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.

Dos resultados especialmente destacables del ejercicio 2018 han sido la concesión de la mención como "Unidad de Excelencia María de Maeztu" por parte de la Agencia Estatal de Investigación, así como el lanzamiento en mayo y posterior aterrizaje con éxito en noviembre de la misión InSight de NASA, con los sensores meteorológicos TWINS a bordo, desarrollados por investigadores del CAB. Junto con la entrega de los instrumentos MEDA y RAMAN para las misiones Mars2020 de NASA y ExoMars2020 de ESA, respectivamente, el CAB se consolida como centro de referencia de exploración espacial en España.

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 (in 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, biogeochemistry, 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.

Two highlights of 2018 have been the "Maria de Maeztu Unit of Excellence" award by the Spanish Administration, and the launch in May and successful arrival to Mars in November of the NASA InSight mission, carrying the TWINS meteorological sensors developed by CAB researchers. Together with the completion and delivery of the MEDA and RAMAN instruments for the NASA Mars2020 and ESA ExoMars2020 missions, respectively,CAB is consolidating as the reference center in Space Exploration in Spain.

INSTITUTE ORGANIZATION

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

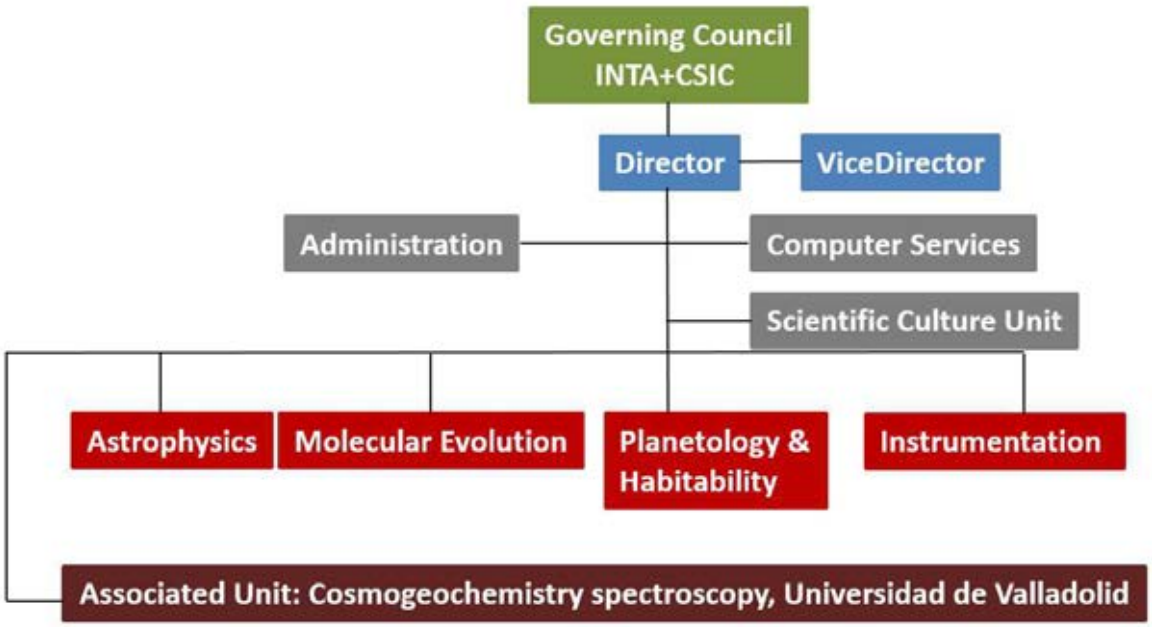


Figure: Organization of Centro de Astrobiología in 2017.

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 MEMBERS:

En representación del Ministerio de Ciencia, Innovación y Universidades

Secretaria de Estado de Universidades, Investigación, Desarrollo e Innovación, Dña. Ángeles Heras Caballero.

En representación del Ministerio de Defensa

Secretario de Estado de Defensa, D. Ángel Olivares Ramírez.

En representación a la Comunidad de Madrid (CAM)*

Consejero de Educación e Investigación de la CAM, D. Rafael van Grieken Salvador

En representación a la Agencia Estatal Consejo Superior de Investigaciones Científicas (CSIC)

Presidenta de la Agencia Estatal CSIC, Dña. Rosa Menéndez.

Vicepresidente de Investigación Científica y Técnica de la Agencia Estatal CSIC, D. Jesús Marco de Lucas.

En representación del Instituto Nacional de Técnica Aeroespacial (INTA)

Director General del INTA, D. José María Salom Piqueres

Subdirector General de Coordinación y Planes del INTA, D. Julio Ayuso

En representación del Centro de Astrobiología (CAB)

Director del CAB, D. José Miguel Mas Hesse (ejerce la Presidencia).

DIRECTION AND CENTER EXECUTIVE BOARD

José Miguel Mas

Victor Parro

Name	Position
J. Miguel Mas Hesse	Director
Victor Parro García	Deputy Director
Jose María Delgado/Sagrario Salado Rey	Administrative Manager
Francisco Najarro de la Parra	Head of Astrophysics
Felipe Gómez / Olga Prieto	Head of Planetology and Habitability
José Eduardo González	Head of Molecular Evolution
Eduardo Sebastián Martínez	Head of Advanced Instrumentation
Benjamín Montesinos Cimno	Researcher
Merecedes 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

ALACID	POLO	JOSE MANUEL
ALFONSO	GARZON	JULIA
ALONSO	HERRERO	ALMUDENA
ALVAREZ	MARQUEZ	JAVIER
ARRIBAS	MOCOROA	SANTIAGO
BAEZ	RUBIO	ALEJANDRO
BARCELÓ	FORTEZA	SEBASTIÁ
BARRADO	NAVASCUÉS	DAVID
BLANCO	SANCHEZ	CARMEN MARIA
CABALLERO	HERNANDEZ	JOSE ANTONIO
CARRASCOSA	DE LUCAS	HÉCTOR
CATALÁN	TORRECILLA	CRISTINA
CERVIÑO	SAAVEDRA	MIGUEL ANTONIO
CIFUENTES	SAN ROMAN	CARLOS
COLINA	ROBLEDO	LUIS
CORTES	CONTRERAS	MIRIAM
COSTANTIN		LUCA
CRESPO	GOMEZ	ALEJANDRO
DELGADO	ALVAREZ	MARIA ARANZAZU
DOMINGO	GARAU	ALBERT
ESTRADA	PIQUERAS	ALBERTO
FUENTE	GUILLEN	DIEGO DE LA
GARCIA	GARCIA	MIRIAM
GARCIA	TAVORA	VICENTE
GIUSTINI		MARGHERITA
GONZALEZ	ALVAREZ	ESTER
GUZMAN	DIAZ	JORGE
HUELAMO	BAUTISTA	NURIA

JIMENEZ	ESTEBAN	FRANCISCO MANUEL
JIMENEZ	SERRA	IZASKUN MAITE
LABIANO	ORTEGA	ALVARO
MAIZ	APELLANIZ	JESUS
MARCOS	ARENAL	PABLO
MARQUES	COELHO CHAVES	RUI JOSE
MARTIN	GUERRERO DE ESCALANTE	EDUARDO L.
MARTIN-PINTADO	MARTIN	JESUS
MAS	HESSE	JOSE MIGUEL
MENDIGUTIA	GOMEZ	IGNACIO ANTONIO
MINIUTTI		GIOVANNI
MONTESINOS	COMINO	BENJAMIN
MORALES	CALDERON	MARIA
MUÑOZ	CARO	GUILLERMO
NAJARRO DE LA	PARRA	FRANCISCO
PEREZ	GONZALEZ	PABLO GUILLERMO
PEREZ	GARCIA	ANA MARIA
Perna		Michele
PIQUERAS	LOPEZ	JAVIER
RICO	VILLAS	FERNANDO
RIZZO	CAMINOS	JOSÉ RICARDO
RODRIGO	BLANCO	CARLOS
RODRIGUEZ	DEL PINO	BRUNO
SANCHEZ	CONTRERAS	MARIA CARMEN
SANCHEZ	GARCIA	MARIA
SANZ	FORCADA	JORGE
Sanz	Fernandez de Córdoba	Lourdes
SOLANO	MARQUEZ	ENRIQUE
VALBUENA	MARTINEZ	ANGEL
VELASCO	TRASMONTE	ALMUDENA
VILLAR	MARTIN	M.MONTSERRAT
ZAPATERO	OSORIO	M.ROSA

Planetology and Habitability

AZUA	BUSTOS	ARMANDO JAVIER
CARRIZO	GALLARDO	DANIEL ALEJANDRO
ERCILLA	HERRERO	OSCAR
ESCUDERO	PARADA	CRISTINA
FERNÁNDEZ	SAMPEDRO	MARÍA TERESA
GIL	LOZANO	CAROLINA
GÓMEZ	GÓMEZ	FELIPE
GONZALEZ	FAIREN	ALBERTO
HERREROS	CID	MARIA ISABEL
MARTIN	REDONDO	MARIA PAZ
MARTÍNEZ	SARMIENTO	PALOMA
MUÑOZ	IGLESIAS	MARIA VICTORIA

OLOF	ORMO	JENS
PRIETO	BALLESTEROS	OLGA
RODRIGUEZ	GONZALEZ	NURIA
VEGA	GARCIA	SONIA MARIA
ZORZANO	MIER	MARIA PAZ

Molecular Evolution

AGUILERA	BAZÁN	ÁNGELES
ARRIBAS	HERNÁN	MARÍA
BENGUIGUI	DE LA CAMARA	MACARENA
BRIONES	LLORENTE	CARLOS
CID	SÁNCHEZ	CRISTINA
CUETO	DIAZ	EDUARDO JOSE
DE DIEGO	CASTILLA	GRACIELA
DE FRANCISCO	MARTINEZ	PATRICIA
DOS SANTOS	SEVERINO	RITA SOFIA
FERNÁNDEZ	ALGAR	MARÍA
GALVEZ	MARTINEZ	SANTOS
GARCIA	LOPEZ	EVA
GARCIA	VILLADANGOS	MIRIAM
GOMEZ	FRUTOS	SARA
GONZALEZ	DE FIGUERAS	CAROLINA
GONZALEZ	PASTOR	JOSÉ EDUARDO
GONZÁLEZ	TORIL	ELENA
HERMIRA	HERRANZ	MARGARITA
HOCHBERG	NEWMAN	DAVID
LAMPRECHT	GRANDIO	MARIA
LÁZARO	LÁZARO	MARÍA ESTER
LEZCANO	VEGA	MARIA ANGELES
LLORENTE	FLORES	ELENA
MATEO	MARTÍ	EVA
MIRETE	CASTAÑEDA	SALVADOR
MORENO	PAZ	MERCEDES
OCHOA DE ERIBE	CASAS	JON ANDER
OSUNA	ESTEBAN	SUSANA
PARRO	GARCIA	VICTORINO
POSTIGO	CACHO	MARINA
RAYO	PIZARROSO	PEDRO
RUIZ	BERMEJO	MARTA
SANCHEZ	GARCIA	LAURA
WHITE		JOSEPH JOHN

Advanced Instrumentation

FERRANDIZ	GUIBELALDE	RICARDO
GIMENEZ	TORREGROSA	SILVIA
GOMEZ	GUTIERREZ	ALICIA
LEPINETTE	MALVITTE	ALAIN
MARIN	JIMENEZ	MARIA DE LAS MERCEDES
MARTIN	SOLER	JAVIER
MOLINA	JURADO	ANTONIO
MORA	SOTOMAYOR	LUIS
NAVARRO	LOPEZ	SARA
PEINADO	GONZALEZ	VERONICA
PLA	GARCIA	JORGE
RODRIGUEZ	MANFREDI	JOSE ANTONIO
ROMERAL	PLANELLÓ	JULIO JOSÉ
SEBASTIÁN	MARTÍNEZ	EDUARDO
SOBRADO	VALLECILLO	JESUS MANUEL
TORRES	REDONDO	JOSEFINA
URQUI	O'CALLAGHAN	MARIA ROSARIO
VIUDEZ	MOREIRAS	DANIEL
ZURITA	ZURITA	SOFIA

SUPPORT

ALONSO	VALDIVIESO	MIGUEL ANGEL
ALONSO	DEL VAL	PILAR
BERMUDEZ	CASTILLO	ESTER
DEL OLMO	ANDRÉS	ROSA
DELGADO	LUCAS	JOSÉ MARÍA
FRAILE	NORIEGA	TATIANA
GARCIA	CLIMENT	INMACULADA
GARCÍA	MARTÍN	MARÍA TERESA
GORGUES	VALENCIANO	ALEJANDRO
GUITART	MARTÍN	MARGIE
GUTIERREZ	ORTEGA	MACARENA
MARTINEZ	DE LLERA	CARMEN
MONCAYO	ORTEGA	CONSUELO
PARRAS	RICO	ANTONIO
SALADO	REY	M.SAGRARIO
SANCHEZ	NARRILLOS	PAULA
SUAREZ	MARSA	VIRGINIA
SUÁREZ	CARRASCO	SERGIO
VAQUERIZO	GALLEGO	JUAN ANGEL

Department of Astrophysics

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 2018, 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- 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 2018:

(1) Star-forming galaxies in the SHARDS survey

We have identified 160 star-forming galaxies in the SHARDS sample, with redshifts below 0.5. Combining the SHARDS data with ALHAMBRA and GALEX photometry we have been able to characterize the UV to IR SEDs, finding that it is always dominated by the contribution of young SF bursts with sub-solar metallicities and low extinction, as well as by an old stellar population, in different proportions across the sample. This suggests that the young component is built up by a recent burst of SF in an otherwise old galaxy, already evolved at $z < 0.5$.

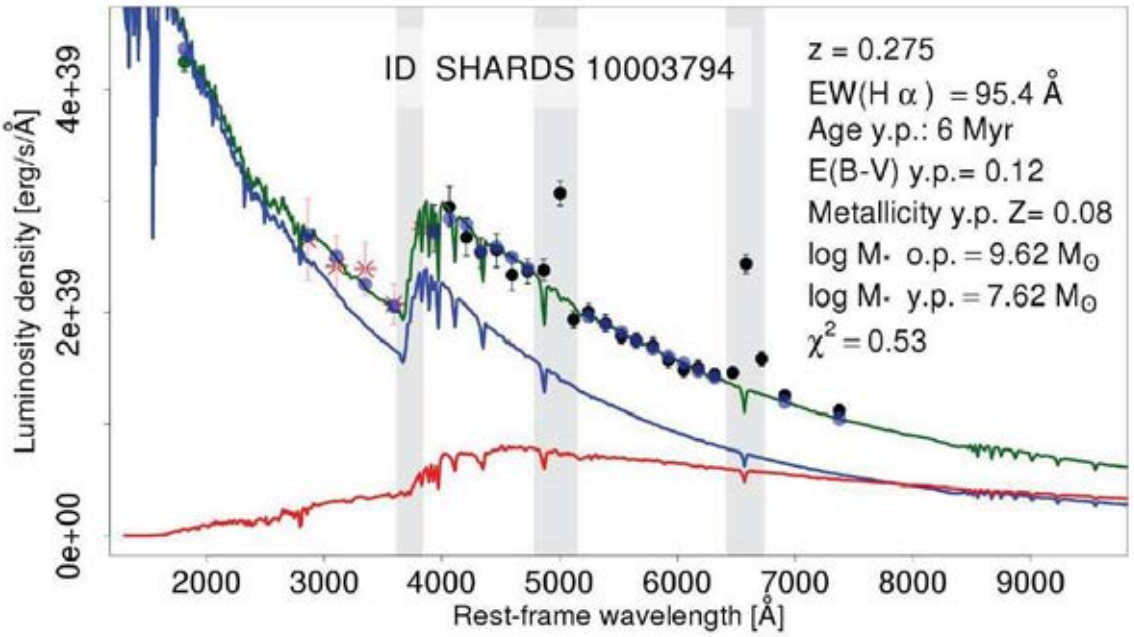


Figure 2-17: SED fit of one galaxy in the Shards sample. Black dots correspond to SHARDS photometric points, red stars to ALHAMBRA data, and dark green dots to GALEX data. The red line represents the stellar spectrum of the old stellar population, while the blue one represents the young population, and the sum of both is shown in dark green.

(2) Cold molecular gas outflows in star-forming galaxies

We have observed at high spatial resolution a series of Ultra-Luminous Infrared Galaxies (ULIRG) at low redshift. In 5 out of 6 nuclei, we detect massive cold molecular gas outflows with outflow velocities of 350-550 km s-1. The mass outflow rates range from a few tens to a few hundred Solar masses per year. Our results show that these massive outflows are unlikely to be able to completely quench the nuclear starburst. The outflow are consistent with being originated by the starburst itself, although a contribution from heavily obscured active galactic nuclei cannot be firmly excluded.

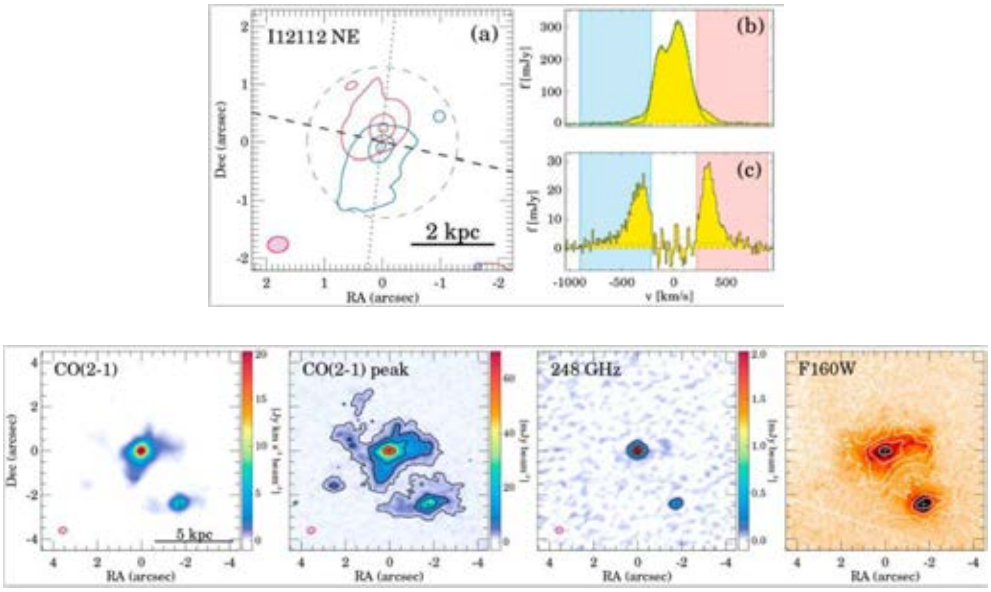


Figure 2-18: In the upper Figure, we show the blue- and red-shifted high velocity CO(2-1) emission as blue and red contours respectively. Dotted and dashed lines represent the outflow and kinematic major axis respectively. Panels (b) and (c) show the nuclear emission (yellow), model (grey), and data-model difference. The lower figures show the ALMA and HST maps. In both cases, we show the case of IRAS 12112.

(3) Dissecting the inner region of the galaxy NGC 5643 with ALMA and the VLT

We have observed the nearby Compton-thick Seyfert Galaxy NGC 5643 with ALMA at angular resolutions of 0.″11-0. 26 (9-21 pc). The CO(2-1) integrated line map reveals emission from the nuclear and circumnuclear region with a two-arm nuclear spiral extending about 10″ on each side. The circumnuclear CO(2-1) kinematics can be fitted with a rotating disk, although there are regions with large residual velocities and/or velocity dispersions. The CO(2-1) line profiles of these regions show two different velocity components. One is ascribed to the circular component and the other to the interaction of the AGN outflow, as traced by the [O III]" 5007 Å emission, with molecular gas in the disk a few hundred parsecs from the AGN. On nuclear scales, we detected an inclined CO(2-1) disk (diameter 26 pc, FWHM) oriented almost in a north-south direction. The CO(2-1) nuclear kinematics can be fitted with a rotating disk that appears to be tilted with respect to the large-scale disk. There are strong non-circular motions in the central 0.″2-0.″3 with velocities of up to 110 km s-1. In the absence of a nuclear bar, these motions could be explained as radial outflows in the nuclear disk. We interpret this nuclear molecular gas disk as the obscuring torus of NGC 5643 as well as the collimating structure of the ionization cone.

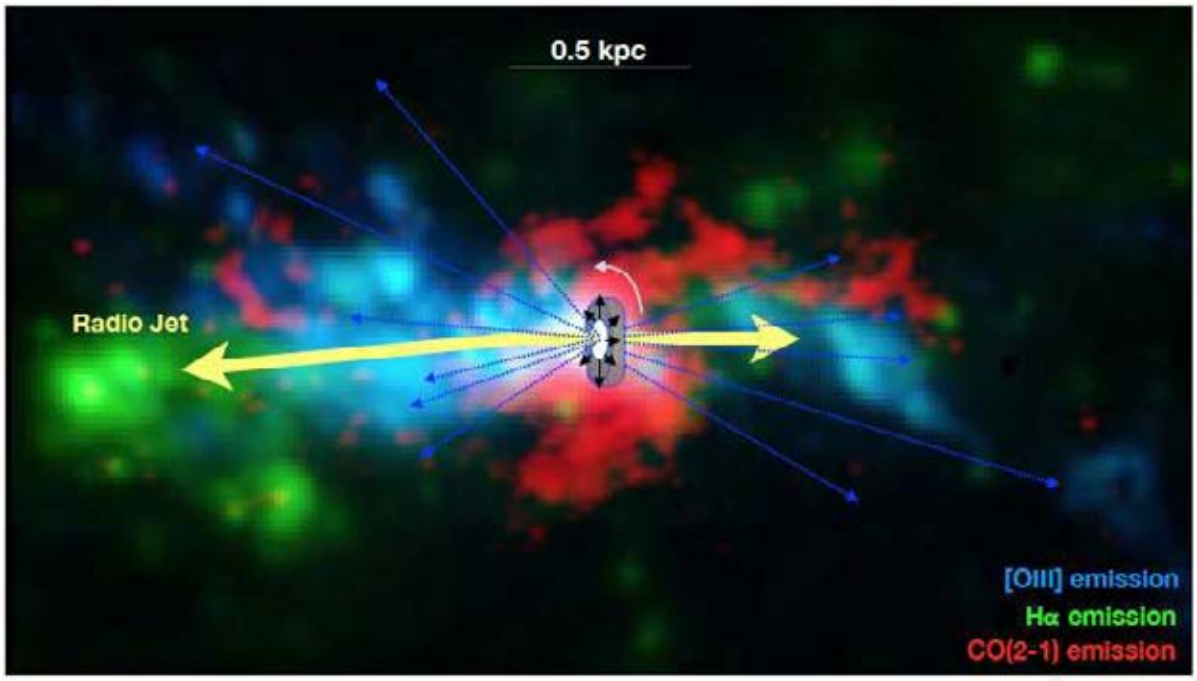


Figure 2-19: Cartoon showing the nuclear and circum-nuclear region of the Compton-thick Seyfert galaxy NGC 5643 using data from MUSE (blue in [OIII] and green in H**α**) and in CO(2-1) in red from ALMA.

(4) Tidal disruption of a star by a supermassive black hole in Arp 299

Tidal disruption events (TDEs) are transient flares produced when a star is ripped apart by the gravitational field of a supermassive black hole (SMBH). We have observed a transient source in the western nucleus of the merging galaxy pair Arp 299 that radiated >1.5 × 1052 erg at infrared and radio wavelengths but was not luminous at optical or x-ray wavelengths. We interpret this as a TDE with much of its emission reradiated at infrared wavelengths by dust. Efficient reprocessing by dense gas and dust may explain the difference between theoretical predictions and observed luminosities of TDEs. The radio observations resolve an expanding and decelerating jet, probing the jet formation and evolution around a SMBH.

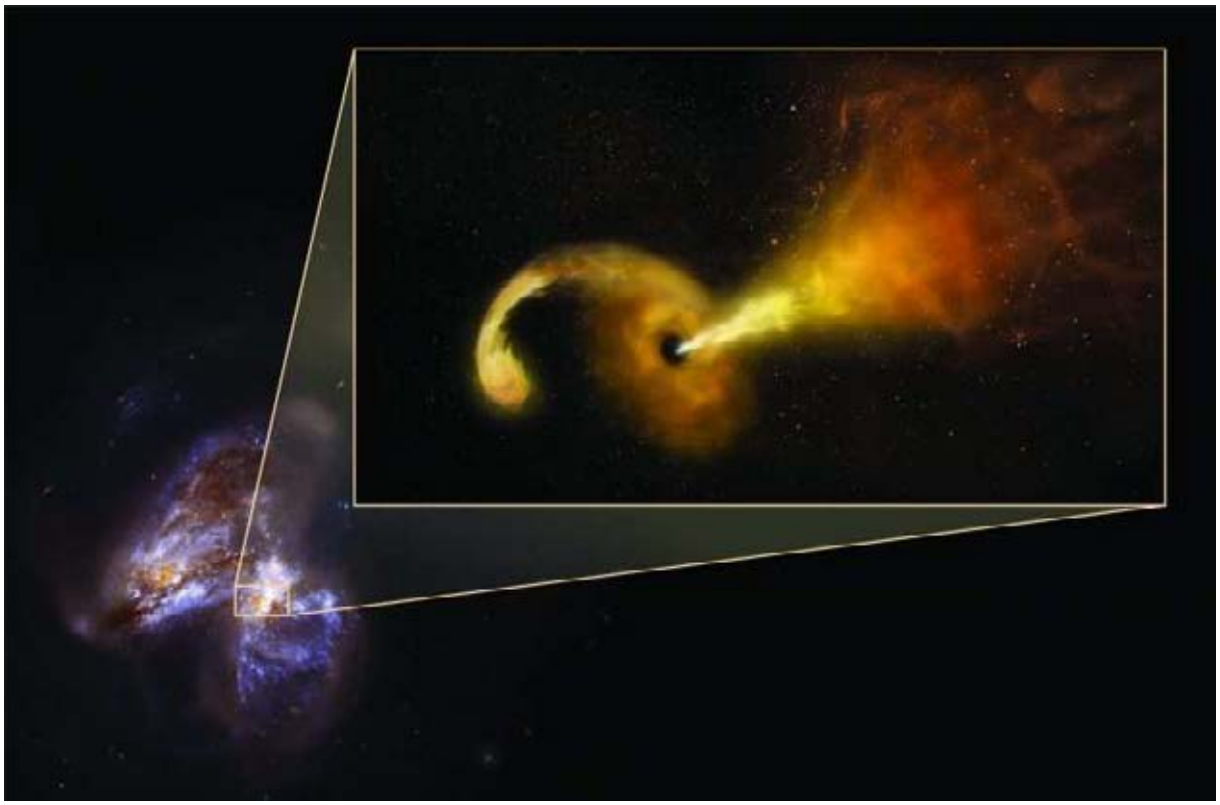


Figure 2-20: Artistic impression of the tidal disruption of a massive star by the supermassive black hole in the center of Arp 299.

(5) X-ray ultra-fast outflow from a local quasar

We have presented an analysis of XMM-Newton X-ray spectra of the low-redshift quasar IRAS 13349+2438. The Reflection Grating Spectrometer spectrum shows a large number of absorption lines from two zones of warm absorption, with outflow velocities of ~ 600 km s-1, as noted by previous authors. Additionally, we find robust evidence from multiple Ly absorption lines for a previously undiscovered ultrafast zone of absorption, with an outflow velocity of 0.13 c (~ 39000 km s-1). The warm absorbers and ultrafast outflow have similar mass outflow rates, around 40 % of the Eddington accretion rate, but the kinetic power is dominated by the high-velocity gas that has a power of ~ 4 % of the Eddington luminosity, enough to provide significant feedback onto the host galaxy.

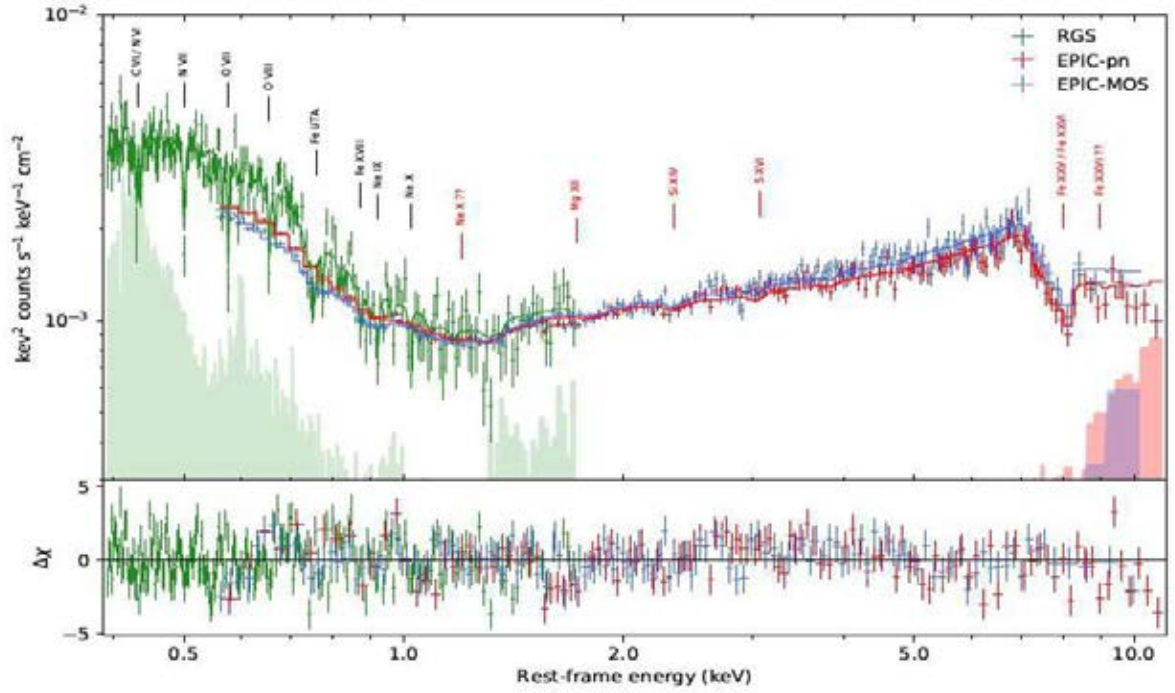


Figure 2-21: Broadband X-ray spectrum of IRAS 13349 from the RGS (green), EPIC-pn (red), and MOS (blue) detectors on board XMM-Newton. The absorption features that define the low velocity warm absorber, and the relativistic ultra-fast outflow are shown as black and red vertical lines respectively.

(6) E-ELT Harmoni Preliminary Design Review (PDR) and Athena X-IFU Intrument Preliminary Requirement Review (IPRR) successfully completed

Members of the Group are involved in the development of HARMONI, one of the first-light instruments for the ELT (Extremely Large Telescope). During 2018, the HARMONI team has completed all the tasks identified by the Preliminary Design Review (PDR) Committee, and therefore successfully completed its Phase B. Members of the group are involved at the consortium level in the development of the X-IFU instrument that will be on board the Athena X-ray mission. The X-IFU instrument has successfully completed IPRR during 2018.

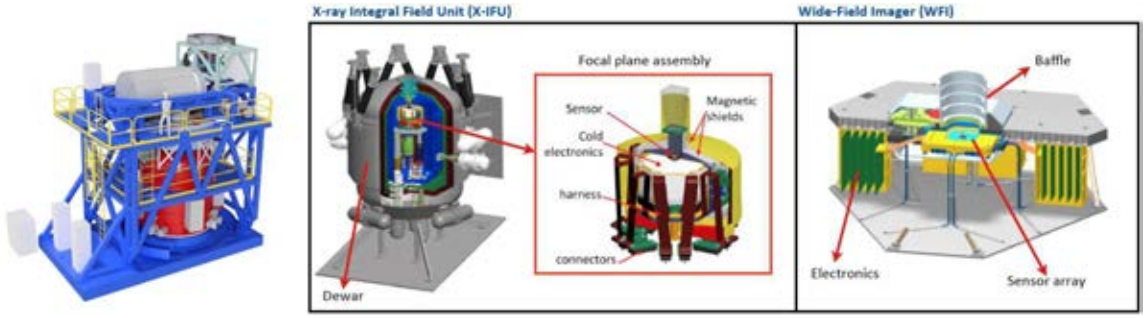


Figure: A view of the HARMONI (lef) and X-IFU (right) instruments.

Interstellar and circumstellar medium

Coordinator: Guillermo M. Muñoz Caro

Abstract:

This group is composed of 15 persons: 5 senior scientists (Jesús Martín Pintado, Carmen Sánchez Contreras, Ricardo Rizzo, Izaskun Jiménez Serra, and Guillermo M. Muñoz Caro), 3 postdocs (Alicia Gómez Gutiérrez, Alejandro Báez Rubio, and Cristóbal González Díaz), 4 PhD students (Cristóbal Bordiú, Jesús Ramos, Héctor Carrascosa, and Fernando Rico), a software developer (Carmen M. Blanco), and lab support (Maite Magaz and Ángel Valbuena). 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 the NSRRC synchrotron 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. The complex region toward the Galactic Center with a rich chemistry is also a subject of research within our group. In diffuse clouds, some chemical reactions take place, but most 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 H2O, CO, CO2, CH3OH, CH4, NH3, 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. More than 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 phenomena 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 as we know it on Earth.

2018 Activities:

During 2018, the members of this team have contributed to about 20 articles in peer-reviewed journals in astrophysics (ApJ, A&A, and MNRAS) and co-edited the book ¨Laboratory Astrophysics¨ (Springer). They 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 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 continued our studies of circumstellar envelopes around low-to-intermediate mass evolved stars (AGB, post-AGB, pPNe, and PNe) through observations of these systems at multiple wavelengths, from the X-rays to the radio regime. For instance, we carried out 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/post-AGB/PNe with unprecedented detail and to improve our understanding of the origin of the remarkable morphological and kinematical differences between AGB circumstellar envelopes, and their more evolved counterparts, post-AGB and PNe. 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 wind collimation responsible of PN-shaping. In 2018, we reported the ALMA observations of a rotating disk with a slowly expanding and rotating wind and a fast bipolar wind. We also published our search for recombination lines in emission at mm-wavelengths with ALMA in compact 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.

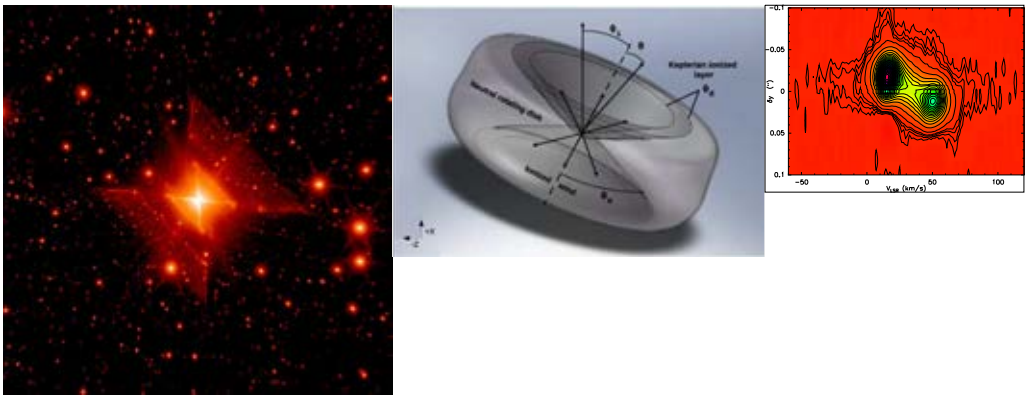


Fig. 2-24. ALMA observations of a rotating disk with a slowly expanding and rotating wind and a fast bipolar wind.

We observed the continuum emission around 5 LBVs with the IRAM-30 m radiotelescope. Another work was published on the slowly expanding torus associated with the candidate LBV MGE 042.0787+00.5084, based on the detection of 4 CO and 13CO lines (see Fig. 2-25). This constitutes the first molecular torus around a LBV star, exceptuating eta Car.

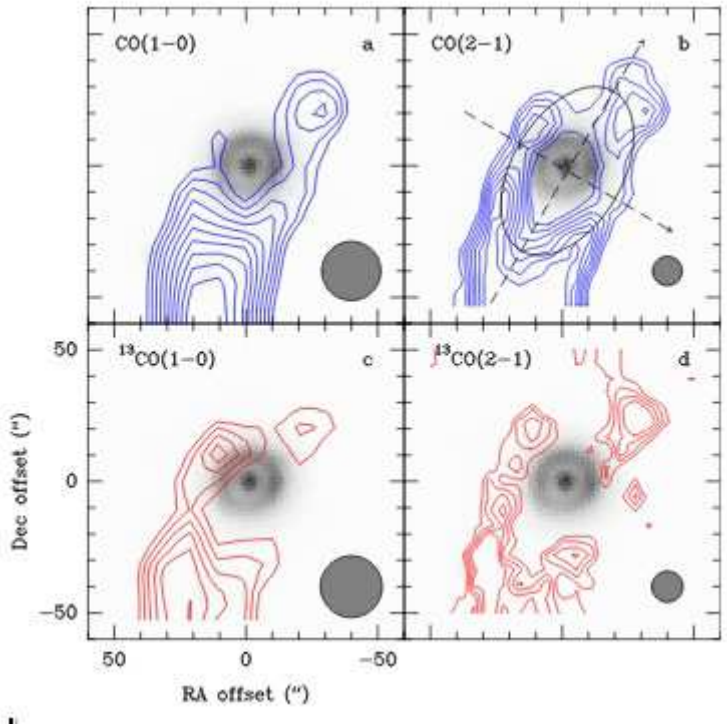


Fig. 2-25. CO and 13CO lines in a slowly expanding torus.

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. With the incorporation of a new staff member to our group, I. Jiménez Serra, this research line will be strongly reinforced. Chemical modeling of glycoladehyde and ethylene glycol was performed, and the chemistry of formamide was constrained to study how such prebiotic species are preserved and transferred in PPDs. A new inventory of Nitrogen-bearing complex organics has been established toward the Center of our Galaxy, stressing the chemical richness of this region in pre-biotic species. A molecule of pre-biotic interest, glycolonitrile (HOCH2CN), was detected for the first time in the interstellar medium and around a proto-Sun (see Fig.2-26). In the pre-RNA world, glycolonitrile is essential for the assembly of ribonucleotides, which are thought to be precursors of nucleic acids. The formation of this species occurs presumably in icy dust mantles, the seeds of planetary systems and cometesimals. The detection of this molecule supports the importance of prebiotic chemistry in space and its contribution to the origin of life on Earth. In this context, the chemistry of Phosphorus-bearing molecules was theoretically explored under the effects of energetic phenomena such as UV radiation, stellar heating, cosmic rays and shock waves, which are typically found in star forming regions and in the nuclei of galaxies. This work aimed at understanding the formation of such Phosphorus-bearing molecules in space. The species PO was detected for the first time in a star-forming region toward the Galactic Center. Regarding the chemistry beyond our Milky Way, we found evidence for the first extragalactic Hydrogen recombination line maser in NGC 253.

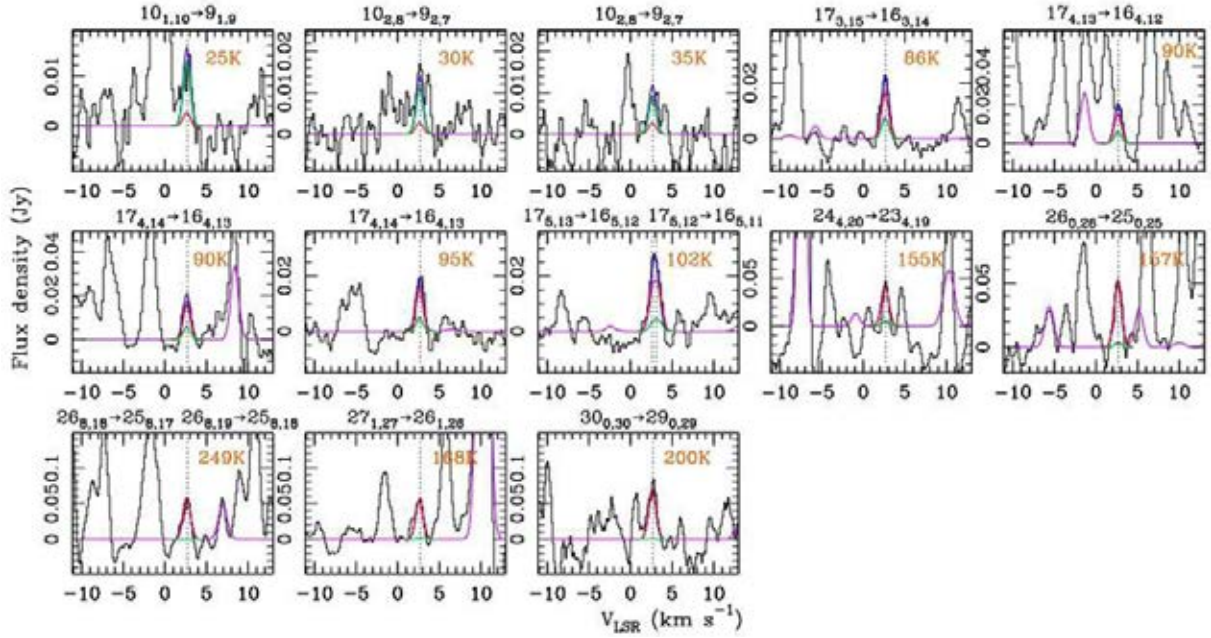


Fig. 2-26. First detection of pre-biotic glycolonitrile (HOCH2CN) in the interstellar medium.

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 2018, the CAB team has been working on the definition of the science cases. In particular, it has been very active on the field of prebiotic chemistry in the interstellar medium in the context of future searches with the SKA, and in the study of feedback and feeding in the Context of Galaxy Evolution with SPICA.

Laboratory astrochemistry

This research line continued its activity regarding the experimental study of physico-chemical processes in icy dust grains present in dense interstellar clouds, circumstellar regions and pre-cometary material. We co-edited the book ¨Laboratory Astrophysics¨, which serves as an introduction to this subject for PhD students and observers. The prebiotic chemistry induced by UV and X-ray irradiation of astrophysically realistic H2O:CO:NH3 ice mixtures was explored in the laboratory. It was observed that both UV and X-rays lead to similar photoproducts which include amino acids like glycine, formamide, and other prebiotic species. It is thus expected that these molecules should be present in the above-mentioned astrophysical environments. This is the first work that studies the effect of soft X-rays in the ice of relevance for the evolution of circumstellar regions near young stars. The need for a non-thermal desorption mechanism of molecules from the ice to the gas phase in cold regions, has led us to simulate the photon-induced desorption of ice molecules. We completed this work with the incorporation of pure H2O and NH3 ice analogs, which were submitted to UV radiation. Of interest is the photo-desorption of radicals in the case of H2O ice irradiation, and the formation of NHx radicals in irradiated NH3 ice, the latter start to react after warm-up to about 60 K. The detailed study of CO ice, a molecular solid that displays a high photodesorption yield, was continued with the estimation of this parameter as a function of the angle of deposition of the ice (see Fig. 2-27).

