 2016

During 2016 ICCUB researchers worked on: the design transfers to libration point orbits through graphics processing unit parallel computing; the study of the dynamics in the center manifold around equilibrium points periodically perturbed three-body problems; the study of the dynamics in the invariant manifolds around equilibrium points in a Sun-Earth-Moon coherent restricted four-body model; the computation of solar

LINES OF RESEARCH

- Develop tools to explain in a natural way different astronomical and astrodynamical patterns

ICCUB MEMBERS

Farrés, A. • Gómez, G.

VISITING SCHOLARS

Jorba, À.

radiation pressure assisted transfers between Lissajous orbits of the Sun-Earth system; the determination of pseudo-heteroclinic connections between bicircular restricted four-body problems; the study of transfers from LEOs to GEOs visiting libration points of the Sun-Earth circular restricted three-body problem; spacecraft formation flight using Lorentz forces.

ASTRONOMICAL IMAGE PROCESSING AND HIGH ANGULAR RESOLUTION TECHNIQUES

The Astronomical Image Processing and High Angular Resolution Techniques group at ICCUB is focused on the use of the wavelet and curvelet transforms to improve the ability of image sensors to detect faint stars and moving objects, as well as the development of applications to astronomy and remote sensing. In particular, the group is studying the effects of the curvelet transform over interferometric images and the effect of deconvolution (using wavelets and curvelets based maximum likelihood estimator) in adaptive optics observations. Work is also under way to obtaining super-resolution using additive-substitutive wavelets techniques on remotely sensed images. The group also studies observational techniques and software development for the automatic detection of Space debris using the TFRM telescope under the SSA/SST programs of the ESA and the European Union. Lately, a new research line on the search of Trojan asteroids of the Earth-Moon system has been incorporated.

LINES OF RESEARCH

- Image deconvolution by means of multiresolution analysis (wavelet and curvelet transform)
- Application of Image deconvolution to Space Debris observation
- Observational techniques and software for space debris detection
- Search for Trojan asteroids of the Earth-Moon system

ICCUB MEMBERS

Merino, M.T • Núñez, J.C. • del Ser, D. • Rosselló-Gómez, M.

Activity 2016

During the year 2016 the main activities were focused on the application of deconvolution to increase the limiting magnitude of images obtained for space debris detection. Apart from this, a considerable effort was devoted to continue the software development to obtain stand alone software to detect and extract the position of space debris

in astronomical images. In addition, the group continued studying the deconvolution by multiresolution of images obtained using adaptive optics. Studies of image fusion and superresolution also continued. The new line on Trojan asteroids of the Earth–Moon system consists in the search for these objects using theoretical calculations and the large FOV of the TFRM telescope to look for such unknown objects.

CHIRALITY AND PREBIOTIC CHEMISTRY

The group works in the definition of thermodynamic scenarios in applied chemistry in which a transition to chirality is possible. The experimental expertise in this area is the study of the stereo and enantioselective effect of hydrodynamic flows in the formation of supramolecular systems by self-assembly as well as the phase transitions from achiral building blocks to chiral supramolecules. The general objective of these works is to understand chiral polarizations in the spontaneous emergence of chirality during the chemical evolution.

Activity 2016

In 2016, the ability of hypercyclic autocatalysis (first order autocatalysis plus cross catalysis) to yield spontaneous mirror symmetry breaking was shown. The results suggest a common scenario for the emergence of abiotic replicators and homochirality in the nucleic acid/ protein domain. Apart from this, ICCUB researchers continued studying the effect of mechanical forces on racemic mixtures on chiral nanotubes/self-assembly of achiral amphiphilic

LINES OF RESEARCH

- Mirror symmetry breaking in autocatalytic systems: Critical phenomena in chemical evolution
- Effect of shear forces (flows with gradient of shear rates) on the emergence of chirality in soft matter

ICCUB MEMBERS

Crusats, J. • El-Hachemi, Z.

VISITING SCHOLARS

Ribó, J.M.

porphyrins. New substituted amphiphilic porphyrins were synthesized in order to determine the structural patterns leading to either chiral or achiral aggregates and, in case of formation of racemic conglomerate mixtures, the effects and experimental conditions necessary to lead to a bias from the racemic composition.

HELIOSPHERIC PHYSICS AND SPACE WEATHER

LINES OF RESEARCH

- Solar energetic particle (SEP) events, interplanetary shocks and related solar activity
- Modeling gradual proton events: magnetohydrodynamic shock simulations plus particle transport simulations and applications
- Modeling near-relativistic electron events: inversion methods and applications
- Space weather: Engineering models for prediction of peak flux and fluences of solar energetic particle events

ICCUB MEMBERS

Àgueda, N. • Aran, A. • Pacheco, D. • Sanahuja, B.

The Heliospheric Physics and Space Weather group of the ICCUB mainly focuses on solar energetic particle (SEP) events triggered by solar activity and by interplanetary disturbances. Solar flares and coronal mass ejections, the main agents of SEP acceleration, together with proxies of solar activity, the solar wind plasma and the interplanetary magnetic field, are the background components of the SEP scenario. In this context, ICCUB researchers are performing both data analysis and modeling of SEP events including multi-spacecraft events.

ICCUB members in this area also provide scientific support to other Spanish groups involved in the development of instrumentation for the ESA's Solar Orbiter mission (see *Electronic and Instrumentation Development*).

Activity 2016

During 2016 ICCUB researchers continued their work in HESPERIA (High Energy Solar Particle Events foRecastIng and Analysis), a project funded by the EU

under the H2020 program. Their role in this project is to lead the development of the first inversion method to infer the sources of relativistic SEPs (> 500 MeV), based on the observations provided by the worldwide network of ground-based neutron monitors. Relativistic SEPs provide key observations for understanding the most energetic acceleration processes occurring during solar eruptive events.

Progress was also done on the study of the variation of the proton intensity–time profiles in gradual SEP events in relation to the relative observer's position in the interplanetary space to the direction of propagation of the particles sources.

Finally, ICCUB members went on with their participation in SOL2UP, an ESA-sponsored project, to update the physics-based code SOLPENCO2 (SOLar Particle ENgineering COde 2). This tool provides the heliocentric radial distance scaling (from 0.2 AU to 1.6 AU) of the maximum intensity and fluence during SEP events for 5–200 MeV protons.

KNOWLEDGE TRANSFER AND INNOVATION

SERVICES AND ACTIVITIES

- DAPCOM Data Services.
- Ideas Service (SiUB).

ICCUB research generates products and technologies transferable to industry and society through the licensing of patents and creation of services. To date, its technology transfer program has given rise to several applications from medical imaging to space industry. The ICCUB also participates in one spin-off, DAPCOM, in an instrumental service, SiUB.

DAPCOM Data Services (ESA BIC Barcelona)

DAPCOM Data Services S.L. is a spin-off company which the University of Barcelona (UB) and the Technical University of Catalonia (UPC) participate in the handling and processing of large amounts of data. It provides software engineering solutions and high-performance data compression strategies including proprietary implementations.

DAPCOM commercializes FAPEC (Fully Adaptive Prediction Error Coder), a patented lossless data compression algorithm originally created for satellite payloads. Besides being resilient to outliers in the data, it offers an optimum compromise between resource consumption and compression ratio. It can be applied to scientific research projects, supercomputing or companies dealing with Big Data scenarios.

<http://www.dapcom.es>

Ideas Service (SiUB)

The IDEAS Service (*Servei per la Innovació del Disseny Electrònic Avançat de Sistemes a la UB*), or SiUB, is an instrumentation service of the Physics Faculty of the UB which, on the one hand, provides electronics and microelectronics instrumentation design, development and test to research groups of the UB and other research institutions, and on the other hand, enhances the industry

ICCUB MEMBERS

Casajús, A. • Castañeda, J. • Clotet, M. • Garrido, L. • Gascón, D. • Gaciani-Díaz, R. • Graugés, E. • Guzmán, R. | Julbe, F. • Luri, X. • Mauricio, J. • Picatoste, E. • Portell, J. • Salvador, E. • Sanuy, A. • Torra, J.

technology transfer. SiUB staff and associate members hold more than ten years of experience developing instrumentation at different levels: design and test of application-specific integrated circuits (ASICs), design and test of cards and PCBs, and development of equipment and systems.

<http://siub.ub.edu>

Activity 2016

In 2016 two patent applications have been filed. The first one, “Summation for multi-channel photomultiplier array signals” (EP15382478.4 – 1807) corresponds to a method developed by ICCUB engineers in the context of the CTA project. The second one, “Resistive interpolation mesh circuit for time-to-digital converter” (EP16382039) describes a circuit developed in the context of PET imaging. A technology transfer agreement has been signed based on this development, and several research contracts have been signed with the industry.

In 2016 DAPCOM has made a small study for a private company doing drug discovery software, within the frame of a H2020 project, aiming at more efficient data transfer and storage for genomics.

Finally, ICCUB researcher R. Graciani has been invited to represent Spain in the preparation of a new European Infrastructure providing access to technology for the development of Multi-parametric Molecular Imaging devices. In order to do so, the creation of an Spanish Consortium of institutions (public and private) concerned with the development of these technologies (Spanish Infrastructure for Molecular Imaging Technologies, SIMIT) has been proposed.

PROJECTS AND FUNDS

4

EUROPEAN PROJECTS AND FUNDS

ERC Projects

A New Strategy for Gravity and Black Holes (GravBHs)

Reference: 692951 (8P1ERC - HORIZON 2020.
PILLAR 1-EXCELLENT SCIENCE. ERC. European
Research Council.)
PI: Roberto Emparan
Agency: European Community (EC)
Period: 01/10/2016 - 30/09/2021

Holography for the LHC era (HoloLHC)

Reference: 306605 (FP7-IDEAS-ERC)
PI: David Mateos
Agency: European Community (EC)
Period: 01/10/2012 - 30/09/2017
Other European Projects

Cosmology with future large-scale surveys (COSMOFLAGS)

Reference: 706896 (8P1MCA - HORIZON 2020.
PILLAR 1-EXCELLENT SCIENCE. MCA. Marie
Sklodowska-Curie Actions.)
PI: (ICCUB: Licia Verde)
Agency: European Community (EC)
Period: 01/10/2016 - 30/09/2018

European Particle physics Latin American NETwork (EPLANET)

Reference: PIRSES-GA-2009-246806 (FP7-PEOPLE)
PI: Luciano Maiani (Università degli Studi di Roma, "La
Sapienza") (ICCUB: Domènec Espriu)
Agency: European Community (EC)
Period: 01/02/2011 - 2016

Fast Advanced Scintillator Timing

Reference: TD1401
PI: Etiennette Auffray (ICCUB: David Gascón, Ricardo
Graciani)
Agency: EU
Period: 20/11/2014 - 19/11/2018

Fast Thermalization of the Quark-Gluon Plasma (FastTh)

Reference: 658574 (8P1MCA - HORIZON 2020.
PILLAR 1-EXCELLENT SCIENCE. MCA. Marie
Sklodowska-Curie Actions.)
PI: David Mateos
Agency: European Community (EC)
Period: 01/09/2015 - 31/08/2017

Gaia European Network for Improved User Services (GENIUS)

Reference: 606740 - GENIUS (FP7- SPACE)
PI: Xavier Luri
Agency: European Community (EC)
Period: 01/10/2013 - 31/03/2017

High Energy Solar Particle Events foRecastIng and Analysis (HESPERIA)

Reference: 637324 (8P2SPA - HORIZON 2020.
PILLAR 2-INDUSTRIAL LEADERSHIP. LEIT-
SPA. Leadership in Enabling and Industrial
Technologies-Space.)
PI: (ICCUB: Neus Àgueda)
Agency: European Community (EC)
Period: 01/05/2015 - 30/04/2017

