

REPORT OF  
ACTIVITIES

2015



## FOREWORD

In 2015, the Institute of Cosmos Sciences was awarded the *Unidad de Excelencia Maria de Maeztu* distinction in the first call organized by the Ministry of Economy and Competitiveness (MINECO). This award represents not only an important recognition of the work done so far, but also a challenge for the future. In order to extract the maximum benefits of this award, the ICCUB underwent an internal reorganization intended to boost excellence and broaden our research, as recommended by our International Advisory Committee.

Currently, the additional financial support associated to the ICCUB has allowed us to reinforce some specific research groups, as well as to boost some parallel lines of research and technology, by allocating several postdoctoral researchers, PhD students, and technical personnel. Being a university institute, we lack permanent and direct support from our local or central government, and for this reason we need

the support of our university, which we hope is going to materialize soon in many ways, including new allocated spaces for the technological part of ICCUB.

With this award we plan to increase our scientific achievements during the next years. In particular, we plan to pay special attention to our technological aspects of research, not only along our usual lines of space missions, particle detectors, and astronomical instrumentation, but also by opening new lines related to transferring technology to industry. We also hope to boost our internalization by enlarging our collaborations with other groups and institutes worldwide.

**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 2015, the ICCUB was chosen as a María de Maeztu center 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 2015

### 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.



## 2015 - THE ICCUB IN FIGURES

### Staff

- 58 Permanent Staff
- 7 Ramon y Cajal Members
- 4 Juan de la Cierva Members
- 25 Postdoc Fellows
- 10 Visiting Scholars
- 45 PhD Students
- 19 Engineers and Technicians
- 6 Services and Administration Personnel

### Projects and Funds

- 2 ERC Grants
- 14 European Projects
- 3 International projects
- 35 National Plan & Consolider Projects
- 8 Consolidated Groups
- 9 Contracts with the industry

### Publications

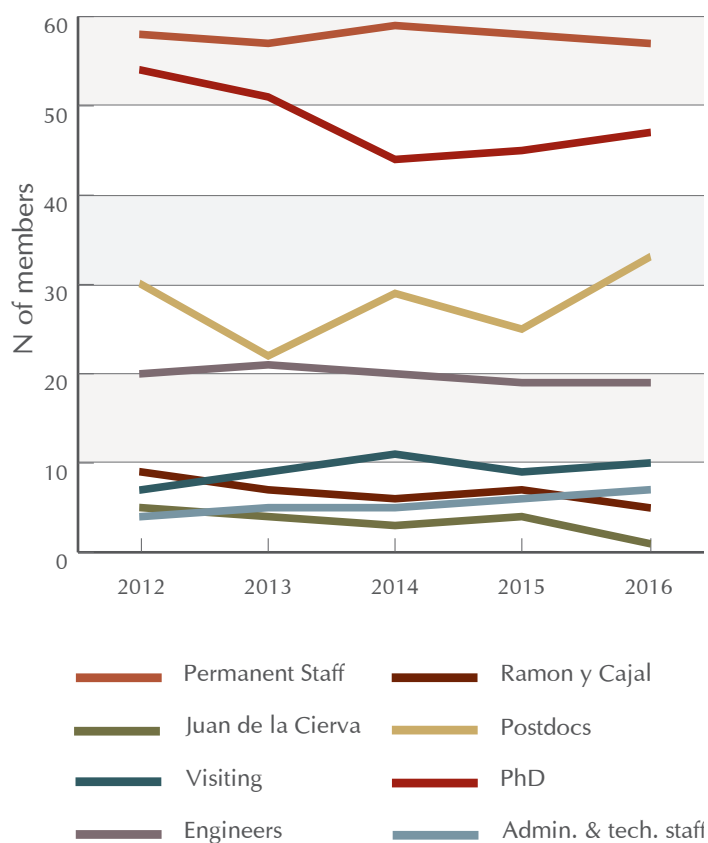
- 284 SCI Publications
- 86 Non SCI-Publications
- 83 Technical Reports

### Theses

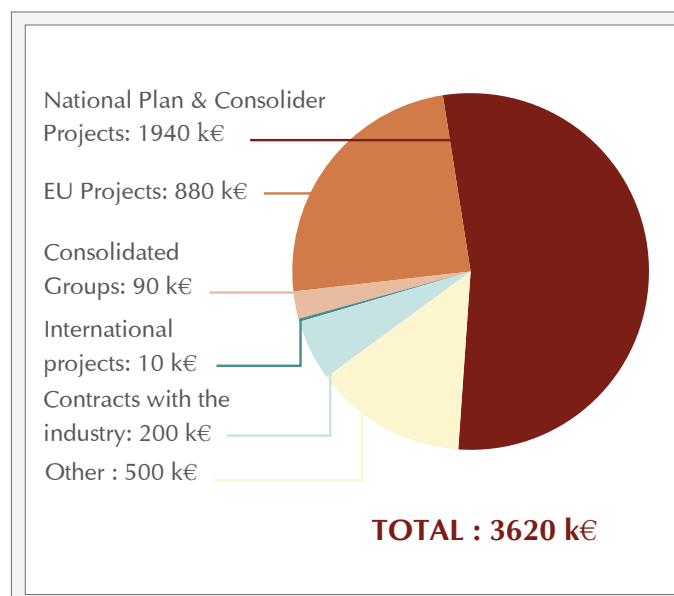
- 12 Finished PhD Theses
- 35 Ongoing PhD Theses
- 20 Finished Master Theses

### Activities

- 7 ICCUB Colloquia
- 108 Group Seminars
- 26 Event Organization
- 24 Public Talks
- 11 Showings of itinerant exhibitions



ICCUB'S STAFF EVOLUTION



PROJECTS AND FUNDS: 2015 BUDGET

For projects with an execution period longer than one year, only the proportional amount has been considered

## RESEARCHERS

### Permanent Staff

Canal, Ramon (UB)  
Centelles, Mario (UB)  
Crusats, Joaquim (UB)  
D'Enterría, David (ICREA, leave of absence)  
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  
Iblisdir, Sofyan  
Julià, Bruno  
Migliari, Simone  
Notari, Alessio

### Juan de la Cierva Members

García, Miguel  
Tarrío, Luis Javier  
Tywoniuk, Konrad  
Zanin, Roberta

### Postdoc Fellows

Àgueda Costafreda, Neus  
Aliu Ester  
Aran, Àngels  
Attems, Maximilian  
Balaguer, Dolores  
Bellini, Emilio  
Bergström, Johannes  
Carrasco, José M.  
Cuesta, Antonio José  
Fernández-Faedo, Antón  
Gracia, Gonzalo  
Haibo, Qiu  
Hofer, Lars  
Hu, Bin  
Izumi, Keisuke  
Masana, Eduard  
Pantelidou Christiana  
Portell, Jordi  
Roca, Santi  
Rocha, Jorge  
Romero, Mercè  
Simpson, Fergus Rae Goalen  
Voss, Holger  
Weiler, Michael  
Zilhao MigueL

### Visiting Scholars

Andrianov, Alexander  
Casademunt, Jaume  
Jorba, Àngel  
Lizzi, Fedele  
Ribó, Josep Maria  
Ruiz-Lapiente, M. Pilar  
Ruiz, Josep Xavier  
Talavera, Pere  
Torrelles, Txema  
Yun, Joao Lin

**PhD Students**

Abedi, Hoda  
 Alsina, Daniel  
 Ariño Prats, Andreu  
 Bernal, José Luís  
 Casamiquela, Laia  
 Cervera, Alba  
 Cheng, Yu  
 Dector, Aldo  
 Del Ser, Daniel  
 Di Dato, Adriana  
 Farràs, Martí  
 Feijoo, Albert  
 Fernández, Isabel  
 Gabbanelli, Luciano  
 Galindo, Daniel  
 García, Carles

Garolera, Blai  
 Gómez, Adrià  
 Gontcho A Gontcho, Satya  
 Juan, Enric  
 Juárez, Carmen  
 Karimkhani, Elahe  
 Maneu, Jordi  
 Marcote, Benito  
 Marín, Carla  
 Mariño, Mauricio  
 Martínez, Marina  
 Merino, M. Teresa  
 Mor, Roger  
 Moreno, Víctor  
 Olikara, Zubin Philip  
 Oriol, Pablo  
 Pablos, Daniel  
 Pacheco, Daniel

Paita, Fabrizio  
 Palmer, Max  
 Paredes, Xavier  
 Pérez, Daniel  
 Pérez, Ignasi  
 Pravos, David  
 Renau, Albert  
 Rives, Vicente  
 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  
 Roma, David  
 Sabater, Josep  
 Sanuy, Andreu

**SERVICES AND ADMINISTRATION PERSONNEL****ICCUB Secretariat**

Frutos, Ariadna  
 Moreno, Ana Belén

**Group Support**

Bascon, Susana  
 Macduff, Kayla  
 Olarte, Surinye

**Collaborating Students**

Ortiz, Elisenda

## 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- $\alpha$  emission from galaxies at high redshifts
- Reionization of the intergalactic medium

### ICCUB MEMBERS

Ariño, A. • Bellini, E. • Bernal, J.L. • Canal, R. • Cuesta, A.J. • Gontcho A Gontcho, S. • Guzmán, R. • Hu, B. • Jimenez, R. • Juan, E. • Manrique, A. • Miralda-Escudé, J. • Pérez-Ràfols, I. • Porqueres, N. • Sala, F. • Salvador, E. • Simpson, F. • Verde, L.

### VISITING SCHOLARS

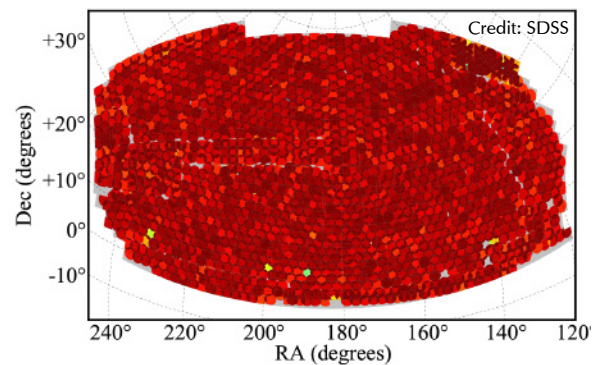
Ruiz-Lapuente, P.

Research in Cosmology and Large Scale Structure 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 2015

ICCUB researchers continued their work on the metal line properties of Damped Lyman Alpha systems (DLAs) and the large-scale bias factors of MgII systems, quasars and DLAs. The cross-correlation of quasars with Lyman- $\alpha$  emission was also investigated. Lyman- $\alpha$  emission is a potential new tracer of star formation, and a first tentative detection at very low surface brightness levels has been made possible by using the BOSS fiber spectra that were designed to target low-redshift galaxies but which may contain Lyman- $\alpha$  light at higher redshift as well. The detection may indicate a very high escape fraction of Lyman- $\alpha$  photons from star-forming galaxies, or else a special Lyman- $\alpha$  emission process near quasars arising from the ionizing radiation or quasar jets. Furthermore, new results on the Lyman- $\alpha$  forest non-linear power spectrum from hydrodynamic simulations were presented, with a new practical formula for fitting observational results from BOSS and future surveys.

Apart from this, the implications of the latest cosmological observations for neutrino properties were elucidated, producing stringent and robust constraints on its mass scale



BOSS SKY COVERAGE (NORTH GALACTIC CAP)

In 2015 the SDSS3 final data release 12 was made public along with the cosmological interpretation and latest BAO (baryon acoustic oscillations) and redshift-space distortions measurements. The figure shows the observations made by the BOSS project.

and developing the methodology to further strengthen the indirect detection of the cosmic neutrino background.

ICCUB members also presented a new way to analyze cosmic shear surveys and a new way to analyze cosmological survey data, which yield insights on the nature of dark energy.

Finally, the first lower limit on possible values of the cosmological constant was reported. The observed value of the cosmological constant is a great puzzle. Upper limits on this value are known: a value too high would not enable gravity to create enough galaxies, stars and planets to support life. But following this argument any infinitely small (or even negative) value would be acceptable. Why then is the observed value small yet non zero and positive? It was shown that a too low value is also bad because of the effect of cosmic explosions on the survival of complex life on Earth-like planets.

## 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 Geiger mode avalanche photodiodes for tracking detectors of future accelerators
- Development of time of flight readout electronics for photo-sensors

### ICCUB MEMBERS

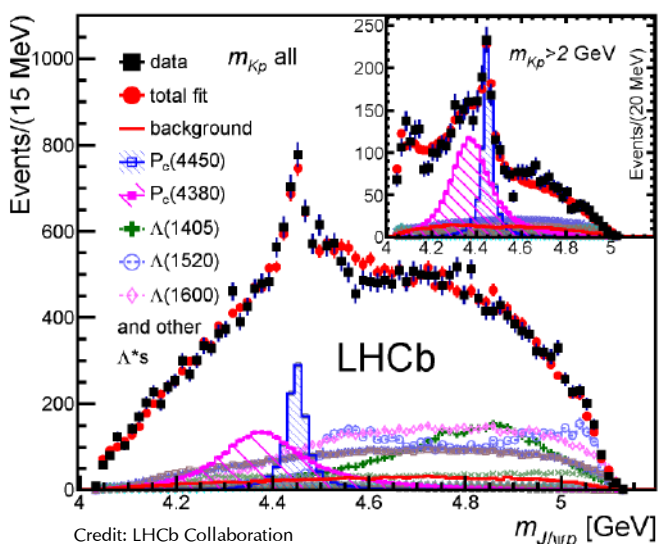
Casajús, A. • Ciaglia, D. • Garrido, L. • Gascón, D. • Gómez, S. • Graciani, R. • Graugés, E. • Marín, C. • Mauricio, J. • Picatoste, E. • Rives, V. • Ruiz, H. • Sanuy, A.

ICCUB's experimental particle physicists are specialized in the study of flavor physics. Specifically, in measuring charge-parity 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 for mid 2018 to start operation. 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 was consolidated in 2015, with partnership from industry, where applications to medical imaging and time of flight measurements of photo-sensor electronics are exploited.

### Activity 2015

In 2015 the research focused on the study of the radiative B meson decays. This kind of decays offer a unique opportunity to look for new physics beyond the Standard Model by precisely measuring the photon polarization of such decays, analyzing either the B meson decay time or the angular distribution of its decay products.



### 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  $J/\psi p$  invariant mass spectrum for the  $\Lambda_b^0 \rightarrow J/\psi p K$  decay, with each fit component shown individually. The contribution of the pentaquarks is shown by hatched histograms.

Apart from this, the ICCUB has contributed to the design and development of the readout electronics for the calorimeter and the Scintillating Fiber Tracking of the LHCb experiment upgrade. The cross-application of the LHCb-generated knowledge in photo-sensor readout electronics has generated several service contracts with semiconductor companies and several medical applications (PET devices).

## 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

### ICCUB MEMBERS

Abedi, H. • 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. • Mor, R. • Palmer, M. • Reina, M. • Roca, S. • Romero, M. • Solanes, J.M. • Torra, J. • Voss, H. • Weiler, M.

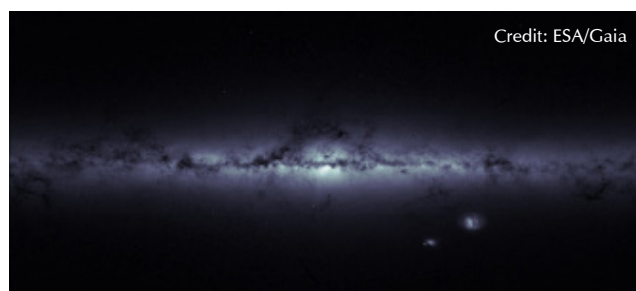
At present, the research in Galactic Astronomy at the ICCUB is highly influenced by the preparation of the scientific exploitation of the ESA's Gaia mission, in which ICCUB researchers are deeply involved (see *Very Large Data Processing and Analysis*). Beyond this, research is also being carried out in the modeling of galaxies and their aggregations, the study of stellar constituents and the calibration of stellar luminosity. Some members are also devoting their efforts to investigating the very complex process of galaxy formation and to explore the physical mechanisms driving their evolution. ICCUB members coordinate the Red Española de Explotación Científica de Gaia and are active members of the international networks created for the scientific exploitation of Gaia.