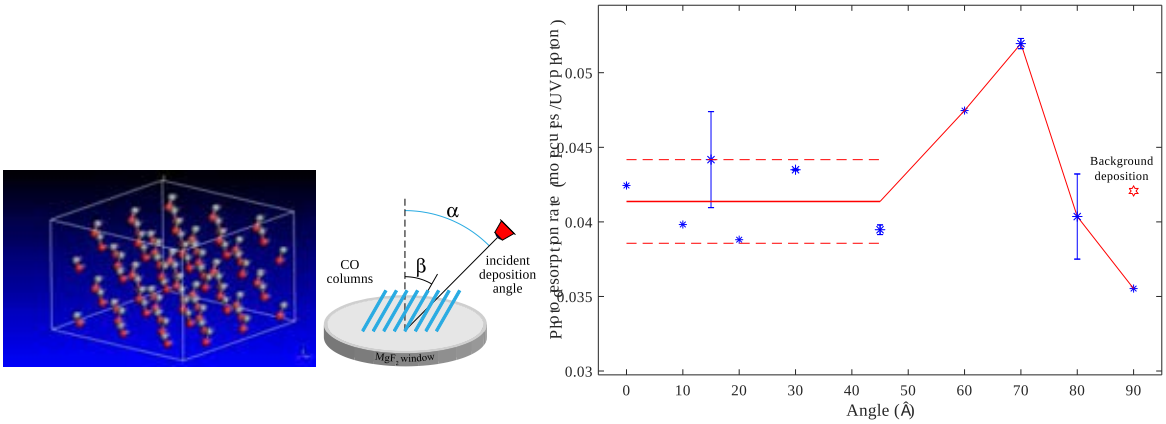


Fig. 2-27. Left and middle: Study of the effect of column formation in CO ice films, grown at different angles of gas deposition, on the ejection of ice molecules to the gas phase due to UV irradiation, a phenomenon known as photodesorption. Right: At 70º deposition angle, the columns are more pronounced and the photodesorption efficiency is the highest.

Data analysis

In 2018, work on the development of MADCUBA (Madrid Data Cube Analysis) was continued. The implemented capabilities of this code are:

- Data cube visualization and reduction. The visualization and analysis (soothing, crop, extract spectrum, etc.) of spatially synchronized cubes has been implemented during 2018.

- Automatic import data cubes from ALMA and cubes and spectra from all Herschel instruments was incorporated.
- Advanced LTE analysis of molecular line profiles using the JPL and CDMS catalogs and recombination lines is possible.

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 6 years the scientific results have been very satisfactory, leading to several publications.

During 2018, 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 design of the instrument and the optical components, and the development of state-of-the-art Microwave Kinetic Inductance Detectors (MKIDs) for mm/sub/far infrared. The activities in 2018 were:

- NIKA2 Collaboration – 30m Telescope at Granada. Commissioning of polarization at 260 GHz.
- KISS instrument Comissioning - 80-300 GHz spectrometer for Quijote. Ti/Al bilayers devices with 300 pixels fabricated for sensing below 100 GHz.
- Polarization sensitive prototypes for future CMB studies: “Polarization filter for microstrip lumped-element kinetic inductance detectors”, “Microfabrication Developments for Future Instruments Using KIDs”.
- Member of the CSIC Platform for Quantum Technologies developing superconducting circuits for quantum computing.

Formation and evolution of stars, brown dwarfs and planets

Coordinators: María Rosa Zapatero Osorio and Benjamín Montesinos Comino.

As in the past years, our group has been very active, addressing 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.

The main areas the group is investigating are:

- Search and identification of low-mass stars, brown dwarfs and isolated planets in star forming regions and young stellar clusters.
- Search and characterization through multiwavelength quantitative spectroscopy of massive stars in the Milky Way and in low-metallicity galaxies.
- Study of the stellar and substellar mass functions: upper and lower limits and influence of the surroundings.
- Protoplanetary and debris discs.
- Search for brown dwarfs, planets and comets around stars, using direct and indirect techniques.
- Characterization of the physical and chemical properties of stars, brown dwarfs and planets using photometry, spectroscopy and astrometry, covering all the electromagnetic range.

The members of the group in 2018 were:

- Nine staff researchers: José Antonio Caballero Hernández, David Barrado Navascués, Nuria Huélamo Bautista and Jorge Sanz Forcada (INTA), and Jesús Maíz Apellániz, Eduardo L. Martín Guerrero de Escalante, Benjamín Montesinos Comino, Francisco Najarro de la Parra, and María Rosa Zapatero Osorio (CSIC).
- One researcher under an "Atracción de Talento" grant co-funded by the CSIC and the Comunidad Autónoma de Madrid: Ignacio Mendigutía Gómez.
- Six postdoctoral researchers: Sebastià Barceló Forteza, Miriam García García, Julia Alfonso Garzón, Esther González Álvarez, María Morales Calderón, and Hugo Martín Tabernero Guzmán.
- Six PhD students: Carlos Cifuentes San Román, Nuria Fonseca Bonilla, Jorge Guzmán Díaz, Emilio Trigueros Páez, and Alice Gabriela Yumiri Pérez and Miguel Vioque, the latter two spending one-year stays, coming from Leeds University.

For 2019, we foresee the arrival of Alba Aller Egea, Jorge Lillo Box, and a third postdoc.

Several projects funded by different Agencies are lead or with active participation of members of the group:

- Spanish contribution to phase B SAFARI/SPICA (F. Najarro, PNE)
- Brown dwarfs and planets in clusters and around stars (M.R. Zapatero Osorio, J. Sanz, PNAyA)
- Surveys of massive stars in the Galaxy (J. Maíz, PNAyA)
- Herbig AeBe stars and their connection with planet formation (I. Mendigutía, CAM)

On-going space- and ground-based instrumental projects with active involvement of some members of the group are: INTEGRAL/OMC (since 2002), CHEOPS (ESA small mission to be launched by the end of 2019), MIRI/JWST (NASA mission to be launched in 2021), PLATO (adopted mission by ESA, expected launch in 2026), ARIEL (recommended as M4 mission of ESA, expected launch 2028), SAFARI/SPICA (proposed M5 space mission to ESA, ~2029); CARMENES/CAHA-3.5 (planet-hunter spectrograph operating at visible and near-infrared wavelengths on Calar Alto Observatory), and ESPRESSO/VLT (planet-hunter spectrograph operating at visible wavelengths on Paranal Observatory). There is also an active participation in long-term space projects, such as LUVOIR (LUMOS, POLLUX) and the Habitable Exoplanet Observatory (HabEX); and ground based GTC-AO, J-PLUS, MEGARA and WEAVE.

We make emphasis that various projects and science cases that will be tackled with the above missions/telescopes/instruments, are devoted to the search and/or characterization of planets disks, and small bodies orbiting stars of the Galaxy, i.e., with clear implications in the several fields of Astrobiology.

In 2018, the group has published 75 papers in refereed journals according to the NASA-ADS database. In 27 of these papers, members of the group are in first, second or third place in the author list. In addition, around 60 papers were published in non-refereed journals or in proceedings of conferences. In both cases, the numbers for 2018 imply an increase with respect to the number of publications in 2017 (51 and 55 respectively).

The evaluation carried out by CSIC corresponding to the period 2012-2016, that was released at the end of 2018, gives a mark B to the group, “well evaluated with some aspects suitable to be improved” (mainly the number of postdoctoral researchers and PhD students is apparently low, which is an obvious problem that not only the group but the Center for Astrobiology has as a whole).

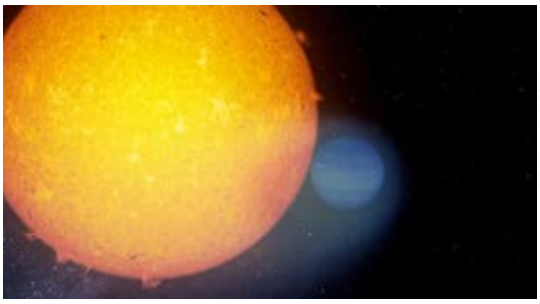
In what follows, some scientific highlights produced by group members are summarized:

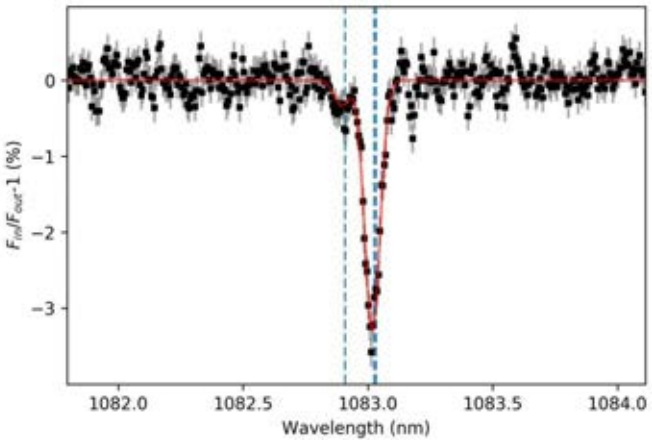
- An study of the early phases in the stellar and substellar formation and evolution, using infrared and submillimiter data en the Barnard 30 cloud was carried out (Barrado et al., Astronomy and Astrophysics).
- The asteroseismic potential of the CHEOPS space observatory was addressed (Moya et al., Astronomy and Astrophysics). Asteroseismology is a powerful technique, first developed to study our Sun's oscillation modes, that allows a precise characterization of the stellar parameters and structure.
- Work has been carried out taking advantage of the second Gaia Data Release (DR2). The main result in this area is the best ever photometric calibration achieved for an all-sky survey in the optical range: the systematic errors have been erased and the random uncertainties for most of the stars are of the order of 8-10 mmag (millimagnitudes) (Maíz-Apellániz & Weiler, Astronomy and Astrophysics).

- The TROY project. II: multi-technique constraints on exotrojans in nine planetarry systems (Lillo-Box et al., Astronomy and Astrophysics). TROY is an ambitious project aimed at the detection of asteroids, similar to the Traojans in our Solar System, around other stars. Whereas the detection of exoplanets has reached a very mature status, the detection of smaller bodies (exomoons, exoasteroids, exocomets), is a hot topic in exoplanetary science.

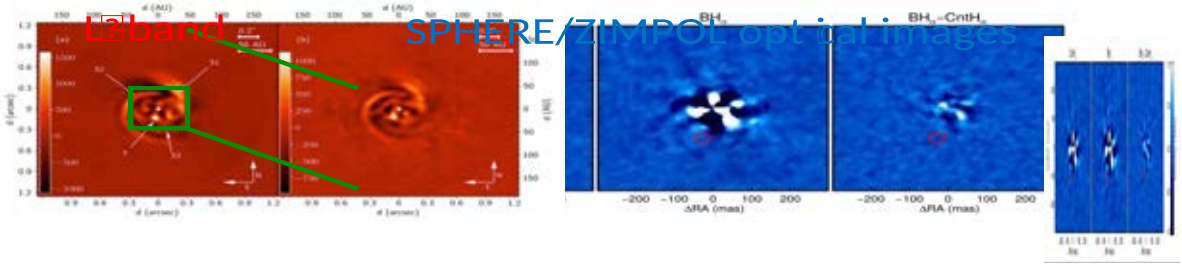
- CARMENES is now working at cruise speed. A total of 12 CAB researchers are directly or indirectly involved in the proyect; Two papers appeard in Nature and Science, 11 papers in Astronomy and Astrophysics, five more are accepted in this journal and four are submitted. A remarkable results is, e.g. the detection of a super-Earth -mass around 9 times that of the Earth- around the M dwarf HD 79211.

- Also using CARMENES, the detection of the vaporization and wind in a planetary atmosphere using the He I line at 1083.0 nm has been feasible (Nortman et al., Science). Modern techniques and detailed observations are starting to show us the composition and dynamics of exoplanetary atmospheres.





- Searching for Hα emitting sources around MWC 758 with SPHERE/ZIMPOL imaging (Huélamo et al., Astronomy and Astrophysics). State-of-the art technology is allowing us the detection of bodies in the vicinity of stars/brown dwarfs whose brightness, compared with the central object, makes it difficult a detection via direct imaging.



- An Earth-sized exoplanet, K2-229 b- with a Mercury-like composition was found (Santene et al., including members of the group, Nature Astronomy)

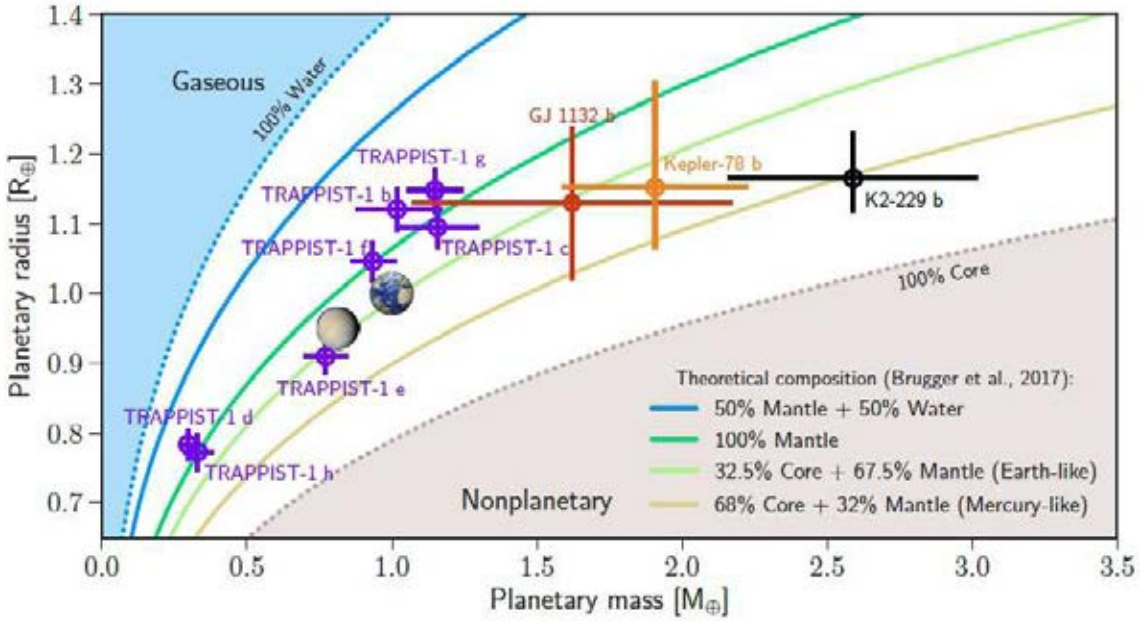
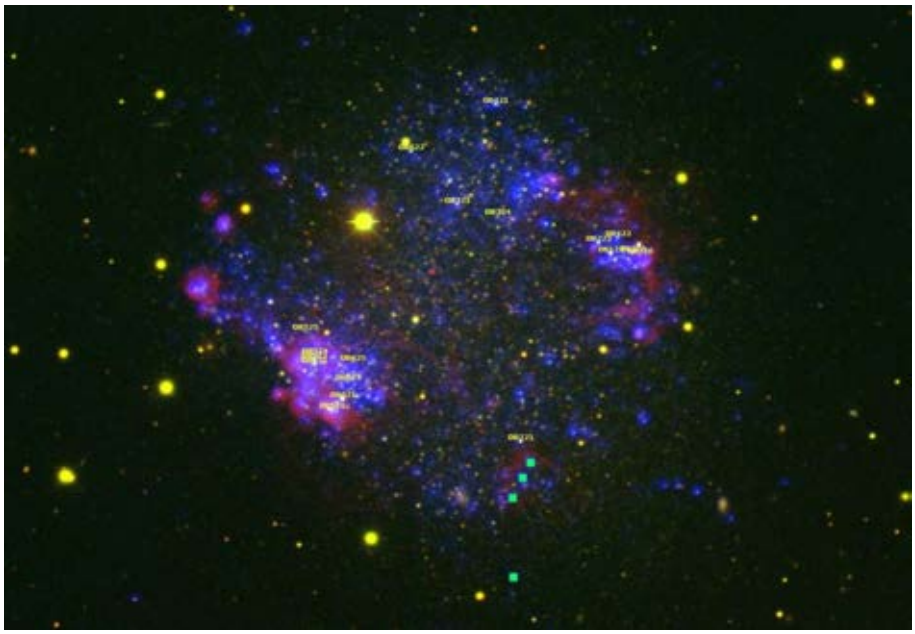
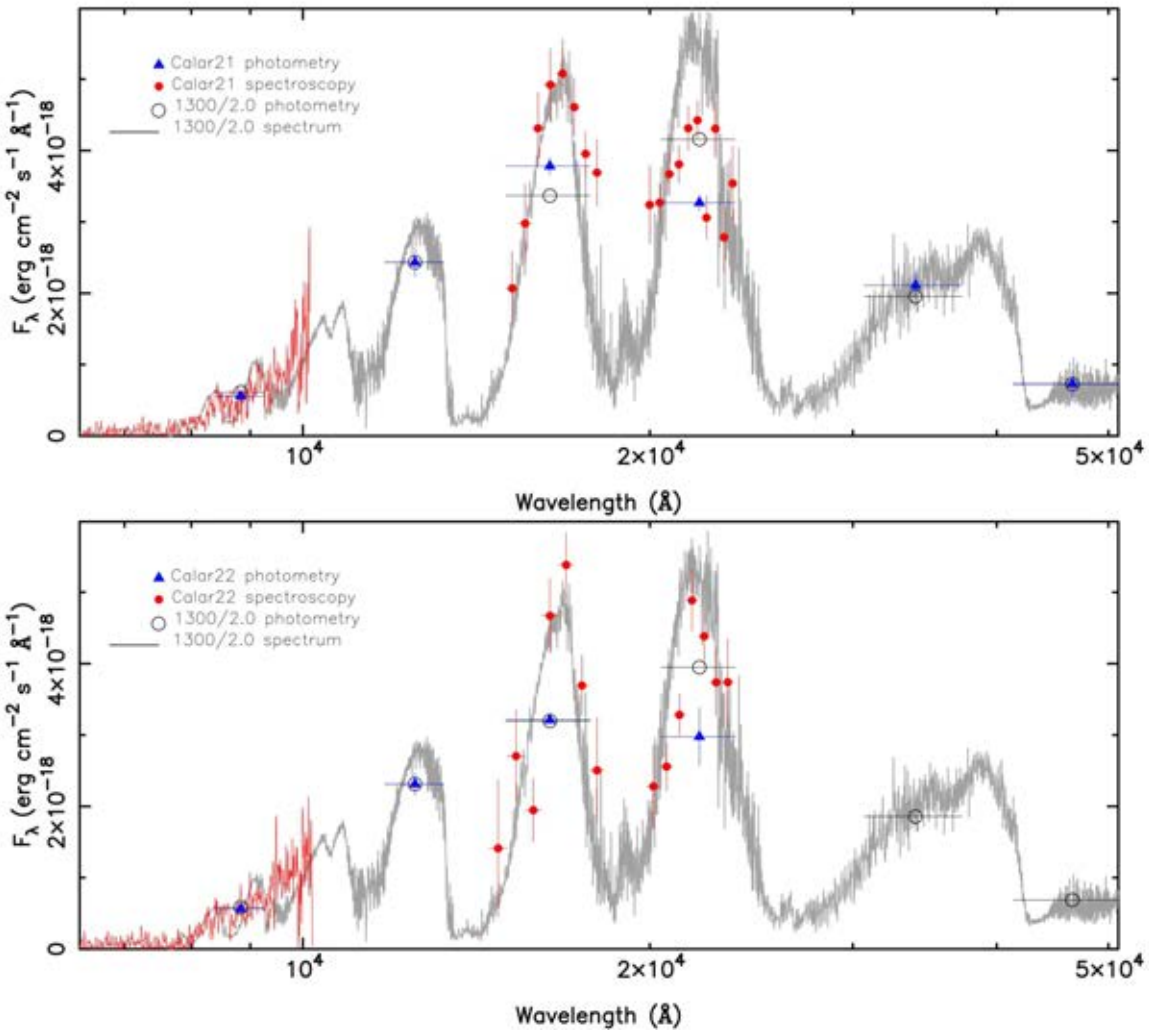


Figure 2: **Mass – Radius diagram of known Earth-sized planets.** Only planets that have a mass measured with a precision better than 50% are shown here (source: NASA exoplanet archive). The different lines represent possible theoretical compositions for terrestrial worlds[19]. Objects denser than 100% core are considered as non-planetary objects and those less dense than 100% water are considered to be gaseous.

- A detailed study of the on-going star formation at the outskirts of Sextans-A has been carried out (García et al., MNRAS). The study of the processes leading to the birth of new stars, in this case, massive ones, sheds light into the -so far incomplete- theory of star formation.

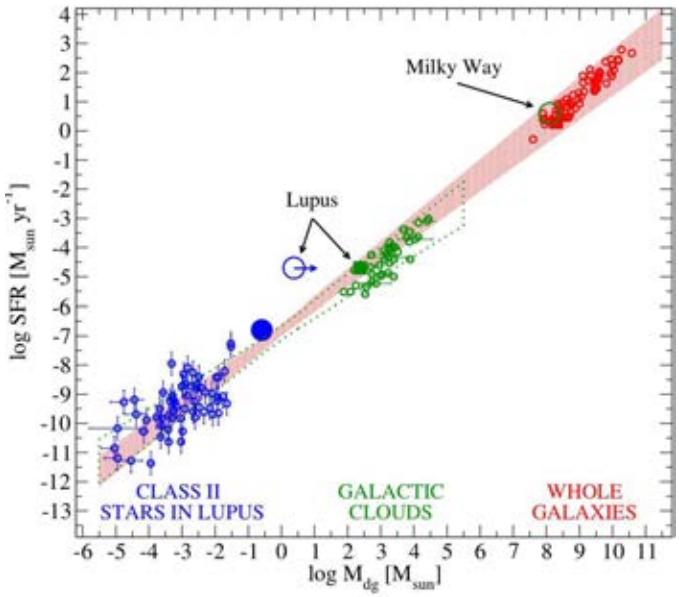


- It has been possible to detect and characterize using photometry and spectroscopy, the smallest isolated planets, with masses between 5 and 15 Jupiter masses in Upper Scorpius (10 million years) and Pleiades (120 million years) (Lodieu, and Zapatero-Osorio et al., Astronomy and Astrophysics).



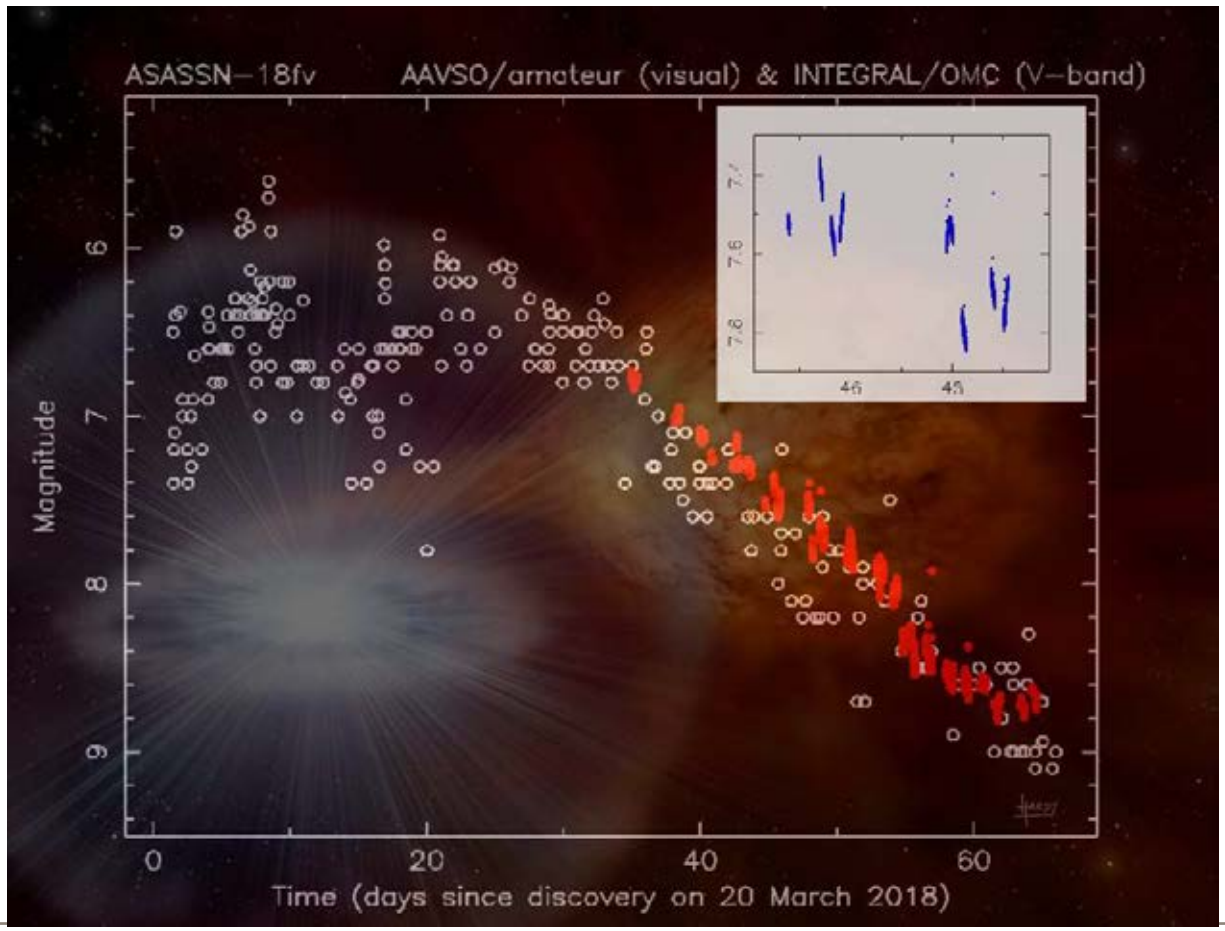
- Characterization of the most massive clusters in the Milky Way such as Westerlund1 and Quintuplet and Arches in the Galactic Centre (Clark et al. including F. Najarro)

- An empirical correlation linking young stars, molecular clouds and galaxies (Mendigutía et al., Astronomy and Astrophysics) has been found. The surprising correlation covers 16 orders of magnitude in Star Formation Rates.

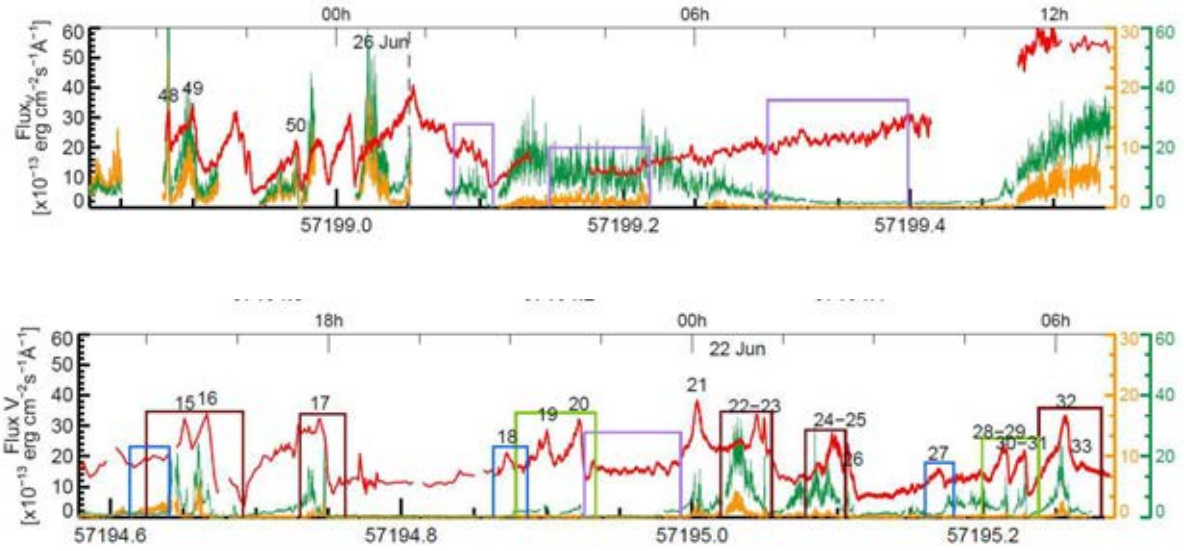


- The construction of an archive, residing in the Spanish Virtual Observatory, containing the most comprehensive information about Herbig AeBe stars (Mendigutía et al.)

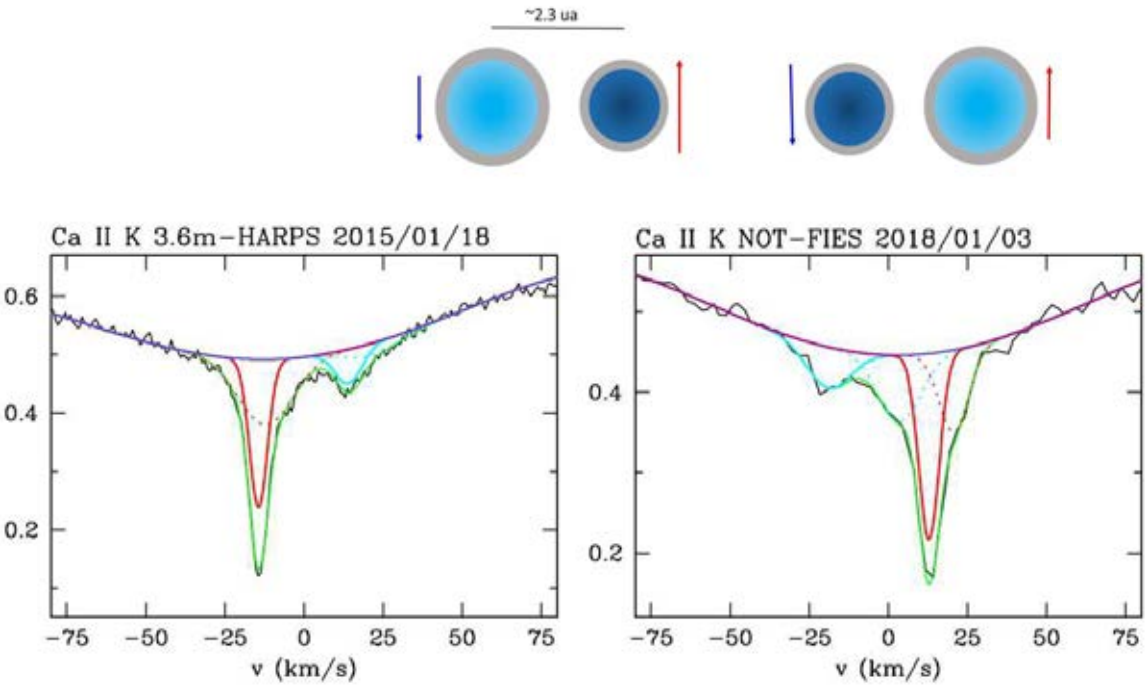
- INTEGRAL/OMC optical observations of the bright nova ASASSN-18FV were carried out, following up the evolution of its light curve (INTEGRAL/OMC team)



- Optical/X-ray correlations during the V404 Cygni June 2015 outburst have been studied in detail (Alfonso-Garzón et al., Astronomy and Astrophysics)



- A complete study of HR 10, slighly evolved binary (the first of its class discovered), with individual circumstellar envelopes around each component, is underway. Dedicated campaigns with six telescopes, using echelle spectroscopy and interferometric VLT/PIONIER observations (Montesinos et al., Astronomy and Astrophysics, in preparation)



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 2018 has been the following:

1.- The CAB Astronomical Data Centre

- First steps towards the implementation of a reduction pipeline for the GTC OSIRIS (Broad Band Image and Spectra), MEGARA and EMIR instruments .
- Maintenance and development of new functionalities in the CARMENES and Calar Alto data archives.
- Development of archives using our VO-publishing tools (e.g. SVOCat).
- Building of a catalogue of sources from the GTC OSIRIS Broad Band images.

2.- Virtual Observatory tools

- Implementation of new functionalities in VOSA, 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 1800 users who have analysed almost 6 000 000 objects and have published 140 refereed papers.
- Improvement of Clusterix, a tool that allows to estimate the membership probability of a list of objects to a given stellar cluster.

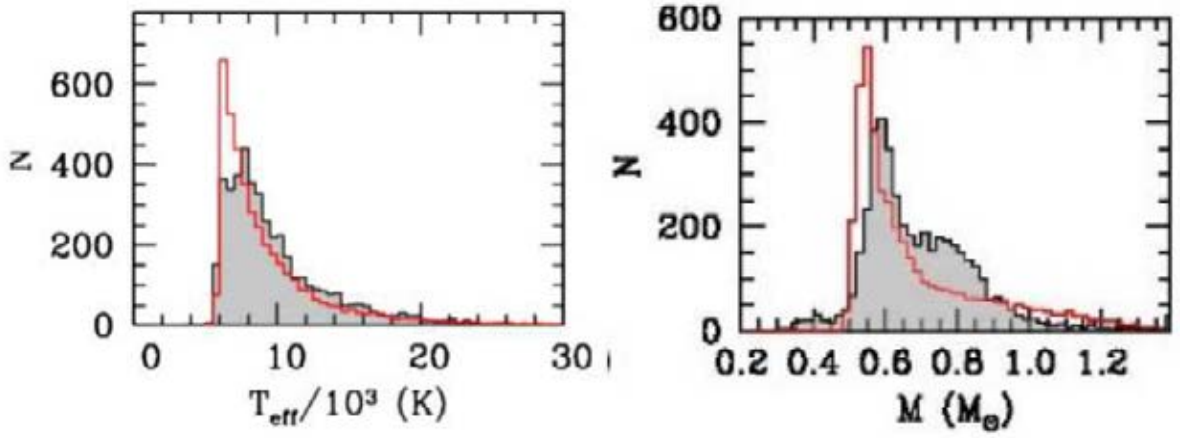
- Improvement of SVO Discovery Tool, a tool that, given a list of objects, discovers all the information available in VO services

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

- Development of the most complete catalogue of nearby (<100pc) white dwarfs using Gaia DR2 and the Virtual Observatory.
- Identification and characterization of solar system objects in astronomical surveys (in collaboration with the Nice Observatory).
- Physical parameters of CARMENES stars (CAB collaboration).
- Identification of ultracool dwarfs in the J-PLUS survey as well as in extragalactic fields (COSMOS, ALHAMBRA) (CAB collaboration).
- Characterization of binary hot subdwarfs (in collaboration with the University of Vigo).
- Identification and characterization of white dwarfs with infrared excess (in collaboration with Universidad Politécnica de Cataluña).



Distribution of effective temperatures and masses for the nearby white dwarfs (solid grey histogram) compared to model predictions (empty red histogram).

5.- Education and Outreach activities

- Organisation of three SVO School: Centro de Astrobiología (Torrejón, May 2018, 17 participants); Universidad Autónoma de Madrid (November 2018, 15 participants) and Congreso Estatal de Astronomía (Cuenca, Noviembre 2018, 19 participants).
- Participation in the IV ASTERICS VO School. Strasbourg (France). November 2017. 50 participants.
- Supervision of three Master Thesis.

- Development and maintenance of the data archive of STARS4ALL,a H2020 project aimed at studying the light pollution in Europe.
- Two press releases.
- Youtube video (20m) on the SVO activities.

Youtube presentation on the Spanish Virtual Observatory activities.

Department of Planetology and Habitability

Planetology and Habitability

Head of Department: Felipe Gómez

Crucial to research in the field of astrobiology are studies on the limits of life and its interaction with the geology of a given ecosystem. The department of planetology and habitability focuses its objectives on planetary geology and the understanding of what is life and habitability potential trough the studies of life in extreme environments and the identification of lipid biomarkers.

These objectives are approached 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.

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 astrobiological potential of planetary objects of the Solar system, such as Mars and Ocean Worlds, through geological studies. We have special interest to assess the habitability requirements that future missions under development could detect. Investigations involve laboratory activities, fieldwork, and participation in the supporting science of development of exploration instruments and space missions.

During 2018 we investigated samples of two geothermal areas of Iceland (Krýsuvik and Hveragerdi) as analogs to materials found on the Mars surface. They help to understand the mineral changes produced by the substrate-atmosphere interaction on Mars. Our interest were in water-related minerals produced by weathering and hydrothermal processes because they are indicators of potential habitability. Indeed, hydration/dehydration of these mineral assemblages might affect the actual water cycle on Mars, e.g., phase change by absorption / release of water (deliquescence/efflorescence). Interesting Icelandic samples comprise mixtures of several minerals such as Al-clays, opal, alunite, anatase, calcite, and iron oxides, which occasionally have different crystallinity and thermal behaviour. We use the semi-quantitative analyses of XRD and spectroscopy (IR and Raman) to determine the mineral ratio for calculations in calorimetric measurements. Specific heat of the mineral assemblages were obtained, which will be used for modelling the thermal inertia of Mars substrate.

Other research line that we are investigating is the cryomagmatism in the Solar system. In this period, we simulated the effect of thermal perturbation in the icy crusts. Several evidences indicate that the icy crust of Europa has a renewal mechanism (subject to tectonic and volcanic resurfacing processes) that keeps the surface clean of impact craters and with a varied and characteristic geological signature. Extensional deformations or breaking (and disruption of the surface) appear in the form of faults, ridges, lenticulae and chaos terrains, and most of them are related to reddish non-icy materials that could be outcrops of materials from the interior of the moon. The experiments we did at high pressure showed that slight differences in the pressure-temperature paths followed by the rising cryomagmas, and in the proportion between the compounds, result in a diversity of processes with different volume changes and final features and mineral assemblages. If the magnitude is enough, these movements may favour the breaking of the icy crust surrounding the cryomagmatic chamber. Our experimental study helps to constrain the mechanisms occurring under the surface and the structure of the outer part of the Europa's icy crust.

We are evaluating the stability of hydrated salts under planetary conditions. The resulting products after exposing hydrated sulfates, like those detected on the surface of Europa, to ultra vacuum, UV radiation and low temperatures were characterized by Raman spectroscopy and X-ray diffraction. The low temperatures maintain the stability of these phases despite the conditions of 10-9 mbar. In the icy moon, the endogenous activity modify the temperature of the surface materials and produce local dehydration and amorphization. These changes might relax the crystalline structure and generate structural defects that might result in the colour change detected in the salts of Europa.

Theoretical calculations and related experiments were carried out on the density and stability of high-pressure phases of CO2 and CH4 clathrates, which have relevance for the deep layers of Ganymede. The results produced accurate descriptions of the structure, stability, state equations, phase transitions and vibration frequencies of the clathrate hydrates of CH4 and CO2.

We also studied the effect of compositional changes on the thermal properties of the terrestrial seawater. Despite the uncertainties, there is an agreement that the first seawaters formed on Earth were in balance with a primitive atmosphere rich in carbon dioxide (CO2). They were anoxic, poor in sulfate, and with a concentration in bicarbonate (HCO3-) higher than calcium (Ca2+), resulting in an alkaline brine where the precipitation of carbonate minerals such as nahcolite and trona was propitious. Later, the decrease in temperature favoured the continental crust formation and the weathering of the CO2, probably causing the acidification of the ocean to a neutral state. The following “Great Oxidation Event” introduced the oxygen (O2) to the environment and subsequently sulfate (SO42-) concentration started to increase from around 10 m in the Silurian to 29 m nowadays. The ratio HCO3-/Ca2+ inverted, promoting the precipitation of gypsum instead of carbonates. Attending to the Mg/Ca ratio from the Phanerozoic, it has occurred a periodically exchange between brines rich in Ca and brines rich in Mg, for instance, this ratio was around 1.5 at Silurian times while currently it has a mean value of 5.2. Changes in the thermal properties of the seawater affect the interaction among the atmosphere-crust-ocean and, consequently, the cycles of energy and some elements and the habitability conditions during the planet’s history.

The work of impact craters group coordinated by Dr. Ormö is focused on the geology of craters formed by cosmic impacts and how they can be used to reconstruct the paleoenvironment in which they formed. This is of significance in the search for Life habitats elsewhere in the Solar System.

Main activities during 2018 include laboratory experiments of projectile impacts, analysis of drill core data from various impact craters, as well as fieldwork at a couple of them. During two weeks in January the Laboratory for Experimental Impact Cratering at CAB was visited by Dr. Anna Loziak from University of Exeter, UK. Together with Dr. Ormö she performed simulations of the influence of target properties on the shape of the Kaali Crater, Estonia.

The CAB impact crater group is also third party member of the IODP-ICDP Expedition 364-Drilling the Chicxulub Impact Crater at the Yucatan peninsula, Mexico. The main role in this expedition has been to study the sediments recorded in the drill core M0077A obtained from the peak ring of the crater. The 200 km wide Chicxulub crater is one of the largest in the world and is the culprit for the mass extinction that a.o. led to the demise of the dinosaurs. The goal of the expedition has been to investigate the effects of the impact on Life as well as to develop a better understanding on the formation of peak rings in large impact craters. In connection with this work the group participated in fieldwork on the ejecta exposures in southern Yucatan in June

Figure PH1: Dr. Ormö studying Chicxulub ejecta deposits at southern Yucatan.

But impact craters on Earth come in various shapes and sizes. Small craters of a few tens of meters in diameter may appear insignificant compare to the large “global killers”. However, their frequency of formation is much higher and, thus, may be of greater importance to our civilization. During a week in July Dr. Ormö participated in fieldwork at the approximately 70 m wide Thor Crater in the mountains of central Sweden. It is presumed to have formed about 2000 yrs ago. In collaboration with a team from universities in UK, Sweden, Estonia, and Poland the crater was subject to geophysical surveys including magnetometry, ground penetrating radar, and electric resistivity. Detailed excavations of the crater ejecta were also carried out to look for evidence of the cosmic impact in the form of shock evidence and charcoal.

Habitability and Extreme Environments group

Coordinator: Felipe Gómez Gómez

The activities around the group of Extreme Environments and Habitability during 2018 have focused on the study of the microbial biodiversity of Dallol geothermal area in the Danakil depression (Ethiopia) and depper studies in the extreme environment of Río Tinto and Tírez lake in Spain, Ibbn Battuta desert in Morocco among others.

Figure PH2: Expedition to the extreme environment of Dallol (Ethiopia). Credits: F. Gómez / Europlanet

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. We have described the presence of life reported for the first time in Dallol geothermal area, published in Scientific Report journal. It is for the first time that life has been reported in this multi-extreme environment which is Dallol geothermal area in the Danakil depression (Ethiopia). But, not only it is relevant for reporting the presence of life, if not for the kind of life which has been reported. Small bacteria has been idenfied emtombed in the salt layers deposited over the small chymnies in Dallol.

The Dallol geothermal area in the northern part of the Danakil Depression (up to 124 – 155 meter below sea level) is deemed one of the most extreme environments on Earth. In fact, it is the hottest place on Earth.

This multi extreme environmet is located at the Afar Depression, an incipient seafloor

spreading center located at the triple junction, between Nubian, Somali and Arabian Plates (it is characterized by an attenuated continental crust, which is less than 15 km thick with zones shallow (3–5 km deep) magma chambers beneath its axial), and for hosting environments at the very edge of natural physical-chemical extremities. This is a narrow lowland salt plain (up to 124 m below sea level) running inland, quasi-parallel to the coast of the Red Sea, which formed when part of the Red Sea was isolated during the Pleistocene. Just in the north of the area a salt plain accumulation of marine evaporite deposits has been deposited and host the Dallol volcano. The interaction between the evaporitic deposit and the volcanic activity have created the unique Dallol hot springs, which are highly acidic (pH. 0) and saline (saturation) with maximum temperatures ranging between 90 and 109°C. At the surface, the water temperature at the source is above 100 °C and highly acidic (pH~ 0). The resultant hot pools vary in color depending on the high metal concentration- (e.g., iron 35.6 g/L, copper 93 mg/l). A combination of these extreme chemical and physical parameters (e.g. temperature, pH, salinity and heavy metals) has resulted in a unique multi-extreme environment.