INVISIBLES

Reference: PITN-GA-2011-289442 (FP7-PEOPLE)
PI: B. Gavela (UAM) (ICCUB: M^a Concepción
González-García)
Agency: European Community (EC)
Period: 01/04/2012 - 31/03/2016

InvisiblesPlus (InvisiblesPlus)

Reference: 690575 (8P1MCA - HORIZON 2020.
PILLAR 1-EXCELLENT SCIENCE. MCA. Marie
Sklodowska-Curie Actions.)
PI: Belen Gavela Legazpi (UAM) (ICCUB: M^a
Concepción González-García)
Agency: European Community (EC)
Period: 01/02/2016 - 31/01/2020

Probing strongly coupled deconfined matter at the LHC (DECOLHC)

Reference: PCIG12-GA-2012-333786 (FP7-PEOPLE)
 PI: Joan Soto, Jorge Casalderrey-Solana
 Agency: European Community (EC)
 Period: 01/03/2013 - 31/10/2016

Rotational effects on strongly gravitating systems with matter (REGMat)

Reference: 656882 (8P1MCA - HORIZON 2020, PILLAR 1-EXCELLENT SCIENCE. MCA. Marie Skłodowska-Curie Actions.)
 PI: Roberto Emparan
 Agency: European Community (EC)
 Period: 01/10/2015 - 30/09/2017

Studying at high energies the dynamical and non-thermal processes in astrophysical outflows (ASTFLOW)

Reference: PCIG11-GA-2012-321520 (7PEOPL - PEOPLE. 7è Programa Marc. PEOPLE Programme - Marie Curie Actions (Programa PERSONES - Accions Marie Curie).)
 PI: Josep M^a Paredes, Valentí Bosch-Ramon
 Agency: European Community (EC)
 Period: 01/03/2013 - 28/02/2017

The Elusives Enterprise: Asymmetries of the Invisible Universe (ELUSIVES)

Reference: 674896 (8P1MCA - HORIZON 2020, PILLAR 1-EXCELLENT SCIENCE. MCA. Marie

Skłodowska-Curie Actions.)

PI: Belen Gavela Legazpi (UAM) (ICCUB: M^a Concepción González-García)
 Agency: European Community (EC)
 Period: 01/04/2016 - 31/03/2020

The fate of black holes in high-energy physics -- exploring their dynamical instabilities (BHstabNL)

Reference: 655360 (8P1MCA - HORIZON 2020, PILLAR 1-EXCELLENT SCIENCE. MCA. Marie Skłodowska-Curie Actions.)
 PI: (ICCUB: Roberto Emparan)
 Agency: European Community (EC)
 Period: 01/08/2016 - 31/07/2018

The String Theory Universe

Reference: MP1210 (Cost Action)
 PI: Silvia Penati (Universita' di Milano-Bicocca) (ICCUB: Roberto Emparan)
 Agency: COST Action (European Cooperation in Science and Technology)
 Period: 04/03/2013 - 03/03/2017

Updation SOLPENCO2 and New Analysis on Downstream Fluence

Reference: Contr. 4000114116/15/NL/H
 PI: Àngels Aran
 Agency: European Space Agency
 Period: 01/06/2015 - 01/02/2016

NATIONAL PLAN PROJECTS

Contribución al desarrollo científico y tecnológico de la misión Gaia IV

Reference: ESP2014-55996-C2-1-R
 PI: Xavier Luri
 Agency: MINECO
 Period: 01/01/2015 - 31/12/2016

Cosmología Física en la época de grandes cartografiados

Reference: AYA2014-58747-P
 PI: Licia Verde
 Agency: MINECO
 Period: 01/01/2015 - 31/12/2018

Desafíos presentes y futuros del experimento LHCb del CERN

Reference: FPA2014-57896-C4-2-R
 PI: Eugeni Graugés
 Agency: MINECO
 Period: 01/01/2015 - 31/12/2017

Desarrollo de detectores ultra-rápidos para una nueva generación de sistemas de imagen médica basados en luz Cherenkov

Reference: FPA2016-80917-R
 PI: David Gascón
 Agency: MINECO
 Period: 30/12/2016 - 29/12/2018

Detectores de 'vertexing' y 'tracking' avanzados para los futuros experimentos colisionadores

Reference: FPA2015-71292-C2-2-P
 PI: Ángel Diéguez
 Agency: MINECO
 Period: 01/01/2016 - 31/12/2017

El medio intergaláctico: una herramienta para el estudio de la composición y el origen del universo y de las primeras estrellas

Reference: AYA2015-71091-P
 PI: Jordi Miralda-Escudé
 Agency: MINECO
 Period: 01/01/2016 - 31/12/2018

El papel de las fusiones en la formación de las galaxias de tipo temprano y su conexión con la actividad nuclear

Reference: AYA2016-76682-C3-3-P
 PI: Josep M^a Solanes
 Agency: MINECO
 Period: 30/12/2016 - 29/12/2019

Entrelazamiento cuántico en sistemas de muchas partículas

Reference: FIS2015-69167-C2-2-P
 PI: José Ignacio Latorre
 Agency: MINECO
 Period: 01/01/2016 - 31/12/2018

Estructura a Gran Escala, Cuásares y las Primeras Estrellas con los Espectros de Absorción de Cuásares de BOSS

Reference: AYA2012-33938
 PI: Jordi Miralda-Escudé
 Agency: MICINN
 Period: 01/01/2013 - 31/12/2016

Estudio multidisciplinar de procesos altamente energéticos en eyecciones astrofísicas: teoría y observaciones

Reference: AYA2016-76012-C3-1-P
 PI: Josep M. Paredes
 Agency: MINECO
 Period: 30/12/2016 - 29/12/2019

Eyecciones astrofísicas en procesos de alta energía no térmicos. Teoría y observaciones multi-longitud de onda

Reference: AYA2013-47447-C3-1-P
 PI: Josep M^a Paredes
 Agency: MINECO
 Period: 01/01/2014 - 31/12/2017

Fabricación e integración de SOIPHI (Polarimetric and Helioseismic Imager for Solar Orbiter)

Reference: ESP2015-66494-R
 PI: Josep M^a Gómez-Cama
 Agency: MINECO
 Period: 01/01/2016 - 31/12/2017

Física Hadrónica

Reference: FIS2014-57026-REDT
 PI: Assumpta Parreño
 Agency: MINECO
 Period: 01/12/2014 - 30/11/2016

Física y simulación del transporte de protones. Aplicaciones en el CNA

Reference: FPA2016-77689-C2-2-R
 PI: Francesc Salvat
 Agency: MINECO
 Period: 30/12/2016 - 29/12/2018

Formación Estelar Multi-Escala: de la Fuente Galáctica a Estrellas Individuales

Reference: AYA2014-57134-P
 PI: Paolo Padoan
 Agency: MINECO
 Period: 01/01/2015 - 31/12/2017

Hadrones, núcleos y átomos - Nuevos retos para problemas de muchos cuerpos

Reference: FIS2014-54672-P
 PI: Artur Polls
 Agency: MINECO
 Period: 01/01/2015 - 31/12/2017

Institut de Ciències del Cosmos (ICC)

Reference: MDM-2014-0369
 PI: Josep M. Paredes
 Agency: MINECO
 Period: 01/07/2015 - 30/06/2019

Integración y commissioning del primer large Size Telescope y otros elementos clave del proyecto ESFRI CTA: subproyecto del ICCUB

Reference: FPA2015-69210-C6-2-R
 PI: Marc Ribó
 Agency: MINECO
 Period: 01/01/2016 - 31/12/2017

Los datos de Gaia para las próximas décadas / Gaia data for the next decades

Reference: ESP2016-80079-C2-1-R

PI: Xavier Luri, Carme Jordi
 Agency: MINECO
 Period: 30/12/2016 – 29/12/2018

Materia blanda forzada, activa y viva

Reference: FIS2013-41144-P
 PI: Jaume Casademunt
 Agency: MINECO
 Period: 01/01/2014 – 31/12/2016

Modelado teórico y desarrollos tecnológicos para la observación de galaxias emisoras Lyman-alfa a muy alto z.

Reference: AYA2015-70498-C2-2-R
 PI: Eduard Salvador
 Agency: MINECO
 Period: 01/01/2016 – 31/12/2017

Non-thermal high-energy processes in astrophysical outflows. Theory and multi-wavelength observations

Reference: AYA2013-47447-C3-2-P
 PI: Kazushi Iwasawa
 Agency: MINECO
 Period: 01/01/2014 – 31/12/2016

Núcleos de gas molecular, discos y jets: el efecto del campo magnético

Reference: AYA2014-57369-C3-2-P
 PI: Rosario López
 Agency: MINECO
 Period: 01/01/2015 – 31/12/2017

Red Consolider Centro Nacional de Física de Partículas, Astropartículas y Nuclear, (CPAN)

Reference: FPA2015-69037-REDC
 PI: Lluís Garrido
 Agency: MINECO
 Period: 15/10/2015 – 14/10/2017

Red de infraestructuras de astronomía

Reference: AYA2014-53365-REDT
 PI: Jordi Torra
 Agency: MINECO
 Period: 01/12/2014 – 30/11/2016

Red Española de Explotación Científica de Gaia

Reference: AYA2015-71820-REDT
 PI: Xavier Luri
 Agency: MINECO
 Period: 15/10/2015 – 14/10/2017

Simulación Monte Carlo del transporte de radiación. Emisión de electrones secundarios

Reference: FPA2013-44549-P
 PI: Francesc Salvat
 Agency: MINECO
 Period: 01/01/2014 – 31/12/2016

Simulaciones de interacciones y fusiones de galaxias durante la formación de grupos

Reference: AYA2013-40609-P
 PI: Josep M^a Solanes
 Agency: MINECO
 Period: 01/01/2014 – 31/12/2017

Sucesos de partículas solares energéticas: modelos y aplicaciones para misiones espaciales (Solar Orbiter) y para tiempo espacial

Reference: AYA2016-77939-P
 PI: Blai Sanahuja
 Agency: MINECO
 Period: 30/12/2016 – 29/12/2018

Sucesos solares de partículas energéticas: análisis y modelos. Aplicaciones para Solar Orbiter y herramientas para el tiempo espacial

Reference: AYA2013-42614-P
 PI: Blai Sanahuja
 Agency: MINECO
 Period: 01/01/2014 – 30/06/2017

Teoría y Fenomenología de las Interacciones Fundamentales: física de partículas y unificación de las fuerzas

Reference: FPA2016-76005-C2-1-P
 PI: M^a Concepción González-García
 Agency: MINECO
 Period: 30/12/2016 – 29/12/2019

Teoría y fenomenología de las interacciones fundamentales: física de partículas y unificación de las fuerzas

Reference: FPA2013-46570-C2-1-P
 PI: Domènec Espriu
 Agency: MINECO
 Period: 01/01/2014 – 31/12/2017

Teoría y fenomenología de las interacciones fundamentales: gravitación y cosmología

Reference: FPA2013-46570-C2-2-P
 PI: Roberto Emparan
 Agency: MINECO
 Period: 01/01/2014 – 31/12/2017

Teoría y fenomenología de las interacciones fundamentales: Gravitación y Cosmología

Reference: FPA2016-76005-C2-2-P

PI: Jaume Garriga

Agency: MINECO

Period: 30/12/2016 - 29/12/2019

OTHER NATIONAL GRANTS

Nuevas herramientas de análisis para el estudio de la radiación de partículas energéticas con Solar Orbiter