### Activity 2015

In 2015 new tools were explored for the scientific exploitation of Gaia —innovative and far from traditional. ICCUB members took part of the Gaia-ESO survey, the Open Clusters OCCASO survey and the WEAVE@WHT consortium to complement Gaia data with high resolution spectroscopy from ground. They also worked in the definition of synergies with large present and future surveys.

The work developed in galaxy modeling included the characterization of the central bar, the development of novel methods to unveil the nature of the spiral structure and the update of the kinematic model to describe different morphologies of the galactic warp, such as lopsidedness. High-resolution cosmological N-body with hydrodynamics simulations for Milky Way-like galaxies allowed new insights in the disk large scale structures and baryonic content to be provided.

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



GAIA STELLAR DENSITY MAP

The outline of our Galaxy, the Milky Way, and of its neighbouring Magellanic Clouds, in an image based on housekeeping data from ESAs Gaia satellite, indicating the total number of stars detected every second in each of the satellite's fields of view.

photometric analysis of open clusters and they determined their radial velocities. The availability of the Gaia Object Generator (GOG) was used in this occasion for scientific analysis and work is in progress to improve the Besançon-Barcelona Population Synthesis Galaxy Model. The Besançon Galaxy Model was used as a background to evaluate the Gaia capabilities to detect ultra-faint dwarf galaxies. Besides, by means of controlled collisionless simulations of the previrialization stage of galaxy groups, it was possible to demonstrate that the fraction of the merger time in which strong dual AGN activity can be detected is independent of the orbital configuration and typical of the order of a few percent.

Apart from this, controlled simulations of forming galaxy groups were used to demonstrate that the multiple mergers that take place during the hierarchical build-up of these systems are able to create fully realistic first-ranked galaxies without the additional consideration of a dissipative component, thus making a strong case for considering hierarchical dissipationless merging a viable route for the formation of the largest galaxies of the universe.

## 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

### ICCUB MEMBERS

Di Dato, A. • Emparan, R.A. • Fernández, A. • Fernández, I. • Fiol, B. • Garolera, B. • Garriga, J. • Germani, C. • Guasch, J. • Izumi, K. • Karimkhani, E. • Llosa, J. • Martínez, M. • Molina, A. • Mateos, D. • Notari, A. • Pantelidou, C. • Pravos, D. • Rocha, J. • Solà, J. • Tarrio, L.J. • Torrents, G. • Triana, M. • Verdaguer, E. • Zilhao, M.

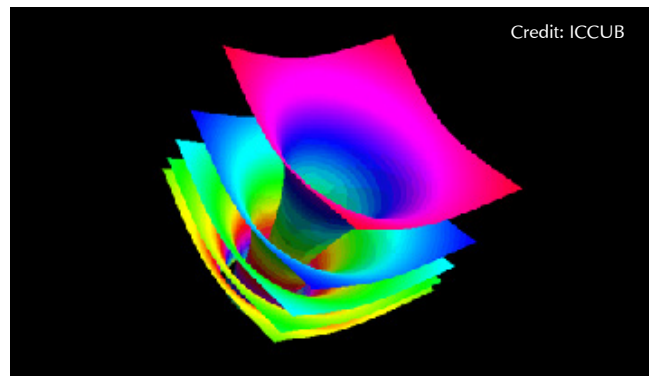
Research made by this ICCUB group focuses on cosmology, gravity and holography. Its members also collaborate with researchers in the Theoretical Physics group to make incursions into particle physics and the gauge/gravity correspondence.

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 2015

Concerning cosmology, in 2015 ICCUB researchers of this group extended their research about anomalies in the Cosmic Microwave Background. Furthermore, they considered possible observational imprints of black holes and topological defects in multiverse scenarios, and they discussed a mechanism to stabilize the electroweak vacuum via non-minimal couplings to gravity. 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 and they applied it to study several of their



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.

properties. Additionally, they studied the breakdown of the semi-classical description of black holes.

Lastly, concerning holography ICCUB researchers analytically constructed gravity solutions dual to three-dimensional gauge theories with flavor, both with zero and non-zero quark density. These solutions display quasi-conformal dynamics (walking) in a range of parameters. ICCUB researchers also proposed a new way to compute the 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. • Feijoo, A. • Fernández, J.M. • Haibo, Q. • Julià, B. • Magas, V. • Maneu, J. • Parreño, A. • Polls, A. • Ramos, A. • Salvat, F. • Viñas, X.

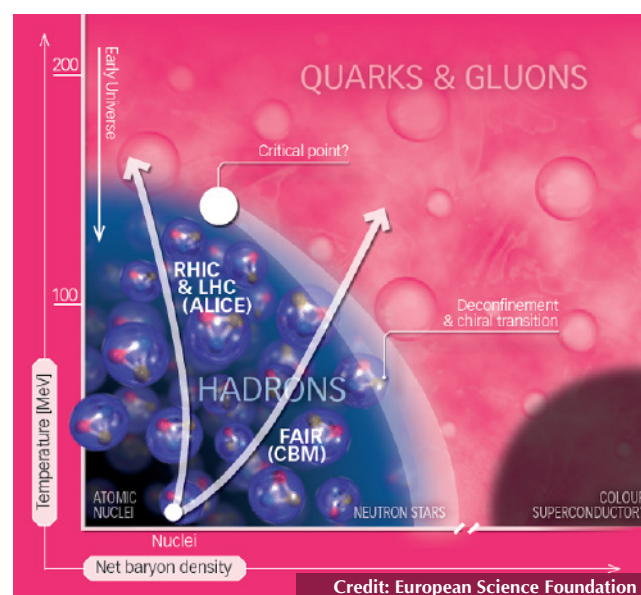
The group has conducted research on the theoretical description of hadron systems with strangeness and/or charm in the vacuum, in nuclear matter, and in the hot medium generated in relativistic heavy ion collisions. In the atomic sector, models for the numerical study of the interaction of electrons, photons and ions with matter have been improved, while many efforts have also been devoted to the study of ultra-cold atomic gases in various geometrical configurations. These multidisciplinary activities have a direct connection with experiments at world leading physics laboratories, as BNL, CERN, ELSA-Bonn, Fz-Jülich, GSI, GANIL, JLAB, JPARC, MAMI-Mainz, RIA or RIKEN.

### Activity 2015

A unified equation of state for neutron stars has been obtained from the outer crust to the core of the star based on modern microscopic calculations. In addition, new constraints on the neutron skin thickness of nuclei and the nuclear symmetry energy have been derived from the recent experimental determination of the electric dipole polarizability in  $^{68}\text{Ni}$ ,  $^{120}\text{Sn}$ , and  $^{208}\text{Pb}$ .

Using Lattice QCD calculations, the magnetic moments and magnetic polarizabilities of nuclear systems with  $A \leq 4$  have been determined, along with the cross section for the radiative capture process  $np \rightarrow d\gamma$  from extrapolations to physical quark masses.

In the exotic sector, a coupled channel chiral model up to next-to-leading of the  $\bar{K}N$  interaction has been developed and applied to give predictions for the  $\Lambda b \rightarrow J/\Psi K \Xi$  and  $\Lambda b \rightarrow J/\Psi \eta \Lambda$  processes, the latter permitting to analyze the possible existence of a  $S=-1$  partner of the LHCb pentaquark.



### THE PHASE DIAGRAM OF NUCLEAR MATTER

The phases of nuclear matter over different values of temperatures and pressure (taken from the NuPECC Long Range Plan 2010 Booklet "Nuclear physics: science and applications").

Research performed in atomic physics included a theoretical description of the quantum synchronization between coupled ultracold atomic gases, the mesoscopic superpositions of Tonks-Girardeau states and the Bose-Fermi mapping in one-dimensional systems. Simultaneously, code development and applications

## 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

Aliu, E. • Bosch-Ramon, V. • Galindo, D. • Iwasawa, K. • Marcote, B. • Migliari, S. • Moreno, V. • Paredes, X. • Paredes, J.M. • Ribó, M. • Torres, N. • Zanin, R.

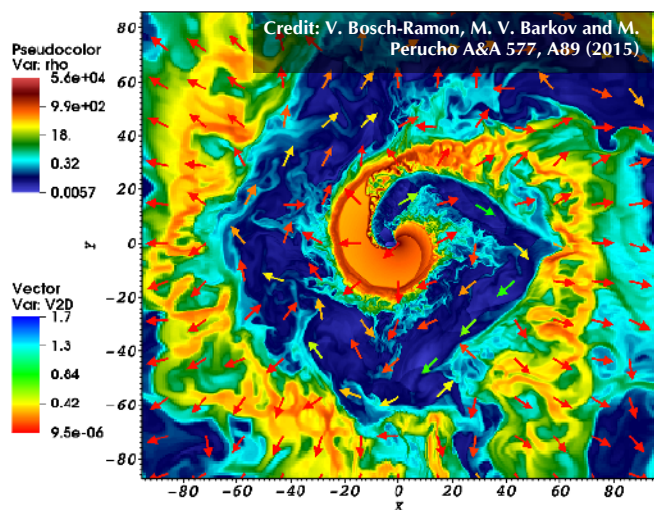
A general aim of ICCUB researchers working on this field is to achieve a better understanding of the high energy galactic and extragalactic sources, gathering data over a large wavelength range (from radio to TeV energies) as well as modeling emission processes in different scenarios (pulsar winds, jets,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

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, as 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, an initiative to build the next generation of ground-based gamma-ray instrument (see *Electronic and Instrumentation Development*).

### Activity 2015

In 2015 research in High Energy Astrophysics was focused on observations, theoretical modeling and numerical simulations to understand the physics of relativistic astrophysical outflows. Semi-analytical and numerical calculations of the hydrodynamics and the radiation processes taking place in high energy sources were developed in order to enable predictions of observable features in the different scenarios under investigation (small and large scales, galactic and extragalactic sources of outflows), which can be tested observationally.



THE ORBITAL EVOLUTION OF COLLIDING STAR AND PULSAR WINDS

A relativistic and a non-relativistic wind interact in a high-mass binary hosting a non-accreting pulsar. The orbital motion induces non-ballistic unstable structures that are potential sites of high-energy radiation, in one of the most powerful gamma-ray emitting sources in the Galaxy.

On the observational side, ICCUB researchers conducted simultaneous Chandra/VLA observations of MWC 656, the first Be/black hole system, which revealed an extremely quiescent state. They also detected the gamma-ray binary LSI+61303 at 150 MHz with both GMRT and LOFAR for the first time, and they studied its low-frequency variability. In addition, ICCUB members continued the monitoring of gamma-ray binaries with the TFRM and they started dedicated campaigns with the TJO. Finally, they conducted the first interferometric observations with VLTI to resolve the discs of Be stars in gamma-ray binaries.

## 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

Attems, M. • Bergström, J. • Casalderrey, J. • D'Enterria, D. • Espriu, D. • García-Echevarria, M. • Gómez, A. • González, M.C. • Guasch, J. • Hofer, L. • Latorre, J.I. • Mescia, F. • Pablos, D. • Renau, A. • Solà, J. • Soto, J. • Taron, J.M. • Tywoniuk, K.

### VISITING SCHOLARS

Andrianov, A.

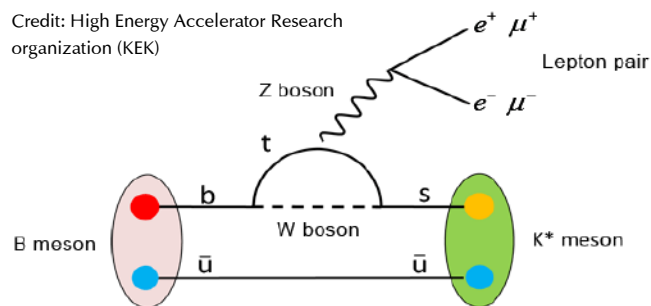
The phenomenological aspects of Particle Physics are central to ICCUB research, covering many aspects of the areas reported in the hep-ph, hep-th and hep-lat archives. The composition of the group reveals this variety of interests, extending to many of the forefront areas of research in Particle Physics.

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 2015

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

In the area of b-physics, ICCUB researchers continued studying possible new observables that might reveal the presence of new physics, and participated actively in the European Twisted Mass lattice Collaboration (ETMC).



### 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, particularly in the domain of hard probes and the study of properties of QCD under extreme conditions, 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.

Finally, very relevant contributions were made in the field of neutrino physics, mostly in the form of global fits to the data. Axion physics and other dark matter candidates as well as dark energy also merited attention from ICCUB members of this group, who worked in collaboration with other groups at ICCUB.

## 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

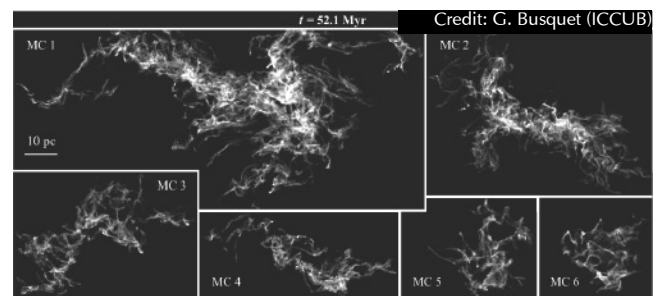
Torrelles, J.M. • Yun, J.

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. Observations and simulations are compared through the generation of synthetic observations of the simulations.

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 2015

The observational study of fragmentation in high-mass star-forming regions continued with high angular resolution observations of the 1.3 mm continuum emission carried out with the Submillimeter Array (SMA) toward two hubs, G14.2-hub-N and G14.2-hub-S, in the Infrared Dark Cloud G14.225-0.506 together with observations of the dust emission at 870 and 350  $\mu\text{m}$  obtained with APEX and the CSO single-dish telescopes. The density structure of the two hubs was studied by means of a simultaneous



### 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.

fit of the radial intensity profile at 870 and 350  $\mu\text{m}$  and the spectral energy distribution. ICCUB researchers also studied the interplay between magnetic field, turbulence, gravity and UV radiation feedback.

The computational effort was focused on the study of supernova (SN) feedback in the star-forming gas. ICCUB researchers carried out the highest-resolution simulation to date of SN-driven turbulence, on a scale of 250pc, to study the origin and dynamics of molecular clouds (MCs). Thanks to the large dynamic range of the simulation, not only individual MCs and SN remnants were well resolved, but they also formed self-consistently as the result of larger-scale dynamics, with realistic initial and boundary conditions. The simulation provided a large sample of clouds and thus constrained also the probability distribution of cloud properties. It was found that clouds selected from the simulations (see figure above) have mass and size distributions, and velocity-size and mass-size relations consistent with the observations. Using tracer particles, ICCUB members also studied their evolution and found that they form and disperse in approximately four dynamical times. They concluded that SN-driven turbulence alone can explain the formation and dynamics of star-forming clouds.

## 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 too 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 2015

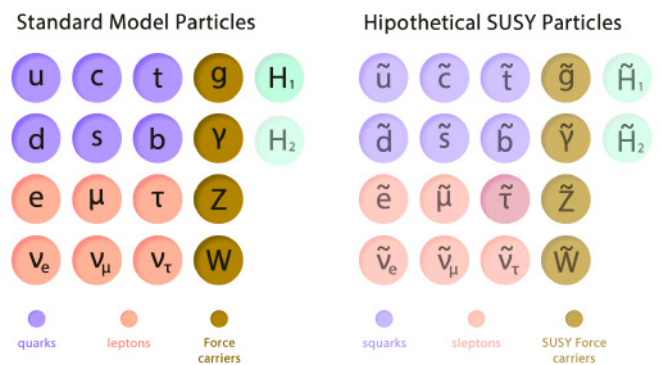
In 2015, a very active research line searched for exact results in nonabelian gauge theories. Using supersymmetric localization, matrix integrals and resurgence techniques, various aspects of supersymmetric gauge theories in three and four dimensions were studied, including quantum phase transitions and vacuum expectation values of Wilson operators. In addition, ICCUB researchers used the AdS/CFT duality to study various Yang-Mills theories at finite heavy-quark density and their renormalization group flows. Strongly coupled condensed matter systems

### ICCUB MEMBERS

Alsina, D. • Attems, M. • Casallerrey, J. • Cervera, A. • Dector, A. • Emparan, R.A. • Espriu, D. • Fernández-Faedo, A. • Fiol, B. • Gabbanelli, L. • Garolera, B. • Gomis, J. • Iblisdir, S. • Latorre, J.I. • Mariño, M. • Mateos, D. • Pablos, D. • Pantelidou, C. • Pons, J.M. • Rocha, J. • Russo, J.G. • Solà, J. • Tarrío, L.J. • Tywoniuk, K. • 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

and other theories involving large couplings (such as some extended EWSB sectors) were also investigated and ICCUB researchers plan to continue this investigation in the future. The group also worked in the more theoretical aspects of the holographic treatment to heavy ion collisions. Concerning quantum information theory, research focused on maximally entangled states, quantum simulations, quantum statistical systems and other related issues. Compression algorithms were also studied. Finally, there was also some activity in the areas of non-commutative geometry, emergent gravity and black hole physics.

