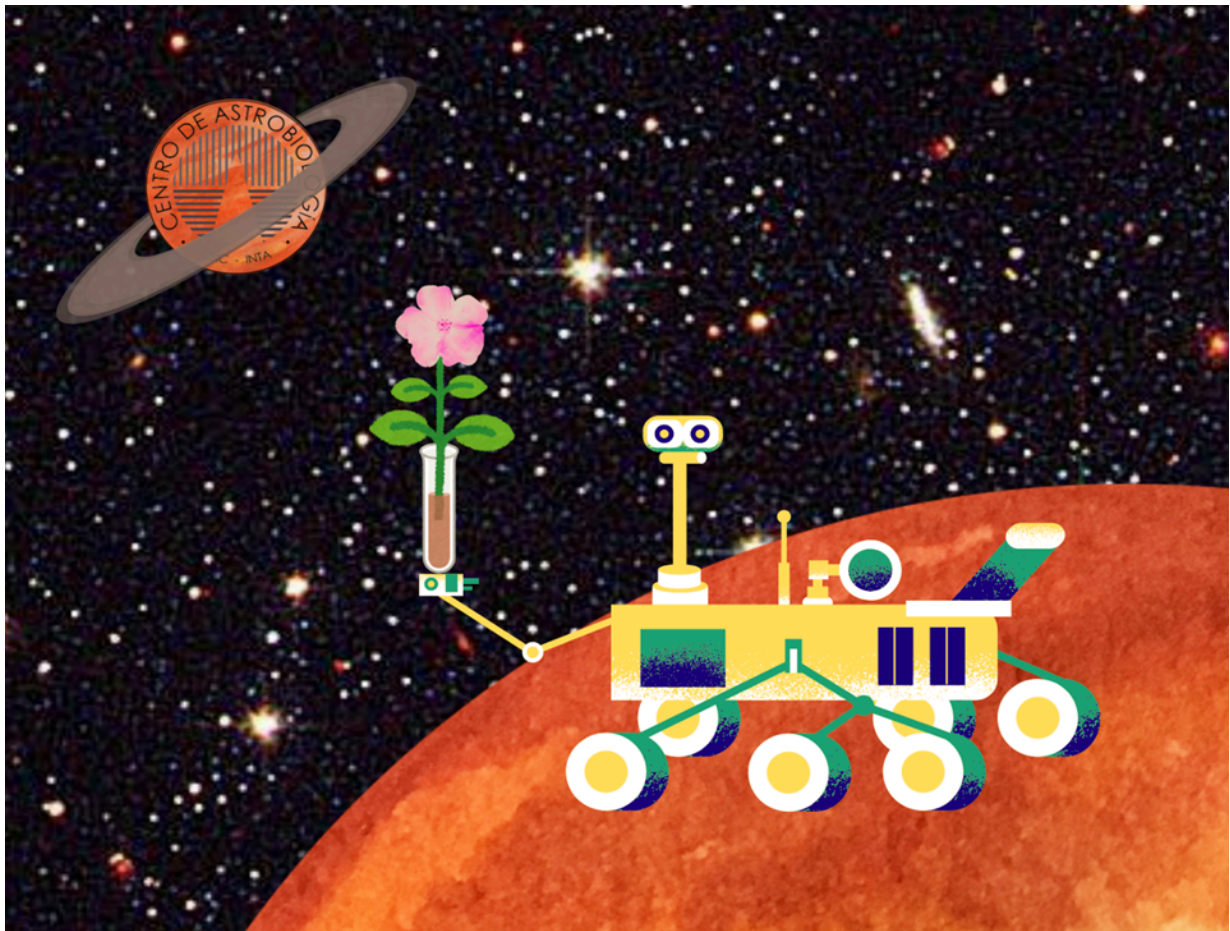
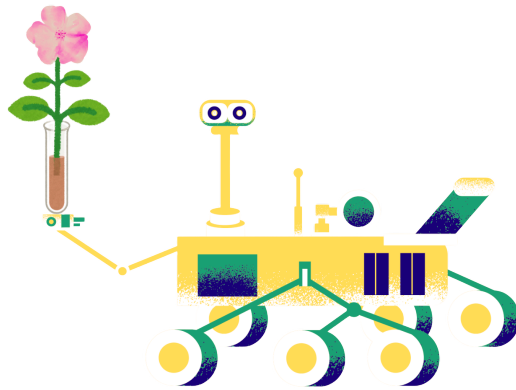