Reference: EUIN2015-62419

PI: Neus Àgueda

Agency: MINECO

Period: 15/09/2015 - 14/09/2016

PTA Mod. Impulso a la Participación Internacional

Reference: PTA2012-7891-A

PI: Jordi Torra, M. Dolores Balaguer-Núñez

Agency: MINECO

Period: 01/10/2013 - 30/09/2016

Red Española de Estudios sobre la Contaminación Lumínica

Reference: AYA2015-71542-REDT

PI: Eduard Masana

Agency: MINECO

Period: 01/12/2015 - 31/11/2017

CONSOLIDATED GROUPS

Astronomia i Astrofísica

Reference: 2014SGR86

PI: Josep M^a Paredes

Agency: AGAUR

Period: 01/01/2014 - 30/04/2017

Física nuclear teòrica i de moltes partícules en interacció

Reference: 2014SGR401

PI: Àngels Ramos

Agency: AGAUR

Period: 01/01/2014 - 30/04/2017

Gravitation, Strings, and Cosmology

Reference: 2014SGR1474

PI: Jaume Garriga

Agency: AGAUR

Period: 01/01/2014 - 30/04/2017

Grup de Física experimental d'altres energies

Reference: 2014SGR769

PI: Lluís Garrido

Agency: AGAUR

Period: 01/01/2014 - 30/04/2017

Grup de Física Teòrica d'Altes Energies (FISALTEN)

Reference: 2014SGR104

PI: Jorge Russo

Agency: AGAUR

Period: 01/01/2014 - 30/04/2017

Grup de Sistemes Dinàmics

Reference: 2014SGR1145

PI: Àngel Jorba

Agency: AGAUR

Period: 01/01/2014 - 30/04/2017

Grup d'informació i simulació quàntiques (UB)

Reference: 2014SGR727

PI: José Ignacio Latorre

Agency: AGAUR

Period: 01/01/2014 - 30/04/2017

Physical Cosmology, PhysCos

Reference: 2014SGR921

PI: Licia Verde

Agency: AGAUR

Period: 01/01/2014 - 30/04/2017

CONTRACTS WITH THE INDUSTRY***Assessorament en física de l'estat sòlid***

Reference: FBG 308561

PI: Francesc Salvat

Agency: Rovalma S.A

Period: 25/11/2015 - 30/01/2016

Design and production of preamplifier for synchrotron facility

Reference: -

PI: Lluís Garrido

Agency: Scientifica Internacional, S.L

Period: -

Joint research agreement. Work: Further development of the modification and/or customization of PENELOPE, which is under consulting service between the parties, for use with lower energy particles below 100 eV

Reference: FBG 308407

PI: Francesc Salvat

Agency: Hamamatsu Photonics K.K.

Period: 01/04/2015 - 31/03/2016

Updating SOLPENCO2 and New Analysis on Downstream Fluence

Reference: Contr. 4000114116/15/NL/H

PI: Àngels Aran

Agency: Agencia Espacial Europea (ESA)

Period: 01/06/2015 - 01/02/2016

SCI PUBLICATIONS

Aaij, R.; et al (LHCb collaboration. ICCUB: Badalov, A.; **Camboni, A.; Coquereau, S.; Garrido, L.; Gascon, D.; Graciani Diaz, R.; Grauges, E.; Marin, C.; Picatoste, E.; Rives, V.**)

Measurement of CP Violation in $B^0 \rightarrow D^+ D^-$ Decays. Article

Physical Review Letters, Vol. 117, Num. 261801 (2016)

[10.1103/PhysRevLett.117.261801](https://arxiv.org/abs/10.1103/PhysRevLett.117.261801)

Aaij, R.; et al (LHCb collaboration. ICCUB: Badalov, A.; **Camboni, A.; Coquereau, S.; Garrido, L.; Gascon, D.; Graciani Diaz, R.; Grauges, E.; Marin, C.; Picatoste, E.; Rives, V.**)

Measurement of the CKM angle γ from a combination of LHCb results. Article

Journal of High Energy Physics, Vol. 2016, Num. 87 (2016)

[10.1007/JHEP12\(2016\)087](https://arxiv.org/abs/10.1007/JHEP12(2016)087)

Aaij, R.; et al (LHCb collaboration. ICCUB: Badalov, A.; **Camboni, A.; Garrido, L.; Gascon, D.; Diaz, R. Graciani; Grauges, E.; Benito, C. Marin; Olloqui, E. Picatoste; Rives Molina, V.**)

Search for Structure in the $B_s^0 \pi^\pm$ Invariant Mass Spectrum. Article

Physical Review Letters, Vol. 117, Num. 152003 (2016)

[10.1103/PhysRevLett.117.152003](https://arxiv.org/abs/10.1103/PhysRevLett.117.152003)

Aaij, R.; et al (LHCb collaboration. ICCUB: Badalov, A.; **Camboni, A.; Garrido, L.; Gascon, D.; Graciani Diaz, R.; Grauges, E.; Marin, C.; Picatoste, E.; Rives, V.**)

Amplitude analysis of $B^- \rightarrow D^+ \pi^- \pi^-$ decays. Article

Physical Review D, Vol. 94, Num. 72001 (2016)

[10.1103/PhysRevD.94.072001](https://arxiv.org/abs/10.1103/PhysRevD.94.072001)

Aaij, R.; et al (LHCb collaboration. ICCUB: Badalov, A.; **Camboni, A.; Garrido, L.; Gascon, D.; Graciani Diaz, R.; Grauges, E.; Marin, C.; Picatoste, E.; Rives, V.**)

Measurement of forward $W \rightarrow e\nu$ production in pp

collisions at $\sqrt{s}=8$ TeV. Article

Journal of High Energy Physics, Vol. 2016, Num. 30 (2016)

[10.1007/JHEP10\(2016\)030](https://arxiv.org/abs/10.1007/JHEP10(2016)030)

Aaij, R.; et al (LHCb collaboration. ICCUB: Badalov, A.; **Camboni, A.; Garrido, L.; Gascon, D.; Graciani Diaz, R.; Grauges, E.; Marin, C.; Picatoste, E.; Rives, V.**)

Measurement of the forward Z boson production cross-section in pp collisions at $\sqrt{s}=13$ TeV. Article

Journal of High Energy Physics, Vol. 2016, Num. 136 (2016)

[10.1007/JHEP09\(2016\)136](https://arxiv.org/abs/10.1007/JHEP09(2016)136)

Aaij, R.; et al (LHCb collaboration. ICCUB: Badalov, A.; **Garrido, L.; Gascon, D.; Graciani Diaz, R.; Grauges, E.; Marin Benito, C.; Picatoste Olloqui, E.; Rives Molina, V.; Ruiz, H.**)

Studies of the resonance structure in $D^0 \rightarrow K_S^0 K^\pm \pi^\pm$ decays. Article

Physical Review D, Vol. 93, Num. 52018 (2016)

[10.1103/PhysRevD.93.052018](https://arxiv.org/abs/10.1103/PhysRevD.93.052018)

Aaij, R.; et al (LHCb collaboration. ICCUB: Badalov, A.; Gomez, M.C.; Casanova Mohr, R.; **Garrido, L.; Gascon, D.; Graciani Diaz, R.; Grauges, E.; Marin Benito, C.; Picatoste Olloqui, E.; Ruiz, H.; Vilasis-Cardona, X.**)

First observation of the decay $B_s^0 \rightarrow K_S^0 K^{}(892)^0$ at LHCb.* Article

Journal of High Energy Physics, Vol. 2016, Num. 12 (2016)

[10.1007/JHEP01\(2016\)012](https://arxiv.org/abs/10.1007/JHEP01(2016)012)

Aaij, R.; et al (LHCb collaboration. ICCUB: Badalov, A.; Gomez, M.C.; **Garrido, L.; Gascon, D.; Graciani Diaz, R.; Grauges, E.; Marin Benito, C.; Picatoste Olloqui, E.; Ruiz, H.; Vilasis-Cardona, X.**)

Measurement of the Difference of Time-Integrated CP Asymmetries in $D^0 \rightarrow K^- K^+$ and $D^0 \rightarrow \pi^- \pi^+$ Decays.

Article

Physical Review Letters, Vol. 116, Num. 184601 (2016)
[10.1103/PhysRevLett.116.191601](https://doi.org/10.1103/PhysRevLett.116.191601)

Aaij, R.; et al (LHCb collaboration. ICCUB: **Camboni, A.; Coquereau, S.; Garrido, L.; Gascon, D.; Graciani Diaz, R.; Grauges, E.; Marin Benito, C.; Picatoste Olloqui, E.; Rives Molina, V.**)

Study of B_c^+ decays to the $K^+K^-\pi^+$ final state and evidence for the decay $B_c^+ \rightarrow \chi_{c0}\pi^+$. Article
 Physical Review D, Vol. 94, Num. 91102 (2016)

[10.1103/PhysRevD.94.091102](https://doi.org/10.1103/PhysRevD.94.091102)

Aaij, R.; et al (LHCb collaboration. ICCUB: **Garrido, L.; Gascon, D.; Graciani Diaz, R.; Grauges, E.; Marin Benito, C.; Picatoste Olloqui, E.; Rives Molina, V.**)
A new algorithm for identifying the flavour of B^0_s mesons at LHCb. Article

Journal Of Instrumentation, Vol. 11, Issue P05010 (2016)

[10.1088/1748-0221/11/05/P05010](https://doi.org/10.1088/1748-0221/11/05/P05010)

Aaij, R.; et al (LHCb collaboration. ICCUB: **Garrido, L.; Gascon, D.; Graciani Diaz, R.; Grauges, E.; Marin Benito, C.; Picatoste Olloqui, E.; Rives Molina, V.**)

A precise measurement of the B^0 meson oscillation frequency. Article

European Physical Journal C, Vol. 76, Num. 412 (2016)

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Best values of parameters of cosmological Dark Energy in various models and gravity

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Caracterització de la contaminació lumínica en zones protegides i urbanes

Author: Salvador Ribas Rubio
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Author: Eduardo Picatoste Olloqui
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Microscopic analysis of rotating black holes

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New insights into holography from supersymmetric localization

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Observational and theoretical study of the interaction of relativistic winds from young pulsars with inhomogeneous stellar winds

Author: Xavier Paredes-Fortuny
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Author: Juan Alejandro García Alvarez
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Study of b-hadron decays into two hadrons and a photon at LHCb and first observation of b-baryon radiative decays

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Author: Andreu Sanuy Charles
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Ongoing PhD theses

Agujeros negros y modelos de gravitación emergente

Author: Luciano Gabbanelli
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Analysis and modelling of the solar energetic particle radiation environment in the inner heliosphere in preparation for Solar Orbiter

Author: Daniel Pacheco Mateo
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Chemical and dynamical analysis of Open Clusters in the context of the Milky Way disc

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Collapse scenarios in magnetized star-forming regions

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Contribution to GNSS inter-satellite link technique: Usage of low earth orbital and sub-orbital measurements

Author: David Roma Dollase
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Correlacions quàntiques en sistemes d'àtoms ultrafreds amb interacció d'espín-òrbita sintètica

Author: Pere Mujal Torrelblanca
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Coupling fluid-dynamics and non-thermal processes to study sources of high energy emission

Author: Víctor Moreno de la Cita
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Determination of the Dark Energy Components at the 1% level

Author: Nicola Bellomo
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Estudi de la polarització del fotó en desintegracions radiatives d'hadrons B amb el detector LHCb.