## 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 2015

During 2015 ICCUB researchers worked on the computation of Lagrangian Coherent Structures for the determination of invariant manifolds and long-term stability regions in Celestial Mechanics and Astrodynamics.

Moreover, they finished their activities related to the end of life disposal of spacecraft at the libration point regions. They completed their studies on the LEO-GEO transfers visiting the libration point regions of the Sun-Earth system.

#### LINES OF RESEARCH

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

#### ICCUB MEMBERS

Cheng, Y. • Gómez, G. • Olikara, Z.P. • Paita, F. • Pérez, D.

#### VISITING SCHOLARS

Jorba, À.

Lastly, ICCUB researchers continued their research in spacecraft formation flight considering both the orbit control using Lorentz forces and attitude control by means of a behavioral approach.

### ASTRONOMICAL IMAGE PROCESSING AND HIGH ANGULAR RESOLUTION TECHNIQUES

The group on Image Processing 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. Particularly, 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.

#### LINES OF RESEARCH

- Image deconvolution by means of multiresolution analysis (wavelet and curvelet transform)
- Image fusion and super-resolution by means of multiresolution analysis (wavelet transforms)
- Application of Image deconvolution to Space Debris observation
- Observational techniques and software for space debris detection

#### ICCUB MEMBERS

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

## Activity 2015

During the year 2015 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 obtaining standalone software that could 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 and the comparison of classical, myopic and blind algorithms. Studies of image fusion and superresolution also continued.

## CHIRALITY AND PREBIOTIC CHEMISTRY

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 group also works in the definition of thermodynamic scenarios in applied chemistry in which such a transition to chirality is possible. The general objective of these works is to understand chiral polarizations in the spontaneous emergence of chirality during the chemical evolution.

## Activity 2015

In 2015, the effect of mechanical forces on racemic mixtures on chiral nanotubes/self-assembly of achiral amphiphilic porphyrins were studied. Additionally, new substituted amphiphilic porphyrins were synthesized in order to elucidate which were the structural patterns leading either to chiral or to achiral aggregates and, in the case of formation of racemic conglomerate mixtures, which were the effects and the experimental conditions

necessary to lead to a bias from the racemic composition. Finally, results will soon be published of research into the theoretical studies on how enantioselective autocatalysis couple to reactions implying the deletion of chiral substance leads to parity breaking.

### LINES OF RESEARCH

- Effect of mechanical forces (flows with gradient of shear rates) on the emergence of chirality in soft matter
- Mirror symmetry breaking in autocatalytic systems: Crystallizations and aggregations showing critical phenomena

### ICCUB MEMBERS

Crusats, J. • El-Hachemi, Z.

### VISITING SCHOLARS

Ribó, J.M.

## 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 2015

During 2015 ICCUB researchers worked in HESPERIA (High Energy Solar Particle Events foRecastIng and Ana-

lysis), 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.

The team also continued to study 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 worked in an ESA-sponsored project, SOL2UP, 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.

## MICROGRAVITY AND TWO-PHASE FLOWS

### LINES OF RESEARCH

- Dynamics of turbulent bubble flows
- Controlled boiling in microgravity.
- in microgravity.

### VISITING SCHOLARS

Casademunt, J. • Ruiz, J.X.

In recent years, ICCUB's visiting scholars have been consistently studying the formation and management of small bubbles under microgravity conditions, in particular in the context of turbulent flows, an area of fundamental interest in multiphase flows and with important applications in space technology, from life support systems to thermal control of space vehicles.

Experiments are conducted in the European Space Agency (ESA) Drop Tower facility at ZARM (Bremen, Germany). The use of the tower is supported by ESA and the research is financially supported by the US Air Force Office of Scientific Research (AFOSR) through the European Office of Aerospace Research and Development. The main objective is to elucidate physical mechanisms that control bubble formation, bubble-flow interactions, and heat exchange in the absence of gravity, in view of

improving current designs and searching for new strategies for efficient thermal control in microgravity environments.

### Activity 2015

In 2015 the group finished the optimization and characterization of an innovative design for capillary boiling through controlled localized nucleation. The prototype system was proven to work robustly and independently of the gravity environment. The different regimes of bubble formation were identified and quantitatively characterized. The device generates regular slug flows that can be used as input for heat-exchange or other devices. Some fundamental questions concerning scaling of nucleation were also raised and solved by means of a simplified simulation model. Possible extensions of this work are currently being explored.



## 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. • Garrido, L. • Gascón, D. • Gómez, J.M. • Graciani, R. • Graugés, E. • Mauricio, J. • Núñez, J.C. • Oriol, P. • Picatoste, E. • Ribó, M. • Roma, D. • Ruiz, H. • Sabater, J. • 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, which will serve as an open observatory to a wide astrophysics community and which will provide a deep insight into the non-thermal high-energy universe. In addition to physics case studies, the ICCUB is involved in the design and prototyping of the CTA telescope cameras. This involves designing ASICs for preamplification, signal processing and triggering.

**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:** The ICCUB is part of the MIRADAS project of the Gran Telescopio de Canarias (GTC). The basic MIRADAS concept is a near-infrared multi-object echelle spectrograph operating at spectral resolution  $R=20,000$  over the 1-2.5 $\mu\text{m}$  bandpass. MIRADAS selects targets using  $\sim 12$  deployable probe arms with pickoff mirror

optics, each feeding a 4.0x1.2-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 it.

**Solar Orbiter:** The ICCUB is part of the Polarimetric and Helioseismic Imager instrument for the Solar Orbiter mission (SO/ PHI). The ICCUB responsibility is the development and implementation of an Image Stabilization System (ISS) that 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 ISS has been optimized minimizing the power consumption while reaching the required performance.

**Telescope Fabra-ROA:** ICCUB researchers are working since more than ten years ago in 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 as 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 2015

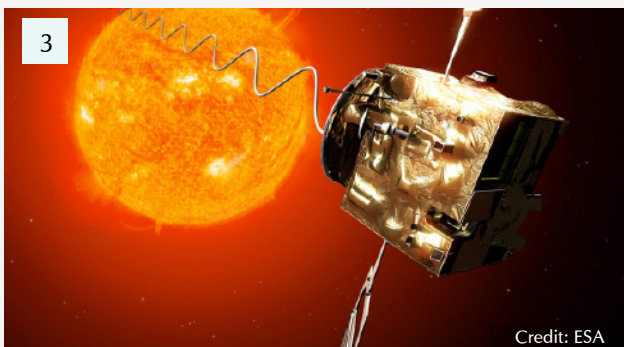
Concerning CTA, three ASICs developed and successfully tested in 2013 and 2014, were prepared for production: PACTAv1.4 (a wideband 16 bit dynamic range current mode PreAmplifier), ACTAf 2Ch F (a wideband pulse amplifier for NECTAr chip) and TL0R1 (a versatile ASIC for L0 triggering in Cherenkov Telescopes). PACTA and TL0R will presumably be used in the Large Size Telescopes (LST) and in the Middle Size Telescopes cameras of CTA, whereas ACTA was designed only to be used in MST. Also, another ASIC, the Multiple Use SiPM Integrated Circuit (MUSIC), was designed to alleviate SiPM limitations due to high capacitance. It is an 8 channel ASIC for SiPM anode readout based on a novel low input impedance current conveyor that can deal with sensors from different manufacturers, covering most of the available SiPM devices in the market. MUSIC offers three main features: (1) differential output of the sum of (selectable) individual input channels for 15 bit accuracy; (2) 8 individual single ended analog outputs and; (3) 8 individual binary outputs.

In regard to the upgrade of the LHCb calorimeter, the final chip (ICECALv3) of the analog signal processing channel was designed, produced, tested and validated for irradiated environment. Apart from this, a third proto-

type of the PACIFIC ASIC with the input stage and shaper was designed for SiPM readout in the new planned Scintillating Fiber Tracker.

With respect to PET, a multi-purpose 4-channel time to digital converter (TDC) was designed based on a patented resistive clock interpolation mesh circuit, a two-dimensional regular structure with outstanding performance in terms of power consumption, area and low process variability. New PET modules based on ICCUB and CIEMAT ASIC FlexToT were also developed for monolithic crystals.

Finally, in the context of space debris, the TFRM collaborated in the ISON network, and participated in the contract Test-Bed for the Remote Control of an Automated Follow-Up Telescope and in the Spanish Space Surveillance and Tracking (S3T) coordinated by the ESA. The total number of observations reported was 197731, corresponding to 29807 objects (tracks) with a mean of 263.8 objects per night. A mean of 24.6 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.



- 1 CTA prototype designs From Left: Three different SST, the MST and the LST-
2. Members of the LHCb collaboration posing in front of the detector.
3. Artist view of Solar Orbiter.
4. Telescope Fabra-ROA at Montec Astronomical Observatory.

## 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.

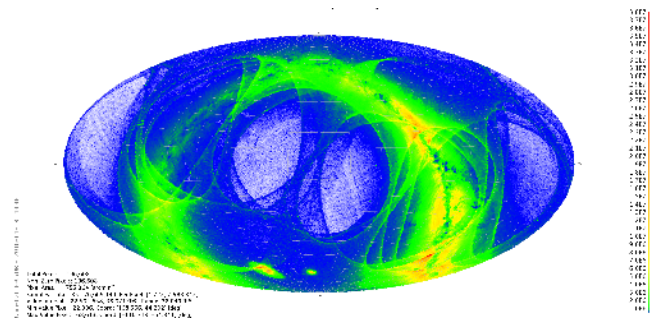
The ICCUB provides massive data processing algorithms and software which are essential for the success of large international projects. Expertise of ICCUB members is applicable to ground and space. The institute is currently participating in the following projects:

**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 2015

Concerning Gaia DPAC, during 2015 ICCUB members continued analyzing the data received from the satellite to precisely evaluate its performance. Instrumental and photometric models were improved. The daily data



DENSITY OF TRANSITS PROCESSED BY THE GAIA IDT SYSTEM IN EQUATORIAL COORDINATES

The data was taken during the first year and a half of nominal operations. The Galactic Plane can be seen, as well as the effect of the scanning law. More than 35 billion transits (over 350 billion images) have been processed. .

processing system (IDT), led by the ICCUB, reached a routine operation state. The first execution of the IDU Cross-Matching was done at BSC/MareNostrum, which determines the contents of the first Gaia Data Release envisaged for 2016. Large simulations have been generated to test systems such as data mining and archive, which are becoming ready for the first data release.

Concerning DIRAC, the Consortium developed new partnerships with the Institute of High Energy Physics, IHEP at Beijing, China, and the High Energy Accelerator Research Organization, KEK at Sukuba, Japan. The extension of the DIRAC user base beyond high energy physics consolidated thanks to the DIRAC4EGI instance operated in collaboration with CYFRONET at Krakow and the UAB. The ESFRI projects EISCAT-3D and ENVRI+ also started to use this DIRAC service as a possible baseline for the future distributed data processing environment. In regard to the updates of DIRAC ICCUB during 2015 a campaign started to raise private funds for the development of the new version in collaboration with a major ICT company.

## KNOWLEDGE TRANSFER AND INNOVATION

### SERVICES

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

### 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.

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. Also, one spin-off, DAPCOM, and one instrumental service, SiUB, have been created.

#### DAPCOM Data Services (ESA BIC Barcelona)

DAPCOM Data Services S.L. is a spin-off company participated by the University of Barcelona (UB) and the Technical University of Catalonia (UPC) which is specialized on 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 resources 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, by the one hand, provides a service on electronics and microelectronics instrumentation design, development and test to research groups of the UB

and other research institutions, and by the other hand, enhances the industry 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 2015

In 2014 DAPCOM became one of the first companies selected for the new ESA Business Incubation Centre (BIC) of Barcelona due to the potential of FAPEC for being transferred to terrestrial applications. The two-years incubation program at the UPC Campus of Castelldefels provides the necessary resources to boost the R&D activities, including the IEEC-DAPCOM PICFAPEC project (Parallel and Imaging Capabilities for FAPEC) which was concluded during 2015. As a result, the first public release (FAPEC Core 2015.0) was issued in September 2015, offering high-performance and reliable data compression for science data, images, spectral imaging, raw video or text data, either lossless or lossy, for space or ground systems.

Concerning SiUB, several ASIC designs were produced for the LHCb and CTA projects, using different technologies (IBM 130nm, TSMC 130nm and AMS 350nm SiGe BICMOS). The PACTA family of ASICs (wideband 16 bit dynamic range current mode preamplifiers) showed good characteristics for a variety of applications related to photomultiplier readout, which allowed using it in two other projects for ICFO and CNRS.

# PROJECTS AND FUNDS

# 4

## EUROPEAN PROJECTS AND FUNDS

### ERC Projects

#### *Cosmological physics with future large scale structure surveys (PHYSS.LSS)*

Reference: 240117 (FP7-IDEAS-ERC)

PI: Licia Verde

Agency: European Research Council (ERC)

Period: 01/11/2009 - 30/11/2015

#### *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

#### *Advanced European Infrastructures for Detectors at Accelerators (AIDA)*

Reference: 262025 (FP7-INFRASTRUCTURES)

PI: Laurent Serin (CERN) (ICCUB: Ángel Diéguez)

Agency: European Community (EC)

Period: 01/02/2011 - 31/01/2015

#### *European Particle physics Latin American NETWORK (EPLANET)*

Reference: PIRSES-GA-2009-246806 (FP7-PEOPLE)

PI: Luciano Maiani (Univ. degli Studi di Roma, "La Sapienza") (ICCUB: Domènec Espriu )

Agency: European Community (EC)

Period: 01/02/2011 - 2016

#### *Fast Thermalization of the Quark-Gluon Plasma (FastTh)*

Reference: 658574 (HORIZON 2020-PILLAR 1 -MSCA)

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

#### *Gaia Research for European Astronomy Training (GREAT)*

Reference: 08-RNP-118 (Research Networking Program)

PI: Nick Walton (ICCUB: Carme Jordi )

Agency: European Science Foundation (ESF)

Period: 18/02/2010 - 17/02/2015

#### *Gaia Research for European Astronomy Training (GREAT-ITN)*

Reference: PITN-GA-2010-264895 (FP7-PEOPLE)

PI: Nick Walton (ICCUB: Francesca Figueras )

Agency: European Community (EC)

Period: 01/03/2011 - 28/02/2015

#### *High Energy Solar Particle Events foRecastIng and Analysis (HESPERIA)*

Reference: 637324 (HORIZON 2020. PILLAR 2-LEIT-Space.)