In this so extreme conditions, high temperatura, high acidity (pH below 0), salt content and metals we report for the first time evidence of life existing with these hot springs using a combination of morphological and molecular analyses.

Ultra-small structures are shown (which seems at the first look to be mineral precipitates) to be entombed within mineral deposits, which are identified as members of the Order Nanohaloarchaea. The results from this study suggest the microorganisms can survive, and potential live, within this extreme environment, which has implications for understanding the limits of habitability on Earth and on (early) Mars.

During 2018 deeper studies on rio Tinto has been focused in the study of the iron burnish precipitated over the rocks present in the river bed. This study has important astrobiological implications since the interaction of the microorganisms with the minerals and its role in the precipitation patterns of them have been reported.

During 2018, the lipid biomarkers group has developed a sampling campaign (20 days) in Antarctica, with the project "Extreme environments in planetary exploration: geolipids, stable isotopes and associated mineralogy in King George Island" of which I am IP. During this year, we have increased the analytical capacity of the laboratory of stable isotopes, through the coupling of a gas chromatograph (GC) to the equipment of mass spectrometry of isotopic relations (IRMS), thus we have implemented the specific compound isotope analysis (CSIA) of dD, d13C, d15N and d18O. At the same time, we have improved the facilities of the biomarker laboratory with the purchase of a rotovapor and closed circuit cooler, nitrogen sample concentrator and a new vertical freezer.

During 2018, the "early Mars" team, led by Dr. Fairén, finished the development of the European Research Council Starting Grant "icyMARS", and was awarded a new ERC Grant, the Consolidator Grant "MarsFirstWater".

European Research Council

Established by the European Commission

A rainbow in the hyperarid core of the Atacama Desert.

Major achievements of the group during 2018 were:

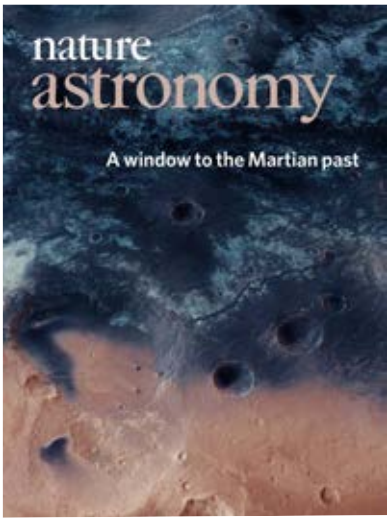
1. Analyzing the first rains in centuries in the core of the Atacama Desert.

The Atacama Desert, the driest and oldest desert on Earth, located in northern Chile, hides a hyper-arid core in which no rain has been recorded during the past 500 years. But this situation changed on 2015-2018: for the first time, rainfall was documented in the hyper-arid core of the Atacama and, contrary to what was expected, the water supply caused a great devastation among local microbial species. The extinction

range reached 85%, as a result of the osmotic stress that has caused the sudden abundance of water: the autochthonous microorganisms, which were perfectly adapted to thrive under conditions of extreme dryness and had strategies optimized for the extraction of the scarce humidity of their environment, were unable to adapt to the new conditions of sudden flooding and died from excess water. This study helped to understand the microbiology of extremely arid environments, and also presented a new paradigm to decode the evolutionary path of a hypothetical early microbiota of Mars, since Mars is a hyper-arid planet that experienced catastrophic floods in ancient times. Therefore, our Atacama study suggests that the recurrence of liquid water on Mars could have contributed to the disappearance of Martian life, if it ever existed, instead of representing an opportunity for resilient microbiota to bloom again.

In addition, our study noted that large deposits of nitrates at the Atacama Desert offer evidence of long periods of extreme dryness in the past. The nitrates were concentrated at valley bottoms and former lakes by sporadic rains about 13 million years ago, and can be food for microbes. The Atacama nitrates may represent a convincing analog to the nitrate deposits recently discovered on Mars by the rover Curiosity.

2. Analyzing clay formation on Mars to understand the planet's early climate.

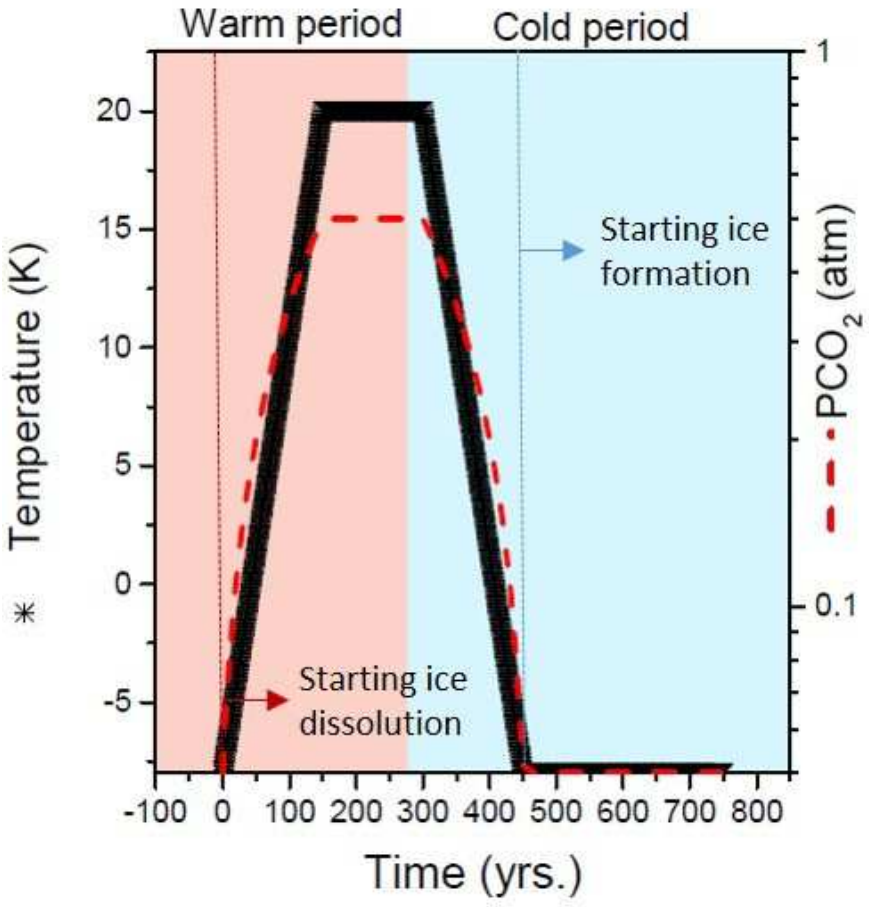


The climate on early Mars has presented an enduring enigma for planetary scientists. On the one hand, surface features such as valley networks, deltas and paleolake basins indicate abundant liquid water was present; in addition, the clay and sulfate minerals found in most ancient surface rocks needed liquid water to form. And the presence of liquid water would have implied warm temperatures. On the other hand, though, atmospheric models generally do not support a climate on early Mars warm enough to sustain liquid water on the surface. Our study showed that part of this early martian climate puzzle comes down to how warm is "warm", because cold liquid water is not warm enough for surface clays to form. We combined our research results from different areas: studies of weathering in the field, clay synthesis experiments in the lab, and geochemical modeling of clay formation. Our study evaluated the types of clays present in ancient, altered rocks on Mars and separated these into 3 categories: 1) Mg-rich clays formed at high temperatures (100-400 °C) below surface (e.g. mixtures of saponite, serpentine, chlorite, talc and carbonate); 2) clays formed at warm temperatures (20-50 °C) in lakes, streams or rainy environments (dioctahedral Fe-rich or Al-rich smectites); and 3) poorly crystalline aluminosilicates such as allophane formed at cold temperatures (<20 °C). Our study showed that short-term warm environments, occurring sporadically in a generally cold early Mars, enabled formation of the observed surface smectite occurrences on Mars. Further, there was a trade-off between temperature and time. Cooler temperatures (15-20 °C seasonal, diurnal Tmax) would have required sustained periods of high water/rock ratio on Mars to produce the observed smectite outcrops. This could mean hundreds

of millions of years at 5 °C global mean average temperature on Mars, which is unlikely given the current models of the atmosphere. Our study concluded that surface smectite (nontronite, montmorillonite) beds may have formed quickly during short-term periods of warm temperatures (25-40 °C seasonal, diurnal Tmax) in a generally cold early Mars. This could mean from tens of thousands to a few millions of years at a global mean average temperature of 10 °C on Mars at intervals over hundreds of millions of years with sub-freezing temperatures. These transient elevated temperatures could have been caused by volcanism, obliquity changes, or large impacts.

3. Other areas of research by the "early Mars" group during 2018 included:

3.1. Analysis of the oxidation of silicates catalyzed by pyrite microparticles under Martian conditions. We combined the experimental study of the surface layer of oxidation under a CO2 atmosphere of different mixtures of olivine and pyrite, the stability of solid samples in conditions similar to those of current Mars (PASC) and geochemical models to study the long-term reaction and under different geological scenarios relevant for early Mars.



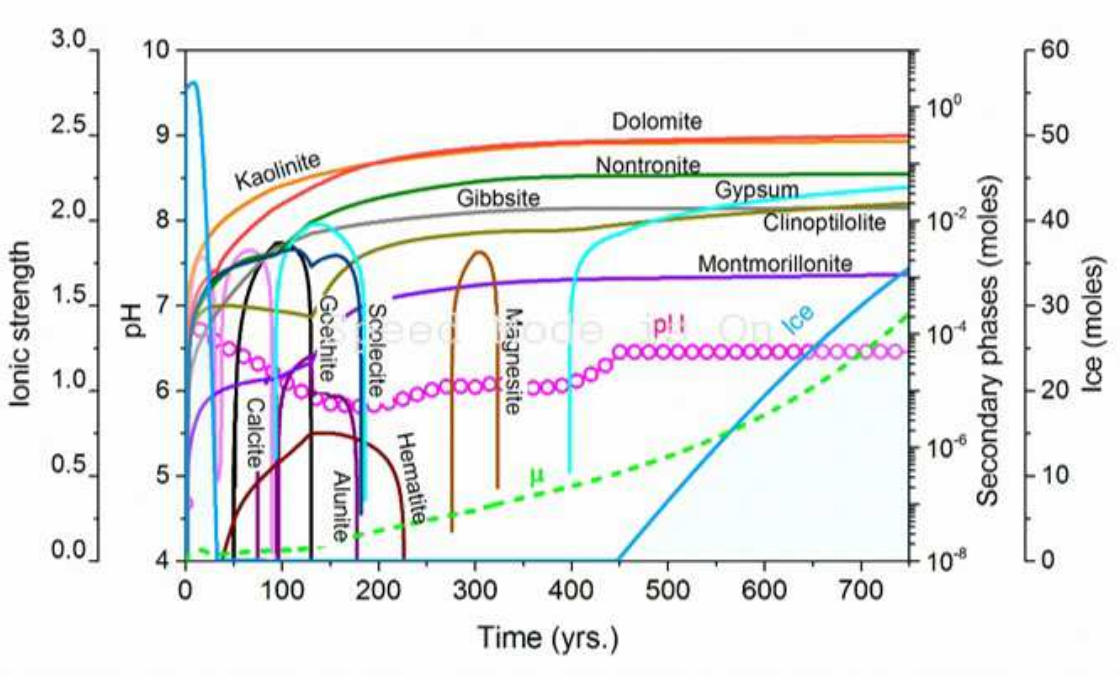


Figure PH3: Example of a geochemical simulation: variation of the PCO2 and T conditions throughout the simulation (left), formation of secondary phases (right).

3.2. Investigation of the preservation capacity of organics in clays under conditions similar to those of Mars, with the aim of determining the clay mineral most suitable to preserve organic compounds in conditions similar to those of Mars. We also investigated whether the exposure to different environmental conditions might compromise their ability to act as "protective shields".

3.3. We revitalized the case to resume a dedicated search for life on Mars, including requesting a re-evaluation of Planetary Protection policies. We argued that we need to avoid that forthcoming astronaut missions would contaminate the Martian surface with Earth's microorganisms before we know if there's life on Mars or not. Under current policies, spacecraft are sent to visit Mars to look for "habitability", but they are not allowed to investigate the regions that might be especially likely to harbor life, and as a result there is not a dedicated strategy to search for life on Mars. We started a public debate with NASA's Planetary Protection officers, and they claimed that "the Mars community is not convinced that a mission to attempt detection of extant martian life is a high priority". We disputed this contention and argued that there is nothing more appealing to the Mars community than the prospect of finding Martian life.

3.4. Alberto Fairén was the co-advisor of 1 PhD Thesis defended on 2018 at the University of Vigo, presented 10 abstracts/posters at international meetings, and published 20 popular science articles in different newspapers and magazines (in Spanish).

Department of Molecular Evolution

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 almost universally accepted nowadays that the homochirality of biomolecules (the fact that all the amino acids and carbohydrates employed in the molecules of life: DNA, RNA, proteins, are almost exclusively composed by the same handedness or chirality) is a prerequisite for life, but the problem of how, in the course of chemical evolution, prebiotic reactions led first to an enantiomeric (chiral) imbalance that finally resulted in the achievement of system homochirality remains a serious challenge and has been extensively debated and studied during the last few decades. In 2018, we have continued our physico-chemical research employing theoretical analysis, modeling and numerical simulation of spontaneous mirror-symmetry breaking scenarios and to the study of replicators in open systems and also to study the impact that external noise (i.e., environmental fluctuations) has on chemical progress; having (i) demonstrated how non-enzymatic template catalysis and template yield are strongly affected by strict thermodynamic constraints in both closed and open reaction systems, showing (ii) how externally adjustable noise can be used to select reaction pathways and therefore control reaction yields using a simple stochastic autocatalytic chemical system and (iii) by applying, and for the first time, techniques of Stoichiometric Network Analysis (SNA) with non-equilibrium thermodynamics to study the production of entropy (dissipation) in chemical reactions in open systems with applications to the further study of spontaneous mirror symmetry breaking in chemical reactions and its relation of chiral selection to dissipation. The most relevant aspects of these results are summarized below.

Open-flow non-enzymatic template catalysis and replication

Inanimate prebiotic chemistry evolved towards biological chemistry (biochemistry) through the formation of self-replicating molecules. In the very earliest stages of chemical evolution, this would have taken place in the absence of enzymes. In this respect, mention must be made of the first experimental enzyme-free replication system reported by von Kiedrowski, who framed a general description of such systems denoted as Minimal Replicator Theory. Other series of self-replicating molecules have been designed and characterized experimentally since then, including organic molecules and also peptides as well as nucleic acids, for DNA, and also for RNA. The underlying autocatalytic mechanism for all these systems is based on non-enzymatic template assisted ligation. In these chemical processes, a template T pre-organizes two constituent fragments, one termed the electrophile E and the other a nucleophile N. This preliminary stage promotes the ligation (attachment at the ends) of these two fragments to yield a second identical copy of the template T which can then go on to participate in another autocatalytic cycle, see Fig. 1. Here we have analyzed numerically the steady state solutions of this reversible network: whereas chemical thermodynamics leads to very low template yield in closed systems, high yields can be obtained when the system is driven out of equilibrium via open-flow even for very small flow rates.

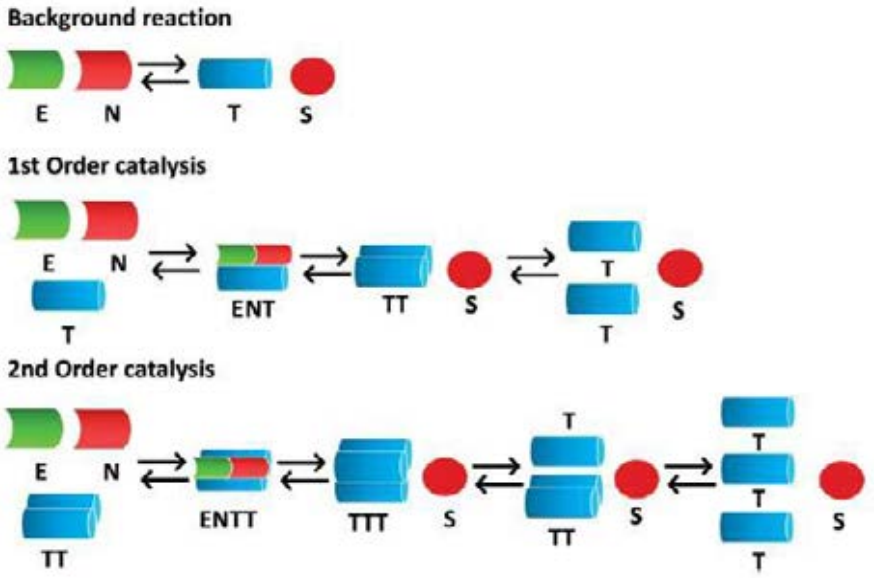


Figure 1. Schematic diagram for self-replication. Top: non-catalyzed template T formation, where E and N join to form a template. Middle: first order reaction where T is a catalyst for its own production (autocatalysis). Bottom: second order reaction where the template dimer TT is the catalyst. All transformations are reversible: S denotes the thiol molecule.

Selection and control of chemical pathways using externally adjustable noise

It is well-known that fluctuations and noise can affect the behavior of various systems, from running coupling constants in high-energy particle physics to phase transitions in condensed matter physics and noise-induced transitions in complex systems. In particular, noise can affect the dynamics of chemical reactions. For example, it has been shown that periodic light illumination can be used to control the appearance of oscillations and Turing structures in the chlorine dioxide-iodine-malonic acid reaction, and that coherence resonance can be induced in the Belousov-Zhabotinsky reaction using colored noise. The goal of our research is to demonstrate how external experimentally tunable noise can be used to control and perhaps even select chemical pathways. In this work we consider noise as an external tool to manipulate and control the chemical system, which could have numerous potential applications in chemical engineering. Additionally, external noise plays a fundamental role in gene expression

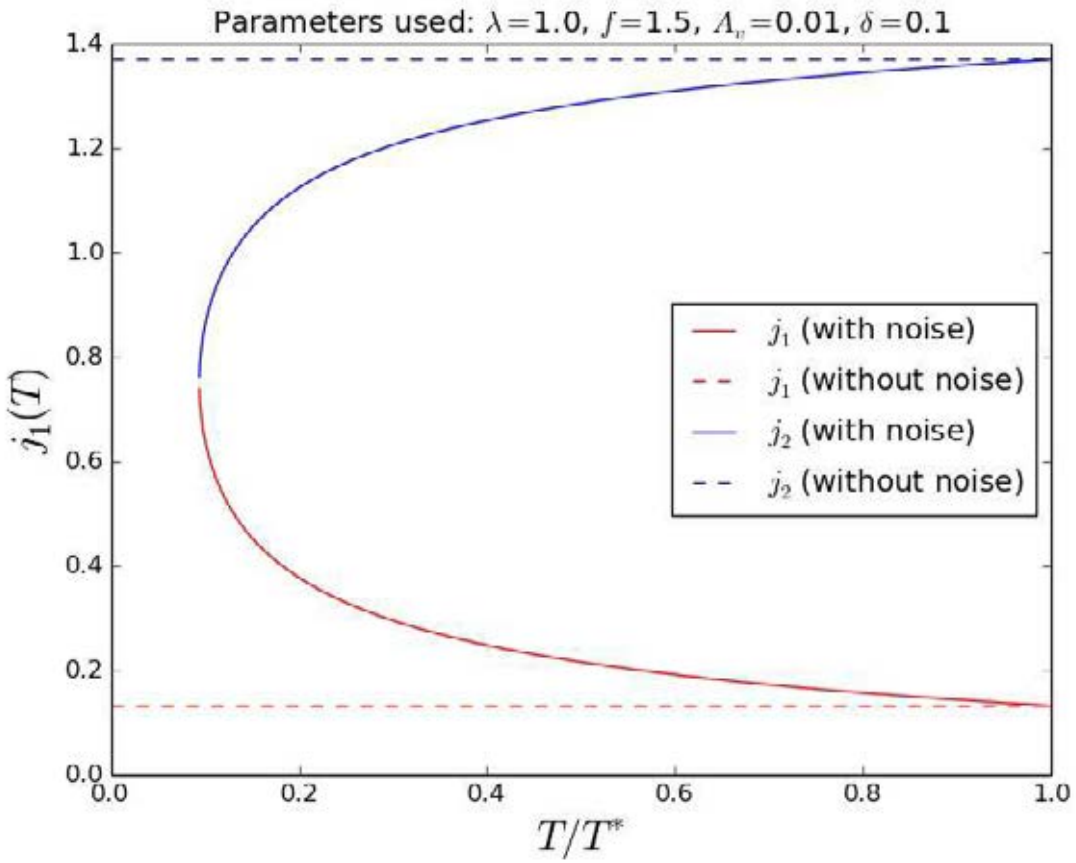


Figure2.
Dependence of the matter fluxes j1 and j2 with respect to time scale T (normalized to reference time scale T*) corresponding to cubic autocatalysis and decay in a simple autocatalytic reaction model subject to external correlated temporal noise.

and other biochemical aspects of living systems, thus influencing the evolution and adaptation of chemical and biological systems. The method developed in this work could be potentially used in many applications ranging from the optimization of chemical reactions to artificial life. The figure below shows how the chemical fluxes j1 and j2, through two different pathways ,in an autocatalytic reaction system, can either increase (blue curve) or decrease (red curve) as a function of the intensity (T/T*) of the external temporally correlated noise.

Stoichiometric network analysis of entropy production in chemical reactions

Entropy is a measure of irreversibility and plays a pivotal role in all the natural sciences. Changes in entropy encompass all aspects of the transformations of every physical, chemical and biological system in Nature, ans they obey a relationship between the entropy changes generated inside the system itself (diS) with those of the entropy exchanged with its surroundings (deS), as expressed by the balance equation underpinning the modern approach to irreversible thermodynamics: dS = deS + diS. In this research line, we have successfully combined Stoichiometric Network Analysis (SNA) with non-equilibrium thermodynamics to obtain a flux-based approach for understanding how entropy is both produced and exchanged with the environment in chemical reactions taking place in open systems, and how production and exchange are perfectly balanced when the system is in any non-equilibrium steady state. An example of the production, exchange and balance of entropy is calculated for a chiral Onsager triangle network (right hand side) with species A,L,D showing the four open flow pathways in red that are responsible for the entropy production. In the graph, the red (blue) curves show the evolution of the entropy produced (exchanged with the environment) and their balance in the non-equilibrium stationary state.

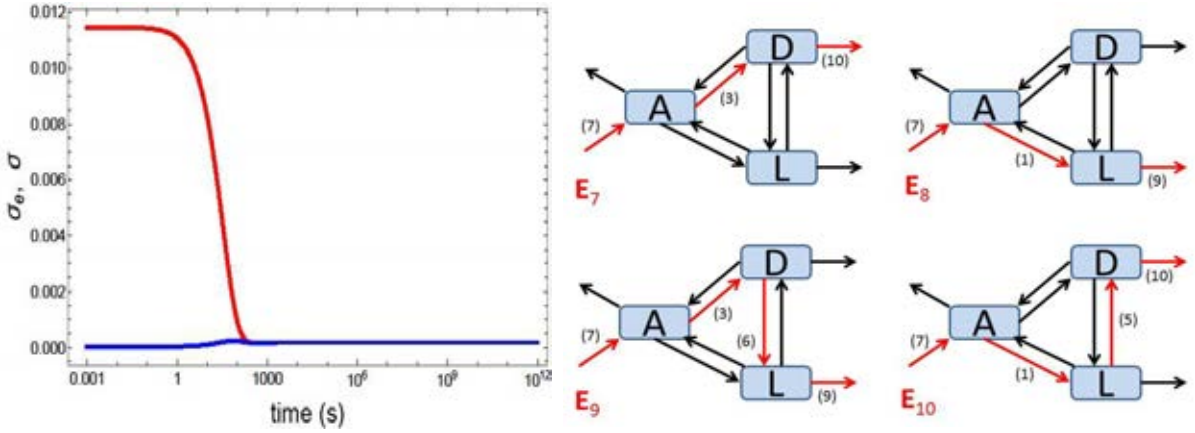


Figure 3. Left: (red) the entropy production and (blue) exchange entropy for a chiral Onsager triangle reaction (right) as a function of time on the approach to the non-equilibrium steady state where they balance each other. Right: indication of the four open flow pathways E7, E8, E9, ad E10, (in red) that traverse the chiral triangle, and which are responsible for the net production of entropy and the entropy exchange with the exterior. s

Reactions on surfaces and Molecular self-organization

(Eva Mateo-Martí)

Minerals can be very promising surfaces for studying biomolecule-surface processes, which are of principal relevance in the origin of life and a source of chemical complexity. Mineral surface adsorption could help to overcome the problem of the extremely dilute concentration of amino acids in prebiotic oceans; among them, due to its catalytic activity, the pyrite surface plays an important role in heterogeneous catalysis and a role in the origin of life and prebiotic chemistry. The adsorption of small molecules onto specific mineral surfaces for selective concentration, catalytic polymerization, protection from UV light, etc., is critical for understanding the selective mechanisms for the accumulation of the amino acids ors nucleotides involved in chemical evolution. The surrounding mineral conditions affect the surface processes and how the molecular and physicochemical inorganic aspects drive the prebiotic chemistry process. A detailed study of the pyrite UV oxidation process and reactivity of molecule/pyrite systems at the molecular level is fundamental to understanding the chemistry of this mineral in a wide variety of environments.

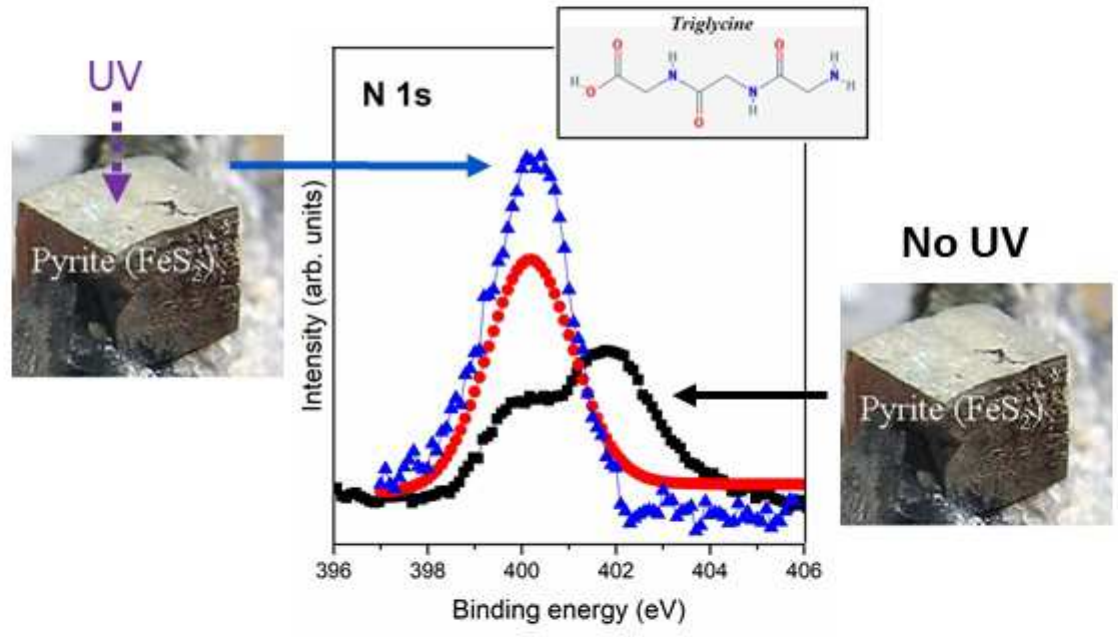


Figure 4. XPS photoemission spectra of N 1s core level peak of triglycine, peptide molecule, adsorbed from the gas phase under anoxic conditions (black line) and from solution before (red line) and after pyrite surface UV irradiation exposure (blue line).

We characterized the effect of UV irradiation on a pyrite surface by X-ray photoemission spectroscopy. Spectroscopic features probe the presence of a new chemical species since pyrite surface chemistry is highly sensitive to the chemical changes induced by UV irradiation. Furthermore, adsorption of triglycine molecules on a pyrite surface has been simulated under several environmental conditions. We have performed the first spectroscopic characterization of triglycine adsorption on a UV irradiated pyrite surface. XPS analysis was employed to efficiently explore the molecular adsorption, to understand surface chemistry, and finally to describe the critical influence of the different environmental conditions in the small peptides-pyrite system. Molecular adsorption from a solution discriminates the NH2 as a unique molecular adsorption form. In contrast, the triglycine molecular adsorption on a pyrite surface under anoxic conditions shows two different chemical species. Finally, even if the molecular diversity is lower in a solution showing molecular adsorption, the molecular concentration is higher, and it is even favoured if the pyrite surface has been irradiated before the molecular

adsorption occurs. Therefore, UV is a relevant parameter to increase the molecular concentration on the pyrite surface.We demonstrate how pyrite minerals can concentrate and act as adsorption substrates for small peptides during wetting conditions and even under inert anoxic conditions. The successful adsorption of several molecules, from amino acids to small peptides, under a wide range of experimental conditions indicates the potential of pyrite as a catalyst under different environmental conditions. The pyrite surface offers the possibility of binding species that are chemically different as a multiple-site surface, and therefore, the co-adsorbates may produce products that would be difficult to form on a surface with a single surface site. These studies could therefore shed light into prebiotic chemistry reactions.

Kinetic and structural studies of HCN polymers

(Marta Ruiz Bermejo)

A compound is considered as a prebiotic reactant when it is available in adequate concentrations on the primitive Earth, or elsewhere, and when it can lead to the formation of other more complex molecules by compatible reactions with the geochemical and geophysical constraints of a particular environment, planetary or interstellar. These prebiotic transformations most likely occurred in water (oceans, lagoons or lakes) or in solid-state conditions caused by the slow evaporation of water. In this context, HCN can be considered as an excellent prebiotic reagent because it is a ubiquitous molecule in the Universe. This compound has been observed in planetary and interstellar locations and is easily produced in plausible prebiotic environments. HCN has been detected in remote galaxies, in interstellar clouds, notably in star-forming regions, in reflection nebulae, in planetary nebulae, in interplanetary dust, in circumstellar envelopes and discs, in comets, in meteorites, in the atmospheres of the outer planets and their moons and, in a terrestrial context, in volcanic gases and hydrothermal vents. HCN is the major product when appropriate gas mixtures are subjected to intense physical energy, such as from electric discharges, UV radiation or shock waves. In addition, currently there is an increasing number of publications about the formation, concentration and of HCN in the atmosphere of the early Earth.

More than fifty years ago, J. Oró claimed the first prebiotic synthesis of adenine from refluxed solutions of concentrated ammonium cyanide. Since then, HCN oligomerization/polymerization has been considered as a preferential prebiotic route for the synthesis of purines and pyrimidine derivatives. Thus, numerous studies were carried out over the last fifty years to define the molecules present in the HCN oligomers/polymers and important bioorganics have been identified such as amino acids, and heterocycles containing nitrogen (hidantoins, purines, pyrimidines and imidazoles) ,but also more recently carboxylic acids involved in the rTCA cycle and one pteridines.

Additionally, HCN polymers have recently received great attention in the field of material sciences because they have been proposed as coatings and adhesives with potential biomedical applications, and HCN-based polymers have also been suggested to serve as valuable models for functional materials with emergent properties, including semiconductors, ferroelectricity, catalysis and photocatalysis. In addition, there is a growing interest in HCN polymeric clusters due to the generation of an energized charge carrier with light irradiation to induce photo redox reactions for stable hydrogen production and heterogeneous organosynthesis, which may enrich the discussion of chemical reactions under prebiotic conditions.

Considering that the properties of a suitable material are controlled by several features, such as the chemical composition, molecular weight, molecular distribution, morphology, stereochemical distribution and others, it is mandatory to acquire greater structural information possible about HCN polymers due to their high potential as materials with different applications and to the new perspectives in prebiotic chemistry. In view of these goals, HCN polymers were prepared using different reaction conditions (several temperatures, reaction times and starting reactants) and the final products of the polymerization processes were systematically studied using different spectroscopic and analytical techniques. The new HCN polymers synthetized exhibited a fine-tuning of their bulk structure and textural properties and thus new properties, such as conductivity and electrochemical activity, making these materials potential candidates in a wide range of applications. Moreover, a fundamental investigation of the kinetics of this polymerization process is needed for acquiring a better understanding of the formation mechanism, and the plausibility of obtaining quantitative models opens a new path towards the successful application of this innovative reactive system. Thus, the kinetics of production of HCN polymers at relatively high temperatures and in the presence or absence of air were studied. The Kamal autocatalytic model can adequately

describe them when they are performed at high temperatures and under atmospheric pressure. However, all of the kinetic parameters determined, including reaction orders and activation energy, suggest that the polymerization kinetics of HCN cannot be based on a simplistic single mechanism.

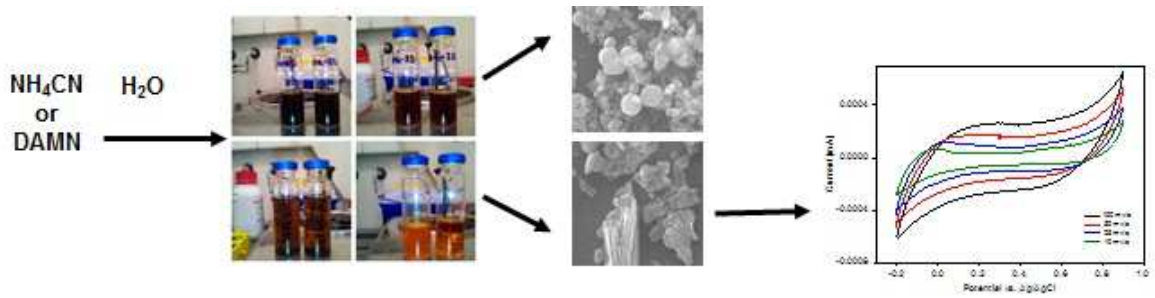


Figure 5. Different reaction conditions lead to HCN polymers with different morphological and electrochemical properties.

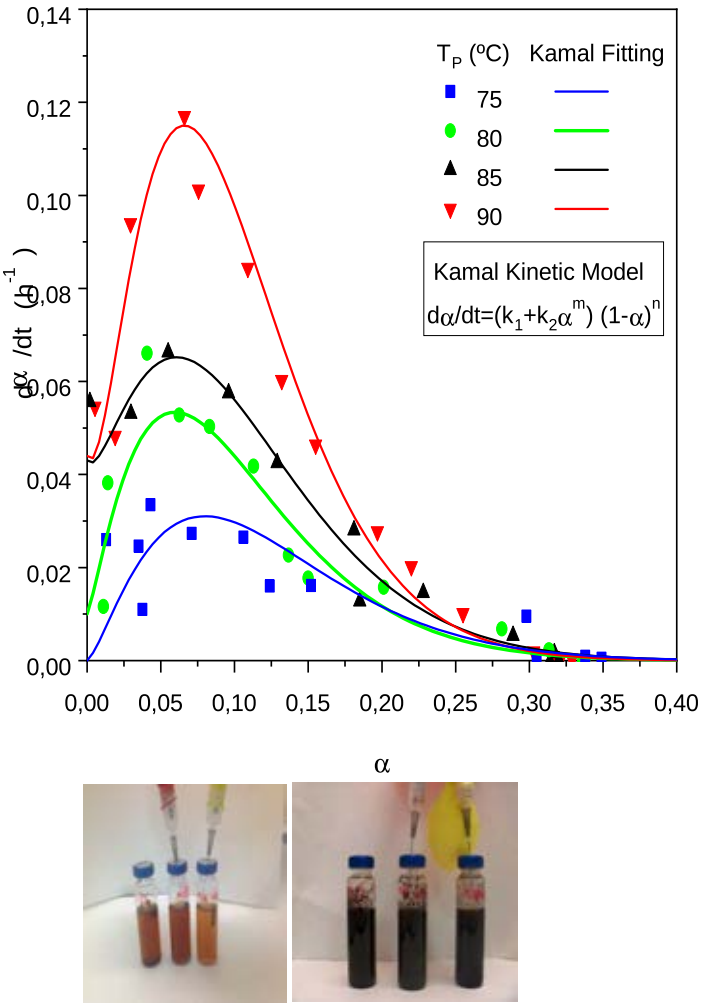


Figure 6. An autocatalytic kinetic model can be applied to the polymerization of cyanide at high temperatures, but the model fails at lower temperatures, indicating a very complex polymerization process.

EXPERIMENTAL EVOLUTION STUDIES WITH VIRUSES AND MICROORGANISMS

Coordinator: Ester Lázaro Lázaro

Experimental evolution uses laboratory systems to understand the mechanisms of evolutionary change. One key goal in these studies is to analyze the molecular basis of adaptation, this is which mutations underlie the process and the reasons why.

Laboratory evolution experiments usually are carried out with viruses and bacteria, due to the ease of their manipulation and the rapidity of their evolution. By initiating a large number of replicate populations from the same starting point and keeping them in identical conditions, it is possible to directly observe the role of chance and contingency in the evolutionary outcomes. The reproducibility and predictability of evolution can be quantified by measuring the degree of parallelism in both the phenotypic and genetic responses to selection. In addition, experimental conditions –population size, mutation rates and environmental variables influencing replication- can be finely controlled. Finally, populations can be preserved, creating a "frozen fossil record" that can be further analyzed or used for new experiments.

Our experimental system is a bacteriophage that infects the bacterium Escherichia coli, the bacteriophage Qß, 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, 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.

Evolutionary experiments carried out in our group are usually focused on determining the changes in fitness experienced by Qß when it is propagated under the particular conditions whose influence on evolution we want to analyze. Fitness determinations are complemented with genetic studies aimed not only to the analysis of consensus sequences but also to the characterization of the changes that occur in the internal structure of populations, which may be determinant for the evolutionary outcomes.

During year 2018, we have continued our studies of adaptation of Qß to high temperature initiated in previous years. We have chosen this environmental variable because it influences most biological processes and, thus, it acts as a wide spectrum selective pressure. In addition, this condition can be easily manipulated in the laboratory, and, in the last decades, it has acquired a great relevance due to global warming. The main research lines that we have carried out are: 1) study of the intra-population dynamics of Qß through adaptation to high temperature, and 2) analysis of the influence of the pattern of environmental change on adaptation and de-adaptation. The most relevant results we have obtained are summarized in the following sections:

Intra-population dynamics of Qß during adaptation to high temperature

Bacteriophage Qß was propagated in two parallel populations at 43ºC for 25 serial transfers. Each five transfers we determined the consensus sequence of populations, which revealed that fixation of mutations was not sequential. Instead of that, we found that some mutations that had reached high frequencies at a certain transfer were lost at later evolutionary stages.

Intriguingly, some of those mutations increased virus fitness at high temperature when they were introduced in an infectious clone of the virus to generate single mutants. Altogether the results indicate that interactions among different mutants within the population, or among mutations in the same genome, are driving the fate of particular mutations. To get a deeper insight on this subject we determined the consensus sequence of an ensemble of biological clones (individual viruses) isolated from the evolving population at two different points. This analysis allowed us to determine how competition among different viruses (containing different combinations of mutations in their genomes) gives rise to a complex dynamics in which it is not easy to predict the final otucome. We recreated the competition process by mixing viruses with known sequences and determining whether some of them was able to displace the others. Finally, we reinitiated the adaptation of Qß to high temperature starting with site-directed mutant viruses containing some of the beneficial mutations that were lost during adaptation of the wild type virus. Our results show that processes such as clonal interference, epistasis, and differences in mutational robustness are driving the adaptive dynamics of Qß.

Figure 7. Evolution of the consensus sequences of the evolutionary lineages of Qß evolved at 43ºC. Each column represent a particular mutation. The horizontal rows indicate the number of transfer at which the consensus sequence was analyzed. The color indicate the absence (white) or presence (blue) of a particular mutation. The intensity of the color indicates whether the mutation is fixed (dark blue) or is polymorphic (the lighter the color the less represented is the mutation).

Influence of the pattern of environmental change on adaptation

The dynamics of adaptation in response to a sudden environmental change that is kept constant thereafter have been well characterized in many experiments. However, real environmental changes might happen more gradually, and it is important to know whether adaptation proceeds through the same evolutionary pathways and ends in similar or different solutions. To analyze the influence of the rate of environmental change on adaptation, we propagated populations of bacteriophage Qß (three replicates for each condition) under three different patterns of temperature increase: a sudden increase to 43ºC (after which the temperature was kept constant) and two gradual increases that also ended in 43ºC. The results obtained after 60 transfers show that all evolutionary lineages experienced similar fitness gains, although there were marked differences in the adaptation dynamics that depended on the pattern of temperature increase followed. A similar scenario

was found at the genetic level: at transfer number 60 there was a set of mutations that was shared by most populations, although the order of fixation of mutations depended on the pattern of change at which the virus had been subjected. We have identified some mutations whose beneficial effects are restricted to a range of temperatures, and others that seem to be associated preferentially with a particular pattern of change. Altogether the results show a great influence of the pattern of change in the evolutionary pathways followed by the virus. We are currently applying deep sequencing techniques to obtain a detailed knowledge of the structure of the evolved populations with the aim of studying how it influences further evolution under new conditions.

