CENTRO DE ASTROBIOLOGÍA
ASOCIADO AL NASA ASTROBIOLOGY INSTITUTE

GOBIERNO DE ESPAÑA

CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

Instituto Nacional de Técnica Aeroespacial

EXCELENCIA MARÍA DE MAEZTU

Centro de Astrobiología (CSIC-INTA)

Annual Report

2017

Table of contents

INTRODUCCIÓN 2
INTRODUCTION 3
I INSTITUTE ORGANIZATION 4
GOVERNING COUNCIL 4
DIRECTION AND CENTER EXECUTIVE BOARD 5
ADVISORY BOARD 6
RESEARCH DEPARTMENTS 6
Astrophysics 6
Planetology and Habitability 7
Molecular Evolution 8
Advanced Instrumentation 10
SUPPORT UNITS 11
II RESEARCH ACTIVITIES 12
DEPARTMENTS AND RESEARCH GROUPS 12
Astrophysics 13
Planetology and Habitability 29
Molecular Evolution 37
Advanced Instrumentation 58
III PUBLICATIONS AND SCIENTIFIC PRODUCTION 66
PUBLICATIONS 66
PARTICIPATION IN CONFERENCES 90
IV SCIENTIFIC COOPERATION 112
INVITED RESEARCHERS CONFERENCES/SEMINARS AT CAB 112
VISITORS 113
IV TEACHING, OUTREACH AND OTHER ACTIVITIES 115
PH. D. THESES 115
MASTER, GRADE AND OTHER DEGREES THESES 116
TEACHING 117
COURSES, CONFERENCES AND SEMINARS 119
OUTREACH ACTIVITIES 124
AWARDS 128
V COMPETITIVE FUNDING 129
SUMMARY OF EXTERNAL GRANTS 129

INTRODUCCIÓN

El Centro de Astrobiología (CAB) se fundó en 1999 como un Centro Mixto entre el Consejo Superior de Investigaciones Científicas (CSIC) y el Instituto Nacional de Técnica Aeroespacial (INTA). Localizado en el campus del INTA en Torrejón de Ardoz (Madrid), el CAB se convirtió en el primer centro fuera de los Estados Unidos asociado al recién creado *NASA Astrobiology Institute (NAI)*, convirtiéndose en miembro formal en el año 2000. La Astrobiología considera la vida como una consecuencia natural de la evolución del Universo, y en el CAB trabajamos para estudiar el origen, evolución, distribución y futuro de la vida en el Universo, tanto en la Tierra como en entornos extraterrestres.

La aplicación del método científico a la Astrobiología requiere la combinación de teoría, simulación, observación y experimentación. Esta aplicación de la Ciencia fundamental a las cuestiones de la Astrobiología es el principal objetivo del CAB. La organización multi- y transdiciplinar del Centro fomenta la interacción de los ingenieros con investigadores experimentales, teóricos y observacionales de varios campos: astronomía, geología, bioquímica, biología, genética, teledetección, ecología microbiana, ciencias de la computación, física, robótica e ingeniería de las comunicaciones. La investigación en el CAB aborda la sistematización de la cadena de eventos que tuvieron lugar entre el Big Bang inicial y el origen de la vida, incluyendo la autoorganización del gas interestelar en moléculas complejas y la formación de sistemas planetarios con ambientes benignos para el florecimiento de la vida. El objetivo final es investigar la posible existencia de vida en otros mundos, reconociendo biosferas diferentes de la terrestre, para ayudarnos en la comprensión del origen de la vida. El camino será todavía largo, pero la meta está cada vez más próxima.

INTRODUCTION

The Centro de Astrobiología (CAB) was founded in 1999 as a joint centre between the National Research Council (CSIC) and the National Institute for Aerospace Technologies (INTA). Located within the INTA campus in Torrejón de Ardoz (Madrid), CAB became the first astrobiology organisation outside the United States to be associated with the NASA Astrobiology Institute (NAI) – formally becoming an associate partner in the year 2000. Astrobiology considers life as a natural consequence of the evolution of the Universe, and CAB aims to study the origin, evolution, distribution, and future of life in the Universe, both on Earth and in extraterrestrial environments.

Application of the scientific method to astrobiology requires the combination of theory, simulation, observation and experimentation. This application of fundamental science to the questions of astrobiology is the most important goal for CAB. The multi- and transdisciplinary setting available at CAB allows engineers to interact with experimental, theoretical and observational scientists from various fields: astronomy, geology, bio-geochemistry, biology, genetics, remote sensing, microbial ecology, computer science, physics, robotics and communications engineering. The research at CAB relates to the systematisation of the chain of events that took place between the Big Bang and the origin and evolution of life, including the self-organisation of the interstellar gas into complex molecules and the formation of planetary systems with benign conditions fostering the flourishing of life. The final aim is to investigate the possibility of life on other worlds, recognising biospheres that might be different from that on Earth, to help us understanding the origin of life. It will be still a long way, but the destination is becoming closer and closer. .

I INSTITUTE ORGANIZATION

Centro de Astrobiología is a joint institute participated by Agencia Estatal Consejo Superior de Investigaciones Científicas (CSIC) and Instituto Nacional de Técnicas Aeroespaciales (INTA). Its Governing Council is therefore chaired by CSIC President and INTA Director General, to whom the CAB Director and Deputy Director report.

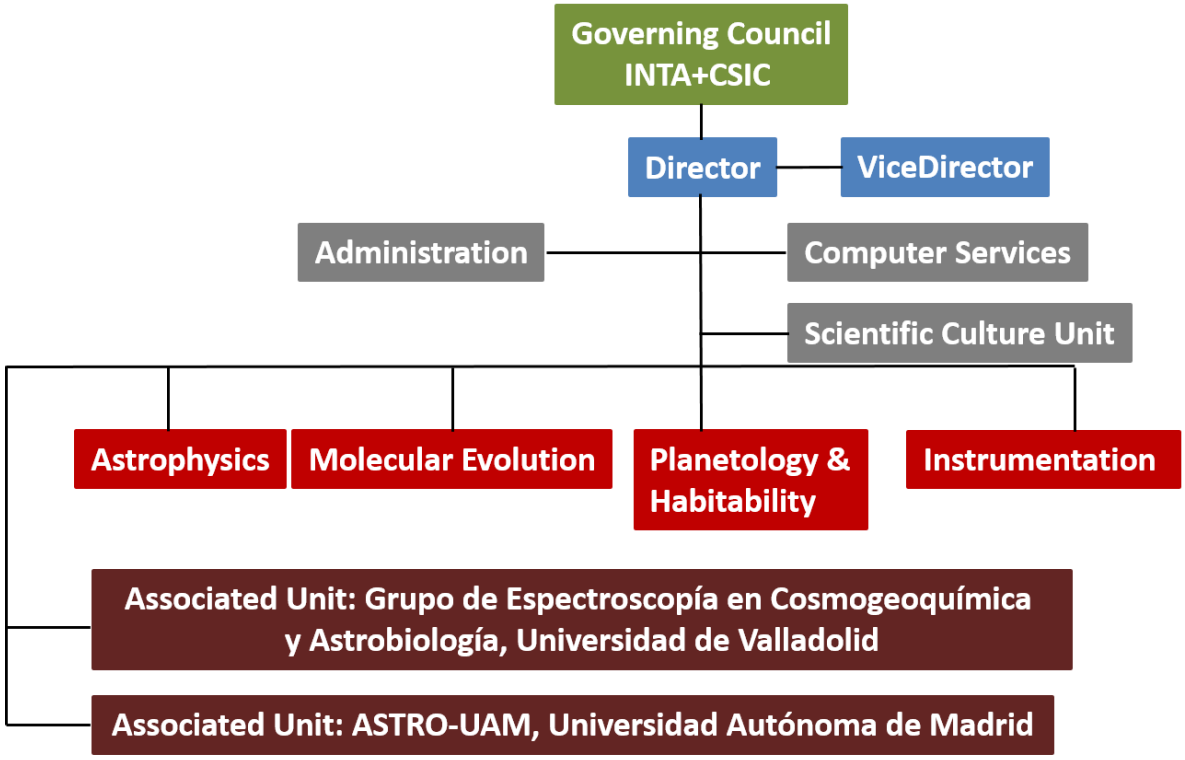


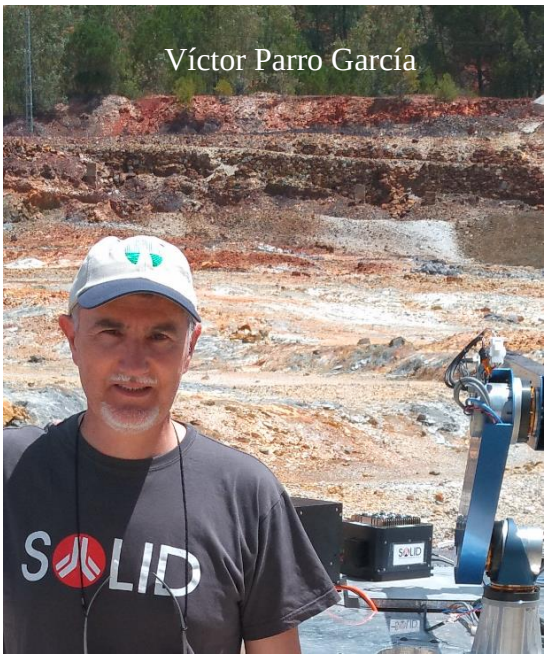
Figure: *Organization of Centro de Astrobiología in 2017.*

Centro de Astrobiología was organized in 2017 in 4 Research Departments and 2 Associated Units with the universities of Valladolid and Autónoma de Madrid, respectively. Some additional units provide the requird support for the operations of CAB. The departments operate a number of laboratories and facilities covering the very different areas of activity.

GOVERNING COUNCIL

Name	Position
Emilio Lora-Tamayo D'Ocón	CSIC President (Jan-Oct)
Rosa María Menéndez López	CSIC President (Nov-Dec)
Ignacio Azqueta Ortiz	INTA Director General

DIRECTION AND CENTER EXECUTIVE BOARD



Name	Position
J. Miguel Mas Hesse	Director
Victorino Parro García	Deputy Director
Jose María Delgado Lucas	Administrative Manager, Board secretary
Francisco Najarro de la Parra	Head of Astrophysics Department
Olga Prieto Ballesteros	Head of Planetology and Habitability Department
Eduardo González Pastor	Head of Molecular Evolution Department
Eduardo Sebastián Martínez	Head of Advanced Instrumentation Department
Benjamín Montesinos Comino	Researcher
Mercedes Moreno Paz	Researcher
Esther Bermúdez Castillo	Administration

ADVISORY BOARD

The former Directors of CAB constitute its Advisory Board:

- 1999 – 2008: Juan Pérez Mercader (CSIC)
- 2008 – 2010: Álvaro Giménez Cañete (CSIC)
- 2010 – 2015: Javier Gómez Elvira (INTA)

RESEARCH DEPARTMENTS

Astrophysics

Name	Position
Alacid Polo, José Manuel	ISDEFE
Alfonso Garzón, Julia	Post-doc
Alonso Herrero, Almudena	Staff
Arribas Mocoroa, Santiago	Staff
Barrado Navascués, David	Staff
Barceló Forteza, Sebastiá	Post-doc
Blanco Sánchez, Carmen María	Tit.Sup.ATP
Caballero Hernández, Jose Antonio	Staff
Carrascosa de Lucas, Héctor	Pre-doc
Colina Robledo, Luis	Staff
Cortés Contreras, Miriam	Post-doc
Crespo Gómez, Alejandro	Pre-doc
Domingo Garau, Albert	Post-doc
García García, Miriam	Post-doc
Huelamo Bautista, Nuria	Staff
Jimenez Esteban, Francisco	Post-doc
Labiano Ortega, Álvaro	Post-doc
López del Fresno, Mauro	Tit. Sup. ATP
Maiz Apellaniz, Jesús	Staff
Martín Doménech, Rafael	Tit. Sup. ATP
Martín Guerrero de Escalante, Eduardo L.	Staff
Martín-Pintado Martín, Jesús	Staff
Martinsson, Thomas Per Krister	Post-doc
Mas Hesse, J. Miguel	Staff

Mendiguitía Gómez, Ignacio Antonio	CM-post-doc
Miniutti, Giovanni	Staff
Montesinos Comino, Benjamin	Staff
Morales Calderón, María	Post-doc
Morales Durán, Carmen	Staff
Moya Bedón, Andrés	Post-doc
Muñoz Caro, Guillermo Manuel	Staff
Najarro de la Parra, Francisco	Staff
Oliva Rubio, María	Tit.Sup.ATP
Piqueras López, Javier	Post-doc
Prieto Vizán, Patricia	Tit.Sup.ATP
Rico Villas, Fernando	Pre-doc
Rizzo Caminos, Ricardo	ISDEFE
Rodrigo Blanco, Carlos	Tit.Sup.ATP
Rodriguez del Pino, Bruno	Tit.Sup.ATP
Sánchez Contreras, María del Carmen	Staff
Sánchez García, María	Pre-doc
Sanz Forcada, Jorge	Staff
Sanz Fernández de Cordoba, Lourdes	Staff
Solano Márquez, Enrique	Staff
Urbano Mayorgas, Juan José	Pre-doc
Velasco Trasmonte, Almudena	ISDEFE
Villar Martín, M.Montserrat	Staff
Zapatero Osorio, M. Rosa	Staff

Planetology and Habitability

Name	Position
Amils Pibernat, Ricardo	Staff (UAM-CAB)
Azúa Bustos, Armando Javier	Post-doc
Carrizo Gallardo, Daniel Alejandro	RyC post-doc
Cuesta Crespo, Luis	Post-doc
Fernández Sampedro, María Teresa	Staff
Flores Jiménez, Beatriz	Tit.Sup.ATP

García Descalzo, Laura	Post-doc
Gil Lozano, Carolina	Post-doc
Gómez Gómez, Felipe	Staff
Gómez González, Juan Luis	Pre-doc
González Fairén, Alberto	Staff
Marín Redondo, María Paz	PTA MINECO
Martínez Sarmiento, Paloma	Staff
Muñoz Iglesias, María Victoria	Post-doc
Neto Lima, Joana Filipa	Pre-doc
Olof Ormo, Jens	Staff
Prieto Ballesteros, Olga	Staff
Robas García, Cristina	Pre-doc
Rodriguez González, Nuria	Staff
Rodrigo Montero, Rafael	Staff
Tornos Arroyo, Fernando	Staff
Zorzano Mier, María Paz	Staff

Molecular Evolution

Name	Position
Aguilera Bazán, Angeles	Staff
Arribas Hernán, María	Staff
Benguigui de la Cámara, Macarena	Pre-doc
Blanco López, Yolanda	Post-doc
Briones Llorente, Carlos	Staff
Cid Sánchez, Cristina	Staff
De Diego Castilla, Graciela	Post-doc
Espigares Castillo, Patricia	Pre-doc
Fernández Martínez, Miguel Ángel	CM post-doc
Fernández Algar, María	Staff
Gálvez Martínez, Santos	Pre-doc
García López, Eva	PTA MINECO
García Villadangos, Miriam	Staff
Gómez Frutos, Sara	Pre-doc

González Figueras, Carolina	Staff
González Pastor, José Eduardo	Staff
González Toril, Elena	Staff
Hochberg Newman, David	Staff
Lamprecht Grandio, Maria	Tit.Sup.ATP
Lázaro Lázaro, Ester	Staff
De Lucas Cerrillo, Ana María	Tit.Sup.ATP
Manchado Ortega, Juan Manuel	Tit.Sup.ATP
Mateo Martí, Eva	Staff
Mirete Castañeda, Salvador	Staff
Moreno Molina, Miguel	Post-doc
Moreno Paz, Mercedes	Staff
Narrillos Fernández, David	CM-Tit.Sup.ATP
Ochoa de Eribe Casas, Jon Ander	Tit.Sup.ATP
Osuna Esteban, Susana	Staff
Parro García, Víctor	Staff
Pascual Silva, Carolina	CM-Tit.Sup.ATP
Postigo Cacho, Marina	Staff
Ruiz Bermejo, Marta	Staff
Sánchez García, Laura	Post-doc
Torres Vázquez, Beatriz	Pre-doc
White, Joseph John	Tit.Sup.ATP

Advanced Instrumentation

Name	Position
Benitez Berrocal, Sara	Pre-doc
Bravo Cuesta, Andres	Pre-doc
Carretero Saiz, Sara	CM-Tit.Sup.ATP
Ferrandiz Guibelalde, Ricardo	Staff
Gómez Gutierrez, Alicia	Post-doc
Lepinette Malvite, Alain	Staff
Magaz Pérez, María Teresa	Tit.Sup.ATP
Marín Jiménez, María de las Mercedes	Tit.Sup.ATP
Martín Soler, Javier	Staff
Molina Jurado, Antonio	Tit.Sup.ATP
Mora Sotomayor, Luis	Tit.Sup.ATP
Navarro López, Sara	Staff
Peinado González, Verónica	Tit.Sup.ATP
Pérez Izquierdo, Joel	Pre-doc
Pla García, Jorge	Tit.Sup.ATP
Rincón Lozano, Tomás	PTA MINECO
Rodríguez Manfredi, José Antonio	Staff
Romeral Planelló, Julio José	Staff
Sobrado Vallecillo, Jesús Manuel	Staff
Torres Redondo, Josefina	Staff
Urqui O´Callaghan, Roser	ISDEFE
Viudez Moreiras, Daniel	Tit.Sup.ATP
Zurita Zurita, Sofia	Tit.Sup.ATP

SUPPORT UNITS

Name	Position
Alonso del Val, Pilar	Laboratory support/ISDEFE
Alonso Valdivieso, Miguel Ángel	Scientific culture unit
Bermúdez Castillo, Esther	Administration
Camps Martínez, Fernando	Computer services
Cañete Mata, Juan Manuel	Computer services
Conde Martín, Jose Ignacio	Maintenance/workshop
Del Olmo Andrés, Rosa María	Reception/ISDEFE
Delgado González, Cristina	Scientific culture unit
Delgado Lucas, Jose María	Administration
Fraile Noriega, Tatiana	Administration/ISDEFE
García Climent, Inmaculada	Administration/ISDEFE
García Martín, Maria Teresa	Administration/ISDEFE
Guitart Martín, Margie	Administration
Gutiérrez Ortega, Macarena	Administration/ISDEFE
Martínez de Llera, Carmen	Administration/ISDEFE
Moncayo Ortega, Consuelo	Administration
Parras Rico, Antonio	Computer services/ISDEFE
Roncero Holgado, Diego Manuel	Computer services
Sánchez Narrillos, Paula	Scientific culture unit
Suárez Marsá, Virginia	Administration
Suárez Carrasco, Sergio	Computer services/ISDEFE
Vaquerizo Gallego, Juan Ángel	Scientific culture unit/ISDEFE

II RESEARCH ACTIVITIES

DEPARTMENTS AND RESEARCH GROUPS

- Astrophysics (AP)
- Planetology and Habitability (PH)
- Molecular Evolution (ME)
- Advanced Instrumentation (AI)

Astrophysics

Head of Department: Francisco Najarro

Throughout the history of the Universe, generations of stars have created in their interior all the heavy elements that we know. The atoms of these chemical elements formed molecules, dust grains and ice sheets in the interstellar and intergalactic medium to condense into planetary systems with rocky planets. Liquid water, as on the Earth, allowed the conditions in which life arose more than 3.5 billion years ago and must have been repeated in a large number of planetary systems.

We investigate key processes that were necessary for the appearance and evolution of life in the Universe such as: the formation of chemical elements in the interior of the stars and the formation and evolution of the galaxies that house them, processes of planet formation around new stars, the formation and evolution of chemical compounds of a range of complexity in interstellar space, or the search for new extrasolar planets.

The astrophysics department has a strong participation and leadership in technological activities associated with future astronomical instrumentation both in space and on the ground. Further, the department is also heavily involved in the scientific exploitation of ground and space facilities, which are currently under operation and basically cover the whole electromagnetic range, from Gamma-Rays to Radio wavelengths.

During 2017, we have continued our research on the physico-chemical processes that play a significant role in interstellar and circumstellar environments, which are rich in chemical species crucial for appearance of life. Within the field of stellar astrophysics, we have carried out studies across all the evolutionary stages, seeking to understand the formation and evolution from high to very low mass stars, including protoplanetary discs and exoplanets. At larger scales we have investigated massive star-formation in both nearby and distant luminous star-forming galaxies as well as its relation with the presence of massive black holes in their nuclei. Finally, our Virtual Observatory group has been very successful in the improvement the CAB Data Centre, providing support to other Spanish data centres. It has also actively continued with the development of VO standards and tools related with data mining combined with education and outreach activities.

The Department is organized in 4 Research Groups:

- Galaxies Formation and Evolution
- Interstellar and Circumstellar Medium
- Formation and Evolution of Stars, Brown Dwarfs and Planets
- Virtual Observatory Group: Scientific exploitation of astronomical archives

Galaxies Formation and Evolution

Coordinator: Giovanni Miniutti

Research topics:

The "Galaxies Formation and Evolution" group at CAB aims at providing a global view of the processes of galaxy formation and evolution across cosmic time. The group has a great expertise in observational studies of massive star-formation in both nearby and distant luminous star-forming galaxies using, for instance, the Lyman-α emission as a tracer of star formation processes. Integral-field spectroscopy of luminous and ultra-luminous infrared galaxies in the near infrared is routinely used to differentiate the different ionization mechanisms of the interstellar medium over a very broad range of luminosities and to characterize the galaxy properties. Neutral and ionized gas outflows, their kinematics, their effect on the star-formation rate and thus on the overall galaxy evolution, are also observationally studied in the optical and infrared. Any theoretical model of galaxy evolution must take into account the presence of a central super-massive black hole which, when active, reveals itself as an Active Galactic Nucleus (AGN). AGN observations are from radio to X-rays covering th majority of research topics of interest in the field.

The group is also heavily involved in technological projects of future astronomical instrumentation both in space and on the ground in the framework of the European Space Agency and the European Southern Observatory programs. We participate in the instrument teams of the MIRI and NIRSpec instruments for the James Webb Space Telescope (JWST), and group members are involved in the preparation of the first science programs to be carried out with the JWST. Members of the group also take part in the team responsible for the development of HARMONI, first-light instrument of the European Extremely Large Telescope (ELT). Group members also participate to the definition of the next ESA large X-ray observatory Athena both at the scientific and hardware levels (X-IFU instrument), as well as in other space-based international projects that are still under competitive ESA selection procedures.

Selection of scientific results in 2017:

[1] Star-formation within a galactic outflow: Observations of massive molecular outflows in galaxies have often revealed sufficiently high gas densities to form stars within the outflow itself. This star-formation mode, in which stars form with high radial velocities, could contribute to the morphological evolution of galaxies, to the evolution in size and velocity dispersion of the spheroidal component of galaxies, as well as provide in situ chemical enrichment of the circumgalactic and intergalactic medium. Up to now, there exists some observational evidence for star-formation triggered by outflows or jets in their host galaxies due to gas mechanical compression, but direct evidence for star-formation occurring within the outflow itself was missing. The group participated in 2017 in a study that revealed, for the first time and thanks to unambiguous spectroscopic evidences, star-formation occurring within the galactic outflow in the relatively nearby galaxy IRAS F23128-5919 at redshift z=0.0448 (or about 600 million light-years from Earth).

This conclusion comes, primarily, from the detection of a very young stellar population in the outflow. These stars are not only young: their motion and velocity indicate that

they are travelling at very high velocities away from the galaxy center, as expected for stars caught in a stream of fast-moving material, namely the outflow itself. Theoretical models have long predicted that star-formation within galactic outflows could play an important, if not major, role. These results provide the first evidence that this phenomenon does indeed occur.

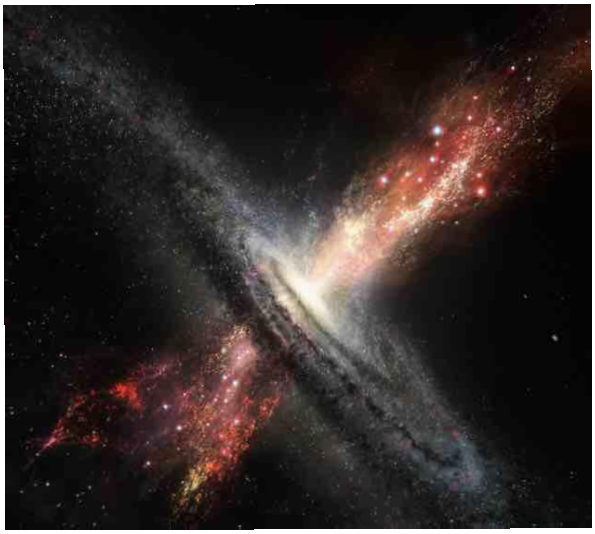


Figure AP1: *Artistic view of star-formation occurring within a large scale galactic outflow*

[2] The response of AGN ultra-fast outflows to X-ray variability: Active Galactic Nuclei (AGN) are thought to have a profound effect on large scales through feedback mechanisms. The fastest gas outflows (the so-called Ultra Fast Outflows or UFOs) have velocities higher than 10,000 km/s and are observed at X-ray energies. We have participated in the detection of an UFO in the AGN IRAS 13224-3809 with a velocity of 71,000 km/s (about 24% the velocity of light).

Figure AP2: *Artist impression of a super-massive black hole with X-ray emission emanating from its inner region (pink) and ultrafast winds streaming from the surrounding disk (purple). Credit: ESA*

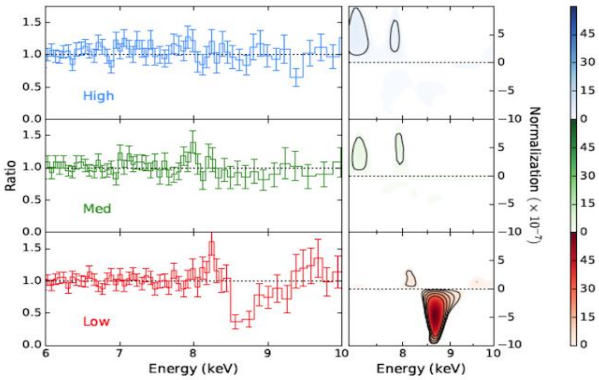


Figure AP3: *Flux-selected X-ray spectra of IRAS 13224-3809 at different flux levels. Absorption features between 8 and 9 keV are significant only in the lowest X-ray flux state (bottom).*

The most relevant result is that the outflow is seen to respond to the X-ray variability in less than an hour, hundreds of times faster than ever seen before. As the flux increases, the temperature of the outflow gets higher (because the gas is more irradiated by X-

rays), electrons are stripped away from their atoms in the wind, and the strength of the observed absorption features is reduced accordingly. These findings provide clear evidence for the link between the X-ray emission from the inner accretion flow and the outer wind, and they are a key step forward in understanding how black hole winds and outflows are launched and accelerated.

[3] Massive outflows of hot molecular gas in ULIRGs: The group has studied some nearby Ultra-Luminous Infrared Galaxies (ULIRGs) using the near-IR integral-field spectrograph SINFONI on the ESO Very Large Telescope (VLT). This resulted in the detection of massive outflows of hot molecular gas (in the form of H_2 molecules) with velocities of few hundreds km/s on spatial scales of 0.7-1.6 kpc. The mass outflow rate is found to be of the order of 30-85 Solar masses per year, a factor of a few lower than the star-formation rate in these ULIRGs. Most of the outflowing molecular gas does not reach the escape velocity of their systems, meaning that the bulk of the gas will remain bound to the system. The gas is then re-distributed within the galaxy and thus is still available to potentially fuel future star-formation episodes.

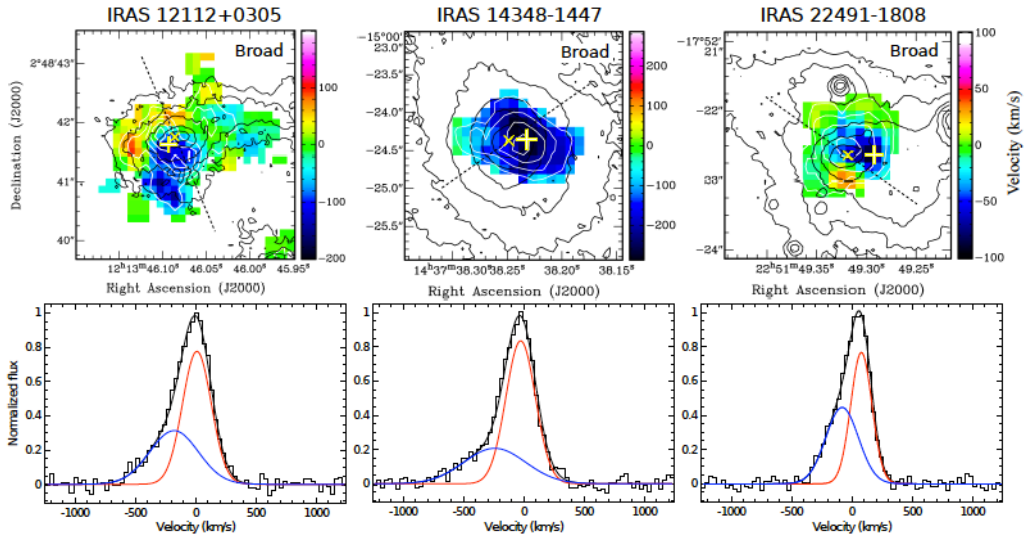


Figure AP4: *The velocity maps of H_2 in 3 ULIRGs are shown in color in the top figures. The bottom panels are the H_2 spectra (and best-fitting double-Gaussian models) extracted from the region (marked with "+" in the top panels) where the outflow reaches maximum velocity.*

[4] Survival of the obscuring torus in the most powerful AGN: Dedicated searches have generally found that the fraction of obscured (heavily absorbed) AGN decreases with AGN luminosity. This has often been interpreted as evidence for a decrease of the covering factor of the obscuring torus with increasing luminosity, the so-called receding torus model. Using data from AGN X-ray surveys together with results obtained from CLUMPY AGN tori models, members of the group were able to reveal a significant population of X-ray undetected AGN with high covering factor tori that are increasingly numerous at high AGN luminosities. This implies that the majority of luminous and rapidly accreting super-massive black holes in the local Universe (redshifts z<1) reside in heavily obscured nuclear environments, most of them being so deeply embedded that they have so far escaped detection in X-ray wide area surveys performed below 10 keV.