PI: Olga Malandraki (National Observatory Athens) (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<sup>a</sup> Concepción González-García)

Agency: European Community (EC)

Period: 01/04/2012 - 31/03/2016

#### *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 (HORIZON 2020-PILLAR 1 -MSCA)  
 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 (FP7-PEOPLE)  
 PI: Josep M<sup>a</sup> Paredes, Valentí Bosch-Ramon  
 Agency: European Community (EC)  
 Period: 01/03/2013 - 28/02/2017

***The Astrodynamics Network (ASTRONET-II)***

Reference: PITN-GA-2011-289240 (FP7-PEOPLE (RTN))  
 PI: Gerard Gómez

Agency: European Community (EC)  
 Period: 01/01/2012 - 31/12/2015

***The String Theory Universe***

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

***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

**INTERNATIONAL PROJECTS*****Contract for the final design of the MIRADAS Instrument for the Gran Telescopio Canarias***

Reference: MIRADAS III  
 PI: Jordi Torra  
 Agency: University of Florida  
 Period: 01/01/2015 - 31/12/2015

***Injection of nucleate-boiling slug flows into a heat exchange chamber***

Reference: FA8655-12-1-2060  
 PI: Jaume Casademunt

Agency: Air Force Office of Scientific Research (USA)  
 Period: 20/03/2012 - 19/03/2015

***Preconditioning of the interplanetary medium as responsible for large intense SEP events: Radial and longitudinal effects***

Reference: NNX11AO83G  
 PI: David Lario (Johns Hopkins University/APL)  
 (ICCUB: Neus Àgueda )  
 Agency: NASA  
 Period: 01/08/2011 - 01/07/2015

**NATIONAL PLAN PROJECTS*****Contribución al desarrollo científico y tecnológico de la misión Gaia III***

Reference: ESP2013-48318-C2-1-R  
 PI: Jordi Torra  
 Agency: MINECO  
 Period: 01/01/2014 - 30/09/2015

***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 nuevos detectores y estudios de física para futuros colisionadores lineales***

Reference: FPA2013-48387-C6-4-P

PI: Ángel Diéguez

Agency: MINECO

Period: 01/01/2014 - 31/12/2015

***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 de la Violación de CP con el detector LHCb***

Reference: FPA2011-30163-C02-01

PI: Eugeni Graugés

Agency: MICINN

Period: 01/01/2012 - 31/12/2015

***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<sup>a</sup> Paredes

Agency: MINECO

Period: 01/01/2014 - 31/12/2016

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

Reference: ESP2013-47349-C6-3-R

PI: Josep M<sup>a</sup> Gómez-Cama

Agency: MINECO

Period: 01/01/2014 - 31/12/2015

***Física Hadrónica***

Reference: FIS2014-57026-REDT

PI: Assumpta Parreño

Agency: MINECO

Period: 01/12/2014 - 30/11/2016

***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

***Información Cuántica: entrelazamiento, frustración, gases fríos y orden topológico***

Reference: FIS2013-41757-P

PI: José Ignacio Latorre

Agency: MINECO

Period: 01/01/2014 - 31/12/2015

***Institut de Ciències del Cosmos (ICC)***

Reference: MDM-2014-0369

PI: Josep M. Paredes

Agency: MINECO

Period: 01/07/2015 - 30/06/2019

***Interstellar medium at high-angular resolution: preparing for the ALMA era***

Reference: AYA2011-30228-C03-03

PI: Robert Estalella

Agency: MICINN

Period: 01/01/2012 - 30/09/2015

***Las Componentes del Universo***

Reference: AYA2012-36353

PI: M. Pilar Ruiz Lapuente

Agency: MINECO

Period: 01/01/2013 - 31/12/2015

***Materia blanda forzada, activa y viva***

Reference: FIS2013-41144-P

PI: Jaume Casademunt

Agency: MINECO

Period: 01/01/2014 - 31/12/2016

***Métodos constructivos en sistemas dinámicos y aplicaciones***

Reference: MTM2012-32541

PI: Ángel Jorba

Agency: MINECO

Period: 01/01/2013 - 31/12/2015

***Modelado de la reionización del universo y de las galaxias que la causan***

Reference: AYA2012-39168-C03-02

PI: Eduard Salvador-Solé

Agency: MINECO

Period: 01/01/2013 - 31/12/2015

***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

***Participación española en el diseño y prototipado del Cherenkov Telescope Array: contribución del ICC-UB***

Reference: FPA2014-55819-C4-4-P

PI: Marc Ribó

Agency: MINECO

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

***Participación española en el diseño y prototipado del Cherenkov Telescope Array: perspectivas de física, prototipado de ASICs y explotación de DIRAC***

Reference: FPA2013-48381-C6-6-P

PI: Marc Ribó

Agency: MINECO

Period: 01/01/2014 - 31/12/2015

***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<sup>a</sup> Solanes

Agency: MINECO

Period: 01/01/2014 - 31/12/2016

***Sistemas de Fermi fuertemente correlacionados: átomos, núcleos y hadrones***

Reference: FIS2011-24154

PI: Xavier Viñas

Agency: MICINN

Period: 01/01/2012 - 31/12/2015

***Spanish Participation in the LHCb experiment at CERN: Physics exploitation and Upgrade***

Reference: FPA2013-48020-C3-3-P

PI: Ricardo Graciani Díaz

Agency: MINECO

Period: 01/01/2014 - 31/12/2015

***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 - 31/12/2016

***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 - 31/12/2016

***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 - 31/12/2016

***Teorías efectivas de las interacciones fuertes: aplicaciones a quarkonium pesado y a QCD bajo condiciones externas***

Reference: FPA2010-16963

PI: Joan Soto

Agency: MICINN

Period: 01/01/2011 - 30/06/2015



## CONSOLIDER INGENIO PROJECTS & CONSOLIDER NETWORKS

### *Canfranc Underground Physics*

Reference: CSD2008-00037

PI: M<sup>a</sup> Concepción González-García

Agency: MEC

Period: 15/12/2008 - 14/12/2015

### *Centro nacional de física de partículas, astropartículas y nuclear*

Reference: CSD2007-00042

PI: Antonio Pich, IFIC (ICCUB: Lluís Garrido)

Agency: MEC

Period: 01/10/2007 - 09/06/2015

### *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

## CONSOLIDATED GROUPS

### *Astronomia i Astrofísica*

Reference: 2014SGR86

PI: Josep M<sup>a</sup> Paredes

Agency: AGAUR

Period: 01/01/2014 - 31/12/2016

### *Física nuclear teòrica i de moltes partícules en interacció*

Reference: 2014SGR401

PI: Àngels Ramos

Agency: AGAUR

Period: 01/01/2014 - 31/12/2016

### *Gravitation, Strings, and Cosmology*

Reference: 2014SGR1474

PI: Jaume Garriga

Agency: AGAUR

Period: 01/01/2014 - 31/12/2016

### *Grup de Física experimental d'altres energies*

Reference: 2014SGR769

PI: Lluís Garrido

Agency: AGAUR

Period: 01/01/2014 - 31/12/2016

### *Grup de Física Teòrica d'Altes Energies (FISALTEN)*

Reference: 2014SGR104

PI: Jorge Russo

Agency: AGAUR

Period: 01/01/2014 - 31/12/2016

### *Grup de Sistemes Dinàmics*

Reference: 2014SGR1145

PI: Àngel Jorba

Agency: AGAUR

Period: 01/01/2014 - 31/12/2016

### *Grup d'informació i simulació quàntiques (UB)*

Reference: 2014SGR727

PI: José Ignacio Latorre

Agency: AGAUR

Period: 01/01/2014 - 31/12/2016

### *Physical Cosmology, PhysCos*

Reference: 2014SGR921

PI: Licia Verde

Agency: AGAUR

Period: 01/01/2014 - 31/12/2016

## CONTRACTS WITH THE INDUSTRY

### *Assessment on radiation detectors*

Reference: FBG 201502759

PI: Andreu Sanuy

Agency: Arktis Radiation Detectors Ltd

Period: 24/08/2015-31/12/2015

### *Assessorament en física de l'estat sòlid*

Reference: FBG 308561

PI: Francesc Salvat

Agency: Rovalma S.A

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

### *Assessorament i investigació aplicada en el camp de la física*

Reference: FBG 307886

PI: J. M. Fernández Varea

Agency: Fundació Bosch i Gimpera

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

### *Assessorament, transferència, col·laboració i investigació aplicada en el camp de la instrumentació electrònica avançada*

Reference: FBG 307594

PI: Ricardo Graciani Díaz

Agency: Fundació Bosch i Gimpera

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

### *Contract for intellectual services relative to Penelope course 2015*

Reference: FBG 308375

PI: Francesc Salvat

Agency: OECD. Organisation for Economic Co-operation and Development

Period: 29/06/2015 - 03/07/2015

### *Design and production of preamplifier for synchrotron facility*

Reference: FBG 201503042

PI: David Gascón

Agency: Scientifica Internacional, S.L

Period: 2015

### *Further development of the modification and/or customization of PENELOPE*

Reference: FBG 307269

PI: Francesc Salvat

Agency: Hamamatsu Photonics K.K.

Period: 01/04/2013 - 31/03/2015

### *Further development of the modification and/or customization of PENELOPE*

Reference: FBG 308407

PI: Francesc Salvat

Agency: Hamamatsu Photonics K.K.

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

### *Upgraded electronics for Hamamatsu detectors I II and III*

Reference: FBG 308324

PI: Ricardo Graciani Díaz

Agency: Hamamatsu Photonics France S.A.R.L.

Period: 03/05/2015 - 15/12/2015

## SCI PUBLICATIONS

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.; Ruiz, H.**)

*Differential branching fraction and angular analysis of  $A_b^0 \rightarrow \Lambda \mu^+ \mu^-$  decays.* Article.

Journal of High Energy Physics, Vol. 2015, Num. 115 (2015)

[10.1007/JHEP06\(2015\)115](https://doi.org/10.1007/JHEP06(2015)115)

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.; Ruiz, H.**)

*Determination of the quark coupling strength  $|V_{ub}|$  using baryonic decays.* Article.

Nature Physics, Vol. 11, Num. 9, p. 743 - 747 (2015)

[10.1038/nphys3415](https://doi.org/10.1038/nphys3415)

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.; Ruiz, H.**)

*Measurement of the time-dependent CP asymmetries in  $B_s^0 \rightarrow J/\psi K_s^0$ .* Article.

Journal of High Energy Physics, Vol. 2015, Num. 131 (2015)

[10.1007/JHEP06\(2015\)131](https://doi.org/10.1007/JHEP06(2015)131)

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.; Ruiz, H.**)

*Observation of the  $B_s^0 \rightarrow \eta' \eta'$  Decay.* Article.

Physical Review Letters, Vol. 115, Num. 51801 (2015)

[10.1103/PhysRevLett.115.051801](https://doi.org/10.1103/PhysRevLett.115.051801)

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

*First observation and amplitude analysis of the  $B^- \rightarrow$*

*$D^+ K^- \pi^-$  decay.* Article.

Physical Review D, Vol. 91, Num. 92002 (2015)

[10.1103/PhysRevD.91.092002](https://doi.org/10.1103/PhysRevD.91.092002)

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

*Measurement of the forward Z boson production cross-section in pp collisions at  $\sqrt{s} = 7$  TeV.* Article.

Journal of High Energy Physics, Vol. 2015, Num. 39 (2015)

[10.1007/JHEP08\(2015\)039](https://doi.org/10.1007/JHEP08(2015)039)

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

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GAIA-C5-PR-IOA-FVL-138 (sep-15)
- van Leeuwen, F.; Brown, A.; Bunclark, P.; Cacciari, C.; De Angeli, F.; Evans, D.W.; Hambly, N.; Hodgkin, S.; **Jordi, C.**; Pancino, E.; Richards, P.J. *CU5 internal report 2015.08*  
GAIA-C5-PR-IOA-FVL-138 (oct-15)
- van Leeuwen, F.; Brown, A.; Bunclark, P.; Cacciari, C.; De Angeli, F.; Evans, D.W.; Hambly, N.; Hodgkin, S.; **Jordi, C.**; Pancino, E.; Richards, P.J. *CU5 internal report 2015.09*  
GAIA-C5-PR-IOA-FVL-138 (nov-15)
- van Leeuwen, F.; Brown, A.; Bunclark, P.; Cacciari, C.; De Angeli, F.; Evans, D.W.; Hambly, N.; Hodgkin, S.; **Jordi, C.**; Pancino, E.; Richards, P.J. *CU5 internal report 2015.10*  
GAIA-C5-PR-IOA-FVL-138 (dec-15)
- van Leeuwen, F.; Busso, G.; Cacciari, C.; Cowell, S.; De Angeli, F.; Evans, D. W.; Fyfe, D.; Harrison, D. L.; Hodgkin, S.; **Jordi, C.**; Pancino, E.; Richards, P. J.; Riello M. *CU5 Internal Report 2015.01*  
GAIA-C5-PR-IOA-FVL-137 (feb-15)
- van Leeuwen, F.; Busso, G.; Cacciari, C.; Cowell, S.; De Angeli, F.; Evans, D. W.; Fyfe, D.; Harrison, D. L.; Hodgkin, S.; **Jordi, C.**; Pancino, E.; Richards, P. J.; Riello M. *CU5 Internal Report 2015.02*  
GAIA-C5-PR-IOA-FVL-138 (mar-15)
- van Leeuwen, M., Utrilla, E., **Farras Casas, M.**, et al. *Instructions for the preparation of documentation for GDR1*  
GAIA-C9-TN-IOA-MVL-002 (dec-15)
- Voss, H.** *Saturation fraction for gated observation after decontamination step 5 and refocus of FoV 1.*  
GAIA-CH-TN-UB-HV-028 (jan-15)

## PHD THESES

**Finished Theses*****AdS/CFT Correspondence and Superconductivity:  
Various Approaches and Magnetic Phenomena***

Author: Aldo Dector  
Director/s: Jorge Russo  
Date: 28/10/2015

***Astrostatistics for Luminosity Calibration in the Gaia Era***

Author: Max Palmer  
Director/s: Xavier Luri, Frédéric Arenou (Observatoire de Paris)  
Date: 13/01/2015

***Correspondences in higher-dimensional gravity***

Author: Adriana Di Dato  
Director/s: Roberto Emparan  
Date: 12/11/2015

***COTS Analog Prototype for LHCb's Calorimeter Upgrade***

Author: Carlos Abellán  
Director/s: David Gascón, Atilà Herms  
Date: 30/01/2015

***Dynamical transport mechanisms in celestial mechanics and astrodynamics problems***

Author: Daniel Pérez  
Director/s: Gerard Gómez, Josep Masdemont  
Date: 30/11/2015

***High performance computing of massive Astrometry and Photometry data from Gaia***

Author: Javier Castañeda  
Director/s: Claus Fabricius, Jordi Torra  
Date: 15/12/2015

***Monitor and control strategies to reduce the impact of process variations in digital circuits***

Author: Joan Mauricio Ferré  
Director/s: Francesc Moll (UPC)  
Date: 14/12/2015

***Non-thermal emission from high-energy binaries through interferometric radio observations***

Author: Benito Marcote  
Director/s: Marc Ribó, Josep M<sup>a</sup> Paredes  
Date: 27/10/2015

***On the characterisation of the galactic warp in the Gaia era***

Author: Hoda Abedi  
Director/s: Francesca Figueras, Luís Alberto Aguilar (UNAM, Méjico)  
Date: 27/02/2015

***Physics of the Intergalactic Medium: a Study of the Power Spectrum of the Lyman Alpha Forest and the Metal Content of Damped Lyman Alpha Systems***

Author: Andreu Ariño  
Director/s: Jordi Miralda Escudé  
Date: 03/02/2015

***Probing Gauge Theories: Exact Results and Holographic Computations***

Author: Blai Garolera  
Director/s: Bartomeu Fiol  
Date: 27/02/2015

***Some theoretical and experimental aspects of axion physics***

Author: Albert Renau  
Director/s: Federico Mescia, Domènec Espriu  
Date: 11/11/2015

**Ongoing PhD theses*****Agujeros negros y modelos de gravitación emergente***

Author: Luciano Gabbanelli  
Director/s: Domènec Espriu  
Tentative Date: March 2019

***Anàlisi i modelització de l'entorn de radiació de partícules solars energètiques a l'heliòsfera interior com a preparació per Solar Orbiter***

Author: Daniel Pacheco Mateo

Director/s: Àngels Aran, Neus Àgueda  
Tentative Date: 2018

***Analysis of Periodic and Quasi-Periodic Orbits in Three Body Problems and Applications***

Author: Yu Cheng  
Director/s: JianPing Yuan, Gerard Gómez Muntané  
Tentative Date: December 2017

***Analytic Derivation of Non-Linear Dark Matter Clustering from the Filtering of the Primordial Density Field***

Author: Enric Juan Rovira  
Director/s: Eduard Salvador Solé  
Tentative Date: February 2016

***Caracterització de la contaminació lumínica en zones protegides i urbanes***

Author: Salvador Ribas Rubio  
Director/s: Jordi Torra  
Tentative Date: January 2016

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

Author: David Roma Dollase  
Director/s: J. Maria Gómez Cama, M. Hernandez-Pajares (UPC)  
Tentative Date: January 2017

***Coupling fluid-dynamics and non-thermal processes to study sources of high energy emission***

Author: Víctor Moreno de la Cita  
Director/s: Valentí Bosch-Ramon  
Tentative Date: October 2016

***Disseny d'algoritmes de control per posicionadors multiobjectes per instrumentació de telescopis terrestres***

Author: Pablo Oriol Bitaubé  
Director/s: J. Maria Gómez Cama, J.Torra

***Electronics control and signal processing for the LHCb fast calorimeter detectors***

Author: Eduardo Picatoste  
Director/s: David Gascón, Atilà Herms  
Tentative Date: December 2016