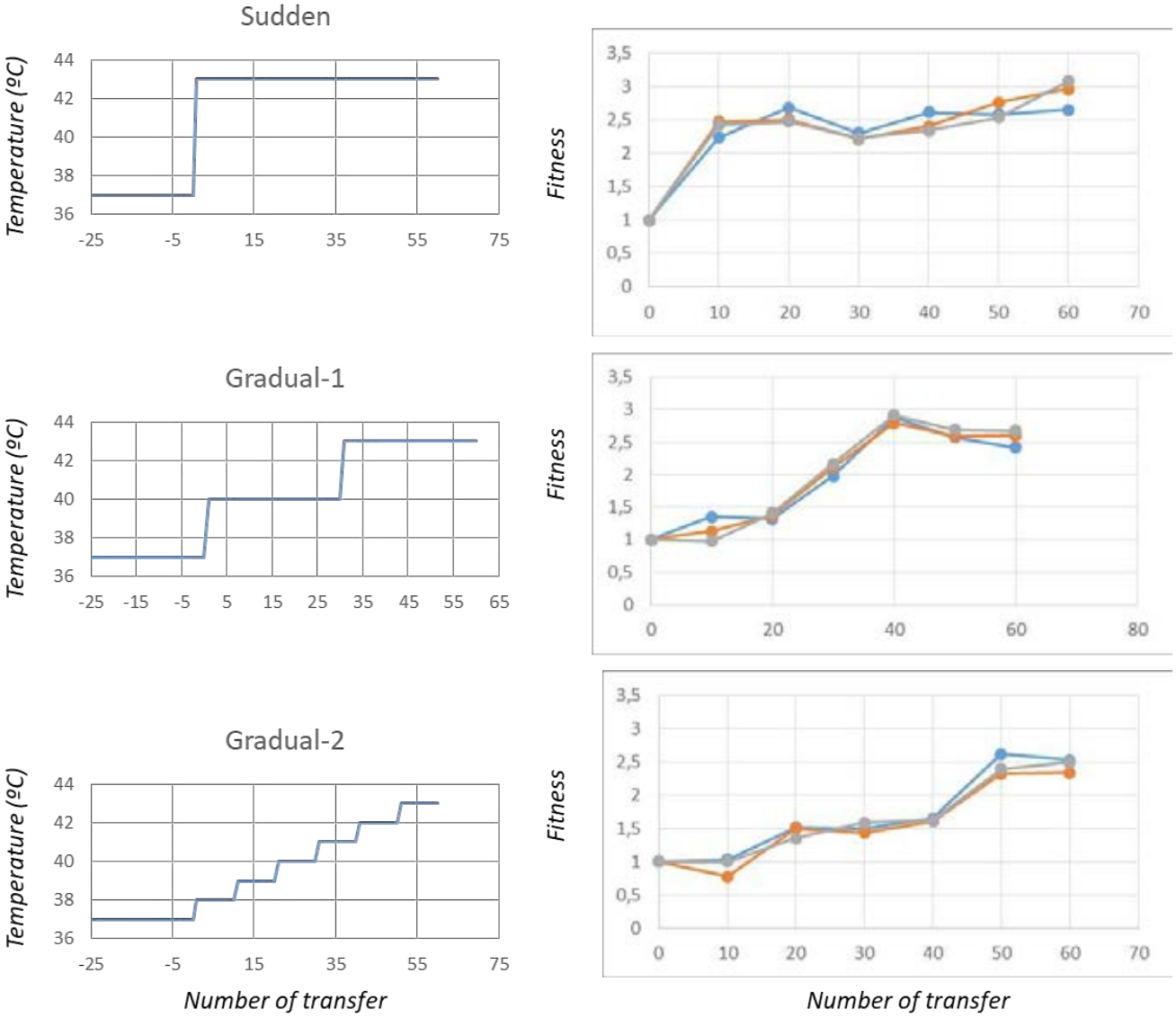


Figure 8. Dynamics of fitness gains in Qß populations evolved according to the pattern of temperature increase shown in the left part of the figure

MOLECULAR EVOLUTION, RNA WORLD AND BIOSENSORS

Coordinator: Carlos Briones

The research group 'Molecular Evolution, RNA world and Biosensors' is focused on the origin and early evolution of life (including experimental and theoretical approaches to the RNA world hypothesis), in vitro selection and evolution of nucleic acids (RNA and ssDNA aptamers), biosensor development (DNA microarray technology, aptamer-based sensors, bionanotechnology-inspired biosensors), and the study of sequence-structure-function relationships in viral or viroidal RNA (including their visualization using AFM). We also collaborate with interdisciplinary research projects devoted to the analysis of the microbial biodiversity of extreme environments.

Aptamers are RNA or single-stranded DNA (ssDNA) oligonucleotides selected in vitro from large libraries of synthetic random oligonucleotides (using a method termed 'Systematic Evolution of Ligands by EXponential enrichment' or SELEX) which can bind with high affinity and specificity to a given target molecule. The three-dimensional solution structure of aptamers depends on their sequence and the physicochemical features of the folding buffer (including temperature, pH, ionic strength and concentration of divalent cations). Aptamers can establish non-covalent molecular interactions with a broad variety of targets, ranging from low molecular weight compounds to whole cells. In 2018, we have worked in the in vitro selection of RNA and ssDNA aptamers specific for low molecular weight compounds useful 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).

We have set up an optimized method for the high-throughput characterization of the in vitro selected ssDNA and RNA aptamers in parallel, thus allowing the search for the fittest aptamers obtained after the last amplification/selection round of any SELEX experiment. Our approach consists in an Enzyme-Linked OligoNucleotide Assay (ELONA) coupled to either real-time, quantitative PCR (qPCR, for ssDNA aptamers) or reverse transcription followed by quantitative PCR (RTqPCR, for RNA aptamers). These experimental systems offer a number of advantages over traditional colorimetric ELONA, and allow the detection of aptamer-target interactions in the high femtomolar range. The developed technology has been used to quantify the dissociation constant (Kd) and maximum binding capacity (Bmax) of 16 high affinity aptamers selected against the pleiotropic protein PCBP-2 [in collaboration with researchers from Centro de Biología Molecular 'Severo Ochoa' (CBMSO, CSIC-UAM)]. Colorimetric ELONA was used as a control method for the analysis of ssDNA aptamers, and Electrophoretic Mobility Shift Assays (EMSA) have been performed to check the binding of RNA aptamers to PCBP-2 in solution.

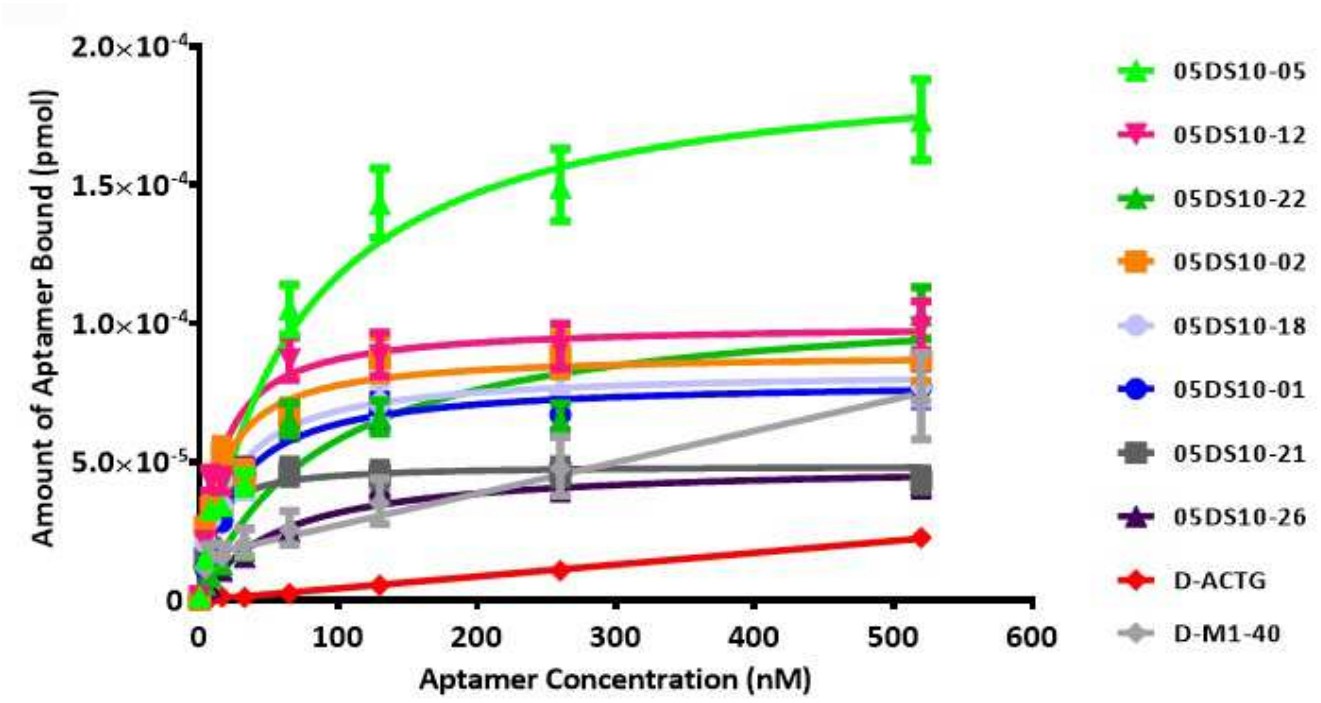


Figure 9. Characterization of the PCBP-2-specific, high affinity ssDNA aptamers selected in vitro, by means of ELONA-qPCR. The best fit curve corresponded to a One site - specific binding model in all cases, from which the Kd (from 8.4 to 89.9 nM) and Bmax values were derived. D-ACTG molecule and the initial population D-M1-40 were used as negative controls.

One of the high-affinity ssDNA aptamers selected against PCBP-2 has been used [in collaboration with researchers from the Instituto de Ciencia de Materiales de Madrid (ICMM, CSIC), Instituto de Microelectrónica de Barcelona (IMB-CNM, CSIC) and other groups] as an optimized probe molecule to develop novel biosensors based on chemically functionalized graphene. This label-free and highly sensitive biosensing platforms can be applied to various fields of biotechnology.

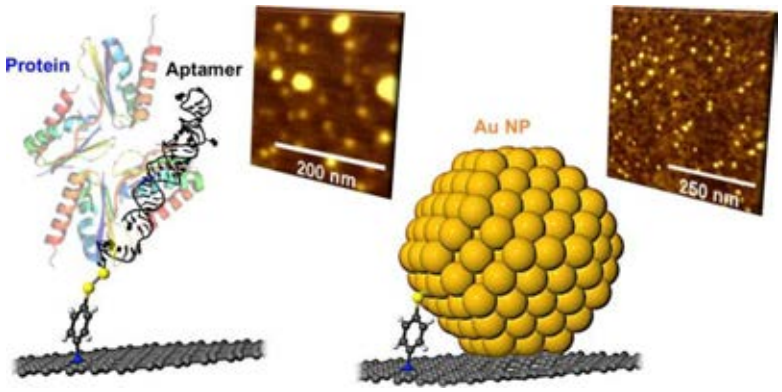


Figure 10. Left: Schematic representation of the developed biosensing platform, based on the covalent binding of thiol-modified aptamers to aminothiophenol-modified graphene. The aptamer-PCBP-2 interaction is visualized by AFM. Right: A control experiment using gold nanoparticles (Au NP) bound to graphene via the aminothiophenol linker.

An analogous method was used for the selection and characterization of ssDNA and RNA aptamers specific for different variants of hepatitis C virus (HCV) core protein, a multifunctional molecule that is mainly involved in the encapsidation of the viral genome. With that aim, different variants of recombinant HCV core protein belonging to each of the four major genotypes (HCV-1 to HCV-4) were produced in baculovirus-insect cell expression

systems, including a terminal 6xHis-tag to purify and, afterwards, to attach it to the copper-covered plates used in SELEX. Up to fourteen rounds of in vitro selection of 76 nt-long, RNA and ssDNA aptamers were carried out in parallel for each of the four target proteins. Different counter-selection strategies were used along the in vitro processes to obtain genotype-specific aptamers. Enriched populations resulting from each selection process were sequenced by ultradeep, next-generation sequencing (NGS), and the most abundant aptamer sequences and structures were identified using bioinformatics tools. Kd and Bmax values of the selected aptamers were quantified by means of the previously developed ELONA-based methodologies. The obtained Kd values of the best ssDNA aptamers were in the nano-molar range, as low as 0.4 nM, thus evidencing a very high affinity for HCV core protein.

Additionally, we have deepened into our previous experimental work devoted to the study of the sequence-structure-function relationships in RNA molecules using atomic force microscopy (AFM) [in collaboration with researchers from ICMM and the Instituto de Biología Molecular y Celular de Plantas (IBMCP, CSIC-UPV, Valencia)]. We analyzed 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. They are classified into two families: Pospiviroidae, composed of species that have a central conserved region (CCR) and replicate in the cell nucleus, and Avsunviroidae, containing species that lack a CCR and whose multimeric replicative intermediates of either polarity generated in plastids self-cleave through hammerhead ribozymes. Due to the fact that direct data about their native tertiary structure remain scarce, we have applied AFM to image at single-molecule resolution different variants of three representative viroids at 0 and 4 mM Mg2+: potato spindle tuber viroid (PSTVd, family Pospiviroidae), peach latent mosaic viroid and eggplant latent viroid (PLMVd and ELVd, family Avsunviroidae). Our results provide the first direct visualization of the 3D conformation of viroids and highlight the key roles that some RNA elements play in the stabilization of their tertiary structure.

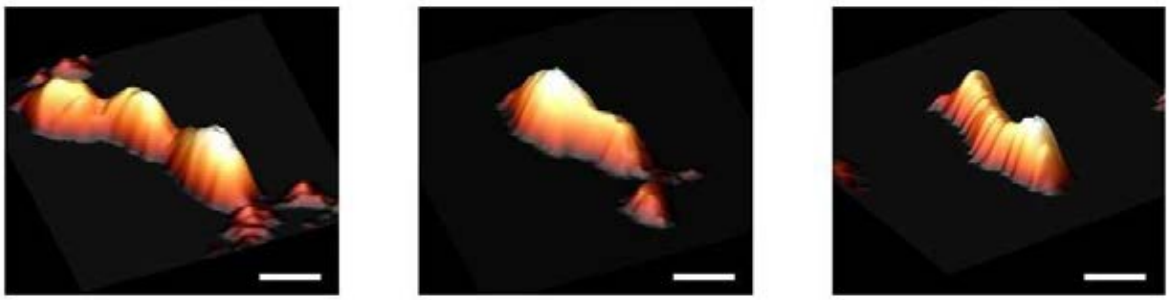


Figure 11. 3D images of the three viroids (from left to right: PSTVd, ELVd and PLMVd) in native conditions, analyzed by AFM. Bar represents 10 nm.

MICROBIAL BIODIVERSITY

Coordinator: Cristina Cid Sánchez

Microbial communities in coastal polar glaciers

(Cristina Cid Sánchez and Eva García López)

Global warming is having a great impact on the Arctic region, due to the change of air temperature and precipitation. As a consequence, the glacial ice melts and englacial materials are being transported into the ocean. These substances can constitute a source of nutrients in food webs or, on the contrary, a source of contaminants. In this project seven marine Svalbard glaciers and their tidewater tongues were focused. This survey provides a first attempt comparing microbial communities from coastal and tidewater glaciers that reveal a hitherto unknown microbial diversity. A wider diversity was found in glaciers than in seawater samples. Glacier microorganisms mainly corresponded to the phylum Proteobacteria (48.8%), Bacteroidetes (29.1%) and Cyanobacteria (16.3%). Seawater microorganisms belonged to Bacteroidetes (40.3%), Actinobacteria (31.7%) and Proteobacteria (25.4%). Other phyla found such as Firmicutes, Thermi, Gemmatimonadetes, Verrucomicrobia, Nitrospirae, Chloroflexi, Planctomycetes, and Chlamydiae were less abundant. The distribution of microbial communities was affected in different extent by the concentration of nutrients (nitrogen nutrients, dissolved organic carbon and soluble reactive phosphorus) and by environmental parameters such as salinity. Nevertheless, the environmental variables did not influence in the distribution of the microbial communities as much as the concentration of nutrients did.

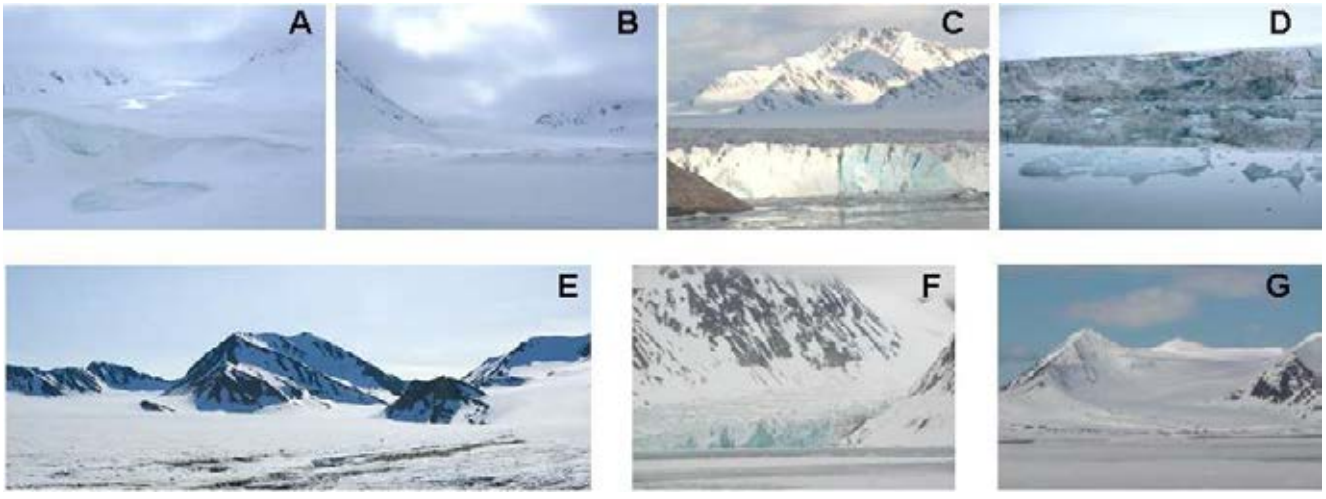


Figure 12. Images of the seven Svalbard glaciers. (A) Lovénbreen Midtre, Sherdahlfjellet; (B) Lovénbreen Austre, Slatlofjellet; (C) Kongsvegen; (D) Kronebreen; (E) Brøggerbreen; (F) Ytre Norskøya, Hamiltonbukta; (G) Poolepynten, Archibald Geikiebreen.

Our results demonstrate an interchange between glacier and coastal microbial populations as well as the presence of some indicator species (i.e., Hymenobacter) as possible sentinels for bacterial transport between glaciers and their downstream seawaters.

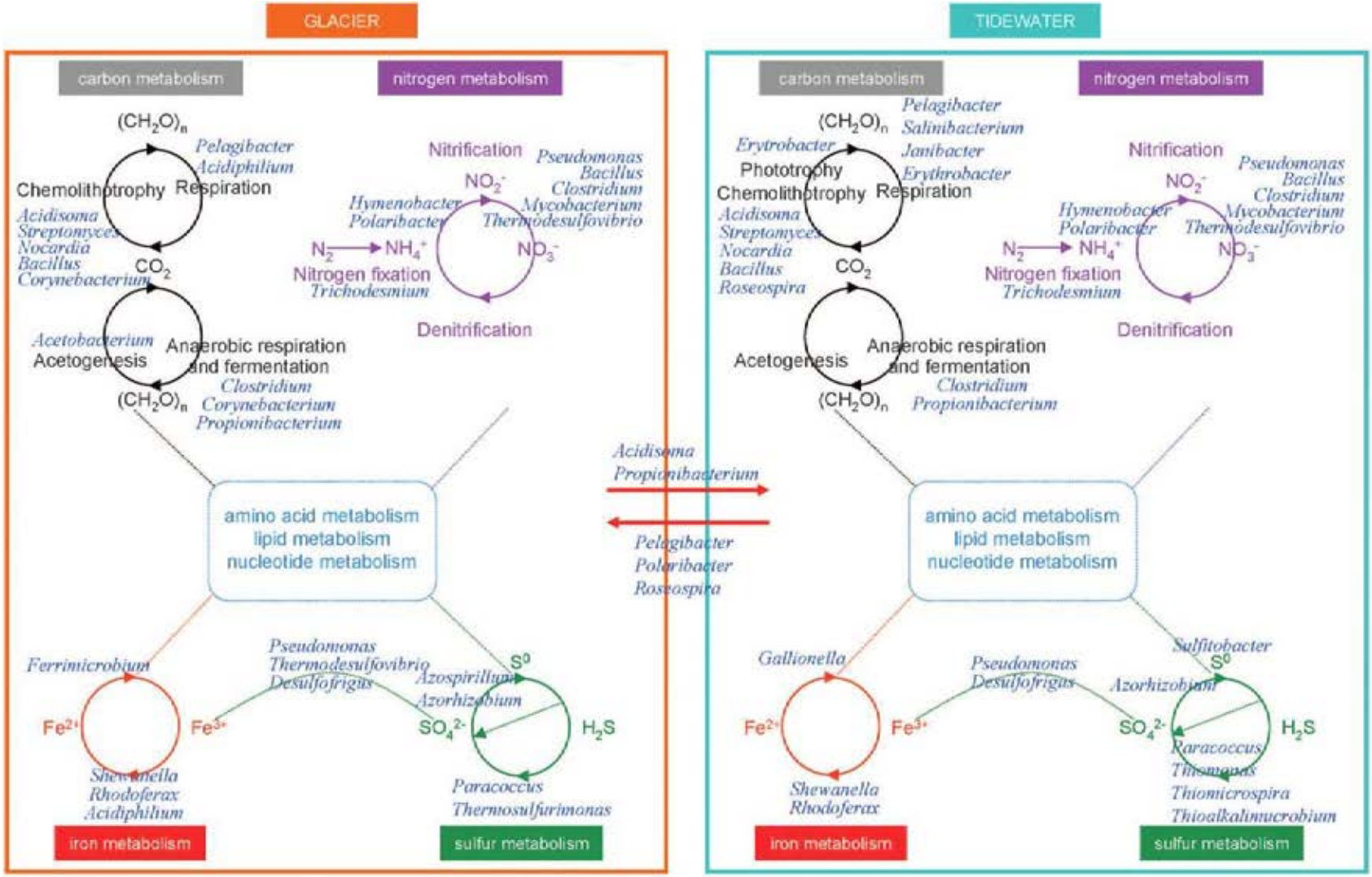

GLACIER
TIDEWATER
carbon metabolism
nitrogen metabolism
$(CH_2O)_n$
Pelagibacter
Acidiphilium
Chemolithotrophy
Respiration
Acidisoma
Streptomyces
Nocardia
Bacillus
Corynebacterium
CO_2
Acetobacterium
Acetogenesis
Anaerobic respiration
and fermentation
Clostridium
Corynebacterium
Propionibacterium
Nitrification
Pseudomonas
Bacillus
Clostridium
NO_2^-
Hymenobacter
Polaribacter
Mycobacterium
Thermodesulfovibrio
N_2
NH_4^+
NO_3^-
Nitrogen fixation
Trichodesmium
Denitrification
Erythrobacter
Phototrophy
Salinibacterium
Janibacter
Roseospira
amino acid metabolism
lipid metabolism
nucleotide metabolism
Acidisoma
Propionibacterium
Pelagibacter
Polaribacter
Roseospira
Ferrimicrobium
Fe^{2+}
Fe^{3+}
Shewanella
Rhodoferax
Acidiphilium
Pseudomonas
Thermodesulfovibrio
Desulfofrigus
Azospirillum
Azorhizobium
SO_4^{2-}
S^0
H_2S
Paracoccus
Thermosulfurimonas
Gallionella
Sulfitobacter
Thiomonas
Thiomicrospira
Thioalkalimicrobium
iron metabolism
sulfur metabolism

Figure 13. Overview of the tentative interactions with the biogeochemical cycles in microorganisms from glaciers and tidewater samples. Microorganisms were identified by Illumina sequencing. Some key members of carbon, nitrogen, iron, and sulfur cycles in glacier (left) and tidewater samples (right). They are represented at the genus level.

In conclusion, the glaciers on the Northwest coast of Svalbard are undergoing a rapid change due to climate change. This effect is important in the coastal glaciers, but it is even more so in the interior glaciers. If the glaciers inland continue to melt, they will increasingly drag a greater amount of materials and sediments in their runoff waters. The consequence of this process will be the possible alteration of the water composition of the fiords. If this effect is maintained over time, the microbial populations of the coasts could be modified and they would be more similar to the current populations of the tidewater area close to inland glacier samples. This process can have serious consequences throughout the marine ecosystem and in the cycling of globally important elements.

Scientific missions from manned and unmanned flying research platforms (MICRAS and ELECTROBIOTA)

(Elena González Toril, Ángeles Aguilera Bazán and Susana Osuna Esteban)

MICRAS and ELECTROBIOTA are multidisciplinary projects 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. This allows us to optimize resources, because 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.

At this moment, the sampling of external air is carried out by means of an isokinetic probe which will be the first thing we developed. The isokinetic probe avoids accelerating and decelerating the air current in the inlet to ensure that the actual concentration of particles is being measured. This system is equipped with pressure and temperature devices as well as the mass flow. A Venturi tube or a Pitot-static system measures the volumetric flow. Finally, a system to drive the flow by means of a suitable aspirator is connected to the system. The whole set must have the highest degree of automation possible; to achieve an on-board system on a remotely piloted aerial platform that allows the automatic acquisition of biological samples. In addition to the above mentioned requirements, there is the asepsis requirement of the sampling system, which is fundamental for the collection of biological samples. Thus, the system must be able to be adequately sterilized to ensure that it has not been contaminated before or during sample collection,

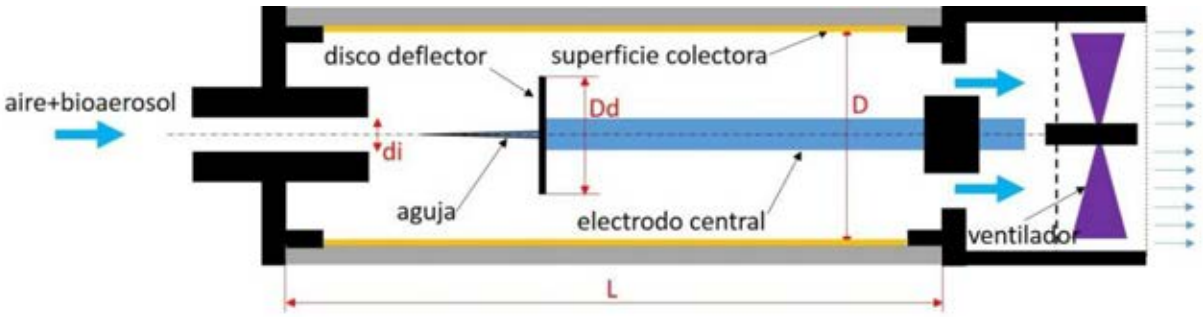


Figure 14. Preliminary design scheme of the biological electrostatic filter

Both projects present 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 projects are 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.

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.

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: i) salt and UV radiation in microorganisms that inhabit hypersaline environments, which are able to thrive in high salt concentrations and high doses of radiation; and ii) cold temperature in microorganisms from rhizosphere of Antarctic plants. Hypersaline and cold 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 three samples at different salinities from Santa Pola salterns (Alicante, Spain): CR30 (39.2% salinity), CCAB (30.4% salinity) and CO-71 (21.2% salinity). Three metagenomic libraries were constructed to search for genes involved in salt and UV resistance, total DNA extracted from those hypersaline environments (CO-71, 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, 9 fragments of environmental DNA (6 from CR30 and 3 from CCAB), and a total of 20 ORFs from archaea and bacteria have been identified and 7 of them are involved in UV resistance. All of them have been sequenced, and every gene from each fragment was cloned to determine which ones are directly involved in UV resistance. We found that the genes that are directly involve in UV resistance codify for a 30S ribosomal protein S10, codify for hypothetical protein. Most of them belong to the archaea Haloquadratum walsbyi and two to the bacterium Salinibacter ruber.

Study of adaptation mechanisms to salt changes in hyperhalophilic microbial communities using a metatranscriptomic approach.

The main goal of this study was to identify adaptation mechanisms to salt content variation in hypersaline microorganism communities. For this purpose, two different experiments were carried out using two brines collected from Santa Pola salterns (Alicante, Spain): i) CCAB brines (30.4% salt) were diluted to 25% salt with water; and ii) CO-71 brine (20% salt) was

concentrated to 30% salt. Total DNA and RNA (cDNA) of these samples were sequenced using Illumina® HiSeqTM (Sistemas Genómicos, Spain), the reads were aligned in contigs, and genes were predicted. Taxonomic assignation of metagenomic sequences derived from C071 and CCAB revealed members of both Archaea (C071: 30%; CCAB: 51%) and Bacteria (C071: 70%; CCAB: 49%) domains. Overall, there was a high proportion of sequences derived from members of the phyla Actinobacteria, Proteobacteria and Firmicutes. About the differential gene expression analysis by metatranscriptomics, in the salt concentration experiment, it was observed that genes from Archaea were significantly induced and genes from Bacteria were mainly repressed after the treatment. On the other hand, in the salt dilution experiment most of the induced genes belong to Archaea. In both experiments, we observed different adaptation mechanisms to salt variation, including genes related to transposases, defense mechanisms, intracellular trafficking, secretion and posttranscriptional modification and chaperones.

Effect of day/night cycles on hyperhalophilic microbial populations

The aim of this research is to understand the effect of day and night cycles in the physiology and interactions of different microorganisms in natural hypersaline environments. Therefore, six samples (three replicates from each sampling point) from a salt pond in Es Trenc salterns (Mallorca, Spain) were collected during the day and night. Total DNA and RNA (cDNA) have been sequenced, reads were aligned in contigs, and genes were predicted. Metagenomic data (DNA analysis) showed a taxonomic distribution highly diverse, with Euryarchaeota and Bacteroidetes as majority phylum in light and dark conditions, respectively. Besides, Haloquadratum (an archaea belonging to phylum Euryarchaeota) and Salinibacter (bacteria belonging to phylum Bacteroidetes) turn up as the most abundant genera in both situations. Focusing in the majority genera, metatranscriptomic data showed that Salinibacter seems to be more transcriptionally active during dark conditions. On the other hand, Haloquadratum is more active during ligh conditions. Further analysis of these data will determine the specific functions of the genes induced or repressed during the day and night

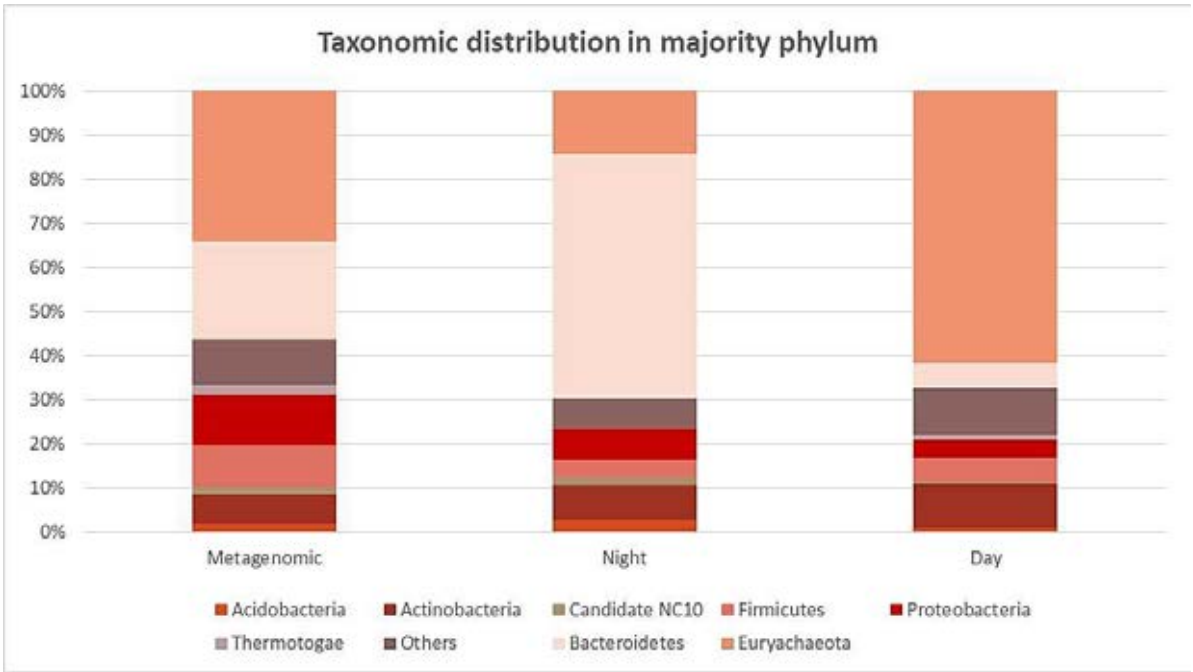


Figure 15. Taxonomic distribution of genes by phylum in the metagenome (A) and in the metatranscriptome during the day (B) and night (C) in natural populations of solar salterns.

Search of cold resistance genes from metagenomic libraries of rhizosphere microbial communities of Antarctic plants

The cold-sensitive strains of E. coli DH10B ΔcsdA was constructed to host metagenomic libraries from the rhizosphere of two Antarctic plants: Colobanthus quitensis (library C) and Deschampsia antarctica (library D). The gene csdA encodes for a DEAD-box RNA helicase that is essential for cold-acclimation. Its single mutation slows down the normal growth of E. coli at 15°C and allowed us to perform a screening for cold-resistance genes from both libraries. 3 x 106 clones from both libraries were evaluated at 15°C using the strain DH10B ΔcsdA as a host and as a result 13 clones from library C and 7 clones from library D were isolated and characterized. All of them have been sequenced and every gene from each fragment is being cloned to determine which ones are directly involved in cold resistance. Cold-resistance tests are being carried out in solid and liquid media under 15°C conditions to determine the ability of each DNA fragment to restore normal growth rate parameters in our cold-sensitive mutant.

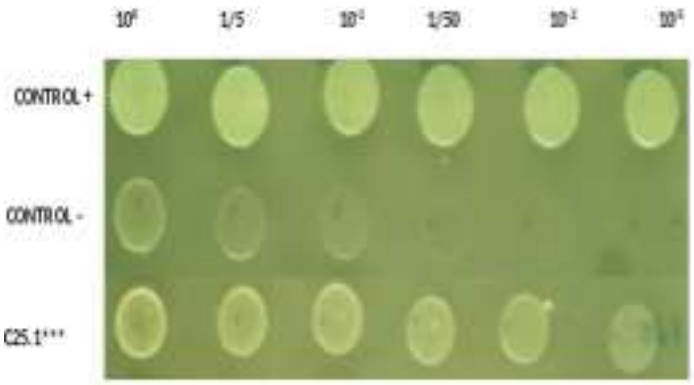


Figure 16. Example of a cold-resistance test where our cold-resistant clone (C25.1) is compared to a positive (DH10B strain) and a negative control (DH10B ΔcsdA) after 8 days growing at 15°C.

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

The bifunctional plasmid pAJ, previously demonstrated to drive the expression of a salt-modified green fluorescent protein (GFP) variant in two different hosts, Escherichia coli (mesophile) and Haloferax volcanii (hyperhalophile), was used to generate metagenomic libraries with DNA extracted from microbial communities of hypersaline environments (Es Trenc and Santa Pola salterns). These libraries are being screened to find genes conferring resistance to different abiotic stressors, including UV radiation, acidic pH and hyper oxidative stress, with the aim to discover molecular mechanisms involved in their adaptation.

Development of fluorescent hosts to search for genes involved in quorum quenching in metagenomic libraries using microfluidics

E. coli DH10B ΔrbsAR::cat_luxR_gfp strains were engineered with a chromosomally inserted cassette bearing a fluorescence gene that is repressed when cells are cultured in the presence of the quorum signalling molecule N-(3-Oxododecanoyl)-L-homoserine lactone. The mechanism of this repression is interrupted by lactonase-type quorum quenching molecules, thereby restoring fluorescence. In collaboration with the laboratories of José Berenguer and

Aurelio Hidalgo (CBM-Severo Ochoa, Madrid), we have demonstrated that this strain can be used in microfluidic sorting for the detection of quorum quenching genes. We are therefore now using this strain as a host for metagenomics =libraries isolated from Rio Tinto and rhizosphere of Antarctic plants and are screening them for quorum quenching genes using a microfluidics device that selects fluorescent droplets. One positive hit has so far been isolated from the Rio Tinto metagenomics library and the causal genetic insert is being analysed.

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 (4.300 m altitude) in Argentina, environments exposed to high UV-B doses of radiation. 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 third generation of two different constructions were tested for UV resistance. Preliminary results indicate that plants expressing a gene encoding a putative endonuclease (pML84-orf1) or a conserved hypothetical protein (pML6-orf1) are more resistant to UV radiation.

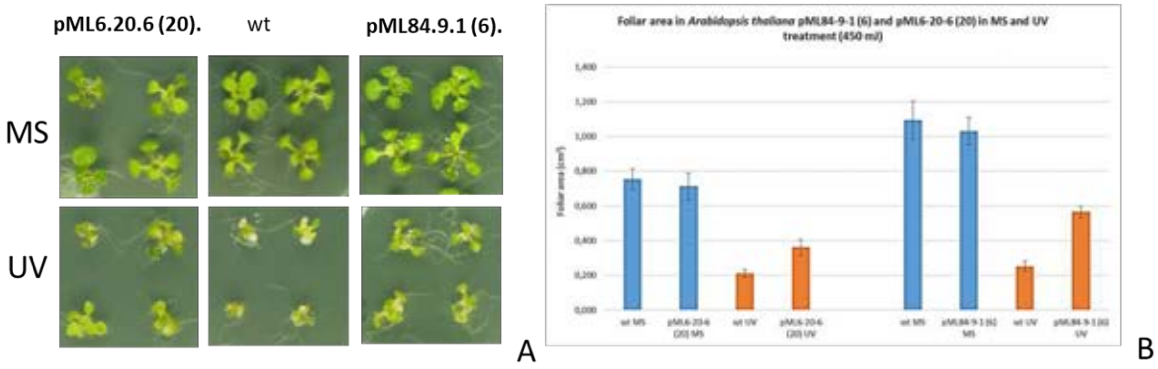


Figure 17. A) plants expressing selected genes have larger size and less chlorosis compared to wild type plants, one week after UV-C radiation exposure, B) the percentage of foliar area after exposure to UV is greater in the both lines of transgenic plants than in the wt plant.

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 analog environments to other 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:

- The study of the metabolic potential and conservation of biological information in changing extreme environments (salty deserts, icy deserts, arctic and Antarctic Permafrost, deep continental subsurface)
- Identification of molecular biomarkers in samples from extreme environments and development of methods for their detection in situ.
- 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
- Searching for opportunities of SOLID-LDChip for future planetary exploration missions

Exploring the metabolic potential of deep continental subsurface.

We reported for the first time viable cyanobacteria in the deep continental subsurface, 600 m deep in the Iberian Pyrite Belt in the Rio Tinto area (Huelva, Spain). Cyanobacteria are ecologically versatile microorganisms inhabiting most environments, ranging from marine systems to arid deserts. Although they possess several pathways for light-independent energy generation, until now their ecological range appeared to be restricted to environments with at least occasional exposure to sunlight. We showed immunological (LDChip), microscopic, and metagenomic evidences that cyanobacteria predominate in deep subsurface rock samples from the Iberian Pyrite Belt Mars analog (southwestern Spain). Metagenomics showed the potential for a hydrogen-based lithoautotrophic cyanobacterial metabolism. These cyanobacteria were related to surface rock-dwelling lineages known for their high tolerance to environmental and nutritional stress. We discuss how these adaptations allow cyanobacteria to thrive in the dark underground, a lifestyle that might trace back to their nonphotosynthetic ancestors. Collectively, our results suggest that they may play an important role as primary producers within the deep-Earth biosphere. Our description of this previously unknown ecological niche for cyanobacteria paves the way for models on their origin and evolution, as well as on their potential presence in current or primitive biospheres in other planetary bodies, and on the extant, primitive, and putative extraterrestrial biospheres.

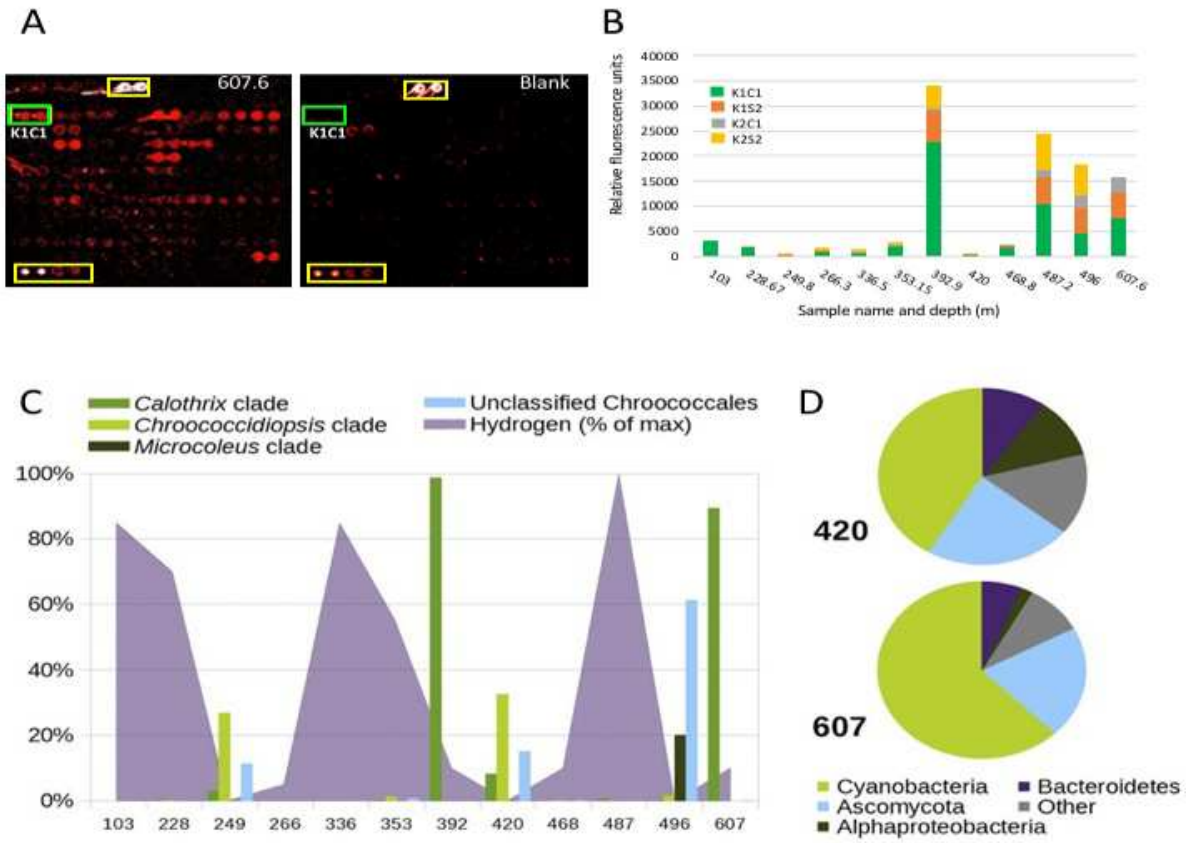


Figure 18. Detection of Cyanobacteria in the deep subsurface with LDChip and DNA sequencing. (A) Partial LDChip microarray image obtained with sample 607.6 and the corresponding blank section (right) showing fluorescence signal in the duplicated spots corresponding to antibody K1C1 against the type cyanobacterial strain Anabaena sp. PCC7120 (order Nostocales). (B) Chart showing the sum of the fluorescence intensities of the four anti-cyanobacteria antibodies present on the LDChip after assaying the different samples: K1C1 and K1S2 are antibodies against Anabaena cells and exopolymeric fraction, respectively, grown in the presence of nitrate; K2C1 and K2S2, are against Anabaena grown in the absence of nitrate, that is, under nitrogen fixation conditions. Yellow rectangles indicate fluorescent frame markers. Red spots correspond to positive immunodetections with the corresponding antibodies. (C) Relative abundance of different cyanobacterial clades based on 16S rRNA amplicons (bars) and hydrogen concentrations (purple area) across the borehole samples. Hydrogen concentrations are shown relative to the sample with the highest hydrogen concentration. The correlation with the H2(g) concentration is indicated. (D) Taxonomic composition of the metagenomic reads from samples 420 and 607

Microbial profiling of Antarctic nunataks with SOLID-LDChip as potential analogue of cold and wet early Mars.