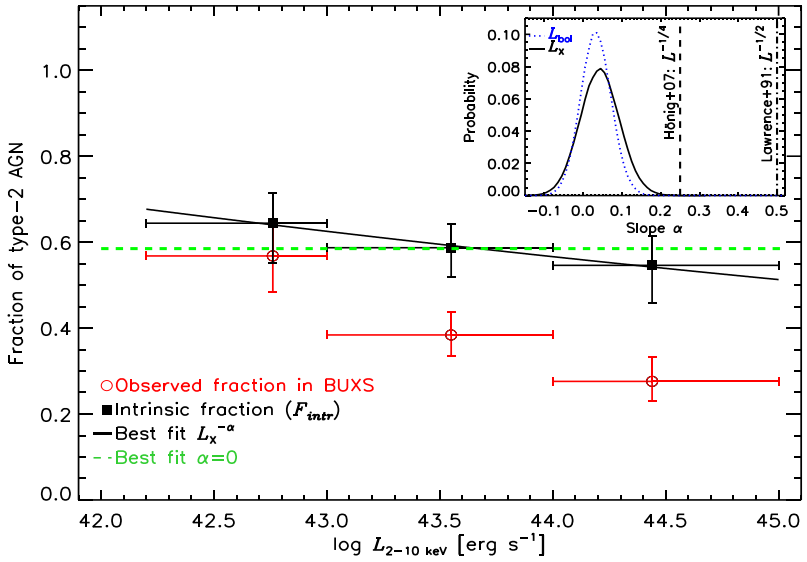


Figure AP5: *Luminosity dependence of the observed (red) and intrinsic (black) type-2 AGN fractions.*

[5] Galaxy-wide radio-induced feedback (in a radio-quiet quasar): Group members have reported the discovery of unambiguous evidence for AGN radio-induced feedback acting on very large scales (up to 26 kpc away from the AGN at the centre) in a radio-quiet and obscured quasar (known as the "Beetle" quasar). This is the very first radio quiet system where radio-induced feedback has been securely identified at ≫several kpc from the AGN. The morphological, ionization and kinematic properties of the extended ionized gas are correlated with the radio structures. The proposed scenario is one in which the radio structures have perforated the interstellar medium of the galaxy and escaped into the circumgalactic medium. While advancing, they have interacted with in-situ gas modifying its properties. These results show that jets of even modest power can be the dominant feedback mechanism acting across huge volumes in radio quiet systems, including highly accreting luminous AGN, where radiative mode feedback may be expected.

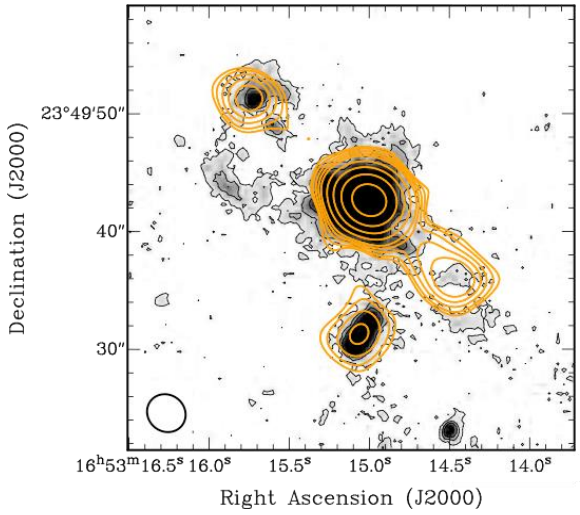


Figure AP6: *Huge bubbles of ionized gas shaped by the radio structure associated with the Beetle radio-quiet obscured quasar*

Technological activities, instrumentation, future ground- and spece-based observatories:

As mentioned, the Galaxies Formation and Evolution group is heavily involved in technological activities associated with future astronomical instrumentation both in space and on the ground. In particular, group members have continued their active participation into the James Webb Space Telescope project: members of the group have a strong involvement in the GTO programs through the participation in the scientific teams of two JWST instruments: NIRSpec, and MIRI. Group's members also participated in test campaigns (telescope+instruments) with NASA as well as actively contributed to the calibration working groups for the NIRSpec and MIRI. Group's members are also heavily involved with the HARMONI instrument (first light instrument for the ELT) where they have responsibilities for the calibration plan, calibration module, and low-order wavefront sub-system. They are also part of the Science Team of the instrument, providing scientific advise to the technical team, and leading one of the science cases of HARMONI. During December 2017, the project finished its PDR phase and carried out the associated reviews at ESO. Group members provide scientific support for the future ESA large X-ray mission Athena, chairing one of its Science Working Groups (SWG 2.4). Technological participation in Athena is associated to the main Athena X-ray detector, the X-IFU instrument. Group's researchers are part of the X-IFU consortium, as well as members of its Science Advisory team XSAT.

Interstellar and circumstellar medium

Coordinator: Guillermo M. Muñoz Caro

Summary: This group is composed of 12 persons: 4 senior scientists (Jesús Martín Pintado, Carmen Sánchez Contreras, Ricardo Rizzo, and Guillermo M. Muñoz Caro), 2 postdocs (Alicia Gómez Gutiérrez and Cristóbal González Díaz), 4 PhD students (Cristóbal Bordiú, Jesús Ramos Medina, Héctor Carrascosa, and Fernando Rico), a software developer (Carmen M. Blanco Sánchez), and lab support (Maite Magaz). The field known as Astrochemistry or Molecular Astrophysics is approached from three main different perspectives: i) ***Observational*** (ALMA observations, preparation of SAFARI-SPICA mission, Robledo de Chavela antennas, and access to other multi-wavelength observatories), ii) ***Theoretical*** (development of molecular excitation, radiative transfer, chemical evolution models, and MADCUBA code for data analysis), iii) ***Instrumentation*** (design and construction of SAFARI spectrometer, development of KID detectors to observe from mm to far-infrared, and iv) ***Experimental*** (laboratory experiments dedicated to ice processes using the ultra-high vacuum InterStellar Astrochemistry Chamber (ISAC), and use of external radiation facilities abroad such as GANIL in France and NSRRC in Taiwan).

This line of research is dedicated to the four-fold study mentioned above (observational, theoretical, instrumentation, and experimental) aiming to understand the physico-chemical processes that play a significant role in interstellar and circumstellar environments. Large circumstellar envelopes around evolved stars and the chemistry in protoplanetary disks are investigated. In diffuse clouds, some chemical reactions take place, but molecules are dissociated by the strong radiation field. In dense clouds like Orion, the sites of star formation, the detection of numerous molecular species results from a complex chemical reactions network and the interplay between dust and species in the gas phase. The dust grains act as small chemical reactors. In dense clouds they are covered by ice mantles composed of H_2O, CO, CO_2, CH_3OH, CH_4, NH_3, etc. Irradiation (energetic photons and cosmic rays) of the ice generates complex molecular species of prebiotic interest that are incorporated into comets and minor bodies of the primitive solar system. Nearly 200 molecules have already been detected in these environments, and every year a few new species enlarge this list. The chemistry of different environments in the Galaxy is often determined by the presence of intense UV fields from nearby stars, cosmic rays, shocks, turbulence, and other fenomena that are often not well characterized. The main goal of this team is to obtain a detailed description of the above environments, to understand the gas and dust lifecycle in our Galaxy and to determine the limits of chemical complexity before the appearance of life.

2017 Activities

During 2017, the members of this team have contributed to about 30 articles in peer-reviewed journals in astrophysics and high-impact factor journals of general interest (ApJ, A&A, MNRAS, Phys. Rev. Letters, etc.) and they have presented their results in several national and international conferences. In addition, several observing proposals have been submitted to different observatories (ALMA, IRAM-30m, IRAM-NOEMA, XMM, HST, etc.); a large number of them were accepted. The team is very active in the formation of junior scientists (PhD students and young postdocs).

Observational studies using different telescopes at different wavelengths:

Circumstellar envelopes around evolved stars: We have continued our studies of circumstellar envelopes around low-to-intermediate mass evolved stars (AGB, post-AGB and PN) through observations of these systems at multiple wavelengths, from the X-rays to the radio regime. For example, we have carried out (and published) a series of molecular line and continuum emission studies in the submm/mm-wavelength range with ALMA. The unique capabilities of ALMA (exquisite sensitivity and angular resolution) have enabled us to characterize the nebular morphology and dynamics of several AGB/pAGB/PNe with unprecedented detail and to improve our understanding of the origin of the remarkable morphological and kinematical differences between AGB circumstellar envelopes, which expand isotropically at low velocity (5-15km/s), and their more evolved counterparts, pAGB and PNe, which show fast-expanding (>100km/s) elongated lobes along one or more axes. Our team is leader in the search and direct characterization of rotating disks in these systems. Disks are postulated to play a major role in the (yet unknown) wind collimation process responsible of PN-shaping. In 2017, we reported the discovery (with ALMA) of two more objects with rotating disks. This year, we also published a pilot search for recombination line emission at mm-wavelengths with the IRAM-30m antenna in a small sample of pAGB objects with emerging central ionized regions. These lines are excellent probes of the dense inner (<150 A.U.) and heavily obscured regions of these objects, where the yet unknown agents for PN-shaping originate. We find mass-loss rates that are significantly higher (~10^{-6} to 10^{-7} M_{sun}/yr) than the values adopted by stellar evolution models currently in use and that would result in an AGB-to-PN transition much faster than hitherto assumed.

Interstellar Medium: Several studies to characterize interstellar regions have been carried out. The goal is to understand the chemistry in these environments, and in particular, the formation of complex organic molecules of interest for astrobiology. The molecule methyl-isocyanate (CH_3NCO) was detected for the first time in a solar-type protostar, IRAS16293-2422B, using the extraordinary sensitivity and angular resolution of the Atacama Large Millimeter Array (ALMA) by an international group led by CAB (see Fig.XX1). This object is 400 light years away from Earth. It is considered that this molecule, the simplest of the amides, could be a precursor of prebiotic molecules such as proteins and nitrogenous bases. The presence of this molecule, also detected in comet 67P/Churyumov-Gerasimenko, suggests that the chemistry in the disk that surrounds the solar-type protostar is similar to that of comets in our solar system. It is proposed that the formation of this molecule occurs in icy dust mantles, the seeds of planetary systems. The detection of this molecule supports the importance of prebiotic chemistry in space and its contribution to the origin of life on Earth.

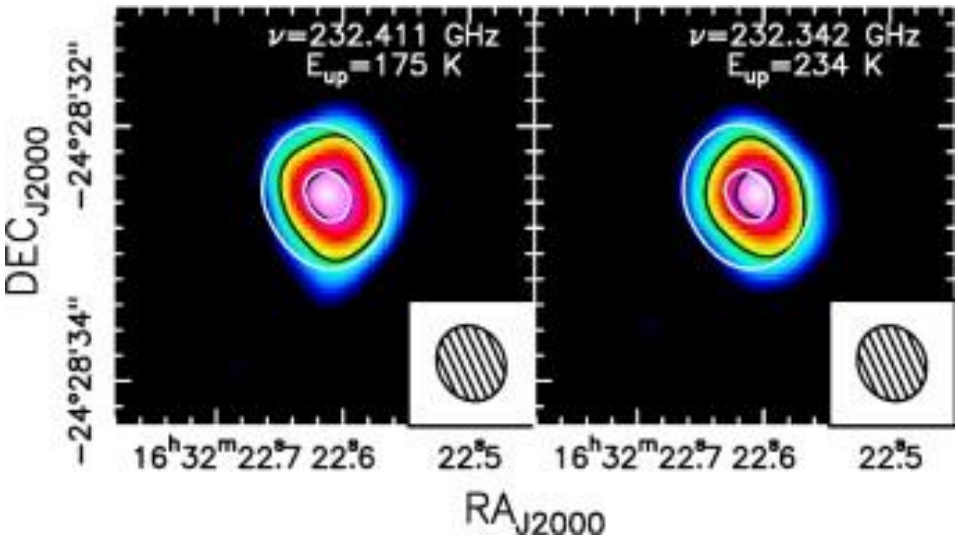


Figure AP7: *Maps of two representative CH3NCO lines observed towards IRAS16293 B. Black contours indicate 50 per cent and 90 per cent of the peak line emission, while white contours indicate 20 per cent and 80 per cent of the continuum peak emission at 232 GHz. The rest frequency and Eup of the transitions are shown in every panel (see also Table 1). Beam sizes are shown in the bottom right-hand corner (From Martín-Doménech et al. 2017, MNRAS. 469, 2230).*

Members of this team have worked on

- **Analysis of spectral lines surveys in a variety of objects observed with 30m and ALMA in cold cores (low mass –stars), hot cores (massive stars), Galactic center and extragalactic nuclei**
- **Star formation (both high and low mass)**
- **Proposals to international facilities at mm/submm**: ALMA, e-VLA, GBT, IRAM, APEX..
- **New astronomical facilities both on ground and space** (SKA, SPICA, …) During 2017, the CAB team has been working on the definition of the science cases. In particular, it has been very active on the field of the study of feedback and feeding in the Context of Galaxy Evolution with SPICA.

Laboratory astrochemistry

The presence of HS_2 radicals was proposed based on its efficient formation during UV/X-ray irradiation of H_2S bearing-ices, and this species was successfully detected this year (Fuente et al. 2017), with participation of our group. Progress was made in the study of complex chemical reactions in irradiated ice analogues. A long-standing project to study the photon-induced desorption of pure ice components was completed, incorporating H_2O and NH_3 ices to our set of molecules in 2017. Photo-desorption is invoked to explain the abundances of gas molecules in cold interstellar clouds. Several projects were performed with the use of the ISAC chamber concerning the formation of astrochemically relevant species: a joint PICS project with the French CNRS to study carbon grain analogues and their role in the formation of H_2 and complex organic molecules, a collaboration with NCU in Taiwan to study ice photochemistry in both laboratories, and a detailed study of CO accretion and desorption in collaboration with

NCU and TU Delft. We also participated in experiments on X-ray irradiation of interstellar ice analogs performed at the National Taiwanese Synchrotron (NSRRC), mimicking these processes in circumstellar environments of young stars, in collaboration with NCU and Palermo Observatory.

A PhD thesis has been presented on laboratory astrochemistry.

Data analysis

In 2017, work on the development of MADCUBA (Madrid Data Cube Analysis) was continued. The main capabilities of this code are:

- Data cube visualization and reduction. The visualization and analysis (soothing, crop, extract spectrum..) of spatially synchronized cubes has been implemented during 2017.
- Automatic import data cubes from ALMA and cubes and spectra from all Herschel instruments
- Advanced LTE analysis of molecular line profiles using the JPL and CDMS catalogs and recombination lines.

Instrumentation

In order to observe at lower frequencies than ALMA, several researchers coordinated the construction and integration of new instrumentation for the Robledo de Chavela antennas (*Host Country*). A new intermediate frequency processor and a broadband backend were installed. In the last 5 years the scientific results have been very satisfactory, leasing to several publications. A work published in 2017 reports a spectroscopic survey of Orion KL between 40 and 50 GHz.

During 2017, this group contributed to the preparation of SAFARI, a new far infrared spectrometer for SPICA Space Telescope. SPICA is an international project led by the JAXA (Japan), ESA (Europe) and several European institutions, including CAB. CAB contributes with the development of state-of-the-art Microwave Kinetic Inductance Detectors (MKIDs) for mm/sub/far infrared. It also participates in the design of the instrument and the optical components. In the context of the FP7 project "SPACEKIDS" the CAB has participated in the construction and characterization of 961-pixel imaging array (see Fig. XX2) based upon MKIDS operating at 850 GHz (350 microns). The evaluation of the detector array showed excellent system performance in terms of sensitivity, dynamic range, optical efficiency, cosmic ray rejection and pixel-pixel crosstalk, demonstrating that the technology is now mature to be considered for the development of state of the art future instrumentation.

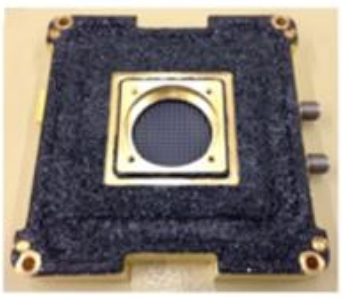


Figure AP8: *Photograph of the of 961 pixel imaging array (see Fig. 2) based upon MKIDS operating at 850 GHz (350 microns) in its holder, with the lens array clearly visible (from Baselmans et al. 2017, A&A 601, 89*

Formation and evolution of stars, brown dwarfs and planets

Coordinators: María Rosa Zapatero Osorio and Benjamín Montesinos Comino.

Our group is very active and addresses a significant number of scientific objectives, all of which are related to the formation and evolution of massive and low-mass stars, brown dwarfs, and planets. On-going space- and ground-based instrumental projects which some members of the group are fully involved in and of which great advances occurred during 2017 are the following: CHEOPS (ESA small mission to be launched by the end of 2018), MIRI/JWST (NASA mission to be launched in 2019), PLATO (adopted mission by ESA, expected launch in 2024), ARIEL (nearly-approved M4 mission of ESA), SAFARI/SPICA (proposed M5 space mission to ESA), CARMENES (planet-hunter spectrograph operating at visible and near-infrared wavelengths on Calar Alto Observatory), and ESPRESSO (planet-hunter spectrograph operating at visible wavelengths on Paranal Observatory). With the exception of JWST and SPICA, which are space-based observatories, all projects are devoted to the search and/or characterization of planets orbiting stars of the Galaxy. Highlights related to these instruments are the following:

- Definition of the Guaranteed Time targets for JWST.
- Successful commissioning of the ESPRESSO instrument (for the VLT), which will be offered to the community in the next call for proposals by ESO.
- PLATO adoption by ESA on June 2017.
- CHEOPS: the integration of the flight model of the platform was successfully completed at Airbus-CASA.
- SAFARI/Spica: the proposal was submitted to the ESA M5 call. The selection of the M5 mission will be announced, hopefully, in 2018.
- ARIEL: this is the recommended M4 mission. Acceptance by ESA was delayed from November 2017 to early 2018.

In what follows, scientific highlights produced by group members are summarized:

- The most complete long-term optical study of the Be/-ray binary H 1145-619 in correlation with its X-ray activity reveals, for the first time, the presence of a retrograde density perturbation in the circumstellar disc of a Be/X-ray binary.
- Near-infrared spectra of dust-embedded stars at the center of the Galactic's center Quintuplet Cluster reveals broad emission lines due to ionized carbon and helium, thus confirming the late-type carbon Wolf-Rayet nature of the stars.
- ALMA data at 880 μm reveal five unresolved sources whose masses are estimated between 0.9 and 67 times the mass of Jupiter. In combination with APEX/LABOCA data, two of these sources appear to be undergoing gravitational contraction. They could be the precursors of isolated planets and brown dwarfs, and are called proto-brown-dwarfs.
- Using VLT/SPHERE/ZIMPOL observations of HD 100546, it was possible to detect filaments of dust (bar-like structure) with a size of approximately 20 AU connecting

the outer and the inner disks. It is tentatively suggested that the bar could be dust dragged by infalling gas that radially flows from the outer disk to the inner region (see Figure AP9).

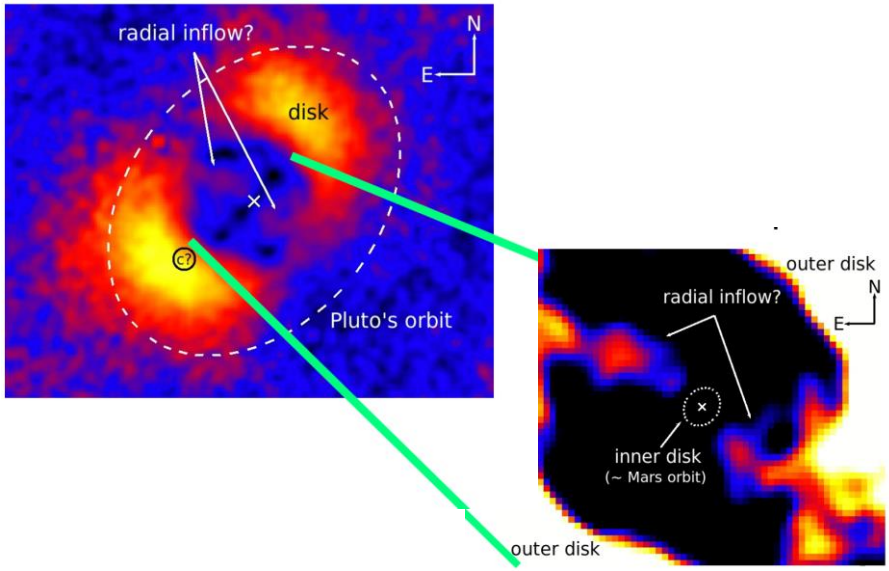


Figure AP9: *(Left panel) SPHERE/ZIMPOL images of HD 100546 in the continuum of Hα show the external disk, which has a radius similar to the orbital size of Pluto. The positions of the central star and a possible planet are indicated with a white cross and a black circle, respectively. (Right panel) Zoom-in images displaying the bar-like structure extending from the outer to the inner disk.*

- It was computed that the nominal G passband of the GAIA mission is too blue for the first Data Release photometry, and that a correction to the passband in the form of a power law in wavelength is to be applied to eliminate the effects of the color term.

- The effect of the stellar flares from the solar-like stars HD 209458 and HD 189733 on their respective giant planets was studied. It was found that the neutral upper atmospheres of the extrasolar planets arre not significantly affected by the typical flares on any of the two cases. Therefore, stellar flares alone would not cause large changes in planetary mass losses. However, the simulations reveal an enhancement in electron number density in the ionosphere of these planets.

- Optical and near-infrared spectra of young isolated planetary mass objects of the σ Orionis cluster, with masses between 6 and 13 times the mass of Jupiter, reveal that their atmospheric properties are strongly governed by low temperatures and low pressures. (See Figure AP10). These objects are a reference for the correct interpretation of the observations of the atmospheres of planets around stars that will be certainly obtained with JWST. The extrapolation of the σ Orionis mass function to the solar neighborhood may indicate that isolated planetary-mass objects with temperatures of ~200-300 K and masses in the interval 6-13 M_{Jup} may be as numerous as very low-mass stars.

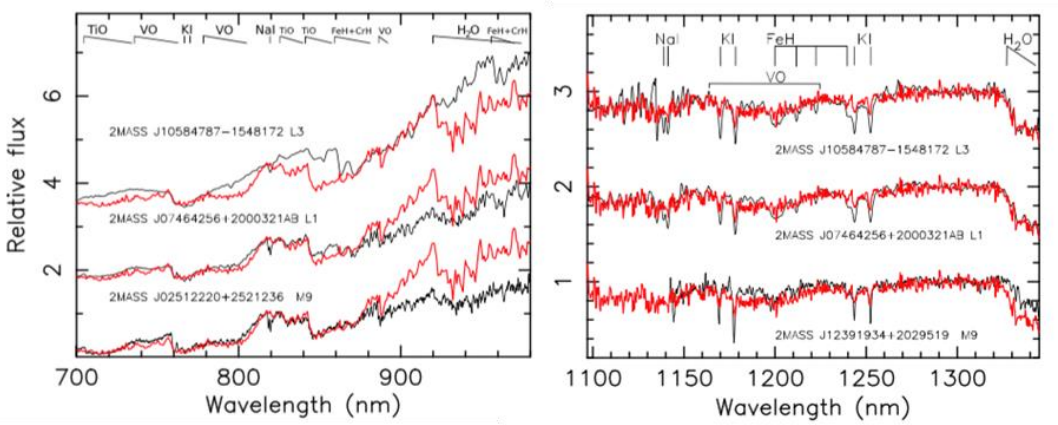


Figure AP10: *Optical (left) and near-infrared (right) spectra of σ Orionis young planetary-mass objects (red) obtained with GTC (left) and VLT (right) on La Palma and Paranal, respectively. The strongest atomic and molecular features are indicated. The black spectra correspond to dwarfs with higher gravity atmospheres. The young sources (that have temperatures of about 1800 K and low gravity atmospheres) are characterized by weak potassium lines and hydrides (CrH and FeH) and strong oxides (VO and TiO).*

- Linear polarimetric observations of young and old M7-L7 dwarfs (this is, low-mass stars and brown dwarfs) reveal that there is no apparent difference in the linear polarimetry intensity between the two populations that could be ascribed to differing atmospheric gravities.

- HST observations of two exoplanets revealed two different atmospheres: water vapour in emission implies the first stratosphere identified in an exoplanet, the ultrahot gas giant WASP-121b; the inflated hot Jupiter WASP-101b lacks instead of water vapour absorption, and no clear atmosphere seems to be present

- High spatial resolution images of 490 CARMENES potential targets were obtained using the lucky imaging technique. Results indicate that the bias-corrected multiplicity fraction is 19.5% (with an error bar of 2.3%) for angular separations of 0.2 to 5.0 arcsec on the sky (or projected orbital separations between 1.4 and 65.6 AU), with a peak in the distribution of the projected physical separations at 2.5-7.5 AU. By considering the fraction of spectroscopic binaries identified from previous searches, the total multiplicity fraction of M dwarfs increases to at least 36%.

Virtual Observatory: Scientific exploitation of astronomical archives

Coordinator: Enrique Solano

The Virtual Observatory (VO) is an international initiative whose main goal is to guarantee an easy and efficient access and analysis of the information hosted in astronomical archives and services. VO is a world-wide community-based initiative with the potential to open new research methodologies in Astronomy. The importance of the Virtual Observatory as a research e- infrastructure has been clearly identified by the European Union (which has supported the development and operation of the European VO through different FP6 and FP7 projects), as well as by other international consortia like Astronet or the Research Data Alliance (RDA). The Virtual Observatory is also fully aligned with the principles expressed in H2020 EU funding program and by the G8 Science Ministers, which explicitly promote Open Access to research data.

The Spanish Virtual Observatory (SVO, http://svo.cab.inta-csic.es) is a project successfully working since 2004. The project is led at CAB. SVO coordinates and collaborates with the Spanish astronomical groups with interest in the VO and acts as the national contact point for the international VO initiatives, in particular the International Virtual Observatory Alliance (IVOA) and the Euro-VO project.

The project is structured in four major lines of work, namely:

- Improve the CAB Data Centre and provide support to other Spanish data centres.
- Develop VO standards and tools with special emphasis on data mining tools.
- Foster collaborations in VO-science.
- Develop of Education and Outreach activities.

The main activities carried out in 2017 has been the following:

1.- The CAB Astronomical Data Centre

- New capabilities added to the GTC (Gran Telescopio Canarias) archive[1]. Among them we highlight the possibility of managing private data in addition to public data.
- First steps towards the implementation of a reduction pipeline for the OSIRIS (Broad Band Image and Spectra) and CanariCam instruments.
- Maintenance and development of new functionalities in the CARMENES private data archive[2].
- Improvement and implementation of VO standards to efficiently manage stellar spectral libraries[3].

1 http://gtc.sdc.cab.inta-csic.es/gtc/
2 http://carmenes.cab.inta-csic.es
3 http://svo2.cab.inta-csic.es/theory/libraries/

2.- Virtual Observatory tools

- Implementation of new functionalities in VOSA[4], a VO tool to estimate physical parameters of thousands of stars by comparing their spectral energy distribution with theoretical models. VOSA is a robust and well-tested tool as demonstrated by the more than 1400 users who have analysed almost 3 500 000 objects and have published 97 refereed papers.
- Development of an operational version of Clusterix[5], a tool that allows to estimate the membership probability of a list of objects to a given stellar cluster.
- Development of an operational version of SVO Discovery Tool[6], a tool that, given a list of objects, discovers all the information available in VO services.

3.- Data Mining tools

- Application of machine learning techniques to the estimation of physical parameters of M stars using spectroscopic data.
- Development of a supervised classifier to identify ultracool objects in the J-PLUS survey.

4.- VO-science projects

- Discovery of binary systems using TGAS data (CAB collaboration).
- Characterization of infrared donors in obscured high-mass X-ray binaries (in collaboration with the University of Alicante).
- Identification of asteroids in RoPACS images (in collaboration with the Nice Observatory).
- The Pleiades as seen by TGAS and the VO (CAB collaboration).
- Debris discs around late-type Main Sequence stars (CAB collaboration).
- High mass companions to ultracool dwarfs (in collaboration with the Instituto de Astrofísica de Canarias).
- Physical parameters of CARMENES stars (CAB collaboration).
- Identification of ultracool dwarfs in extragalactic fields (COSMOS, ALHAMBRA) (CAB collaboration).

5.- Education and Outreach activities

- Organisation of the X SVO School. Instituto de Astrofísica de Canarias. March 2017. 50 participants
- Organisation of the III ASTERICS VO School. ESAC. November 2017. 35 participants.
- Development and maintenance of the data archive of STARS4ALL,a H2020 project aimed at studying the light pollution in Europe.

4 http://svo2.cab.inta-csic.es/theory/vosa/
5 http://clusterix.cab.inta-csic.es
6 http://sdc.cab.inta-csic.es/SVODiscoveryTool

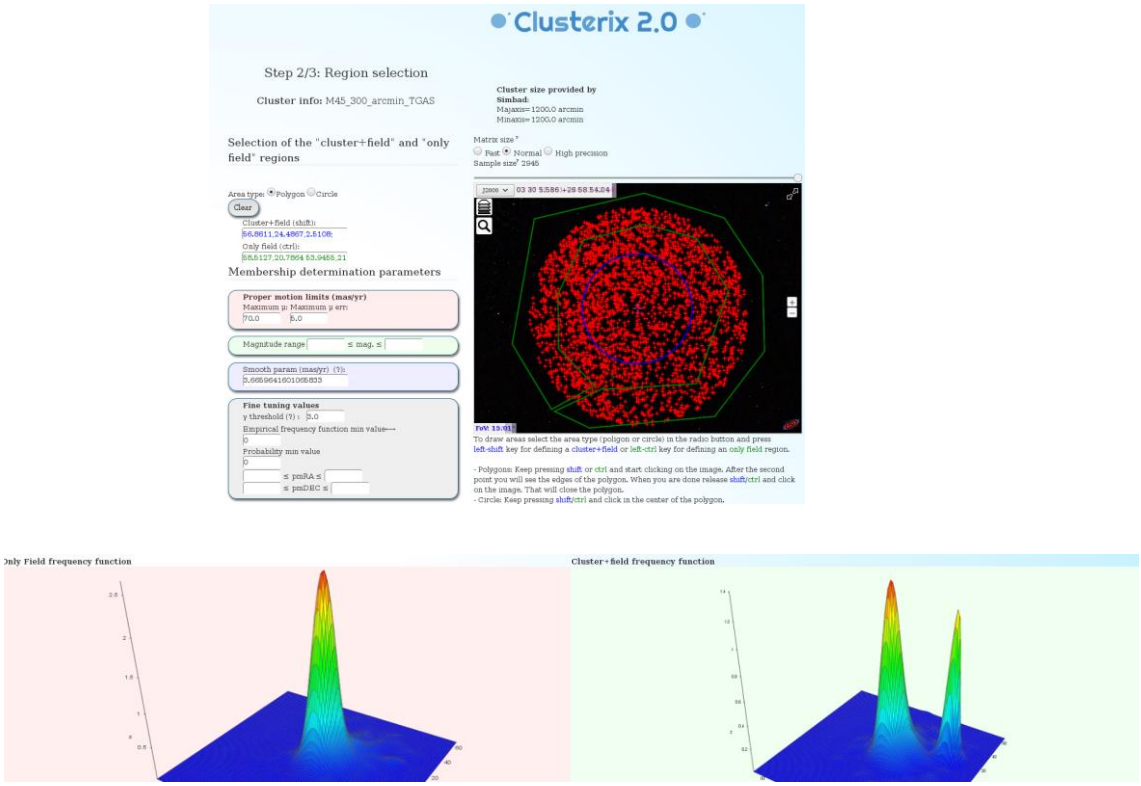


Figure AP11: *Clusterix: Selection of the "cluster+field" and "only field" regions and representation of the associated frequency functions that will be used to estimate the membership probability.*

Planetology and Habitability

Head of Department: Olga Prieto

The origin and evolution of planetary bodies and the understanding of the habitability potential of those bodies are the main objectives of the department. These objectives are aproched by the research activities in planetary geology, atmospheres, extreme environments and habitability that we developed at the department. Planetary Geology is the study of solid Surface planetary objects in the Universe, including Earth. Specifically, this scientific discipline investigates the composition, structure and processes and agents by which planets, satellites, comets, asteroids and meteorites evolve since its formation. The understanding of life in extreme conditions and the biodiversity present at these extreme ecosystems by other side will give us some clues about the limits of life on Earth and the potential habitability out of planet Earth.