Author: Carla Marín Benito
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 Director/s: Jordi Miralda
 Tentative Date: June 2019

Exploring the universe with quasar absorption spectra: correlations among tracers of the mass density field and the impact of ionizing background intensity fluctuations

Author: Satya Gontcho A Gontcho
 Director/s: Jordi Miralda Escudé
 Tentative Date: September 2017

Explotació científica del survey TFRM-PSES: detecció d'exoplanetes per transit, caracterització de la variabilitat d'estrelles Ks i Ms, i optimització de l'anàlisi de dades TFRM-PSES

Author: Daniel del Ser Badia
 Director/s: Jorge Núñez de Murga, Octavi Fors
 Tentative Date: January 2018

Gauge/string duality for strongly coupled theories with finite baryon density

Author: David Pravos Fernández
 Director/s: David Mateos
 Tentative Date: May 2019

Gravitació anàloga amb metamaterials

Author: Isabel Fernández Núñez
 Director/s: Enric Verdagner, Oleg Bulashenko
 Tentative Date: 2018

Holographic collisions and non-conformal dynamics

Author: Miquel Triana i Iglesias
 Director/s: David Mateos
 Tentative Date: September 2017

Holographic approach of physics beyond the Standard Model

Author: Alisa Katanaeva
 Director/s: Domènec Espriu
 Tentative Date: February 2020

Leptonic CP violation and its origin

Author: Iván Esteban Muñoz
 Director/s: M^a Concepción González-García

Tentative Date: September 2020

Meson-Baryon interactions from effective Chiral Lagrangians

Author: Albert Feijoo Aliau

Director/s: Àngels Ramos, Volodymyr Magas

Tentative Date: September 2017

Multipartite entanglement and quantum algorithms

Author: Daniel Alsina Leal

Director/s: José Ignacio Latorre

Tentative Date: September 2017

Neutron-rich matter in nuclei and neutron stars

Author: Clàudia González Boquera

Director/s: Mario Centelles, Xavier Viñas

Tentative Date: 2020

New strategies for black hole physics

Author: Raimon Luna Perelló

Director/s: Roberto Emparan

Tentative Date: September 2020

Optimized PET module using monolithic crystals

Author: David Sánchez Gonzalo

Director/s: Ricardo Graciani

Tentative Date: June 2019

Physical Cosmology in the epoch of large surveys

Author: José Luí Bernal Mera

Director/s: Licia Verde, Antonio J. Cuesta

Tentative Date: Fall 2019

Physical mechanisms in high-energy pulsars and their environments

Author: Daniel Galindo

Director/s: Roberta Zanin, Josep M. Paredes

Tentative Date: May 2019

Probing the correlation between IR and X-ray emission in Luminous Infrared Galaxies

Author: Núria Torres Albà

Director/s: Valenti Bosch Ramon, Kazushi Iwasawa

Tentative Date: October 2019

Quantum simulators with ultracold atomic circuits

Author: Albert Escrivà Mañas

Director/s: Montserrat Guilleumas, Bruno Julià-Díaz

Tentative Date: October 2020

Teories Gauge i Principi de Màxima Entropia

Author: Alba Cervera Lierta

Director/s: José Ignacio Latorre

Tentative Date: June 2019

The Milky Way stellar population in the Gaia era: Archive validation tasks and First Science

Author: Roger Mor

Director/s: Francesca Figueras, Annie Robin (Observatori de Besançon, França)

Tentative Date: 2018

Towards de solution of the flavour problem at LHC

Author: Pere Arnau Vendrell

Director/s: Federico Mescia

Tentative Date: December 2019

Vacuum energy in Quantum Field Theory and Cosmology

Author: Adrià Gómez Valent

Director/s: Joan Solà Peracaula

Tentative Date: September 2017

Weak decay of doubly strange systems

Author: Jordi Maneu Victoria

Director/s: Assumpta Parreño

Tentative Date: November 2017

MASTER THESES

Bjorken expansion with gradual freeze out via HBT

Author: Marc Borrell Martínez
 Director/s: Volodymyr Magas
 Date: 2016

Can the Tremaine-Weinberg method be used to determine the pattern speed of the bar and the spiral arms of the Milky Way?

Author: Marta Reina Campos
 Director/s: Francesca Figueras, Teresa Antoja
 Date: 29/06/2016

Canonical realization of BMS

Author: Víctor Manuel Campello Román
 Director/s: Joaquim Gomis, Carles Batlle
 Date: 30/06/2016

Carroll symmetries and non-linear realizations

Author: Biel Cardona Rotger
 Director/s: Joaquim Gomis
 Date: 05/02/2016

Comparing Cosmic Accelerating Models during Inflation

Author: Ellis Coll Terrett
 Director/s: Joan Solà
 Date: 07/09/2016

Distribuciones angulares de partículas energéticas solares en la heliosfera interna

Author: José Miguel Rubio Chueca
 Director/s: Neus Àgueda
 Date: 2016

Dust Extinction in Lyman Break galaxies at high redshifts

Author: Marc Oncins Fernández
 Director/s: Alberto Manrique
 Date: 05/09/2016

Dynamics of neutral and charged black p-branes at large D

Author: Raimon Luna Perello
 Director/s: Roberto Emparan
 Date: 30/06/2016

Evolución a alto redshift de las galaxias enanas masivas

Author: Victor de Paula Vila
 Director/s: Eduard Salvador
 Date: 05/09/2016

Evolution of the Lyman-Alpha Emission from High Redshift Lyman-Alpha emitters

Author: David Canales García
 Director/s: Eduard Salvador
 Date: 05/09/2016

Holography, walking and confinement in 2+1 dimensions

Author: Javier Gomez Subils
 Director/s: David Mateos
 Date: 30/06/2016

Hybrid models of holographic and dynamical vacuum energy confronted with observations

Author: Jordi Illa Miralles
 Director/s: Joan Solà
 Date: 07/09/2016

K+K- pair production in proton induced reactions in nuclei

Author: Carlos Pérez Dengra
 Director/s: Volodymyr Magas
 Date: 2016

Matrix Models and Confinement

Author: Giorgio Valocchi
 Director/s: Jorge Russo
 Date: 07/09/2016

Mixing of heavy hybrid and heavy quarkonium in EFT

Author: Rubén Mesa Oncala
 Director/s: Joan Soto
 Date: 30/06/2016

Neutrino Oscillations and CP violation: analysis of NovA Data

Author: Iván Esteban Muñoz
 Director/s: M^a Concepción González-García
 Date: 30/06/2016

Non-relativistic limits of extended objects

Author: Daniel Not Not
 Director/s: Joaquim Gomis, Carles Batlle
 Date: 30/06/2016

Orbits of Electrically Charged Particle in Magnetic Reissner-Nordström Metric

Author: Armun Liaghat

Director/s: Jorge Russo

Date: 07/09/2016

Peccei-Quinn Symmetry in a fundamental Composite 2HDM

Author: Clara Tieso Gomez

Director/s: Domènec Espriu

Date: 07/09/2016

Photometric study of the Be/BH binary system candidate HD13831

Author: Elia Do Souto Espiñeira

Director/s: Marc Ribó

Date: 05/09/2016

Reconstruction of the Cosmic Expansion History

Author: Natalia Porqueres Rosa

Director/s: Alberto Manrique

Date: 29/06/2016

Standard Model Higgs-driven inflation as source of large scale magnetic fields

Author: Alejandro Alfonso Albero

Director/s: Alessio Notari

Date: 07/09/2016

Synchrotron emission of wind-loaded helical jets in high mass microquasars

Author: Edgar Molina Lumbreras

Director/s: Valentí Bosch-Ramon

Date: 05/09/2016

Unitarity violation in Inflationary models

Author: Albert Escrivà Mañas

Director/s: Cristiano Germani

Date: 07/09/2016

ACTIVITIES

7

ICCUB COLLOQUIA

The ICCUB Colloquia are talks given by world renowned speakers about cutting-edge topics in cosmology, astrophysics and particle and nuclear physics. The talks are directed to a diverse audience, including not only ICCUB members but also external researchers and graduate and master students.

Colloquia Comission

- Bartomeu Fiol
- Bruno Julià
- Federico Mescia
- Paolo Padoan

2016 ICCUB Colloquia

Nir Shaviv (Racah Institute of Physics (The Hebrew University of Jerusalem))
The Cosmic Ray climate link - from geological time scales to 20th century climate change
18/02/2016

Fernando Quevedo (University of Cambridge & ICTP Director)
String Theory and Physics?
31/03/2016

Andrew C Fabian (Institute of Astronomy, University of Cambridge)
Heating and Cooling in Clusters of Galaxies
14/04/2016

Karlheinz Langanke (Technische Universität Darmstadt)
The Universe in the Laboratory - The Facility for Antiproton and Ion Research
19/05/2016

Licia Verde (ICREA-ICCUB)
Precision cosmology and beyond
Data: 10/11/2016



ICCUB COLLOQUIA 2016 SPEAKERS

From left to right: N. Shaviv, F. Quevedo, A.C. Fabian, K. Langanke, L. Verde

SEMINARS

Seminars are more specialized talks given by either ICCUB members or visitors.

We distinguish those seminars organized directly by the institute (ICCUB Seminars), and group seminars organized in collaboration with UB departments:

- High Energy Physics Group (HEP),
- Atomic, Molecular and Nuclear Physics Group (FAN),
- Department of Astronomy and Meteorology (DAM).

2016 Seminars

Mar Mezcua (Département de Physique, Université de Montréal)

Growing black holes: from the first seeds to active galactic nuclei

DAM Seminar
08/01/2016

Mika Juvela (University of Helsinki)

Planck and Herschel studies of Galactic star formation

ICCUB Seminar
13/01/2016

Carme Gallart (Instituto Astrofísico de Canarias)

On the origin of dwarf galaxy types and on the building blocks of large spiral galaxies: clues from the Local Group

DAM Seminar
15/01/2016

Manel Perucho (Universidad de Valencia)

The complex dance between extragalactic jets and host galaxies

DAM Seminar
21/01/2016

Michele Cirafici (IST Lisboa)

Persistent Homology and String Vacua

HEP Seminar
21/01/2016

Pedro Luis Luque (Universidad de Jaén)

Evolución en Tiempo Real de Chorros Relativistas a Gran Escala

DAM Seminar
22/01/2016

Miquel Triana (ICCUB)

Shock wave collisions in a family of non-conformal theories

HEP Seminar
22/01/2016

Ayan Mukhopadhyay (TU Wien)

Semiholography for QCD: Applications and derivation

HEP Seminar
28/01/2016

Martin Clevel (ICCUB)

Hadronic Molecules in the Heavy Quark Sector

FAN Seminar
28/01/2016

Evangelie (Lia) Athanassoula (Aix-Marseille

Universite (AMU))

Formation of disc galaxies in wet major mergers: The N-body view

DAM Seminar
01/02/2016

Juan Pedraza (U. Amsterdam)

Charged quenches and entanglement entropy

HEP Seminar
04/02/2016

Jorge Ovalle (ICTP Trieste)

Extra-dimensional Gravity: New black hole solutions

HEP Seminar
05/02/2016

Dmitry Khangulyan (Rikkyo University)

Fast variability of gamma-rays from AGNs and its implication

DAM Seminar
10/02/2016

Yen Chin Ong (Nordita Stockholm)

Naked Firewalls

HEP Seminar
18/02/2016

Nicolas Bizot (Université de Montpellier)
LHC constraints on new fermions and the diphoton excess
 HEP Seminar
 25/02/2016

Jan Rosseel (Universität Bern)
New developments in non-relativistic (super)gravity
 HEP Seminar
 03/03/2016

Joaquim Gomis (ICCUB)
Canonical Realization of BMS symmetry
 HEP Seminar
 04/03/2016

Subhajit Mazumdar (Tata Institute, Mumbai)
A Membrane Paradigm : The Next to Leading Order Story
 HEP Seminar
 07/03/2016

Guiseppe Policastro (ENS Paris)
A Membrane Paradigm : The response of semi-holographic non-Fermi liquids
 HEP Seminar
 08/03/2016

Diego Rodriguez-Gomez (U. Oviedo)
Gauge theories on CP^2
 HEP Seminar
 10/03/2016