# Abstract Book



Keep you uP<sup>h</sup>Dated days  
CAB-INTA  
19<sup>th</sup>-21<sup>st</sup> January 2026





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# Welcome

Welcome once again to the **Keep You uPhDated Days CAB-INTA 2025/26**, the fourth edition of our in-house conference dedicated exclusively to predoctoral researchers conducting innovative studies at the Centro de Astrobiología (CAB) and the Instituto Nacional de Técnica Aeroespacial (INTA). Building on the success of previous editions, this year promises another insightful and enriching experience. Our program will feature 31 presentations and 8 posters spanning key areas such as Astrophysics and Astrochemistry, Planetology and Habitability, Molecular Evolution and Life Sciences, as well as Instrumentation and Space Missions. In response to the valuable feedback from previous events, we have designed a schedule that blends technical discussions with engaging non-technical activities, ensuring a dynamic and comprehensive experience for all participants.

This year, we are excited to highlight the following sessions. First, the Roundtable: ***Applying to grants and fellowships***. A stimulating discussion on the ropes of applying to grants and fellowships, including Spanish national grant (La Caixa) or international grant (Marie Curie). We are pleased to have in-house speakers Luca Costantin, Pablo Finkel and Inês Patrulho who will share their experience and insights for successful applications. You are invited to ask questions to create a lively discussion.

Second, we will have a seminar by David Carabantes Alarcón: ***How to properly use AI by PhD Students. How AI is affecting science?*** This seminar addresses how PhD students can use artificial intelligence (AI) in an appropriate, responsible, critical, and transparent manner, discussing best practices and associated risks, and reflecting on the impact that AI is having on contemporary science, with particular attention to the context of astrobiology and interdisciplinary research.

And finally the ***Mental Health Seminar***, led by Álvaro Santalla Arrebola. The seminar will address mental health in doctoral students and the factors associated with psychological distress at the individual, academic, and organizational levels. The latest research findings will be presented, and emotional regulation and self-care among doctoral candidates will be explored in depth.

We are confident that these activities, alongside the scientific presentations, will provide a comprehensive experience that fosters both academic and personal growth for all attendees. We also encourage you to make the most of the coffee breaks and rest periods to connect with your colleagues, exchange ideas, and learn more about the fascinating research being conducted by your peers. These informal moments are excellent opportunities to expand your network and spark interdisciplinary collaborations!

We extend our heartfelt gratitude to all presenters and attendees for their invaluable contributions to the success of this conference. We look forward to sharing an inspiring and memorable event with you!

Andrea, Carlota, Carmen, Ivanna, Bruno & Fuen (the organizing committee)