These issues are crucial in determining the habitability of planetary environments, and basically outline the main objectives of the department at CAB: 1) determination of the influence of the geology on extreme paleo, and current terrestrial environments analogous to those developed on other planets, 2) the characterization of planetary material regarding habitability, 3) understanding the geological processes that affects the evolution of the planets and natural satellites and 4) participation in planetary exploration missions. Extreme environments are crucial in order to understand the limits of life and potential habitability of harsh micro or macro niches.

The planetology and habitability department is composed of 2 Research Groups:

- Planetary Geology and Atmospheres
- Habitability and Extreme Environments

Planetary Geology group

Coordinator: Olga Prieto Ballesteros

It is a main goal of our group to determine the astrobiology potential of planetary objects of the Solar system, such as Mars and Ocean Worlds, through geological studies. We have special interest to asses the habitability requirements that future missions under development could detect. Investigations involves laboratory activities, field work, and participation in the supporting science of development of exploration instruments and space missions.

During 2017, laboratory studies were focused on 2 questions related to the exchange of chemicals between the potentially habitable interior and the observable surface of Ocean Worlds: 1) how crystallization of aqueous fluids from deep environments affects the detectable tracers of habitability. Experiments were performed using CAB-design simulation chambers, where any change in the chemical system was registered by Raman spectroscopy. We have found that formation of clathrate hydrates acts as a mechanism of chemical differentiation promoting the ascent of volatile-rich fluids; 2) understand serpentinization process at low temperature and ammonia-rich conditions. Our data support this aqueous alteration mechanism of olivine-rich rocks as a source of bio-essential elements and energy that could sustain life.

We have investigated Mars habitability as well. We have used the Iceland analogue to Mars hydrothermal environment to produce unique and valuable data for the European science and technology teams of MEDA/Mars 2020. During the Iceland field campaign-2017 funded by Europlanet-TA program, we visited two main geothermal areas (Krýsuvik and Hveragerdi) and some accessible small geothermal patches with no specific names around them**.** We sampled active and extinct sites that showed different colours, textures, and ground humidity. Sample types taken were: fresh bedrock, hydrothermally altered minerals, fluids from hot springs, and mud pools materials. The objectives of the campaign included: a) Characterization of mineral changes suffered during the substrate-atmosphere interaction that could indicate details of potential habitability. b) Thermal properties of hydrothermal mineral assemblages for: a) calibrating in situ IR-thermal sensors; b) interpreting the ground thermal inertia.

Figure PH1: *Iceland field campaign-2017 funded by Europlanet-TA program.*

The regional geological study of Coogoon Valles, south west of Oxia Planum, which is one landing site candidate for Exomars, were finished. It is a complex fluvial network with a long-lasting water history, where an alternation between erosion, transport and sedimentation is recorded.

By other side, the research carried out at the Laboratory for Experimental Impact Cratering (LEIC) at CAB is threefold: Experimental simulations of cosmic impacts, fieldwork at natural impact craters and planetary environmental analogue sites, as well as remote sensing of planetary impact craters and other landforms that reflect the formational environment. Impact craters are strongly affected by the properties of target, which can be used to reconstruct the paleoenvironment in which they formed, i.e. warm/wet targets suitable for hosting life. The work during 2017 focused on data collection on representative and important examples of mainly craters formed by cosmic impacts into shallow seas, as well as the continued development and application of the Experimental Projectile Impact Chamber (EPIC) which constitutes the core part of LEIC. Other planned activities for the year included service to the scientific community in the form of editorial board member of the journal Scientific Reports, review grant proposals as member of the NASA Solar System Workings geophysics evaluation panel, review manuscripts submitted to international journals, and supervision of two undergraduate students.

The main achievements during 2017 have been:

Fieldwork was carried out at proven and suspected impact sites. The Morasko Crater Field in Poland was visited for photographic documentation in connection with a workshop of craters formed by aerodynamic breakup of objects entering the Earth´s atmosphere. At the much larger (7.5km) Lockne Crater in Sweden, a gravimeter survey was carried out over a large fracture zone crossing the crater. Preliminary results show that fracturing by the impact had much larger effects on the local gravity signature than the pre-existing fracture zone. In this way the effects from the fracture zone can be extracted in the analysis of the subsurface extent of the crater. Reconnaissance

fieldwork and sampling was done at a potential 3km impact structure in southern Spain. Preliminary analysis of samples and field outcrops indicate shock pressures diagnostic for cosmic impacts as well as a likely marine formation, which would give information on the paleoenvironment at the time of impact. These special sedimentological indications for a marine impact were also studied in drill cores at the 20km wide Rochechouart impact structure (France), core photos from the 200km Chicxulub crater (Mexico), cores from the 4km Flynn Creek Crater (Tennessee) now stored in Flagstaff, Arizona, as well as in cores kept at CAB that were retrieved previously at the Vakkejokk Crater in the Scandinavian arctic. These latter two studies of drill cores were done in conjunction with the supervision of an undergraduate student from Auburn University (USA) and one from Stockholm University (Sweden). Altogether the core logging results from these craters indicate a stronger influence by the target seawater on the crater modification processes than hitherto assumed, which gives valuable information on the paleoenvironment and, thus, the effect the impacts may have had on life in the target areas.

Figure PH2: Core drilling at the Rochechouart impact structure within the Center for International Research on Impact and Rochechouart (CIRIR) 2017 core drilling project in which Dr. Ormö is co-principal investigator.

Among the activities run regarding planetary atmospheres, we have continued with REMS science operation, on the NASA MSL Curiosity Rover. Data analysis and publications, as well as the continuation of INTA project AViación y ATmósfera: aerosols study and gasses AeRoespacial (AVATAR), cirrus cloud analysis of LIDAR measurements. During 2017 we have continued the work on development of planetary instrumentation for atmospheric observation in collaboration with LTU (Sweden): (1) For Mars atmosphere, contributing to the ExoMars instrument HABIT (HABitability: Brines, Irradiance and Temperature) whose design continues with Omnisys Sweden, SNSB and IKI/Roscosmos/ESA. The HABIT Engineering Model was delivered to IKI,

now the HABIT QM is being prepared and preliminary calibrations for the sensors have been performed. A HABIT EM unit was tested in the MINAR-5 campaign. (2) For interaction of space weather with the Earth atmosphere, with the design, deployment and stratospheric testing of PACKMAN (PArticle Counter k-index Magnetic ANomaly), a space weather portable instrument which has been installed at 1.1 km depth in the mine of Boulby UK, and launched to 30 km (stratosphere) within two balloon campaigns Zero2Infinity (Córdoba, Spain, 2017) and Swedish Space Corporation (ESRANGE, Sweden, 2017). The instrument was presented internationally at the 23rd ESA Symposium on European Rocket and Balloon Programmes Visby, Sweden (2017). (3) For Earth observation, FORUM (Far-infrared-Outgoing-Radiation Understanding and Monitoring), PI Luca Palchetti (INO-CNR), Italy. This instrument was submitted and approved for Phase A, on the ESA Earth Explorer-9 "Fast Track" mission proposals Earth observation. This mission is intended to be used to conduct research in the field of Earth Observation and/or to demonstrate the potential of innovative Earth Observation techniques of relevance to both the scientific and the application communities. Co-Is from 8 European countries and international partners from USA. Phase A, for final selection within two years between two competitive, proposals for an Earth observation satellite. (4) For space propulsion, PVT-GAMERS, is an instrument for microgravity testing of a novel method of propellant gauging for electric propulsion. This was one of the only two instruments selected this year in all Europe for the ESA-Academy Fly Your Thesis! campaign. The flight-model instrument is now under development and the campaign will take place during the fall of 2018. This instrument was presented at the 68th International Astronautical Congress (IAC), Adelaide, Australia, 25-29 September 2017.

Some other activities to underline in the Atmospheres framework are the participation on a study for the ESA Planetary Protection Office. "*Environmental evaluation of Oxia Planum as landing site for ExoMars. Data analysis and implications for the Planetary Protection*". Member of the International Mars sample return Objectives and Samples Team (iMOST) Co-chaired by Dave Beaty, Monica Grady, Hap McSween, and Elliot Sefton-Nash, and supported by Brandi Carrier (Mars Program Office at JPL); And the participation in field campaigns: MINAR-5 (October 8-20, 2017) testing instruments for exploration: HABIT, METABOLT, PACKMAN. MINAR 5 was the largest of the MINAR campaigns, it was carried out as a collaboration with Spaceward Bound (NASA) and the Kalam Centre, India.

Habitability and Extreme Environments group

Coordinator: Felipe Gómez Gómez

The group of Extreme Environments and Habitability has the objective of studying the limits of life through extreme ecosystems. This is intended to understand the physical-chemical process of life and the habitability potential of other planetary bodies out of planet Earth. These studies are made on terrestrial analogues, which are extreme environments that have some resemblance in physical-chemical or mineralogical parameters with some other planetary body.

The activities around the group of Extreme Environments and Habitability during 2017 have focused on the study of extreme environments and the validation of some of these extreme environments as terrestrial analogues. During 2017 several field campaigns have been carried out in extreme environments such as the Dallol hydrothermal area in the Danakil depression, Ethiopia. We have continued with studies in the extreme environment of Río Tinto and Tírez lake in Spain, Ibbn Battuta desert in Morocco among others.

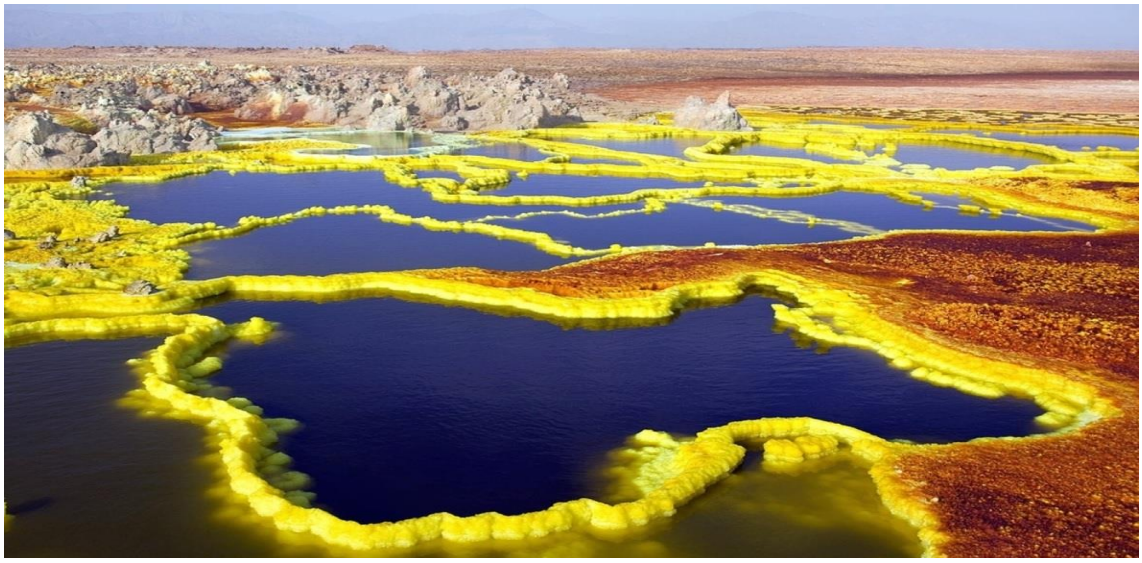


Figure PH3: *Expedition to the extreme environment of Dallol (Ethiopia).*

In the context of the Europlanet project we have studied the characteristics of the extreme environment of Dallol that has finally been validated as terrestrial analogue. In this context, international collaborations have been established for the development of biodiversity studies in extreme environments.

Regarding Mars analogues for space exploration activity and in the frame of MASE (Mars Analogues for Space Exploration) project the work has focused on the final design of the 'HaloMASE chip' as a tool for biomarkers detection in anaerobic and salty environments. At the same time and monitoring the changes and evolution of redox potential in microbial communities [from an alpine glacier (Tyrol, Austria during the AMEDEE-15 campaign) and Lake Graenvatn in Iceland] forced/induced to a mineralization process in liquid medium. Searching for the detectability of biomarkers in these mineralized samples were carried out by by sandwich multiarray immunoassay

(SMI) to examine the preservation or loss of the biomarkers during the process and their potential correlation with variations in potential Redox. Biomarker detection were perfomed as well in samples resulting from an evaporite formation process induced by dehydration / desiccation in anoxia and vacuum in a silica gel matrix. On this sample, the presence of biomarkers was determined by sandwich multiarray immunoassay (SMI).

As well as previously described research activities, icyMars project is run in the Extreme Environments and Habitability research group. This project proposed to conduct interdisciplinary investigations in order to define and test a new hypothesis to understand the early environmental traits on Mars: that the young Martian surface was characterized by global mean freezing conditions, as predicted by climate models, and at the same time a vigorous hydrogeological cycle was active during hundreds of millions of years, as confirmed by geomorphological and mineralogical analyses. We are comprehensively analyzing the triggers, traits and consequences of a cold aqueous environment dominating the Noachian, studying the geomorphological, mineralogical and geochemical evidences that such a hydrological cycle would have left behind, and also proposing new paths for the astrobiological exploration of Mars on the basis of geochemical and geomicrobiological studies in cold aqueous environments. Mission-derived datasets are used to test hypotheses through paleogeomorphological reconstructions, theoretical modeling and experiments in the laboratory.

During 2017, we analyzed the sedimentary mineralogy on Mars, where mineral sequences show that salts generally do not appear together with clays. We tackled this problem by assuming that the driving factor separating the different mineralogies was temperature (climate change), but we have discovered that the synthesis of clays vs sulfates on Mars was initially controlled by the reactive surface of primary minerals.

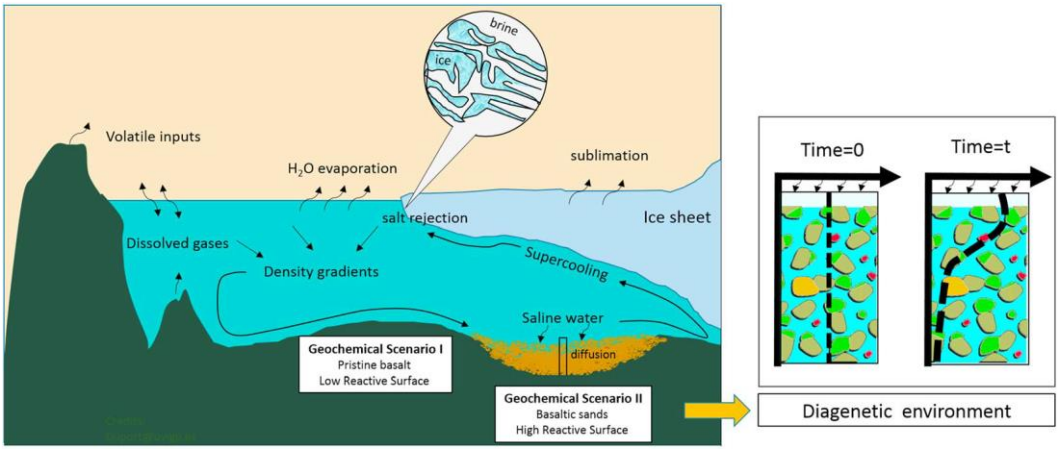


Figure PH4: *Water-sediment interaction scheme.*

We consider two scenarios at the water-sediment interface: (1) If the basaltic basement is not fractured, the absence of diffusion—and diagenesis—restricts the mineral dissolution/ precipitation to authigenic processes. In this scenario, we evaluate two conditions: high and low reactive surface of minerals at the interface. And (2) when the solid substrate is fractured at depth, it results in a certain degree of porosity (ϕ), inducing molecular diffusion and the triggering of diagenetic processes (published in JGR-Planets 2017).

We also focused on the process of melting/freezing of ionic solutions or brines at and below 273K, and the role of the enthalpy of phase transition in this process. Innovative 2017 published outcomes include the analysis of multiple eutectic and/or peritectic points in binary and multicomponent systems of enantiotropic substances (i.e., the different phases of Mg-sulfate), and descriptions of the enhanced overfreezing effect due to the continuous increasing of the ionic strength in systems undergoing evaporation. We also investigated long-term oxidation processes taking place in anoxic environments, as those occurred during the weathering of primary minerals in early Mars. Our results suggest that pyrite dissolution can act as a natural Fenton reagent, influencing the oxidation of third-party species during the long–term evolution of geochemical systems, even in the early Mars oxygen-limited environments.

Finally, during 2017 we also developed several new concepts related to the potential of low-temperature solutions and brines that existed on early Mars to support growth and/or survivability of Martian analogue extremophiles, with the aim of fingerprinting putative paths of microbial adaptation on a “cold and wet” early Mars.

Regarding student training, in 2017 we have joined the Geoplanet Project consortium, which involves research centers and universities over the world, led by University of Nantes. We have joined master programs with Bologne University as well receiving students at our laboratories.

Molecular Evolution

Head of Department: José Eduardo González Pastor

Life can be considered as a consequence of the evolution of matter and energy in the Universe. Regardless it where originated, there are key questions to be answered: What was the prebiotic chemistry that led to the first complex polymers? How did the different molecular species behave and persisted? How did they replicate and acquire information storage capability? How did they evolve and adapt to the environment? How did microbes adapt to extreme environments? How can we distinguish and detect true biomolecules (molecular biomarkers) from other non-biological organic molecules?

These and other questions constitute the scientific basis of the Department, which organizes its research strategy on four fundamental lines: Prebiotic Chemistry, Molecular Evolution, Molecular Mechanisms of Biological Adaptation and the detection of Biomolecules in Planetary Exploration.

The Molecular Evolution Department is organized in 6 Research Groups:

- Prebiotic Chemistry
- Experimental Evolution Studies with Viruses and Microorganisms
- Molecular Evolution, RNA World and Biosensors
- Microbial Biodiversity
- Molecular Mechanisms of Biological Adaptation
- Biomolecules in Planetary Exploration

Prebiotic chemistry

Coordinator: David Hochberg

Spontaneous mirror symmetry breaking and origin of biological homochirality (David Hochberg)

It is widely accepted nowadays that the homochirality of biomolecules (the fact that the absolute configuration of all the amino acids and carbohydrates employed in the molecules of life is almost exclusively uniform) is a prerequisite for life, but the problem of how, in the course of chemical evolution, prebiotic reactions led first to an enantiomeric imbalance that finally resulted in the achievement of system homochirality remains a challenge and has been extensively debated and studied during the last few decades. In 2017, we have continued our work devoted to theoretical analysis, modeling and simulation of spontaneous mirror-symmetry breaking scenarios; having (i) demonstrated that homochirality in nucleated enantioselective polymerization can be achieved through mechanical breakage of homochiral polymers, (ii) how external noise affects the dynamics of non-linear reaction diffusion systems where primitive cell-like structures are formed, (iii) the feasibility of spontaneous mirror symmetry breaking in heterocatalytically coupled enantioselective replicators (in chiral hypercycles) and (iv) we have formulated a Stoichiometric Network Analysis of spontaneous mirror symmetry breaking in chemical reactions.

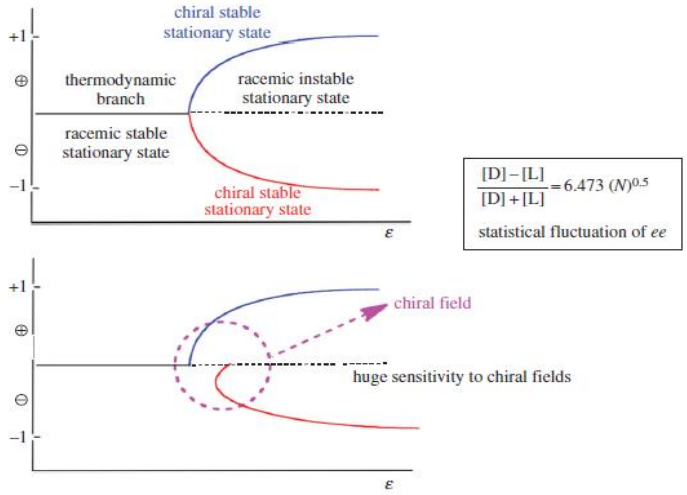
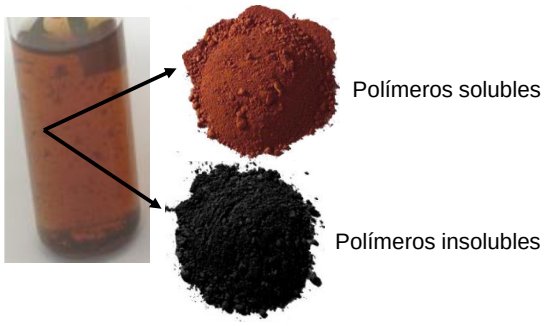


Figure ME1: *Bifurcation scenario: the racemic state may become unstable and chiral statistical fluctuations drive the racemic stationary state towards one of two energetically degenerate chiral stable states.*

Kinetic and structural studies of HCN polymers (Marta Ruíz Bermejo)



During 2017, we have continued to explore the aqueous chemistry of cyanide polymers. These polymers are of great interest in the area of prebiotic chemistry, cosmochemistry and in general in the field of astrobiology, but recently they are also of interest in materials science due to their characteristics as coating materials with potential biomedical applications. We have completed the studies of these highly complex substances using thermal analysis techniques, proposing new macromolecular structures. On the other hand, we have started a new line of work to understand the kinetics of polymerization of these systems. Initially, we focused on the study of the soluble phase, which was characterized by UV-vis spectroscopy, revealing that the experimental conditions of synthesis greatly influence the kinetics of the process. Subsequently, the kinetics of formation of the insoluble phase was analyzed by gravimetric methods. Additionally, the polymers formed were characterized by different techniques in order to evaluate the macromolecular progression of the system over time.

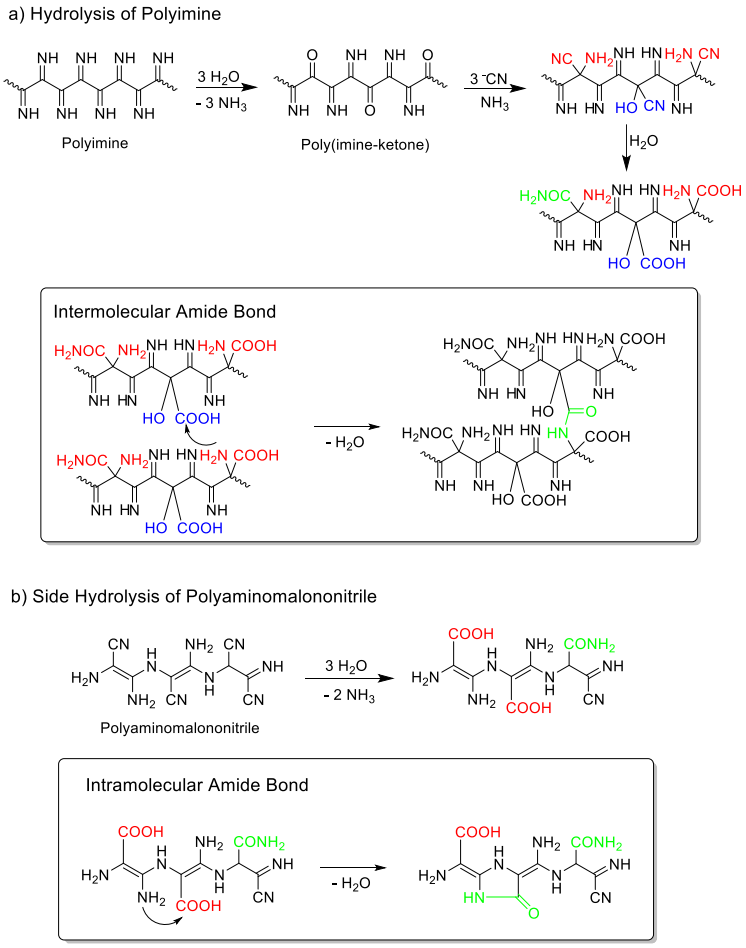


Figure ME2: *New structures proposed to explain the macromolecular nature of the cyanide polymers synthesized in water.*

Molecular self-organization and surface reactions (Eva Mateo-Marti)

Pyrite is a key surface in the context of the origin of life and prebiotic chemistry. A possible alternative to the prebiotic soup theory was proposed by Wächtershäuser, who advocates that the first reactions for amino acid formation did not occur in a bulk solution in the oceans, but rather on mineral surfaces (such as pyrite); due to the surface catalytic properties, amino acids can adsorb, concentrate and react. Therefore, amino acid adsorption is a promising method to study pyrite surface properties and the chemical impact of the surface on the adsorbed molecules. Pyrite surface preparation was performed under ultra-high vacuum (UHV) conditions. The use of an ultra-high vacuum system is a prerequisite for conducting these experiments as it allows the accurate control of the molecular dosing conditions, UHV clean environment and sample temperature to the desired experimental conditions. Our equipment has been specifically developed to make feasible *in situ* molecular dosing and *in situ* physico-chemical characterization of the sample by X-ray photoemission spectroscopy (XPS) and low energy electron diffraction (LEED). We focused our efforts on the spectroscopic characterization of amino acid adsorption on pyrite surfaces from different preparation treatment conditions, which drive the molecular adsorption process in different ways.

Our studies describes the first successful adsorption of the cysteine, cystine, methionine and alanine amino acids on the pyrite (100) surface under UHV conditions with crucial chemical adsorption parameters driving the process. We have demonstrated by XPS that the surface pretreatment annealing process on pyrite surfaces is a critical parameter driving surface reactivity. The presence of enriched monosulfide species on the pyrite (100) surface favours the amino acid NH_2 chemical form, whereas a longer annealing surface pretreatment of over 3 hours repairs the sulfur vacancies in the pyrite, enriching disulfide species on the pyrite surface, which promotes NH_3^+ adsorption due to the sulfur vacancies in the pyrite being replaced by sulfur atom dimers (S_2^{2-}) on the surface. Furthermore, even if the surface chemistry (monosulfide or disulfide species enrichment) is the main factor promoting a partial conversion from NH_2 to NH_3^+ species, the unique chemical structure of each amino acid provides a particular fingerprint in the process. Understanding common guidelines that govern the molecular adsorption onto surfaces has great implications in prebiotic chemistry and origin of life.

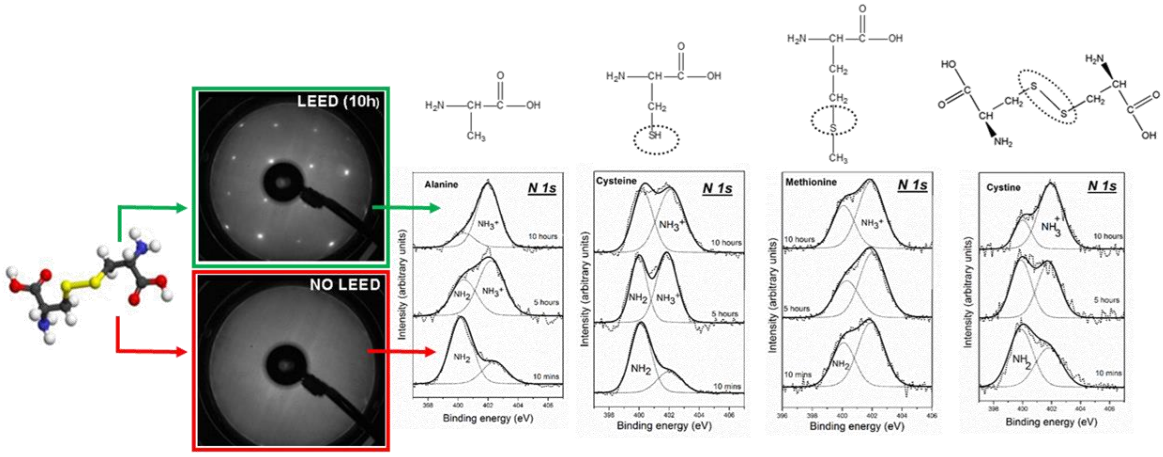


Figure ME3: *Surface characterization of the presence or absence of the surface ordering, as indicated by the LEED pattern, as a function of the surface annealing process. Comparison of the XPS core-level peaks of N(1s) evolution during the pyrite surface annealing pretreatment process for alanine, cysteine, methionine and cystine under UHV conditions. Iron disulfide surface enrichment favours the zwitterionic amino acid adsorption form.*

Experimental evolution studies with viruses and microorganisms

Coordinator: Ester Lázaro Lázaro

The study of the evolutionary process presents multiple difficulties, which derive from several facts: i) its results are usually only observable after long periods of time, ii) the relationships between the genomes (the genotype) and their expression (the phenotype) are usually complex and difficult to establish, iii) its ultimate cause lies in a random process, the generation of mutations, and iv) it is subjected to multiple contingencies that condition the action of selective processes. All these difficulties have motivated that many of the essential principles driving evolution are still unknown. To investigate this subject, we recreate evolutionary processes in the laboratory, with the aim of being able to apply the scientific method to their study and understand the molecular dynamics underlying the change experienced by populations through time. Our experimental system is a bacteriophage that infects the bacterium *Escherichia coli*, the bacteriophage Qβ, which is characterized by giving rise to highly heterogeneous populations that evolve much faster than cellular systems. This phage also has a very small genome, which encodes only four proteins, thus facilitating the establishment of genotype-phenotype relationships. Like all viruses, it does not possess a metabolism, which brings it closer to the world of primitive replicators, being also an adequate system for the study of evolution prior to the generation of cellular life.

During year 2017, we have carried out studies in which bacteriophage Qβ was propagated at higher-than-optimal temperature (43ºC versus 37ºC), in order to characterize: 1) the molecular mechanisms that allow adaptation to high temperatures, a condition of particular relevance given the increase of temperature that our planet is currently experiencing, 2) the dynamics of adaptation at the population level, 3) the effect of the pattern of change in the selective pressures on the adaptive pathways followed, and 4) the possibility that the virus can adapt simultaneously to replicate at 43ºC and withstand high temperatures in the extracellular environment. The most relevant results we have obtained are summarized in the following sections:

Dynamics of adaptation to high temperature

The evolutionary process followed by bacteriophage Qβ during its propagation at 43ºC was characterized throughout time. To do that, we analyzed the consensus sequence (the average sequence of the population) and the mutant spectrum (complete sequences of individual genomes). We did not observe a sequential fixation of mutations, but observed signs of competition among different beneficial mutants that coexist within the complex population, causing that some mutations present at high frequencies at early evolutionary stages were absent at later stages. We also observed that the initial condition strongly influenced the final evolutionary outcome. To better understand the mutational dynamics, we plan to characterize some of the populations through massive sequencing.