Although the past presence of liquid water on Mars has been broadly evidenced, the climate that allowed water in the liquid state is still controversial. To help solving this problem, a 'Cold and Icy Early Mars' climate model has been proposed by some authors in which liquid water would have been supported by the presence of salts and a denser atmosphere. We have studied a potential Early Icy Mars analog environment: the Antarctic nunataks in Livingston Island, South Shetlands Islands (c. 62°39 S 60°26 W). A nunatak is an exposed rocky area within an ice field that is not covered with ice or snow during most of the year. In order to understand the adaptation and distribution of a hypothetical ancient Martian microbiota, we studied the composition and distribution of soil and endolithic prokaryotic communities at these areas. Soils and rocks were collected at two nunataks (MacGregor and Moores) in Livingston Island, with sampling points established following sun orientation,

altitudinal and depth gradients. Geochemical (ICP-MS, IC, IRMS), mineralogical (XRD, thin section microscopy) and microbiological approaches (LDChip, high throughput DNA sequencing, electron and fluorescence microscopy) were carried out for their study. Preliminary results showed a rich microbiology associated to the rocks and soils where nitrogen fixation seemed to be a critical process and where cyanobacteria were the main primary producers in an oligotrophic environment. Our LDChip reported a complex microbial community and biomarkers in agreement with DNA results and demonstrate once more that it is a suitable technique for rapid assessment in planetary exploration.

Maturing the SOLID-LDChip instrument in a drilling mission concept for life detection in planetary exploration.

We participated on the third field campaign of the ARADS (Atacama Rover Astrobiology Drilling Studies), a NASA ASTEP projects lead by NASA Ames Research Center. The objective was to set up SOLID instrument on the deck of a rover equipped with a drilling system and operate remotely. During the 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 remotely analyzed with SOLID, controlled through cable connections. In addition, all the samples were analyzed with LDChip following the manual system to decipher the microbial markers in the field. Microbial biomarker profiles down to 2 m depth were inferred, demonstrating that LDChip was able to detect microbial markers even in one of the driest places on Earth. Geochemical and metagenomic studies on samples obtained with the robotic drill confirmed and expanded the on-site SOLID-LDChip results, demonstrating the capability of this system for obtaining valuable scientific information from the subsurface of extreme saline and arid environments.

Investigating the microbial biomarkers in hydrothermal environments throughout space and time.

We participated, as co-Is of the NAI-CAN7 project, in a NASA-Ames/SETI institute field campaign in the High Andes (Chile). Samples were collected in the geothermal area of el Tatio as a terrestrial analogue of ancient hydrothermal environment on Mars. In addition, a new optical system for SOLID instrument was successfully tested and microbial markers were detected in drilled powder from extinct geysers with LDChip. Samples are currently being analyzed.

Profiling the molecular biomarkers in the subsurface (>100 m depth) of the Salar Grande (Atacama, Chile) evaporitic deposits

The Late Miocene–Pliocene aged hyperarid evaporitic system of Salar Grande is a unique, halite-rich sedimentary basin in the Cordillera de la Costa of the Central Andes (Chile) whose bio- sedimentary record is poorly understood. The persistence of hyperacidity over millions of years, the hypersalinity, and the intense UV radiation make it a terrestrial analogue to assess the potential presence of organic matter in the halite deposits found on Mars. We investigated the occurrence and distribution of biomolecules along a 100-m depth drill down to the 9 Ma old detrital deposits topped by **La Soledad Formation (ESF).** We have identified two well-defined mineralogical and geochemical units by X-ray diffractometry (XRD) and ion chromatography: a nearly pure halite down to 40 m, and a detrital one down to 100 m depth. One-dimensional GC–MS and two-dimensional GC 9 GC-TOF–MS gas chromatography–mass spectrometry techniques allowed us to detect a variety of lipidic

compounds (n-alkanes, n-alkanols, isoprenoids, steroids, and hopanoids), and a relative abundance of functionalized hydrocarbons (n-fatty acids or n-aldehydes), mostly in the upper halite. We also detected biopolymers and microbial markers by fluorescence sandwich-microarray immunoassays with LDChip. A dominant prokaryotic origin was associated with halophile bacteria and archaea, with minor contributions of lichens, macrophytes, or higher plants. The lipidic record was also imprinted by oxic (high pristane over phytane ratios) and saline (squalane, and mono-methyl n-alkanes) signatures. The vertical abundance and distribution of biomarkers in the Salar Grande was explained by a generalized effect of xeropreservation, combined with salt encapsulation in the upper halite deposits, or with protective organics-mineral interactions in the deeper detrital unit. The results contribute to the interpretation of terrestrial bio-sedimentary records of halite deposits and their association to environmental conditions. The high potential for preservation of biosignatures at Salar Grande suggests that similar evaporitic deposits in Mars should be priority targets for searching for signs of life.

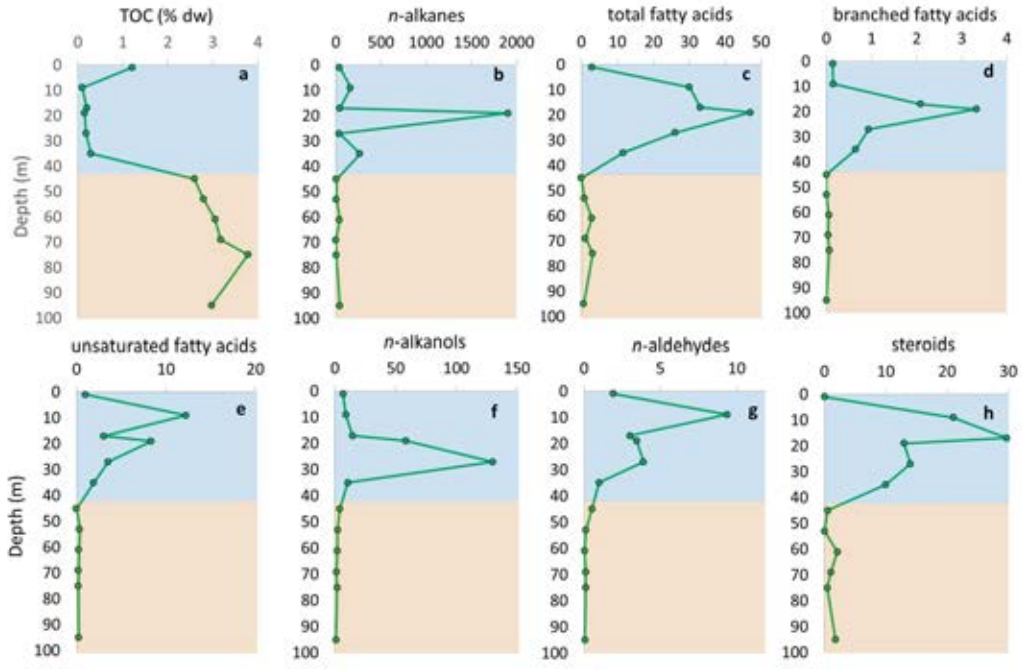


Figure 19. Total organic carbon (TOC, as % of dry weight) and lipids concentration and compositional distributions in the Salar Grande ESF drill profile (ug g-1 of TOC), where the halite and detrital units are represented by shaded blue and shaded orange areas respectively.

Implementation of SOLID-LDChip for detecting organic compounds in 140 My type IV kerogen as a carbonaceous chondrite Analogue.

Potential martian molecular targets include those supplied by meteoritic carbonaceous chondrites such as amino acids and polycyclic aromatic hydrocarbons and true biomarkers stemming from any hypothetical martian biota (organic architectures that can be directly related to once living organisms). Heat extraction and pyrolysis-based methods currently used in planetary exploration are highly aggressive and very often modify the target molecules making their identification a cumbersome task. We have developed and validated a mild, nondestructive, multiplex inhibitory microarray immunoassay and demonstrated its implementation in the SOLID (Signs of Life Detector) instrument for simultaneous detection of several nonvolatile life- and nonlife-derived organic molecules relevant in planetary exploration and environmental monitoring. By utilizing a set of highly specific antibodies that recognize D- or L- aromatic amino acids (Phe, Tyr, Trp), benzo[a]pyrene (B[a]P),

pentachlorophenol, and sulfone-containing aromatic compounds, respectively, the assay was validated in the SOLID instrument for the analysis of carbon-rich samples used as analogues of the organic material in carbonaceous chondrites or even Mars samples. Most of the antibodies enabled sensitivities at the 1-10 ppb level and some even at the ppt level. The multiplex immunoassay allowed the detection of B[a]P as well as aromatic sulfones in a water/methanol extract of an Early Cretaceous lignite sample (c.a., 140 Ma) representing type IV kerogen. No L- or D-aromatic amino acids were detected, reflecting the advanced diagenetic stage and the fossil nature of the sample. The results demonstrate the ability of the liquid extraction by ultrasonication and the versatility of the multiplex inhibitory immunoassays in the SOLID instrument to discriminate between organic matter derived from life and nonlife processes, an essential step toward life detection outside Earth.

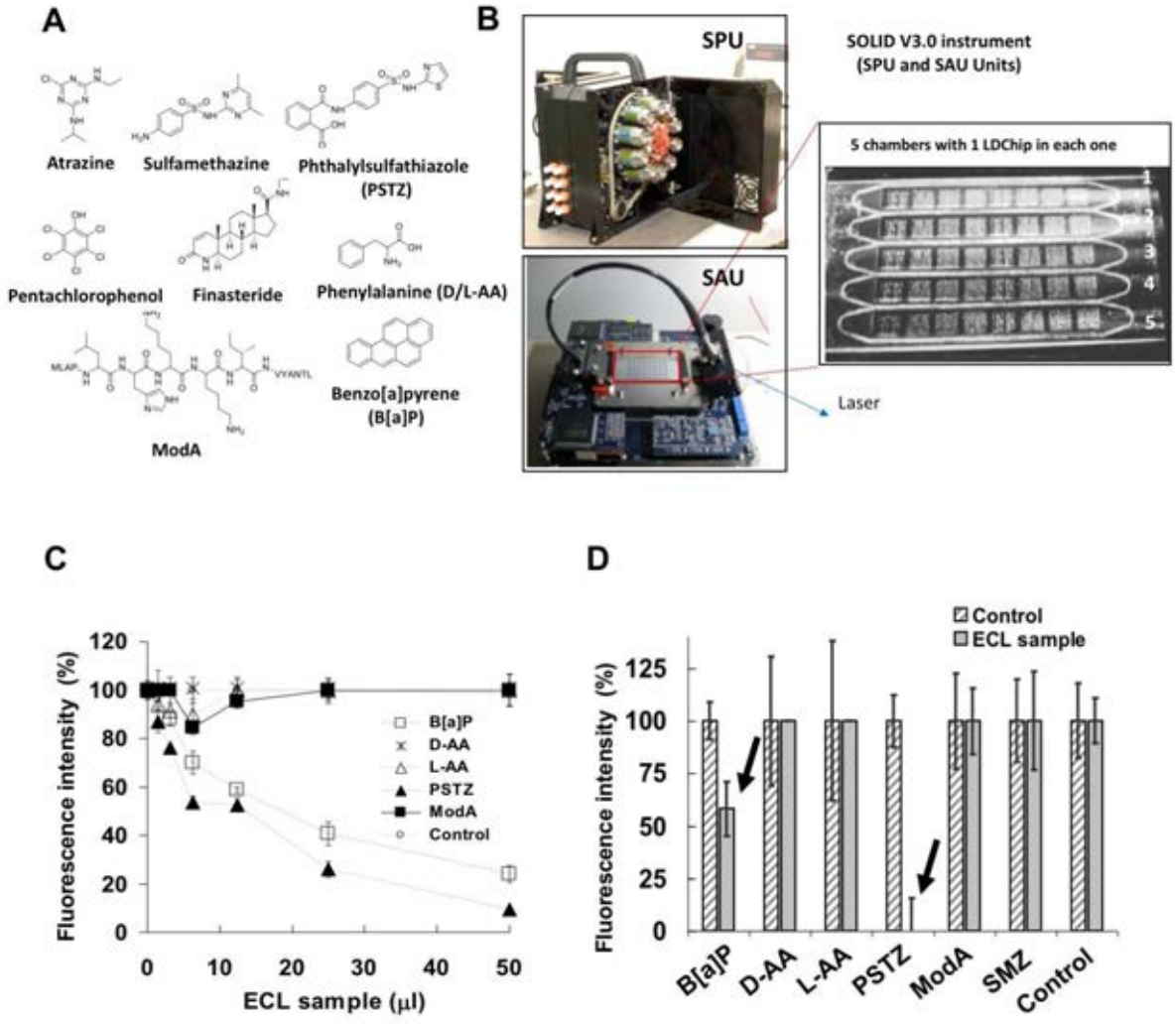


Figure 20. SOLID detected organic compounds in ancient kerogen sample by a multiplex fluorescent inhibitory immunoassay. A) the type of compounds to which antibodies were developed. B) SOLID sample preparation unit (SPU) for sample homogenization with te extraction cells, and sample analysis unit (SAU) for immunoassay with LDChip, with 5 chambers. C) calibrating the extract from kerogen in a parallel immunoassay using different amounts of extract. D) Detection of Benzopyrene and PSTZ-like compounds in 140 My kerogen samples using the whole SOLID system.

Investigating Effects of Gamma and Electron Radiations on the Structural Integrity of Organic Molecules and Macromolecular Biomarkers.

High-energy ionizing radiation in the form of solar energetic particles and galactic cosmic rays is pervasive on the surface of planetary bodies with thin atmospheres or in space facilities for humans, and it may seriously affect the chemistry and the structure of organic and biological material. We used fluorescent microarray immunoassays to assess how different doses of electron and gamma radiations affect the stability of target compounds such as biological polymers and small molecules (haptens) conjugated to large proteins. The radiation effect was monitored by measuring the loss in the immunoidentification of the target due to an impaired ability of the antibodies for binding their corresponding irradiated and damaged epitopes (the part of the target molecule to which antibodies bind). Exposure to electron radiation alone was more damaging at low doses (1 kGy) than exposure to gamma radiation alone, but this effect was reversed at the highest radiation dose (500 kGy). Differences in the dose-effect immunoidentification patterns suggested that it was the amount (dose) and not the type of radiation the main factor for the cumulative damage on the majority of the assayed molecules. Molecules irradiated with both types of radiation showed a response similar to that of the individual treatments at increasing radiation doses, although the pattern obtained with electrons-only was the most similar. The calculated radiolysis constant did not show a unique pattern, it rather suggested a different behavior perhaps associated with the unique structure of each molecule. Our results may contribute to understand the effects of ionizing radiation on complex molecules and the search for biomarkers through bioaffinity-based systems in planetary exploration

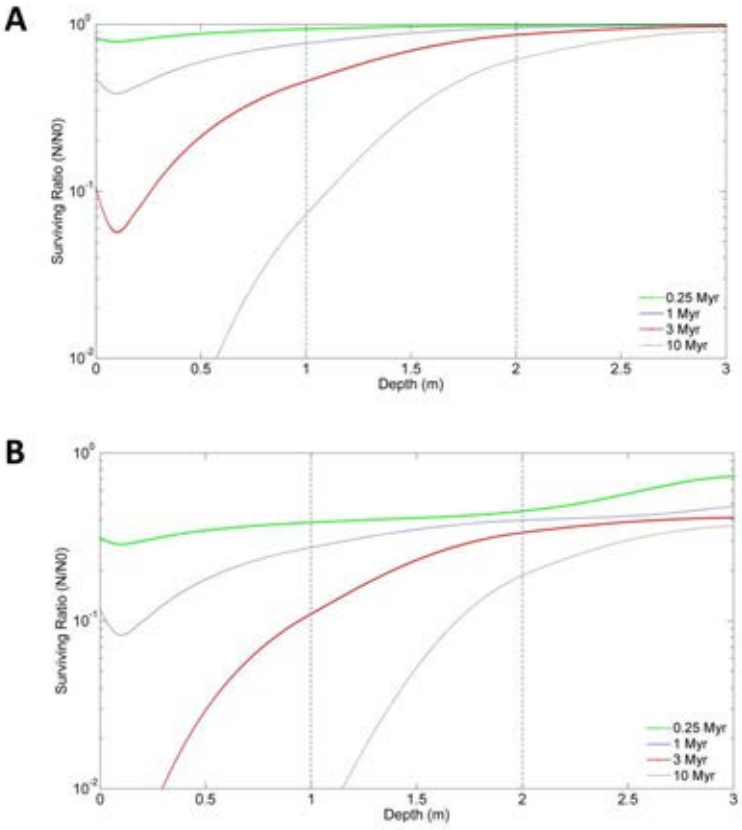


Figure 21. Depth-dependent surviving fraction (N/N0) of the irradiated polymeric compounds, simulated by a linear model, after being exposed to 0.25 (green), 1 (blue), 3 (red), and 10 Myr (gray) to the ionizing radiation in the Martian subsurface at the MSL landing site.

Department of Advanced Instrumentation

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 2018 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 1 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 2018 were:

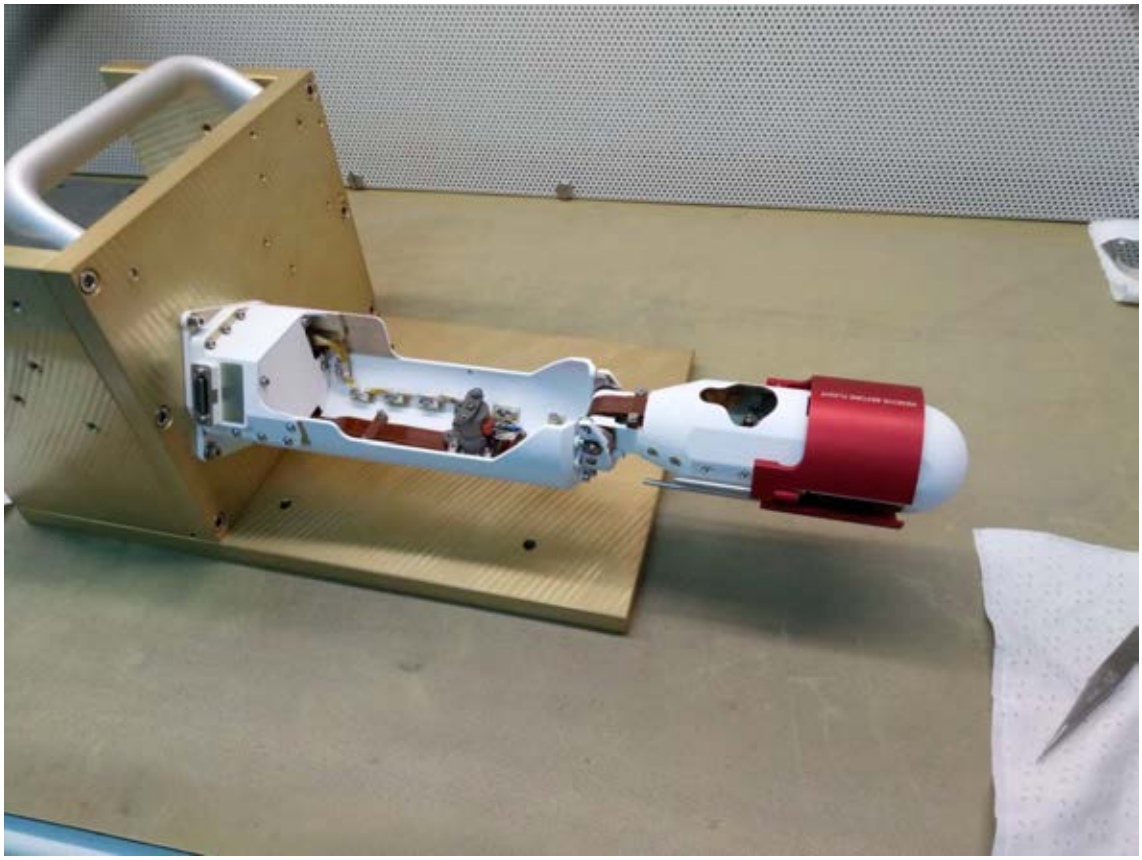
Instrumentation for space missions: MEDA.

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 at 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. Additionally, 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).

Throughout the year 2018 the international team faced phase D of the development, focusing on the manufacturing activities of the flight models, the associated acceptance environmental tests and the calibration campaigns of each of the sensors. In parallel with these activities, the qualification and technological validation campaigns have continued. The IDR (Instrument Delivery Review) was successfully held in November finishing with the delivered of the flight models of the ATS, TIRS, PS, and HS, as well as the ICU (the Instrument Control Unit).

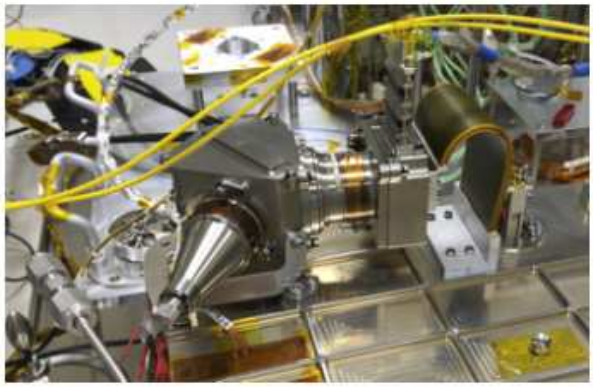


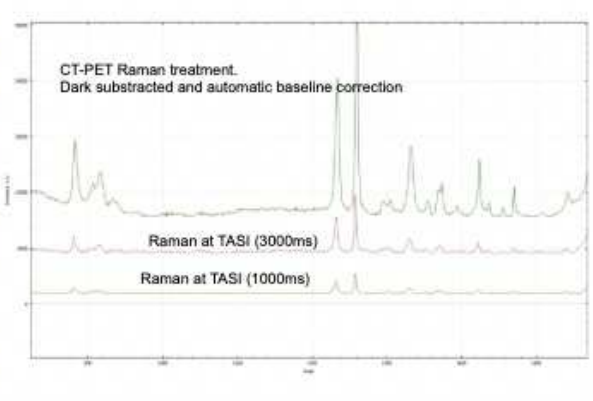
Different flight models of MEDA sensors. (Top) WS2 (Wind Sensor 2), (bottom-left) ATS (Air Temperature Sensor), (bottom-right) TIRS (Thermal InfraRed Sensor)

Instrumentation for space missions: RLS.

The year 2018 was a very intense year for the RLS team at INTA:

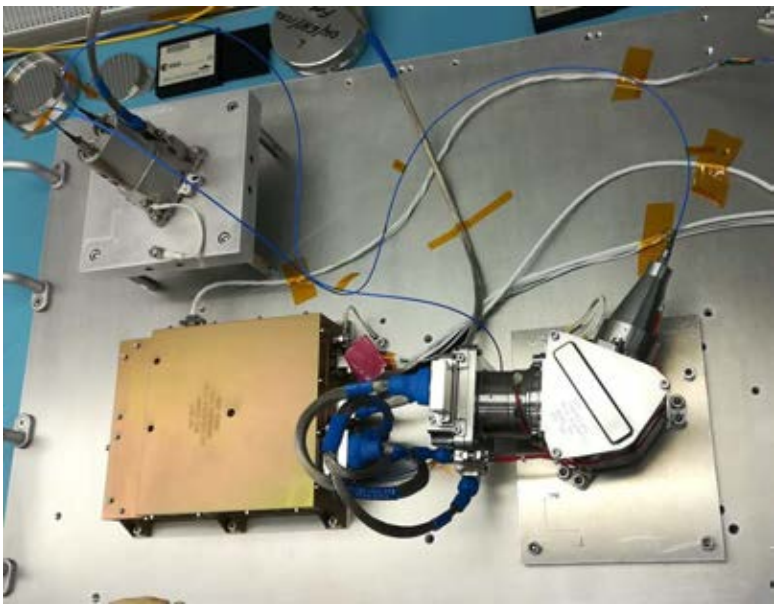
Throughout the first half of the year, the team carried out very actively the integration and verification of the instrument's engineering and qualification model (EQM), which was delivered to ESA' prime contractor (Thales Alenia Space Italia) by the end of 2017. Also, the team took part on the different validation campaigns, specially on the End-to-End verification campaign that involved all the systems from the sample preparation task to delivery to the instruments within the ALD (Analytical Laboratory Drawer), as well as involving the emerging collaborative science.





RLS EQM integrated in the ALD

Also, over those first months of 2018, the team manufactured, integrated and performed the acceptance tests of the flight model unit (FM) (i.e. the Spectrometer Unit (SPU), the Internal Optical Head (iOH), and the laser), in addition to the fine tuning of other flight elements (electrical and optical harnesses -EH and OH-, and the flight Application Software -ASW-). These activities ended with the reception of the electronics unit in November, and the final verification at system level in representative conditions, as the final step prior to deliver the instrument in December.



Verification of RLS FM at INTA.

Other important activities to remark were the development and delivery to ESA of the Electrical Interface Simulator (EIS), and the Software Interface Simulator (SWIS). Both allowed the ALD and Rover to simulate the RLS operational behavior, prior to be integrated.

The team also took part on the ESA ExoFit field campaign that took place in Almeria, in the fall of 2018, where the Mission Project simulated the future Rover operation. With that purpose, the team provided and operated the EQM unit, in-situ analyzing the samples that the Rover's drill got.

ESA ExoFit field campaign, in Tabernas (Almería)

Instrumentation for space missions: TWINS.

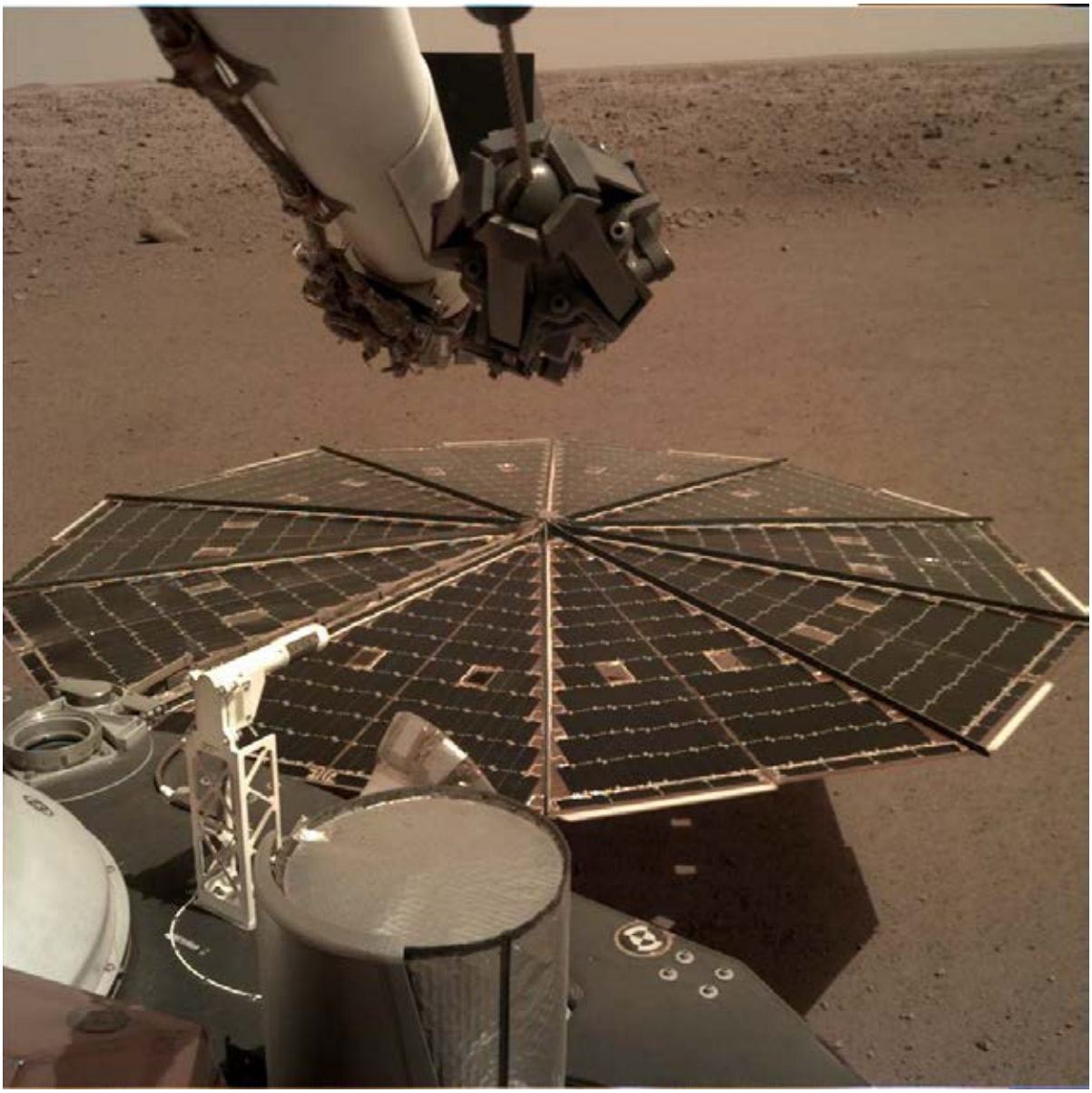
The Department of Instrumentation of the CAB is responsible of the TWINS (Temperatures and Winds for InSight), an instrument dedicated to environmental characterization of the Martian atmosphere. TWINS is part the mission InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) of NASA, for the characterization of the interior of the planet Mars through a lander.

The TWINS flight hardware was developed for the REMS instrument in the framework of the Mars Science Laboratory mission, also from NASA. With respect its predecessor. TWINS has undergone some remodeling and adjustments in order to adapt the instrument to the specific needs and limitations of InSight.

Act of presentation of the InSight-TWINS landing in the auditorium of the CAB

In May of 2018 the mission was launched, reaching the surface of Mars in the month of November of that same year. During the cruise to Mars the project team has given support to check-out activities. Since its landing, TWINS has been played a role of vital importance for the scientific return of the mission. In the first suns (name given to the Martian day) TWINS scientific and technical staffs were working in the instrument commissioning phase and then in the characterization the local environment, determining the precise moment in which wind conditions were calm for the safe deployment of the instruments located on InSight lander platform.

The scientific data provided by TWINS will allow discarding false seismic readings caused by the strong winds of the environment. Also, 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.



InSight Lander platform during Martian operations. In the image you can see one of TWINS booms.

Instrumentation for space missions: REMS.

During 2018, 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 36 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.

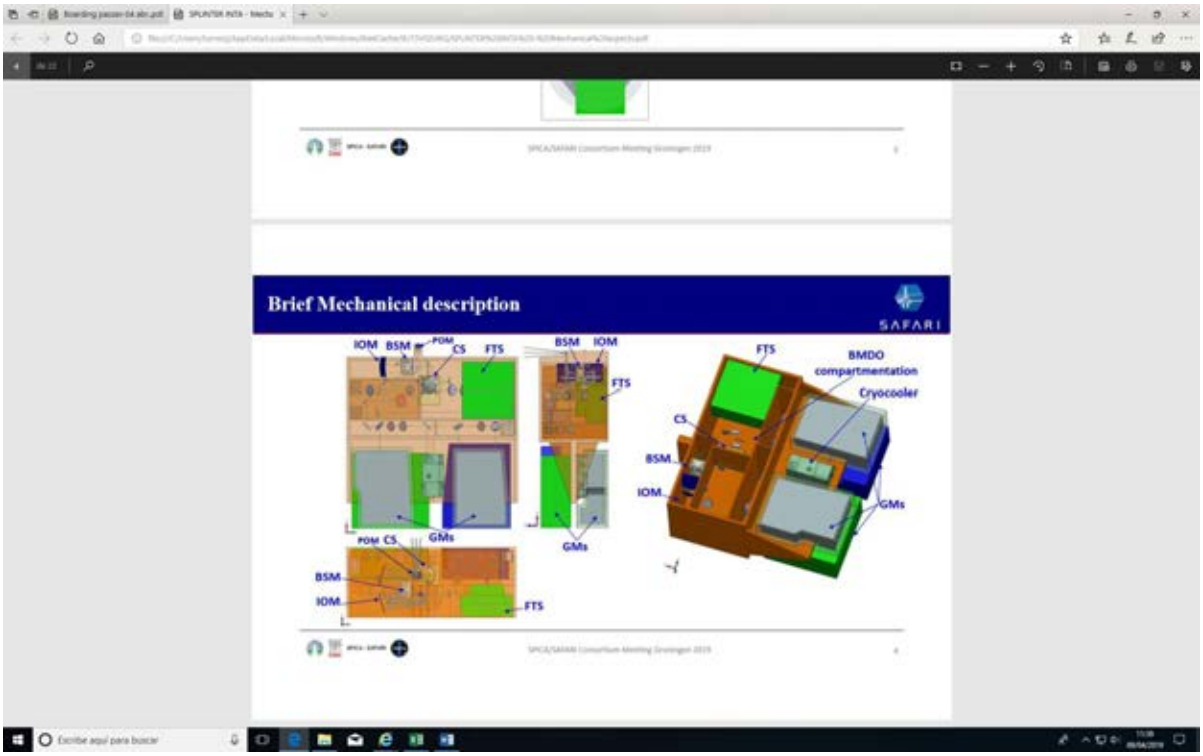
Photo of the REMS boom 2 and UV sensor taken by one of the Curiosity cameras during July 2018 Martian global dust storm.

Technological developments of the SAFARI / SPICA project.

The Space Instrumentation Group has continued its contribution to the technological development of the SAFARI instrument.

Spain is the lead mechanical and optical responsible for the Safari Instrument, during the past year the design has consolidated in order to have a good reference design in 2020 for M5 selection. During the year 2018, the opto-mechanical reference design for the FPU (Focal Plane Unit) was changed in order to improve its modularity and competitiveness. The new design incorporates a FTSM (Fourier Transform Spectrometer Mechanism) and four grating-based point source spectrometer working in the 34-230 m 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 fit within the mass and volume budget.



Design of the SAFARI focal plane unit SAFARI

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 2018, we have realized the first test with moss and algae from a lagoon of glacial origin, preparing it for samples of cyanobacteria from Antarctica. We have recreated the hydrological water cycle inside a vacuum chamber for to facilitate the emergence of biological sample.

Images of the WLOM set-up inside MARTE chamber

Scientific Culture Unit

Scientific Culture Unit (UCC)

The UCC is responsible for the dissemination of scientific advances in the field of astrobiology. It does so by optimizing the existing internal and external communication channels, as well as enabling an effective interaction between the CAB´s Research Community and the general public. First, the UCC develops a Communication Plan consisting of the drafting and publication of press releases, the relationship with mass media (press, radio and television), the participation in social networks and collaboration with scientific outreach magazines, such as AstronomiA magazine. Second, it develops an Annual Disclosure Activities Plan. The most relevant activities carried out during the year 2018.

- Production of press releases and other materials. 29 press releases.
- Attention to the mass media. 180 media impacts.
- Curation of CAB website contents.
- Social networks maintenance.
  - Twitter: 5688 (22/10)
  - Facebook: 3238 (followers) – 3101 (likes)
  - YouTube channel: 328 (subscriptors)
- Attention to schools and public visits to CAB. 2470 visitors.
- Planning and conducting outreach activities, talks, courses and workshops. 75 activities, 3200 attendants from general public.
- Participation in education & public outreach events:
  - Madrid Science Week (Semana de la ciencia). 250 visitors.
  - Madrid Scientific Weekend (Finde Científico). 10,000 visitors.
  - European Researchers' Night (Noche Europea de los investigadores). 75 visitors.
  - Pint of Science Spain.
  - "City Science" Project (Ciudad Ciencia). More than 500 students.
  - "Science in the Neighborhood" Project (Ciencia en el Barrio). 200 students.
- Organization and support for scientific, social or outreach events in the CAB.
- Support to other outreach projects:
  - The Martian Potato. A Space Cooking Contest.
  - Culture with the C of Cosmos C3. Astronomy & Art as part of our Cultural Heritage. More than 50 activities.
- Active participation in the FECYT's Network of Scientific Culture and Innovation Units (FECYT is the Spanish Foundation for Science & Technology).

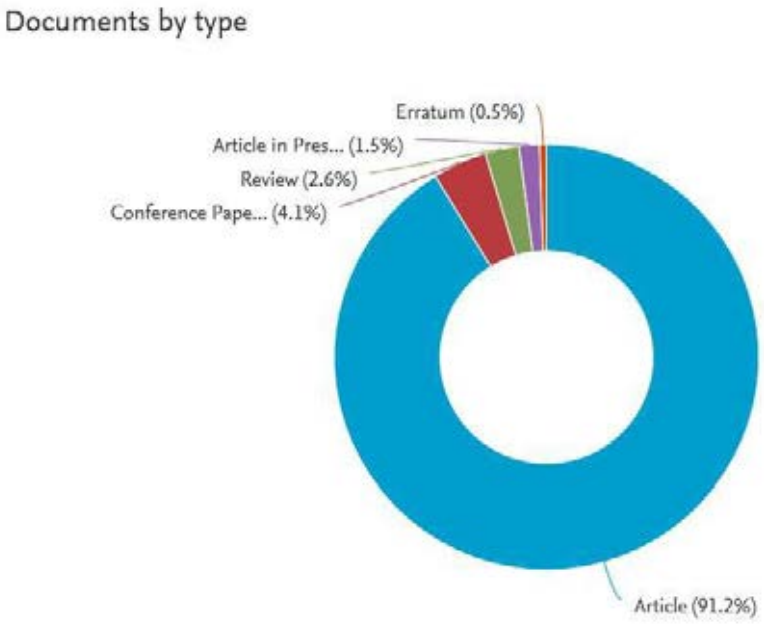
Publications and Scientific Production

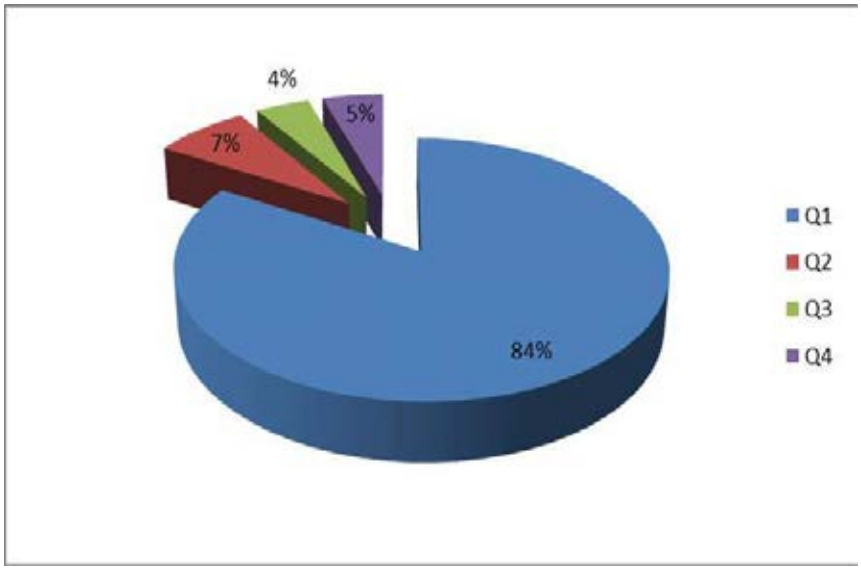
Scientific Production

RESUMEN PUBLICACIONES 2018 (SCOPUS)

Año	Papers	Primer autor
2013	200	76
2014	195	71
2015	217	56
2016	204	48
2017	***183***	***34***
2018	***194***	***45***

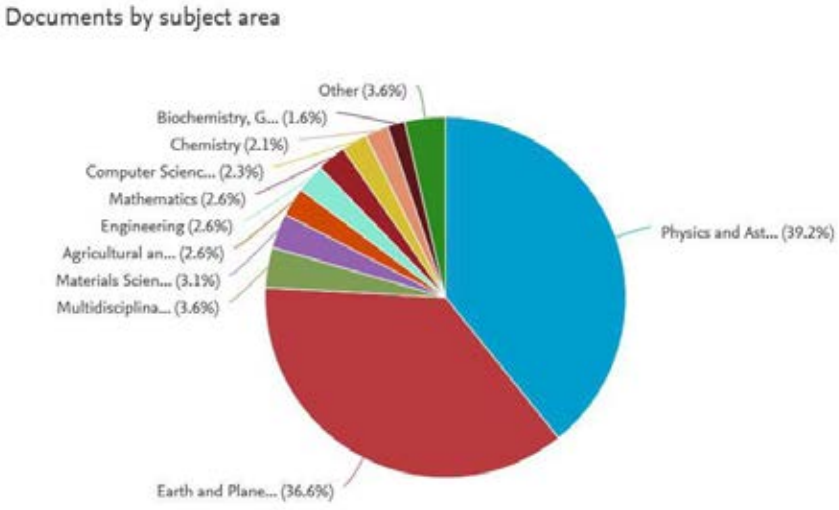
TIPO DE CONTRIBUCIÓN	ARTÍCULOS
Article	177
Conference Paper	8
Article in Press	3
Review	5
Erratum	1
Letter	1





DISTRIBUCIÓN POR MATERIAS

MATERIA	ARTÍCULOS
Physics and Astronomy	151
Earth and Planetary Sciences	141
Multidisciplinary	14
Materials Science	12
Agricultural and Biological Sciences	10
Engineering	10
Computer Science	9
Mathematics	9
Chemistry	8
Biochemistry, Genetics and Molecular Biology	6
Environmental Science	5
Immunology and Microbiology	5
Medicine	3
Chemical Engineering	1



DISTRIBUCIÓN POR REVISTAS

REVISTA	ARTÍCULOS	Q
Astronomy And Astrophysics	69	Q1
Monthly Notices Of The Royal Astronomical Society	28	Q1
Astrophysical Journal	9	Q1
Astrobiology	5	Q1
Scientific Reports	5	Q1
Science	5	Q1
Astronomical Journal	3	Q1
Nature Astronomy	3	Q1
Physical Chemistry Chemical Physics	3	Q1
Astrophysical Journal Letters	2	Q1
Biogeochemistry	2	Q1
Frontiers In Microbiology	2	Q1
Journal Of Cosmology And Astroparticle Physics	2	Q1
Proceedings Of The National Academy Of Sciences Of The United States Of America	2	Q1
Aquatic Toxicology	1	Q1
Astrophysical Journal Supplement Series	1	Q1
Catalysts	1	Q1
Chemical Science	1	Q1
Ecological Engineering	1	Q1
Geophysical Research Letters	1	Q1
Geosciences Switzerland	1	Q1
Heliyon	1	Q1
Journal Of Geophysical Research Biogeosciences	1	Q1
Life	1	Q1
Measurement Journal Of The International Measurement Confederation	1	Q1
Mineralium Deposita	1	Q1
Monthly Notices Of The Royal Astronomical Society Letters	1	Q1
Nature	1	Q1
Plos One	1	Q1
Spectrochimica Acta Part A Molecular And Biomolecular Spectroscopy	1	Q1
Trac Trends In Analytical Chemistry	1	Q1
Icarus	4	Q2
Experimental Astronomy	2	Q2
International Journal Of Astrobiology	2	Q2
Meteoritics And Planetary Science	2	Q2
International Journal Of Speleology	1	Q2
Planetary And Space Science	1	Q2
Publications Of The Astronomical Society Of Australia	1	Q2
Rapid Communications In Mass Spectrometry	1	Q2
Journal Of Low Temperature Physics	3	Q3
Astronomische Nachrichten	1	Q3
Canadian Journal Of Microbiology	1	Q3
FEMS Microbiology Letters	1	Q3
Genome Announcements	1	Q3
International Microbiology	1	Q3
Proceedings Of SPIE The International Society For Optical Engineering	9	Q4
Galaxies	2	

Scientific Production

Articles

1. **Adrian, D. R., King, D. T., Jaret, S. J., Ormö, J., Petruny, L. W., Hagerty, J. J., & Gaither, T. A. (2018). Sedimentological and petrographic analysis of drill core FC77-1 from the flank of the central uplift, flynn creek impact structure, tennessee. Meteoritics and Planetary Science, 53(4), 857-873. doi: 10.1111/maps.12862**

2. **Agís-González, B., Hutsemékers, D., & Miniutti, G. (2018). A changing-look AGN to be probed by X-ray polarimetry.** *Galaxies, 6* **(2) doi:10.3390/galaxies6020052**