***Estudi de la polarització del fotó en desintegracions radiatives d'hadrons B amb el detector LHCb***

Author: Carla Marín Benito  
Director/s: Lluís Garrido, Albert Puig (U. Zurich)  
Tentative Date: September 2017

***Estudi de l'halo de matèria fosca de la Via Làctia amb rieres de marea dels seus satèl·lits***

Author: Carles García Palau  
Director/s: Jordi Miralda  
Tentative Date: 2019

***Estudi Espectroscòpic de cúmuls oberts per a l'anàlisi de la metal·licitat de la galàxia***

Author: Laia Casamiquela  
Director/s: Carme Jordi, Dolores Balaguer, Ricardo Carrera (IAC)  
Tentative Date: 2017

***Explotació científica del survey TFRM-PSES: detecció d'exoplanetes per trànsit, 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

***Far-from-equilibrium holography and heavy ion collisions***

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

***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 Verdaguer, Oleg Bulashenko  
Tentative Date: 2018

***Jets as Probes of Strongly Coupled Quark-Gluon Plasma***

Author: Daniel Pablos Alfonso  
Director/s: Jorge Casalderrey Solana  
Tentative Date: 22/06/2016

***Lyman-alpha autocorrelation, small scales structures and fluctuations of the radiation background***

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

***Meson-Baryon interactions in free space and in the medium from effective Chiral Lagrangians***

Author: Albert Feijoo Aliau  
Director/s: Volodymyr Magas, Àngels Ramos  
Tentative Date: July 2016

***Multipartite quantum entanglement***

Author: Daniel Alsina Leal

Director/s: José Ignacio Latorre

Tentative Date: June 2017

***New insights into holography from supersymmetric localization***

Author: Genís Torrents Verdaguer

Director/s: Tomeu Fiol Núñez

Tentative Date: June 2016

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

Author: Xavier Paredes-Fortuny

Director/s: Marc Ribó Gomis, Valentí Bosch-Ramon

Tentative Date: October 2016

***Physical Cosmology in the epoch of large surveys***

Author: José Luís 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: Josep M. Paredes, Kazushi Iwasawa

Tentative Date: October 2019

***Rotation, magnetic fields and fragmentation in the earliest stages of star formation: High angular resolution observations in the ALMA and JVL A era***

Author: Carmen Juárez Rodríguez

Director/s: J. Miquel Girart Medina

Tentative Date: September 2016

***Studies of Black Hole Horizons***

Author: Marina Martínez Montero

Director/s: Roberto Emparan García de Salazar

Tentative Date: October 2016

***Study of b-hadron decays into two hadrons and a photon at LHCb and first observation of b-baryon radiative decays***

Author: Vicente Rives Molina

Director/s: Albert Puig

Tentative Date: October 2016

***Super-resolución de imágenes astronómicas y teledetección***Author: M<sup>a</sup> Teresa Merino Espasa

Director/s: Jorge C. Núñez

***Teories Gauge i Principi de Màxima Entropia***

Author: Alba Cervera Lierta

Director/s: José Ignacio Latorre

Tentative Date: June 2019

***The cross-correlation among tracers of the underlying large-scale mass distribution in the universe***

Author: Ignasi Pérez Ràfols

Director/s: Jordi Miralda Escudé

Tentative Date: October 2016

***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

***Vacuum energy in Quantum Field Theory and Cosmology***

Author: Adrià Gómez Valent

Director/s: Joan Solà Peracaula

Tentative Date: Spring 2018

***Weak decay of doubly strange systems***

Author: Jordi Maneu Victoria

Director/s: Assumpta Parreño

Tentative Date: November 2017

***Wideband pulse amplifiers for the integrated cameras of the Cherenkov Telescope Array***

Author: Andreu Sanuy

Director/s: David Gascón

Tentative Date: February 2016

## MASTER THESES

### *A consistency test of General Relativity using Expansion History and Growth of Structures*

Author: José Luís Bernal  
 Director/s: Alexander Knebe, Licia Verde, Antonio J. Cuesta  
 Date: 01/07/2015

### *Black holes in the limit of very many dimensions*

Author: Joan Garcia i Tormo  
 Director/s: Roberto Emparan  
 Date: 01/09/2015

### *Bose-Fermi mixtures in 1D few-sites optical lattices*

Author: Gerard Pelegrí  
 Director/s: Bruno Julià-Díaz, Artur Polls  
 Date: 01/07/2015

### *Dynamical Vacuum Energy in the Expanding Universe*

Author: Javier de Cruz  
 Director/s: Joan Solà  
 Date: 03/07/2015

### *Effects of Lambda on gravitational waves and possible measurement through pulsar timing arrays*

Author: Galo Gallardo  
 Director/s: Domènec Espriu  
 Date: 01/09/2015

### *Effects of the Image Cleaning on Monte Carlo simulations of Moonlight observations with the MAGIC telescopes*

Author: Cristina Sans  
 Director/s: Marc Ribó  
 Date: 06/07/2015

### *Emission spectrum and inclusive cross section of strings*

Author: Ramon Masachs  
 Director/s: Jorge G. Russo  
 Date: 03/07/2015

### *Majorana Fermions in a Spin ladder*

Author: Felipe LeVot  
 Director/s: Sofyan Iblisdir  
 Date: 03/07/2015

### *Neutron and spin-orbit effects in nuclear charge density and electron-nucleus scattering*

Author: Clàudia González  
 Director/s: Mario Centelles, Xavier Viñas  
 Date: 01/09/2015

### *Non-Unitary Neutrino Oscillations*

Author: Alba Cervera  
 Director/s: M. Concepción González García  
 Date: 03/07/2015

### *Oblique corrections in the Dine-Fischler-Srednicki-Zhitnitsky axion model*

Author: Alisa Katanaeva  
 Director/s: Domènec Espriu  
 Date: 01/09/2015

### *Photometric Follow-up of Gaia Alerts From Montsec Observatory*

Author: Umut Burgaz  
 Director/s: Josep Manel Carrasco  
 Date: 06/07/2015

### *Probing the correlation between IR and X-ray emission in luminous infrared galaxies*

Author: Núria Torres  
 Director/s: Kazushi Iwasawa, Valentí Bosch Ramon  
 Date: 06/07/2015

### *Quantum properties of two-component two-sites Bose-Hubbard model*

Author: Pere Mujal  
 Director/s: Bruno Julià-Díaz, Artur Polls  
 Date: 01/07/2015

### *Sensitivity to the photon polarization in $B^0_s \rightarrow \phi \gamma$ at the LHCb experiment*

Author: Miguel Larrañaga  
 Director/s: Lluís Garrido  
 Date: 03/07/2015

### *Shortcut to adiabaticity in spin fragmented condensates*

Author: David López  
 Director/s: Bruno Julià-Díaz, Artur Polls  
 Date: 01/07/2015

### *Static Fields via Probe Computations using AdS/CFT duality*

Author: Susana Vásquez  
 Director/s: Bartomeu Fiol  
 Date: 03/07/2015

### *Study of radiative B decays in LHCb: $B_s \rightarrow KK \gamma$*

Author: Joan Arnau  
 Director/s: Ricardo Graciani  
 Date: 03/07/2015

*Study of the efficiency of the LHCb Trigger for the  $K^0_S \rightarrow e\pi\pi$  decay*

Author: Carles García

Director/s: Lluís Garrido

Date: 03/07/2015

*Unitarisation of WW scattering and interpretation of a 2 TeV resonance in a strongly interacting electroweak symmetry-breaking sector*

Author: Pere Arnan

Director/s: Domènec Espriu

Date: 01/09/2015

# 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

### 2015 ICCUB Colloquia

**Ignacio Cirac** (Max-Planck Institut für Quantenoptik)  
*Quantum simulations*  
26/02/2015

**Gordon Baym** (Deptt of Physics, Univ. of Illinois at Urbana-Champaign)  
*Quarks and cold atoms: Many particle physics from the hottest to the densest to the coldest places in the Universe*  
09/04/2015

**Roberto Emparan** (ICREA / ICCUB)  
*Heart of darkness: General Relativity @ 100*  
07/05/2015

**Bernard J. T. Jones** (Kapteyn Astronomical Institute, Univ. of Groningen)  
*Discovering the environment in which galaxies form - The Cosmic Web*  
04/06/2015

**Rashid Sunyaev** (Max-Planck Institute for Astrophysics, Garching)  
*Two important milestones in the history of the Universe: The surface of the last scattering and the black body photosphere. The inevitable spectral distortions of the Cosmic Microwave Background Radiation*  
02/07/2015

**Ruprecht Machleidt** (Department of Physics, University of Idaho)  
*Understanding the Atomic Nucleus: Recent Dramatic Advances and Remaining Challenges*  
15/10/2015

**Laura Baudis** (Physik Institut, Univ. of Zurich)  
*Direct detection of dark matter in the Milky Way*  
26/11/2015

### ICCUB COLLOQUIA 2016 SPEAKERS

From left to right: I. Cirac , G. Baym, B.J.T. Jones, R. Emparan, L. Baudis, R. Machleidt



## 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).

### 2015 Seminars

**Sugumi Kanno** (UPV)

*Quantum Entanglement in the Multiverse*

HEP Seminar

08/01/2015

**Petra H. Huentemeyer** (MTU, Michigan Tech University, USA)

*First Preliminary Results and Science Potential of the HAWC Observatory*

DAM Seminar

09/01/2015

**Javier Virto** (Siegen University)

*Flavoured Conspiracies and Conundrums*

HEP Seminar

15/01/2015

**Marina Martínez** (ICCUB)

*Bumpy Black Holes*

HEP Seminar

16/01/2015

**Nathalie Palanque-Delabrouille** (CEA, Paris)

*Constraints on massive neutrinos using Lyman-alpha forest*

DAM Seminar

22/01/2015

**Matteo Viel** (Trieste Observatory)

*Modelling the effect of neutrinos on cosmological structure formation*

DAM Seminar

22/01/2015

**Vladimir Mitev** (Humboldt University)

*The Exact Effective Couplings of 4D  $N=2$  Gauge Theories*

HEP Seminar

22/01/2015

**Suresh Nampuri** (University of the Witwatersrand)

*Hot Attractors*

HEP Seminar

23/01/2015

**Geraldine Servant** (IFAE & ICREA)

*Higgs (and axion) implications for baryogenesis*

HEP Seminar

29/01/2015

**Matteo Viel** (Trieste Observatory)

*Modelling the effect of neutrinos on cosmological structure formation*

ICCUB Seminar

03/02/2015

**Nathalie Palanque-Delabrouille** (CEA, Paris)

*Constraints on massive neutrinos using Lyman-alpha forest*

ICCUB Seminar

04/02/2015

**Antonio Cuesta** (ICCUB)

*Robustness of cosmic neutrino background detection in the Cosmic Microwave Background*

ICCUB Seminar

04/02/2015

**Gloria Koenigsberger** (I. de Ciencias Físicas, UNAM)

*On the Evolution of Asynchronous Binary Systems*

DAM Seminar

05/02/2015

**Eric Bergshoeff** (Groningen University)

*Supergravity, T-duality and Double Field Theory*

HEP Seminar

05/02/2015

**Miguel Zilhão** (ICCUB)

*Simulating Accreting Binary Black Holes*

HEP Seminar

06/02/2015

**Hugo F. Arellano** (U. Chile)

*Di-nucleons in infinite nuclear matter*

FAN Seminar

10/02/2015



**Dimitrios Giataganas** (Oxford University)

*Gauge/Gravity duality with Anisotropies*

HEP Seminar

12/02/2015

**Stephan Stetina** (Vienna University of Technology)

*From Field Theory to the Hydrodynamics of Relativistic Superfluids*

HEP Seminar

13/02/2015

**José Oñorbe** (MPIA, Heidelberg, Germany)

*Characterisation of the Intergalactic Medium Jeans Scale and its measurement using quasar pairs*

ICCUB Seminar

18/02/2015

**Drazen Glavan** (Utrecht University)

*Late-time quantum backreaction in cosmology*

HEP Seminar

19/02/2015

**Jakub Zakrzewski** (Jagiellonian University)

*Beyond the standard Bose-Hubbard model description of cold bosons in optical lattice potential*

FAN Seminar

19/02/2015

**Jorge Russo** (ICREA / ICCUB)

*Large N Phase Transitions in massive  $N = 2$  Gauge Theories*

HEP Seminar

19/02/2015

**Yuko Urakawa** (Nagoya University)

*Infrared radiative stability and the initial state of the inflationary universe*

HEP Seminar

20/02/2015

**Justin Read** (University of Surrey)

*Astrophysical probes of dark matter*

DAM Seminar

26/02/2015

**Lorenzo Calibbi** (ULB, Brussels)

*Phenomenology of low-energy flavour models: rare processes and dark matter*

HEP Seminar

26/02/2015

**Cristiano Germani** (Munich University)

*Firewalls as artefacts of inconsistent truncations of*

*quantum geometries*

HEP Seminar

27/02/2015

**Marina Martínez-García & Xavier Xirgu** (H2020

Programme Officer / Chief Innovation Officer at Univ. Girona)

*H2020: how to increase the impact and success*

ICCUB Seminar

03/03/2015

**Giorgio Arcadi** (LPT, Orsay)

*Phenomenology of minimal decaying dark matter scenarios*

HEP Seminar

05/03/2015

**Mallory Roberts** (New York University Abu Dhabi (NYYAD) and Eureka Scientific)

*Heating Before Eating: X-Ray observations of Redback Millisecond Pulsar Systems in the ablation state*

DAM Seminar

06/03/2015

**Yuichiro Kiyo** (Juntendo University)

*Update of quarkonium phenomenology at NNNLO*

HEP Seminar

06/03/2015

**Lorenzo Vitale** (ITPP Lausanne)

*Hamiltonian Truncation methods for strongly-coupled QFTs*

HEP Seminar

09/03/2015

**Clifford Burgess** (McMaster University & Perimeter Institute & CERN)

*Self-Tuning Under the Microscope: Last Chance to be Wrong About What the LHC Will Find?*

HEP Seminar

12/03/2015

**Daniel Pablos** (ICCUB)

*A Hybrid Strong/Weak Coupling Approach to Jet Quenching*

HEP Seminar

13/03/2015

**Pau Figueras** (DAMPT)

*New frontiers in numerical general relativity*

ICCUB Seminar

16/03/2015

**Vitor Cardoso** (IST Lisbon)  
*Black holes as particle detectors*  
 HEP Seminar  
 19/03/2015

**Konrad Tywoniuk** (ICCUB)  
*Long-range correlations in the quark-gluon plasma from QCD confinement*  
 HEP Seminar  
 20/03/2015

**Sophie Renner** (DAMTP, Cambridge)  
*Composite leptoquarks and anomalies in B decays*  
 HEP Seminar  
 26/03/2015

**Nicola Serra** (Zurich University)  
*Angular analysis of the decay  $B_0 \rightarrow K^* \mu \mu$  at LHCb*  
 HEP Seminar  
 27/03/2015

**Luca Merlo** (IFT UAM/CSIC)  
*Masses and Mixings from Continuous Symmetries*  
 HEP Seminar  
 09/04/2015

**Adrià Gómez** (ICCUB)  
*Dynamical vacuum energy in the expanding Universe*  
 HEP Seminar  
 10/04/2015

**Daniel Ceverino** (CAB-CSIC-INTA)  
*Simulations of Galaxy Formation: Feedback and the early formation of compact spheroids by disc instabilities*  
 DAM Seminar  
 16/04/2015

**Rafel Escribano** (IFAE)  
*Combined analysis of the decays  $\tau \rightarrow KS\pi\nu\tau$  and  $\tau \rightarrow K\eta\nu\tau$*   
 HEP Seminar  
 16/04/2015

**Andrés Goya** (Universidad de Buenos Aires)  
*Three Dimensional Bigravity as a New Model for AdS/CFT Extensions*  
 HEP Seminar  
 23/04/2015

**Federico Mescia** (ICCUB)  
*Axion - Higgs interplay in the 2 Higgs Doublet model*  
 HEP Seminar  
 24/04/2015

**Alessio Celi** (ICFO)  
*Synthetic Lattices & applications*  
 HEP Seminar  
 30/04/2015

**Luca di Luzio** (Genova University)  
*Invisible axion and massive neutrinos: are they related?*  
 HEP Seminar  
 30/04/2015

**Carles Badenes** (University of Pittsburgh)  
*The Persistence of Memory: What Supernova Remnants Can Tell Us about Type Ia Supernova Progenitors*  
 ICCUB Seminar  
 04/05/2015