Alejandro Kievski (INFN Pisa)
Matching Universal Behavior using Potential Models
 FAN Seminar
 10/03/2016

Joaquim Loizu (Max-Planck-Princeton Center for Plasma Physics)
Plasma physics and controlled fusion: an overview
 FAN Seminar
 10/03/2016

Kamal Hajian (IPM Tehran)
Solution phase space and conserved charges
 HEP Seminar
 16/03/2016

Juan M. Uson (Instituto Astrofísico de Canarias)
The Universe in 2016: A "house of cards?"
 DAM Seminar
 17/03/2016

Ignacy Sawicki (Geneva University)
Disambiguating the Cosmological Dark Sector
 HEP Seminar
 17/03/2016

Javier Menendez (U. Tokyo)
Neutrinoless double-beta decay: studying neutrinos with atomic nuclei
 FAN Seminar
 17/03/2016

Teresa Bautista (LPTHE Paris)
Weyl Anomalies and Quantum Cosmology
 HEP Seminar
 18/03/2016

Igor Buchberger (Karlstads Universitet)
Reducing supersymmetry in string loop amplitudes
 HEP Seminar
 01/04/2016

Elena Pancino (Istituto Nazionale di Astrofisica (INAF) – Osservatorio Astronomico di Bologna)
Globular clusters and the Galactic halo with Gaia
 ICCUB Seminar
 04/04/2016

Andrea Puhm (UC Santa Barbara)
Tunneling into Black Hole Microstates
 HEP Seminar
 05/04/2016

Oscar Cata (LMU München)
Novel approaches to dark matter decay
 HEP Seminar
 07/04/2016

Miguel García Echevarría (ICCUB)
Exploring the 3D structure of hadrons
 HEP Seminar
 15/04/2016

Olcyr Sumensari (LPT Paris)
Origin of Lepton Flavor Violation
 HEP Seminar
 21/04/2016

Carlos Herdeiro (U. Aveiro)
Kerr black holes with scalar or Proca hair
 HEP Seminar
 22/04/2016

Robert Brandenberger (McGill University and ETH Zurich)
Coupled dark energy and dark matter from axions
 HEP Seminar
 26/04/2016

Carlos Carrasco (Instituto de Radioastronomía y Astrofísica, Universidad Nacional Autónoma de México)
Observing Planet Formation with the VLA at the ALMA era
 DAM Seminar
 27/04/2016

Saeedeh Sadeghian (Alzahra University, Tehran)
Extremal Vanishing Horizon Black Holes
 HEP Seminar
 05/05/2016

Tomeu Fiol (ICCUB)
Exact results in Quantum Field Theory
 HEP Seminar
 06/05/2016

Alisa Katanaeva (ICCUB)
Holographic study of the QCD matter under external conditions
 HEP Seminar
 13/05/2016

Gaston Giribet (Université Libre de Bruxelles)
Infinite-dimensional symmetry and BMS supertranslation at the black hole horizon
 HEP Seminar
 26/05/2016

Christian Gogolin (ICFO)
Equilibration and thermalization in quantum systems
 FAN Seminar
 26/05/2016

Jorge Russo (ICCUB)
D branes in background fluxes and Nielsen-Olesen instabilities
 HEP Seminar
 27/05/2016

Manuel Barranco (UB and IRSAMC (Université Paul Sabatier, Toulouse))
Superfluid Helium droplets as a very cold nanolaboratory
 FAN Seminar
 01/06/2016

Alex Buchel (Perimeter Institute)
Beyond adiabatic approx. in Big Bang Cosmology: hydrodynamics, resurgence and entropy prod. in the Universe
 HEP Seminar
 02/06/2016

Martín González-Alonso (IPN Lyon)
EFT analyses of New Physics searches: from nuclei to the LHC
 HEP Seminar
 08/06/2016

Daniel Pablos (ICCUB)
Jet Formation and Interference within a QCD Plasma
 HEP Seminar
 10/06/2016

Jorge Peñarrubia (Royal Observatory of Edinburgh)
Local constraints on Dark Matter theories
 ICCUB Seminar
 13/06/2016

Albert Gallemí (Universitat de Barcelona)
Persistent current nucleation in polariton condensates with spin-orbit coupling
 FAN Seminar
 16/06/2016

Juan José Sanz (Universidad Autónoma de Madrid)
A sum-rule approach to a broad 750 GeV diphoton resonance
 HEP Seminar
 17/06/2016

Elena Giusarma (Carnegie Mellon University)
Testing neutrino physics with cosmological observables
 ICCUB Seminar
 20/06/2016

Guifré Vidal (Perimeter Institute)
Tensor networks for quantum fields: conformal invariance and emergent de Sitter space
 HEP Seminar
 21/06/2016

Helvi Witek (University of Nottingham)
Compact objects in Einstein-dilaton Gauss-Bonnet gravity
 HEP Seminar
 22/06/2016

Nadejda Blagorodnova (University of Cambridge)
Red transient reveals the ejection of a binary star Common Envelope
 DAM Seminar
 23/06/2016

Angela Mecca (INFN, Roma 1)
Unified description of equation of state and transport properties of the Fermi hard-sphere system
 FAN Seminar
 23/06/2016

Nicola Tamanini (Saclay, SPhT)
Cosmology with gravitational waves
 ICCUB Seminar
 27/06/2016

Naresh Dadhich (IUCAA, Pune)
Could we have as well lived in higher dimensions?
 HEP Seminar
 14/07/2016

Jordi Maneu (ICCUB)
Hypernuclear decay of strangeness -2 hypernuclei
 FAN Seminar
 14/07/2016

Pere Mujal (ICCUB)
Quantum properties of a binary bosonic mixture in a double well
 FAN Seminar
 21/07/2016

Monica Laurenza (IAPS-INAF, Roma)
The Weibull functional form for the energetic particle spectra at interplanetary shock waves
 DAM Seminar
 26/07/2016

Juan Alberto Yepes (Institute of Theoretical Physics, Beijing)
Left-right non-linear dynamical Higgs effects
 HEP Seminar
 15/09/2016

Misao Sasaki (YITP Kyoto)
Inflationary Magnetogenesis with Broken Local $U(1)$ Symmetry
 HEP Seminar
 22/09/2016

Daniel Michalik (Lund Observatory)
Tycho-Gaia and beyond: The special character of Gaia Data Release 1
 DAM Seminar
 23/09/2016

Guillem Domènech (Kyoto University)
Scale dependent non-gaussianity on the CMB from Scalar-Scalar-Tensor interactions
 HEP Seminar
 23/09/2016

Antonio Cuesta (ICCUB)
Results from the clustering of galaxies in the completed BOSS survey
 ICCUB Seminar
 27/09/2016

John C. Mather (NASA Observational Cosmology Laboratory)
From the Big Bang to the end of the universe, and how we'll learn more with the James Webb Space Telescope
 ICCUB Seminar
 28/09/2016

Salvatore Capozziello (Università Napoli)
Constraining models of Extended Gravity using Gravity Probe B and LARES experiments
 HEP Seminar
 29/09/2016

Cristina Manuel (Instituto de Ciencias del Espacio)
On-shell effective field theory: a new tool in thermal field theory
 HEP Seminar
 30/09/2016

Anze Slosar (Brookhaven National Laboratory (New York, USA))
Cosmology with the Baryon Oscillations Spectroscopic Survey (SDSS-III)
 ICCUB Seminar
 04/10/2016

Jorge Alfaro (Universidad Católica de Chile)
Electroweak standard model with very special relativity
 HEP Seminar
 06/10/2016

César Gómez (LMU Munich & IFT Madrid)

The Beauty of The Infra Red

ICCUB Seminar

07/10/2016

Pere Arnau (ICCUB)

Loop effects of heavy new scalars and fermions in $b \rightarrow s \mu^+ \mu^-$

HEP Seminar

07/10/2016

Harvey Reall (DAMTP Cambridge)

Instability of supersymmetric microstate geometries

HEP Seminar

13/10/2016

Mitsutoshi Fujita (University of Kentucky)

Holographic Chern-Simons Defects

HEP Seminar

13/10/2016

Jordi Garra (University of Cambridge)

The CKM angle gamma at LHCb: past, present and future

HEP Seminar

14/10/2016

Benito Marcote (JIVE, Països Baixos)

On the origin of Fast Radio Bursts and sub-millisecond localization

DAM Seminar

18/10/2016

Luis A. Martínez (UNAM)

Imprints of the spiral arms (Radial Migration) on the Metallicity Distribution Function

ICCUB Seminar

20/10/2016

Yves Dirian (Université de Genève)

Observational constraints and Bayesian model comparison in non-local gravity

HEP Seminar

20/10/2016

Angel Gómez (Universidad Complutense Madrid)

Chiral Symmetry Restoration: recent advances

HEP Seminar

21/10/2016

Nick Kaiser (University of Hawaii)

On gravitational redshifts in clusters - and elsewhere

ICCUB Seminar

25/10/2016

Cecilia Mateu (CIDA, Venezuela)

Predictions for the detection of Tidal Streams with Gaia using Great Circle Methods

ICCUB Seminar

26/10/2016

Tommaso Grassi (Starplan Center, University of Copenhagen and Niels Bohr Institute)

Astrophysical environments where microphysics matters

ICCUB Seminar

27/10/2016

Admir Greljo (Universität Zürich)

Implications of lepton flavor non-universality in B decays for high- p_T searches at LHC

HEP Seminar

27/10/2016

Yago Bea (ICCUB)

Non-abelian T-duality and new AdS3 backgrounds. The ABJM theory and applications to condensed matter physics

HEP Seminar

28/10/2016

Sabya Sachi Chatterjee (Institute of Physics Bhubaneswar)

Physics Reach of Long Baseline Neutrino Experiments in presence of a eV scale sterile neutrino

HEP Seminar

03/11/2016

Luciano Gabbanelli (ICCUB)

Bose-Einstein Condensates as a picture for Black Holes

HEP Seminar

04/11/2016

Susana Lizano (Instituto de Radioastronomía y Astrofísica, UNAM, Morelia, Mexico)

Formation and Structure of Magnetized Protoplanetary Disks

ICCUB Seminar

07/11/2016

Tanio Díaz-Santos (Universidad Diego Portales (Santiago, Chile))

Gas and Dust Properties of Luminous Infrared Galaxies

ICCUB Seminar

08/11/2016

Pedro F. Ramírez (IFT-UAM)

Non-Abelian black holes and microstate geometries

HEP Seminar

09/11/2016

Leonardo Trombetta (ICTP, Trieste)

Infrared effects in de Sitter spacetime: nonperturbative treatment of secular terms

HEP Seminar

10/11/2016

Ilia Musco (Observatoire de Paris)

Cosmological perturbations and primordial black hole formation

HEP Seminar

11/11/2016

David Marzocca (Universität Zürich)

Challenges in the EFT interpretation of LHC data

HEP Seminar

17/11/2016

Diego Blas (CERN)

TSPT: a new method for large scale structure in the mildly non-linear regime

HEP Seminar

18/11/2016

Jonathan C. Tan (University of Florida)

Massive Star Formation Through The Universe

ICCUB Seminar

23/11/2016

Nuria Rius (IFIC Valencia)

Sterile neutrino portal to Dark Matter: making visibles the invisibles

HEP Seminar

25/11/2016

Fergus Simpson (ICCUB)

Dark energy from a frozen scalar field

ICCUB Seminar

14/12/2016

Ben Freivogel (University of Amsterdam)

All Vacua Must Die

HEP Seminar

15/12/2016

Guifré Vidal (Perimeter Institute)

Tensor networks and conformal field theory on the lattice

HEP Seminar

20/12/2016

EVENT ORGANIZATION

AT ICCUB

Figueras, F.; Balaguer, D.