# Programme



## Monday 19th January

09:15 – 09:30	Registration and welcome
09:30 – 10:30	<b>Session 1 – La Sagra</b>
9:30 – 9:45	<b>Carla Alejandre:</b> A complexity-theory perspective on the origin of self-replicating RNA systems in prebiotic Earth
9:45 – 10:00	<b>Marina Fernández Ruz:</b> Strong parameter hierarchy in the interstellar phosphorus chemical network
10:00 – 10:15	<b>Jesús Gómez Mantecón:</b> Tracing Massive Stars and Extinction at Low Metallicity: Insights into the Early Universe
10:15 – 10:30	<b>Ángel Melguizo Baena:</b> Magnetometría y caracterización magnética de rocas de la erupción de Tajogaite de 2021
10:30 – 10:45	Coffee break
10:45 – 11:00	Poster Flash-talks
10:45 – 11:00	<b>Session 2 – Peñalara</b>
11:00 – 11:15	<b>Clara Lorenzo Corvo:</b> Characterization of Martian atmospheric turbulence using radiative measurements from the Radiation and Dust Sensor (RDS)
11:15 – 11:30	<b>Alberto Álvaro Díaz:</b> Spin Induction from Tidal Torquing in Hyperbolic Black Hole Encounters: An Analytical Approach
11:30 – 11:45	<b>Víctor Sansegundo Romero:</b> Estudio de la adsorción e interacción de biomoléculas en superficies minerales en condiciones ambientales y de Ultra Alto Vacío (UHV)
11:45 – 12:00	Coffee break
12:00 – 13:00	Round table: <i>Applying to grants and fellowships</i> <ul style="list-style-type: none"><li>- Luca Costantin (Talento, La Caixa)</li><li>- Pablo Finkel (ESA fellowship)</li><li>- Inês Patrulho (Marie Curie)</li></ul>

13:00 – 13:15	Coffee break
13:15 – 14:15	<b>Session 3 – Pico Almanzor</b>
13:15 – 13:30	<b>Juan A. Molina Calzada:</b> A Massive Star Census in the Magellanic Clouds
13:30 – 13:45	<b>Joaquín Delgado Amar:</b> Quantifying UV Photodesorption from Astrophysical CO Ices with FTIR and QMS
13:45 – 14:00	<b>Sergio Quevedo Caraballo:</b> Correlating techniques and methods for unequivocal life detection in planetary exploration
14:00 – 14:15	<b>Aitana Tasa-Chaveli:</b> Refractory and volatile sulfur in massive star-forming regions
14:15	Closing

# Tuesday 20th January

09:30 – 10:30	<b>Session 4 – Monte Perdido</b>
9:30 – 9:45	<b>Ana Varo O'Ferrall:</b> Attenuation Laws: Looking at Early Galaxies Through a Dusty Window
9:45 – 10:00	<b>Víctor Muñoz Hisado:</b> Microbial Diversity in Pyrenean Ice Caves
10:00 – 10:15	<b>Ángel Ortuño Carrión:</b> The secrets of Martian corrosion
10:15 – 10:30	<b>Alexandre Legault:</b> JWST's View of Massive Stars in the Arches Clustern
10:30 – 11:30	<b>Coffee break</b>
11:30 – 12:30	Seminar by David Carabantes Alarcón: <i>How to properly use AI by PhD Student. How AI is affecting science?</i>
12:30 – 12:45	<b>Coffee break</b>
12:45 – 13:30	<b>Session 5 – Posets</b>
12:45 – 13:00	<b>Andrea Hidalgo Arias:</b> Molecular adaptations of Bacillus subtilis under Mars surface simulation
13:00 – 13:15	<b>Sergio Angulo Cosín:</b> GNSS SpAmming: ataques de denegación de servicio GNSS basados en spoofing
13:15 – 13:30	<b>Leonor Arriscado:</b> Chasing the dust: what the UV bump tells us about galaxies
13:30 – 13:45	<b>Coffee break</b>
13:45 – 14:30	<b>Session 6 - Veleta</b>
13:45 – 14:00	<b>Sergio Turrado Prieto:</b> Exploring the red side of cool exoplanet-host stars
14:00 – 14:15	<b>Raúl Rodríguez Veloso:</b> Aerosol optical properties observed by MEDA Radiation and Dust Sensor (RDS) at Jezero Crater, Mars
14:15 – 14:30	<b>Julián José Miranzo Pastor:</b> Looking for H <sub>2</sub> S in young protostellar systems
14:15	<b>Closing</b>