**Roberto Terlevich** (Institute of Astronomy, Cambridge Univ.)  
*Towards precision Cosmology with HII galaxies*  
 ICCUB Seminar  
 06/05/2015

**David Martínez-Delgado** (Universidad de Heildelberg)  
*Stellar Tidal Streams in nearby spiral galaxies*  
 DAM Seminar  
 07/05/2015

**David Berenstein** (UCSB)  
*Extremal chiral ring states in AdS/CFT are described by free fermions*  
 HEP Seminar  
 07/05/2015

**Konrad Tywoniuk** (ICCUB)  
*Transport in a plasma of confining gluons*  
 HEP Seminar  
 08/05/2015

**Christian Duval** (Aix-Marseille University & CPT)  
*On the Schrödinger-Newton equation and its symmetries*  
 HEP Seminar  
 14/05/2015

**Joaquim Gomis** (ICCUB)  
*The symmetries of Carroll (super) particle*  
 HEP Seminar  
 15/05/2015

**Thomas Zojer** (Groningen University)  
*Non-relativistic (super)gravity*  
 HEP Seminar  
 21/05/2015

**Juan M. Torres-Rincon** (Subatech, U. Nantes)  
*Flavor dependence of hadron melting temperatures*  
 FAN Seminar  
 21/05/2015

**Adriana di Dato** (ICCUB)  
*Hydrodynamics from charged dilaton black brane*  
 HEP Seminar  
 22/05/2015

**Giulio Bonelli** (SISSA)  
*The  $N=2, D=4$  gauge theory partition function on compact toric manifolds*  
 HEP Seminar  
 28/05/2015

**Daniel Alsina** (ICCUB)  
*Absolutely maximally entangled states*  
 HEP Seminar  
 29/05/2015

**Andreas Reisenegger** (Pontificia Universidad Católica de Chile, Santiago, Chile)  
*Internal heating and ultraviolet emission of old neutron stars*  
 ICCUB Seminar  
 03/06/2015

**Jordi Miralda** & Àngels Egea (ICCUB / UB)  
*Una nova aportació a la terminologia catalana per l'astrofísica*  
 ICCUB Seminar  
 03/06/2015

**Juliana Saponara** (Facultad de Ciencias Astronómicas y Geofísicas (FCAG-UNLP). La Plata)  
*Cinemática de galaxias enanas locales y CHIPÁ*  
 DAM Seminar  
 04/06/2015

**Ignatios Antoniadis** (AEC Bern & LPTHE Paris)  
*Aspects of string phenomenology in particle physics and cosmology*  
 HEP Seminar  
 04/06/2015

**Benjo Fraser** (Athens University)  
*Higher Rank Wilson Loops in the  $N=2$   $SU(N)_xSU(N)$  Conformal Quiver*  
 HEP Seminar  
 05/06/2015

**Genís Torrents** (ICCUB)  
*Holographic D3 probes*  
 HEP Seminar  
 11/06/2015

**Alexander Andrianov** (St. Petersburg State University)  
*PT symmetric classical and quantum cosmology: PToms against phantoms*  
 HEP Seminar  
 12/06/2015

**Hideo Kodama** (KEK, Tsukuba)  
*Non-linear evolution of the black hole-axion system and its observation by gravitational waves*  
 HEP Seminar  
 15/06/2015

**Álvaro Sánchez Monge** (Physikalisches Institut, Universität zu Köln)  
*High-mass star formation: from dense cores to HII regions*  
 DAM Seminar  
 16/06/2015

**Álvaro Sánchez Monge** (Physikalisches Institut, Universität zu Köln)  
*XCLASS: Introduction and tutorial*  
 DAM Seminar  
 18/06/2015

**Leonardo Giusti** (Milano-Bicocca University)  
*Implications of Poincare symmetry for thermal field theories*  
 HEP Seminar  
 18/06/2015

**Alexei Bazavov** (UC Riverside & University of Iowa)  
*The equation of state and deconfinement in QCD*  
 HEP Seminar  
 19/06/2015

**Diego Correa** (Universidad Nacional de La Plata)  
*Cusped Wilson lines and ladders*  
 HEP Seminar  
 25/06/2015

**Alexander Andrianov** (St. Petersburg State University)  
*PT symmetric classical and quantum cosmology: PToms against phantoms*  
 HEP Seminar  
 26/06/2015

**Francisco Moldón Vara** (ASTRON, Netherlands  
Institute for Radio Astronomy)  
*Exploring the low-frequency universe. High resolution  
images of extragalactic jets with the international LOFAR*  
DAM Seminar  
08/07/2015

**Michal Heller** (Perimeter Institute)  
*Hydrodynamics Beyond the Gradient Expansion:  
Resurgence and Resummation*  
HEP Seminar  
09/07/2015

**Chunshan Lin** (YITP, Kyoto University)  
*Resonant Primordial Gravitational Waves amplification*  
HEP Seminar  
10/07/2015

**Joseph Hennawi** (Max-Planck-Institut für Astronomie,  
Heidelberg)  
*The First Characterization of the Jeans Filtering Scale of  
the Intergalactic Medium*  
ICCUB Seminar  
13/07/2015

**Enrique Ruiz Arriola** (Univ. Granada)  
*Coarse graining of Interactions and the Renormalization  
Group in Nuclear and Molecular Physics*  
FAN Seminar  
21/07/2015

**Albert Gallemí** (UB)  
*Coherent Quantum Phase Slip in Bosonic Atomtronic  
Circuits*  
FAN Seminar  
28/07/2015

**Christian Reichardt** (University of Melbourne)  
*Measuring CMB Polarization with POLARBEAR and  
the Simons Array: Towards New Constraints on Neutrino  
Masses and Inflation*  
ICCUB Seminar  
07/09/2015

**Douglas Scott** (University of British Columbia)  
*New Results from the Planck satellite*  
ICCUB Seminar  
10/09/2015

**Giacomo Cacciapaglia** (Université de Lyon)  
*Recent developments in composite dynamics: Dark Matter  
and the di-boson excess*

HEP Seminar  
17/09/2015

**Takahiro Tanaka** (Kyoto University)  
*An attempt to derive bigravity from braneworld*  
HEP Seminar  
21/09/2015

**Miguel Quartin** (Univ. Federal de Rio de Janeiro)  
*Measuring cosmic structure with supernovae*  
HEP Seminar  
23/09/2015

**Daniele Musso** (ICTP)  
*A goldstino at the end of the cascade*  
HEP Seminar  
25/09/2015

**Markus Froeb** (ITP Leipzig)  
*Constructing interacting QFTs via OPEs*  
HEP Seminar  
01/10/2015

**Daniel Elander** (Purdue University)  
*Walking dynamics from gauge-gravity duality*  
HEP Seminar  
02/10/2015

**Xavier Bekaert** (LMPT Tours)  
*Torsional Newton-Cartan geometry and its relativistic origin*  
HEP Seminar  
08/10/2015

**Sayantani Bhattacharyya** (Indian Inst. Tech., Kanpur)  
*A Charged Membrane Paradigm at Large Dimension*  
HEP Seminar  
19/10/2015

**Nico Wintergerst** (Stockholm University)  
*Approaches to black hole information*  
HEP Seminar  
20/10/2015

**Rainer Stiele** (Goethe University & Institute of Space  
Sciences)  
*Thermodynamics and Phase Structure of Strongly-  
Interacting Matter in a Quark-Meson Model*  
FAN Seminar  
20/10/2015

**Tamas Csorgo** (Wigner Research Centre for Physics,  
Budapest, & KRF, Gyongyos, Hungary)

*Multiple diffraction theory of elastic pp scattering, with applications to pp data at LHC energies*

FAN Seminar  
21/10/2015

**Sera Markoff** (API/GRAPPA, University of Amsterdam)

*Understanding the dominant state of active black holes in the Universe*

DAM Seminar  
26/10/2015

**Ishwara Chandra CH.** (National Center for Radio Astrophysics, TIFR, Pune, India)

*GMRT Survey of Cygnus OB2 region at 610 and 325 MHz*

DAM Seminar  
28/10/2015

**Juan Rojo** (Oxford University)

*Discovery through precision: perturbative QCD at the dawn of Run II*

HEP Seminar  
29/10/2015

**Martin Heinze** (DESY)

*Orbit method quantization of AdS superparticles*

HEP Seminar  
30/10/2015

**Johannes Schmude** (Universidad de Oviedo)

*Supersymmetric Field Theories on Five-Manifolds*

HEP Seminar  
05/11/2015

**Óscar Dias** (Southampton University)

*Black resonators: evading black hole theorems and the path to cosmic censorship violation*

HEP Seminar  
09/11/2015

**Eulogio Oset** (U. Valencia /IFIC)

*Testing the nature of resonances in B, D, Lambda\_b weak decays*

FAN Seminar  
12/11/2015

**Jorge Rocha** (ICCUB)

*Rotating thin shells, gravitational collapse and cosmic censorship*

HEP Seminar  
13/11/2015

**Vitor Cardoso** (Universidade de Lisboa)

*The gravity of fundamental fields*

HEP Seminar  
19/11/2015

**Andreas Crivellin** (CERN)

*New Physics in B decays and correlations with LHC searches*

HEP Seminar  
20/11/2015

**Alfonso Ramallo** (Universidad de Santiago de Compostela)

*Cold holographic matter in a top-down model*

HEP Seminar  
26/11/2015

**Jon Marcaide** (Astronomy and Astrophysics Department, University of Valencia)

*Supernova 1987A seen with ALMA's eyes*

DAM Seminar  
27/11/2015

**Keisuke Izumi** (ICCUB)

*Causal Structures in Gauss-Bonnet gravity*

HEP Seminar  
27/11/2015

**Miguel Vázquez-Mozo** (Universidad de Salamanca)

*On the double copy structure of soft gravitons*

HEP Seminar  
03/12/2015

**Guillem Domènech** (Kyoto University)

*Metric transformations: cosmological disformal invariance and frame "dependence" of inflation*

HEP Seminar  
04/12/2015

**Lars Hofer** (ICCUB)

*Flavour and high-energy physics in the precision era of the LHC*

HEP Seminar  
11/12/2015

**Enric Verdaguer** (ICCUB)

*Riemann correlator in de Sitter including loop corrections from matter fields*

HEP Seminar  
18/12/2015

## EVENT ORGANIZATION

- Jordi, C.**  
Chair of organizing committee  
*Gaia CU5 Plenary meeting #14*  
Facultat de Física, UB  
27/01/15–29/01/15
- Calvo, M.; **Garrido, L.**; Lefèvre, R.; Oyanguren, A.; Puig, A.  
Organizing committee  
*2nd Workshop on Radiative decays at LHCb*  
Physics Faculty, UB  
04/05/15–06/05/15
- Bertolín, A.; **Espriu, D.**; García-Berro, E.; Martín, V.; Nofrarias, M.; Sopena, C.F.  
Organizing committee  
*IGMW2015 “5th Iberian Gravitational Wave Meeting”*  
Universitat Politècnica de Catalunya (UPC)  
12/05/15–14/05/15
- Gómez, G.**  
Organizing committee  
*AstroNet-II International Final Conference*  
Gran Hotel Reyamar, Tossa de Mar (Spain)  
15/06/15–19/06/15
- Gascón, D.; Paredes, J.M.**; Ward, J.  
Organizing committee  
*GAMMA-400 Workshop*  
Physics Faculty, UB  
29/06/15–30/06/15
- Figueras, F.; Romero-Gómez, M.; Balaguer-Núñez, L.; Mor, R.; Molina, D.**  
Organizing committee  
*Third Gaia Challenge Workshop*  
Physics Faculty, UB  
31/08/15–04/09/15
- Espriu, D.; Pons, J.M.; Russo, J.**; Simon, J.  
Organizing committee  
*Symmetries in Particles and Strings – A Conference to celebrate the 70th birthday of Quim Gomis*  
Physics Faculty, UB  
04/09/2015
- Luri, X.; Jordi, C.; Balaguer-Núñez, L.; Molina, D.**  
Organizing committee  
*Gaia Catalogue Access CU9 plenary Meeting*  
Physics Faculty, UB  
21/09/15–23/09/15
- Àgueda, N.; Aran, A.; Sanahuja, B.**  
Organizing committee  
*HESPERIA Progress Meeting*  
Physics Faculty, UB  
19/10/15–20/10/15
- Germani, C.**  
Organizing committee  
*Vacuum2015 “The vacuum of the Universe: from cosmology to particle physics”*  
Physics Faculty, UB  
21/10/15–23/10/15
- Aran, A.; Bosch-Ramon, V.; Garrido, L.; Mescia, E.; Miralda-Escudé, J.; Parreño, A.**  
Organizing committee  
*ICCUB Christmas Meeting*  
Physics Faculty, UB  
21/12/15–22/12/15
- Verde, L.**  
Chair of organizer committee  
*Beyond LCDM*  
Scandic Holmenkollen Park Hotel  
13/01/2015–17/01/2015
- Figueras, F.**  
Coordinator  
*Gaia Perseus Weave*  
University of Alicante  
16/02/2015
- Jordi, C.**  
Secretary of organizer committee  
*Un matí d’astrobiologia a la UB*  
University of Barcelona  
06/03/2015
- Verde, L.**  
Participation in organizing committee  
*Aspen Winter Conference, Closing in on the cosmological model*  
Aspen Center for Physics  
08/03/2015–14/03/2015

**Bosch-Ramon, V.**

Main Organizer  
*Variable Galactic Gamma-Ray Sources III*  
 Max-Planck-Haus  
 04/05/15-06/05/15

**Iwasawa, K.**

Science Organizing Committee  
*The 2nd Spanish X-ray Astronomy 2015*  
 Instituto de Física de Cantabria (IFCA)  
 03/06/15-05/06/15

**Verdaguer-Oms, E.**

Secretary of organizer committee  
*Peyresq Physics-20 International Workshop: 'Micro and Macro Structure of Spacetime'*  
 Peyresq, Alpes de Haute-Provence  
 13/06/15-19/06/15

**Solà, J.**

Participation in the organizing committee  
*12th International Symposium on Radiative Corrections (RADCOR 2015)*  
 University of California  
 15/06/15-19/06/15

**Jordi, C.**

Participation in organizing committee  
*First Science From Gaia - the Gaia Research for European Astronomy Training (GREAT) Network Science Symposium, EWASS 2015*  
 University of La Laguna  
 23/06/15-24/06/15

**Parreño, A.**

Participation in organizing committee  
*The 8th International Workshop on Chiral Dynamics 2015*  
 Pisa University  
 29/06/15-03/07/15

**Emparan, R.**

Chair of organizing committee  
*Gravity: New perspectives from strings and higher dimensions*  
 Centro de Ciencias de Benasque Pedro Pascual  
 12/07/15-24/07/15

**Verde, L.**

Participation in organizer committee  
*MPA/ESO/MPE/EXC Joint Conference on the large-scale structure*  
 Headquarters of the European Southern Observatory (ESO)  
 20/07/2015-24/07/2015

**Russo, J.**

Co-Organizer  
*Gauge theories, supergravity and superstrings, 2015*  
 Centro de Ciencias de Benasque Pedro Pascual  
 02/08/15-15/08/15

**Verde, L.**

Chair of organizing committee  
*From Inflation to Galaxies: a workshop in honour of Sabino Matarrese*  
 Castello Pasquini  
 31/08/2015-03/09/2015

**Bosch-Ramon, V.; Paredes, J.M.**

Participation in organizing committee  
*High Energy Phenomena in Relativistic Outflows V (HEPRO V)*  
 Honorable House of Senators of the Province of Buenos Aires  
 05/10/15-08/10/15

## 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 of the Faculty of Physics.

In 2015 two sessions were held on the 2nd and 9th of March at the Faculty of Physics. 157 students from 114 high schools all around Catalonia attended.

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

### Exhibitions

The ICCUB owns four travelling exhibitions. These exhibitions have different printed versions in the Institute that are annually exposed in different external centers, like high schools, libraries or community centers. Two of these exhibitions have been entirely produced by the ICCUB.

#### *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 14 informative plaques edited and printed in Catalan and Spanish.

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

Itinerary 2015 of the Catalan version:

- IES Menéndez y Pelayo, Barcelona  
From November 9th to December 4th

Itinerary 2015 of the Spanish version:

- Parque Metropolitano Marismas de los Toruños y Pinar de la Algaida de El Puerto de Santa María, Cádiz  
From the 3rd to the 12th of July, in the context of the *IIIrd Astrophysical Conference*.