Organizing committee

WEAVE: Stellar, Circumstellar, and Interstellar Physics Survey (SCIP)

Physics Building, University of Barcelona
07/03/16-09/03/16

Bellini, E.; Germani, C.

Organizers

Tensor calculus with xAct

Physics Building, University of Barcelona
16/03/16-18/03/16

Balaguer, D.; Jordi, C.

Organizers

Abundance ratios as tools to understand the chemical evolution of stellar systems

Physics Building, University of Barcelona
05/04/16-07/04/16

Padoan, P.

Participation in organizer committee

4th Session of the Sant Cugat Forum on Astrophysics. Workshop on Young Solar Systems

Sant Cugat, Barcelona. Spain
18/04/16-22/04/16

Latorre, J.I.

Participation in organizer committee

Multipartite Entanglement

Centro de Ciencias de Benasque Pedro Pascual
22/05/16-27/05/16

Figueras, F.; Balaguer, D.

Organizing committee

Gaia: IV Reunión Científica de la REG

Physics Building, University of Barcelona
23/05/16-25/05/16

Bellini, E.; Cuesta, A.; Miralda, J. (Chair); Notari, A.; Verde, L.

Participation in organizer committee

Meeting on Fundamental Cosmology

Physics Building, University of Barcelona
15/06/16-17/06/16

Paredes, J.M.

Participation in organizer committee

CCF Face-to-face meeting

Physics Building, University of Barcelona
20/06/16-24/06/16

Ballabriga, R. (Co-chair); Figueras, F.; Garrido, L.; Gascon, D. (Chair); Graciani, R.; Guzmán, R.; Paredes, J.M.; Torra, J.

Organizing committee

First Barcelona Techno Week: Course on semiconductor detectors

Physics Building, University of Barcelona
11/07/16-15/07/16

Fernández-Varea, José M.

Organizer

Advanced topics in statistical methods for experimental sciences

Physics Building, University of Barcelona
05/09/16-16/09/16

Paredes, J.M.

Organizer

Methods of X-ray Data Analysis

Physics Building, University of Barcelona
19/09/16-23/09/16

Àgueda, N.; Aran, A.; Bertolín, A.; Frutos, A.; Montes, P.; Pacheco, D.; Sanahuja, B.

Organizing committee

Exploring plasma energization in space turbulence

Physics Building, University of Barcelona
27/09/16-29/09/16

Graciani, R.; Julbe, F.; Luri, X.; Puig, A.; Vilasis, X.

Organizing committee

ICCUB School: Machine Learning and Data Mining in Physics

Physics Building, University of Barcelona
17/10/16-21/10/16

Salvador, E.

Organizer

Intensive course on Bayesian methods

Physics Building, University of Barcelona
20/10/16-26/10/16

Balaguer, D.; Figueras, F.

Organizers

*An introduction to Bayesian Statistics through
Astronomical Applications*

Physics Building, University of Barcelona

24/10/16–27/10/16

Tolós, L.; Magas, V.; Parreño, A.; Ramos, A.

Organizing committee

Escuela de Física Hadrónica

Physics Building, University of Barcelona

21/11/16–25/11/16

Balaguer, D.; Jordi, C.

Organizers

Gaia CU5 Plenary Meeting

Physics Building, University of Barcelona

12/12/16–14/12/16

AT OTHER INSTITUTIONS**Soto, J.**

Participation in scientific/organizer committee

*International Workshop on Heavy Quarkonium
(QWG2016)*

Pacific Northwest National Laboratory

06/06/16–10/06/16

Verdaguer-Oms, E.

Secretary of scientific/organizer committee

*Peyresq Physics-21 International Workshop: ‘Micro and
Macro Structure of Spacetime’*

Peyresq, Alpes de Haute-Provence

11/06/16–17/06/16

Jordi, C.

Participation in scientific/organizer committee

*On the Threshold of 1st Gaia Data – the Gaia Research
for European Astronomy Training (GREAT) Network
Science Symposium, EWASS 2016*

Eugenides Foundation and the Metropolitan hotel

04/07/16–08/07/16

Verde, L.

Scientific Organizing Committee

*XXVII International Conference on Neutrino Physics and
Astrophysics (Neutrino 2016)*Ondaatje Theatre located in the Royal Geographical
Society

04/07/16–09/07/16

Emparan, R.

Member of the Scientific Organizing Committee

*GR21: 21st International Conference on General
Relativity and Gravitation*

Columbia University

10/07/16–15/07/16

Paredes, J.M.

Participation in scientific/organizer committee

*6th International Symposium on High-Energy Gamma-
Ray Astronomy*

Kongresshaus Stadthalle Heidelberg

11/07/16–15/07/16

Soto, J.

International Advisory Committee

*XIIIth Quark Confinement and the Hadron Spectrum
Makedonia Palace conference centre*

28/08/16–04/09/16

Paredes, J.M.

Participation in scientific/organizer committee

The Lake Baikal Three Messenger Conference

Center of Listvyanka on Lake Baikal

29/08/16–03–09/16

Parreño, A.

Participation in scientific/organizer committee

2nd Hadron Spanish Network Days

Universidad Complutense de Madrid

08/09/16–09/09/16

PUBLIC OUTREACH

Courses and Workshops

Masterclass on Particle Physics 2015

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 presentation about the courses offered at the Faculty of Physics.

In 2016 two sessions were held on the 26th of February and the 11th of March at the Faculty of Physics. 154 students from 140 high schools all around Catalonia attended.

<http://www.lhc.cat/taller.php>

Exhibitions

The ICCUB owns six travelling exhibitions. These exhibitions have different printed versions in the Institute that are exposed annually in different external centers, like high schools, libraries or community centers. Three of these exhibitions have been entirely produced by the ICCUB. One of the exhibitions has been added this year and the rest of them have been checked and repaired.

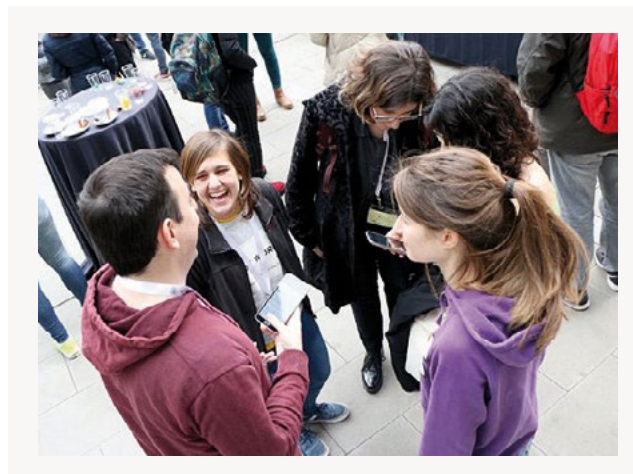
A thousand million eyes for a thousand million stars

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. Three new posters have been made on the occasion of First Gaia Data Release (Gaia-DR1) in Catalan, Spanish and English. The German version has been made in Heidelberg. The Catalan version has been printed and the others are digitally available on ServiAstro.

<http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/ExpoGaia>

Itinerary 2016 of the Catalan version:

- Claver Raimat School, Lleida
From 8th January to 8th February
- INS Ramon Berenguer, Amposta
From 15th February to 11th March



MASTERCLAS ON PARTICLE PHYSICS 2016

Attendees talk to each other and ICCUB members during the coffee break.

- INS Mercè Rodoreda, Hospitalet de Llobregat
From 29th February to 31 March
- IPSI School, Barcelona
From 31st March to 29th April
- Tabor School, Santa Perpètua de la Mogoda,
From 5th May to 2nd June
- Viladecans Library, Viladecans
From 3rd October to 2nd December
- Physics Faculty, Barcelona
From 14th to 26th December

Amb A d'Astrònoma

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

<http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/AmbA>

Itinerary 2016:

- Biology Faculty of UB, Barcelona
From 18th January to 18th February
- INS Castellbisbal, Castellbisbal
From 20th February to 20th March
- Salesians de Sarrià, Barcelona
From 10th November to 22th December

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.

Nowadays, the ICCUB is responsible for the informative plaques and manages the itinerary of the exhibition.

<http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/DistanciesCosmiques>

Itinerary 2016:

- Escola Baloo, Barcelona
From 15th January to 25th February
- Escola IPSI, Barcelona
From 1st to 31st March
- INS La Ferreria, Montcada i Reixac
From 22nd April to 20th May
- Library of Viladecans, Viladecans

From 3rd October to 2nd December

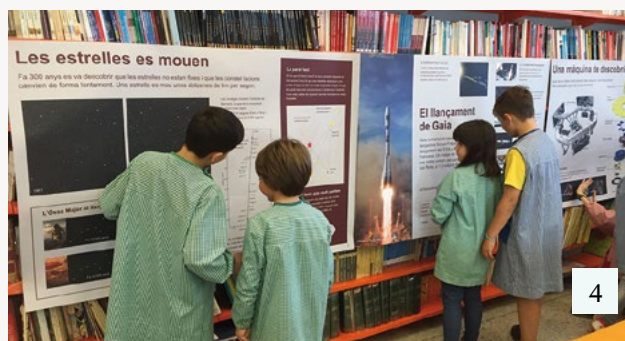
- Montagut School, Vilafranca del Penedès
From 5th to 22nd December

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.

<http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/DistanciesCosmiques>

- Baloo School, Barcelona
From 15th January to 11th March
- Montagut School, Vilafranca del Penedès
From 31st October to 2nd December



EXHIBITIONS

- 1 "Amb A d'AstrònomA" at INS Castellbisbal 2: "De la Terra a l'Univers" at Baloo School
3: "Les distàncies còsmiques", at INS La Ferreria 4: "Mil milions d'ulls per a mil milions d'estrelles" at Tabor School

Telescopi Assumpció Català

This new exhibition has been fully created by ICCUB members who belonged to the ancient 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 shows 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.

<http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/TelescopCatala>

Itinerary 2016:

- Centre d'Observació de l'Univers. Parc Astronòmic Montsec, Àger
From 4th March to 9th October
- Faculty of Physics, University of Barcelona
From 17th October to 4th November

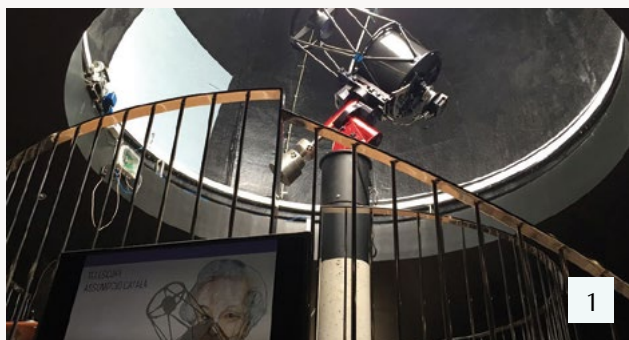
Investigadores en Física nuclear

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

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 Institute of Cosmos Sciences (ICCUB).

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

In November 2016 this exhibition has been adapted to a travelling format and a website was developed for the exhibition.



EXHIBITIONS

1,3: "Telescopi Assumpció Català"

2,4: "Investigadores en Física Nuclear"

Web Sites

ServiAstro

ServiAstro is the website for public outreach on astronomy of the Institut of Cosmos Sciences (ICCUB) and the Quantum Physics and Astrophysics Department (FQA) of the University of Barcelona.

ServiAstro offers all kind of outreach material, as well as information about past and future astronomical events which are visible from Catalonia. Furthermore, on ServiAstro visitors will find a compilation of astronomical ephemerides, tools for astronomical calculations, news, answers to frequently asked questions and links to lots of other websites about astronomy.

<http://serviastro.am.ub.edu/>

In 2016 it has been under development and content maintenance, and specifically has been added a page dedicated to the activities made by ICCUB members.