The structure of the population determines whether particular mutations will reach fixation or not

We had previously identified several mutations that were selected during the evolution of bacteriophage Qβ at 43ºC. In particular, we focused in two of them (U2776C and U3402C, both placed in the replicase gene), and compared their behavior at the normal and the selective temperatures. To do that, we carried out experiments in which phage mutants containing only one of those mutations were propagated together with the wild virus. Since mutations U2776C and U3402C only have beneficial effects at 43ºC, our expectation was that the mutants would be selected against at 37ºC, whereas they would be dominant at 43ºC. In contrast to this, we found that the selective advantage of the mutants over the wild type at the permissive temperature depended on the distance of both competitor populations to their clonal origin. These results highlight the relevance of the composition and structure of the ensemble of genomes composing a population on the final fate of the mutations that arise in it.

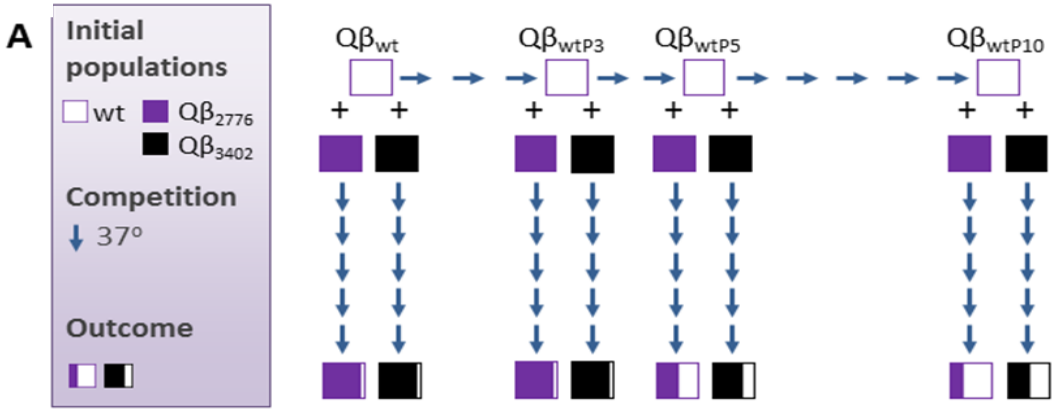


Figure ME4: *Scheme showing how the final outcome of the joint propagation of two different viruses depends on the population structure. Previously to competition, the clonal wild virus (Qβwt) was propagated for 3 (QβwtP3), 5 (QβwtP5), or 10 transfers (QβwtP10), a fact that profoundly influenced which virus was dominant after joint propagation.*

Evolutionary adaptation of bacteriophage Qβ to the simultaneous increase in the within-host and extracellular temperatures

As a result of global warming, the average Earth's temperature is increasing, which represents a stressful condition for most species including bacteriophages. In this study we analyzed the evolutionary ability of the bacteriophage Qβ when it was confronted with a temperature increase that affects both the extracellular and the intracellular media. Our results showed that Qβ can optimize its survivability when exposed to short-term high temperature extracellular heat shocks (applied at 60ºC), as well as its replicative ability at higher-than-optimal temperature (43ºC). Mutations responsible for simultaneous adaptation were the same as those selected when adaptation to each condition proceeded separately, showing the absence of important trade-offs between survival and reproduction in Qβ. Further studies, including co-evolution with the bacterial host, will help to determine how evolution of phages in response to global change can influence the composition and structure of the ecosystems.

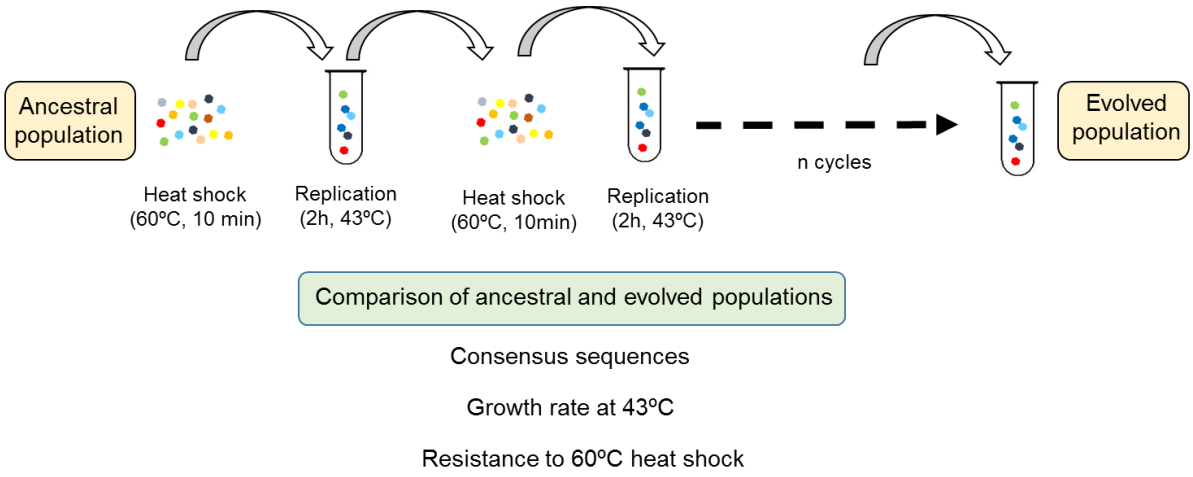


Figure ME5: *Scheme showing the experimental procedure to study the adaption of bacteriophage Qβ to the simultaneous increase in the within-host and extracellular temperatures.*

Determination of the mechanisms by which mutations selected at high temperatures increase fitness under this condition

We are currently performing several assay to determine the molecular mechanisms by which the mutations selected at 43ºC increase fitness at this temperature. In particular we are testing whether any of the mutations have some effect on: mutational robustness (understood as a measure of the average effect of mutations on fitness), replication error rate, stability of the capsids in the extracellular environment, virus attachment to the receptor, and entry inside the bacteria.

Molecular evolution, RNA World and biosensors

Coordinator: Carlos Briones

This research group is focused on the origin and early evolution of life (including experimental and theoretical approaches to the RNA world hypothesis), *in vitro* evolution of nucleic acids (RNA and ssDNA aptamers), biosensor development (DNA microarray technology, PNA- and aptamer-based sensors, bionanotechnology-inspired biosensors), and genetics of RNA viruses (dynamics of viral quasispecies and sequence-structure-function relationships in viral or viroidal RNA). We also collaborate with interdisciplinary research projects devoted to the analysis of the microbial biodiversity of extreme environments.

In 2017, we have deepened into our previous work on prebiotic systems chemistry and the origin of life, in collaboration with researchers from the Autonomous University of Madrid and the University of the Basque Country. We extended the Darwinian framework for the study of prebiotic chemical evolution, shifting the attention from homogeneous mixtures of naked molecular species to populations of heterogeneous, compartmentalized and functionally integrated assemblies of molecules. We have analyzed the implications of this shift of perspective, both in terms of the individual units (which require an adequate characterization as self-maintaining systems with an internal organization) as well as in relation to their collective and long-term evolutionary dynamics, based on competition, collaboration and selection processes among those complex individuals. On these lines, we have published a proposal for the four molecular control mechanisms that could have been coupled to bring about autonomous functional systems, at the interface between chemistry and biology: spatial, kinetic, energetic and variability control.

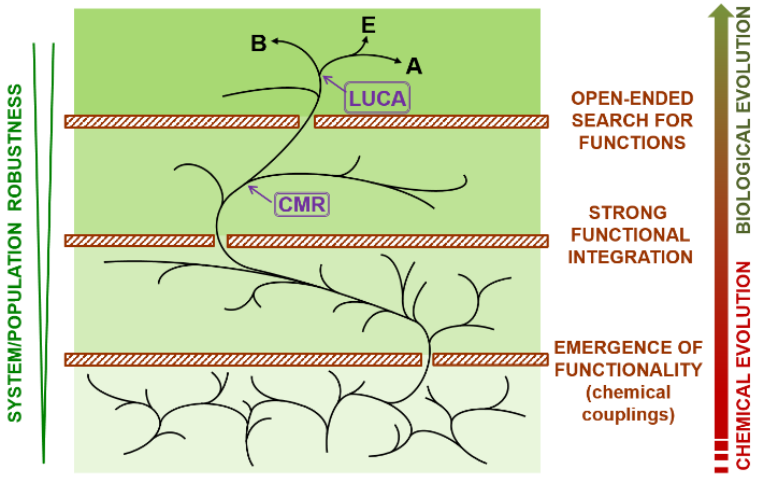


Figure ME6: *Scheme of the different stages and bottlenecks that could have occurred during the transition from chemical to biological evolution.*

Shifting to the experimental research in origin of life-related work, we have collaborated with the group of Prebiotic Chemistry in the characterization of the experimental conditions that affect the kinetics of HCN polymerization process in

aqueous media, using molecular biology techniques such as UV-Vis spectroscopy and electrophoresis.

A considerable experimental effort has been made by our group in the field of *in vitro* selection and evolution of nucleic acids, in collaboration with researchers from Centro de Biología Molecular "Severo Ochoa" (CSIC-UAM) and Instituto Ramón y Cajal de Investigaciones Sanitarias. In 2017, we have worked in the development of aptamers specific for low molecular weight compounds that can be used as biomarkers in astrobiology and biotechnology (including amino acids and related molecules), peptides of different sequence and structure, as well as proteins [such as the poly(C)-binding protein 2 (PCBP-2), and the core protein of hepatitis C virus (HCVcore)]

An open issue in this field is that improvements in aptamer selection and DNA sequencing methods have led to the identification of a large number of active nucleic acid molecules after any *in vitro* selection experiment. Thus, the search for the fittest aptamers has become a laborious and very time-consuming task. To overcome such experimental limitation, we have set up an optimized approach for the high-throughput characterization of ssDNA and RNA aptamers in parallel. The developed method consists in an Enzyme-Linked OligoNucleotide Assay (ELONA) coupled to either real-time, quantitative PCR (qPCR, for DNA aptamers) or reverse transcription and quantitative PCR (RTqPCR, for RNA aptamers), which allows the detection of aptamer-target interactions in the high femtomolar range. We have applied this methodology to the affinity analysis of DNA and RNA aptamers selected for the first time against PCBP-2. In addition, we have used ELONA-(RT)qPCR to quantify the dissociation constant (*Kd*) and maximum binding capacity (*Bmax*) of 16 high affinity aptamers. Electrophoretic Mobility Shift Assays (EMSA) have been performed in parallel to check the binding of representative PCBP-2-specific RNA aptamers in solution. An analogous method has been used for the selection and characterization of DNA and RNA aptamers specific for different variants of HCVcore protein, whose applicability in biotechnology and biomedicine is currently being analyzed.

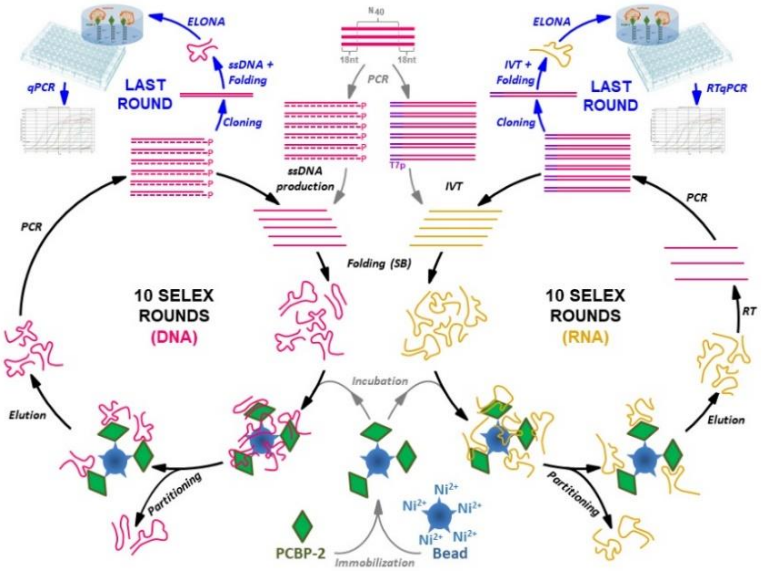


Figure ME7: *Schematic representation of the in vitro processes performed to select ssDNA and RNA aptamers in parallel using PCBP-2 as the target molecule, coupled to the ELONA-(RT)qPCR methodology developed for the functional characterization of the individual aptamers present at the last round.*

Finally, also in the field of the RNA World research, we have continued our previous experimental work devoted to the study of the sequence-structure-function relationships in RNA. With this aim, we have used atomic force microscopy (AFM) technology, in collaboration with researchers from Instituto de Ciencia de Materiales de Madrid (ICMM) and the Polytechnic University of Valencia. In 2017, we have analyzed by AFM three viroids, which are sub-viral plant pathogens composed of independently-replicating circular RNAs of small size (256-401 nucleotides), with compact secondary structure and lacking protein-coding capacity. This is the first time that viroid RNAs are imaged in native conditions by a structural technique allowing nanometer resolution. Potato spindle tuber viroid (PSTVd), the type member of the family *Pospiviroidae*, shows a 359 nt-long genome adopting a rod-like secondary structure in the native state, with five structural domains that are critical for replication in the cell nucleus. In turn, members of the family *Avsunvioidae*, like eggplant latent viroid (ELVd) and peach latent mosaic viroid (PLMVd), replicate in plastids and their 332-351 nt-long genomes adopt either bifurcated or multibranched conformations. Our AFM images of wild type and mutant viroids have confirmed the main features of their previously known rod-like and multibranched secondary structures, respectively, and provide very valuable information on the tertiary structure of independently-replicating RNAs in native conditions.

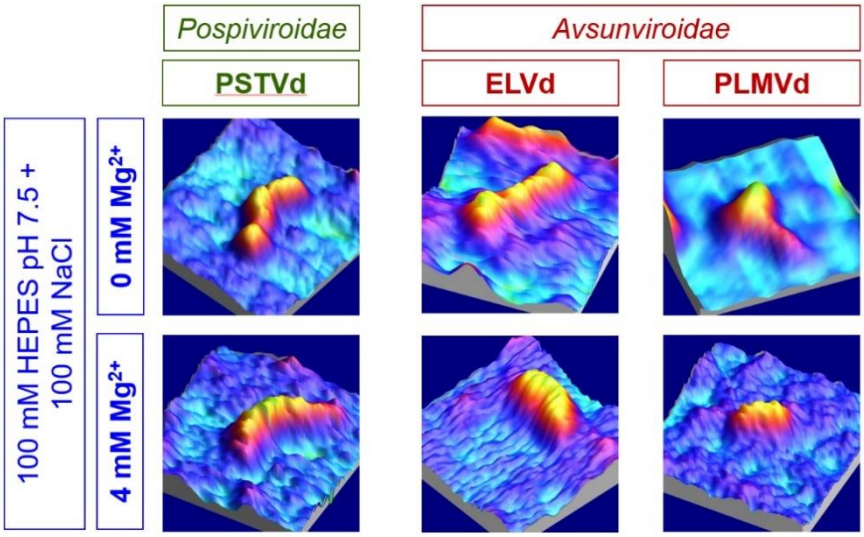


Figure ME8: *Representative 3D images of the three wild type viroids analyzed by AFM (PSTVd, ELVd and PLMVd) in buffers lacking* Mg^{2+} *or containing 4 mM* Mg^{2+}.

Microbial biodiversity

Coordinator: Cristina Cid Sánchez

Glaciers and ice sheets as analog environments of potentially habitable icy worlds
(Cristina Cid Sánchez and Eva García López)

Icy worlds in the solar system and beyond have attracted a remarkable attention as possible habitats for life. The current consideration about whether life exists beyond Earth is based on our knowledge of life in terrestrial cold environments. On Earth, glaciers and ice sheets have been considered uninhabited for a long time as they seemed too hostile to harbor life. However, these environments are unique biomes dominated by microbial communities which maintain active biochemical routes. Thanks to techniques such as microscopy and more recently DNA sequencing methods, a great biodiversity of prokaryote and eukaryote microorganisms have been discovered. These microorganisms are adapted to a harsh environment, in which the most extreme features are the lack of liquid water, extremely cold temperatures, high solar radiation and nutrient shortage.

This project compares the environmental characteristics of icy worlds and the environmental characteristics of terrestrial glaciers and ice sheets in order to address some interesting questions:

1) Which are the characteristics of habitability known for the frozen worlds, and which could be compatible with life?

2) What are the environmental characteristics of terrestrial glaciers and ice sheets that can be life-limiting?

3) What are the microbial communities of prokaryotic and eukaryotic microorganisms that can live in them?

4) Could any of the known planets or satellites meet the conditions of habitability?

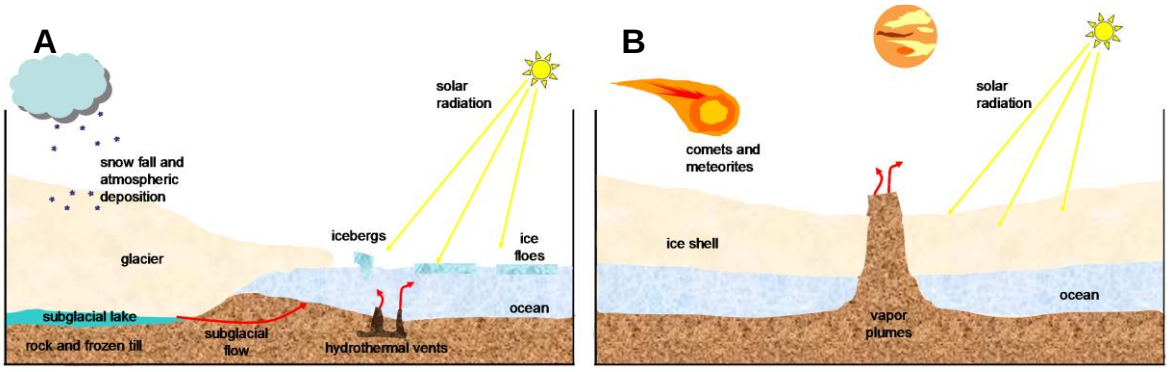


Figure ME9: *A schematic diagram of cold environments. Surface layers of (A) a terrestrial glacier and (B) an icy satellite such as Europa.*

In this project, the icy worlds are considered from the point of view of astrobiological exploration. With the aim of determining whether icy worlds could be potentially habitable, they have been compared with the environmental features of glaciers and ice sheets on Earth. We also perform some field and laboratory investigations about microorganisms that live in analogue environments of icy worlds, where they are not only viable but also metabolically active.

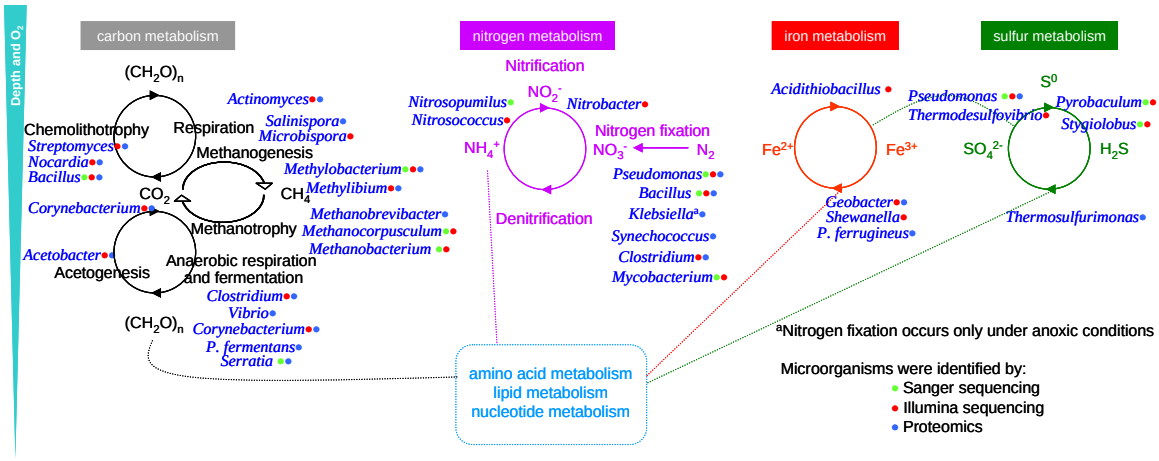


Figure ME10: *Overview of the metabolic networks between dominant microorganisms in the englacial ecosystem.*

Scientific missions from manned and unmanned flying research platforms (MICRAS) (Elena González Toril, Ángeles Aguilera Bazán and Susana Osuna Esteban)

MICRAS is a multidisciplinary project for the study of atmospheric aerosols, using flying research platforms. From the interaction between disciplines such as chemistry, physic, microbiology and a clear support of engineering, will allow us to cover a complete study of microbial ecology of aerosols.

The success of this project is the fact that it would take place at the National Institute for Aerospace Technology (INTA) belonging to the Spanish Ministry of Defence. This public agency is specialized in aerospace research and technology development since 1942.

Figure ME11: *C-212 aircraft used during air sampling campaign*

This allows us to optimize resources, because since 1994 the INTA is provided with its own air research infrastructure: two aircraft CASA C-212-200 suitably modified to adapt as flying research platforms. Such aircrafts will be a basic tool in our research, and represent a huge advantage in the study of atmospheric microbial ecology and the different environments that we could find. Moreover, the engineering specialized team from INTA will enable us to adapt the flying platforms to develop of our goals. Furthermore, INTA is developing sophisticated unmanned flying platforms with high potential in the study of the atmosphere, especially in microbial ecology. Therefore, manned platforms allow atmospheric studies over long distances and altitude and unmanned platforms allow researches in areas with low accessibility for aircraft.

This project presents a scientific and engineering duality: (i) the study of microbial ecology of the atmosphere and (ii) the adequacy of manned and unmanned flying platforms for the study of atmospheric microbial ecology. The objectives at which the project is aimed are the following:

1. Study of the microbial ecology of the atmosphere using manned and unmanned flying research platforms. This objective includes a chemical, physical and microbiological diversity research of the sampling areas.
2. Correlation database by multivariate statistics and model development

3. Development of sampling equipment and software suitable for the proposed objectives.

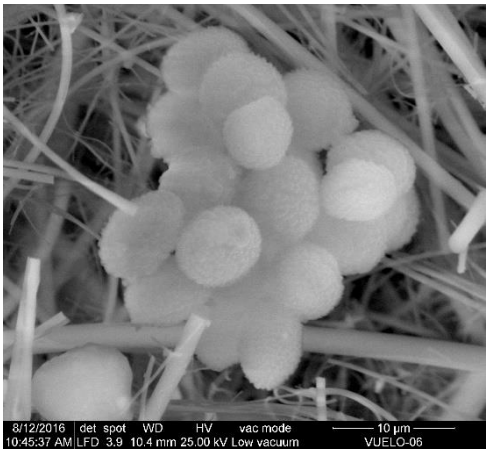


Figure ME12: *SEM images of a bacterial colony from an air sample*

Scientific working group of this project is made up of specialized researchers in microbial ecology of extreme environments and analytical chemistry since 1999. Engineering team is specialized in flying platform with an experience of more than 25 years.

In summary, the combination of molecular ecology techniques, chemistry and physics, with appropriate technological support, will unveil the uniqueness of air microbial ecosystems and modeling of these interesting and little known environments.

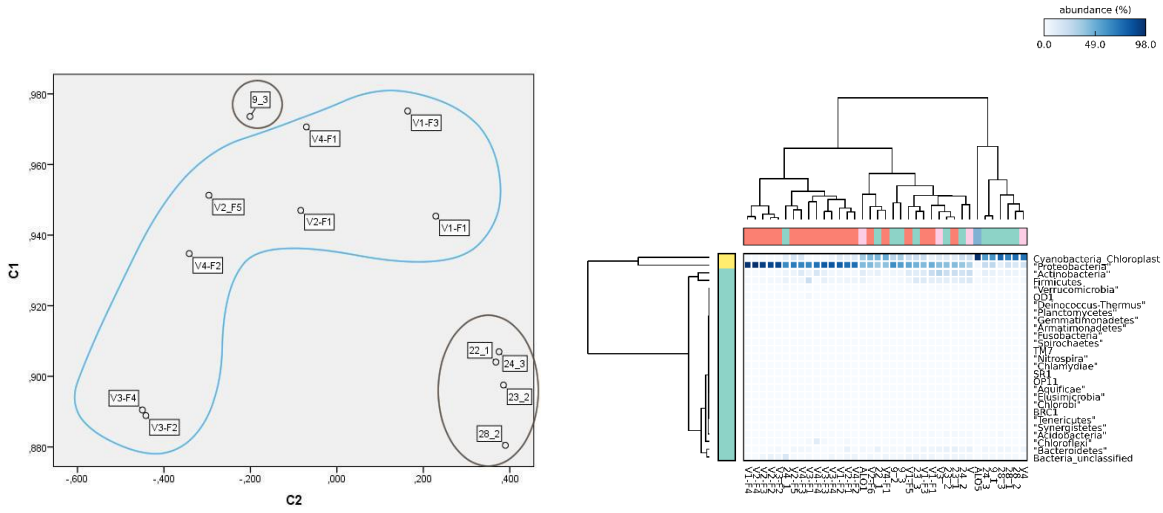


Figure ME13: *Microbial diversity study during a desert dust storm*

Molecular Mechanisms of Biological Adaptation

Coordinator: José Eduardo González Pastor

Microorganisms that inhabit extreme environments have developed complex molecular mechanisms that allow them to survive in these conditions. In our group we are interested in discovering new adaptation mechanisms, but a major problem is that a high percentage of microorganisms can not be cultivated or there are no molecular tools for their genetic manipulation, and therefore can not be studied. Thus, we are using independent culture techniques, such as metagenomic sequencing, functional metagenomics and metatranscriptomics, which allow us to access the genetic information of all the microorganisms present in a certain environmental sample, and then be able to study their adaptation strategies to extreme conditions.

Currently we are interested in studying the molecular mechanism of adaptation to salt and UV radiation in microorganisms that inhabit hypersaline environments, which are able to thrive in high salt concentrations and high doses of radiation. Hypersaline environments can be considered analogous to Mars and icy satellites such as Europa (Jupiter) and Enceladus (Saturn). In addition, we are developing molecular tools for the screening of metagenomic libraries in mesophilic and hyperhalophilic microorganisms using microfluidics. This work is funded by the European Project: METAFLUIDICS (H2020, GA685474) and the Coordinated Project: CGL2015_66686-C3-2 (MINECO, Spain)

Search of mechanisms of adaptation to UV radiation in microorganisms from salterns using a functional metagenomics approach

Metagenomic DNA was isolated from the microorganisms of four samples at different salinities from Santa Pola salterns (Alicante, Spain): CR30 (39.2% salinity), CCAB (30.4% salinity), CO-71 (21.2% salinity) and Bras (12.4% salinity). Metagenomic DNA of four of these samples, CR30, CCAB CO-71 and Bras have been sequenced using Illumina® HiSeq™ (Sistemas Genómicos, Spain), the reads were aligned in contigs, and genes were predicted. Taxonomic assignation of the different genes predicted revealed that most of the metagenomic sequences derived from the BRAS sample belonged almost exclusively to the domain *Bacteria*, with a high proportion of sequences derived from members of the order *Rhodobacterales*. In the case of the more saline samples (CR30, CCAB and C071), a higher proportion of sequences derived from archaeal members whereas less bacterial sequences were found. It was observed a higher number of archaeal members as the salt concentration increased across the samples. From these, the most abundant sequences were closely related to the *Halobacteriales* and *Haloferacales* orders. Regarding the presence of members of the domain *Bacteria*, the bacterioidetes are the more abundant (mainly *Salinibacter ruber*). Three metagenomic libraries were constructed to search for genes involved in salt and UV resistance, total DNA extracted from those hypersaline environments (C071, CCAB and CR30) was partially digested with the Sau3A1 enzyme, and short DNA fragments (1-8 kb) were cloned into the plasmid pBluescript-SKII, using *E. coli* as host. The libraries were exposed on solid medium to UV-B radiation, under conditions that are lethal for the host *E. coli* strain. In total, 52 fragments of environmental DNA (19 from CR30, 7 from CCAB and 26 from C071) from archaea, bacteria and viruses have been identified as involved in UV resistance. All of them have been sequenced, and every gene from each

fragment is being cloned to determine which ones are directly involved in UV resistance.

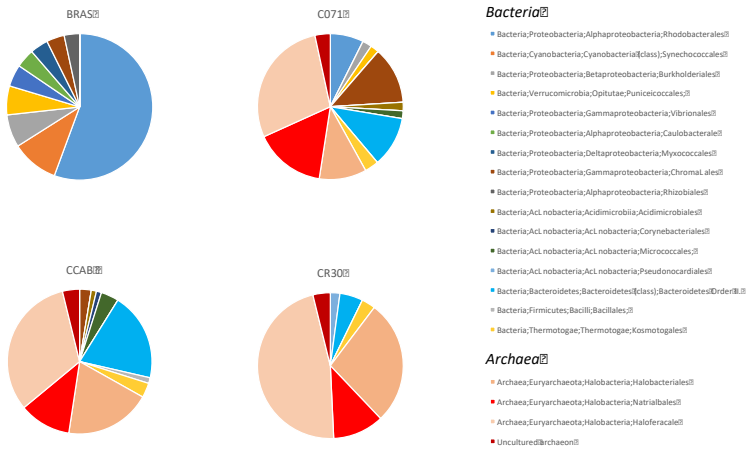


Figure ME14: *Taxonomic affiliation of bacterial and archaeal sequences retrieved from the different saline samples.*

Life support systems: UV resistant plants

The main goal is to generate plants more resistant to UV radiation, to improve their capabilities to survive in space conditions. Five genes from bacteria and archaea involved in UV resistance were introduced in the genomes of different *Arabidopsis thaliana* plants. Those genes were retrieved in a previous study from microorganisms of a saltern (Es Trenc, Spain) and from hypersaline ponds from the Andean Highlands in Argentina, environments exposed to high UV-B doses of radiation, specially those in the Highlands (4.300 m altitude). The selected genes encodes two hypothetical proteins, one putative transcription factor, a putative ribonuclease III and a putative endonuclease. Those genes were cloned in the plasmid pCAMBIA 3500 (from Carlos Alonso, CNB), and then introduced in *Agrobacterium tumefaciens*, which were used to transfer the genes by floral dipping to the genome of *Arabidopsis thaliana* Columbia-0. Several independent transgenic lines were obtained for each construction, and the first generation of two different constructions were tested for UV resistance. Preliminary results indicate that plants expressing the gene encoding a putative endonuclease (ORF1 from pML84) are more resistant to UV radiation.