# Wednesday 21st January

09:30 – 10:30	<b>Session 7 – Aneto</b>
9:30 – 9:45	<b>Alejandra Fernández Rio:</b> Where are all the runners? Red supergiant runaway stars in the LMC
9:45 – 10:00	<b>Leo Pérez Peña:</b> The role of autocatalytic chemistry on protocell growth
10:00 – 10:15	<b>Gonzalo José:</b> Overleaf is evil and you should not use it
10:15 – 10:30	<b>Gabriel Jaimes-Illanes:</b> Machine Learning-Based Automated Interpretation of Interstellar Molecular Spectra
10:30 – 11:00	Coffee break
11:00 – 11:45	<b>Session 8 – Mulhacén</b>
11:00 – 11:45	<b>Marta Rey Montejo:</b> Chemical complexity in the Galactic Center
13:00 – 13:15	<b>Adrián Barriopedro Pérez:</b> Size matters: Host density and population size shape viral evolution
13:15 – 13:30	<b>Julio Martínez Giménez:</b> Exploring the Origin of Phobos: the MMX Mission and Raman Spectroscopy
11:45 – 12:00	Coffee break
12:00 – 13:00	Seminar by Álvaro Santalla Arrebola: <i>Mental health</i>
13:00 – 13:15	Coffee break
13:15 – 14:00	<b>Session 9 - Teide</b>
13:15 – 13:30	<b>Paula López Dones:</b> Más allá del sesgo observacional: análisis de la componente molecular de las nebulosas preplanetarias “olvidadas”
13:30 – 13:45	<b>Samuel Aguilera Cortés:</b> Exploring Prebiotic Pathways toward Alternative RNA Worlds: Experimental Approaches to Heterocyclic Nucleobase Synthesis.
13:45 – 14:00	<b>David Haasler García:</b> Multi-transition spatial analysis of phosphorus-bearing molecules towards the solar-like protostellar system IRAS 16293-2422
14:00	Closing

# Abstracts

## Session 1 – La Sagra

**Monday 19<sup>th</sup> 9:30-10:30**

**9:30 – 9:45**

**Carla Alejandre**

**Molecular evolution & Life Sciences**

**CAB**

### **A complexity-theory perspective on the origin of self-replicating RNA systems in prebiotic Earth**

How life emerged from non-living matter around 4 Gyrs ago is one of the deepest unresolved questions in science. Because direct empirical evidence from the early Earth is scarce, this problem is particularly suited to theoretical and computational exploration. In our research, we approach this challenge from a systems perspective, focusing on the abrupt rise in complexity that occurred when RNA molecules first appeared and began to undergo Darwinian evolution.

RNA is the only known biopolymer that combines genotype and phenotype in a single molecular entity, being this the basis of the RNA world hypothesis. However, understanding how the first RNA polymers could have emerged and subsequently replicated and evolved in early Earth, where no complex enzymes or even accurate replication were present, remains challenging.

We recently developed a theoretical and computational framework called EarlyWorld [1]. Using this platform, we showed that non-enzymatic polymerization of ribonucleotides and template-dependent replication of RNA polymers, sufficiently long to fold and acquire basic functions (>15 nt), were feasible at clay-water interfaces in the prebiotic Earth. The essential requirement is that the physico-chemical environment was characterized by large-amplitude oscillations with a periodicity compatible with spring tide dynamics. Now, we are going a step further to study the evolutionary potential of primordial RNA polymers, by considering both environmental and internal selection factors and incorporating the effects of RNA phenotypes on their own replication.

[1] C. Alejandre, A. Aguirre-Tamaral, C. Briones and J. Aguirre, Polymerization and replication of primordial RNA induced by clay-water interface dynamics, Communications Chemistry 8(1), 236, 2025