MASTERCLAS ON PARTICLE PHYSICS 2015

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

- Physics Faculty, Univ. of Santiago de Compostela (Galicia)  
From the 10th to the 31st of July

#### *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 2015:

- Centre d'Observació de l'Univers, Àger, Lleida  
From August 1st to November 15th
- Escola Virolai, Barcelona  
From the 12th to the 26th of November
- Centre Cívic Espai Gatassa, Mataró.  
From November 27th to January 15th

#### *The cosmic distances*

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 in 2015:

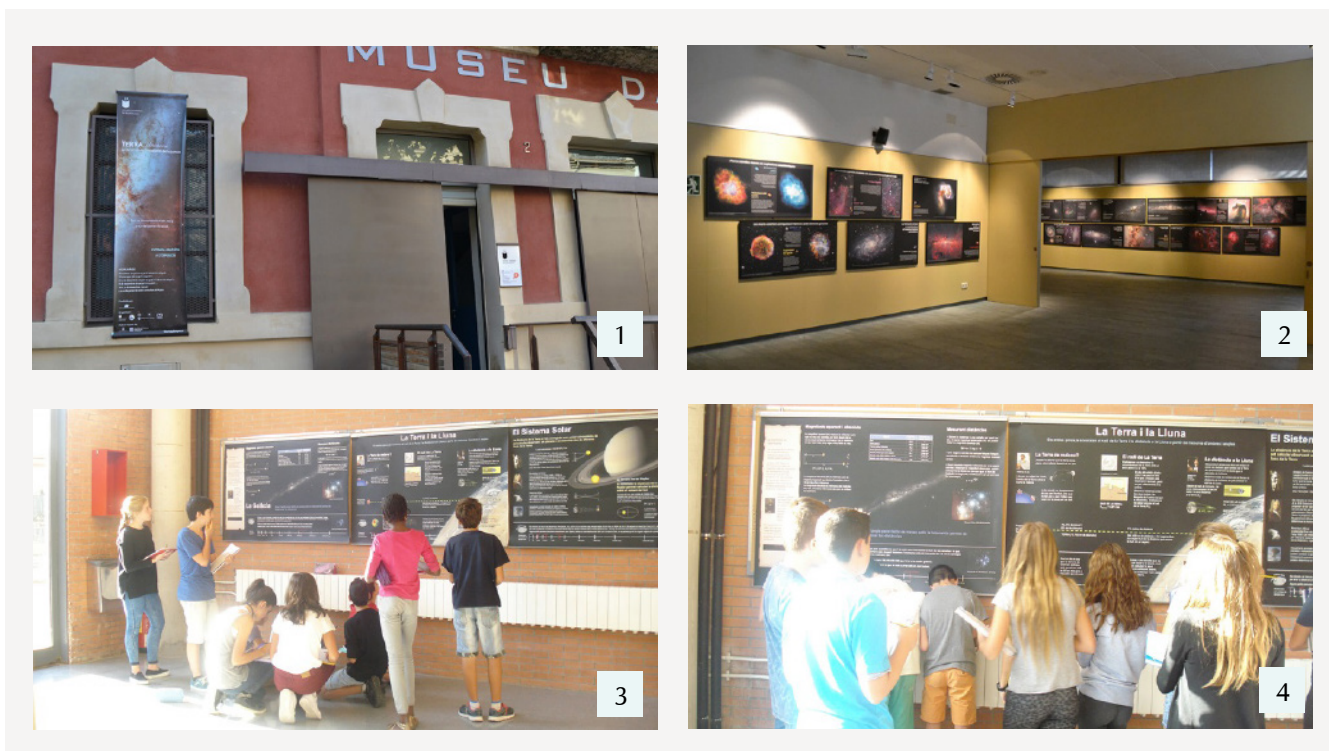
- Escola Octavio Paz, Barcelona,  
From February 23rd to March 1st
- Institut Castellbisbal, Castellbisbal  
From September 17th to November 4th
- Escola Jesuïtes Sarrià Sant Ignasi, Barcelona  
From the 9th to the 23rd of November

### *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>

- Escola Pia de Mataró, Mataró  
From September 21st to November 5th
- Museu Darder de Banyoles, Banyoles  
From November 20th to January 11th



#### EXHIBITIONS

1 and 2: "From the Earth to the Universe" on exhibition at Darder Museum of Banyoles

3, 4: "The cosmic distances", on exhibition at Castellbisbal High School

## 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/>

### 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*.

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

## The ICCUB in the social networks

### Institutional Channels



@ICC\_UB



ICCUB

### Group and members channels:

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

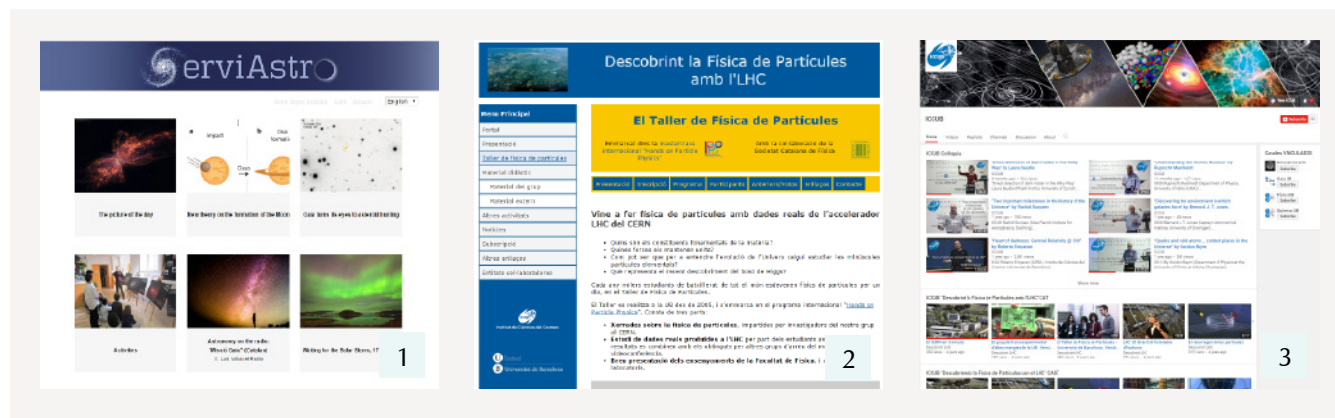
- <https://www.facebook.com/gaiaub>,
- <https://twitter.com/GaiaUB>
- <https://www.youtube.com/channel/UCAdmF8h-oCilZZjMFxWPm5A>

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>



### THE ICCUB ON THE INTERNET

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

## Outreach Material

### Posters SDSS-BOSS

Two posters were created to describe the operation of BOSS as well as the activity of the Institute in this exploration, to accompany an original plate from the telescope that has been hung in the office area ICCUB-IEEC.

### Short documentary *La ciència de la llum - La llum que ens parla des dels estels*

Short documentary produced by the University of Barcelona in the occasion of the *Setmana de la Ciència* in which the ICCUB researcher Carme Jordi talks about how astronomers use light coming from the stars to determine their characteristics and study different phenomena.



SOME OUTREACH MATERIAL PRODUCED AT ICCUB IN 2016

1 and 2: Posters about SDSS and BOSS for the ICCUB-IEEC area

3 and 4: Screenshots from the video "La ciència de la llum - La llum que ens parla des dels estels"

## Publications

**Carrasco, J.M.**, Masana, E., *Cómo ver el eclipse solar en Barcelona*, Newspaper *La Vanguardia*, 18/03/2015  
<http://www.lavanguardia.com/ciencia/20150318/54429070811/eclipse-solar-2015-barcelona.html>

**DAM-ICCUB**, *La UB retransmitirá por internet el eclipse de sol del próximo viernes*, Newspaper *La Vanguardia*, 18/03/2015  
<http://www.lavanguardia.com/vida/20150318/54429071187/la-ub-retransmitira-por-internet-el-eclipse-de-sol-del-proximo-viernes.html>

**Carrasco, J.M.**, *Una casualitat còsmica i meteorològica permet veure durant uns instants l'eclipsi a Barcelona*, Newspaper *ARA*, 20/03/2015  
[http://www.ara.cat/societat/Expectacio-maxima-davant-eclipsi-repetira\\_0\\_1324067681.html](http://www.ara.cat/societat/Expectacio-maxima-davant-eclipsi-repetira_0_1324067681.html)

**Carrasco, J.M.**, *Por fin, hemos llegado a Plutón*, Newspaper *La Vanguardia* 15/07/2015  
<http://www.lavanguardia.com/ciencia/fisica-espacio/20150715/54433927101/new-horizons-pluton-paso-enorme-historia-exploracion-espacial.html>

**Carrasco, J.M.**, *Plutón tiene montañas de agua helada de 3.500 metros*, 16/07/2015  
<http://www.lavanguardia.com/ciencia/fisica-espacio/20150716/54433435515/pluton-montana-agua-helada.html>

**Emparan, R.** *¿Fuego en el horizonte?*, Magazine *Investigación y Ciencia*, Vol. 463, p. 21 - 21 (2015)  
<http://www.investigacionyciencia.es/revistas/investigacion-y-ciencia/numero/463/fuego-en-el-horizonte-13018>

**Luri, X.**, *La meitat de les estrelles de l'Univers van per lliure*, Newspaper *ARA*, 04/01/2015  
[http://www.ara.cat/suplements/diumenge/meitat-estrelles-lunivers-lliure\\_0\\_1279072091.html](http://www.ara.cat/suplements/diumenge/meitat-estrelles-lunivers-lliure_0_1279072091.html)

**Gaia Team**, *La imatge més inusual de la Via Làctia*, 06/07/2015  
[http://www.ara.cat/societat/lactia-via-fotografia-agencia-espacial-europea\\_0\\_1388861346.html](http://www.ara.cat/societat/lactia-via-fotografia-agencia-espacial-europea_0_1388861346.html)

**Gaia Team**, *Contando estrellas con Gaia*, 06/07/2015  
[http://www.lavanguardia.com/ciencia/fisica-espacio/20150706/54433741802/satelite-gaia-esa-via-](http://www.lavanguardia.com/ciencia/fisica-espacio/20150706/54433741802/satelite-gaia-esa-via-lactea-nubes-de-magallanes.html)

[lactea-nubes-de-magallanes.html](http://www.lavanguardia.com/ciencia/fisica-espacio/20150706/54433741802/satelite-gaia-esa-via-lactea-nubes-de-magallanes.html)

**Jordi, C.**, *Diez desafíos caídos del cielo*, 12/08/2015  
<http://www.elcultural.com/noticias/ciencia/Diez-desafios-caidos-del-cielo/8154>

**Jordi, C.** *Gaia ya ha cubierto el cielo completo*, 23/06/2015  
<http://www.iac.es/divulgacion.php?op1=16&op2=402&id=78>

**Jordi, C.** *Gaia alerta de asteroides desconocidos*, 30/06/2015, Newspaper *El País*  
[http://elpais.com/elpais/2015/06/25/ciencia/1435230474\\_414196.html](http://elpais.com/elpais/2015/06/25/ciencia/1435230474_414196.html)

**Luri, X.**, *La piràmide i altres misteris marcians*. Newspaper *ARA*, 30/08/2015  
[http://www.ara.cat/premium/piramide-altres-misteris-marcians\\_0\\_1421258108.html](http://www.ara.cat/premium/piramide-altres-misteris-marcians_0_1421258108.html)

**Luri, X.**, *La Terra i la Lluna, un naixement d'impacte*. Newspaper *ARA*, 31/05/2015  
[http://www.ara.cat/suplements/diumenge/Terra-lluna-naixement-dimpacte\\_0\\_1367263271.html](http://www.ara.cat/suplements/diumenge/Terra-lluna-naixement-dimpacte_0_1367263271.html)

**Luri, X.**, *Mart, el primer pas per a somiar en la colonització d'un altre planeta*. Newspaper *ARA*, 29/09/2015  
[http://www.ara.cat/societat/pas-somiar-colonizacio-dun-planeta\\_0\\_1440455971.html](http://www.ara.cat/societat/pas-somiar-colonizacio-dun-planeta_0_1440455971.html)

**Luri, X.**, *Tot a punt per a l'eclipsi solar* Newspaper *ARA*, 18/03/2015  
[http://www.ara.cat/societat/punt-leclipsi-solar\\_0\\_1323467669.html](http://www.ara.cat/societat/punt-leclipsi-solar_0_1323467669.html)

**Luri, X.** *Astronomía: la ciencia más mágica*. Article. Newspaper *El Mundo* 11/09/2015  
<http://www.elmundo.es/ciencia/2015/09/11/55eff8d122601d995a8b4572.html>

## Press releases

**The Faculty of Physics hosts the exhibition “Physics in our lives”**

13 January 2015

[http://www.ub.edu/web/ub/en/menu\\_eines/noticies/2015/01/010.html](http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/01/010.html)

***The UB participates in second period of operation of the Large Hadron Collider***

25 February 2015

[http://www.ub.edu/web/ub/en/menu\\_eines/noticies/2015/02/042.html](http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/02/042.html)

***The UB live-streams the solar eclipse that happens on 20 March and provides two telescopes to observe it***

19 March 2015

[http://www.ub.edu/web/ub/en/menu\\_eines/noticies/2015/03/060.html](http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/03/060.html)

***ICCUB and BGSMath receive the distinction María de Maeztu and IBEC obtains Severo Ochoa Excellence Award***

23 April 2015

[http://www.ub.edu/web/ub/en/menu\\_eines/noticies/2015/04/038.html](http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/04/038.html)

***CMS and LHCb experiments reveal new rare particle decay***

14 May 2015

[http://www.ub.edu/web/ub/en/menu\\_eines/noticies/2015/05/034.html](http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/05/034.html)

***UB participates in the new season of the large hadron collider***

8 June 2015

[http://www.ub.edu/web/ub/en/menu\\_eines/noticies/2015/fotonoticies/06/001.html](http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/fotonoticies/06/001.html)

***Award-winning UB centres receive the distinctions María de Maeztu and Severo Ochoa***

17 July 2015

[http://www.ub.edu/web/ub/en/menu\\_eines/noticies/2015/07/035.html](http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/07/035.html)

***Gaiaverse, the new portal of the Gaia mission***

28 July 2015

[http://www.ub.edu/web/ub/en/menu\\_eines/noticies/2015/07/050.html](http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/07/050.html)

***Gaia's first year of scientific observations***

28 August 2015

[http://www.ub.edu/web/ub/en/menu\\_eines/noticies/2015/08/017.html](http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/08/017.html)

***Foundation stone laying ceremony of a new generation of high-energy telescopes***

13 October 2015

[http://www.ub.edu/web/ub/en/menu\\_eines/noticies/2015/fotonoticies/10/002.html](http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/fotonoticies/10/002.html)

***Jordi Torra, new director of the Institute of Space Studies of Catalonia (IECC)***

26 October 2015

[http://www.ub.edu/web/ub/en/menu\\_eines/noticies/2015/10/058.html](http://www.ub.edu/web/ub/en/menu_eines/noticies/2015/10/058.html)

## Public Talks

**Jordi, C.**, *La lluna mentidera*, January 2015

**Ribó, M.**, *Què fa un astrònom?*, Escola del Parc, El Prat de Llobregat, 27/01/15

**Bosch-Ramon, V.**, *Coupling non-thermal radiation to hydrodynamics*, Univ. Valencia, Burjassot, 01/03/15

**Jordi, C.**, *La professió d'astrònoma. Què faig a la Universitat?*, Escola Octacio Paz, 09/03/15

**Jordi, C.**, *Projecció i comentari d'imatges del cel profund*, in the context of the *International Year of Light*, Associació Astronòmica Sant Cugat-Valldoreix. Sant Cugat del Vallès, 14/03/15

**Jordi, C.**, *La detecció dels exoplanetes: tècniques i limitacions*, in the context of the event *Un matí d'astrobiologia a la UB*, Aula Magna Faculty of Biology, 06/03/2015

**Salvador, E.**, *La primera llum de l'Univers i els seus efectes*, Agrupació Astronòmica de Sabadell, 18/03/15

**Miralda, J.**, *Present i futur de la vida a l'Univers*, Centre Cultural de Terrassa, organized by Agrupació Astronòmica de Terrassa i Òmnium Cultural Terrassa, 20/03/15

**Torra, J.**, *Gaia, els primers resultats i nous reptes*, Central office of the Agrupació Astronòmica de Sabadell, 25/03/15