3. **Alfonso-Garzón, J., Sánchez-Fernández, C., Charles, P. A., Mas-Hesse, J. M., Gandhi, P., Kimura, M., . . . Chenevez, J. (2018). Optical/X-ray correlations during the V404 cygni june 2015 outburst.** *Astronomy and Astrophysics, 620* **doi:10.1051/0004-6361/201834102**

4. **Aller, A., Lillo-Box, J., Vu kovi , M., Van Winckel, H., Jones, D., Montesinos, B., . . . Miranda, L. F. (2018). A new look inside planetary nebula LoTr 5: A long-period binary with hints of a possible third component.** *Monthly Notices of the Royal Astronomical Society, 476* **(1), 1140-1150. doi:10.1093/MNRAS/STY174**

5. **Alonso-Albi, T., Riviere-Marichalar, P., Fuente, A., Pacheco-Vázquez, S., Montesinos, B., Bachiller, R., & Treviño-Morales, S. P. (2018). Revisiting the case of R monocerotis: Is CO removed at R < 20 au?** *Astronomy and Astrophysics, 617* **doi:10.1051/0004-6361/201731658**

6. **Alonso-Herrero, A., Pereira-Santaella, M., García-Burillo, S., Davies, R. I., Combes, F., Asmus, D., . . . Ward, M. J. (2018). Resolving the nuclear obscuring disk in the compton-thick seyfert galaxy NGC 5643 with ALMA.** *Astrophysical Journal, 859* **(2) doi:10.3847/1538-4357/aabe30**

7. **Alvarado-Gómez, J. D., Hussain, G. A. J., Drake, J. J., Donati, J. -., Sanz-Forcada, J., Stelzer, B., . . . Oksala, M. E. (2018). Far beyond the sun - I. the beating magnetic heart in horologium.** *Monthly Notices of the Royal Astronomical Society, 473* **(4), 4326-4338. doi:10.1093/MNRAS/STX2642**

8. **Aramendia, J., Gomez-Nubla, L., Castro, K., Fdez-Ortiz de Vallejuelo, S., Arana, G., Maguregui, M., . . . Madariaga, J. M. (2018). Overview of the techniques used for the study of non-terrestrial bodies: Proposition of novel non-destructive methodology.** *TrAC - Trends in Analytical Chemistry, 98* **, 36-46. doi: 10.1016/j.trac.2017.10.018**

9. **Arrazola, D., Fernández, M., González Fernández, L. M., Belenguer, T., Jellema, W., Rafael, G., . . . Roelfsema, P. (2018). The optical design of a far infrared spectrometer for SPICA: Grating modules evaluation. Paper presented at the** *Proceedings of SPIE - the International Society for Optical Engineering, , 10708* **doi:10.1117/12.2315971 Retrieved from**

10. **Attree, N., Groussin, O., Jorda, L., Nébouy, D., Thomas, N., Brouet, Y., . . . Shi, X. (2018). Corrigendum: Tensile strength of 67P/Churyumov-gerasimenko nucleus material from overhangs (astronomy and astrophysics (2018) 611 (A33) DOI: 10.1051/0004-6361/201732155).** *Astronomy and Astrophysics, 614* **doi:10.1051/0004-6361/201732155e**

11. **Attree, N., Groussin, O., Jorda, L., Nébouy, D., Thomas, N., Brouet, Y., . . . Shi, X. (2018). Tensile strength of 67P/Churyumov-gerasimenko nucleus material from overhangs.** *Astronomy and Astrophysics, 611* **doi:10.1051/0004-6361/201732155**

12. **Auger, A. -., Groussin, O., Jorda, L., El-Maarry, M. R., Bouley, S., Séjourné, A., . . . Wenzel, K. -. (2018). Meter-scale thermal contraction crack polygons on the nucleus of comet 67P/Churyumov-gerasimenko.** *Icarus, 301* **, 173-188. doi:10.1016/j.icarus.2017.09.037**

13. **Azua-Bustos, A., Fairén, A. G., González-Silva, C., Ascaso, C., Carrizo, D., Fernández-Martínez, M. Á., . . . Parro, V. (2018). Unprecedented rains decimate surface microbial communities in the hyperarid core of the atacama desert.** *Scientific Reports, 8* **(1) doi:10.1038/s41598-018-35051-w**

14. **Babusiaux, C., Van Leeuwen, F., Barstow, M. A., Jordi, C., Vallenari, A., Bossini, D., . . . Zwitter, T. (2018). Observational hertzsprung-russell diagrams.** *Astronomy and Astrophysics, 616* **doi: 10.1051/0004-6361/201832843**

15. **Báez-Rubio, A., Jiménez-Serra, I., Martin-Pintado, J., Zhang, Q., & Curiel, S. (2018). On the nature of orion source i.** *Astrophysical Journal, 853* **(1) doi:10.3847/1538-4357/aaa24b**

16. **Báez-Rubio, A., Martin-Pintado, J., Rico-Villas, F., & Jiménez-Serra, I. (2018). Evidence for the first extragalactic hydrogen recombination line maser in NGC 253.** *Astrophysical Journal Letters, 867* **(1) doi:10.3847/2041-8213/aae825**

17. **Barceló Forteza, S., Roca Cortés, T., & García, R. A. (2018). The envelope of the power spectra of over a thousand scuti stars: The teff- maxscaling relation.** *Astronomy and Astrophysics, 614* **doi: 10.1051/0004-6361/201731803**

18. **Baroch, D., Morales, J. C., Ribas, I., Tal-Or, L., Zechmeister, M., Reiners, A., . . . Seifert, W. (2018). The CARMENES search for exoplanets around M dwarfs: Nine new double-line spectroscopic binary stars.** *Astronomy and Astrophysics, 619* **doi:10.1051/0004-6361/201833440**

19. **Barrado, D., De Gregorio Monsalvo, I., Huélamo, N., Morales-Calderón, M., Bayo, A., Palau, A., . . . Noriega-Crespo, A. (2018). Early phases in the stellar and substellar formation and evolution: Infrared and submillimeter data in the barnard 30 dark cloud.** *Astronomy and Astrophysics, 612* **doi: 10.1051/0004-6361/201527938**

20. **Barret, D., Lam Trong, T., Den Herder, J. -., Piro, L., Cappi, M., Houvelin, J., . . . Natalucci, L. (2018). The ATHENA X-ray integral field unit (X-IFU).** *Proceedings of SPIE - the International Society for Optical Engineering, 10699* **doi:10.1117/12.2312409**

21. **Beblo-Vranesevic, K., Bohmeier, M., Perras, A. K., Schwendner, P., Rabbow, E., Moissl-Eichinger, C., . . . Rettberg, P. (2018). Lack of correlation of desiccation and radiation tolerance in microorganisms from diverse extreme environments tested under anoxic conditions.** *FEMS Microbiology Letters, 365* **(6) doi:10.1093/femsle/fny044**

22. **Berlanas, S. R., Herrero, A., Comerón, F., Simón-Díaz, S., Cerviño, M., & Pasquali, A. (2018). Oxygen and silicon abundances in cygnus OB2: Chemical homogeneity in a sample of OB slow rotators.** *Astronomy and Astrophysics, 620* **doi:10.1051/0004-6361/201833989**

23. **Bishop, J. L., Fairén, A. G., Michalski, J. R., Gago-Duport, L., Baker, L. L., Velbel, M. A., . . . Rampe, E. B. (2018). Surface clay formation during short-term warmer and wetter conditions on a largely cold ancient mars.** *Nature Astronomy, 2* **(3), 206-213. doi:10.1038/s41550-017-0377-9**

24. **Blanco, Y., De Diego-Castilla, G., Viúdez-Moreiras, D., Cavalcante-Silva, E., Rodríguez-Manfredi, J. A., Davila, A. F., . . . Parro, V. (2018). Effects of gamma and electron radiation on the structural integrity of organic molecules and macromolecular biomarkers measured by microarray immunoassays and their astrobiological implications.** *Astrobiology, 18* **(12), 1497-1516. doi:10.1089/ast.2016.1645**

25. **Bourrier, V., Lecavelier Des Etangs, A., Ehrenreich, D., Sanz-Forcada, J., Allart, R., Ballester, G. E., . . . Wakeford, H. R. (2018). Hubble PanCET: An extended upper atmosphere of neutral hydrogen around the warm neptune GJ 3470b.** *Astronomy and Astrophysics, 620* **doi:10.1051/0004-6361/201833675**

26. **Bouvier, J., Barrado, D., Moraux, E., Stauffer, J., Rebull, L., Hillenbrand, L., . . . Morales Calderón, M. (2018). The lithium-rotation connection in the 125 myr-old pleiades cluster.** *Astronomy and Astrophysics, 613* **doi:10.1051/0004-6361/201731881**

27. **Brauneck, U., Gallego, J., Cardiel, N., Cabello, C., Guzmán, R., Rodríguez-Espinosa, J. M., . . . Marín-Franch, A. (2018). First results using a new near-infrared 1% narrow-band filter in the GTC 10.4m telescope to detect galaxies at the dawn of the universe. Paper presented at the** *Proceedings of SPIE - the International Society for Optical Engineering, , 10702* **doi:10.1117/12.2303803 Retrieved from**

28. **Bravi, L., Zari, E., Sacco, G. G., Randich, S., Jeffries, R. D., Jackson, R. J., . . . Zaggia, S. (2018). The GAIA-ESO survey: A kinematical and dynamical study of four young open clusters.** *Astronomy and Astrophysics, 615* **doi:10.1051/0004-6361/201832645**

29. **Bridge, J. S., Hayes, M., Melinder, J., Östlin, G., Gronwall, C., Ciardullo, R., . . . Pardy, S. A. (2018). The ly reference sample. VIII. characterizing ly scattering in nearby galaxies.** *Astrophysical Journal, 852* **(1) doi:10.3847/1538-4357/aa9932**

30. **Brown, A. G. A., Vallenari, A., Prusti, T., De Bruijne, J. H. J., Babusiaux, C., Bailer-Jones, C. A. L., . . . Zwitter, T. (2018). Summary of the contents and survey properties.** *Astronomy and Astrophysics, 616* **doi: 10.1051/0004-6361/201833051**

31. **Buisson, D. J. K., Lohfink, A. M., Alston, W. N., Cackett, E. M., Chiang, C. -., Dauser, T., . . . Wilkins, D. R. (2018). Is there a UV/X-ray connection in IRAS 13224-3809?** *Monthly Notices of the Royal Astronomical Society, 475* **(2), 2306-2313. doi:10.1093/mnras/sty008**

32. **Bujarrabal, V., Castro-Carrizo, A., Winckel, H. V., Alcolea, J., Sánchez Contreras, C., Santander-García, M., & Hillen, M. (2018). High-resolution observations of IRAS 08544-4431: Detection of a disk orbiting a post-AGB star and of a slow disk wind.** *Astronomy and Astrophysics, 614* **doi:10.1051/0004-6361/201732422**

33. **Caballero, J. A. (2018). A review on substellar objects below the deuterium burning mass limit: Planets, brown dwarfs or what?** *Geosciences (Switzerland), 8* **(10) doi:10.3390/geosciences8100362**

34. **Caballero, J. A., Novalbos, I., Tobal, T., & Miret, F. X. (2018). Wide orionis binaries resolved by UKIDSS.** *Astronomische Nachrichten, 339* **(1), 60-71. doi:10.1002/asna.201713314**

35. **Carrasco, E., Gil De Paz, A., Gallego, J., Iglesias-Páramo, J., Cedazo, R., García Vargas, M. L., . . . Vega, O. (2018). MEGARA, the R=6000-20000 IFU and MOS of GTC. Paper presented at the** *Proceedings of SPIE - the International Society for Optical Engineering, , 10702* **doi:10.1117/12.2313040 Retrieved from**

36. **Clark, J. S., Lohr, M. E., Najarro, F., Dong, H., & Martins, F. (2018). The arches cluster revisited: I. data presentation and stellar census.** *Astronomy and Astrophysics, 617* **doi:10.1051/0004-6361/201832826**

37. **Clark, J. S., Lohr, M. E., Patrick, L. R., Najarro, F., Dong, H., & Figer, D. F. (2018). An updated stellar census of the quintuplet cluster.** *Astronomy and Astrophysics, 618* **doi:10.1051/0004-6361/201833041**

38. **Cockell, C. S., Holt, J., Campbell, J., Groseman, H., Josset, J. -., Bontognali, T. R. R., . . . Suckling, B. (2018). Subsurface scientific exploration of extraterrestrial environments (MINAR 5): Analogue science, technology and education in the boulby mine, UK.** *International Journal of Astrobiology,* **, 1-26. doi:10.1017/S1473550418000186**

39. **Cockell, C. S., Schwendner, P., Perras, A., Rettberg, P., Beblo-Vranesevic, K., Bohmeier, M., . . . Walter, N. (2018). Anaerobic microorganisms in astrobiological analogue environments: From field site to culture collection.** *International Journal of Astrobiology, 17* **(4), 314-328. doi:10.1017/S1473550417000246**

40. **Contreras, C. S., Alcolea, J., Bujarrabal, V., & Castro-Carrizo, A. (2018). ALMA's acute view of pPNe: Through the magnifying glass.. and what we found there.** *Galaxies, 6* **(3) doi:10.3390/galaxies6030094**

41. **Cruz, C. M., Márquez, I. R., Mariz, I. F. A., Blanco, V., Sánchez-Sánchez, C., Sobrado, J. M., . . . Campaña, A. G. (2018). Enantiopure distorted ribbon-shaped nanographene combining two-photon absorption-based upconversion and circularly polarized luminescence.** *Chemical Science, 9* **(16), 3917-3924. doi:10.1039/c8sc00427g**

42. **Cruz, P., Diaz, M., Birkby, J., Barrado, D., Sipöcz, B., & Hodgkin, S. (2018). Low-mass eclipsing binaries in the WFCAM transit survey: The persistence of the M-dwarf radius inflation problem.** *Monthly Notices of the Royal Astronomical Society, 476* **(4), 5253-5267. doi:10.1093/MNRAS/STY541**

43. **Cruz-Diaz, G. A., Martín-Doménech, R., Moreno, E., Caro, G. M. M., & Chen, Y. -. (2018). New measurements on water ice photodesorption and product formation under ultraviolet irradiation.** *Monthly Notices of the Royal Astronomical Society, 474* **(3), 3080-3089. doi:10.1093/mnras/stx2966**

44. **Cunningham, N., Lumsden, S. L., Moore, T. J. T., Maud, L. T., & Mendigutía, I. (2018). Infall and outflow motions towards a sample of massive star-forming regions from the RMS survey.** *Monthly Notices of the Royal Astronomical Society, 477* **(2), 2455-2469. doi:10.1093/mnras/sty701**

45. **De Bernardis, P., Ade, P. A. R., Baselmans, J. J. A., Battistelli, E. S., Benoit, A., Bersanelli, M., . . . Vittorio, N. (2018). Exploring cosmic origins with CORE: The instrument.** *Journal of Cosmology and Astroparticle Physics, 2018* **(4) doi:10.1088/1475-7516/2018/04/015**

46. **de la Fuente, V., Rufo, L., Sánchez-Gavilán, I., Ramírez, E., Rodríguez, N., & Amils, R. (2018). Plant tissues and embryos biominerals in sarcocornia pruinosa, a halophyte from the río tinto salt marshes.** *Catalysts, 8* **(11) doi:10.3390/min8110505**

47. **Deshapriya, J. D. P., Barucci, M. A., Fornasier, S., Hasselmann, P. H., Feller, C., Sierks, H., . . . Vincent, J. -. (2018). Exposed bright features on the comet 67P/Churyumov-gerasimenko: Distribution and evolution.** *Astronomy and Astrophysics, 613* **doi:10.1051/0004-6361/201732112**

48. **Donevski, D., Buat, V., Boone, F., Pappalardo, C., Bethermin, M., Schreiber, C., . . . Duivenvoorden, S. (2018). Towards a census of high-redshift dusty galaxies with herschel: A selection of "500 m-risers".** *Astronomy and Astrophysics, 614* **doi:10.1051/0004-6361/201731888**

49. **Echeverría-Vega, A., Chong, G., Serrano, A. E., Guajardo, M., Encalada, O., Parro, V., . . . Demergasso, C. S. (2018). Watershed-induced limnological and microbial status in two oligotrophic andean lakes exposed to the same climatic scenario.** *Frontiers in Microbiology, 9* **(MAR) doi:10.3389/fmicb.2018.00357**

50. **Escudero, C., Oggerin, M., & Amils, R. (2018). The deep continental subsurface: The dark biosphere.** *International Microbiology, 21* **(1-2), 3-14. doi:10.1007/s10123-018-0009-y**

51. **Escudero, C., Vera, M., Oggerin, M., & Amils, R. (2018). Active microbial biofilms in deep poor porous continental subsurface rocks.** *Scientific Reports, 8* **(1) doi:10.1038/s41598-018-19903-z**

52. **Esparza-Arredondo, D., González-Martín, O., Dultzin, D., Alonso-Herrero, A., Almeida, C. R., Díaz-Santos, T., . . . Rodríguez-Espinosa, J. M. (2018). Circumnuclear star formation and AGN activity: Clues from surface brightness radial profile of PAHs and [S IV].** *Astrophysical Journal, 859* **(2) doi:10.3847/1538-4357/aabcbc**

53. **Fairén, A. G., Parro, V., Schulze-Makuch, D., & Whyte, L. (2018). Is searching for martian life a priority for the mars community?** *Astrobiology, 18* **(2), 101-107. doi:10.1089/ast.2017.1772**

54. **Fenech, D. M., Clark, J. S., Prinja, R. K., Dougherty, S., Najarro, F., Negueruela, I., . . . Andrews, H. (2018). An ALMA 3 mm continuum census of westerlund 1.** *Astronomy and Astrophysics, 617* **doi:10.1051/0004-6361/201832754**

55. **Fernández, A., Ruiz-Bermejo, M., & De La Fuente, J. L. (2018). Modelling the kinetics and structural property evolution of a versatile reaction: Aqueous HCN polymerization.** *Physical Chemistry Chemical Physics, 20* **(25), 17353-17366. doi:10.1039/c8cp01662c**

56. **Fernández-Remolar, D. C., Harir, M., Carrizo, D., Schmitt-Kopplin, P., & Amils, R. (2018). Productivity contribution of paleozoic woodlands to the formation of shale-hosted massive sulfide deposits in the iberian pyrite belt (tharsis, spain).** *Journal of Geophysical Research: Biogeosciences, 123* **(3), 1017-1040. doi:10.1002/2017JG004144**

57. **Ferrari, S., Penasa, L., La Forgia, F., Massironi, M., Naletto, G., Lazzarin, M., . . . Vincent, J. -. (2018). The big lobe of 67P/Churyumov-gerasimenko comet: Morphological and spectrophotometric evidences of layering as from OSIRIS data.** *Monthly Notices of the Royal Astronomical Society, 479* **(2), 1555-1568. doi:10.1093/mnras/sty1656**

58. **Flaccomio, E., Micela, G., Sciortino, S., Cody, A. M., Guarcello, M. G., Morales-Calderòn, M., . . . Stauffer, J. R. (2018). A multi-wavelength view of magnetic flaring from PMS stars.** *Astronomy and Astrophysics, 620* **doi:10.1051/0004-6361/201833308**

59. **Fonseca, R. M., Zorzano-Mier, M. -., & Martín-Torres, J. (2018). Planetary boundary layer and circulation dynamics at gale crater, mars.** *Icarus, 302* **, 537-559. doi:10.1016/j.icarus.2017.11.036**

60. **Fulle, M., Bertini, I., Della Corte, V., Güttler, C., Ivanovski, S., La Forgia, F., . . . Tubiana, C. (2018). The phase function and density of the dust observed at comet 67P/Churyumov-gerasimenko.** *Monthly Notices of the Royal Astronomical Society, 476* **(2), 2835-2839. doi:10.1093/mnras/sty464**

61. **Gagnon, J. -., Hochberg, D., & Pérez-Mercader, J. (2018). Selection and control of pathways by using externally adjustable noise on a stochastic cubic autocatalytic chemical system.** *Physical Review E, 98* **(6) doi:10.1103/PhysRevE.98.062216**

62. **Galvez-Martinez, S., & Mateo-Marti, E. (2018). Ultraviolet irradiation on a pyrite surface improves triglycine adsorption.** *Life, 8* **(4) doi:10.3390/life8040050**

63. **Garcia, M. (2018). Massive stars in the sagittarius dwarf irregular galaxy.** *Monthly Notices of the Royal Astronomical Society: Letters, 474* **(1), L66-L70. doi:10.1093/mnrasl/slx194**

64. **García, R., Martínez, J. M., Leandro, T., & Amils, R. (2018). Draft genome sequence of rhizobium sp. strain T2.30D-1.1, isolated from 538.5 meters deep on the subsurface of the iberian pyrite belt.** *Microbiology Resource Announcements, 7* **(16) doi:10.1128/MRA.01098-18**

65. **Gerig, S. -., Marschall, R., Thomas, N., Bertini, I., Bodewits, D., Davidsson, B., . . . Vincent, J. -. (2018). On deviations from free-radial outflow in the inner coma of comet 67P/Churyumov–Gerasimenko.** *Icarus, 311* **, 1-22. doi:10.1016/j.icarus.2018.03.010**

66. **Gil De Paz, A., Carrasco, E., Gallego, J., Iglesias-Páramo, J., Cedazo, R., García-Vargas, M. L., . . . Vega, O. (2018). First scientific observations with MEGARA at GTC. Paper presented at the** *Proceedings of SPIE - the International Society for Optical Engineering, , 10702* **doi:10.1117/12.2313299 Retrieved from**

67. **Gomez, A., Calvo, M., Goupy, J., Bideaud, A., Lévy-Bertrand, F., Catalano, A., . . . Monfardini, A. (2018). Polarization filter for microstrip lumped-element kinetic inductance detectors.** *Journal of Low Temperature Physics, 193* **(3-4), 157-162. doi:10.1007/s10909-018-2021-1**

68. **Gómez, J. F., Niccolini, G., Suárez, O., Miranda, L. F., Rizzo, J. R., Uscanga, L., . . . De Gregorio-Monsalvo, I. (2018). ALMA imaging of the nascent planetary nebula IRAS 15103-5754.** *Monthly Notices of the Royal Astronomical Society, 480* **(4), 4991-5009. doi:10.1093/mnras/sty2193**

69. **Gonçalves Da Silva, L. H., & Hochberg, D. (2018). Open flow non-enzymatic template catalysis and replication.** *Physical Chemistry Chemical Physics, 20* **(21), 14864-14875. doi:10.1039/c8cp01828f**

70. **González-Peinado, R., Caballero, J. A., Montes, D., & Cifuentes, C. (2018). Cool dwarfs in wide multiple systems paper 6: A curious quintuple system of a compact sun-like triple and a close pair of an M dwarf and a very cool white dwarf at a wide separation.** *Observatory, 138* **(1267), 292-298. Retrieved from**

71. **Goupy, J., Benoit, A., Bideaud, A., Bourrion, O., Calvo, M., Catalano, A., . . . Schuster, K. F. (2018). Microfabrication developments for future instruments using KID detectors.** *Journal of Low Temperature Physics, 193* **(5-6), 739-743. doi:10.1007/s10909-018-2080-3**

72. **Guirado, J. C., Azulay, R., Gauza, B., Pérez-Torres, M. A., Rebolo, R., Climent, J. B., & Zapatero Osorio, M. R. (2018). Radio emission in ultracool dwarfs: The nearby substellar triple system VHS1256-1257.** *Astronomy and Astrophysics, 610* **doi:10.1051/0004-6361/201732130**

73. **Helmi, A., Van Leeuwen, F., McMillan, P. J., Massari, D., Antoja, T., Robin, A. C., . . . Zwitter, T. (2018). Gaia data release 2: Kinematics of globular clusters and dwarf galaxies around the milky way.** *Astronomy and Astrophysics, 616* **doi:10.1051/0004-6361/201832698**

74. **Hennig, M. G., Riffel, R. A., Dors, O. L., Riffel, R., Storchi-Bergmann, T., & Colina, L. (2018). Circumnuclear star formation in mrk 42 mapped with gemini near-infrared integral field spectrograph.** *Monthly Notices of the Royal Astronomical Society, 477* **(1), 1086-1098. doi:10.1093/mnras/sty547**

75. **Hochberg, D., & Ribó, J. M. (2018). Stoichiometric network analysis of entropy production in chemical reactions.** *Physical Chemistry Chemical Physics, 20* **(36), 23726-23739. doi:10.1039/c8cp04398a**

76. **Holl, B., Audard, M., Nienartowicz, K., Jevardat De Fombelle, G., Marchal, O., Mowlavi, N., . . . Eyer, L. (2018). Gaia data release 2: Summary of the variability processing and analysis results.** *Astronomy and Astrophysics, 618* **doi:10.1051/0004-6361/201832892**

77. **Hönig, S. F., Herrero, A. A., Gandhi, P., Kishimoto, M., Pott, J. -., Almeida, C. R., . . . Tristram, K. R. W. (2018). New active galactic nuclei science cases with interferometry: An incomplete preview.** *Experimental Astronomy, 46* **(3), 413-419. doi:10.1007/s10686-018-9612-3**

78. **Huang, T., Wang, R., Xiao, L., Wang, H., Martínez, J. M., Escudero, C., . . . Xu, Y. (2018). Dalangtan playa (qaidam basin, NW china): Its microbial life and physicochemical characteristics and their astrobiological implications.** *PLoS ONE, 13* **(8) doi:10.1371/journal.pone.0200949**

79. **Huélamo, N., Chauvin, G., Schmid, H. M., Quanz, S. P., Whelan, E., Lillo-Box, J., . . . Pantin, E. (2018). Searching for H emitting sources around MWC 758: SPHERE/ZIMPOL high-contrast imaging.** *Astronomy and Astrophysics, 613* **doi:10.1051/0004-6361/201832874**

80. **Jeffers, S. V., Schöfer, P., Lamert, A., Reiners, A., Montes, D., Caballero, J. A., . . . Sarmiento, L. F. (2018). CARMENES input catalogue of M dwarfs: III. rotation and activity from high-resolution spectroscopic observations.** *Astronomy and Astrophysics, 614* **doi:10.1051/0004-6361/201629599**

81. **Jiang, J., Parker, M. L., Fabian, A. C., Alston, W. N., Buisson, D. J. K., Cackett, E. M., . . . Wilkins, D. R. (2018). The 1.5Ms observing campaign on IRAS 13224-3809 - I. X-ray spectral analysis.** *Monthly Notices of the Royal Astronomical Society, 477* **(3), 3711-3726. doi:10.1093/mnras/sty836**

82. **Jiménez-Escobar, A., Ciaravella, A., Cecchi-Pestellini, C., Huang, C. -., Sie, N. -., Chen, Y. -., & Munoz Caro, G. M. (2018). X-ray photo-desorption of H 2 O:CO:NH 3 circumstellar ice analogs: Gas-phase enrichment.** *Astrophysical Journal, 868* **(1) doi:10.3847/1538-4357/aae711**

83. **Jiménez-Esteban, F. M., Torres, S., Rebassa-Mansergas, A., Skorobogatov, G., Solano, E., Cantero, C., & Rodrigo, C. (2018). A white dwarf catalogue from gaia-DR2 and the virtual observatory.** *Monthly Notices of the Royal Astronomical Society, 480* **(4), 4505-4518. doi:10.1093/MNRAS/STY2120**

84. **Kaminski, A., Trifonov, T., Caballero, J. A., Quirrenbach, A., Ribas, I., Reiners, A., . . . Udry, S. (2018). The CARMENES search for exoplanets around M dwarfs: A neptune-mass planet traversing the habitable zone around HD 180617.** *Astronomy and Astrophysics, 618* **doi:10.1051/0004-6361/201833354**

85. **Katz, D., Antoja, T., Romero-Gómez, M., Drimmel, R., Reylé, C., Seabroke, G. M., . . . Zwitter, T. (2018). Mapping the milky way disc kinematics.** *Astronomy and Astrophysics, 616* **doi:10.1051/0004-6361/201832865**

86. **Korablev, O., Montmessin, F., Trokhimovskiy, A., Fedorova, A. A., Shakun, A. V., Grigoriev, A. V., . . . Zorzano, M. P. (2018). The atmospheric chemistry suite (ACS) of three spectrometers for the ExoMars 2016 trace gas orbiter.** *Space Science Reviews, 214* **(1) doi:10.1007/s11214-017-0437-6**

87. **Lam, K. W. F., Santerne, A., Sousa, S. G., Vigan, A., Armstrong, D. J., Barros, S. C. C., . . . Wheatley, P. J. (2018). K2-265 b: A transiting rocky super-earth.** *Astronomy and Astrophysics, 620* **doi:10.1051/0004-6361/201834073**

88. **Lasue, J., Cousin, A., Meslin, P. -., Mangold, N., Wiens, R. C., Berger, G., . . . Zorzano, M. P. (2018). Martian eolian dust probed by ChemCam.** *Geophysical Research Letters, 45* **(20), 10,968-"10,977". doi: 10.1029/2018GL079210**

89. **Lázaro, E., Arribas, M., Cabanillas, L., Román, I., & Acosta, E. (2018). Evolutionary adaptation of an RNA bacteriophage to the simultaneous increase in the within-host and extracellular temperatures.** *Scientific Reports, 8* **(1) doi:10.1038/s41598-018-26443-z**

90. **Leandro, T., Rodriguez, N., Rojas, P., Sanz, J. L., da Costa, M. S., & Amils, R. (2018). Study of methanogenic enrichment cultures of rock cores from the deep subsurface of the iberian pyritic belt.** *Heliyon, 4* **(4) doi:10.1016/j.heliyon.2018.e00605**

91. **Lillo-Box, J., Barrado, D., Figueira, P., Leleu, A., Santos, N. C., Correia, A. C. M., . . . Faria, J. P. (2018). The TROY project: Searching for co-orbital bodies to known planets: I. project goals and first results from archival radial velocity.** *Astronomy and Astrophysics, 609* **doi:10.1051/0004-6361/201730652**

92. **Lillo-Box, J., Leleu, A., Parviainen, H., Figueira, P., Mallonn, M., Correia, A. C. M., . . . Neal, J. (2018). The TROY project: II. multi-technique constraints on exotrojans in nine planetary systems.** *Astronomy and Astrophysics, 618* **doi:10.1051/0004-6361/201833312**

93. **Lodieu, N., Osorio, M. R. Z., Béjar, V. J. S., & Ramírez, K. P. (2018). The optical + infrared L dwarf spectral sequence of young planetary-mass objects in the upper scorpius association.** *Monthly Notices of the Royal Astronomical Society, 473* **(2), 2020-2059. doi:10.1093/mnras/stx2279**

94. **Lohr, M. E., Clark, J. S., Najarro, F., Patrick, L. R., Crowther, P. A., & Evans, C. J. (2018). The arches cluster revisited: II. A massive eclipsing spectroscopic binary in the arches cluster.** *Astronomy and Astrophysics, 617* **doi:10.1051/0004-6361/201832670**

95. **Lopez-Rodriguez, E., Alonso-Herrero, A., Diaz-Santos, T., Gonzalez-Martin, O., Ichikawa, K., Levenson, N. A., . . . Telesco, C. M. (2018). The origin of the mid-infrared nuclear polarization of active galactic nuclei.** *Monthly Notices of the Royal Astronomical Society, 478* **(2), 2350-2358. doi:10.1093/MNRAS/STY1197**

96. **Lopez-Rodriguez, E., Fuller, L., Alonso-Herrero, A., Efstathiou, A., Ichikawa, K., Levenson, N. A., . . . Herter, T. (2018). The emission and distribution of dust of the torus of NGC 1068.** *Astrophysical Journal, 859***(2) doi:10.3847/1538-4357/aabd7b**

97. **Luque, R., Nowak, G., Pallé, E., Kossakowski, D., Trifonov, T., Zechmeister, M., . . . Schweitzer, A. (2018). The CARMENES search for exoplanets around M dwarfs: The warm super-earths in twin orbits around the mid-type M dwarfs ross 1020 (GJ 3779) and LP 819-052 (GJ 1265).** *Astronomy and Astrophysics, 620* **doi:10.1051/0004-6361/201833423**

98. **Macìas-Pérez, J. F., Delabrouille, J., De Bernardis, P., Bouchet, F. R., Achúcarro, A., Ade, P. A. R., . . . Zannoni, M. (2018). Exploring cosmic origins with CORE: Survey requirements and mission design.** *Journal of Cosmology and Astroparticle Physics, 2018* **(4) doi:10.1088/1475-7516/2018/04/014**

99. **Madonna, S., Bautista, M., Dinerstein, H. L., Sterling, N. C., Garcia-Rojas, J., Kaplan, K. F., . . . Garzón, F. (2018). Neutron-capture elements in planetary nebulae: First detections of near-infrared [te iii] and [br v] emission lines.** *Astrophysical Journal Letters, 861* **(1) doi:10.3847/2041-8213/aaccef**

100. **Magrini, L., Spina, L., Randich, S., Friel, E., Kordopatis, G., Worley, C., . . . Zaggia, S. (2018). The gaia -ESO survey: The origin and evolution of s -process elements.** *Astronomy and Astrophysics, 617* **doi:10.1051/0004-6361/201832841**

101. **Magrini, L., Vincenzo, F., Randich, S., Pancino, E., Casali, G., Tautvaišien, G., . . . Worley, C. (2018). The gaia -ESO survey: The N/O abundance ratio in the milky way?** *Astronomy and Astrophysics, 618* **doi:10.1051/0004-6361/201833224**

102. **Mahlke, M., Bouy, H., Altieri, B., Verdoes Kleijn, G., Carry, B., Bertin, E., . . . Valentijn, E. (2018). Mining the kilo-degree survey for solar system objects.** *Astronomy and Astrophysics, 610* **doi:10.1051/0004-6361/201730924**

103. **Maíz Apellániz, J., & Barbá, R. H. (2018). Optical-NIR dust extinction towards galactic O stars.** *Astronomy and Astrophysics, 613* **doi:10.1051/0004-6361/201732050**

104. **Maíz Apellániz, J., Barbá, R. H., Simón-Díaz, S., Sota, A., Trigueros Páez, E., Caballero, J. A., & Alfaro, E. J. (2018). Lucky spectroscopy, an equivalent technique to lucky imaging spatially resolved spectroscopy of massive close visual binaries using the william herschel telescope.** *Astronomy and Astrophysics, 615* **doi:10.1051/0004-6361/201832885**

105. **Maíz Apellániz, J., & Pantaleoni González, M. (2018). A reevaluation of the 2MASS zero points using CALSPEC spectrophotometry complemented with gaia data release 2 parallaxes.** *Astronomy and Astrophysics, 616* **doi:10.1051/0004-6361/201833918**

106. **Maíz Apellániz, J., Pantaleoni González, M., Barbá, R. H., Simón-Díaz, S., Negueruela, I., Lennon, D. J., . . . Trigueros Páez, E. (2018). Search for galactic runaway stars using gaia data release 1 and HIPPARCOS proper motions.** *Astronomy and Astrophysics, 616* **doi:10.1051/0004-6361/201832787**

107. **Maíz Apellániz, J., & Weiler, M. (2018). Reanalysis of the gaia data release 2 photometric sensitivity curves using HST/STIS spectrophotometry.** *Astronomy and Astrophysics, 619* **doi:10.1051/0004-6361/201834051**

108. **Marín-Yaseli, M. R., Moreno, M., de la Fuente, J. L., Briones, C., & Ruiz-Bermejo, M. (2018). Experimental conditions affecting the kinetics of aqueous HCN polymerization as revealed by UV–vis spectroscopy.** *Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy, 191* **, 389-397. doi:10.1016/j.saa.2017.10.003**

109. **Martín, E. L., Lodieu, N., Pavlenko, Y., & Béjar, V. J. S. (2018). The lithium depletion boundary and the age of the hyades cluster.** *Astrophysical Journal, 856* **(1) doi:10.3847/1538-4357/aaaeb8**

110. **Martín-Doménech, R., Cruz-Díaz, G. A., & Muñoz Caro, G. M. (2018). UV photoprocessing of NH3 ice: Photon-induced desorption mechanisms.** *Monthly Notices of the Royal Astronomical Society, 473* **(2), 2575-2582. doi:10.1093/mnras/stx2510**

111. **Martínez, L., Lauwaet, K., Santoro, G., Sobrado, J. M., Peláez, R. J., Herrero, V. J., . . . Martín-Gago, J. A. (2018). Precisely controlled fabrication, manipulation and in-situ analysis of cu based nanoparticles.** *Scientific Reports, 8* **(1) doi:10.1038/s41598-018-25472-y**

112. **Martinsson, T. P. K., Sarzi, M., Knapen, J. H., Coccato, L., Falcón-Barroso, J., Elmegreen, B. G., & De Zeeuw, T. (2018). MUSE observations of the counter-rotating nuclear ring in NGC 7742.** *Astronomy and Astrophysics, 612* **doi:10.1051/0004-6361/201730955**

113. **Mattila, S., Pérez-Torres, M., Efstathiou, A., Mimica, P., Fraser, M., Kankare, E., . . . Östlin, G. (2018). A dust-enshrouded tidal disruption event with a resolved radio jet in a galaxy merger.** *Science, 361* **(6401), 482-485. doi:10.1126/science.aao4669**

114. **Melero-Asensio, I., Ormö, J., Sturkell, E., Stockmann, G., & Mansfeld, J. (2018). Geophysical signature of målingen, the minor crater of the Lockne–Målingen doublet impact structure.** *Meteoritics and Planetary Science, 53* **(7), 1456-1475. doi:10.1111/maps.13090**

115. **Mendigutía, I., Lada, C. J., & Oudmaijer, R. D. (2018). A global correlation linking young stars, clouds, and galaxies: Towards a unified view of star formation.** *Astronomy and Astrophysics, 618* **doi: 10.1051/0004-6361/201833166**

116. **Mendigutía, I., Oudmaijer, R. D., Schneider, P. C., Huélamo, N., Baines, D., Brittain, S. D., & Aberasturi, M. (2018). Spectro-astrometry of the pre-transitional star LkCa 15 does not reveal an accreting planet but extended H emission.** *Astronomy and Astrophysics, 618* **doi:10.1051/0004-6361/201834233**

117. **Michałowski, M. J., Karska, A., Rizzo, J. R., Baes, M., Castro-Tirado, A. J., Hjorth, J., . . . Van Der Werf, P. (2018). Molecular gas masses of gamma-ray burst host galaxies.** *Astronomy and Astrophysics, 617* **doi: 10.1051/0004-6361/201833250**

118. **Mignard, F., Klioner, S. A., Lindegren, L., Hernández, J., Bastian, U., Bombrun, A., . . . Zwitter, T. (2018). Gaia data release 2: The celestial reference frame (gaia -CRF2).** *Astronomy and Astrophysics, 616* **doi:10.1051/0004-6361/201832916**

119. **Monnier, J. D., Ireland, M., Kraus, S., Alonso-Herrero, A., Bonsor, A., Baron, F., . . . Zúñiga-Fernández, S. (2018). Planet formation imager: Project update. Paper presented at the** *Proceedings of SPIE - the International Society for Optical Engineering, , 10701* **doi:10.1117/12.2312683 Retrieved from**

120. **Montes, D., González-Peinado, R., Tabernero, H. M., Caballero, J. A., Marfil, E., Alonso-Floriano, F. J., . . . Moreno-Jódar, C. (2018). Calibrating the metallicity of M dwarfs in wide physical binaries with F-, G-, and K-primaries - I: High-resolution spectroscopy with HERMES: Stellar parameters, abundances, and kinematics.** *Monthly Notices of the Royal Astronomical Society, 479* **(1), 1332-1382. doi: 10.1093/MNRAS/STY1295**

121. **Moreno, F., Guirado, D., Munoz, O., Bertini, I., Tubiana, C., Güttler, C., . . . Shi, X. (2018). Models of Rosetta/OSIRIS 67P dust coma phase function.** *Astronomical Journal, 156* **(5) doi:10.3847/1538-3881/ aae526**

122. **Moreno-Paz, M., Gómez-Cifuentes, A., Ruiz-Bermejo, M., Hofstetter, O., Maquieira, A., Manchado, J. M., . . . Parro, V. (2018). Detecting nonvolatile life- and nonlife-derived organics in a carbonaceous chondrite analogue with a new multiplex immunoassay and its relevance for planetary exploration.** *Astrobiology, 18* **(8), 1041-1056. doi:10.1089/ast.2017.1747**

123. **Moya, A., Barceló Forteza, S., Bonfanti, A., Salmon, S. J. A. J., Van Grootel, V., & Barrado, D. (2018). Asteroseismic potential of CHEOPS.** *Astronomy and Astrophysics, 620* **doi:10.1051/0004-6361/201833772**

124. **Nikolov, N., Sing, D. K., Goyal, J., Henry, G. W., Wakeford, H. R., Evans, T. M., . . . Williamson, M. H. (2018). Hubble PanCET: An isothermal day-side atmosphere for the bloated gas-giant HAT-P-32Ab.** *Monthly Notices of the Royal Astronomical Society, 474* **(2), 1705-1717. doi:10.1093/mnras/stx2865**

125. **Nishiyama, S., Saida, H., Takamori, Y., Takahashi, M., Schödel, R., Najarro, F., . . . Nagata, T. (2018). Radial velocity measurements of an orbiting star around sgr A.** *Publications of the Astronomical Society of Japan, 70* **(4) doi:10.1093/pasj/psy067**

126. **Nogueras-Lara, F., Gallego-Calvente, A. T., Dong, H., Gallego-Cano, E., Girard, J. H. V., Hilker, M., . . . Schödel, R. (2018). GALACTICNUCLEUS: A high angular resolution JHK s imaging survey of the galactic centre: I. methodology, performance, and near-infrared extinction towards the galactic centre.** *Astronomy and Astrophysics, 610* **doi:10.1051/0004-6361/201732002**

127. **Nogueras-Lara, F., Schödel, R., Dong, H., Najarro, F., Gallego-Calvente, A. T., Hilker, M., . . . Pietrinferni, A. (2018). Star formation history and metallicity in the galactic inner bulge revealed by the red giant branch bump.** *Astronomy and Astrophysics, 620* **doi:10.1051/0004-6361/201833518**

128. **Nortmann, L., Pallé, E., Salz, M., Sanz-Forcada, J., Nagel, E., Alonso-Floriano, F. J., . . . Zapatero Osorio, M. R. (2018). Ground-based detection of an extended helium atmosphere in the saturn-mass exoplanet WASP-69b.** *Science, 362* **(6421), 1388-1391. doi:10.1126/science.aat5348**

129. **Olivares, J., Moraux, E., Sarro, L. M., Bouy, H., Berihuete, A., Barrado, D., . . . Bouvier, J. (2018). The seven sisters DANCe: III. projected spatial distribution.** *Astronomy and Astrophysics, 612* **doi: 10.1051/0004-6361/201731996**

130. **Olivares, J., Sarro, L. M., Moraux, E., Berihuete, A., Bouy, H., Hernández-Jiménez, S., . . . Barrado, D. (2018). The seven sisters DANCe: IV. bayesian hierarchical model.** *Astronomy and Astrophysics, 617* **doi: 10.1051/0004-6361/201730972**