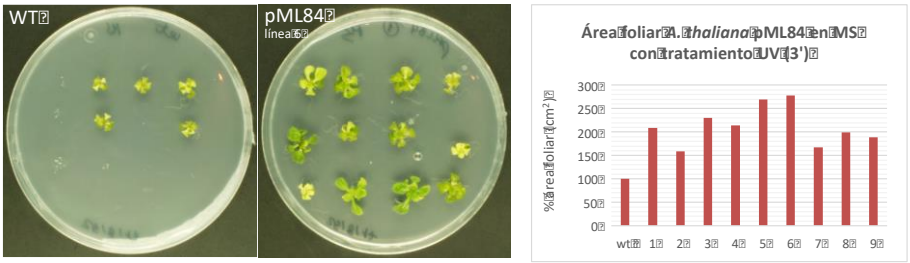


Figure ME15: *Left) plants expressing ORF1-pML84 have larger size and less loss of coloration as compared to wild type plants, one week after UV-C radiation exposure, right) the percentage of foliar area after exposure to UV is grater in the nine lines of plants expressing ORF1-pML84 than in the wt plant.*

Development of molecular tools for screening of metagenomic libraries in both mesophilic and hyperhalophilic microorganisms

We have tested the use of a bifunctional vector pAJ to express metagenomic DNA in the hyperhalophilic archaea *Haloferax volcanii* and in the mesophilic bacterium *Escherichia coli*. Plasmid pAJ contains the pHV2 replicon from *H. volcanii*, a replicon from *E. coli* and a constitutive promoter of *amyH* derived from *Haloarcula hispanica* driving dual expression in archaea and bacteria hosts. As a test of concept, a salt-tolerant green fluorescent protein (GFP) variant (smGFP) was inserted into pAJ This construct was transformed into the hypersaline archaeal host *H. volcanii* DS70 and successfully expressed a functional salt-stable GFP in live *E. coli* and *H. volcanii* cells. Then, two libraries were successfully constructed in the *E. coli* host DH10B strain: CR30 library with a 27% of recombinant clones and C071 library with a 38% of recombinant clones. The average size of inserts was of 1800 bp and 5900 bp for C071 and CR30 libraries respectively.

Development of fluorescent hosts to search for genes involved in resistance to extreme conditions in metagenomic libraries using microfluidics

E. coli DH10B and DH5a strains were engineered to constitutively express fluorescence by inserting in their genomes a gene encoding a superfolder enhanced Green Fluorescent Protein (sfGFP) under the transcription of the constitutive $P_L\lambda$phage promoter. In collaboration with the laboratories of José Berenguer and Aurelio Hidalgo (CBM-Severo Ochoa, Madrid), we have tested the encapsulation in microfluidic droplets of the fluorescent cells. The fluorescent cells will be used as hosts for our metagenomic libraries, which will be exposed to some extreme conditions and will be screened to search for resistance genes using a microfluidics device that selects fluorescent droplets.

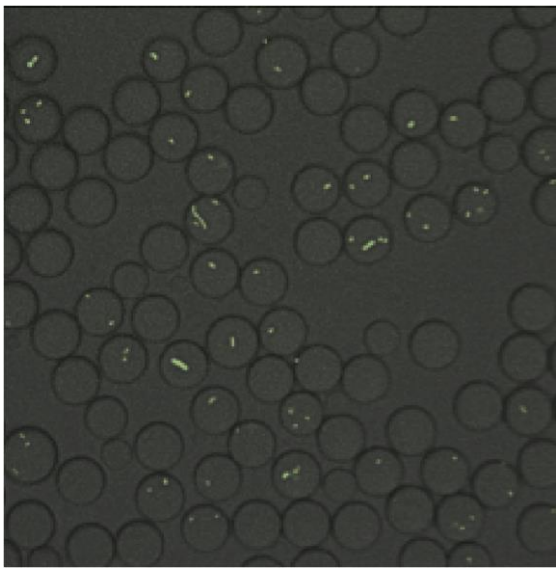


Figure ME16: *Overlay of microscope images of droplets containing one or more cells of E. coli fluorescent strain DH10B*

Biomolecules in Planetary Exploration

Coordinator: Victor Parro García

Multidisciplinary group with biologists, chemists, engineers, technicians and students of different levels (training, Ph.D., degree) whose goal is to understand the metabolic potential and the preservation of molecular biomarkers (in space and time) in terrestrial environments analog to those found in other planetary bodies. A transdisciplinary approach will bring us to an integrative vision about the feasibility of life in other planets.

The experimental approach is based on the study of the material and biological information both in situ (through field campaigns) and in the laboratory, its preservation and interaction with the physical environment, the identification of molecular biomarkers, and the development of methodologies and instrumentation for in-situ detection.

The main objectives are:

1. The study of the conservation of biological information in changing extreme environments (salty deserts, icy deserts, arctic and Antarctic Permafrost, deep continental subsurface)
2. Identification of molecular biomarkers in samples from extreme environments and development of methods for their detection in situ.
3. Implementation and increasing the maturity level of the immunological biosensor LDChip (Life Detector Chip) and SOLID (Signs Of LIfe Detector) instrument, as well developing new concepts of instrumentation for planetary exploration
4. Searching for opportunities of SOLID-LDChip for future planetary exploration missions

The strategy to achieve these objectives is based on:

1.- Geomicrobiological studies of extreme environments considered terrestrial analogs of other planetary environments. Sampling techniques are employed for surface (water, rocks, soil, sediment) and at depth by drilling shallow (1-5 m) and deep (600 m), mineralogical study (XRD, Raman), geochemical (ICP-MS, ion chromatography), Organic Chemistry and lipid forensic (GC / MS), biochemical (proteins and total sugars as well as amino acids and monosaccharides), Microbiology (enrichment cultures, meta-omics techniques, and microscopy).

2.- Developing antibody microarray-based immunosensors: Production of antibodies against natural extracts, microbial strains, proteins, nucleic acids, exopolysaccharides, etc, and development of immunoassays procedures. We have a unique collection of 400 antibodies and a microarray (LDChip) tested in the field. Metaproteomics and epitope mapping with random peptide and oligosaccharide microarrays to identify potential targets in nature.

3.- Implementing tools for biomarker detection in situ. We developed the instrument SOLID (Signs Of LIfe Detector) capable of processing a sample of up to 1 g of soil or ground rock and analyzed by automated LDChip immunosensor. Currently SOLID has

a TRL6 level (NASA standards), it has been submitted in several calls for instruments for the exploration of Mars.

During year 2017, we carried out several research activities:

- The LDChip was complemented with new antibodies to detect cyanobacterial strains usually found on extreme environments such as Chroococcidiopsis spp. or Synechocystis spp. We have now a collection of 23 antibodies to cyanobacteria which form the CYANOCHIP. We have demonstrated the utility of CYANOCHIP for detecting toxins producing cyanobacteria in spring water reservoirs as well as the detection of endolithic strains as Chroococcidiopsis in environmental samples from extreme environments as Atacama Desert, high Arctic or deep subsurface.
- We have participated in two field campaigns as part of our involvement in two NASA ASTEP projects: LMAP (Life detection Mars Analogue Project) and ARADS (Atacama Rover Astrobiology Drilling Studies) both lead by NASA Ames Research Center. We organized and participated in the LMAP2017 campaign in Río Tinto to test the coupling of SOLID instrument with the drill and the robotic arm + scoop loading system on the Phoenix-like lander platform. The campaign was held in June and we performed several robotic drills and sample loading and analysis with SOLID, demonstrating that the system worked. In parallel we performed two bore-holes (2 m and 1 m depth) and the retrieved cores were analyzed in situ with LDChip as ground-truth to support the robotic drilling system. The campaign attracted the attention of the big media, and the campaing was presented in the TV show (http://www.rtve.es/television/20170919/viaje-marte/1619481.shtml) "El Cazador de Cerebros" on RTVE2. The retrieved samples are currently being analyzed with multiple techniques, among them lipid forensics, and will be the material for a couple of manuscripts.
- Also, we participated in the ARADS campaign in the Atacama Desert in February 2017. The objective was to set up SOLID instrument on the deck of a rover equipped with a drilling system. The interfaces were developed and SOLID was previously set and tested in another campaign at Ames Research Center. During the Atacama campaign, several drills were performed in the Salar Yungay and soils next to it. Some of the samples were delivered by the robotic arm and analyzed with SOLID, controlled through cable connections. All the samples were analyzed with LDChip following the manual system to decipher the microbial markers in the field. Additional tests were performed to follow the contamination during robotic drilling and sampling.
- We have done a critical assessment of several analytical techniques used in the search for biomarkers on mars through the in-depth study of a mummified microbial mat from the Antarctica Ice Shelf. The aim of this work was to highlight the main constraints, performance, and complementarity of several techniques that have already been implemented or are planned to be implemented on Mars for detection of organic and molecular biomarkers on a best-case sample scenario. We analyzed a 1000-year-old desiccated and mummified microbial mat from Antarctica by Raman and IR (infrared) spectroscopies (near- and mid-IR), thermogravimetry (TG), differential thermal analysis, mass spectrometry (MS), and immunological detection with the LDChip. In spite of the high organic content (ca. 20% wt/wt) of the sample,

the Raman spectra only showed the characteristic spectral peaks of the remaining beta-carotene biomarker and faint peaks of phyllosilicates over a strong fluorescence background. IR spectra complemented the mineralogical information from Raman spectra and showed the main molecular vibrations of the humic acid functional groups. The TG-MS system showed the release of several volatile compounds attributed to biopolymers. No cyanobacterial DNA sequences were retrieved from the mummified biofilms, indicating that it was seriously damaged or fully degraded by UV radiation or oxidation. However, a subset of LDChip antibodies, devoted to cyanobacteria (CYANOCHIP), detected biomarkers from Chroococcales, Nostocales, and Oscillatoriales orders, indicating that proteins or other biopolymers were still recognizable by the antibodies and validating the utility of LDChip to identify microbial markers even when no DNA is present. In general, the results highlighted the limitations of each technique and suggested the necessity of complementary approaches in the search for biomarkers because some of the analytical techniques might be impaired by sample composition, presentation, or processing, or simply, their targets might be more altered.

Figure ME17: *LMAP campaign in rio Tinto. (left) NASA Phoenix mockup equipped with a robotic drill, arm, and scoop to collect a sample from the subsurface and load SOLID for processing and searching for microbial markers with LDChip. (right) The scoop delivering a small amount of material to the SOLID sample extraction cell.*

- We have contributed to the forward planetary protection debate by publishing an opinion paper where we suggest a re-evaluation of the strong restrictions imposed to the planetary missions aimed to search for life on Special Regions on Mars. Decades of robotic exploration have confirmed that in the distant past, Mars was warmer and wetter and its surface was habitable. However, none of the spacecraft missions to Mars have included among their scientific objectives the exploration of Special Regions, those places on the planet that could be inhabited by extant martian life or where terrestrial microorganisms might replicate. A major reason for this is because of Planetary Protection constraints, which are implemented to protect Mars from terrestrial biological contamination. At the same time, plans are being drafted to send humans to Mars during the 2030 decade, both from international space agencies and the private sector. We argue that these two parallel strategies for the exploration of Mars (i.e., delaying any efforts for the biological reconnaissance of

Mars during the next two or three decades and then directly sending human missions to the planet) demand reconsideration because once an astronaut sets foot on Mars, Planetary Protection policies as we conceive them today will no longer be valid as human arrival will inevitably increase the introduction of terrestrial and organic contaminants and that could jeopardize the identification of indigenous martian life. We advocate for reassessment over the relationships between robotic searches, paying increased attention to proactive astrobiological investigation and sampling of areas more likely to host indigenous life, and fundamentally doing this in advance of manned missions.

Advanced Instrumentation

Head of Department: Eduardo Sebastián

Experimentation and simulation play a fundamental role in the accomplishment of the different research lines in the Center. In many cases they are carried out in the laboratory, in others during field campaigns by studying natural processes, and in other cases in space, either by remote observation or by in situ analysis and measurements on the surface of planetary bodies.

The Department devotes its research activity to the development of space instrumentation technologies for planetary and astrophysical exploration, as well as the development of simulation chambers for planetary environments. In this last aspect, the Instrumentation Department has different infrastructures, planetary simulation chambers and vacuum technologies to scientifically and technologically support the researchers of the group. All the technological developments are the result of a multi and transdisciplinary relationship between the members of the Instrumentation Department and the rest of the center's scientists.

The technological aspects of this development range from the conception of prototypes and new concepts of instrumentation, the design and supervision of the industry specialized in the manufacture of flight models, through the execution of testing campaigns for the validation and maturation of the instrumentation and developed technologies, either in simulation chambers or in representative environments (so-called terrestrial analogues). Within the framework of the group's activity, the operation and exploitation of the scientific data collected by the technological developments is also carried out, in direct collaboration with the rest of the center's staff and associated units.

During the year 2017 the department consolidated the experience acquired in previous years and projects. Clearest examples in the field of flight instrumentation are the leadership of the REMS (Rover Environmental Monitoring Station), aboard the Curiosity rover in the Mars Science Laboratory mission, TWINS (Temperature and Wind Sensors for InSight mission) aboard the lander of the InSight mission, and MEDA (Mars Environmental Dynamics Analyzer) of the MARS2020 mission, all of them from NASA.

The Advanced Instrumentation Department is organized in a single Research Group:

- Space Instrumentation

Space Instrumentation

Coordinator: Jose Antonio Rodriguez Manfredi

All the technological activities and the members of the Instrumentation Department are included in this group of research and development of Spatial Instrumentation. The main activities carried out during the year 2017 were:

Instrumentation for space missions: MEDA.

The Center for Astrobiology leads the development of the space instrument MEDA (Mars Environmental Dynamics Analyzer) for NASA's Mars 2020 mission.

Together with the CAB, the Departamento de Cargas Útiles del Instituto Nacional de Técnica Aeroespacial, CRISA Airbus Defense and Space, AVS Added Value Solutions, ALTER Technology, the University of the Basque Country, the Rocasolano Physics-Chemistry Institute (CSIC) and the University of Alcalá participate in this development as Spanish partners. Additinonally, the Finnish Meteorological Institute, the Jet Propulsion Laboratory, the University of Michigan, Aeolis Research, the University of Texas A & M, NASA Goddard Space Flight Center, and the John Hopkins APL as international partners.

The scientific objective of the instrument is to characterize the environmental parameters and physical properties of the dust, in the local environment of the new vehicle that NASA plans to send to Mars. For this, the instrument is conceived as a suit of sensors that will record: the relative humidity (Relative Humidity Sensor - HS), the air temperature (Air Temperature Sensor - ATS), the net balance of IR radiation (Thermal IR Sensor - TIRS), the speed and direction of the Martian wind (Wind Sensors - WS), the radiation and the properties of the suspended aerosols (Radiation and Dust Sensor - RDS), and the atmospheric pressure (Pressure Sensor - PS).

During the first months of 2017, the international team faced the end of phase C of the development, successfully passing the CDR (Critical Design Review) review with NASA. From that date to the end of the year, and in phase D of development, the different teams have focused on the activities of manufacturing engineering, qualification and flight models, as well as the realization of the different qualification and validation tests.

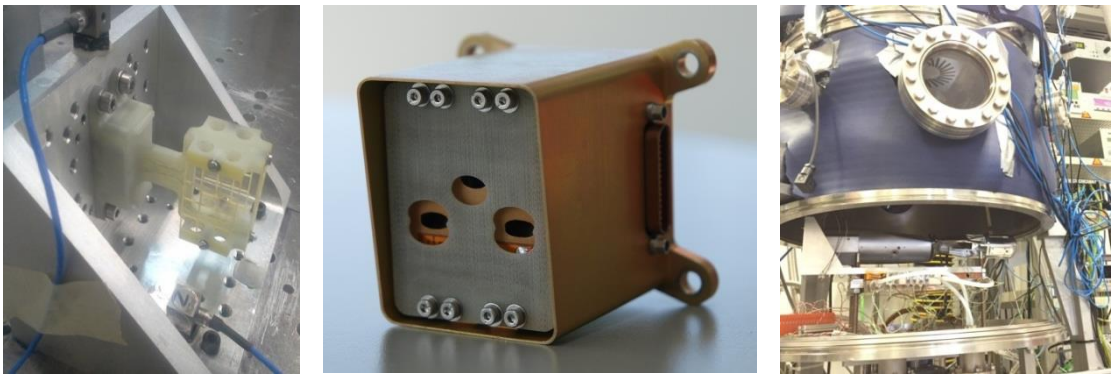


Figure AI1: *Different validation models of MEDA sensors. From left to right. ATS (Ambient Temperature Sensor), TIRS (Thermal InfraRed Sensor) y WS (Wind Sensor).*

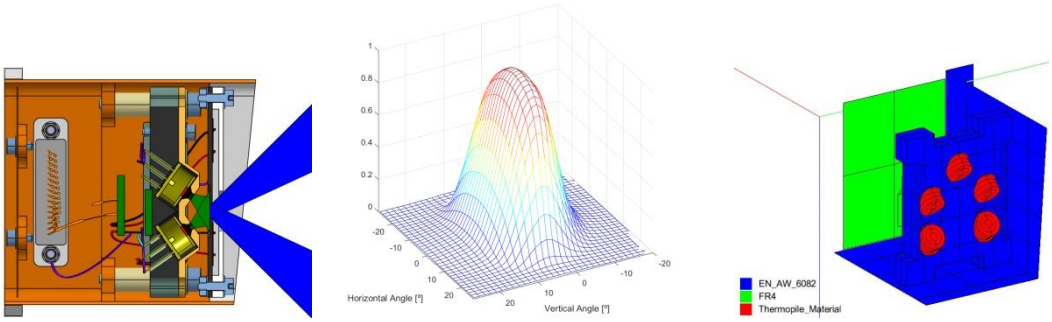


Figure AI2: *TIRS filed of views and thermal model representation. From left to right. Vertical representation of external (green) and target (blue) field of views, calibrated and normalized target field of view, and TIRS support plate thermal response.*

Instrumentation for space missions: RLS.

Throughout the year 2017, a multidisciplinary group composed of members of the Instrumentation Department, the Department of Planetology and Habitability, INTA staff (especially from the Space Instrumentation Laboratory), and the CAB Associated Unit with the Cosmogeochemistry and Astrobiology group of the University of Valladolid, continued with the development of the spatial instrument Raman Laser Spectrometer, RLS, for the ExoMars 2020 mission of the European Space Agency. During this period the design of the instrument is in the D phase of development, carried out the main technological activities of the qualification and flight models such as assembly and tests campaigns. (See scientific details in the framework of this activity in the Planetary Geology and Atmospheres Group)

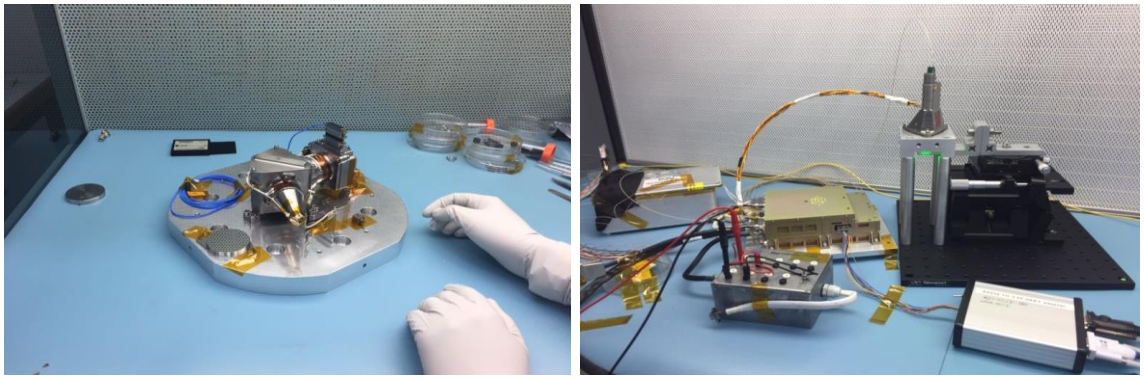


Figure AI3: *Current status of the Raman EQM for Exomars. Left the spectrometer, right, the optical head and the control electronics.*

Instrumentation for space missions: TWINS. During the year 2017 the participation of the Department of Instrumentation in the mission InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) of NASA, for the characterization of the interior of the planet Mars through a lander, through the TWINS (Temperatures and Winds for INSight) instrument continued. TWINS (Temperatures and Winds for INSight), responsible for the environmental characterization of the Martian environment. The launch of the mission is scheduled for May 2018.

The participation in the InSight mission was materialized through the inclusion of scientific instrumentation aboard the lander, of the spare models that were developed for the REMS instrument in the framework of the Mars Science Laboratory mission, also from NASA. TWINS, with respect to its predecessor REMS, has undergone some remodeling and adjustments in order to adapt the instrument to the specific needs and limitations of InSight for Martian environment characterization.

The role and scientific return that the TWINS instrument will play in the InSight mission will be of vital importance: (i) in a first phase, it will characterize the local environment, determining the precise moment in which wind conditions are calm and the safe deployment of the instruments located on board may be carried out; (ii) once the instruments are deployed, the scientific data provided by TWINS will allow to discard false seismic readings caused by the strong winds of the environment; (iii) finally, the data provided by TWINS will be of great scientific value given the detailed record that will be carried out, and will complement those provided by REMS in the Martian Gale crater, constituting the first meteorological-environmental network on the surface of Mars.

The flight hardware was sent in 2014 to Jet Propulsion Laboratory (JPL) and Lockheed Martin for its integration in the platform, and performing some integration tests with the rest of the systems. During the year 2017 the team has given support to these tasks and integration tests, as well as development of the ground software for the analysis of scientific and engineering data and the integrated operation strategies of the instrument. For this, numerous meetings were held with JPL and CNES.

Figure AI4: *Integration of the instrumental systems on the InSight Lander platform. In the image you can see the TWINS booms.*

Instrumentation for space missions: REMS.

During 2017, the successful operation of the REMS (Rover Environmental Monitoring Station) on Mars, aboard Curiosity, continued. Curiosity, NASA's exploration vehicle, has been since August 2012 recognizing and characterizing the habitation environment of Gale Martian Crater. REMS is the instrument in charge of the environmental

characterization of the environment, continuously collecting data on pressure, air and soil temperatures, wind speed and direction, atmospheric humidity and incident ultraviolet radiation. During this time, the instrument collected more than 30 million readings from each of the sensors.

In addition to the daily operation of REMS, the group participates in the analysis of the scientific data obtained by the instrument, also contributing to the discussions and scientific meetings that periodically and frequently gather all the national and international members of the REMS team.

Figure AI5: *Photo of the boom 2 and REMS UV sensor taken by one of the Curiosity cameras in a landscape of Martian dunes. In boom 2 you can see the air temperature sensor, the humidity sensor, the wind sensor.*

Instrumentation for space missions: SuperCam.

The CAB Associated Unit with the Cosmogeochemistry and Astrobiology group of the University of Valladolid contributes to the development of the individual and cross-calibration system of the five spectroscopic techniques contained in the SuperCam instrument for NASA's Mars 2020 mission. The system involves the technological development of the support and the fixing systems of a set of 28 samples to SuperCam in-flight calibration. This includes the verification of all the samples, from the chemical and structural point of view, as well as the thermo-mechanical tests of the unit. Throughout the year 2017, technological activities have focused on the phases of design qualification and construction of the flight model.

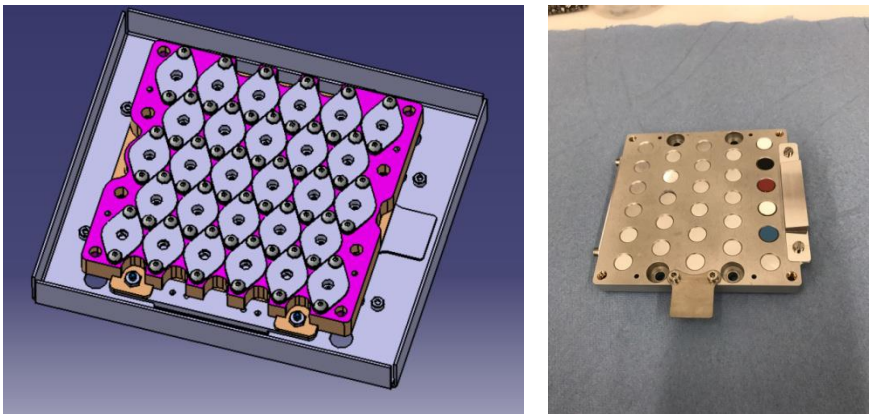


Figure AI6: *Detail of the sample fixation system developed (left) and complete EM device (right) after passing the shock tests at 4000G.*

Technological developments of the SAFARI / SPICA project.

In parallel to the scientific activities carried out within the Department of Astrophysics, the Space Instrumentation Group has continued its contribution to the technological development of the SAFARI instrument.

During 2017, the opto-mechanical reference design for the FPU (Focal Plane Unit) was changed in order to improve its modularity and competitiveness. The new design eliminates the use of the FTS (Fourier Transform Spectrometer) and incorporates a Grating-based point source spectrometer working in the 34-230 μm wavelength range. The design and its subsequent implementation represent a challenge both from the mechanical and thermal point of view, when working at cryogenic temperatures between 4.5K and 0.05K, and it will have to be optimized to improve its weight and volume.

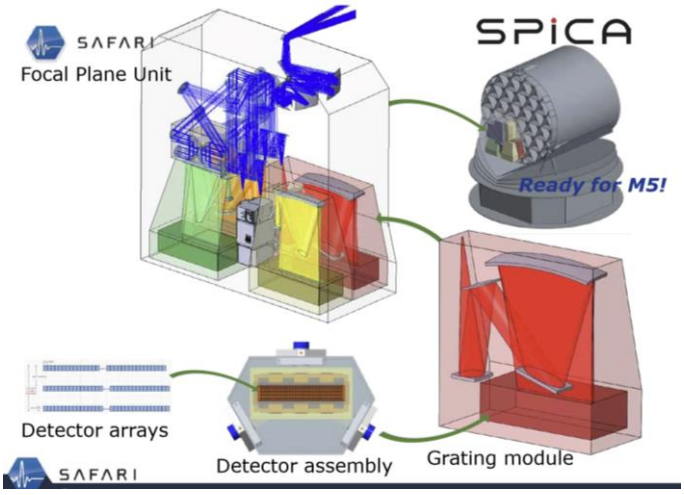


Figure AI7: *New conceptual design of the focal plane unit SAFARI / SPICA.*

Technological developments of the European project *Multiparametric probe for monitoring in real time environmental variables in drilling boreholes*. This project belongs to the EU H2020 call, Proof of Concept (PoC), ERC-2016-PoC and represents the continuation of the technological activities of the IPBSL project. Throughout the year 2017 the activities have been focused on the development and assembly of prototypes of different physical and chemical sensors (based on ISFET technologies), for the determination of ions of calcium, ammonium, potassium, phosphorus and chlorine, among others magnitudes. As part of the PoC program, the team also worked on the patenting and dissemination process.

Figure AI8: *Prototype of the geo-biological characterization system of the subsoil during final field trials*

Technological developments of the European project NANOCOSMOS.

The Spatial Instrumentation Group has contributed to the design and development of the vacuum system known as StarDust, within the NANOCOSMOS project (ERC-2013-SyG Grant Agreement No. 610256), whose activities are carried out in collaboration with Spanish and French project teams.

During the year 2017 the construction the vacuum and sensory systems of StarDust facility, have been completed in the ICMM-CSIC laboratory (Instituto de Ciencia de Materiales de Madrid del Consejo Superior de Investigaciones Científicas). Subsequently, activities such as fundamental tests to validate project requirements have been started.

WLOM Project (Water Liquid On Mars).

This is a project led by researchers of the Space Instrumentation Group whose main objective is to simulate the poles of the planet Mars, analyzing the possible coexistence of liquid water in vacuum conditions and the adaptation of Antarctic extremophile mats to the poles of Mars. Throughout the year 2017, the adaptation and preparation of the MARTE chamber to mimic Mars relative humidity, radiation and temperature conditions has been carried out. The chamber has also been equipped with the necessary instrumentation to inject water and measure the oxygen produced by the photosynthesis of algae (cyanobacteria), all under controlled pressure conditions.