**Romero, M.**, *Gaia, la màquina dels descobriments*, Col·legi La Farga, St Cugat del Vallès, 26/03/15

**Roca, S.**, *Gaia, la màquina dels descobriments*, Col·legi La Farga, St Cugat del Vallès, 27/03/15

**Jordi, C.**, *El color de les estrelles*, Associació astronòmica Sant Cugat-Valldoreix. Sant Cugat del Vallès, 16/04/15

**Carrasco, J.M.; Luri, X.**, *Misión Gaia: imágenes para crear el mapa de la galaxia*, Saló del Còmic, 18/04/15

**Carrasco, J.M.; Luri, X.,** *Mapas del cielo: la misión Gaia y la Vía Láctea en 3D*, Festival Pint of Science. Michael Collins, 18/05/15

**Ribó, M.,** *Forats negres silenciosos amagats en sistemes binaris*, central office of ASTER, Barcelona, 11/06/15

**Luri, X.,** *El mètode científic aplicat a la vida diària*, Museu Darder de Banyoles, 13/06/15

**Ribó, M.,** *Els forats negres... i altres objectes compactes*, Faculty of Physics, 19/06/15

**Carrasco, J.M.; Luri, X.,** *Gaia: El primer pas per a la fundació d'un imperi galàctic*, Biblioteca Zona Nord, 07/07/15

**Jordi, C.,** *La revolució observacional de Gaia*, Inaugural talk for the II congress PRO-AM (collaboration between professional and amateur astronomers) Alcalá de la Real, 12-14/07/2015

**Solanes, J. M.,** *Cosmogènesi: l'origen de l'univers*, Àger, 10/10/15

**Jordi, C.,** Round table, *La ciència de la llum. Mostra de vídeo científic*, Aula Magna from the Faculty of Physics (UB), 02/11/15

**Casamiquela, L.; Romero, M.,** *Gaia*, Escola Minguella. Badalona, 12/11/15

**Romero, M.,** *Amb A d'astrònoma: Dones i astronomia*, Les Avellanes Town Hall (Lleida), 21/11/15

**Paredes, J.M.,** *Radiació gamma: L'univers de raigs gamma*, Sala Gabriel Oliver, aulari Josep Carner, Faculty of Philology (Barcelona), 21/11/15

## Participation in Workshops and Schools

**Ribó, M.,** Eclipse tracing 23/03/15, CEIP Escola de la Concepció, 20/03/15

**Carrasco, J.M.,** *Rockets workshop*, Escola Font de Fargàs de Barcelona, 26/05/15

**Casamiquela, L.; Moreno, V.; Pérez, I.; Roca-Fàbrega, S.,** *Astronomy project*, MónNatura Pirineus, 22/06/15-04/07/15

## Broadcast of Astronomical Events

### Comet Lovejoy (22/01/2015)

To mark the occasion of comet Lovejoy passing near Earth, news and a special section concerning the comet were added to Serviastro's website.

<http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/LovejoyC2014Q2>

### Total solar eclipse, 20 March 2015

Several material and activities were prepared on occasion of this ephemeris:

- Informative page in the website ServiAstro: <http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/InfEc200315>
- Online broadcast of the event: <http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/EcSol200315BCN>
- Public observation from Espai Ciència Saló de l'Ensenyament, Barcelona. Plaça Universitat, Barcelona.
- Material distribution to schools: Observation Pack (8 protection glasses + 15 informative brochure, [http://serviastro.am.ub.edu/twiki/pub/ServiAstro/InfEc200315/Diptic\\_eclipsi\\_200315\\_baixa2.pdf](http://serviastro.am.ub.edu/twiki/pub/ServiAstro/InfEc200315/Diptic_eclipsi_200315_baixa2.pdf))

The following schools participated:

- CEIP Lluís Vives, Barcelona
- Escola El Calderí, Caldes de Monbui
- Escola Nostra Senyora de Montserrat, Rubí
- CEIP Fort Pienc. Barcelona
- CEIP Sant Lluís Gonçaga, La Garriga
- CEIP Abat Oliba, Cornellà de Llobregat
- Escola Costa Llobera, Barcelona
- INS EUROPA, Hospitalet de Llobregat
- Escola de la Concepció. Barcelona

The eclipse in the press: <http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/MitjansComunicacio200315>

### Perseids 2015

The Perseids meteor shower was noted on Serviastro's website and in a radio program.

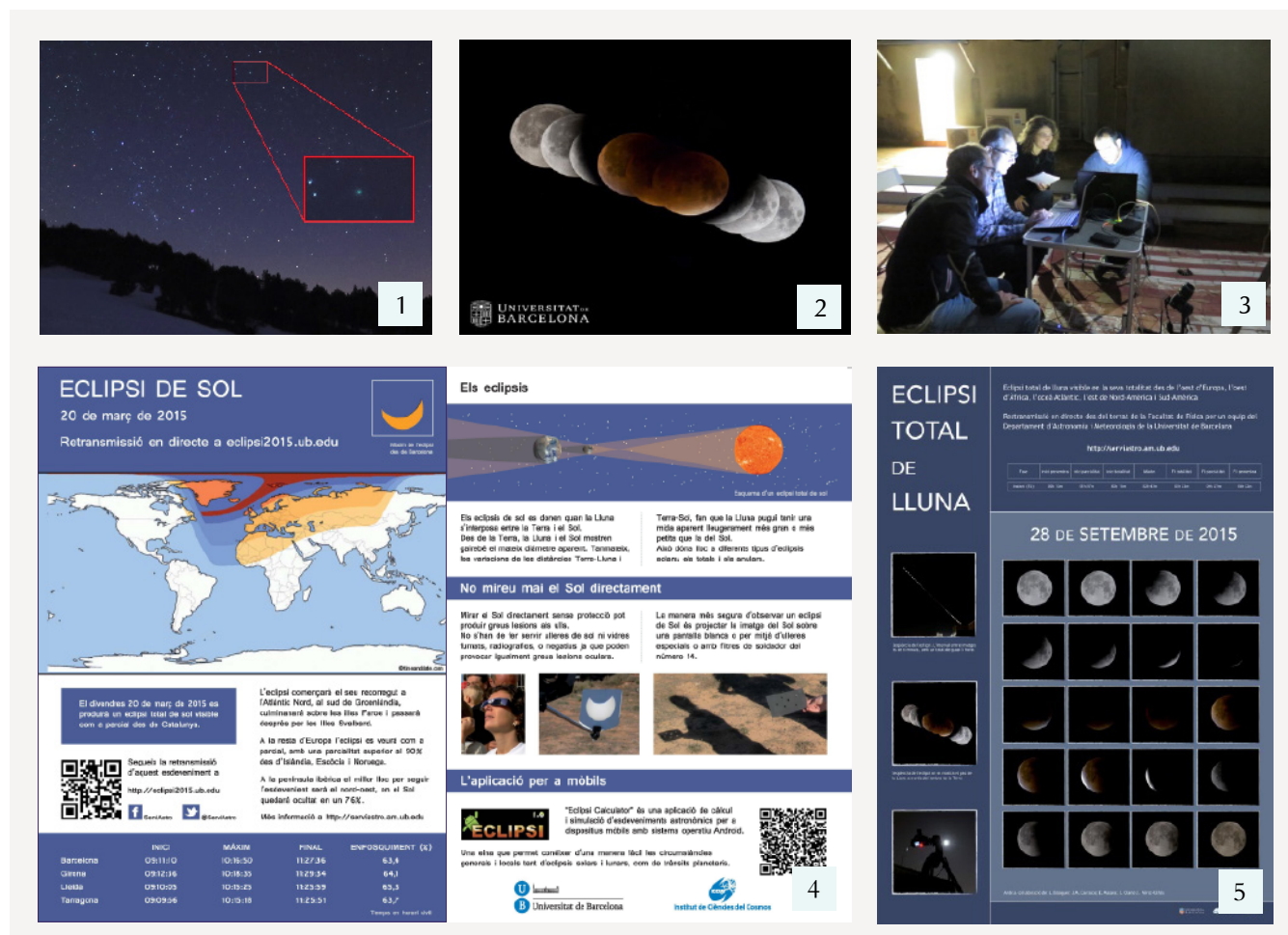
- Special web page in Serviastro: <http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/PerSeides2015>
- Radio program where J.M Carrasco talks about Perseids 2015: *El matí a Radio 4*, 12-08-2015

## Total Lunar eclipse the 28 September 2015

Serviastro broadcasted this event online and created an informative webpage and poster.

- Informative web page: <http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/InfEc280915>

- Online broadcast of the eclipse: <http://serviastro.am.ub.edu/twiki/bin/view/ServiAstro/EcLu280915>
- A poster: [http://serviastro.am.ub.edu/twiki/pub/ServiAstro/InfEc280915/Poster\\_-\\_final\\_baixa\\_EclipsiLLuna280915.pdf](http://serviastro.am.ub.edu/twiki/pub/ServiAstro/InfEc280915/Poster_-_final_baixa_EclipsiLLuna280915.pdf)



## BROADCASTS OF ASTRONOMICAL EVENTS

1: Comet Lovejoy on January 10th 2015 from Camporells (France). Image: Eduard Masana (ICCUB); 2, 3: Broadcast of the Total Lunar eclipse on September 28th 2015; 4: Leaflet of the eclipse 20/03/15; 5: Poster of the Total Lunar eclipse on September 28th 2015

## Astronomy Sessions

**Masana, E.; Balaguer, L.; Molina, D.,** *Sun eclipse observation*, Faculty of Physics, UB, Barcelona, 20/03/15

**Mor, R.; Pérez-Ràfols, I.; Olarte, S.,** *Sun eclipse observation*, Edifici Històric UB, Barcelona 21/03/15

**Roca, S.; Luri, X.,** *Sun eclipse observation*, Saló ensenyament. 22/03/15

**Moreno de la Cita, V.; Pérez-Ràfols, I.; Roca, S.; Olarte, S.,** *Sun observation*, Edifici Històric UB, 22/05/15

**Pérez-Ràfols, I.; Roca, S.,** *Public star observation*, Castellterçol. 28/08/15

**Masana, E.; Jordi, C.,** *Public observation at the refuge of Rebot*, Refugi del Rebot, Parc Natural del Cadí-Moixeró (Bagà, Berguedà), 17/10/15



## ASTRONOMY SESSIONS

1: Poster of the observation in Castellterçol; 2: Solar eclipse observation, Edifici Històric UB. 21/03/15

## Participation in TV and radio shows

**Carrasco, J.M.**, Interview *Eclipsi solar* in the program *Lletra lligada*, Ràdio 4, 16/03/15

**Luri, X.**, Interview *Eclipsi solar* in the program *Què vols ser?*, Ràdio Barcelona, 19/03/15

**Carrasco, J.M.**, Interview *Eclipsi solar* in the program *El Matí*, Cope Catalunya, 19/03/15

**Carrasco, J.M.**, Interview *Eclipsi solar* in the program *Hora Barcelona*, Ràdio Barcelona, 19/03/15

**Carrasco, J.M.**, Interview *Eclipsi solar* in the program *Amics i coneguts*, Ràdio 4, 21/03/15

**Carrasco, J.M.**, Interview *Eclipsi solar* in the program *Connexió Barcelona*, BTV, 20/03/15

**Carrasco, J.M.**, *La New Horizons arriba a Plutó*, in the News program at 10 o'clock of BTV, 14/07/15

**Carrasco, J.M.**, *Gaia*, in the program *La república santboiana*, Science Section, Ràdio Sant Boi, 18/11/15

**Carrasco, J.M.**, *L'estel de Nadal*, in the program *La república santboiana*, Science Section, Ràdio Sant Boi, 16/12/15

**Carrasco, J.M.**, *Sopa d'estrelles: Secció d'Astronomia a "El matí de Catalunya Ràdio"*, Fridays from 24 July to 28 August 2015, <http://www.am.ub.edu/twiki/bin/view/ServiAstro/WebRadio>

- Program 1, 24/07/15: *Arribada de New Horizons. Cançó Pluto Mars. El cel de l'estiu*
- Program 2, 31/07/15: *Planetas extrasolars. Blue Moon. Astronomia*
- Program 3, 07/08/15: *Astronomia i cinema*
- Program 4, 14/08/15: *Els sons de l'astronomia*
- Program 5, 21/08/15: *Gaia*

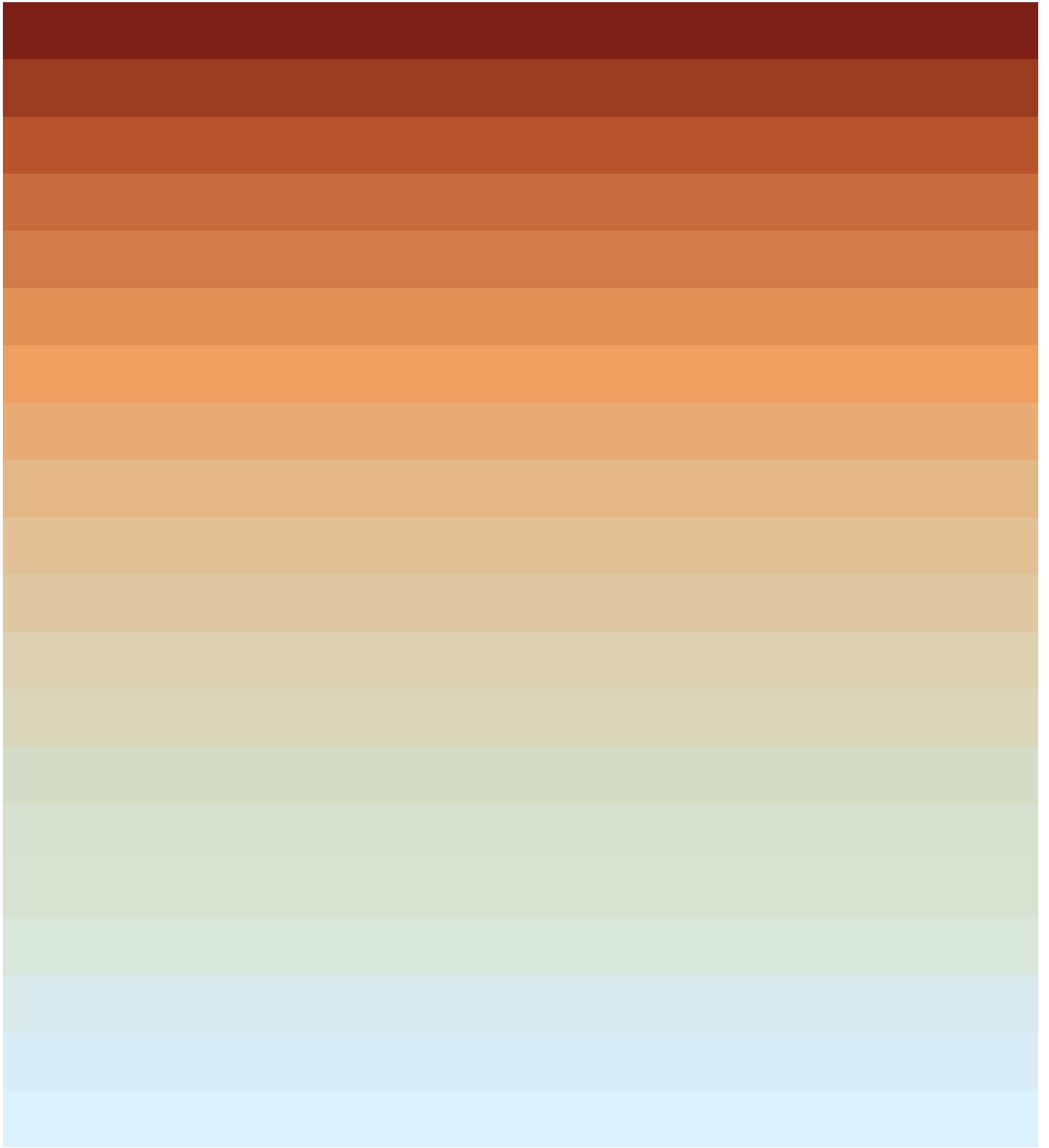


## PARTICIPATION IN TV AND RADIO SHOWS

1: Carrasco, J.M., "La New Horizons arriba a Plutó", in the News program at 10 o'clock of BTV, 14/07/15  
2: Carrasco, J.M., "La república santboiana, secció de ciència", (Ràdio Sant Boi), "L'estel de Nadal", 16/12/15







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