131. **Osorio, M. R. Z., Béjar, V. J. S., Lodieu, N., & Manjavacas, E. (2018). Confirming the least massive members of the pleiades star cluster.** *Monthly Notices of the Royal Astronomical Society, 475* **(1), 139-153. doi:10.1093/mnras/stx3154**

132. **Pajot, F., Barret, D., Lam-Trong, T., den Herder, J. -., Piro, L., Cappi, M., . . . Peille, P. (2018). The athena X-ray integral field unit (X-IFU).** *Journal of Low Temperature Physics, 193* **(5-6), 901-907. doi:10.1007/ s10909-018-1904-5**

133. **Parker, M. L., Matzeu, G. A., Guainazzi, M., Kalfountzou, E., Miniutti, G., Santos-Lleó, M., & Schartel, N. (2018). A high-velocity component to the complex absorption in IRAS 13349+2438.** *Monthly Notices of the Royal Astronomical Society, 480* **(2), 2365-2376. doi:10.1093/MNRAS/STY2020**

134. **Parro, V., Blanco, Y., Puente-Sánchez, F., Rivas, L. A., Moreno-Paz, M., Echeverría, A., . . . Cabrol, N. A. (2018). Biomarkers and metabolic patterns in the sediments of evolving glacial lakes as a proxy for planetary lake exploration.** *Astrobiology, 18* **(5), 586-606. doi:10.1089/ast.2015.1342**

135. **Pascual-Granado, J., Suárez, J. C., Garrido, R., Moya, A., Hernández, A. G., Rodón, J. R., & Lares-Martiz, M. (2018). Impact of gaps in the asteroseismic characterization of pulsating stars: I. the efficiency of pre-whitening.** *Astronomy and Astrophysics, 614* **doi:10.1051/0004-6361/201732431**

136. **Passegger, V. M., Reiners, A., Jeffers, S. V., Wende-Von Berg, S., Schöfer, P., Caballero, J. A., . . . Seifert, W. (2018). The CARMENES search for exoplanets around M dwarfs: Photospheric parameters of target stars from high-resolution spectroscopy.** *Astronomy and Astrophysics, 615* **doi:10.1051/0004-6361/201732312**

137. **Pastor, C., Jellema, W., Zuluaga-Ramírez, P., Arrazola, D., Fernández-Rodríguez, M., Belenguer, T., . . . Roelfsema, P. (2018). SAFARI optical system architecture and design concept. Paper presented at the** *Proceedings of SPIE - the International Society for Optical Engineering, , 10015* **doi:10.1117/12.2248377 Retrieved from**

138. **Pereira-Santaella, M., Colina, L., García-Burillo, S., Combes, F., Emonts, B., Aalto, S., . . . Van Der Werf, P. (2018). Spatially resolved cold molecular outflows in ULIRGs.** *Astronomy and Astrophysics, 616* **doi: 10.1051/0004-6361/201833089**

139. **Pérez-Izquierdo, J., Sebastián, E., M. Martínez, G., Bravo, A., Ramos, M., & Rodríguez Manfredi, J. A. (2018). The thermal infrared sensor (TIRS) of the mars environmental dynamics analyzer (MEDA) instrument onboard mars 2020, a general description and performance analysis.** *Measurement: Journal of the International Measurement Confederation, 122* **, 432-442. doi:10.1016/j.measurement. 2017.12.004**

140. **Puente-Sánchez, F., Arce-Rodríguez, A., Oggerin, M., García-Villadangos, M., Moreno-Paz, M., Blanco, Y., . . . Parro, V. (2018). Viable cyanobacteria in the deep continental subsurface.** *Proceedings of the National Academy of Sciences of the United States of America, 115* **(42), 10702-10707. doi:10.1073/pnas. 1808176115**

141. **Puente-Sánchez, F., Díaz, S., Penacho, V., Aguilera, A., & Olsson, S. (2018). Basis of genetic adaptation to heavy metal stress in the acidophilic green alga chlamydomonas acidophila.** *Aquatic Toxicology, 200* **, 62-72. doi:10.1016/j.aquatox.2018.04.020**

142. **Puente-Sánchez, F., González-Silva, C., Parro, V., Tamames, J., & Azua-Bustos, A. (2018). Draft genome sequence of the extremely desiccation-tolerant cyanobacterium gloeocapsopsis sp. strain AAB1.** *Genome Announcements, 6* **(17) doi:10.1128/genomeA.00216-18**

143. **Quénard, D., Ilee, J. D., Jiménez-Serra, I., Forgan, D. H., Hall, C., & Rice, K. (2018). The fate of formamide in a fragmenting protoplanetary disk.** *Astrophysical Journal, 868* **(1) doi: 10.3847/1538-4357/aae4dd**

144. **Quirrenbach, A., Amado, P. J., Ribas, I., Reiners, A., Caballero, J. A., Seifert, W., . . . Zhao, Z. (2018). CARMENES: High-resolution spectra and precise radial velocities in the red and infrared. Paper presented at the** *Proceedings of SPIE - the International Society for Optical Engineering, , 10702* **doi: 10.1117/12.2313689 Retrieved from**

145. **Ramírez Alegría, S., Herrero, A., Rübke, K., Marín-Franch, A., García, M., & Borissova, J. (2018). Identifying two groups of massive stars aligned in the l 38° galactic direction.** *Astronomy and Astrophysics, 614* **doi:10.1051/0004-6361/201731720**

146. **Ramírez-Olivencia, N., Varenius, E., Pérez-Torres, M., Alberdi, A., Pérez, E., Alonso-Herrero, A., . . . Martí-Vidal, I. (2018). Sub-arcsecond imaging of arp 299-A at 150 MHz with LOFAR: Evidence for a starburst-driven outflow.** *Astronomy and Astrophysics, 610* **doi:10.1051/0004-6361/201732543**

147. **Randich, S., Tognelli, E., Jackson, R., Jeffries, R. D., Degl'Innocenti, S., Pancino, E., . . . Zaggia, S. (2018). The gaia -ESO survey: Open clusters in gaia -DR1: A way forward to stellar age calibration.** *Astronomy and Astrophysics, 612* **doi:10.1051/0004-6361/201731738**

148. **Rebollido, I., Eiroa, C., Montesinos, B., Maldonado, J., Villaver, E., Absil, O., . . . Riviere-Marichalar, P. (2018). The co-existence of hot and cold gas in debris discs.** *Astronomy and Astrophysics, 614* **doi:10.1051/0004-6361/201732329**

149. **Reiners, A., Ribas, I., Zechmeister, M., Caballero, J. A., Trifonov, T., Dreizler, S., . . . Zapatero Osorio, M. R. (2018). The CARMENES search for exoplanets around M dwarfs: HD147379 b: A nearby neptune in the temperate zone of an early-M dwarf.** *Astronomy and Astrophysics, 609* **doi: 10.1051/0004-6361/201732165**

150. **Reiners, A., Zechmeister, M., Caballero, J. A., Ribas, I., Morales, J. C., Jeffers, S. V., . . . Zapatero Osorio, M. R. (2018). The CARMENES search for exoplanets around M dwarfs: High-resolution optical and near-infrared spectroscopy of 324 survey stars.** *Astronomy and Astrophysics, 612* **doi: 10.1051/0004-6361/201732054**

151. **Ribas, I., Tuomi, M., Reiners, A., Butler, R. P., Morales, J. C., Perger, M., . . . Anglada-Escudé, G. (2018). A candidate super-earth planet orbiting near the snow line of Barnard's star.** *Nature, 563* **(7731), 365-368. doi:10.1038/s41586-018-0677-y**

152. **Rivilla, V. M., Jiménez-Serra, I., Zeng, S., Martín, S., Martín-Pintado, J., Armijos-Abendaño, J., . . . Beltrán, M. T. (2018). Phosphorus-bearing molecules in the galactic center.** *Monthly Notices of the Royal Astronomical Society: Letters, 475* **(1), 1-6. Retrieved from**

153. **Roelfsema, P. R., Shibai, H., Armus, L., Arrazola, D., Audard, M., Audley, M. D., . . . Yamamura, I. (2018). SPICA - A large cryogenic infrared space telescope: Unveiling the obscured universe.** *Publications of the Astronomical Society of Australia,* **doi:10.1017/pasa.2018.15**

154. **Rojas, P., Rodríguez, N., de la Fuente, V., Sánchez-Mata, D., Amils, R., & Sanza, J. L. (2018). Microbial diversity associated with the anaerobic sediments of a soda lake (mono lake, california, USA).** *Canadian Journal of Microbiology, 64* **(6), 385-392. doi:10.1139/cjm-2017-0657**

155. **Rollano, V., del Valle, J., Gomez, A., Velez, M., Alvarez-Prado, L. M., Quiros, C., . . . Vicent, J. L. (2018). Magnetic order and disorder in nanomagnets probed by superconducting vortices.** *Scientific Reports, 8* **(1) doi:10.1038/s41598-018-30837-4**

156. **Salz, M., Czesla, S., Schneider, P. C., Nagel, E., Schmitt, J. H. M. M., Nortmann, L., . . . Zechmeister, M. (2018). Detection of he i 10830 Å absorption on HD 189733 b with CARMENES high-resolution transmission spectroscopy.** *Astronomy and Astrophysics, 620* **doi:10.1051/0004-6361/201833694**

157. **Sánchez Contreras, C., Alcolea, J., Bujarrabal, V., Castro-Carrizo, A., Velilla Prieto, L., Santander-García, M., . . . Cernicharo, J. (2018). Through the magnifying glass: ALMA acute viewing of the intricate nebular architecture of OH 231.8+4.2.** *Astronomy and Astrophysics, 618* **doi:10.1051/0004-6361/201833632**

158. **Sánchez-García, L., Aeppli, C., Parro, V., Fernández-Remolar, D., García-Villadangos, M., Chong-Diaz, G., . . . Carrizo, D. (2018). Molecular biomarkers in the subsurface of the salar grande (atacama, chile) evaporitic deposits.** *Biogeochemistry, 140* **(1), 31-52. doi:10.1007/s10533-018-0477-3**

159. **Sánchez-García, L., Aeppli, C., Parro, V., Fernández-Remolar, D., García-Villadangos, M., Chong-Diaz, G., . . . Carrizo, D. (2018). Molecular biomarkers in the subsurface of the salar grande (atacama, chile) evaporitic deposits.** *Biogeochemistry,* **doi:10.1007/s10533-018-0477-3**

160. **Santerne, A., Brugger, B., Armstrong, D. J., Adibekyan, V., Lillo-Box, J., Gosselin, H., . . . Vigan, A. (2018). An earth-sized exoplanet with a mercury-like composition.** *Nature Astronomy, 2* **(5), 393-400. doi:10.1038/s41550-018-0420-5**

161. **Santiago, A., Ramos, G., Sanz-Palomino, M., Gordillo, C., Cabrero, J., Moral, A. G., . . . Rull, F. (2018). Raman laser spectrometer optical head: Flight model performance verification. Paper presented at the** *Proceedings of SPIE - the International Society for Optical Engineering, , 10698* **doi:10.1117/12.2313462 Retrieved from**

162. **Sarkis, P., Henning, T., Kürster, M., Trifonov, T., Zechmeister, M., Tal-Or, L., . . . Montes, D. (2018). The CARMENES search for exoplanets around M dwarfs: A low-mass planet in the temperate zone of the nearby K2-18.** *Astronomical Journal, 155* **(6) doi:10.3847/1538-3881/aac108**

163. **Sarro, L. M., Ordieres-Meré, J., Bello-García, A., González-Marcos, A., & Solano, E. (2018). Estimates of the atmospheric parameters of M-type stars: A machine-learning perspective.** *Monthly Notices of the Royal Astronomical Society, 476* **(1), 1120-1139. doi:10.1093/mnras/sty165**

164. **Schneider, F. R. N., Sana, H., Evans, C. J., Bestenlehner, J. M., Castro, N., Fossati, L., . . . Norman, C. (2018). Response to comment on "An excess of massive stars in the local 30 doradus starburst".** *Science, 361* **(6400) doi:10.1126/science.aat7032**

165. **Schneider, F. R. N., Sana, H., Evans, C. J., Bestenlehner, J. M., Castro, N., Fossati, L., . . . Norman, C. (2018). An excess of massive stars in the local 30 doradus starburst.** *Science, 359* **(6371), 69-71. doi: 10.1126/science.aan0106**

166. **Schulze-Makuch, D., Wagner, D., Kounaves, S. P., Mangelsdorf, K., Devine, K. G., De Vera, J. -., . . . Zamorano, P. (2018). Transitory microbial habitat in the hyperarid atacama desert.** *Proceedings of the National Academy of Sciences of the United States of America, 115* **(11), 2670-2675. doi:10.1073/pnas. 1714341115**

167. **Schwendner, P., Bohmeier, M., Rettberg, P., Beblo-Vranesevic, K., Gaboyer, F., Moissl-Eichinger, C., . . . Cockell, C. (2018). Beyond chloride brines: Variable metabolomic responses in the anaerobic organism yersinia intermedia MASE-LG-1 to NaCl and MgSO4 at identical water activity.** *Frontiers in Microbiology, 9* **(FEB) doi:10.3389/fmicb.2018.00335**

168. **Shi, X., Hu, X., Mottola, S., Sierks, H., Keller, H. U., Rose, M., . . . Vincent, J. -. (2018). Coma morphology of comet 67P controlled by insolation over irregular nucleus.** *Nature Astronomy, 2* **(7), 562-567. doi:10.1038/s41550-018-0481-5**

169. **Silva, M., Humphrey, A., Lagos, P., Villar-Martín, M., Morais, S. G., Alighieri, S. S., . . . Binette, L. (2018). The MUSE 3D view of feedback in a high-metallicity radio galaxy at z = 2.9.** *Monthly Notices of the Royal Astronomical Society, 474* **(3), 3649-3672. doi:10.1093/mnras/stx3019**

170. **Spoto, F., Tanga, P., Mignard, F., Berthier, J., Carry, B., Cellino, A., . . . Zwitter, T. (2018). Observations of solar system objects.** *Astronomy and Astrophysics, 616* **doi:10.1051/0004-6361/201832900**

171. **Stauffer, J., Rebull, L., David, T. J., Jardine, M., Cameron, A. C., Cody, A. M., . . . Briceno, C. (2018). More rapidly rotating PMS M dwarfs with light curves suggestive of orbiting clouds of material.** *Astronomical Journal, 155* **(2) doi:10.3847/1538-3881/aaa19d**

172. **Tal-Or, L., Zechmeister, M., Reiners, A., Jeffers, S. V., Schöfer, P., Quirrenbach, A., . . . Shulyak, D. (2018). The CARMENES search for exoplanets around M dwarfs: Radial-velocity variations of active stars in visual-channel spectra.** *Astronomy and Astrophysics, 614* **doi:10.1051/0004-6361/201732362**

173. **Tanarro, I., Alemán, B., De Vicente, P., Gallego, J. D., Pardo, J. R., Santoro, G., . . . Cernicharo, J. (2018). Using radio astronomical receivers for molecular spectroscopic characterization in astrochemical laboratory simulations: A proof of concept.** *Astronomy and Astrophysics, 609* **doi: 10.1051/0004-6361/201730969**

174. **Thomas, N., El Maarry, M. R., Theologou, P., Preusker, F., Scholten, F., Jorda, L., . . . Vincent, J. B. (2018). Regional unit definition for the nucleus of comet 67P/Churyumov-gerasimenko on the SHAP7 model.** *Planetary and Space Science, 164* **, 19-36. doi:10.1016/j.pss.2018.05.019**

175. **Tinetti, G., Drossart, P., Eccleston, P., Hartogh, P., Heske, A., Leconte, J., . . . Zwart, F. (2018). A chemical survey of exoplanets with ARIEL.** *Experimental Astronomy, 46* **(1), 135-209. doi:10.1007/ s10686-018-9598-x**

176. **Trifonov, T., Kürster, M., Zechmeister, M., Tal-Or, L., Caballero, J. A., Quirrenbach, A., . . . Zapatero Osorio, M. R. (2018). The CARMENES search for exoplanets around M dwarfs: First visual-channel radial-velocity measurements and orbital parameter updates of seven M-dwarf planetary systems.** *Astronomy and Astrophysics, 609* **doi:10.1051/0004-6361/201731442**

177. **Ulloa, A., Gázquez, F., Sanz-Arranz, A., Medina, J., Rull, F., Calaforra, J. M., . . . De Waele, J. (2018). Extremely high diversity of sulfate minerals in caves of the irazú volcano (costa rica) related to crater lake and fumarolic activity.** *International Journal of Speleology, 47* **(2), 229-246. doi:10.5038/1827-806X.47.2.2198**

178. **Vaduvescu, O., Hudin, L., Mocnik, T., Char, F., Sonka, A., Tudor, V., . . . Pleunis, Z. (2018). 280 one-opposition near-earth asteroids recovered by the EURONEAR with the isaac newton telescope.** *Astronomy and Astrophysics, 609* **doi:10.1051/0004-6361/201731844**

179. **Velasco-Acebes, J., Tornos, F., Kidane, A. T., Wiedenbeck, M., Velasco, F., & Delgado, A. (2018). Isotope geochemistry tracks the maturation of submarine massive sulfide mounds (iberian pyrite belt).** *Mineralium Deposita,* **doi:10.1007/s00126-018-0853-x**

180. **Verma, M. P., van Geldern, R., Barth, J. A. C., Monvoisin, G., Rogers, K., Grassa, F., . . . Cortés, H. A. D. (2018). Inter-laboratory test for oxygen and hydrogen stable isotope analyses of geothermal fluids: Assessment of reservoir fluid compositions.** *Rapid Communications in Mass Spectrometry, 32* **(20), 1799-1810. doi:10.1002/rcm.8233**

181. **Villar-Martín, M., Cabrera-Lavers, A., Humphrey, A., Silva, M., Almeida, C. R., Piqueras-López, J., & Emonts, B. (2018). A 100 kpc nebula associated with the 'teacup' fading quasar.** *Monthly Notices of the Royal Astronomical Society, 474* **(2), 2302-2312. doi:10.1093/mnras/stx2911**

182. **Vioque, M., Oudmaijer, R. D., Baines, D., Mendigutía, I., & Pérez-Martínez, R. (2018). Gaia DR2 study of herbig Ae/Be stars.** *Astronomy and Astrophysics, 620* **doi:10.1051/0004-6361/201832870**

183. **Walton, D. J., Brightman, M., Risaliti, G., Fabian, A. C., Fürst, F., Harrison, F. A., . . . Stern, D. (2018). Disentangling the complex broad-band X-ray spectrum of IRAS 13197-1627 with NuSTAR, XMM-newton and suzaku.** *Monthly Notices of the Royal Astronomical Society, 473* **(4), 4377-4391. doi:10.1093/mnras/stx2659**

184. **Wang, W., Kassin, S. A., Pacifici, C., Barro, G., Vega, A. D. L., Simons, R. C., . . . Kodra, D. (2018). Galaxy inclination and the IRX- relation: Effects on UV star formation rate measurements at intermediate to high redshifts.** *Astrophysical Journal, 869* **(2) doi:10.3847/1538-4357/aaef79**

185. **Webster, C. R., Mahaffy, P. R., Atreya, S. K., Moores, J. E., Flesch, G. J., Malespin, C., . . . Vasavada, A. R. (2018). Background levels of methane in mars' atmosphere show strong seasonal variations.** *Science, 360* **(6393), 1093-1096. doi:10.1126/science.aaq0131**

186. **Wilhelm, M. B., Davila, A. F., Parenteau, M. N., Jahnke, L. L., Abate, M., Cooper, G., . . . Warren-Rhodes, K. (2018). Constraints on the metabolic activity of microorganisms in atacama surface soils inferred from refractory biomarkers: Implications for martian habitability and biomarker detection.** *Astrobiology, 18* **(7), 955-966. doi:10.1089/ast.2017.1705**

187. **Williams, C. C., Curtis-Lake, E., Hainline, K. N., Chevallard, J., Robertson, B. E., Charlot, S., . . . Willott, C. J. (2018). The JWST extragalactic mock catalog: Modeling galaxy populations from the UV through the near-IR over 13 billion years of cosmic history.** *Astrophysical Journal, Supplement Series, 236* **(2) doi:10.3847/1538-4365/aabcbb**

188. **Wolf, C., Weinzirl, T., Aragón-Salamanca, A., Gray, M. E., del Pino, B. R., Chies-Santos, A. L., . . . Harborne, K. (2018). OMEGA - OSIRIS mapping of emission-line galaxies in A901/2-IV. extinction of star formation estimators with inclination.** *Monthly Notices of the Royal Astronomical Society, 480* **(3), 3788-3799. doi:10.1093/MNRAS/STY2112**

189. **Zapico, I., Martín Duque, J. F., Bugosh, N., Laronne, J. B., Ortega, A., Molina, A., . . . Sánchez Castillo, L. (2018). Geomorphic reclamation for reestablishment of landform stability at a watershed scale in mined sites: The alto tajo natural park, spain.** *Ecological Engineering, 111* **, 100-116. doi:10.1016/j.ecoleng.2017.11.011**

190. **Zappacosta, L., Piconcelli, E., Duras, F., Vignali, C., Valiante, R., Bianchi, S., . . . Ricci, C. (2018). The hyperluminous compton-thick z 2 quasar nucleus of the hot DOG W1835+4355 observed by NuSTAR.** *Astronomy and Astrophysics, 618* **doi:10.1051/0004-6361/201732557**

191. **Zechmeister, M., Reiners, A., Amado, P. J., Azzaro, M., Bauer, F. F., Béjar, V. J. S., . . . Wolthoff, V. (2018). Spectrum radial velocity analyser (SERVAL): High-precision radial velocities and two alternative spectral indicators.** *Astronomy and Astrophysics, 609* **doi:10.1051/0004-6361/201731483**

192. **Zeng, S., Jiménez-Serra, I., Rivilla, V. M., Martín, S., Martín-Pintado, J., Requena-Torres, M. A., . . . Aladro, R. (2018). Complex organic molecules in the galactic centre: The N-bearing family.** *Monthly Notices of the Royal Astronomical Society, 478* **(3), 2962-2975. doi:10.1093/MNRAS/STY1174**

193. **Zhang, Z. H., Galvez-Ortiz, M. C., Pinfield, D. J., Burgasser, A. J., Lodieu, N., Jones, H. R. A., . . . Rebolo, R. (2018). Primeval very low-mass stars and brown dwarfs - IV. new L subdwarfs, gaia astrometry, population properties, and a blue brown dwarf binary.** *Monthly Notices of the Royal Astronomical Society, 480* **(4), 5447-5474. doi:10.1093/MNRAS/STY2054**

194. **Zhang, Z. H., Pinfield, D. J., Gálvez-Ortiz, M. C., Homeier, D., Burgasser, A. J., Lodieu, N., . . . Rebolo, R. (2018). Primeval very low-mass stars and brown dwarfs - III. the halo transitional brown dwarfs.** *Monthly Notices of the Royal Astronomical Society, 479* **(1), 1383-1391. doi:10.1093/MNRAS/STY1352**

Books

- Alberto Fairén. "Interiors and surfaces of terrestrial planets and major satellites". Handbook of Exoplanets. Springer. 978-3-319-55332-0

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: invited talk, oral, or poster

- 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. The Woodlands (Texas), 19-23 March 2018. Contribution: Abstract (non presential).

- L. Sánchez-García, C. Aeppli, V. Parro, D. Fernández-Remolar, M. García-Villadangos, G. Chong-Diaz, Y. Blanco, D. Carrizo. "*Identification of molecular biomarkers in subsurface evaporites of Salar Grande (Atacama, Chile) with analogies to Mars halite deposits*". European Geosciences Union General Assembly (EGU´18), Vienna (Austria). Geophysical Research Abstracts Vol. 20. ISSN: 1029-7006. Viena (Austria), 8-13 April 2018. Contribution: Oral.

- M. Moreno-Paz, M.A. Fernández-Martínez, J.M. Manchado-Ortega, Y. Blanco, M. García-Villadangos, L. Sánchez-García, J. García, B. Glass, V. Parro. "Caracterización geomicrobiológica de nichos asociados a la interfase roca-suelo de la región hiperárida del desierto de Atacama (Chile)". XV Reunión de la Red Nacional de Microorganismos Extremófilos (RedEx 2018). Matalascañas (Huelva), 23-25 May 2018. Contribution: Oral.

- M.A. Fernández-Martínez, M. Moreno Paz, Y. Blanco López, R.S. dos Santos Severino, I. Gallardo-Carreño, K. Warren-Rhodes, M. García Villadangos, L. Sánchez García, J.M. Manchado Ortega, N.A. Cabrol, V. Parro. "Estudio de la variación con la profundidad de las comunidades microbianas del sueloy de la presencia de biomarcadores en zonas de playas del desierto de Atacama trasun evento húmedo". XV Reunión de la Red Nacional de Microorganismos Extremófilos (RedEx 2018). Matalascañas (Huelva), 23-25 May 2018. Contribution: Oral.

- Jesús Maíz Apellániz. SEA X, Salamanca, Julio 2018. Contribution: one talk and two posters

- M.A. Fernández Martínez, M. García Villadangos, Y. Blanco López, M. Moreno Paz, J.M. Manchado Ortega, L. Sánchez García, V. Parro. "*Geomicrobiología de los 'nunataks' de isla Livingston (Antártida) como posible modelo del Marte temprano frío y húmedo*". IX Simposio de Estudios Polares. Madrid, 5-7 Sept 2018. Contribution: Poster.

- D. Carrizo, L. Sánchez-García, N. Rodríguez, F. Gómez. "Lipidic molecular evidences of life in a poly-

Visitors

- Shaoshan Zeng. Queen Mary University of London (UK). July 20th to 31st, 2018. (Host: Jesus Martin-Pintado)
- Shaoshan Zeng. Queen Mary University of London (UK). October 3rd to 11th, 2018. (Host: Izaskun Jimenez Serra)
- Artemio Herrero Davó. Instituto de Astrofísica de Canarias. February 15th, 2017

PhD Thesis & Masters

- Elena Llorente Flores.. Adaptación del Bacteriófago Qbeta a condiciones ambientales extremas. Trabajo Fin de Grado.Universidad Rey Juan Carlos. 23/10/2018.
- Fernando Izquierdo Ruiz.. Clatratos hidratos de gas en condiciones extremas. Tesis Doctoral.Fundación Universidad de Oviedo. 04/07/2018.
- Jesus García Martinez.. Dessarrollo y control de un sistema de chopeado de radiometros IR para exploración espacial. Trabajo Fin de Grado.Universiad de Alcalá de Henares (UAH). 06/07/2018.
- Inés María Gómez Muñoz.. Discovery and Characterization of ultracool dwarfs in the COSMOS Extragalactic Field. Trabajo Fin de Master.Universitat Internacional Valenciana (VIU). 25/07/2018.
- Jose Alonso Sanchez.. Ensayos de calibracion y validación del radiometro TIRS. Trabajo Fin de Grado.Universiad de Alcalá de Henares (UAH). 08/06/2018.
- María Teresa Fernández Sampedro.. Estabilidad de los sulfatos hidratados en las condiciones extremas de la superficiede las lunas de júpiter. Trabajo Fin de Master.UNED. 09/07/2018.
- Alejandro Domínguez Fernández.. Estudio del Gas Molecular Frío en Cinco Galaxias Seyfert del Universo Local. Trabajo Fin de Master.Facultad de Ciencias Físicas Universidad Complutense de Madrid. 09/02/2018.
- Mónica Vara Lubiano.. Estudio del gas molecular y la formación estelar en la galaxia Seyfert NGC7582. Trabajo Fin de Master.Facultad de Ciencias Físicas Universidad Complutense de Madrid. 14/09/2018.
- Fernando Almazán Gallego.. Formación estelar en la cabeza de orión. Trabajo Fin de Master.Depto. Astrofísica Universidad Complutense de Madrid (UCM). 14/09/2018.

- Ester Sevillano González.. Implementación del cyanochip 2.0 para la búsqueda de vida en exploración planetaria. Trabajo Fin de Grado.Universidad Autonoma De Madrid (UAM). 31/05/2018.
- Rosario Madrigal Oliver.. James Webb Space Telescope: Preparacio ¿n y simulacio ¿n de observaciones de las primerasgalaxias del Universo. Trabajo Fin de Master.Complutense (UCM). 01/09/2018.
- Elisabeth Losa Adams.. Meteorización de silicatos en Marte: el litio y sus isótopos como trazadores geoquímicos. Tesis Doctoral.Universidad de Vigo (UVigo). 18/12/2018.
- MARIA ALEJANDRA LOPEZ IBAÑEZ DE ALDECOA.. Regulación de la producción de dna extracelular en bacillussubtilis y estudio de su distribución en los cuerpos aéreos. Tesis Doctoral.Universidad Autonoma De Madrid (UAM). 27/06/2018.
- Larwsk Goncalves da Silva.. Self-Replication and Non-enzymatic Catalytic Networks subject to Open Flow. Trabajo Fin de Master.Universidad de Porto. 10/10/2018.
- Alfredo Sota Ballano.. Un sondeo espectroscópico de estrellas o galácticaS. Tesis Doctoral.Universidad Autónoma de Madrid (UAM). 03/12/2018.
- Srinitha Nimmakayala .. Validación de planetas tipo terrestre con imagen de alta resolución especial. Trabajo Fin de Master.Depto. Astrofísica Universidad Complutense de Madrid (UCM). 14/09/2018.

Courses / Teaching

- Actualización De La Calibración Fotométrica De La Cámara Omc. Albert Domingo Garau. Facultad De CienciasFísicas.Tutorías De Prácticas. 16/02/2018.
- Asignatura: Interacción VirusHospedador Clase: 'Los Aptámeros Y Sus Aplicaciones Como Antivirales Frente A Hiv Y Hcv'. Carlos Briones Llorente. Facultad DeC. Veterinaria. Universidad Complutense De Madrid.Doctorado. 05/11/2018.
- Biología Del Desarrollo. Salvador Mirete Castañeda. Facultad De Ciencias Biológicas, Universidad Complutense De Madrid.Licenciatura / Grado. 14/03/2018.
- Biotecnología Ambiental. Victorino Parro Garcia. Universidad Autonoma De Madrid.Master. 10/01/2018.
- Biotecnología Aplicada Al Medio Ambiente. Mercedes Moreno Paz. Universidad Complutense DeMadrid.Master. 16/10/2018.
- Clase 'El Origen De La Vida Y Su Búsqueda Fuera De La Tierra'. Carlos Briones Llorente. Universidad DeJaén.Doctorado. 15/03/2018.
- Clasificación De Estrellas Variables Observadas Con La Cámara Omc A Bordo Del Observatorio Espacial Integral. Albert Domingo Garau. Centro De Astrobiologia.Tutorías De Prácticas. 19/03/2018.

- **Edición Xvi (25 A 29 De Junio De 2018): 'Biomarkers: Signs Of Life Through Space And Time'. Carlos BrionesLlorente, Jose Miguel Mas Hesse. UniverisidadInternacional Menéndez Pelayo.Especializacion. 25/06/2018.**

- **Embo Practical Course Molecular Geobiology. Mercedes Moreno Paz. European Molecular BiologyLaboratory.Especializacion. 26/08/2018.**

- **Fundamentos De Ingeniería Genética Y Genómica. Salvador Mirete Castañeda. Facultad De Ciencias Biológicas, Universidad Complutense De Madrid.Licenciatura / Grado. 07/05/2018.**

- **Identificación De La Proteína Clorito Dismutasa (Cld) Mediante Inmunoensayos En Muestras Naturales Del Ártico Canadiense.. Mercedes Moreno Paz, Victorino Parro Garcia. Fundacion General De La Universidad DeAlcala.Tutorías De Prácticas. 17/05/2018.**

- **Iii Curso OnLine De Planetología Y Astrobiología. José Eduardo Gonzalez Pastor. Ilustre Colegio Oficial DeGeologos.Especializacion. 19/11/2018.**

- **Microbial Metagenomics: A 360º Approach. José Eduardo Gonzalez Pastor. European Molecular BiologyLaboratory.Especializacion. 23/04/2018.**

- **Molecular Geobiology. José Eduardo Gonzalez Pastor. European Molecular BiologyLaboratory.Especializacion. 26/08/2018.**

- **Photoshop Para Biólogos. Maria Lamprecht Grandio. Universidad De Alicante.Doctorado. 19/10/2018.**

- **Prácticas Curriculares Jesus García Martínez . Eduardo Sebastián Martínez. Universidad Carlos Iii.Tutorías DePrácticas. 22/01/2018.**

- **Practicas CurricularesJosé Alonso Sánchez. Eduardo Sebastián Martínez. Universiad De Alcalá DeHenares.Licenciatura / Grado. 02/04/2018.**

- **Programa 4ºEso+Empresa Curso 2017/2018 Durante 3 Dias, Se Propusieron A Los Alumnos Diversas Practicas Relacionadas Con La Astrofisica (Busqueda De Asteroides, Clasificacion De Estrellas Binarias Y Curvas De Luz, Etc) Y Se Les Hizo Participes De Las Actividades Habituales De Un Investigador En El Cab. . Maria Carmen Sanchez Contreras. Comunidad De Madrid.Tutorías DePrácticas. 19/03/2018.**

- **Technologies For The Detection Of Molecular Biomarkers Searching For Signs Of Life On Mars. Victorino Parro Garcia. Centro De Astrobiologia.Otros. 25/07/2018.**

- **Técnicas De Análisis Y Tecnologías Ómicas. Salvador Mirete Castañeda. Universidad Complutense De Madrid.Facultad De Biología.Master. 08/10/2018.**

- **The Origin And Early Evolution Of Life ¿ Parts 1, 2, 3 And 4. Carlos Briones Llorente. ObservatorioNacional.Especializacion. 01/10/2018.**

- **Virología Médica Y Veterinaria. María Ester Lázaro Lázaro. Universidad Autónoma De Madrid. DepartamentoDe Biología Molecular.Master. 11/01/2018.**

- **Virus De Microorganismos. María Ester Lázaro Lázaro. Universidad Complutense De Madrid.Master. 13/03/2018.**

Seminars, Conferences, Congresses and Communications

Seminars

- **Seminario 18-12-2018. La información contenida en la dispersión de los datos: el caso de poblaciones estelares.**
  Ponente: Miguel Cerviño, del Instituto de Astrofísica de Andalucía (IAA) Día: 18 de diciembre de 2018 Hora: 12:00 Lugar: Auditorio del Centro de Astrobiología…

- **Seminario 14-12-2018. Geomicrobiología de revestimientos minerales sobre roca en un ambiente ácido extremo: Río Tinto**
  Ponente: José Jordán investigador del Centro de Astrobiología (CSIC-INTA) Día: 14 de diciembre de 2018 Hora: 12:00 Lugar: Auditorio del Centro de…

- **Seminario 11-12-2018. Plasma en Aeronáutica y Otras Potencialidades de las Descargas Débilmente Ionizadas o Cómo Volar con el Cuarto Estado de la Materia**
  Ponente: Mario Sánchez García, investigador en el Departamento de Aerodinámica Experimental del INTA Día: 11 de diciembre 2018 Hora: 12:00 Lugar:…

- **Seminario 27-11-2018. "Historia de la exploración robótica de Marte"**
  Ponente: Daniel Marín (Eureka, Naukas, Radio Skylab) Día: 27 de noviembre de 2018 Hora: 12:00 Lugar: Auditorio del Centro de Astrobiología Instituto…

- **Seminario 20-11-2018. El origen de la vida: una aproximación desde la química de sistemas prebiótica**
  Ponente: Carlos Briones, investigador del Centro de Astrobiología (CSIC-INTA) Día: 20 de noviembre de 2018 Hora: 12:00 Lugar: Auditorio del Centro de…

- **Seminario 30-10-2018. "El 'icing' en aeronáutica, líneas de investigación actuales y futuras"**
  Ponente: Julio Mora Nogués, del Departamento de Estructuras y Materiales del INTA. Día: 30 de octubre de 2018 Hora: 12:00 Lugar: Auditorio del Centro…

- **Seminario 5-10-2018. La conexión entre la estructura y composición de la litosfera de Marte y su estado térmico.**
  Ponente: Laura Parro, investigadora predoctoral de Geología Planetaria en el Departamento de Geodinámica de la UCM. Día: 5 de octubre de 2018 Hora:…

- **Seminario 28-09-2018. Proyecto THOT: Datando las estrellas para entender la evolución de los sistemas exoplanetarios.**
  Ponente: Andrés Moya (Marie Sklodowsa-Curie Fellow en la Universidad de Birmingham. Día: 2u de septiembre de 2018 Hora: 12:00 Lugar: Auditorio del Centro…

- **Seminario 13-07-2018. Hábitats microbianos endolíticos como refugios para la vida en ambientes**

poliextremos del desierto de Atacama y análogos de Marte.
Ponente: Jacek Wierzchos (CSIC, Museo Nacional de Ciencias Naturales) Día: 13 de julio de 2018 Hora: 11:00 Lugar: Auditorio del Centro de Astrobiología…

- Seminario 6-07-2018. Misión Gaia y su segundo 'data release'.
  Ponente: Alcione Mora, miembro del equipo de Gaia en la ESAC Día: 6 de julio de 2018 Hora: 12:00 Lugar: Auditorio del Centro de Astrobiología Instituto…

- Seminario 26-06-2018. Cultura con C de Cosmos
  Ponente: Montserrat Villar, investigadora del Centro de Astrobiología Día: 26 de junio de 2018 Hora: 12:00 Lugar: Auditorio del Centro de Astrobiología…

- Seminario 19-06-2018. El inglés en el ámbito profesional científico-técnico.
  Ponente: Richard Vaughan, creador del método Vaughan. Día: 19 de junio de 2018 Hora: 12:00 Lugar: Auditorio del Centro de Astrobiología Título: “El…

- Seminario 15-06-2018. Operaciones 'Follow-the-Sun' de la Red de Espacio Profundo de la NASA (DSN/NASA) y actividades de radioastronomía en el Complejo de Comunicación del Espacio profundo de Canberra
  Ponente: Shinji Horiuchi, del Complejo de Comunicación del Espacio Profundo de Canberra -CDSCC-(CSIRO) Día: 15 de junio de 2018 Hora: 12:00 Lugar:…

- Seminario 12-06-2018. Supervivencia de extremófilos en el espacio: experimentos en la ISS y en las misiones del satélite Fotón
  Ponente: Rosa de la Torre Noetzel, del Departamento de la Tierra, A. Investigación e Instrumentación Atmosférica Día: 12 de junio de 2018 Hora: 12:00…

- Seminario 8-06-2018. Adaptación de los virus al aumento de la temperatura ambiental
  Ponente: Ester Lázaro, investigadora del Centro de Astrobiología Día: 8 de junio de 2018 Hora: 12:00 Lugar: Auditorio del Centro de Astrobiología…

- Seminario 1-06-2018. Cavidades desarrolladas en rocas magmáticas: troglobios y alteración de la roca. Aplicaciones a la vida extraterrestre
  Ponente: Laura González López, área de Defensa Biológica, departamento de Sistemas de Defensa NBQyM. Subdirección General de Sistemas Terrestres…

- Seminario 29-05-2018. Observaciones directas sobre microbios en condiciones extremas
  Ponente: Anurag Sharma, actualmente en la Universidad de Suffolk, Boston (EEUU). Día: 29 de mayo de 2018 Hora: 12:00 Lugar: Auditorio del Centro de Astrobiología…

- Seminario 22-05-2018. Biodiversidad en roca.
  Ponente: Felipe Gómez Gómez, investigador del Centro de Astrobiología (CSIC-INTA) Día: 22 de

mayo de 2018 Hora: 12:00 Lugar: Auditorio del Centro…

- **Seminario 6-2-2018. El misterioso metano marciano. Evaluación de las detecciones del rover Curiosity (cráter Gale, Marte) con el modelo MRAMS**
  Ponente: Jorge Pla-García, investigador de ciencias planetarias en el Centro de Astrobiología (CSIC-INTA) Día: 6 de febrero de 2018 Hora: 12:00 Lugar:…

- **Seminario 30-1-2018. La nueva era de los ELT: participación del CAB en el ELT-HARMONI**
  Ponente: Javier Piqueras López, Centro de Astrobiología (CSIC-INTA) Día: 30 de enero de 2018 Hora: 12:00 Lugar: Auditorio del Centro de Astrobiología…

Conferencess y Congresses

- Pyrite surface pretreatment drives aminoacids molecular interaction process. E. Mateo-Martí; M.Sanchez-Arenillas; S. Galvez-Martinez. Conferencia. Prebiotic molecules in space and origins of life on earth. 19/03/2018. Physikzentrum Bad Honnef (Germany)

- Presente y futuro de la Nanociencia y la Nanotecnología. Carlos Briones. Conferencia. Workshop NanoCathedral. 25/01/2018. Fundación Catedral Santa María

- El origen de la vida en la Tierra ¿o fuera de ella?. Carlos Briones. Conferencia. Ciclo de Seminarios de L'Acadèmia Mèdica Balear. 21/03/2018. Academia Médica Balear

- Replicationfirst vs Metabolismfirst. Carlos Briones. Comunicación Congreso. Puzzles and Solutions in Astrobiology. 14/05/2018. Earth Life Science Institute

- Characterization of viroid RNA structure at singlemolecule resolution by Atomic Force Microscopy. M. Moreno; L. Vázquez; M.A. López-Carrasco; J.A. Martín-Gago; R. Flores; C. Briones. Comunicación Congreso. VIII Reunión de la Red Temática Española de RNA (RiboRed 2018). 07/06/2018. Red Española de RNA

- RNA and DNA aptamers against HCV core protein of genotypes 1 to 4. B. Torres-Vázquez; M. Moreno; C.Briones. Comunicación Congreso. VIII Reunión de la Red Temática Española de RNA (RiboRed 2018). 07/06/2018. Red Española de RNA

- El origen de la vida en la Tierra ¿o fuera de ella?. Carlos Briones. Conferencia. Ciclo de Seminarios de la Facultad de Biología de la Universidad de Salamanca. 14/11/2018. UNIVERSIDAD DE SALAMANCA

- El origen de la vida. carlos briones. Conferencia. Ciclo de Seminarios del Centro de Astrobiología. 20/11/2018.

- Los aptámeros: una nueva aproximación al diagnóstico y terapia de infecciones virales. carlos briones. Conferencia. X Jornada Monográfica de la Sociedad Española de Virología. 14/12/2018. Sociedad Española de Virología

- On the use of star formation rate tracers in mixed star formation scenarios. Jose Miguel Mas Hesse. Comunicación Congreso. Escape of Lyman radiation from galactic labyrinths. 11/09/2018.

- Searching for Halpha emitting sources around MWC758. Huelamo, N.; Chauvin, G.; Schmid, H.M; Quanz, S.;Whelan, E.; Lillo-Box, J.; Barrado, D.; Montesinos, B.; Alcalá, J.; de Gregorio-Monsalvo, I.; Bouy, H.; Merin, B.. Comunicación Congreso. Diversis Mundi (OPSIII). 05/03/2018. EUROPEAN SOUTHERN OBSERVATORY ESO EUROPEAN ORGANISATION FOR ASTRONOMICAL RESEARCH IN THE SOUTHERN HEMISPHERE

- RECENT BIOMARKER TRANSITION IN A HIGH ALTITUDE HYDROTHERMAL SYSTEM (EL TATIO, CHILE).. D. Carrizo; L. Sánchez-García; V. Parro; S.L. Cady; N.W. Hinman; N.A. Cabrol. Comunicación Congreso. 49th Lunar and Planetary Science Conference 2018. 19/03/2018.