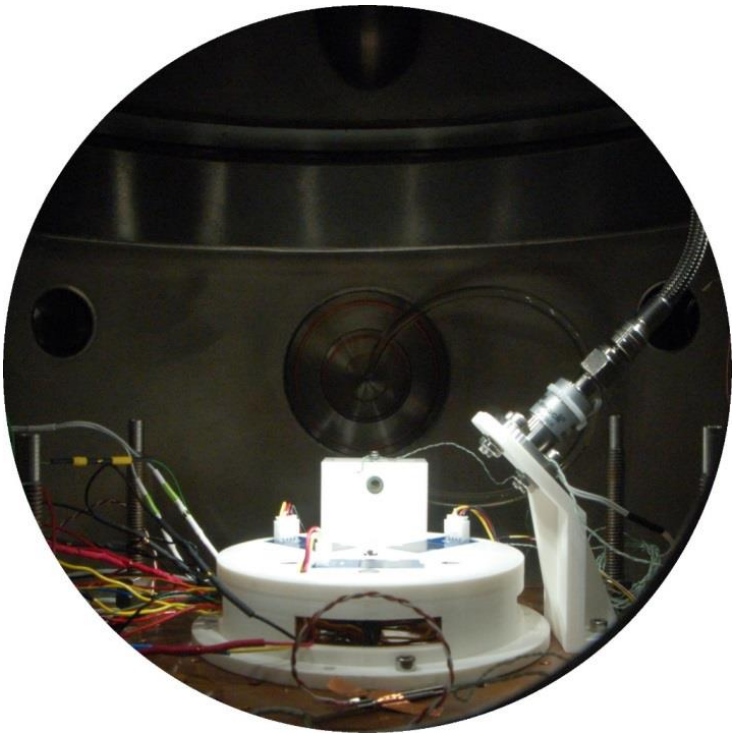


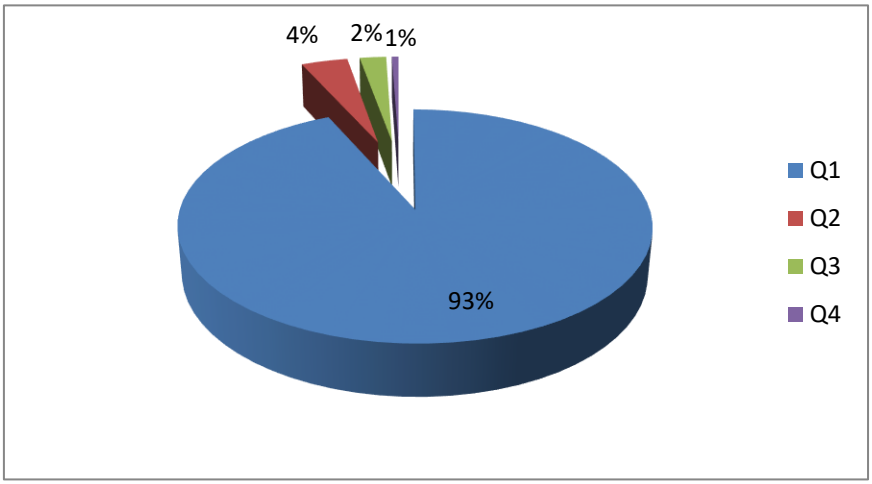
Figure AI9*: Image of the WLOM set-up inside MARTE chamber*

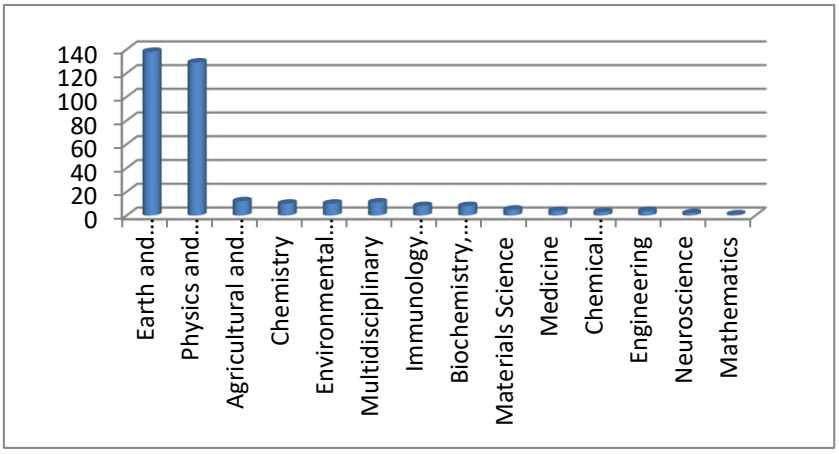
III PUBLICATIONS AND SCIENTIFIC PRODUCTION

PUBLICATIONS

Bibliometrical summary

Year	Papers	First author
2013	200	76
2014	195	71
2015	217	56
2016	204	48
2017	***186***	***36***





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PARTICIPATION IN CONFERENCES

Julia Alfonso-Garzón, Celia Sánchez-Fernández, Jari Kajava, Peter Kretschmar, and J. Miguel Mas-Hesse
"INTEGRAL multiwavelength observations of Be/X-ray binaries"
EWASS 2015 - European Week of Astronomy and Space Science
Tenerife, 22 - 26 Junio 2015
Contribution: oral

Jorge Pla-García: "Meteorological predictions for Mars 2020 Exploration Rover high-priority landing sites"
6th Mars Atmosphere Modeling and Observation Workshop (MAMO).
Granada, 17-20 January 2017
Contribution: poster

Daniel Viúdez-Moreiras, Javier Gómez-Elvira, Claire Newman and the REMS team
"Gale wind speed Weibull distribution based on the first two years of REMS wind data"
6th Mars Atmosphere Modeling and Observation Workshop (MAMO).
Granada, Spain. 17th January 2017
Contribution: talk

Martínez, G. M., A. De Vicente-Retortillo, A. G. Fairén, E. Fischer, S. D. Guzewich, R. M. Haberle, O. Kemppinen, M. Lemmon, C. Newman, N. Renno, M. Richardson, M. D. Smith, M. Torre-Juárez and A. Vasavada.
"An overview of the dust, CO2 and water cycles on Mars as revealed from in-situ environmental data from the Viking to the Curiosity Rover".
6th Mars Atmosphere Modeling and Observation Workshop (MAMO).
Granada, Spain. 17th January 2017
Contribution: talk

María-Paz Zorzano
"A Xenon Mass Gauging through Heat Transfer Modeling for Electric Propulsion Thrusters."
19th International Conference on Aerospace, Propulsion and Energy Sciences,
London, United Kingdom, January 19-20th 2017.
Contribution: Chair and oral presentation

V. Roman; A. Gomez; P. Prieto; D. Granados; J. L. Costa-Kramer; J. Bueno; J. Goupy; J. Martin-Pintado, "Fabrication of Lumped Element Kinetic Inductance Detectors for millimeter and sub-millimeter Astronomy". Workshop Nanolito 2017, Salamanca, España (2017). Contribution: Poster

V. Rollano; A. Gomez; P. Prieto; M.R. Osorio; D. Granados; E. M. Gonzalez; J. L. Vicent, "Fabrication of hybrid systems: Suspended Graphene / Superconductor". Workshop Nanolito 2017, Salamanca, España (2017). Contribution: Poster

Carlos Rodrigo Blanco, Enrique Solano, and Amelia Bayo Arán.
“Spectral Stellar Libraries at the Spanish Virtual Observatory”
IWSSL
Campos do Jordão, February 2017
Contribution: oral.

Carlos Rodrigo Blanco, Enrique Solano
“Datalink implementation for stellar libraries”
ASTERICS DADI Technology Forum 3
February, 22-23. Strasbourg (France)
Contribution: talk

José Manuel Alacid, Enrique Solano
“Implementation of Time Series DM”
ASTERICS DADI Technology Forum 3
February, 22-23. Strasbourg (France)
Contribution: talk

Carolina Gil Lozano, Eva Mateo Martí, Luis Gago Duport, Elizabeth Losa Adams, Vincent F. Chevrier and Alberto G. Fairén.
“Exploring the mineral sequences that can be formed from a disulfide-rich soil on early mars.”
LPSC, March, 20-24. Houston (USA)
Contribution: poster

Bishop, J. L., L. L. Baker, A. G. Fairén, C. Gross, M. A. Velbel, E. B. Rampe, and J. Michalski.
“Unraveling the diversity of early aqueous environments and climate on Mars through the phyllosilicate record”.
Lunar and Planetary Science Conference, #1804, Lunar and Planetary Institute 2017, March, 20-24. Houston (USA)
Contribution: poster

Williams, J.-P., J. M. Dohm, R. J. Soare, J. Flahaut, R. M. C. Lopes, A. V. Pathare, A. G. Fairén, D. Schulze-Makuch, and D. L. Buczkowski.
“Argyre Mons and other volcanic features within Argyre Basin, Mars”.
Lunar and Planetary Science Conference, #2682, Lunar and Planetary Institute 2017, March, 20-24. Houston (USA)
Contribution: poster

Rampe, E. B., D. W. Ming, J. P. Grotzinger, R. V. Morris, D. F. Blake, D. T. Vaniman, T. F. Bristow, S. M. Morrison, A. S. Yen, S. J. Chipera, R. T. Downs, C. N. Achilles, T. S. Peretyazhko, B. Sutter, A. H. Treiman, P. I. Craig, J. D. Farmer, D. J. Des Marais, A. G. Fairén.
“Mineral trends in early Hesperian lacustrine mudstone at Gale crater, Mars”.
Lunar and Planetary Science Conference, #2821, Lunar and Planetary Institute 2017, March, 20-24. Houston (USA)
Contribution: poster

Meslin, P.-Y., J.R. Johnson, O. Forni, P. Beck, A. Cousin, J. Bridges, W. Rapin, B. Cohen, H. Newsom, V. Sautter, E. Lewin, M. Nachon, R.C. Wiens, V. Payré, O. Gasnault, S. Maurice, A.G. Fairén, S. Schröder, N. Mangold, N. Thomas.
"Egg rock encounter: analysis of an iron-nickel meteorite found in Gale crater by Curiosity".
Lunar and Planetary Science Conference, #2258, Lunar and Planetary Institute 2017, March, 20-24. Houston (USA)
Contribution: poster

Stern, J. C., B. Sutter, W. A. Jackson, R. Navarro-González, C. P. McKay, D. W. Ming, P. D. Archer, D. P. Glavin, A. G. Fairén, P. R. Mahaffy.
"Nitrogen on Mars: Insights from Curiosity".
Lunar and Planetary Science Conference, #2726, Lunar and Planetary Institute 2017, March, 20-24. Houston (USA)
Contribution: poster

Losa-Adams, E., C. Gil-Lozano, A. Hoser, A.F. Davila, A.G. Fairén, V.F. Chevrier, L. Gago-Duport.
"Measuring Li-isotope fractionation in clays with high resolution neutron diffraction: a test about the persistence of water in Mars".
Lunar and Planetary Science Conference, #3017, Lunar and Planetary Institute 2017, March, 20-24. Houston (USA)
Contribution: poster

M. García-Hernández, I. Klett, C. Pinto, M. Barragán, L. López, C. Briones, G. Fernández, M.E. Martín, V.M. González, A. García-Sacristán.
"APTUS Biotech: Diagnostic tools for viral pathogens".
Aptamers 2017: 4th International INSOAP Symposium on Aptamers. Oxford (UK). April 11-12, 2017.
Contribution: Oral.

María-Paz Zorzano
"The HABIT instrument for ExoMars"
Space Forum Sweden (Rymdforum),
Kiruna, Sweden. 8th-10th of May, 2017.
Contribution: Oral

José Manuel Alacid, Enrique Solano
"Time Domain at the SVO"
IVOA Interoperability Meeting
May, 14-19. Shanghai (China)
Contribution: talk

Carlos Rodrigo, Enrique Solano
"Datalink implementation for stellar libraries"
IVOA Interoperability Meeting
May, 14-19. Shanghai (China)
Contribution: talk

C. Briones.
"Darwin in the test tube: *in vitro* evolution of RNA".
The RNA World: past and present. Mexico City (Mexico). May 16-22, 2017.
Contribution: Invited plenary talk.

Heydari, E., F. J. Calef, J. Schroeder, T. J. Parker, B. Hallet, A. G. Fairén, S. Rowland. "Depositional environments of the Murray formation at the Pahrump Hills locality, Gale Crater, Mars: Sedimentation on a lake-floor fan controlled by climatic-related lake-level fluctuations".
GSA Cordilleran Meeting, # 292464, Honolulu, 23–25 May 2017.
Contribution: poster

Heydari, E., F. J. Calef, J. Schroeder, T. J. Parker, A. G. Fairén, S. Rowland. "Sedimentological framework, sequence stratigraphy, and relative dating of geological events in the landing ellipse of the Curiosity Rover, Gale Crater, Mars".
GSA Cordilleran Meeting, # 292465, Honolulu, 23–25 May 2017.
Contribution: poster

María-Paz Zorzano
"Lessons learned from Curiosity to ExoMars" and "HABIT project management".
1st HABIT science meeting.
Luleå University of Technology, Luleå, Sweden. 29 May-1st June 2017
Contribution: Oral

M. Moreno, L. Vázquez, A. López-Carrasco, J.A. Martín-Gago, R. Flores, C. Briones.
"Unveiling viroid RNA native structure by Atomic Force Microscopy".
XIV Spanish National Congress of Virology. Cádiz (Spain). June 11-14, 2017.
Contribution: Poster.

B. Torres-Vázquez, M. Moreno, A.M. de Lucas, C. Briones.
"Development of RNA and DNA aptamers against HCV core protein of genotypes 1 to 4: applicability to viral diagnosis and genotyping".
XIV Spanish National Congress of Virology. Cádiz (Spain). June 11-14, 2017.
Contribution: Poster and oral.

V. Martín, C. Perales, M. Fernández-Algar, H.G. Dos Santos, P. Garrido, M. Pernas, V. Parro, M. Moreno, J. García-Pérez, J. Alcamí, J.L. Torán, D. Abia, E. Domingo, C. Briones.
"Development of a genotyping DNA microarray for the characterization of drug-resistance mutations in majority and minority subpopulations of HIV-1".
XIV Spanish National Congress of Virology.. Cádiz (Spain). June 11-14, 2017.
Contribution: Poster.

Ester Lázaro, María Arribas, Jacobo Aguirre, and Susanna Manrubia
"Differences in the optimization dynamics determine the selective advantage of particular mutants in an RNA virus"
XIV Spanish National Congress of Virology
Cádiz. 11-14 June 2017
Contribution: oral

Pedro García-Sáez, Esther Acosta, and Ester Lázaro
"Adaptation of bacteriophage Qβ to replicate in bacteria approaching stationary phase"
XIV Spanish National Congress of Virology
Cádiz. 11-14 June 2017
Contribution: poster

María Arribas, Esther Acosta, Ismael Román, Laura Cabanillas, and Ester Lázaro "Exploration of the adaptive possibilities of bacteriophage Qβ when is exposed to a simultaneous increase in the extracellular and intracellular temperatures"
Cádiz. 11-14 June 2017
Contribution: poster

María-Paz Zorzano
"The Particle Counter K-index Magnetic ANomaly (PACKMAN) instrument"
ESA Symposium on European Rocket & Balloon programmes and Related Research
Visby, Sweden, 11-15th June 2017

María-Paz Zorzano
"Preliminar environmental analysis of Oxia Planum"
ESA's Planetary Protection Working Group Meeting
Helsinki, Finland. June 15th 2017
Contribution: Invited talk

Rodón, José Ramón ;Suárez, Juan Carlos; Moya, Andrés; García Hernández, Antonio; Rodrigo, Carlos ;Solano, Enrique ;Garrido, Rafael ;Pascual, Javier
"AsteroModelGenerator"
European Week of Astronomy and Space Science
June, 26-30. Prague (Czech Republic)
Contribution: poster

Solano, Enrique ;Balaguer Núñez, Lola ;López del Fresno, Mauro ;Massana, Pol ;Galadí, David ;Jordi, Carme ;Masana, Eduard ;Sézima, Thomas ;Paunzen, Ernst
"Clusterix 2.0 for Gaia"
European Week of Astronomy and Space Science
June, 26-30. Prague (Czech Republic)
Contribution: poster

Solano, Enrique
"The Virtual Observatory: A new framework for new science"
European Week of Astronomy and Space Science
June, 26-30. Prague (Czech Republic)
Contribution: invited talk

Solano, Enrique ;Rodrigo, Carlos ;Bayo, Amelia ;Jiménez-Esteban, Francisco
"VOSA: SED building and analysis of thousands of stars in the framework of Gaia"
European Week of Astronomy and Space Science
June, 26-30. Prague (Czech Republic)
Contribution: invited talk

M. Moreno, B. Torres, M. Fernández-Algar, C. Briones.
"Development of quantitative PCR-based technologies for the functional characterization of RNA and DNA aptamers".
XI Meeting on Nucleic Acids and Nucleosides (XI RANN). Madrid (Spain). July 3-4, 2017.
Contribution: Oral.

M. Moreno, L. Vázquez, J.A. Martín-Gago, C. Briones.
"RNA structural analysis under native conditions using atomic force microscopy".
XI Meeting on Nucleic Acids and Nucleosides (XI RANN). Madrid (Spain). July 3-4, 2017.
Contribution: Poster.

A. Monfardini, O. Dupre, A. Benoit, M. Calvo, A. Catalano, J. Goupy, C. Hoarau, T. Klein, K. Le Calvez, B. Sacepe, F. Levy-Bertrand and A. Gomez "The sub-gap KID (SKID): on chip spectroscopy at the centimetric wavelengths". Low Temperature Detectors 2017, Kurume, Japan (July 2017). Contribution: Talk.

J. Goupy, A. Benoit, A. Bideaud, O. Bourrion, M. Calvo, A. Catalano, E. F. C. Driessen, A. Gomez, S. Leclercq, F. Levy-Bertrand, J. F. Macias-Perez, A. Monfardini and K. F. Schuster "Microfabrication Developments for future Instruments using KID Detectors". Low Temperature Detectors 2017, Kurume, Japan (July 2017). Contribution: Poster

A. Gomez, M. Calvo, J. Goupy, A. Bideaud, F. Levy-Bertrand, A. Catalano, A. Benoit, A. Tartari and A. Monfaridini "Polarization filter for microstrip lumped-element kinetic inductance detectors". Low Temperature Detectors 2017, Kurume, Japan (2017). Contribution: Poster

Wiens, R.C., P.-Y. Meslin, D.F. Wellington, J.R. Johnson, A. Fraeman, O. Gasnault, S. Maurice, O. Forni, P. Beck, B.A. Cohen, H. Newsom, J.C. Bridges, V. Sautter, P. Gasda, N. Lanza, A. Ollila, S.E. Johnstone, A. G. Fairén.
"Composition and morphology of iron meteorites found in Gale Crater, Mars".
80th Annual Meeting of The Meteoritical Society, Santa Fe, New Mexico, July 23-28, 2017.
Contribution: poster

Enrique Solano
"VOSA: Analyzing SED in the Virtual Observatory"
École Observatoire Virtuel à l'OCA
Nice, France. 26-27 September 2017

Enrique Solano
"What is the Virtual Observatory"
École Observatoire Virtuel à l'OCA
Nice, France. 26-27 September 2017

Enrique Solano
"Identification of ultracool dwarfs using J-PLUS data and the Virtual Observatory"
Early Data Release and Scientific Exploitation of the J-PLUS Survey
CEFCA, Teruel. 2-3 October 2017

Fairén, A. G., E. Mateo-Martí, L. Gago-Duport, E. Losa-Adams, V. Chevrier and C. Gil-Lozano.
"Coeval formation of mineral sequences on a cold and wet early Mars".
Fourth International Conference on Early Mars: Geologic, Hydrologic, and Climatic Evolution and the Implications for Life. Abstract #3037. Flagstaff, Arizona, October 2–6, 2017.
Contribution: poster

Uceda, E. R., A. G. Fairén, C. Gil-Lozano, E. Losa-Adams, L. Gago-Duport.
"Kinetic modeling of mineral sequences on early Mars using fully open systems".
Fourth International Conference on Early Mars: Geologic, Hydrologic, and Climatic Evolution and the Implications for Life. Abstract #3040. Flagstaff, Arizona, October 2–6, 2017.
Contribution: poster

Bishop, J. L., A. G. Fairén, J. R. Michalski, L. Gago-Duport, L. L. Baker, M. A. Velbel, C. Gross, E. B. Rampe.
"Diverse early Mars aqueous environments and climate revealed by the phyllosilicate record".
Fourth International Conference on Early Mars: Geologic, Hydrologic, and Climatic Evolution and the Implications for Life. Abstract #3030. Flagstaff, Arizona, October 2–6, 2017.
Contribution: poster

Losa.-Adams, E., C. Gil-Lozano, J.L. Bishop, A. Hoser, A.F. Davila, A. G. Fairén, V.F. Chevrier, L. Gago-Duport.
"Li-isotope fractionation into the octahedral framework of clays: a way to understand the weathering of basalt under early Mars conditions".
Fourth International Conference on Early Mars: Geologic, Hydrologic, and Climatic Evolution and the Implications for Life. Abstract #. Flagstaff, Arizona, October 2–6, 2017.
Contribution: poster

Hurowitz, J. A., J. P. Grotzinger, W. W. Fischer, S. M. McLennan, R. E. Milliken, N. Stein, A. R. Vasavada, D. F. Blake, E. Dehouck, J. L Eigenbrode, A. G. Fairén, J. Frydenvang, R. Gellert, J. A. Grant, S. Gupta, K. E. Herkenhoff, D. W. Ming, E. B. Rampe, M. E. Schmidt, K. Siebach, K. Stack-Morgan, D. Y. Sumner, and R. C. Wiens.
Fourth International Conference on Early Mars: Geologic, Hydrologic, and Climatic Evolution and the Implications for Life. Abstract #. Flagstaff, Arizona, October 2–6, 2017.
Contribution: poster

C. Briones.
“Mundo RNA y evolución in vitro de ácidos nucleicos”.
Workshop “Química prebiótica en superficies y quiralidad”. Madrid (Spain). Oct. 19, 2017.
Contribution: Invited talk.

A. Gomez, “Development of Lumped Element Kinetic Inductance Detectors”, The 7th Spanish Workshop in Nanolithography, Madrid, Spain, October 23-25, 201.
Contribution: Invited Talk.

Heydari, E., F. J. Calef, J. Schroeder, J. Van Beek, T. J. Parker, S. Rowland, A. G. Fairén, B. Hallet.
“A magnificent outcrop in the Kimberley Region of Gale Crater, Mars”.
GSA Meeting, # 304962, Seattle, 22–25 October 2017.
Contribution: poster

Enrique Solano
“The Virtual Observatory. A new open-data based framework for new science “
United Nations / Italy Workshop on the Open Universe Initiative
Viena, Austria. 20-22 November 2017

Enrique Solano
“Identification of ultracool objects in the COSMOS field”
Euclid Independent Legacy Science Workshop
ESAC, Madrid. 11-12 December 2017

Enrique Solano
“Identification and characterization of ultracool dwarfs using J-PLUS”
Euclid Independent Legacy Science Workshop
ESAC, Madrid. 11-12 December 2017

Almudena Alonso Herrero
“Clearing out the dust in the nuclear regions of infrared luminous galaxies and quasars”
Observations and Theory of Quasar Outflows
Lorentz Center, Leiden, The Nertherlands. 4-6 March 2017
Contribution: invited talk

Álvaro Labiano
“MRS and MIRI software"
MIRI/JWST Test Team meeting
University of Groningen, The Netherlands, 6-10 March
Contribtion: Chair. Oral presentations.

Nuria Huélamo
“Earliest stages in the substellar regime: observations overview”
Star formation from cores to clusters
Santiago, Chile, March 6-9
Contribution: Invited review talk.

Eva Mateo-Martí, Santos Gálvez-Martínez and María Sánchez-Arenillas
"Pyrite surface pre-treatment drives molecular adsorption: cystine on pyrite(100) investigated by X-ray photoemission spectroscopy and low energy electron diffraction"
NanoSpain
San Sebastian, 7-10 March 2017
Contribution: Oral.

Jorge Pla-García: "Constraining the MSL-SAM Methane Detected Source Location Through Mars Regional Atmospheric Modeling System (MRAMS)"
"European Geosciences Union (EGU) 2017"
Vienna, 23-28 April 2017
Contribution: talk

Jorge Pla-García & Scot Rafkin: "Mesoscale modeling of the water vapor cycle at Mawrth Vallis: a Mars2020 and ExoMars exploration rovers high-priority landing site".
"European Geosciences Union (EGU) 2017"
Vienna, 23-28 April 2017
Contribution: poster

Francisco Jiménez-Esteban
"Identification of binary systems using TGAS data and the Virtual Observatory"
Astrometry and astrophysics in the Gaia sky.
Niza, France, 24-28 April 2017.
Contribution: Poster

Miriam García García
The 2017 Spring Symposium: The lifecycle of metals throughout the Universe
Baltimore-MD, United States, 24th-27th April, 2017
Contribution: talk

Carlos Rodrigo Blanco, Enrique Solano
"DataLink. Working on an implementation for stellar libraries"
IVOA Interoperability Meeting
Shanghai, May 2017
Contribution: oral.

Jesús Maíz Apellániz
"GO 14 104: the 30 Doradus STIS extinction program"
VFTS X
Leuven, 17-19 May 2017
Contribution: talk

Jorge Pla-García: "Constraining the MSL-SAM Methane Detected Source Location Through Mars Regional Atmospheric Modeling System (MRAMS)"
"Japan Geoscience Union (JpGU) Meeting 2017"
Tokyo, 20-25 May 2017
Contribution: invited talk

Jorge Pla-García: “Mars mesoscale modelling with MRAMS”
“Reunión de Ciencias Planetarias y Exploración del Sistema Solar (CPESS-5)”
ESAC, Madrid, 6-8 June 2017
Contribution: talk

Almudena Alonso Herrero
“Finding elusive AGN in the mid-infrared”
Elusive AGN in the next Era
George Mason University, Fairfax, USA. 12-15 June 2017
Contribution: invited review talk

Álvaro Labiano
“JWST/MIRI Commissioning activities"
MIRI/JWST Test Team meeting
CEA-Saclay, Paris, 12-16 June
Contribtion: Oral presentations.

K. Lauwaet, L. Martínez, G. Santoro, J.M. Sobrado, Y. Huttel, G. Ellis, C. Joblin, J. Cernicharo, J.A. Martín-Gago.
“NANOCOSMOS Interstellar Dust Meeting”. Simulating the life of cosmic dust in the laboratory: The STARDUST Machine.
Energetic processing of large molecules and interstellar dust, EPoLM-3, 12-16 June 2017 Université Paul Sabatier (Toulouse, France)
Contribution: poster.

Joel Pérez Izquierdo, Eduardo Sebastián, Andrés Bravo, José Antonio Rodríguez Manfredi, Ricardo Ferrándiz, Maite Fernández
“The Thermal Infrared Sensor (TIRS) of the Mars Environmental Dynamics Analyzer (MEDA) Instrument onboard Mars 2020”
“IEEE 4th Metrology for Aerospace”
Padova, 21-23 Junio 2017
Contribution: talk and conference paper

Eduardo Sebastián, Joel Pérez Izquierdo, Andrés Bravo, José Antonio Rodríguez Manfredi, Ricardo Ferrándiz, Maite Fernández
“Performance analysis of the MEDA’s Thermal InfraRed Sensor (TIRS) on board the Mars 2020”
“IEEE 4th Metrology for Aerospace”
Padova, 21-23 Junio 2017
Contribution: talk and conference paper

Santiago Arribas Mocoroa
“JWST Integral Field Spectroscopy of Galaxies”
European Week of Astronomy and Space Science (EWASS)
Prague, 26-30 June, 2017
Contribution: Invited talk

Almudena Alonso Herrero
"Peering through the nuclear dust of local (U)LIRGs in the mid-infrared"
Behind the Curtain of Dust II - The molecular and multi-wavelength view of activity in (U)LIRGs
Sesto, Italy. 3-7 July 2017
Contribution: invited talk

Miriam García García
National Astronomical Meeting 2017: Parallel Session on Massive Stars as Cosmic Monsters
Hull (United Kingdom), July 6th 2017
Contribution: invited talk

L. Martínez, G. Santoro K. Lauwaet, J.M. Sobrado, C. Joblin, J. Cernicharo, Y. Huttel, J.A. Martín-Gago.
"Gordon Research Conferences". Scaling of adjustable multi-magnetron gas aggregation sources: The STARDUST machine.
Cluster & Nanostructures. Building complex systems with cluster and Nanostructures, 9 -14 Julio, 2017. Mount Holyoke College, South Hadley, MA, EEUU.
Contribution: poster.

Isabel Perez-Grande, Lilian Peinado, Adrian Chamorro, Ignacio Torralbo, Gustavo Alonso, José Antonio Rodriguez Manfredi, Alain Lepinette, Eduardo Sebastian
"Thermal Design of the Air Temperature Sensor (ATS) and the Thermal InfraRed Sensor (TIRS) of the Mars Environmental Dynamics Analyzer (MEDA) for Mars 2020"
47 th International Conference on Environmental Systems , ICES -2017
16-20 July 2017, Charleston, South Carolina
Contribution: oral presentation and conference paper

Santos Gálvez-Martínez and Eva Mateo-Martí,
"Small glycine-peptides on pyrite surface investigated by XPS"
EANA
Aarhus, 14-17 August 2017
Contribution: Poster.

Francisco Jiménez-Esteban
"Clusterix. A VO-tool to estimate cluster membership probabilities"
GES 2017, Gaia-ESO Survey Fourth Science Meeting
Catania, Italy, 4-8 September 2017
Contribution: talk

Julia Alfonso-Garzón
"Long-term optical and X-ray variability of the Be/X-ray binary H 1145-619"
BeXRB 2017
Heraklion, Greece, 11-13 September 2017
Contribution: oral presentation

Miriam García García
Proposing and processing MEGARA observations with GTC
Madrid, September 19th-22th 2017

Jorge Pla-García: "Constraining the MSL-SAM Methane Detected Source Location Through Mars Regional Atmospheric Modeling System (MRAMS)"
"European Planetary Science Congress (EPSC) 2017"
Riga, 17-22 September 2017
Contribution: talk

Eva Mateo-Martí, Santos Gálvez-Martínez and María Sánchez-Arenillas
"Pyrite (100) surface pre-treatment drives amino-acids adsorption"
ICASIA
Montpellier, 24-29 September 2017
Contribution: Oral.

Almudena Alonso Herrero
"Galactic Activity, Torus, and Outflows Survey"
I Meeting (JWST - GO1) of the Red de Excelencia"Los 'Frontier Fields' de Hubble y GTC: una Red de Excelencia Temática española para el estudio de las galaxias más dis
tantes y débiles del Universo"
Contribution: invited talk

Santiago Arribas Mocoroa
"JWST Instruments and GTO Projects: NIRSpec and NIRCam "
Workshop JWST Cycle 1 Proposals. Red de Excelencia AYA2016-81879-REDT
Complutense University, September 27th - 28th
Contribution: Invited talk

Jesús Maíz Apellániz
"GALANTE: Finding All the Optically Accessible Galactic O+B+WR Stars in the Northern Hemisphere"
Early data release and scientific exploitation of the JPLUS survey
Teruel, 2-3 October 2017
Contribution: talk

J.M. Sobrado, J.A. Martín-Gago.
"Iberian Vacuum Conference, RIVA-X". Liquids in vacuum. Coexistence and emergence
4 - 6 October, 2017. Bilbao, Vizkaya, Spain
Contribution: poster

G. Santoro, L. Martínez, K. Lauwaet, J.M. Sobrado, Y. Huttel, G. Ellis, I. Tanarro, V.J. Herrero, C. Joblin, J. Cernicharo, Y. Huttel, J.A. Martín-Gago.
"Iberian Vacuum Conference, RIVA-X". The STARDUST machine: an UHV station for simulating cosmic dust formation and processing
4 - 6 October, 2017. Bilbao, Vizkaya, Spain
Contribution: poster

Miriam García García
ESAC 2017 JWST Workshop
ESAC, October 4th-6th, 2017

M. Sanchez-Arenillas, S. Galvez-Martinez, C. Escudero, V. Pérez-Dieste and E. Mateo-Marti
"Pyrite structure dictates cystine molecular adsorption: prebiotic chemistry implications".
AUSE
Madrid, 9-11 October 2017
Contribution: Oral.