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**9:45 – 10:00**

**Marina Fernández Ruz**

**Astrophysics & Astrochemistry**

**CAB**

### **Strong parameter hierarchy in the interstellar phosphorus chemical network**

Phosphorus-bearing molecules are fundamental for life on Earth, yet their astrochemical origins remain poorly understood. Their formation in the interstellar medium has been challenging to elucidate due to limited spectroscopic detections and the reliance on theoretical models that depend on numerous kinetic parameters whose values are very uncertain. Multi-parameter models often suffer from “sloppiness”, where many parameter combinations exhibit negligible influence on model outcomes, while a few dominate system behavior. In this talk, I will illustrate the concept of sloppiness with simple examples, and then I will introduce the Fisher Information Spectral Reduction (FISR) algorithm, a methodology that we have developed that aims to reduce the complexity of such sloppy models. Consequently, it exposes the strong parameter hierarchy governing these systems by identifying and

eliminating parameters associated with insensitive directions in the parameter space. Applying the FISIR algorithm to the phosphorus astrochemistry network, we reduce the number of reaction rate coefficients from 14 to 3, pinpointing the key reactions and kinetic parameters responsible for forming PO and PN, the main phosphorus-bearing molecules typically detected in interstellar space. The simplified model retains its predictive accuracy, offering deeper insights into the mechanisms driving phosphorus chemistry in the interstellar medium. This methodology is applicable to multi-parameter models of any kind and, specifically in astrochemistry, facilitates the development of simpler, more realistic and interpretable models to effectively guide targeted observational efforts.

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**10:00 – 10:15**  
**Jesús Gómez Mantecón**  
**Astrophysics & Astrochemistry**  
**CAB**

### **Tracing Massive Stars and Extinction at Low Metallicity: Insights into the Early Universe**

Massive stars play a fundamental role in the evolution of galaxies across cosmic time. Through their intense radiation, stellar winds, and final explosive deaths, they regulate star formation, enrich the interstellar medium with heavy elements, and give rise to supernovae, compact objects, and gravitational-wave sources. Understanding how these processes depend on metallicity is essential to interpret the early Universe, where stars formed in environments far more metal-poor than those typically observed today.

In this talk, I will present the main goals of my PhD thesis, which aims to provide the first quantitative constraints on the winds and evolutionary properties for a large sample of massive stars at very low metallicity. While previous studies have focused mainly on the Small Magellanic Cloud, nearby galaxies such as IC 1613 and Sextans A offer access to even more metal-poor regimes, closer to conditions prevalent during earlier cosmic epochs, such as the Cosmic Noon.

I will summarize recent progress based on a detailed spectroscopic analysis of a pilot sample of seven massive stars in IC 1613, for which we have derived their fundamental parameters, including temperatures, gravities, rotation, and stellar wind properties, using state-of-the-art stellar atmosphere models and optical data. Building on this, I will present ongoing work combining Hubble Space Telescope ultraviolet spectroscopy with ground-based optical photometry to compare observed stellar fluxes with theoretical models. This approach allows us to study the dust extinction properties of IC 1613 and explore the possibility of deriving one of the first extinction laws for a low metallicity galaxy.

These results have broad implications, from improving stellar and galactic evolution models to refining the interpretation of unresolved stellar populations at high redshift and optimizing future observations with next-generation facilities such as JWST and the Vera Rubin Observatory.

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**10:15 – 10:30**  
**Ángel Melguizo Baena**  
**Planetology & Habitability**  
**INTA**

### **Magnetometría y caracterización magnética de rocas de la erupción de Tajogaite de 2021**

La erupción de Tajogaite ofrece un escenario reciente sobre la construcción de un edificio volcánico y la oportunidad de hacer un seguimiento de la evolución del volcán y de sus productos. La erupción estuvo activa desde el 19 de septiembre hasta el 13 de diciembre de 2021, haciendo su incursión superficial en el rift volcánico de Cumbre Vieja. A lo largo de los meses, hubo varias bocas eruptivas que fueron construyendo un edificio principal. Entre sus principales productos, se emitieron coladas de

lava de composición tefrítica y basanítica, llegando algunas hasta la costa; materiales piroclásticos cercanos al cono, como bombas; y expulsión de ceniza durante todo el proceso. Esta línea de investigación se centra en el estudio magnético de esos productos a través de magnetometría, un método geofísico no invasivo con el entorno.