Descobrint la Física de Partícules amb l'LHCb

This a web site maintained by the Experimental Particle Physics Group at the ICCUB. It contains didactic material produced by the group and information about their outreach activities, such has the *Masterclass on Particle Physics*.

In 2016 it has been under development and content maintenance, specifically the pages dedicated to the Masterclass on Particle Physics.

<http://www.lhc.cat/>

The ICCUB in the social networks

Institutional Channels

| YOUTUBE ICCUB |
|------------------------|
| SUBSCRIBERS: 30 |
| VIDEOS: 33 |
| VIEWS: 2.174 |
| WATCH TIME: 12.162 min |

| TWITTER - @ ICC-UB |
|--------------------|
| FOLLOWERS: 101 |
| TWITTS: 182 |

The ICCUB maintains a Youtube channel since 2015.

<https://www.youtube.com/channel/UC8HJ3IYkytEHoAOAF9gYYww>

This channel contains three reproduction lists:

- ICCUB Colloquia
- Descobrint la Física de Partícules amb l'LHC (Catalan, Spanish)
- ICCUB participation in Gaia

In 2016 the list of the ICCUB Colloquia videos has been added.

The ICCUB Twitter channel was created in 2015, as a part of the web project. Interesting ICCUB activities and news are automatically published on Twitter using web information.

Apart from the automatic tweets, a manual maintenance has been made in order to increase the visibility of the ICCUB in 2016.

https://twitter.com/ICC_UB



THE ICCUB ON THE INTERNET

1. ServiAstro front webpage. 2. lhc.cat webpage about the Masterclass on Particle Physics. 3. ICCUB Youtube channel

Serviastro Twitter (@ServiAstro) and facebook , (ServiAstro) channels were created in 2015. The ICCUB astronomy and cosmology outreach news activities are announced on these accounts.

- <https://twitter.com/ServiAstro>
- <https://www.facebook.com/>

Group channels:

Gaia Group: channels devoted to the outreach of the Gaia Mission, particularly those activities in which ICCUB members participate.

- <https://www.facebook.com/gaiaub>
- <https://twitter.com/GaiaUB>
- <https://www.youtube.com/channel/UCAdmF8h-oCilZZjMFxWpM5A>

Cataquark: piulades de recerca i divulgació: Twitter account managed by ICCUB researcher J. Guasch which offers interesting outreach news about particle physics.

- <https://twitter.com/cataquark>

Thermalization: Twitter account managed by ICCUB researcher M. Attems about Theoretical particle Physics.

- <https://twitter.com/thermalization>

Publicity and Corporate Image

The following presentation elements have been designed:

- ICCUB information leaflet
- Roll-up institutional
- Roll-up ICCUB Colloquia

The ICCUB logotype has been adapted in order to increase its visibility and to meet the requirements of the UB Marketing Department.



Some publicity material produced at ICCUB in 2016

- 1: Rollup ICCUB 2: Rollup ICCUB Colloquia 3: Leaflet ICCUB
4: Official Logotype 5: O.L. to be used beside UB oficial logotype 6: O.L. to be used when the space left is small

Publications

Gaia, *ESA publishes the most precise map of Milky Way. REA contributes with the GENIUS project*, 06/10/2016
http://ec.europa.eu/geninfo/query/index.do?QueryText=ESA+publishes+the+most+precise+map+of+Milky+Way.+REA+contributes+with+the+GENIUS+project&op=Search&swlang=en&form_build_id=form-ecTTwu3nGPaoFRxMFHC8CPEjW2iDIrfKc1xvv5LQ6Xo&form_id=nexteuropa_europa_sear

Gaia, *El mapa de la Via Làctia, Gaia first data release*, Newspaper *El Periódico* 15/09/2016
<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, *El mapa de la Via Làctia, Gaia first data release*, Newspaper *El Periódico de Aragón* 15/09/2016
<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, *El mapa de la Via Làctia, Gaia first data release*, Newspaper *El Periódico de Extremadura* 15/09/2016
<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, *E1 millor mapa de la Via Làctia revela 400 milions d'estrelles desconegudes*, Newspaper *La Vanguardia* 15/09/2016
<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, *El mapa més colossal*, Newspaper *El Punt AVUI* 15/09/2016
<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, *El primer mapa de la Via Làctia identifica mil milions d'estrelles*, Newspaper *ARA* 15/09/2016 <http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, *El mapa de la Via Làctia*, Newspaper *Córdoba* 15/09/2016
<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Torra, J., *El semàfor* Newspaper *La Vanguardia* 15/09/2016
<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Jordi, C., *Interview*, Newspaper *La Vanguardia*, 23/10/2016
http://serviastro.am.ub.edu/twiki/pub/ServiAstro/WebPremsa/CarmeJordi_LaVanguardia10_16.jpg

Carrasco, J.M., *Interview "Caràcter Ciutadà"*, 31/11/2016
http://serviastro.am.ub.edu/twiki/pub/ServiAstro/WebPremsa/Carrasco_Caracter_text.pdf

Sanahuja, B. *Esperant la gran tempesta solar*, Newspaper *ARA*, 10/12/2016
http://www.ara.cat/societat/Esperant-gran-tempesta-solar_0_1703229766.html "Recull de premsa de la UB sobre l'eclipsi"

Publications Online

Figueras, F., *Francesca Figueras, presidenta electa de la SEA: "España está descuidando a los profesionales de la astronomía"*, Digital Blog @Mujeres Con Ciencia, 03/08/2016
<https://mujeresconciencia.com/2016/08/03/francesca-figueras-presidenta-electa-la-sea-espana-esta-descuidando-los-profesionales-la-astronomia/>

Gaia, *El telescopi Gaia elabora un mapa de més de mil milions d'estrelles de la Via Làctia*, Digital Newspaper @Vilaweb, 14/09/2016
<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, *El primer mapa de l'Univers recull dades de més de mil milions d'estrelles*, Digital Newspaper @ARA.cat, 14/09/2016
<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, *El mapa més colossal*, Digital Newspaper @El Punt, 14/09/2016
<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, *Gaia, el buque insignia de la astronomía espacial europea*, Digital Newspaper @Globoedia, 14/09/2016
<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/Gaia/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, *El mapa de la Via Làctia*, Digital Newspaper @El

diario de Córdoba, 14/09/2016

<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/GaIa/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, Un instrumento de precisión, Digital Newspaper @ *El diario de Córdoba, 14/09/2016*

<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/GaIa/GAIA-press-clipping-UniBarcelona.pdf>

Gaia, La misión europea 'Gaia' obtiene la imagen más precisa de la Vía Láctea, Newspaper @ *El periódico de Catalunya, 14/09/2016*

<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/GaIa/GAIA-press-clipping-UniBarcelona.pdf>

Press releases

Detecten radiació per sobre del teraelectró-volt al púlsar del Cranc

18/01/2016

http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/12/027.html?

Are Earth-like planets our best bet for finding extra-terrestrial life?

04/01/2016

http://www.ub.edu/web/ub/ca/menu_eines/noticies/2016/03/007.html#?

L'ICCUB organitza un acte per seguir en directe els primers resultats sobre la detecció d'ones gravitatòries

010/02/2016

http://www.ub.edu/web/ub/ca/menu_eines/noticies/2016/02/026.html#?

Telescopi 'Assumpció Català': el primer amb nom de dona

04/03/2016

http://www.ub.edu/web/ub/ca/menu_eines/noticies/2016/03/007.html#?

Un estudi determina que el cel nocturn de Barcelona pot ser fins a sis vegades més brillant quan hi ha núvols

31/03/2016

http://www.ub.edu/web/ub/ca/menu_eines/noticies/2016/03/056.html#?

ERC advanced grant awarded to Roberto Emparan's project on gravity and black holes

05/04/2016

http://www.ub.edu/web/ub/en/menu_eines/noticies/2016/04/008.html?

New initiation in the high energy telescope network, CTA

19/04/2016

http://www.ub.edu/web/ub/en/menu_eines/noticies/2016/04/042.html?

Live monitoring of Mercury's transit by the Institute of Cosmos Sciences

06/05/2016

http://www.ub.edu/web/ub/en/menu_eines/noticies/2016/05/001.html?

Roberto Emparan: "Black holes are physics at its limits"

08/06/2016

http://www.ub.edu/web/ub/en/menu_eines/noticies/2016/entrevistes/roberto_emparan.html?

Ciència, emoció i descobertes a la Festa de la Ciència, amb propostes de la Universitat de Barcelona

16/06/2016

http://www.ub.edu/web/ub/ca/menu_eines/noticies/2016/06/044.html#?

The most precise 3D map of galaxies supports the standard cosmological model

14/07/2016

http://www.ub.edu/web/ub/en/menu_eines/noticies/2016/07/002.html?

The Science Communicators Meeting agrees that the University has to continue working on dissemination

20/07/2016

http://www.ub.edu/web/ub/en/menu_eines/noticies/2016/07/044.html?

Professor Francesca Figueras, first President of the Spanish Astronomical Society

28/07/2016

http://www.ub.edu/web/ub/en/menu_eines/noticies/2016/07/064.html?

The first map of the universe of Gaia mission is published

09/09/2016

http://www.ub.edu/web/ub/en/menu_eines/noticies/2016/09/019.html?

Presentation of Gaia mission first data

14/09/2016

<http://serviastro.am.ub.edu/twiki/pub/ServiAstro/GaIa/GAIA-press-clipping-UniBarcelona.pdf>

Som recerca?: hope, creativity and commitment of the University of Barcelona towards society

03/10/2016

http://www.ub.edu/web/ub/en/menu_eines/noticies/2016/09/072.html?

Public Talks

Emparan, R., *Gravitational waves. Have they been found?*, Facultat de Física, 11/02/2016

Miralda, J., *La primera observació directa d'ones gravitatòries i forats negres*, Sala Pi i Sunyer (Institut d'Estudis Catalans), 17/03/2016

Jordi, C., *El trànsit de Mercuri del 9 de maig i la relació amb la mesura de la rotació de la Terra*, Museu del Monestir de Sant Cugat, 14/04/2016

Masana, E.; Carrasco, J.M., *Descobrir l'univers*, Fundació Miró, 30/05/2016

Portell, J., *Del concepte a la realitat: 16 anys de Gaia al CESA/CSUC*, Jornada Catalana de Supercomputació, 26/05/2016

Romero, M., *Missió Gaia: La Via Làctea a fons*, Festa de la Ciència, 18/06/2016

Miralda, J., *La detecció d'ones gravitatòries*, Festa de la Ciència, 18/06/2016

Miralda, J., *La primera observació directa d'ones gravitatòries i forats negres*, Jornada de Recerca INTE (UPC), 15/07/2015

Carrasco, J.M.; Figueras, E.; Portell, J.; Romero, M., *Acte de presentació de les primeres dades de Gaia*, Aula Magna "Enric Casassas", 14/09/2016

Mather, J.C., *The History of the Universe from the beginning to the end: where did we come from, where can we go?*, La Pedrera, 27/09/2016

Mather, J.C., *From the Big Bang to the end of the universe, and how we'll learn more with the James Webb Space Telescope*, Aula Magna Facultat de Física, 28/09/2016

Emparan, R., *Forats negres i ones gravitacionals*, Institut d'Estudis Ilerdencs, 04/10/2016

Carrasco, J.M., *Les primeres dades de la missió Gaia*, Agrupació Astronòmica de Sabadell, 05/10/2016

Salvador, E., *Lisa Randall conversa amb Eduard Salvador*, Cicle de conferències. "Converses a La Pedrera". Auditori de La Pedrera, 17/10/2016