Julia Alfonso-Garzón, J. Miguel Mas-Hesse, Celia Sánchez-Fernández, Jari Kajava, Phil Charles, Albert Domingo, Jérôme Rodriguez and Jérôme Chenevez
"Optical and X-ray correlations of V404 Cyg during the June 2015 outburst observed with INTEGRAL"
INTEGRAL Symposium 2017: Energetic Time Domain Astrophysics
Venice, Italy, 15-20 October 2017
Contribution: poster

J. Miguel Mas-Hesse, Albert Domingo and Julia Alfonso-Garzón
"15 years of INTEGRAL/OMC monitoring"
INTEGRAL Symposium 2017: Energetic Time Domain Astrophysics
Venice, Italy, 15-20 October 2017
Contribution: poster

Miriam García García
"Spectroscopic Surveys with the ELT: A Gigantic Step into the Deep Universe"
Toledo, 17th-20th October, 2017
Contribution: talk

Jorge Pla-García: "Atmospheric modeling of Mars CH4 subsurface clathrates releases mimicking SAM and 2003 Earth-based detections"
"49th Annual Division for Planetary Sciences Meeting (DPS)"
Provo, Utah, 15-20 October 2017
Contribution: talk

Heydari, E., F. J. Calef, J. Schroeder, J. Van Beek, T. J. Parker, S. Rowland, A. G. Fairén, B. Hallet.
"The last recorded deltaic deposition in Gale crater before Mars went cold: evidence from the rugged terrain unit in the Curiosity rover's landing ellipse".
GSA Meeting, # 304923, Seattle, 22–25 October 2017.
Talk

Miriam García García
Inauguration of the JCUVA (The Joint Center for Ultraviolet Astronomy)
Madrid, October 26th-27th, 2017
Contribution: talk

Benguigui, M., Ochoa, J., Antón, M., Lamprecht, M., Mirete S., Antón, J., Rosselló-Móra, R., González-Pastor, J.E.
"Búsqueda de genes que confieren resistencia a radiación UV en metagenomas de ambientes hipersalinos"
XIV Reunión de la Red Nacional de Extremófilos, Ourense, 3-4 November 2017
Contribution: talk

Miriam García García
"EMIR@GTC: aprendiendo a usarlo"
Cádiz, November 23rd-24th, 2017
Contribution: talk

Enrica Bellocchi
"EMIR@GTC: aprendiendo a usarlo"
Cádiz, November 23rd-24th, 2017

C. Briones.
"The origins of life as a process of development of autonomous functional systems".
Astrobiology 2017. Coyhaique (Chile). Nov 26 - Dec 1, 2017.
Contribution: Invited plenary talk.

Jorge Sanz Forcada
"The role of X-rays in exoplanet evolution and habitability"
"51st ESLAB Symposium. Extreme habitable worlds"
ESTEC, Noordwijk, The Netherlands, 4-8 December 2017
Contribution: talk

Jorge Pla-García: "Atmospheric modeling of Mars CH4 subsurface clathrates releases mimicking SAM and 2003 Earth-based detections"
"American Geophysical Union (AGU) Fall Meeting"
New Orleans, 11-15 December 2017
Contribution: poster

Bishop, J. L., Fairén, A. G., J. R. Michalski, L. Gago-Duport, L. L. Baker, M. A. Velbel, C. Gross, E. B. Rampe.
"Implications of martian phyllosilicate formation conditions to the early climate on Mars".
AGU Meeting, # P31F-04, New Orleans, 11–15 December 2017.
Contribution: talk

Vasavada, A. R., R. E. Ardvidson, K. S. Edgett, A. G. Fairén, C. Fedo, J. P. Grotzinger, S. Gupta, C. H. House, K. W. Lewis, F. Rivera-Hernández, R. C. Wiens, and the MSL Team.
"Climate implications of an ancient lake basin in Gale Crater, Mars".
AGU Meeting, # P31F-07, New Orleans, 11–15 December 2017.
Contribution: talk

Heydari, E., F. J. Calef, J. Schroeder, J. Van Beek, T. J. Parker, S. Rowland, A. G. Fairén, B. Hallet.
"Between Two Lakes: Opportunities for the inception of life in Gale Crater, Mars".
AGU Meeting, # P31A-2802, New Orleans, 11–15 December 2017.
Contribution: poster

Joel Pérez Izquierdo, Eduardo Sebastián, Andrés Bravo, José Antonio Rodríguez Manfredi
"The Thermal Infrared Sensor onboard NASA's Mars 2020 Mission"
"American Geophysical Union (AGU) Fall Meeting"
New Orleans, 11-15 December 2017
Contribution: poster

Luis Colina
"MID-IR Spectroscopy of Distant Galaxies with MIRI/JWST"
Distant Galaxies from the Far South
Instituto Balseiro, Centro Atómico, Bariloche, December 11th - 15th
Oral contribution

María-Paz Zorzano
"MANIPULATION AND IRRIGATION OF SELF-SUSTAINED GREENHOUSES"
ESA's Deep Space Gateway (DSG) Workshop
European Space Research and Technology Centre (ESTEC), Noordwijk, the Netherlands, December 5th-6th, 2017.
Contribution: Oral presentation

Luis Colina
"MID-IR Spectroscopy of Distant Galaxies with MIRI/JWST"
Spectral Diagnostics of Galaxies to Explore Cosmic Dawn with JWST
Space Telescope Science Institute, Baltimore, July 31st - August 2nd
Oral contribution

Luis Colina
"JWST Instruments and GTO Projects: MIRI & NIRISS"
Workshop JWST Cycle 1 Proposals. Red de Excelencia AYA2016-81879-REDT
Complutense University, September 27th - 28th
Oral contribution

Álvaro Labiano
"JWST proposal toos"
Workshop JWST Cycle 1 Proposals. Red de Excelencia AYA2016-81879-REDT
Complutense University, September 27th - 28th
Oral contribution (invited)

Luis Colina
"MIRI High-z GTO Program"
MIRI/JWST European Consortium meeting
Institute of Advanced Studies, Dublin
September 13th-17th
SOC of High-z working group and splinter session

Álvaro Labiano
"MIRI MRS calibration data products"
MIRI/JWST European Consortium meeting
Institute of Advanced Studies, Dublin
September 13th-17th
SOC of MRS working group and splinter sessions

Luis Colina
"MIRI High-z GTO Program"
MIRI/JWST European Consortium meeting
Max Planck Institute for Astronomy, Heidelberg
January 31st - February 2nd
SOC of High-z working group and splinter session

Alvaro Labiano
"MIRI MRS Commissioning"
MIRI/JWST European Consortium meeting
Max Planck Institute for Astronomy, Heidelberg
January 31st - February 2nd
SOC of MRS working group and splinter sessions

Laura Sánchez-García, Daniel Carrizo, David Fernández-Remolar, Victor Parro.
"Lipidic biosignatures in diagenetically stabilized ironstones terraces of Rio Tinto, an acidic environment with analogies to Mars".
EPSC2017 - European Planetary Science Congress.
Riga (Latvia), 17-22 Sept.
Contribución: poster.

Daniel Carrizo, Laura Sánchez-García, Victor Parro, S.L. Cady, N.W. Hinman, N.A. Cabrol.
"Biomarkers and taphonomic processes in fresh and fossil biosignatures from Hot Spring silica deposits in El Tatio, Chile, as a Mars Analogue".
EPSC2017 - European Planetary Science Congress.
Riga (Latvia), 17-22 Sept.
Contribución: poster.

Carmen Sánchez Contreras
"Planetary Nebulae genesis: emerging HII regions in post-AGB stars"
POE2017: The Physics of Evolved Stars II: The role of binarity
Niza (Francia), 10-13 Julio, 2017
Contribución: oral

Carmen Sánchez Contreras
"The acute ALMA view of pPNe: through the magnifying glass… and what we found there"
Asymmetrical Planetary Nebulae VII
Hong-Kong (China), 4-8 Diciembre, 2017
Contribución: charla invitada

Francisco Najarro
"Hot-star wind mass-loss rates from H-alpha and IR lines"
European Week of Astronomy and Space Science (EWASS)
Prague, 26-30 June, 2017
Contribution: Invited talk

Francisco Najarro
"Massive stars as probes of the present day metallicity of the Galactic Center and the inner disk"
Piecing the Galactic Darkness
Heidelberg 16-19 October, 2017
Oral contribution

Adrian, D. R., King, D. T., Jaret, S. J., Ormö, J., Petruny, L. W., Hagerty, J. J., Gaither, T. A.
"Sedimentological and Petrographic Analysis of Drill Core FC77-1 from the Flank of the Central Uplift, Flynn Creek Impact Structure, Tennessee".
48th Lunar and Planetary Science Conference, held 20-24 March 2017, at The Woodlands, Texas. LPI Contribution No. 1964, id.1768
Contribution: Poster presentation by D. R. Adrian

Komatsu, G., Ruj, T., Miyamoto, H., Dohm, J. M., Ormö, J., and Kurosawa, K.
"The Hellas Basin on Mars: Further Exploration of Its Anomalous Shape".
48th Lunar and Planetary Science Conference, held 20-24 March 2017, at The Woodlands, Texas. LPI Contribution No. 1964, id.1845
Contribution: Poster presentation by G. Komatsu

Lambert, P. et al. (+46 coauthors incl**.** Ormö, J.)
"CIRIR Programs: Drilling and Research Opportunities at the Rochechouart Impact Structure".
48th Lunar and Planetary Science Conference, held 20-24 March 2017, at The Woodlands, Texas. LPI Contribution No. 1964, id.1936
Contribution: Poster presentation by P. Lambert

de Marchi, L., Ormö, J., Adrian, D. R., King, D. T.
"Marine resurge sequences in drill cores from Flynn Creek impact structure, Tennessee, USA".
European Planetary Science Congress 2017, held 17-22 September, 2017 in Riga Latvia, id. EPSC2017-987
Contribution: Oral presentation by J. Ormö.

de Marchi, L., King, D. T., Ormö, J., Petruny, L. W., Adrian, D. R., Hagerty, J. J., Gaither, T. A., Jaret, S. J.
"Marine Resurge Sequences in Drill Cores FC67-3 and FC77-3 — Flynn Creek Impact Structure, Tennessee".
48th Lunar and Planetary Science Conference, held 20-24 March 2017, at The Woodlands, Texas. LPI Contribution No. 1964, id.1765
Contribution: Poster presentation by L. de Marchi.

Ormö, J.
"Sedimentology of wet-target impact craters".
5a Reunión de Ciencias Planetarias y Exploración del Sistema Solar (CPESS-5), 6-8 June 2017, Centro Europeo de Astronomía Espacial, ESAC, Villanueva de la Cañada, Madrid, Spain.
Contribution: Poster presentation by J. Ormö.

Ormö, J.
"Small impacts potpourri: Things of potential interest for Morasko".
Effects of meteorite impact in unconsolidated sediments - case of iron meteorite shower 'Morasko', Poland".
A workshop by the National Science Centre, Poland. Ref. No. 2013/09/B/ST10/01666. Poznan, Poland, January 24-27, 2017.
Contribution: Invited talk by J. Ormö.

Ormö, J., Minde, P., Nielsen, A. T., Alwmark, C.
"Resurge deposits supporting a marine target of the Early Cambrian Vakkejokk impact, north Sweden".
European Planetary Science Congress 2017, held 17-22 September, 2017 in Riga Latvia, id. EPSC2017-33
Contribution: Poster presentation by J. Ormö.

Ormö, J., Minde, P., Nielsen, A. T., Alwmark, C.
"Using Portable Core Drilling Equipment for the Study of Resurge Deposits at the Proposed Vakkejokk Impact Site in the Scandinavian Arctic".
48th Lunar and Planetary Science Conference, held 20-24 March 2017, at The Woodlands, Texas. LPI Contribution No. 1964, id.1407
Contribution: Poster presentation by J. Ormö.

José Jordán Soria
Jordán Soria, J., Amils Pibernat, R., Moissl-Eichinger, C., Gómez Gómez, F.
"Geomicrobology of Rock Varnish in an extreme acidic environment: Río Tinto"
Docday Graz, Austria
Contribution: Poster presentation by José Jordán

María Rosa Zapatero Osorio
Title of the presentation: "The initial mass function".
Meeting: Workshop on substellar objects with EUCLID, organized by E. L. Martín at ESAC, Villanueva de la Cañada, Madrid (Spain), 11-12 December 2017.

C. R. Stoker, B. Glass, V. Parro, E. Z. Noe Dobrea.
Drilling for Data: Science Results from the 2015 Robotic Drilling Field Tests at Rio Tinto Spain
Astrobiology Science Conference 2017 (2017), Abstract #3504
Poster presentation

C. R. Stoker, C. P. McKay, A. Davila, B. Glass, V. Parro
Periodic Habitability in Northern Plains Ground Ice: The Icebreaker Life Mission Plan
Astrobiology Science Conference 2017 (2017), Abstract #3478
Oral presentation

M. B. Wilhelm, D. Carrizo, A. F. Davila, V. Parro, M. García-Villadangos, Y. Blanco, C. Stoker, B. Glass
Biomolecular Preservation in Subsurface Soils of the Hyperarid Atacama Desert
Astrobiology Science Conference 2017 (2017), Abstract #3433
Oral presentation

V. Parro, I. Gallardo-Carreño, R. Santos-Severino, Y. Blanco, M. Moreno-Paz, M. Fernández-Sampedro, D. Wettergreen, K. Warren-Rhodes, N. Cabrol
Microbial Molecular Markers After a Wet Event in the Atacama: Setting the Timer of Biomarkers Transformation
Astrobiology Science Conference 2017 (2017), Abstract #3083
Oral presentation

Victor Parro
*Searching for life in planetary exploration: from Río Tinto to Mars**
IN International symposium: rio Tinto, fundamental and applied astects of a terrestrial Mars analogue
Invited talk

D. Carrizo, L. Sánchez-García, V. Parro, S.L. Cady, N.A. Cabrol
Biomarkers and taphonomic processes in fresh and fossil biosignatures from Hot Spring silica deposits in El Tatio Chile, as a Mars Analogue.
Poster
EPSC Abstracts Vol. 11, EPSC2017-583, 2017
European Planetary Science Congress 2017,
17–22 September 2017, Riga | Latvia

L. Sánchez-García, D. Carrizo, D. Fernández-Remolar, and V. Parro.
Lipidic biosignatures in diagenetically stabilized ironstones terraces of Rio Tinto, an acidic environment with analogies to Mars
Poster
EPSC Abstracts Vol. 11, EPSC2017-577, 2017
European Planetary Science Congress 2017
17–22 September 2017, Riga | Latvia

B. Glass, V. Parro, D. Bergman, A. Wang, T. Stucky, M. García-Villadangos, J. M. Manchado, S. J. Seitz, C. Stoker
Life-Detection Mars Analog Testing at Rio Tinto
Oral
49th Lunar and Planetary Science Conference (2018), Abstract #2927
March 19-23, The Woodlands, Texas, USA

L. Sanchez-Garcia, D. Carrizo, M. A. Fernandez-Martinez, M. Garcia-Villadangos, J. M. Manchado, Y. Blanco, M. Moreno, C. Stoker, B. Glass, V. Parro.
Multianalytical Detection of Biomarkers on a 1m-Subsurface Drill of an Acidic Environment (Rio Tinto) with Analogies to Mars. Simulating a Future Drilling and Bioanalysis on Mars Polar Latitudes.
49th Lunar and Planetary Science Conference (2018), Abstract #1967
March 19-23, The Woodlands, Texas, USA

D. Carrizo, L. Sánchez-García, V. Parro, S. L. Cady, N. W. Hinman, N. A. Cabrol
Recent Biomarker Transition in a High Altitude Hydrothermal System (El Tatio, Chile)
Publication only
49th Lunar and Planetary Science Conference (2018), Abstract #1837
March 19-23, The Woodlands, Texas, USA

M. Moreno-Paz, A. Gómez-Cifuentes, M. Ruiz-Bermejo, O. Hosftetter, A. Maquieira, S. Morais, M. A. Sephton, D. Knopp, V. Parro.
Detection of Benzo[a]pyrene in Kerogen Type IV with Multiplex Immunoassay: Relevance for Planetary Exploration.
Publication only
48th Lunar and Planetary Science Conference (2017), Abstract #2261
March 20-24, The Woodlands, Texas, USA

S. L. Cady, D. Carrizo, A. Davila, J. D. Farmer, V. Gulick, N. Hinman, J. Moersch, V. Parro, R. Quinn, P. Sobron, P. Sarrazin, K. Warren-Rhodes, N. A. Cabrol
Correlated In Situ and Laboratory-Based Analyses: Key to Understanding Taphonomic Alteration of Biosignatures in Hot Spring Sinters
Oral
Astrobiology Science Conference 2017 (2017), Abstract #3565
April 24-28, 2017, Mesa, Arizona, USA

V. Parro, P. Weiss, V. Taillebot, T. Gobert, A. Prost, J. Gómez-Elvira, M. García-Villadangos, J. M. Manchado, B. Imhof, D. Urbina, J. O. Dalseth, K. R. Fossum, M. McDowell, A. Nottle, M. Hoeckelmann, W. Hoheneder, T. Vögele
The 2016 MOONWALK Simulation Campaign in Rio Tinto (Spain): Human-Robot EVA Training for Mars Exploration
Poster
Astrobiology Science Conference 2017 (2017), Abstract #3085
April 24-28, 2017, Mesa, Arizona, USA

C. R. Stoker, C. P. McKay, A. Davila, B. Glass, V. Parro
Periodic Habitability in Northern Plains Ground Ice: The Icebreaker Life Mission Plan
Oral
Astrobiology Science Conference 2017 (2017), Abstract #3478
April 24-28, 2017, Mesa, Arizona, USA

J. Gomez-Elvira, M. Moreno, V. Parro, O. Prieto
Astrobiology Wet Laboratory for Europa Lander
Poster
Astrobiology Science Conference 2017 (2017), Abstract #3402
April 24-28, 2017, Mesa, Arizona, USA

B. Glass, A. Davila, V. Parro, R. Quinn, P. Willis, W. Brinckerhoff, J. DiRuggiero, M. Wilhelm, D. Bergman, C. McKay, C. Stoker
Atacama Rover Astrobiology Drilling Studies Project: First Deployment.
Oral
Astrobiology Science Conference 2017 (2017), Abstract #3216
April 24-28, 2017, Mesa, Arizona, USA

Y. Blanco, A. Ianneo, J. Aguirre, D. Billi, V. Parro
CYANOCHIP2.0 for In Situ Searching for Cyanobacterial Biomarkers in Planetary Exploration and Environmental Monitoring
Poster
Astrobiology Science Conference 2017 (2017), Abstract #3126
April 24-28, 2017, Mesa, Arizona, USA

Fernández, A.; Espigares, P.; Ruiz-Bermejo, M.; de la Fuente, J. L.
Modeling the kinetic of aqueous HCN polymerizations: New implications in prebiotic chemistry on the autocatalytic nature of the origin of life.
Poster
5 th International Symposium Frontiers in polymer science.
May 17-19, 2017, Sevilla, España.

Fernández, A.; Espigares, P.; Ruiz-Bermejo, M.; de la Fuente, J. L.
New insight into the formation of HCN polymers in aqueous solutions by means of liquid chromatography.
Poster
5 th International Symposium Frontiers in polymer science.
May 17-19, 2017, Sevilla, España.

L. Garcia-Descalzo and F. Gomez and the MASE team.
“Preservation and detection of biomarkers in mineralized communities and its potential link to the variations in orp.”
EPSC.
Riga, 17-22 September 2017
Poster

L. Garcia-Descalzo and F. Gomez and the MASE team.
“Preservation and detection of biomarkers in mineralized communities and its potential link to the variations in orp.”
EANA Astrobiology Conference.
Aarhus, 14-17 August 2017.
Poster

Guillermo M. Muñoz Caro
¨Photon-induced desorption of COMs in ice analogs¨
COST action CM1401 Astrochemistry meeting, Ciudad Real 12-13 Dec., 2017.
Contribution: Invited talk

Guillermo M. Muñoz Caro
¨Dust grain processes: experiments.¨
Conference on Current and future perspectives of chemical modelling in astrophysics", Hamburg, 17-19 July, 2017.
Contribution: Invited review talk

Guillermo M. Muñoz Caro
Wrap-up meeting of MPI for Extraterrestrial Physics, Schloss Rinberg 28-30 June, 2017.
Contribution: Invited reviewer and talk

Guillermo M. Muñoz Caro
¨Prebiotic Chemistry in Space and Earth.¨
XXXVI biennial meeting of the Spanish Royal Society of Chemistry (RSEQ), Sitges 25-29 June, 2017.
Contribution: Invited talk

Guillermo M. Muñoz Caro
¨Photon-induced desorption of astrophysical ice analogs: ice temperature dependence and release of photoproducts during irradiation¨
COST action CM1401 Astrochemistry meeting, Faro 19{20 Jan., 2017.
Contribution: Invited talk

Miriam García García
“EMIR observations of Mercer 23”
EMIR@GTC: aprendiendo a usarlo
23-24 Nov. 2017. Cádiz, Spain
Talk

Miriam García García
“Breaking out of the SMC”
Spectroscopic Surveys with the ELT:A Gigantic Step into the Deep Universe
17-20 Oct. 2017. Toledo, Spain
Talk.

Miriam García García
“Metal-poor Massive Stars”
Workshop on the occasion of the official inauguration of the Joint Center for Ultraviolet Astronomy (JCUVA)
26-27 Oct. 2017. Madrid, Spain
Talk

Miriam García García
“Towards the first (very massive) stars of the Universe: First Stop”
National Astronomy Meeting 2017. Session on Massive Stars.
6 Jul 2017. Hull, United Kindgom
Invited Talk

Miriam García García
“Beyond the SMC: UV+optical Studies of Metal-poor Massive Stars”
2017 Spring Symposium: The lifecycle of metals throughout the Universe. Celebrating 50 Years of UV astronomy
24 Apr- 27 Apr. 2017. Baltimore, USA
Talk

IV SCIENTIFIC COOPERATION

INVITED RESEARCHERS CONFERENCES/SEMINARS AT CAB

Green Moon Project for Google Lunar XPrize
Jose Maria Ortega-Hernandez (IP Green Moon Project)
March 3rd, 2017

Norberto Castro Rodríguez
Department of Astronomy
University of Michigan
March 22nd, 2017

Search for life in Mars
Dominique Gaudez
May 5th, 2017

Planetary storms on Jupiter and Saturn
Agustín Sánchez-Lavega (Universidad del País Vasco)
May 5th, 2017

Juno at Jupiter: Deep Interior and upper atmosphere
Ricardo Hueso (Universidad del País Vasco)
May 30th, 2017

FIRST LIGHT: Hydrodynamical Simulations of Primeval Galaxies
Daniel Ceverino (Institute for Theoretical Astrophysics, University of Heidelberg)
September 14th, 2017

Precision spectrophotometry of L dwarfs from ground-based telescopes
Adam J. Burgasser (University of California Santa Cruz)
Dec, 13rd 2017

Andrew Surman
Glasgow University, UK
20-22 November 2017

VISITORS

Artemio Herrero Davó
Instituto de Astrofísica de Canarias
February 15th, 2017

Jose Maria Ortega-Hernandez
PI Green Moon Project
March 3rd, 2017

Norberto Castro Rodríguez
Department of Astronomy
University of Michigan
March 13th- April 12th, 2017

Dominique Gaudez
Observatoire de Paris
May 3rd - 20th 2017

Agustín Sanchez-Lavega
Universidad del País Vasco
May 5th, 2017

Dr. Puls, Joachim
Universidad de Munich
May 10th-12th, 2017

Daniel J. Lennon
ESAC
May 10th-12th, 2017

Artemio Herrero Davó
Instituto de Astrofísica de Canarias
May 10th-12th, 2017

Sergio Simón Díaz
Instituto de Astrofísica de Canarias
May 10th-12th, 2017

Ricardo Hueso
Universidad del País Vasco
May 30th, 2017

Miguel Pereira Santaella
Astrophysics Department, Oxford University
June 14th - 16th

Danilo Pérez Pantoja
Biotecnología. Universidad Tecnológica Metropolitana, Santiago, Chile
June 30th-July 14th

Itziar de Gregorio-Monsalvo
ALMA, Chile
July 17th-28th

Daniel Ceverino
Institute for Theoretical Astrophysics, University of Heidelberg
September 11th - 15th

João Rodrigo Souza Leão
Universidade Federal do Rio Grande do Norte, Brasil
15-25 October 2017

Rodolfo H. Barbá
Universidad de La Serena, Chile
25 September - 6 October 2017

Dr. Puls, Joachim
Universidad de Munich
October 5th-6th, 2017

Daniel J. Lennon
ESAC
October 5th-6th, 2017

Artemio Herrero Davó
Instituto de Astrofísica de Canarias
October 5th-6th, 2017

Margaret Murray Hanson
University of Cincinnati
October 5th-6th, 2017

Alexander William Fullerton
Space Telescope Science Institute
October 5th-6th, 2017

Dirk Schulze-Makuch & Alessandro Airo
Technische Universität Berlin
November 29 - December 1

Adam J. Burgasser
University of California Santa Cruz
11-15 December 2017

Yu-Jung Chen
National Central University of Taiwan
11-20 December 2017

IV TEACHING, OUTREACH AND OTHER ACTIVITIES

PH. D. THESES

1. Influencia de las interfases acuosas y otras variables experimentales en la síntesis de polímeros de cianuro: Implicaciones en química prebiótica
   Margarita Roig Marín-Yaseli
   Supervisor: Marta Ruiz Bermejo

2. The impact of metallicity on massive star evolution
   Inés Camacho Inesta
   Supervisors: Artemio Herrero Davó (IAC), Miriam García García (CAB)

3. Paleoenvironmental characterization of the Noachian-Hesperian transition on Mars: Ariadnes and Coogoon
   Antonio Molina Jurado
   Supervisors: David Carlos Fernández Remolar (CAB), Miguel Ángel de Pablo Hernández (UAH)

4. The cycle of matter in the interstellar medium: energetic processing of dust and ice
   Rafael Martín Doménech
   Supervisor: Guillermo M. Muñoz Caro

5. Molecular complexity in envelopes of evolved stars: detailed study of the molecular emission of the objects IKTau, OH231.8+4.2, and IRC+10216
   Luis Velilla Prieto
   Supervisor: Carmen Sánchez Contreras (CAB), José Cernicharo Quintanilla (ICM)

6. Legacies of the dust: A multiwavelength study of protoplanetary disks and young exoplanetary systems
   Ignacio Bustamante Bengoechea
   Supervisors: Bruno Merín (ESA), Hervé Bouy (CAB)

7. A study of the X-ray and optical variability of the active galactic nucleus ESO 362-G18: from days to years
   Beatriz Agís González
   Supervisor: Giovanni Miniutti

8. Infrared emission of active galaxies
   Judit García González
   Supervisor: Almudena Alonso Herrero

MASTER, GRADE AND OTHER DEGREES THESES

Miriam García García and Francisco Najarro
Master thesis: Noemí Mateos Álvarez
Title: B-supergiants in M33
University:: Universidad Complutense de Madrid
Defense date: February 2017

Ester Lázaro
Master Thesis: Sara Arroyo Moreno
Title: "Dinámica poblacional de sistemas bacteria-fago. Implicaciones terapéuticas"
University: Universidad Complutense de Madrid
Defense date: June 2017

Jorge Sanz Forcada
Trabajo de Máster de: Almudena Martín Gutiérrez
Título: "Efectos de la radiación de altas energías en planetas extrasolares"
Universidad: Universidad Complutense de Madrid
Fecha de defensa: Septiembre 2017

Francisco Najarro and María del Mar Rubio Díez
Master thesis: Marta Ramos
Title: Infrared Studies of Massive Stars in the Milky Way
University:: Universidad Complutense de Madrid
Defense date: September 2017

Ester Lázaro
Master Thesis: Pedro García Saéz
Title: "Adaptation of bacteriophage Qβ to replicate in bacteria approaching stationary phase"
University: Universidad Complutense de Madrid
Defense date: September 2017

Jens Ormö
B. Sc. thesis: Peder Minde ("Clast analysis of potential resurge deposits as part of the Vakkejokk Breccia in the Torneträsk area, northern Sweden - a proposed impact ejecta layer").
University: Stockholm University, Sweden.
Defense date: 29 May 2017. Degree awarded 5 July 2017.

José Antonio Caballero, Enrique Solano
B. Sc. thesis: Carlos Moreno Jódar
Title: Study of common proper-motion binaries using GWP and Gaia
University: Universidad Complutense de Madrid
Defense date: May 2017

Marta Ruiz Bermejo, José Luis de la Fuente
B. Sc. thesis: Amparo Fernández
Title: Estudio cinético de las reacciones de polimerización de cianuro
University: Universidad de Alcalá de Henares
Defense date: February 2017

María-Paz Zorzano
Master Thesis supervision: Abhilash Vakkada-Ramachandran.
Title: "Thermal heating of pressurized chambers for gas cycles and dry heat microbial sterilization".
University: Erasmus Mundus Master - Space Science and Technology. LTU (Sweden).
Defense date: October 2017

María-Paz Zorzano
Master Thesis supervision: Paula Castilla Lois
Title: "Subsurface thermal diffusion equation at Gale".
University: Master in Geoscience and Meteorology. Universidad de Granada, Spain.
Defense date: September 2017

José A. Caballero, David Montes
MSc thesis: Carlos Cifuentes San Román
"CARMENES target characterisation: Carmencita photometry update and calculation of luminosities"
Universidad Complutense de Madrid
Julio 2017

TEACHING

"Astrofísica de Altas Energías/High Energy Astrophysics", J. Miguel Mas Hesse, Máster en Astrofísica, UCM

"Electrónica Básica", Joel Pérez Izquierdo, Grado en Ingeniería de Computadores, UAH.

Jorge Pla-García. "Instrumentation for Mars Missions" class for "Applications for Planetary Exploration" subjetct from Máster en Ingeniería Aeroespacial. Escuela de Ingeniería Aeroespacial de la Universidad Politécnica de Cataluña. May 10th 2017.

"Radiative processes in Astrophysics", tutorial on spectral energy distribution and spectral fitting, Máster en Astrofísica, Universidad Autónoma de Madrid (UAM)

Colaboración prácticas docentes asignatura: "Fundamentos de biología molecular" Máster de Sistemas biológicos y física de la materia condensada. 8-18 Enero 2018. 30 horas. Universidad Autónoma de Madrid.

"Astronomy I", Francisco Jiménez-Esteban, Suffolk University
"Astronomy I Laboratory", Francisco Jiménez-Esteban, Suffolk University
"Astronomy II", Francisco Jiménez-Esteban, Suffolk University
"Astronomy II Laboratory", Francisco Jiménez-Esteban, Suffolk University

Carmen Sánchez Contreras, Benjamín Montesinos and Enrique Solano. Participación en el programa docente *"4º ESO+empresa"* (curso escolar 2016/2017) de la Consejería de Educación de la Comunidad de Madrid como tutores de alumnos de 4º de la ESO del IES Sapere Aude de Vva. Del Pardillo (Madrid), los dias 4, 5 y 6 de Abril de 2017.

Julia Alfonso Garzón, tutora de prácticas en empresa de una alumna de 1º de Bachillerato dentro del "Shadowing program" del colegio "Hastings School". 24-26 de julio de 2017.

Victor Parro "Ambientes terrestres como modelo para la búsqueda de biomoléculas en exploración planetaria" en Master de Microbiología, UAM, 10 enero de 2017

Ester Lázaro "Clasificación y estructura de los bacteriófagos" . En el Máster en Virología, UCM, 6 de marzo de 2017.

Ester Lázaro "Ciclo biológico general de los bacteriófagos. Ciclos lítico y lisogénico" . En el Máster en Virología, UCM, 6 de marzo de 2017.

Ester Lázaro "Estudios de evolución experimental con bacteriófagos" . En el Máster en Virología, UCM, 10 de marzo de 2017.

Ester Lázaro "Enfermedades infecciosas emergentes" . En el Máster de Microbiología, UAM, 16 de enero de 2017.

Ester Lázaro. Coordinación de la asignatura "Virus de microorganismos" (6 ECTS, 40 horas). Máster en Virología, UCM (marzo de 2017).