- LIFEDETECTION MARS ANALOG TESTING AT RIO TINTO. B. Glass; V. Parro; D. Bergman; C. Stoker; A.Wang; T. Stucky; M. García-Villadangos; J.M. Manchado; S. Seitz. Comunicación Congreso. 49th

Lunar and Planetary Science Conference 2018. 19/03/2018.

- Multianalytical detection of biomarkers on a 1msubsurface drill of an acidic environment (Rio Tinto) with analogies to Mars. Simulating a future drilling and bioanalysis on Mars polar latitudes.. L. Sánchez-García; D.Carrizo; M.A. Fernández-Martínez; M. García-Villadangos; J.M. Manchado; Y. Blanco; M. Moreno; C. Stoker; B. Glass; V . Parro. Comunicación Congreso. 49th Lunar and Planetary Science Conference 2018. 19/03/2018.

- A catalogue of White Dwarf from Gaia DR2 and the Virtual Observatory. Jiménez-Esteban, F. M.; Torres,S.; Rebassa-Mansergas, A.; Skorobogatov, G.; Solano, E.; Cantero, C.; Rodrigo, C.. Comunicación Congreso. V Reunión Científica de la REG. Encuentros en la segunda fase: GaiaDR2. 28/05/2018.

- Identification of binary and multiple systems in TGAS using the Virtual Observatory. Jiménez-Esteban,F.; Solano, E.. Comunicación Congreso. Astrometry and Astrophysics in the Gaia sky. 24/04/2018.

- Asteroides peligrosos para la Tierra. Jiménez-Esteban, F.. Comunicación Congreso. XXIII Congreso Estatal de Astronomía. 01/11/2018.

- Observatorio Virtual Español. Jiménez-Esteban, F.. Comunicación Congreso. XXIII Congreso Estatal de Astronomía. 01/11/2018.

- Influence of the pattern of change on adaptation to increased temperature in an RNA virus. PILARSOMOVILLA; SUSANNA MANRUBIA; ESTER LÁZARO. Comunicación Congreso. VI Congreso de la Sociedad Española de Biología Evolutiva. 18/01/2018.

- The Maseremitting Structure and Time Variability of the SiS Lines J=1413 and 1514 in IRC+10216. J. P . Fonfría; M. Fernández-López; J. R. Pardo; M. Agúndez; C. Sánchez Contreras; L. Velilla-Prieto; J. Cernicharo; M.Santander-García; G. Quintana-Lacaci; A. Castro-Carrizo; S. Curiel. Comunicación Congreso. Why Galaxies Care About AGB Stars. A Continuing Challenge through Cosmic Time. 21/08/2018.

- Circumstellar chemistry of SiC bearing molecules in the Crich AGB star IRC+10216. L. Velilla-Prieto;J. Cernicharo; M. Agúndez; J. P . Fonfría; A. Castro-Carrizo; G. Quintana-Lacaci; N. Marcelino; M. C. McCarthy; C. A. Gottlieb; C. Sánchez-Contreras; K. H. Young; N. A. Patel; C. Joblin; J. A. Martín-Gago. Comunicación Congreso. Why Galaxies Care About AGB Stars. A Continuing Challenge through Cosmic Time. 21/08/2018.

- Microfluidic mining of metagenomic libraries in the hunt for new resistance genes to extreme conditions. Joseph John White; Ana Luísa Ribeiro; Jorge Bravo; Jose Berenguer; Aurelio Hidalgo; Jose Eduardo González Pastor. Comunicación Congreso. RedEx. 23/05/2018.

- Primera etapa en la manipulación genética de la bacteria hiperhalófila Salinibacter ruber: búsqueda de mutaciones de resistencia a novobiocina. Sara Gómez de Frutos; José Eduardo González Pastor; Joseph John White. Comunicación Congreso. XV Reunión de la Red Nacional de Microorganismos Extremófilos. 23/05/2018. Red Nacional de Microorganismos Extremófilos

- Identificación de nuevos genes de resistencia a radiación ultravioleta de microorganismos de ambientes hipersalinos mediante metagenómica funcional. Macarena Benguigui; Jose Eduardo González Pastor. Alcalá de HenaresComunicación Congreso. I Workshop del programa de doctorado

en Investigación Espacial y Astrobiología. 29/11/2018. Universiad de

- Identification and characterization of asteroids using the WFCAM Transit Survey and the Virtual Observatory. Miriam Cortés-Contreras; Francisco M. Jiménez-Esteban; Enrique Solano; Benoit Carry; Carlos Rodrigo. ComunicaciónCongreso. XIII REUNIÓN CIENTÍFICA DE LA SOCIEDAD ESPAÑOLA DE ASTRONOMÍA. 16/07/2018. Sociedad Española de Astronomía

- Physical properties of asteroids using the WFCAM Transit Survey and the Virtual Observatory. Miriam Cortés-Contreras; Francisco M. Jiménez-Esteban; Enrique Solano; Benoit Carry; Carlos Rodrigo. Comunicación Congreso. European Planetary Science Congress 2018. 16/09/2018. Europlanet

- SVOast: A citizenscience project to identify NEAs and Mars crossers using the Virtual Observatory. Enrique Solano; Carlos Rodrigo; Benoit Carry; Miriam Cortés-Contreras. ComunicaciónCongreso. European Planetary Science Congress 2018 European Planetary Science Congress 2018. 16/09/2018. Europlanet

- Explotaition of the GTC/Osiris Public Archive using the Virtual Observatory. Miriam Cortés-Contreras;Enrique Solano; Herve Bouy; Max Mahlke; Francisco M. Jiménez-Esteban; J. Manuel Alacid. Comunicación Congreso. VI Meeting on Science with GTC. 12/12/2018. GRAN TELESCOPIO DE CANARIAS

- The NIRSpec GTO Galaxy Assembly IFS Survey. S. Arribas; R. Maiolino; P . Ferruit. Comunicación Congreso. European Week of Astronomy and Astrophysics. 02/04/2018.

- Preservation of organic matter on Mars: the role of the mineral matrix. Alberto G Fairén. ComunicaciónCongreso. American Geophysical Union Fall Meeting. 10/12/2018.

- Evidence for Shallow, oxic waters in the Gale Crater lake. alberto g fairén. Comunicación Congreso. AGU Fall Meeting. 10/12/2018.

- Source to sink history of sedimentary rocks in the study area of the Curiosity Rover (from Yellowknife Bay to Marias Pass Localities) in Gale Crater, Mars. alberto g fairén. Comunicación Congreso. AGU Fall Meeting. 10/12/2018.

- Oxychlorine detection in Gale Crater, Mars and implications for past environmental conditions. alberto g fairen. Comunicación Congreso. AGU Fall Meeting. 10/12/2018.

- Climate implications of an ancient lake basin in Gale Crater, Mars. alberto g fairen. ComunicaciónCongreso. COSPAR meeting. 14/07/2018.

- Constraining boron geochemistry in the Gale Crater subsurface environment: implications for prebiotic chemistry. alberto g fairen. Comunicación Congreso. AGU Fall Meeting. 10/12/2018.

- Evidence for alteration and diagenesis at Gale Crater, Mars from the Curiosity Rover. alberto g fairen. Comunicación Congreso. AGU Fall Meeting. 10/12/2018.

- Significance of flood deposits in Gale Crater, Mars. alberto g fairen. Comunicación Congreso. GSA Meeting. 04/11/2018.

- Rapid inundation of Gale Crater, Mars, by an expanding ocean. alberto g fairen. Comunicación Congreso. AAPG Meeting. 20/05/2018.

- **Deepsea fan sedimentation on Mars: an example from the Murray Formation at Pahrump Hills locality, Gale Crater. alberto g fairen. Comunicación Congreso. AAPG meeting. 20/05/2018.**

- **GALANTE: finding all the optically accessible Galactic O+B+WR stars in the Galactic Plane. MaízApellániz, J.; Alfaro, E. J.; Barbá, R. H.; Lorenzo, A.; Marín-Franch, A.; Ederoclite, A.; Varela, J.; Vázquez Ramió, H.; Cenarro, J.; Lennon, D. J.; García-Lario, P .. Comunicación Congreso. XIII Scientific Meeting of the Spanish Astronomical Society. 16/07/2018. Sociedad Española de Astronomía**

- **LiLiMaRlin and applications to OWN, MONOS, and CollDIBs. Maíz Apellániz, J.; Trigueros Páez, E.; JiménezMartínez, I.; Barbá, R. H.; Simón-Díaz, S.; Pellerin, A.; Negueruela, I.; Rodrigo Souza Leão, J.. Comunicación Congreso. Proceedings of the XIII Scientific Meeting of the Spanish Astronomical Society. 16/07/2018. sociedad española de astronomia**

- **The Gaia photometric calibration and results on Galactic runaways. Maíz Apellániz, J.; PantaleoniAstronomical Society. 16/07/2018. González, M.; Lennon, D. J.; Barbá, R. H.; Weiler, M.. Comunicación Congreso. Proceedings of the XIII Scientific Meeting of the Spanish**

- **A new classification scheme for Btype stars. Negueruela, I.; Simón, S.; Dorda, R.; González-Fernández, C.;Holgado, G..; Maíz Apellániz, J.; Monguió, M.; Berlanas, S. R.. Comunicación Congreso. Proceedings of the XIII Scientific Meeting of the Spanish Astronomical Society. 16/07/2018. sociedad española de astronomia**

- **OStar binaries in the Northern Hemisphere. Explotation of the LiLiMaRlin data. Trigueros Páez, E.;Negueruela, I.; Maíz Apellániz, J.. Comunicación Congreso. Proceedings of the XIII Scientific Meeting of the Spanish Astronomical Society. 16/07/2018.**

- **Mimicking cosmic dust in the laboratory. The STARDUST machine. Jesús Sobrado; Gonzalo Santoro; LidiaMartínez; Koen Lauwaet; Yves Huttel; Gary Ellis; I.Tanarro; V . Herrero; José Cernicharo; José A. Martín-Gago; Chistine Joblin. Comunicación Congreso. European Vacuum Conference EVC15. 17/06/2018.**

- **STARDUST: experimental station for generation, processing and diagnostics of nanoparticles of astrophysical interest. Lidia Martínez; Koen Lauwaet; Gonzalo Santoro; Jesús M. Sobrado; Ramón J. Peláez; Iabel Tanarro; V. J.Herrero; Gary Ellis; José Cernicharo; Chistine Joblin; Yves Huttel; José A. Martín-Gago. Comunicación Congreso. Europhysics Conference on the Atomic and Molecular Physics of Ionized Gases, ESCAMPIG 2018. 17/07/2018.**

- **A plausible prebiotic hydrocyanic origin of cofactor building blocks and other biorganics. Marta RuizBermejo. Conferencia. ELSI 6th Symposium: Building brigdes from Earth to life. 08/01/2018. Tokyo Institute of Technology**

- **Photochemistry of cyanide in water/ice interphases: Implications for icy words. Marta Ruiz-Bermejo;Margarita R. Marín-Yaseli; Elena González-Toril. Comunicación Congreso. 18 th European Workshop on Astrobiology (EANA 18). 24/09/2018. European Astrobiology Network Association**

- **Estudio de las estrategias de adaptación a variaciones en la concentración de sal en poblaciones naturales de hiperhalófilos mediante análisis metatranscriptómico. Salvador Mirete; Maria Lamprecht Grandío; Eduardo González Pastor. Conferencia. XV Reunión de la Red Nacional de Microorganismos Extremófilos. 25/05/2018. Red Nacional de Extremófilos**

- Pyrite surface a crucial substrate for small peptides adsorption.. E. Mateo-Martí; S. Gálvez-Martínez. Comunicación Congreso. EANA. 24/09/2018.

- Small peptides adsorption on sputtered modify pyrite surface by XPS. S. Gálvez-Martínez; E. Mateo-Martí. Comunicación Congreso. EANA 2018. 24/09/2018.

- Aminoacids and small peptides on mineral surfaces: molecular interaction process. E. Mateo-Martí; S.Gálvez-Martínez; M.Sánchez-Arenillas. Comunicación Congreso. WEHeraeusSeminar on 'Prebiotic Molecules in Space and Origings of Life on Earth',. 20/03/2018.

- Entropic analysis of chiral symmetry breaking in enantioselective hypercycles. David Hochberg; Josep M.Ribó. Comunicación Congreso. Solvay Workshop "Chiral Symmetry Breaking at Molecular Level". 28/11/2018. SOLVAY SA

- Chemical Networks able to show spontaneous mirror symmetry breaking in chemical scenarios. David Hochberg; Josep M. Ribó. Comunicación Congreso. Solvay Workshop: "Chiral Symmetry Breaking at Molecular Level". 28/11/2018. SOLVAY SA

- Noisecontrolled chemical fluxes and pathways in a cubicautocatalytic reaction system. DavidHochberg. Comunicación Congreso. Gordon Research Conference: Systems Chemistry. 29/07/2018. Gordon Research Conferences

- Looking for new waterfountain stars. Uscanga, Lucero; Gómez, José F.; Yung, B.H.K; Imai, H.; Rizzo, J. R.; Suárez,O.; Miranda, L. F.; Trinidad, M. A.; Anglada, G.; Torrelles, J. M.. Comunicación Congreso. Why Galaxies Care About AGB Stars: A Continuing Challenge through Cosmic Time. IAU Symposium 343. 20/08/2018.

- CAB contribution ELTHARMONI: updates after the PDR. Piqueras López, J.; Arribas, S.; Crespo Gómez, A.. Comunicación Congreso. XIII Scientific Meeting of the Spanish Astronomical Society. 20/07/2018.

- Twodimensional stellar kinematics with SINFONI: probing the gravitational potential of local LIRGs. Crespo Gómez, A.; Piqueras López, J.; Arribas, S.. Comunicación Congreso. KMOS@5: Star and Galaxy Formation in 3D Challenges at KMOS 5th Year. 03/12/2018.

- Dynamical properties determination from stellar kinematics in local LIRGs:the case of ESO320 G030. Crespo Gómez, A.; Piqueras López, J.; Arribas, S.. Comunicación Congreso. XIII Scientific Meeting of the Spanish Astronomical Society. 16/07/2018.

- CAB contribution ELTHARMONI. Piqueras López, J.; Arribas, S.; Estrada, A.; Crespo Gómez, A.. ComunicaciónCongreso. Encuentro RIASpaceTec: Instrumentación astronómica en España. 03/10/2018.

- The host galaxies of luminous type 2 AGN at z∼0.30.4. Juan José Urbano Mayorgas; Montserrat VillarMartin; Fernando Buitrago. Comunicación Congreso. XIII Reunión Científica de la Sociedad Española de Astronomía (SEA) en Salamanca 2018.. 16/07/2018. Sociedad Española de Astronomía

- Asteroseismology contributions to brown dwarf research. Barceló Forteza, S.. Comunicación Congreso. Formation of substellar objects: Theory and observations. 21/05/2018.

- Tracing back the mass loss history of MGE042.0787+00.5084. C. Bordiu; J. R. Rizzo; A. Ritacco.

Comunicación Congreso. XIII Reunión Científica de la Sociedad Española de Astronomía. 16/07/2018. Sociedad Española de Astronomía

- Evaluation of instruments for coming Europa missions to conduct research on astrobiology. KereszturiA.; Prieto-Ballesteros O.; Blanc M.; Gomez-Elvira J.; Westall F. Comunicación Congreso. Lunar and Planetary Science Conference 49. 19/03/2018.

- Serpentinization on ocean worlds a study in infrared. J. Neto-Lima; M. Fernández-Sampedro; O. PrietoBallesteros. Comunicación Congreso. Lunar and Planetary Science Conference 49. 19/03/2018.

- Experimental Simulation of Cryomagmatic Processes. Water Ice, Clathrates and Salts. V. MuñozIglesias; O. Prieto-Ballesteros; I. López.. Comunicación Congreso. Cryovolcanism in the Solar System workshop. 05/06/2018.

- Analog studies on Iceland for support of the MEDA instrument of the future Mars 2020 NASA mission. O. Prieto-Ballesteros; A. Molina; D. Carrizo; J. Neto-Lima; V. Muñoz-Iglesias; Maria Teresa Fernandez-Sampedro; JoseAntonio Rodriguez-Manfredi. Comunicación Congreso. European Planetary Science Congress 2018. 16/09/2018.

- Evolution of the thermal properties of ocean aqueous solutions from Archean chemical compositions to modern seawater. Victoria Muñoz-Iglesias; Olga Prieto-Ballesteros. Comunicación Congreso. European Planetary Science Congress 2018. 16/09/2018.

- Preservation of Organic Matter on Mars: The Role of the Mineral Matrix. A. G. Fairén; E. Mateo-Martí; C.Robas; V . Muñoz-Iglesias; D. Carrizo; M. Fernández Sampedro; O. Prieto-Ballesteros; L. Gago-Duport; E. Losa-Adams; N. Lanza; P . J. Gasda; J. L. Bishop; C. Gil-Lozano.. Comunicación Congreso. American Geophysical Union. AGU Fall Meeting 2018. 10/12/2018.

- Análogos terrestres en Planetología. O. Prieto Ballesteros; V. Muñoz-Iglesias. Comunicación Congreso. Congreso Estatal de Astronomía CEA 2018. 01/11/2018.

- Estabilidad de los hidratos del sulfato de magnesio en la superficie de Europa. M. Fernández-Sampedro;V . Muñoz-Iglesias; E. Mateo-Marti; O. Prieto-Ballesteros. Comunicación Congreso. O. Prieto Ballesteros y V. MuñozIglesias. 01/11/2018.

- The envelope of the power spectra of over a thousand delta Scuti stars. Barceló Forteza, S.. ComunicaciónCongreso. SONG 2018. 1st workshop on Science with SONG: 4 more years. 23/10/2018.

- DataLink: Feedback from an implementation for stellar libraries.. Rodrigo, C.; Solano, E.. ComunicaciónCongreso. Asterics DADI Technology Forum 4. 16/04/2018. ASTERICS

- SVO work on stellar libraries. Rodrigo, C.; Solano, E.. Comunicación Congreso. ISSIBJ Meeting: Stellar Libraries of 2020. 24/05/2018. International Space and Science Institut

- Exoplanet hoststar properties: the active environment of exoplanets. D. Barrado; E. Solano. ComunicaciónCongreso. Origins: from the Protosun to the First Steps of Life. 20/08/2018.

- DataLink: Feedback from an implementation for stellar libraries.. Rodrigo, C.; Solano, E.. ComunicaciónCongreso. IVOA Interoperability meeting. 31/05/2018.

- SVOCat: Easily publishing catalogues in the VO (and web). Rodrigo, C.. Comunicación Congreso. Second European Data Provider Forum and Training Event. 27/06/2018. ASTERICS

- A "Hello World" in the VO: Nave tutorial: detailed and super simplified development of a VO Simple ConeSearch Service from scratch. Rodrigo, C.. Comunicación Congreso. Second European Data Provider Forum and Training Event. 01/06/2018. ASTERICS

- Clusterix. E. Solano. Comunicación Congreso. V Reunión Científica de la Red Española de Gaia. 28/05/2018. Universitat Barcelona

- VO tools for Gaia. E. Solano; C. Rodrigo. Comunicación Congreso. V Reunión Científica de la Red Española de Gaia. 28/05/2018. UNIVERSITAT DE BARCELONA

- VOSA: SED building and analysis of thousands of stars in the framework of Gaia. C. Rodrigo; E. Solano;Amelia Bayo; Miriam Cortés-Contreras; F. Jiménez-Esteban. Comunicación Congreso. XIII REUNIÓN CIENTÍFICA DE LA SOCIEDAD ESPAÑOLA DE ASTRONOMÍA. 16/07/2018. Sociedad Española de Astronomía

- Culture with C for Cosmos (Cultura con C de Cosmos). Montserrat Villar. Comunicación Congreso. European Week for Astronomy and Space Science (EWASS). 03/04/2018. European Astronomical Society

- Multiphase characterization of outflows observed in type 2 radioquiet QSOs using nearinfrared EMIR/GTC data. Enrica Bellocchi; Montserrat Villar. Comunicación Congreso. European Week of Astronomy and Space Science (EWASS 2018). 03/04/2018. Royal Astronomical Society

- The exotic emission line spectra of extremely red BOSS quasars. Montserrat Villar; Andrew Humphrey;Luc Binette. Comunicación Congreso. Reunión Científica 2018. Sociedad Española de Astronomía.. 16/07/2018. Sociedad Española de Astronomía

- Cultura con C de Cosmos. Montserrat Villar; David Barrado; José A. Caballero; Carlos Briones; Ester Lazaro; JuanAngel Vaquerizo; Eva Villaver. Comunicación Congreso. Reunión Científica 2018. Sociedad Española de Astronomía.. 16/07/2018. Sociedad Española de Astronomía

- Radio Astronomy from DSN Madrid Complex. J. R. Rizzo. Comunicación Congreso. SCIENCE WITH A POTENTIAL UAE DEEP SPACE NETWORK ANTENNA. 25/03/2018.

- Herschel ObservaonsAstronomy and Space Science. 03/04/2018. of Molecular Emission in Low and IntermediateMass EvolvedStars. P . Garcia-Lario; J. Ramos-Medina; C. Sanchez Contreras; J. Da Silva Santos. Comunicación Congreso. European Week of

- Caracterización de las comunidades microbianas de los tapetes sobre la franja térmica de Cerro Caliente, isla Decepción (Antártida). Mercedes Moreno-Paz; Miguel Angel Fernández-Martínez; Graciela de Diego-Castilla;de 2018.. 05/09/2018. Instituto geológico y minero de EspañaFernando Puente-Sánchez; Yolanda Blanco; Parro Víctor. Comunicación Congreso. IX simposio de Estudios Polares. 5 7 de septiembre

- MEGARA, the R=600020000 IFU and MOS of GTC. Carrasco, E.; Gil de Paz, A.; Gallego, J.; Iglesias-Páramo,J.; Cedazo, R.; García Vargas, M. L.; Arrillaga, X.; Avilés, J. L.; Bouquin, A.; Carbajo, J.; Cardiel, N.; Carrera, M. A.; Castillo Morales, A.; Castillo-Domínguez, E.; Esteban San Román, S.; Ferrusca, D.; Gómez-Álvarez, P .; Izazaga-Pérez, R.; Lefort, B.; López Orozco, J. A.; Maldonado, M.;

Martínez Delgado, I.; Morales Durán, I.; Mújica, E.; Ortiz, R.; Páez, G.; Pascual, S.; Pérez-Calpena, A.; Picazo, P .; Sánchez-Penim, A.; Sánchez-Blanco, E.; Tulloch, S.; Velázquez, M.; Vílchez, J. M.; Zamorano, J.; Aguerri, A. L.; Barrado, D.; Bertone, E.; Cava, A.; Catalán-Torrecilla, C.; Cenarro, J.; Chávez, M.; Dullo, B. T.; Eliche, C.; García, Mi.; García-Rojas, J.; Guichard, J.; GonzálezDelgado, R.; Guzmán, R.; Herrero, A.; Huélamo, N.; Hughes, D. H.; Jiménez-Vicente, J.; Kehrig, C.; Marino, R. A.; Márquez, I.; Masegosa, J.; Mayya, D.; Méndez-Abreu, J.; Mollá, M.; Muñoz-Tuñón, C.; Peimbert, M.; Pérez-González, P . G.; Pérez-Montero, E.; RocaFàbrega, S.; Rodríguez, M.; Rodríguez-Espinosa, J. M.; Rodríguez-Merino, L.; Rodríguez-Muñoz, L.; Rosa-González, D.; SánchezAlmeida, J.; Sánchez Contreras, C.; Sánchez-Blázquez, P .; Sánchez, S. F.; Sarajedini, A.; Silich, S.; Simón-Díaz, S.; Tenorio-Tagle, G.; Terlevich, E.; Terlevich, R.; Torres-Peimbert, S.; Trujillo, I.; Tsamis, Y.; Vega, O.. Comunicación Congreso. Proceedings of the SPIE, Volume 10702, id. 1070216 21 pp. (2018).. 06/07/2018.

- Geomicrobiología de los "nunataks" de isla Livingston (Antártida) como posible modelo del Marte temprano frío y húmedo. Miguel Ángel Fernández-Martínez; Miriam García Villadangos; Yolanda Blanco López; Mercedes MorenoPaz; Juan Manuel Manchado Ortega; Laura Sánchez-García; Victor Parro. Comunicación Congreso. IX simposio de Estudios Polares. 5 7 de septiembre de 2018. Madrid. España.. 05/09/2018. INSTITUTO GEOLOGICO Y MINERO DE ESPAÑA

- Caracterización geomicrobiológica de nichos asociados a rocas de región hiperárida del desierto de Atacama (Chile).. Mercedes Moreno-Paz; Miguel Ángel Fernández-Martínez; Juan Manuel Manchado Ortega; Yolanda BlancoLópez; Miriam García Villadangos; Laura Sánchez García; Victorino Parro García. Comunicación Congreso. XV Reunión de la Red Nacional de Microorganismos Extremófilos, Matalascañas (Huelva), 2018. 23/05/2018. Universidad de Alicante

- Identification of molecular biomarkers in subsurface evaporites of Salar Grande (Atacama, Chile) with analogies to Mars halite deposits.. L. Sánchez-García; C. Aeppli; V. Parro; D. Fernández-Remolar; M. García-Villadangos;G. Chong-Diaz; Y. Blanco; D. Carrizo. Comunicación Congreso. European Geosciences Union General Assembly (EGU18), Vienna (Austria).. 08/04/2018. European Geosciences Union (EGU)

- Organizador: responsable del Scientific Organizing Commiitte y miembro del Local Organizing Committee. María Morales-Calderón; Nuria Huélamo; Benjamín Montesinos; David Barrado; Margie Guitart; Carlos Rodrigo Blanco;Bruno Merín; Ignacio Mendigutía. Comunicación Congreso. Formation of substellar objects: Theory and observations. 21/05/2018. European Space Astronomy Center

- Searching for Short GRBs in Soft Gamma Rays with INTEGRAL/PICsIT. Rodi, James; Bazzano, Angela;Ubertini, Pietro; Natalucci, Lorenzo; Savchenko, V .; Kuulkers, E.; Ferrigno, Carlo; Bozzo, Enrico; Brandt, Soren; Chenevez, Jerome; Courvoisier, T. J.-L.; Diehl, R.; Domingo, A.; Hanlon, L.; Jourdain, E.; von Kienlin, A.; Laurent, P .; Lebrun, F.; Lutovinov, A.; MartinCarrillo, A.; Mereghetti, S.; Roques, J.-P .; Sunyaev, R.. Comunicación Congreso. 231st American Astronomical Society Meeting. 08/01/2018.

- Detection of Nitrites by the Sample Analysis at Mars (SAM) Instrument. Implications for the Oxidation State of the Atmosphere. R. Navarro-González; P . Coll; B. Sutter; J.C. Stern; C.P . Mckay; F.J. Martín-Torres; M.-P .Zorzano-Mier; P .D. Archer; A. Buch; M. Cabane; D. Coscia; D. Glavin; H.B. Franz; C. Freissinet; A.C. McAdam; D.W. Ming; B.D. Prats; F. Raulin; C. Szopa; S. Teinturier; P . Mahaffy; C.A. Malespin; A.R. Vasavada. Comunicación Congreso. 49th LPSC Lunar and Planetary Science Conference 2018. 19/03/2018.

- Optical and Xray observations of the microquasar V404 Cyg during its June 2015 outburst. AlfonsoGarzón, J.; Sánchez-Fernández, C.; Charles, P . A.; Mas-Hesse, J. M.; Gandhi, P .; Kimura, M.; Domingo, A.; Rodriguez, J.; Chenevez, J.. Comunicación Congreso. XIII Reunión Científica de la Sociedad Española de Astronomía (SEA). 16/07/2018. Universidad de Salamanca

- INTEGRAL observations of the gravitationalwave gammaray counterparts. Savchenko, Volodymyr;Ubertini, Pietro; Bazzano, Angela; Courvoisier, Thierry; Kuulkers, Erik; Lebrun, Francois; Lutovinov, Alexander; Chenevez, J.; Brandt, S.; Natalucci, Lorenzo; Laurent, Philippe; Ferrigno, Carlo; Bozzo, Enrico; Jourdain, Elisabeth; Roques, Jean-Pierre; Mereghetti, Sandro; Sunyaev, Rashid; Hanlon, Lorraine; Rodi, James; Diehl, Roland; Domingo, Albert; Von Kienlin, Andreas; Martin-Carrillo, Antonio. Comunicación Congreso. 42nd COSPAR Scientific Assembly. 14/07/2018.

- SOLIS VII: Methanol towards L1544. Jimenez-Serra, I.. Conferencia. GEMS (Gas phase Elemental abundances in Molecular cloudS) workshop. 18/09/2018. Observatorio Astronomico Nacional

- The instrument HABIT (HabitAbility, Brine Irradiation and Temperature) on the ExoMars platform. Javier Martin-Torres; María-Paz Zorzano. Comunicación Congreso. The COSPAR 2018 Scientific Assembly Program. 14/06/2018.

- Environmental observations of present day Mars and implications for habitability. María-Paz Zorzano;Javier Martin-Torres. Comunicación Congreso. The COSPAR 2018 Scientific Assembly Program. 14/06/2018.

- MIRI/JWST Integral field spectrograph. Luis Colina Robledo. Comunicación Congreso. JWST IAC GO1 workshop. 26/02/2018.

- Chair, Comité científico. Luis Colina Robledo. Comunicación Congreso. The Highz Universe Science with MIRI/JWST. 22/01/2018.

- Effect of UV radiation on the transcriptome of the lichen Circinaria gyrosa. Rosa de la Torre Noetzel;Carolina González de Figueras; Elisa Arquero; Andrea Pedraz; Jose E. González-Pastor. Comunicación Congreso. European Astrobiology Conference EANA 2018. 24/09/2018. European Astrobiology Network Association

- Tengo canas en el c.... Natalia Ruiz Zelmanovitch. Conferencia. LA VIDA EN EL UNIVERSO. 17/11/2018. Museo Nacional de Ciencia y Tecnología

- Dust in Active Galactic Nuclei: A close look at the torus and its surroundings. Almudena Alonso Herrero. Comunicación Congreso. Cosmic Dust: origins, applications and implications. 11/06/2018.

- The host galaxies of AGN. Almudena Alonso Herrero. Comunicación Congreso. Are AGN special?. 30/07/2018. Durham University

- The AGNstarburst connection. Almudena Alonso Herrero. Comunicación Congreso. From First Stars to Life: Science with the Origins Space Telescope. 04/09/2018. Oxford University

- Grantecan/CanariCam. Almudena Alonso Herrero. Comunicación Congreso. The Next Generation of ThermalIR Astronomy: How can we Reach the Photon Noise Limit?. 12/11/2018. Lorentz Center

- The dusty molecular torus of Seyfert galaxies is full of surprises. Almudena Alonso Herrero. ComunicaciónCongreso. TORUS 2018 The many faces of the AGN obscuration. 10/12/2018.

- CARMENES: highresolution spectra and precise radial velocities in the red and infrared. Quirrenbach, A.; Amado, P . J.; Ribas, I.; Reiners, A.; Caballero, J. A.; Seifert, W.; Aceituno, J.; Azzaro, M.; Baroch, D.; Barrado, D.; Bauer, F.; Becerril, S.; Bèjar, V . J. S.; Benítez, D.; Brinkmöller, M.; Cardona Guillén, C.; Cifuentes, C.; Colomé, J.; Cortés-

Contreras, M.; Czesla, S. Dreizler, S.; Frölich, K.; Fuhrmeister, B.; Galadí-Enríquez, D.; González Hernández, J. I.; González Peinado, R.; Guenther, E. W.; de Guindos, E.; Hagen, H. -J.; Hatzes, A. P .; Hauschildt, P . H.; Helmling, J.; Henning, Th.; Herbort, O.; Hernández Castaño, L.; Herrero, E.; Hintz, D.; Jeffers, S. V .; Johnson, E. N.; de Juan, E.; Kaminski, A.; Klahr, H.; Kürster, M.; Lafarga, M.; Sairam, L.; Lampón, M.; Lara, L. M.; Launhardt, R.; López del Fresno, M.; López-Puertas, M.; Luque, R.; Mandel, H.; Marfil, E. G.; Martín, E. L.; Martín-Ruiz, S.; Mathar, R. J.; Montes, D.; Morales, J. C.; Nagel, E.; Nortmann, L.; Nowak, G.; Pallé, E.; Passegger, V . -M.; Pavlov, A.; Pedraz, S.; Pérez-Medialdea, D.; Perger, M.; Rebolo, R.; Reffert, S.; Rodríguez, E.; Rodríguez López, C.; Rosich, A.; Sabotta, S.; Sadegi, S.; Salz, M.; Sánchez-López, A.; Sanz-Forcada, J.; Sarkis, P .; Schäfer, S.; Schiller, J.; Schmitt, J. H. M. M.; Schöfer, P .; Schweitzer, A.; Shulyak, D.; Solano, E.; Stahl, O.; Tala Pinto, M.; Trifonov, T.; Zapatero Osorio, M. R.; Yan, F.; Zechmeister, M.; Abellán, F. J.; Abril, M.; AlonsoFloriano, F. J.; Ammler-von Eiff, M.; Anglada-Escudé, G.; Anwand-Heerwart, H.; Arroyo-Torres, B.; Berdiñas, Z. M.; Bergondy, G.; Blümcke, M.; del Burgo, C.; Cano, J.; Carro, J.; Cárdenas, M. C.; Casal, E.; Claret, A.; Díez-Alonso, E.; Doellinger, M.; Dorda, R.; Feiz, C.; Fernández, M.; Ferro, I. M.; Gaisné, G.; Gallardo, I.; Gálvez-Ortiz, M. C.; García-Piquer, A.; García-Vargas, M. L.; Garrido, R.; Gesa, L.; Gómez Galera, V .; González-Álvarez, E.; González-Cuesta, L.; Grohnert, S.; Grözinger, U.; Guàrdia, J.; Guijarro, A.; Hedrosa, R. P .; Hermann, D.; Hermelo, I.; Hernández Arabí, R.; Hernández Hernando, F.; Hidalgo, D.; Holgado, G.; Huber, A.; Huber, K.; Huke, P .; Kehr, M.; Kim, M.; Klein, R.; Klüter, J.; Klutsch, A.; Labarga, F.; Labiche, N.; Lamert, A.; Laun, W.; Lázaro, F. J.; Lemke, U.; Lenzen, R.; Llamas, M.; Lizon, J. -L.; Lodieu, N.; López González, M. J.; López-Morales, M.; López Salas, J. F.; López-Santiago, J.; Magán Madinabeitia, H.; Mall, U.; Mancini, L.; Marín Molina, J. A.; Martínez-Rodríguez, H.; Maroto Fernández, D.; Marvin, C. J.; Mirabet, E.; Moreno-Raya, M. E.; Moya, A.; Mundt, R.; Naranjo, V .; Panduro, J.; Pascual, J.; Pérez-Calpena, A.; Perryman, M. A. C.; Pluto, M.; Ramón, A.; Redondo, P .; Reinhart, S.; Rhode, P .; Rix, H. -W.; Rodler, F.; Rohloff, R. -R.; Sánchez-Blanco, E.; Sánchez Carrasco, M. A.; Sarmiento, L. F.; Schmidt, C.; Storz, C.; Strachan, J. B. P .; Stürmer, J.; Suárez, J. C.; Tabernero, H. M.; Tal-Or, L.; Tulloch, S. M.; Ulbrich, R. -G.; Veredas, G.; Vico Linares, J. L.; Vidal-Dasilva, M.; Vilardell, F.; Wagner, K.; Winkler, J.; Wolthoff, V .; Xu, W.; Zhao, Z.. Comunicación Congreso. SPIE Astronomical Telescopes + Instrumentation 2018. 11/06/2018. Society of PhotoOptical Instrumentation Engineers (SPIE)

- Spanish participation in SPICA: SAFARI. F. Najarro; J. Martin-Pintado; A. Gómez. Comunicación Congreso. Encuentro RIASpaceTec: Instrumentación astronómica en España. 03/10/2018.

- Seven years in the cyclic coronal life of iota Hor. Sanz-Forcada, J.; Stelzer, B.; Coffaro, M.. ComunicaciónCongreso. Timedomain astronomy: a high energy view. 13/06/2018. ESACESA (Agencia Espacial Europea)

- 15 years of INTEGRAL/OMC monitoring. Albert Domingo; Julia Alfonso-Garzón; J. Miguel Mas-Hesse. Comunicación Congreso. XIII Reunión Científica de la Sociedad Española de Astronomía (SEA). 16/07/2018. Universidad de Salamanca

- The ATHENA Xray Integral Field Unit (XIFU). Barret, Didier; Lam Trong, Thien; den Herder, Jan-Willem; Piro,Luigi; Cappi, Massimo; Houvelin, Juhani; Kelley, Richard; Mas-Hesse, J. Miguel; Mitsuda, Kazuhisa; Paltani, Stéphane; Rauw, Gregor; Rozanska, Agata; Wilms, Joern; Bandler, Simon; Barbera, Marco; Barcons, Xavier; Bozzo, Enrico; Ceballos, Maria Teresa; Charles, Ivan; Costantini, Elisa; Decourchelle, Anne; den Hartog, Roland; Duband, Lionel; Duval, Jean-Marc; Fiore, Fabrizio; Gatti, Flavio; Goldwurm, Andrea; Jackson, Brian; Jonker, Peter; Kilbourne, Caroline; Macculi, Claudio; Mendez, Mariano; Molendi, Silvano; Orleanski, Piotr; Pajot, François; Pointecouteau, Etienne; Porter, Frederick; Pratt, Gabriel W.; Prêle, Damien; Ravera, Laurent; Sato, Kosuke; Schaye, Joop; Shinozaki, Keisuke; Thibert, Tanguy; Valenziano, Luca; Valette, Véronique;

Vink, Jacco; Webb, Natalie; Wise, Michael; Yamasaki, Noriko; Douchin, Françoise; Mesnager, Jean-Michel; Pontet, Bernard; Pradines, Alice; Branduardi-Raymont, Graziella; Bulbul, Esra; Dadina, Mauro; Ettori, Stefano; Finoguenov, Alexis; Fukazawa, Yasushi; Janiuk, Agnieszka; Kaastra, Jelle; Mazzotta, Pasquale; Miller, Jon; Miniutti, Giovanni; Naze, Yael; Nicastro, Fabrizio; Scioritino, Salavtore; Simonescu, Aurora; Torrejon, Jose Miguel; Frezouls, Benoit; Geoffray, Hervé; Peille, Philippe; Aicardi, Corinne; André, Jérôme; Daniel, Christophe; Clénet, Antoine; Etcheverry, Christophe; Gloaguen, Emilie; Hervet, Gilles; Jolly, Antoine; Ledot, Aurélien; Paillet, Irwin; Schmisser, Roseline; Vella, Bruno; Damery, Jean-Charles; Boyce, Kevin; Dipirro, Mike; Lotti, Simone; Schwander, Denis; Smith, Stephen; Van Leeuwen, Bert-Joost; van Weers, Henk; Clerc, Nicolas; Cobo, Beatriz; Dauser, Thomas; Kirsch, Christian; Cucchetti, Edoardo; Eckart, Megan; Ferrando, Philippe; Natalucci, Lorenzo. Comunicación Congreso. Space Telescopes and Instrumentation 2018: Ultraviolet to Gamma Ray. 11/06/2018. The Society of Photo Optical Instrumentation Engineers (SPIE)

- The intricate nebular architecture of "The Rotten Egg" disclosed by ALMA. C. Sanchez Contreras; J.Alcolea; V . Bujarrabal; A. Castro-Carrizo; L. Velilla Prieto; M. Santander-Garcia; G. Quintana-Lacaci; J. Cernicharo. Comunicación Congreso. XIII Reunión Científica de la Sociedad Española de Astronomía (SEA). 16/07/2018. Sociedad Española de Astronomía

- Searching for accreting protoplanets in transitional disks: SPHERE/ZIMPOL observations. N.Huelamo; G.Chauvin; A. Lagarrigue; M. Benisty; H.M. Schmidt; S. Quanz; E. Whelan; J.M.Alcala; D. Barrado; B. Montesinos; I. Mendigutia. Comunicación Congreso. Take a Closer Look: The innermost region of protoplanetary discs and its connection to the origin of planets. 15/10/2018. European Southern Observatory (Organismo Intergubernamental)

- Searching for pre and protobrown dwarfs in Barnard 30 with ALMA. N. Huelamo; I. de GregorioMOnsalvo; A. Palau; D. Barrado; A. Bayo; M.T. Ruiz; L. Zapata; M. Morales-Calderon; O. Morata; H. Bouy; C. Eiroa; F. Menard. Comunicación Congreso. Formation of substellar objects: theory and observations. 21/05/2018.

- SUPERCAM calibration target technical development and status. F. Rull; J. A. Manrique; G. Lopez-Reyes; J.Medina; J.M. Madariaga; G. Arana, J. Laserna; V . Garcia; R. Wiens; S. Mauric; A. Cousin; M. Madsen; C. Castro; C. Ortega; I. Sard; A. Fernández; E. Mateo-Martí; O. Prieto-Ballesteros. Comunicación Congreso. Lunar and Planetary Science Conference 49. 19/03/2018.

- First scientific observations with MEGARA at GTC. Gil de Paz, A.; Carrasco, E.; Gallego, J.; Iglesias-Páramo, J.;Cedazo, R.; García-Vargas, M. L.; Arrillaga, X.; Avilés, J. L.; Bouquin, A.; Carbajo, J.; Cardiel, N.; Carrera, M. A.; Castillo-Morales, A.; Castillo-Domínguez, E.; Esteban San Román, S.; Ferrusca, D.; Gómez-Álvarez, P .; Izazaga-Pérez, R.; Lefort, B.; López-Orozco, J. A.; Maldonado, M.; Martínez-Delgado, I.; Morales-Durán, I.; Mujica, E.; Páez, G.; Pascual, S.; Pérez-Calpena, A.; Picazo, P .; Sánchez-Penim, A.; Sánchez-Blanco, E.; Tulloch, S.; Velázquez, M.; Vílchez, J. M.; Zamorano, J.; Aguerri, A. L.; Barrado y Navascues, D.; Berlanas, S. R.; Bertone, E.; Cava, A.; Catalán-Torrecilla, C.; Cenarro, J.; Chávez, M.; Dullo, B. T.; García, M.; García-Rojas, J.; Guichard, J.; GonzálezDelgado, R.; Guzmán, R.; Herrero, A.; Huélamo, N.; Hughes, D. H.; Jiménez-Vicente, J.; Kehrig, C.; Marino, R. A.; Márquez, I.; Masegosa, J.; Mayya, D.; Méndez-Abreu, J.; Mollá, M.; Muñoz-Tuñón, C.; Peimbert, M.; Pérez-González, P . G.; Pérez-Montero, E.; Rodríguez, M.; Rodríguez-Espinosa, J. M.; Rodríguez Merino, L.; Rodríguez-Muñoz, L.; Rosa-González, D.; Sánchez-Almeida, J.; Sánchez-Contreras, C.; Sánchez-Blázquez, P .; Sánchez, S. F.; Sarajedini, A.; Silich, S.; Simón-Díaz, S.; Tenorio-Tagle, G.; Terlevich, E.; Terlevich, R.; Torres-Peimbert, S.; Trujillo, I.; Tsamis, Y.; Vega, O.. Comunicación Congreso. Proceedings of the SPIE, Volume 10702, id. 1070217 20 pp. (2018).. 06/07/2018.