Jordi, C., *"La conquesta de l'espai*, Casa Orlandai, 19/10/2016

Carrasco, J.M., *Les primeres dades de la missió Gaia*, Residència d'investigadors del CSIC, 24/10/2016

Figueras, E., *Dones i Astronomia*, Agrupació Astronòmica de Sabadell, 02/11/2016

Soria, S., *Gaia i l'Univers invisible*, Biblioteca Mercè Rodoreda de Sant Joan d'Espí, 17/11/2016

Jordi, C., *Els primers resultats de la missió Gaia*, Agrupació Astronòmica de Sant Cugat- Vallldoreix, 17/11/2016

Miralda, J., *L'obra de Ramon Llull: una perspectiva des de la ciència moderna*, sala d'actes Gregori Maians del MuVIM. Quevedo, 10. València., 17/11/2016

Figueras, E., *La Galaxia en un petabyte. La missió Gaia de la ESA.*, CosmoCaixa, 20/11/2016

Talks in educational centres

Masana, E.; Pérez-Ràfols, I., *Distàncies Còsmiques*, Escola Baloo, Barcelona, 26/01/2016

Romero, M., *Descobrint la nostra Galàxia amb Gaia*, Institut Joan Oró, Lleida, 05/02/2016

Jordi, C., *El satèl·lit Rosetta i què hem après dels cometes*, Aules de la Gent Gran de la Universitat de Barcelona, 01/03/2016

Jordi, C., *La lluna mentidera*, Aules de la Gent Gran del Poble Nou, 27/01/2016

Jordi, C., *El satèl·lit Rosetta i la seva odissea seguint el cometa 67P. Les darreres novetats*, Aules de la Gent Gran de Sabadell, 11,17/01/2016

Jordi, C., *La lluna mentidera*, Aules de la Gent Gran de

Santa Coloma de Gramanet, 02/03/2016

Miralda, J., *L'astrofísica i cosmologia actuals, una professió de futur.*, INS Galileo Galilei, 26/04/2016

Solanes, J. M., *Cosmologia 101: un univers en continu creixement*, Physis 2016, 15/06/2016

Emparan, R., *Ones gravitatòries*, Physis 2016, 17/06/2016

Fabrics, C., *Gaia*, ICCUB, 16/09/2016

Fabrics, C., *Gaia*, ICCUB, 11/10/2016

Masana, E., *A quina distància són els estels?*, Escola Ntra. Sra. (Poble Nou, Barcelona), 07/11/2016

Verde, L., *Comprender el Universo*, INS Frederic Mompou. Sant Vicenç dels Horts. CRP del Baix Llobregat VI., 16/11/2016

Emparan, R., *Hasta el infinito, y*, Teatre Els Costals de Castellbisbal. Servei Educatiu Vallès Occidental III. Centre de Recursos Pedagògics VOCIII. , 16/11/2016

Emparan, R., *Atrapa la física*, CEIP Collserola, 16/11/2016

Pérez-Ràfols, I., *Preguntes sobre l'Univers*, Escola Fort Pienc, 24/11/2016

Ribó, M., *La Lluna*, Escola de la Concepció, Barcelona, 25/11/2016

Ribó, M., *Coets i astronautes*, Escola de la Concepció, Barcelona, 21/12/2016

Participation in Workshops and Schools

Solanes, J.M. (coord) Bernal, J. L. ; Jordana, N; Torres, N; Miret, N.; Martí, G.; Massana, P.; Pacheco, D.; Pérez-Ràfols, I. (Instr.), *Astronomy workshop: 'Observant el Sol i la seva influència en el clima'*, Experiments de Física 2016, 01/03/2016

Casamiquela; L. , Olarte, S.; Pérez-Rafols, I.; Torres, N.;, *Mesura de distàncies còsmiques*, Saló de l'ensenyament, 10-11/03/2016



1



2



3



4

TALKS AND WORKSHOPS

1: E. Masana at Baloo School 2: J. Portell in the Ceremony Gaia DR1, 3: M. Romero in the Barcelona Science Festival; 4: L. Casamiquela in the Saló de l'ensenyament

Balaguer, L.; Olarte, S., *Solar Observation*, UB Science Festival 2016, 29/04/2016

Varis, *Taller de Física de Partícules*, Festa de la Ciència de la UB 2016, 29/05/2016

Varis, *Un dron engabiat*, UB Science Festival 2016, 29/05/2016

Masana, E.; Miralda, J.; Romero, M., Science Festival, Microtalk. Festa de la Ciència. Ajuntament de Barcelona, 18/06/2016

Eduard Masana, *Taller Aladin Lite*, Science Festival. Ajuntament de Barcelona, 18/06/2016

Solanes, J.M (coord.); Bernal, J.L.; Moreno de la Cita, V; Pérez-Ràfols, I; Torres, N (Instr.), *Astronomia: explorant l'univers*, Physis 2016, 13-17/06/2016

Solanes, J.M. "Cosmologia 101: un univers en continu creixement", Physis 2016, 15/06/2016

Emparan, R. "Ones gravitatòries", Physis 2016, 17/06/2016

Portell, J., *Explora el firmament. "La missió espacial Gaia: Dos anys de processament diari de dades"*, Explora la Natura: Universitat Catalana d'Estiu de la Natura, 13-14/07/2016

Casamiquela, L.; Moreno de la Cita, V; Pérez-Ràfols, I., Roca-Fàbrega, S., *Finestres al Cel*, Programa joves i ciència. Fundació Catalunya-La Pedrera, 27/06/2016-02/07/2016

Moreno de la Cita, V., Pérez-Ràfols, I., *Anàlisi d'observacions astronòmiques a l'Observatori Astronòmic de MónNatura Pirineus (Planes de Son)*, Bojos per la Física, 22-23/10/2016

Participation in Courses

Jordi, C.; Luri, X.; Manrique, A.; Salvador, E.; Sanahuja, B.; Solanes, J.M.; Ribó, M., *Astronomia: els secrets de l'Univers*, Course Gaudir UB, 04/2016-06/2016

JCarrasco, J.M.; Casamiquela, L.; Jordi, C.; Masana, E.; Mor, R.; Moreno de la Cita, V.; Paredes, X.; Pérez Ràfols, I.; Romero, M.;Torra, J. *Estrelles, Galàxies i Cosmologia (Astronomia i Meteorologia)*, Course Universitat de l'experiència, 02/2016-05/2016

Carrasco, J.M.; Casamiquela, L.; Jordi, C.; Masana, E.; Pérez Ràfols, I.; Moreno de la Cita, V.; Torres, N., *Astronomia Observacional (Astronomia i Meteorologia)*, Course Universitat de l'experiència, 09/2016-12/2016

Jordi, C.; Espriu, D.; Manrique, A.; Miralda, J.; Ribó, M.; Solanes, J.M., *Ampliació astronomia i meteorologia*, Course Universitat de l'experiència, 09/2016-12/2016

Broadcast of Astronomical Events

Mercury Transit (09/05/2016)

On the occasion of the Transit of Mercury across de Sun some activities were organised but due to the bad weather they had to be cancelled in the last minut. The transit was announced and some material edited.

<http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/TransitMercuri090516>

<http://icc.ub.edu/activity/720>

Informative page in the website ServiAstro: <http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/TransitMercuri090516>

- Online broadcast of the event: cancelled
- Public observation from Diagonal Av., Barcelona: cancelled
- An article: http://serviastro.am.ub.edu/twiki/pub/ServiAstro/TransiTs/The_story_of_Mercury_Catalan_Version.pdf

The transit in the press: http://www.ub.edu/web/ub/en/menu_eines/noticies/2016/05/001.html?

The transit on the radio:

<https://soundcloud.com/miralcel/el-transit-de-mercuri>

Astronomy Sessions

Balaguer, L.; Olarte, S., *Solar observation*, UB Science Festival, 29/04/16

Masana, E.; Pérez-Ràfols, I.; Roca, S., *Public star observation*, Castellterçol. 09/09/16

Participation in TV and radio shows

Carrasco, J.M., *Per a què serveix l'astronomia?*, La república santboiana, secció de ciència, Radio Sant Boi, 20/01/2016

Portell, J., *Hi ha vida intel·ligent fora del nostre planeta*, La vida, Catalunya Radio, 02/02/2016

Carrasco, J.M., *L'origen de la Lluna*, 3 de febrer de 2016, La república santboiana, secció de ciència, Radio Sant Boi, 03/02/2016

Miralda, J., *"Hi ha vida extraterrestre?"*, Vespre a la 2, RTVE 2, 11/02/2016

Carrasco, J.M., *Les ones gravitacionals*, 17 de febrer, La república santboiana, secció de ciència, Radio Sant Boi, 17/02/2016

Emparan, R., *L'univers ens parla; ara podem començar a escoltar què ens diu*, Notícies 3/24, TV3- canal3/24, 11/02/2016

Carrasco, J.M.; La república santboiana, La radio amb crispetes, Radio Sant Boi,

Portell, J., *La fàbrica de la ciència*, Radio Gavà, 25/02/2016

Escola Baloo, *Els nens i nenes de l'escola Baloo de Barcelona presenten al programa Catakrac! de BTV l'exposició "De la Terra a l'Univers"*, Catacrack, BTV, 06/03/2016

Carrasco, J.M., *L'estació espacial internacional*, 9 de març 2016, La república santboiana, secció de ciència, Radio Sant Boi, 09/03/2016

Carrasco, J.M., *Els calendaris*, 23 de març 2016, La república santboiana, secció de ciència, Radio Sant Boi, 23/03/2016

Carrasco, J.M., *La Relativitat d'Einstein*, 13 d'abril 2016, La república santboiana, secció de ciència, Radio Sant Boi, 13/04/2016

Paredes, J.M., *Entrevista amb J.M. Paredes telenotícies migdia TV3*, Telenotícies migdia, TV3, 13/04/2016

Carrasco, J.M., *El trànsit de Mercuri*, Pa ciència, la nostra, Radio Martorell, Sants3radio, 07/05/2016

Carrasco, J.M., *El trànsit de Mercuri*, La república santboiana, secció de ciència, Radio Sant Boi, 27/04/2016

Carrasco, J.M., *El solstici d'estiu i les estacions*, La república santboiana, secció de ciència, Radio Sant Boi, 15/06/2016

Jordi, C., *La missió Gaia*, La mecànica del caracol, Radio Euskadi, 21/07/2016



PARTICIPATION IN TV AND RADIO SHOWS

1: Carrasco, J.M., la República Santboiana (1/02/2016) 2: Miralda, J., Vespre a la 2 (11/02/2016)

Carrasco, J.M., *Pesèids 2016*, el matí de Ràdio 4, Ràdio 4, 11/08/2016

Carrasco, J.M., *Gaia ens dóna la posició de mil milions d'estrelles*, Informatius, Catalunya Ràdio, 14/09/2016

Luri, X., *“Les dades de la missió Gaia comencen a dibuixar el mapa de la galàxia”*, Telenotícies migdia, TV3, 14/09/2016

Luri, X., *Els valors de la investigació científica*, Temps de Reflexió' de Les 10 notícies, BTV, 09/10/2016

Jordi, C., *Primeros datos de Gaia*, La càpsula de la ciència, Activa tu Neurona radio, 06/10/2016

Carrasco, J.M., *Superluna*, BTV notícies vespre, BTV, 14/11/2016

Carrasco, J.M., *La influència de la Lluna*, Temps de Reflexió' de Les 10 notícies, BTV, 13/11/2016

Jordi, C., *El “Pou” descobreix el primer mapa en 3D de la Via Làctia*, El Pou, Cugat.cat, 16/11/2016

Jordi, C., *Històries de l'Univers*, DeuWatts, BTV, 06/12/2016

Carrasco, J. M., *L'horòscop*, La república santboiana, secció de ciència, Radio Sant Boi, 09/11/2016



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