Carlos Briones. "Early life – simple life?". Exobiology Introductory Course (RED'17) - Rencontres Exobiologiques pour doctorants. Le Teich (France). March 9, 2017.

Carlos Briones. "Los aptámeros y sus aplicaciones como antivirales". Máster en Virología, UCM. Madrid (Spain). Nov. 21, 2017.

Carlos Briones. "Early steps of life". Training School in Astrobiology. European Southern Observatory, Santiago de Chile (Chile). Nov. 25, 2017.

Salvador Mirete "Biología del desarrollo". Grado de Biología. UCM. Marzo-mayo de 2017 (15 horas).

Alicia Gómez, Tutora de Prácticas Externas Curriculares, Máster de Astrofísica, UCM. February - April 2017.

José Eduardo González Pastor. "Comunidades multicelulares y comportamiento social en bacterias" Máster de Microbiología UAM, 10 octubre 2017

Salvador Mirete "Métodos en biología". Grado de Biología. UCM. 20 y 21 diciembre (6 horas).

Salvador Mirete "Técnicas de análisis y tecnologías ómicas". Máster en Biotecnología Industrial y Ambiental. UCM, 25 de octubre.

María Arribas Hernán, tutora prácticas curriculares. Grado Químicas, Universidad Alcalá de Henares (9 Octubre de 2017- 30 de Marzo de 2018).

María-Paz Zorzano "Project Management course for space instrumentation prototyping". PhD course of the Atmospheric Science Group, LTU, Sweden. September-December 2017.

Julia Alfonso Garzón, "Introducción a LateX/Introduction to LaTeX", Máster en Astrofísica, Valencian International University, 14 March 2017

"Estructura y evolución estelar" (profesor), José A. Caballero, Máster de Astrofísica, UAM
"Black Hole Astrophysics", G. Miniutti, Máster en Física Teórica, UAM

COURSES, CONFERENCES AND SEMINARS

Organization

4th Early Mars Conference
Investigador responsable: Alberto González Fairén, Conference co-convener
Lugar: Flagstaff, Arizona, USA
Fechas: 2-6 October
Entidades organizadoras: Lunar and Planetary Institute, Universities Space Research Association, National Aeronautics and Space Administration
Número de participantes: Aprox 80
https://www.hou.usra.edu/meetings/earlymars2017/organizers/

Astrobiology Science Conference
Investigador responsable: Alberto González Fairén, Session co-convener
Lugar: Mesa, Arizona, USA
Fechas: 24-28 April
Entidades organizadoras: ELSI, NASA, ASU, USRA
Número de participantes: >100
https://www.hou.usra.edu/meetings/abscicon2017/

"AstroArte" Complutense Curso de Verano El Escorial
Investigador responsable: José A. Caballero, director
Lugar: El Escorial, Madrid
Fechas: julio 2017
Entidades organizadoras: Fundación UCM, SEA, Radio Clásica
Número de participantes: 40
https://www.ucm.es/data/cont/media/www/pag-13625/71103.pdf

6th CARMENES Science Meeting
Investigador responsable: José A. Caballero, LOC chair
Lugar: CSIC Serrano, Madrid
Fechas: abril 2017
Entidades organizadoras: CSIC, MPG, CAB and many others
Número de participantes: ~50
https://carmenes.caha.es/int/meetings/201704_madrid/

XIV Spanish National Congress of Virology
Investigador responsable: Carlos Briones (Member of Scientific Committee; Session co-convener).
Lugar: Palacio de Congresos, Cádiz, España.
Fechas: 11-14 de junio, 2017.
Entidades organizadoras: Sociedad Española de Virología (SEV)
Número de participantes: 310.
http://www.virologia2017.com/

XV International School of Astrobiology "Josep Comas i Solà"
Investigador responsable: José Miguel Mas (Codirector) y Carlos Briones (Organizer).
Lugar: Palacio de la Magdalena, Santander, España.
Fechas: 26-30 de junio, 2017.
Entidades organizadoras: CAB, NASA Astrobiology Institute (NAI), Agencia Espacial Europea (ESA), Universidad Internacional Menéndez Pelayo (UIMP).
Número de participantes: 40.
http://www.uimp.es/uxxiconsultas/ficheros/8/4115763EC.DEFINITIVO.pdf

Presentations

Ester Lázaro
"Influencia de los patógenos microbianos en la evolución humana"
IV Ciclo Horizontes de Razón Abierta
Universidad Francisco de Vitoria
Madrid, 11 January 2017
Contribution: Invited talk

Julia Alfonso Garzón
"Long-term optical and X-ray variability of the Be/X-ray binary H 1145-619"
Astrolunch
University of Cape Town, 23 January 2017
Contribution: seminar

Jorge Pla-García & Scot Rafkin: "Constraining the MSL-SAM Methane Detected Source Location Through Mars Regional Atmospheric Modeling System (MRAMS)". Mars Science Laboratory Science Team Meeting, Caltech, Pasadena, EEUU. January 25th 2017.
Contribution: talk

Julia Alfonso Garzón
“INTEGRAL multiwavelength observations of X-ray binaries”
South African Astronomical Observatory (SAAO), 24 January 2017
Contribution: seminar

Jorge Pla-García: "Modelado meteorológico mesoescalar de los entornos de misiones a Marte". Concurso Tesis Doctoral en 3 minutos. Universidad Complutense de Madrid. April 8th 2017.
Contribution: talk

Jorge Pla-García & Scot Rafkin: “Atmospheric Characterization for 2020 EDL with the Mars Regional Atmospheric Modeling System”. Mars2020 Council of Atmospheres EDL Peer Review. JPL, Pasadena, EEUU. April 26th 2017.
Contribution: talk

José Eduardo González Pastor
“Metagenomics: Concepts, historical milestones and next advances”
“Metagenomics experimental design: common shortcoming and pitfalls”
EMBL Practical Course: “Microbial Metagenomics: a 360º Approach”
European Molecular Biology Laboratory (EMBL), Heidelberg, Germany, 7th-14th May 2017
Contribution: organizer and invited talks

Jorge Pla-García
“Mars meteorology”
Osaberri Bar, Tokyo, 20th May 2017
Contribution: talk

Ester Lázaro
“El impacto de los virus en la evolución de nuestro planeta”
I Seminario sobre: Retos en Geociencias Planetarias y Astrobiología para el futuro de la Humanidad.
Instituto de Geociencias (CSIC-UCM)
Madrid, 26 June 2017
Contribution: Invited talk

Eva Mateo-Martí
I Seminario sobre: Retos en Geociencias Planetarias y Astrobiología para el futuro de la Humanidad.
Universidad Complutense de Madrid, Madrid , 28th of June 2017
Contribution: 3 hours

Almudena Alonso Herrero
“HERRAMIENTAS MULTI-LONGITUD DE ONDA PARA EXPLORAR EL UNIVERSO”
Cursos de Verano, Universidad de Cantabria. 14-15 July 2017
Contribution: 4 hours

Luis Cuesta Crespo, AstroGalicia 2017. Castrelo de Miño, Orense, SPAIN, 13-15/10/2017. With the following lectures:
Introducción a la Astronomía: evolución estelar (2 H), 15/10/2017
De los átomos a la vida (2 H), 17/10/2017

Jorge Pla-García
"Meteorological modeling of Mars mission environments"
Jet Propulsion Laboratory (JPL) Science Seminars,
Pasadena, 6th November 2017
Contribution: invited talk

Daniel Viúdez-Moreiras, Javier Gómez-Elvira, Claire Newman and the REMS team
"Gale surface wind characterization based on the MSL REMS dataset"
NASA Mars Science Laboratory (MSL) Science Discussion. 8th November 2017
Contribution: talk

Jorge Pla-García
"Meteorología marciana y las estaciones meteorológicas españolas en Marte"
Museo de Ciencias, Cuenca, 14th November 2017
Contribution: invited talk

Daniel Viúdez-Moreiras and Alfonso Saiz-López
"Characterization of the Martian Ozone by MEDA: Preparing the Mars 2020 Landing"
MEDA Annual Science Meeting. Bilbao, 29th November 2017
Contribution: talk

José Eduardo González Pastor
"Vida en el límite y su interés en Astrobiología"
Simposio: Genómica Microbiana y Biotecnología
Universidad Tecnológica Metropolitana, Santiago, Chile, 29th November 2017
Contribution: invited talk

Carlos Briones.
"El Mundo RNA: del origen de la vida a las aplicaciones biotecnológicas".
Seminarios en Biociencias. Universidad de Alicante, Alicante (Spain). March 24. 2017.
Contribution: invited talk

Carlos Briones.
"The origins of life under a systems chemistry perspective".
Colloquia of the Instituto de Ciencia de Materiales de Madrid (CSIC). Cantoblanco, Madrid (Spain). May 8, 2017.
Contribution: invited talk

Carlos Briones.
"La química de sistemas prebiótica en el origen de la vida".
Universidad Nacional Autónoma de Mexico. Mexico City (Mexico). May 17, 2017.
Contribution: invited talk

Carlos Briones.
"Los aptámeros y sus aplicaciones como antivirales frente a HIV y HCV".
Ciclo de seminarios del Hospital Vall d'Hebrón. Barcelona (Spain). Nov 7, 2017.
Contribution: invited talk

Carlos Briones.
"La evolución in vitro de ácidos nucleicos: fundamentos y aplicaciones en biomedicina".
Facultad de Medicina de la Universidad de Chile. Santiago de Chile (Chile). Nov 23, 2017.
Contribution: invited talk

Jorge Pla-García
"Meteorological modeling for MEDA instrument environments"
MEDA Annual Science Meeting. Bilbao, 30th November 2017
Contribution: talk

Eduardo Sebastián
"Instrumentación meteorológica para la exploración de Marte. Instrumentos Españoles REMS, TWIN y MEDA de las misiones de NASA MSL, InSight y Mars2020"
Programa de Posgrado del Dpto. Electrónica de la UAH
5th December 2017
Contribution: invited talk

Jorge Pla-García
"Meteorología marciana y las estaciones meteorológicas españolas en Marte"
PhDay, Facultad Ciencias Geológicas (UCM),
19th December 2017
Contribution: invited talk

Ignacio Mendigutía
"Accretion and planet formation in Herbig Ae/Be stars. from general samples to particular objects (and back)".
Seminario Universidad Autónoma de Madrid.
Mayo 2017.

Salvador Mirete
I Seminario "Retos en geociencias planetarias y astrobiología para el futuro de la humanidad".
Universidad Complutense de Madrid. 19th June 2017

María-Paz Zorzano
"Space Environment and Habitation" Invited talk. Space Environment Course.
Graduate School of Space Technology, LTU, Sweden. March 2017.

José A. Caballero
"AstroArte", director y ponente
Complutense Curso de Verano de El Escorial
El Escorial, Julio 2017

OUTREACH ACTIVITIES

Julia Alfonso Garzón, "Cómo trabaja un Astrónomo".
Jornadas de Orientación Laboral, Colegio Alemán de Madrid, 13-17 de febrero de 2017.

Luis Cuesta Crespo, "Condimentos para un potaje universal". Universidad de Castilla-La Mancha, Ciudad Real, SPAIN, 15/05/2017. Pint of Science 2017.

Luis Cuesta Crespo, "De los átomos a la vida". Training and Visitors Center, NASA Madrid Deep Space Communications Complex, Robledo de Chavela, Madrid, SPAIN, 12/11/2017. Week of Science and Technology 17.

Luis Cuesta Crespo, "Una vida de cine". Training and Visitors Center, NASA Madrid Deep Space Communications Complex, Robledo de Chavela, Madrid, SPAIN, 14/11/2017. Week of Science and Technology 17.

Almudena Alonso Herrero
Public talk "El Telescopio Espacial James Webb: empezando la cuenta atrás"
Agrupación Astronómica de Madrid, Madrid, Spain. May 2017.

María Rosa Zapatero Osorio
Public conference as part of "Ciclo de conferencias Conocimiento y Valores" at the Universidad Internacional Menéndez Pelayo, Santander (Spain). Title of the presentation: *"Extrasolar planets: seeking new Earths"*. 29 June 2017.

Finde Científico 2017 - MUNCYT Alcobendas, May 27th-28th, 2017. Coordinated by Juan Ángel Vaquerizo, with volunteers from all CAB departments.

Jorge Pla-García, Antonio Molina, Javier Gómez-Elvira and REMS team. Outreach Martian Weather report Year 33, Month 10.
http://cab.inta-csic.es/rems/en/weather-report-mars-year-33-month-10/

Jorge Pla-García, Antonio Molina, Javier Gómez-Elvira and REMS team. Outreach Martian Weather report Year 33, Month 11.
http://cab.inta-csic.es/rems/en/weather-report-mars-year-33-month-11/

Benjamín Montesinos: "Saca de la mochila tus 50 dudas astronómicas", Pint of Science 2017, Madrid

Javier Piqueras López: "Hacia la nueva era de los telescopios gigantes", Pint of Science 2017, Madrid

Jorge Pla-García. "El enigma del metano en Marte". Actualidad desde el Centro de Astrobiología. Revista AstronomíA. September 2017. Número 219, página 14

Jorge Pla-García:
El Mundo, March 23rd: "El primer parte del tiempo de Marte"
http://www.elmundo.es/ciencia/2017/03/23/58d11ea2ca4741f9168b45b7.html

Mediaset, March 27th: “Se publica el primer parte meteorológico de Marte: ¿qué tiempo hace en el planeta rojo?”: http://www.eltiempohoy.es/elcielo/meteorologia/publica-meteorologico-Marte-haciendo-tiempo_0_2345700420.html

Telemadrid, April 1st: “La meteorología en Marte se estudia desde Torrejón de Ardoz” http://www.telemadrid.es/noticias/sociedad/noticia/la-meteorologia-en-marte-se-estudia-desde-torrejon-de-ardoz

El matí de Barcelona (radio Betevé), April 5th: “Meteorología marciana” http://beteve.cat/com-es-el-clima-de-mart/

El cinturón de Orión (radio San Vicente), April 18th: “Meteorología marciana” http://www.cinturondeorion.com/2017/05/cdo-no299-jorge-pla-garcia-marte-nasa-diller-tgo/

La Fábrica de la Ciencia (radio Gava), April 20th: “REMS-Curiosity, el tiempo en Marte” http://www.ivoox.com/rems-curiosity-tiempo-marte-fuentes-hidrotermales-de-audios-mp3_rf_18242400_1.html

Revista Atlas Obscura, July 17th: “And Now, a Weather Report From Mars” http://www.atlasobscura.com/articles/weather-report-mars

La Razón, November 18th: “Marte, ¿qué tiempo hace hoy?” https://www.larazon.es/sociedad/marte-que-tiempo-hace-hoy-CI16966501

Buenos días Madrid (Onda Madrid), December 19th: “Mensajes hacia/desde el espacio” http://www.telemadrid.es/audio/buenos-dias-madrid-1000-1200-19122017

Carlos Briones. “En busca de vida fuera de la Tierra”. IES Floridablanca, Murcia (Spain). Feb 10, 2017.

Carlos Briones. “El origen de la vida en la Tierra… ¿o fuera de ella?”. Naukas Coruña. A Coruña (Spain). Feb 25, 2017.

Carlos Briones. “En busca de vida fuera de la Tierra”. Programa de Enriquecimiento Educativo para alumnos con Altas Capacidades (Comunidad de Madrid). IES Juan de la Cierva. Madrid (Spain). April 22, 2017.

Carlos Briones. “El origen de la vida”. Conec-Talks. Universitat de València - Fundació Cañada Blanch, Valencia (Spain). May 10, 2017.

Montse Villar y Carlos Briones. Post “La astronomía transformada en arte”. Cuadernos de Cultura Científica de la Universidad del País Vasco (https://culturacientifica.com/2017/07/14/la-astronomia-transformada-arte/). July 14, 2017.

Carlos Briones. Post "Darwin en el tubo de ensayo: la evolución in vitro cumple medio siglo". Naukas (http://naukas.com/2017/09/11/darwin-en-el-tubo-de-ensayo-la-evolucion-in-vitro-cumple-medio-siglo/). Sept 11, 2017.

Carlos Briones. "La Astrobiología: presente y futuro". Naukas Bilbao. Sept 17, 2017.

Carlos Briones. "En busca del origen de la vida". Fundación Telefónica Chile. Santiago de Chile (Chile). Nov 24, 2017.

Almudena Alonso Herrero
Public talk: "Calentando motores para el lanzamiento del nuevo telescopio espacial James Webb"
Sociedad Aranzadi, San Sebastián, Spain. October 2017

Santiago Arribas Mocoroa
Public talk: " Programa científico y retos tecnológicos del Telescopio Extremadamente Grande"
Sociedad Aranzadi, San Sebastián, Spain. October 2017

Benjamín Montesinos: coordination of the "Curso avanzado de Astrofísica: Descubriendo el Cosmos", CaixaForum Madrid, 2017, including a talk on "Hacia una teoría del Todo".

J. Miguel Mas Hesse: "Cosmología: Origen y evolución del Universo", within the cycle "Curso avanzado de Astrofísica: Descubriendo el Cosmos", CaixaForum Madrid.

Benjamín Montesinos: Coordination of the cycle of talks "Astronomía: La ciencia del Universo" in the new CaixaForum Sevilla, including a talk on "El Sol y las estrellas".

J. Miguel Mas Hesse: "Origen y evolución del Universo", within the cycle "Astronomía: La ciencia del Universo" in the new CaixaForum Sevilla.

J. Miguel Mas Hesse: "Astronomía, Astrobiología y nuestra posición en el Universo", within the I FÓRUM GADEA CIENCIA: PENSAR DESDE LA CIENCIA.

Javier Piqueras López: "Hay Vida en Marte(s): La conquista de un sueño". Espacio Fundación Telefónica Madrid, December 2017

Ignacio Mendigutía: "Dos anillos de gas podrian esconder un sistema planetario". Nota de prensa CSIC. Diciembre 2017

Ignacio Mendigutía: "Descubierto el cordon umbilical de una estrella en formación". Nota de prensa CAB. Diciembre 2017

Ignacio Mendigutía: "¿El huevo o la gallina?: descubrimiento de un posible flujo radial en un disco protoplanetario". Blog de divulgación "Cuaderno de Bitácora estelar". Diciembre 2017.

Victor Parro: LMAP_SOLID 2017. El cazador de cerebros, la 2 de rtve http://www.rtve.es/television/20170919/viaje-marte/1619481.shtml

Victor Parro. SOLID en LMAP-2017 Blog NASA-Ames LMAP2017
https://blogs.nasa.gov/mission-ames/wp-content/uploads/sites/217/2017/06/IMG_7126-copy.jpg

Victor Parro. SOLID en NASA web-page regarding ARADS_2017
https://www.nasa.gov/feature/ames/mars-rover-tests-driving-drilling-and-detecting-life-in-chile-s-high-desert

Victor parro, Javier Gómez-Elvira, Juan Angel Vaquerizo en Exposición en Fundación Telefónica: "Marte. La conquista de un sueño" Inauguración, presentación y material audiovisual de la exposición.

Almudena Alonso Herrero
"Lucha de Titanes: interacciones y fusiones de galaxias"
Anuario del Real Observatorio de Madrid. 2017.

Enrique Solano
"What really is the Virtual Observatory"
IAC Talks
La Laguna. March 2017.

Enrique Solano
"En busca de asteroides"
El diario.es http://www.eldiario.es/hojaderouter/ciencia/ciencia_ciudadana-Observadores_del_Mar-cierzo-Observatorio_Virtual_Espanol-GLOBE_Observer_0_658985305.html

Enrique Solano, Francisco Jiménez
"Comienza la X Escuela del Observatorio Virtual Español"
Nota de prensa. http://www.creativacanaria.com/comienza-la-decima-escuela-del-observatorio-virtual-espanol/

Ester Lázaro
"La ciencia también es cosa nuestra"
Conferencia en el colegio Alba
Torrejón de Ardoz, 8 de Marzo 2017

Alberto González Fairén:
The Conversation, Sep 29: Worries about spreading Earth microbes shouldn't slow search for life on Mars.

Sección mensual de Astrobiología en la revista "AstronomíA":
http://www.globalastronomia.com/

Una docena de artículos en: http://www.espacial.org/

Artículos de prensa:
https://elpais.com/autor/alberto_gonzalez_fairen/a/Si la vida surgió en la Tierra, ¿por qué no en Marte?

José A. Caballero
Escuela de Ingenieros Industriales
Universidad de Castilla-La Mancha
Ciudad Real, Abr. 2017
(invited speaker)

José A. Caballero, varias charlas de divulgación en Estrellas del Pirineo (Aínsa-Boltaña, Huesca, Nov. 2017), Escociencia (San Lorenzo de El Escorial, Madrid, Nov. 2017), Centro Cultural (El Escorial, Madrid, Oct. 2017), CEIP Los Cerros Chicos (San Martín de la Vega, Madrid, Jun. 2017), SpaceIN (ESAC, Villafranca del Castillo, Jun. 2017), 76ª Feria del Libro (Madrid, Jun. 2017), Museo Nacional del Teatro (Almagro, May. 2017)

José A. Caballero, 17 programas de radio Longitud de Onda, Radio Clásica, 2 programas de radio A Nóite É Necesaria, Radiovoz

G. Miniutti
Introducción a la Astronomía
Escuela EWA de Aravaca (primaria)
Octubre 2017

AWARDS

Nombre del premio o reconocimiento: Nombramiento como Vocal de la Junta Directiva de la Sociedad Española de Virología (SEV), el 13 de junio de 2017.
Persona premiada: Carlos Briones
Méritos: Reconocimiento a su trayectoria investigadora y a su papel como Presidente de los Comités Organizador y Científico del XII Congreso Nacional de Virología (Burgos, 2013)

Nombre del premio o reconocimiento: Reconocimiento anual del CSIC (5 de julio de 2017)
Persona premiada: Carlos Briones
Méritos: Obtención del Premio Prismas "Casa de las Ciencias" al mejor libro de divulgación científica publicado en 2015, por "Orígenes. El universo, la vida, los humanos" (Carlos Briones, Alberto Fernández Soto y José María Bermúdez de Castro, Ed. Crítica, Barcelona, 2015). Fallo del Jurado: 15 de octubre de 2016; entrega del premio: 12 de noviembre de 2016.

Nombre del premio o reconocimiento: Mención de Honor, Ciencia en Acción XVIII (Ermua, Oct. 2017)
Persona premiada: Longitud de Onda, Radio Clásica (Fernando Blázquez, Yolando Criado, José Antonio Caballero y colaboradores)
Méritos: Trabajos de Divulgación Científica, Prensa, Radio y Televisión

V COMPETITIVE FUNDING

SUMMARY OF EXTERNAL GRANTS

ENTIDAD	INTA/CSIC	REF. PROYECTO	DURACION PROYECTO	TITULO PROYECTO	INVESTIGADOR PRINCIPAL	2017	TOTAL CONC.
CSIC	CSIC	CIUDAD CIENCIA	01/01/2012 - 31/12/2018	Talleres Ciudad Ciencia	Miguel Mas Hesse		70.340,00
UE-FP7	CSIC	312789	01/06/2012 - 30/05/2017	StrongGravity. Probing strong gravity by black holes across the Range Of Masses	Miguel Mas Hesse	15.785,00	274.189,00
CAM	CSIC	S2013/ICE-2822	01/01/2014 - 31/09/2018	SpaceTec: Desarrollo de nuevas tecnologías para instrumentación espacal en la Comunidad de Madrid	Miguel Mas Hesse		117.760,00
UE-H2020	CSIC	307496.	01/01/2014 - 31/12/2018	ICYMARS: Cold and wet early Mars: Proposing and tesing a new theory to understand the early Martian enviroments	Alberto González Fairen	98.659,00	1.039.319,00
MINECO	CSIC	CGL2014-55949	01/01/2015 - 31/12/2018	Sistemas magmático-hidrotermanles no convencionales: una fuente para metales escasos	Fernando Tornos Arroyo	74.415,00	181.500,00
MINECO	CSIC	AYA2014-60585-P	01/01/2015 - 30/09/2018	Procesos en mantos de hielo astrofísicos: Estudio experimental y observacional	Guillermo Muñoz Caro	42.168,50	102.850,00
MINECO	CSIC	ESP2014-55811-C2-1-P	01/01/2015 - 31/12/2018	Habitabilidad de Ganímedes y Europa: Investigacioes astrobiológicas de apoyo a la misión planetaria Juice	Olga Prieto Ballesteros	74.415,00	181.500,00
ESA	CSIC	MIRI -CP-10007-ATC	01/01/2016 - 31/12/2017	MIRI 2015	Luis Colina Robledo		241.035,20
MINECO	CSIC	ESP2015-68964-P	01/01/2016 - 31/12/2018	Participación española en el telescopio espacial James Weebb: Actividades previas al lanzamiento y explotación científica	Santiago Arribas Mocoroa Luis Colina Robledo	248.010,07	278.663,00
MINECO	CSIC	ESP2015-65597-C4-1-R	01/01/2016 - 30/06/2019	Contribución española en criogenia a misiones espaciales: Desarrollos para Spica y Athena,post-operaciones de Herschel y explotación científica multifrecuencia.	Francisco Najarro de la Parra Jesús Martín-Pintado Martín	242.121,00	556.600,00
MINECO	CSIC	CGL2015-66686-C3-2-P	01/01/2016 - 31/12/2018	Medidas de diversidad, control de población y adaptación molecular a lo largo del gradiente de salinidad	Eduardo González Pastor	31.842,36	187.308,00
MINECO	CSIC	AYA2015-69350-C3-1-P	01/01/2016 - 31/12/2018	Enanas ultrafrias: Un eslabón único entre estrellas y planetas	Eduardo Martín Guerrero Herve Bouy	22.565,26	132.736,97
MINECO	CSIC	AYA2015-64346-C2-2-P	01/01/2016 - 31/12/2018	El impacto de la actividad nuclear en las galaxias activas más potentes a RedShift intermedio	Montserrat Villar Martín	12.485,99	73.447,00
UE - H2020	CSIC	685474	01/06/2016 - 31/05/2020	Metafluidics	Eduardo González Pastor		581.665,70
ESA	CSIC	4000116851/16/NL/IB	01/10/2016 - 30/09/2017	Study of the potential of Euclid to detect position transients	Miguel Mas Hesse	24.635,00	49.635,00
CSIC	CSIC	PICS 2015	01/01/2016 - 31/12/2018	UV Irradiation of carbonaceous cosmic dust analogues	Guillermo Muñoz Caro	3.500,00	10.000,00
ESA	CSIC	4000104071/07/NL/HB	01/01/2016 - 31/12/2017	Instrumentación Miri. Telescopio espacial James Webb	Luis Colina Robledo	120.517,60	241.035,20
ESO	CSIC	64365/ESO/15/66976/JSC	06/06/2016 - 28/02/2029	For the desing, construction and commissioning of the Harmoni insrument and the preliminary desing of the associated LTAO system on the European Extremely Large Telescope (E-ELT)	Santiago Arribas Mocoroa Javier Piqueras López		462.000,00
MINECO	CSIC	AYA2016-75931-C2-2-P	30/12/2016 - 29/12/2018	Cartografía del cielo: sondeos de estrellas o de la vía lactea	Jesús Maiz Apellaniz	90.810,50	95.590,00
MINECO	CSIC	AYA2016-79425-C3-2-P	30/12/2016 - 29/12/2019	Enanas marrones y planetas aislados y como compañeros de estrellas	Mª Rosa Zapatero Osorio	35.211,00	234.740,00
MINECO	CSIC	BIO2016-79618-R	30/12/2016 - 29/12/2019	Desarrollo y caracterización funcional de aptameros como herramientas biotecnológicas frente a virus, RNA patógenos	Carlos Briones Llorente	18.150,00	181.500,00
MINECO	CSIC	CGL2015-74254-JIN	16/02/2017 - 15/02/2020	Búsqueda de evidencias moleculares de vida en ambientes extremos mediante herramientas forenses moleculares (geolípidos) e isotópicas. Limite entre lo biogenico y lo abiotico	Laura Sánchez García	135.384,48	203.280,00
CSIC	CSIC	i-link1151	01/01/2017 - 31/12/2018	Development and implementation of sampling equipment for the study of airborne microorganisms at altitude	Ángeles Aguilera Bazán	13.550,00	24.668,00
UE-H2020	CSIC	ERC-PoC-2016	1/2/2017-31/7/2018	MMP: Multiparametric probe for monitoring in real time environmental cariables in drilling boreholes	Ricardo Amils Pibernat	147.753,39	147.753,39
CSIC	CSIC	201750E006	01/01/2017 -31/12/2019	Participación del CSIC/CAB en el instrumento HARMONI para el E-ELT y proyectos asociados (JWST/NIRSpec)	Santiago Arribas Mocoroa	47.000,00	141.000,00
MINECO	INTA	ESP2014-55811-C2-2-P	01/01/2015 - 31/12/2018	Química Prebiótica: De los experimentos de simulación a la misión espacial JUICE.	Eva Mateo Marta Ruiz	74.415,00	181.500,00
MINECO	INTA	AYA2014-55216-P	01/01/2015 - 30/09/2018	El Observatorio Virtual Español. Explotación científico-técnica de archivos astronómicos.	Enrique Solano Márquez	29.766,00	72.600,00
UE-H2020	INTA	Proposal 653477	01/05/2015 - 30/04/2019	Astronomy ESFRI and Research Infraestructure Cluster (ASTERICS)	Enrique Solano Márquez		704.000,00
MINECO	INTA	ESP2015-65712-C5-1-R	01/01/2016 - 31/12/2018	Contribución española a la misión espacial PLATO 2.0 Fase B2/C	David Barrado Navascues Miguel Mas Hesse	736.890,00	1.694.000,00
MINECO	INTA	ESP2015-69540-R	01/01/2016 - 31/12/2018	Detección de biomoléculas en exploración planetaria	Víctor Parro	27.769,50	326.700,00
MINECO	INTA	CGL2015-69758-P	01/01/2016 - 31/12/2018	Misiones científicas desde plataformas aéreas tripuladas y no tripuladas	Elena González Toril Susana Osuna Esteban	33.652,52	197.956,00
MINECO	INTA	ESP2016-79612-C3-1-R	30/12/2016 - 29/12/2018	Ciencia y tecnología de instrumentos espaciales para la caracterización del ambiente marciano en multiples misiones de NASA - II. REMS (fase E), TWINS (fase E) y MEDA (fase D)	Jose A. Rodríguez Manfredi	987.822,82	1.718.700,00
MINECO	INTA	FIS2016-77578-R	30/12/2016 - 29/12/2019	Imitando los polos en marte. Coexistencia de agua líquida en vacío. Adpatción de tapetes extremófilos de la antartida en los polos de Marte	Jesús M. Sobrado Vallecillo	6.050,00	60.500,00
UE	INTA	MASE	01/2014 - 01/2018	Mars Analogues for Space Exploration	Felipe Gómez Gómez	126.998,70	326.205,65
						3.522.343,69	11.092.277,11