El trabajo general pretende enfocar la magnetometría en la isla de La Palma con fines de exploración planetaria. Permite estudiar la composición mineralógica a través de la caracterización magnética de muestras de roca mediante análisis de remanencia natural, curvas de primera imanación y ciclos de histéresis. Otra aplicación importante es la obtención de firmas magnéticas de estructuras mediante la realización de levantamientos magnéticos, y su posterior procesamiento.

El estudio de análogos terrestres mediante magnetometría es nuestra oportunidad para intentar comprender estructuras geológicas comunes en superficies planetarias, como volcanes y cráteres, a partir de análogos en la Tierra a los que podemos acceder con mayor facilidad. El conocimiento del magnetismo en estas estructuras podrá equipararse en un futuro con las de Marte y la Luna, cuando las misiones espaciales sean capaces de adquirir datos magnéticos de sus superficies.

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## **Session 2 – Peñalara**

**Monday 19<sup>th</sup> 11:00-11:45**

**11:00 – 11:15**

**Clara Lorenzo Corvo  
Instrumentation & Space Missions  
INTA**

### **Characterization of Martian atmospheric turbulence using radiative measurements from the Radiation and Dust Sensor (RDS)**

Dust plays a central role in the Martian atmosphere by interacting with solar radiation through scattering and absorption, thereby modifying both the reflected and absorbed energy fluxes and directly altering the planet's heating rates. These changes in the heating rates—both at the surface and within the atmosphere—are among the primary drivers of Martian atmospheric dynamics. In turn, the resulting atmospheric motions influence the spatial distribution and lifting of dust particles, establishing a complex non-linear feedback system. The Radiation and Dust Sensor (RDS), part of the Mars Environmental Dynamics Analyzer (MEDA) payload onboard the Mars 2020 Perseverance rover, is a radiometer that measures downwelling solar irradiance at the surface across multiple spectral bands. Rapid temporal fluctuations in the measured irradiance are associated with variations in dust concentration induced by atmospheric turbulence. Most previous studies of Martian atmospheric turbulence have relied on near-surface in situ measurements (e.g. wind and temperature sensors) substantially limiting our understanding of Martian turbulence at higher altitudes. In contrast, the column-integrated nature of RDS radiometric observations provides sensitivity to dust fluctuations at higher altitudes, enabling access to turbulent processes that are otherwise difficult to observe directly. Here, we study RDS irradiance fluctuations time series to characterize their spectral properties in the context of atmospheric turbulence; we analyze inertial-range behavior and introduce a preliminary modeling framework to explore the vertical contribution of the different atmospheric layers to the observed RDS signal fluctuations.

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**11:15 – 11:30**  
**Alberto Álvaro Díaz**  
**Astrophysics & Astrochemistry**  
**INTA**

**Spin Induction from Tidal Torquing in Hyperbolic Black Hole Encounters: An Analytical Approach**

Gravitational waves are emitted by binary black holes as they evolve along their orbits. While most of the radiation escapes to infinity, a fraction is absorbed by the black holes, thereby affecting their internal dynamics. This work presents an analytical study of spin induction – tidal torquing – on black holes during hyperbolic encounters within binary systems. Using the framework of Black Hole Perturbation Theory and Post-Newtonian (PN) expansions, we derive expressions for the angular momentum flux absorbed by a black hole's event horizon due to gravitational wave interactions. The formulation incorporates quadrupole contributions in the tidal fields, derived from the Weyl tensor, and computes their contribution to spin induction. We examine non-spinning and spinning black holes, obtaining analytical flux expressions at leading PN order. To characterise orbital dynamics, we compare the Keplerian and Effective One-Body (EOB) formalisms, the latter considered up to fourth-order PN accuracy. Our results show that even a 0PN treatment of the tidal fields, when coupled with a 0PN and 3PN EOB model, yields excellent agreement with Numerical Relativity predictions, even in strong-field and ultra-relativistic regimes. This suggests that simplified analytical models can offer valuable insights into black hole dynamics, with potential applications in future gravitational wave analyses and N-body simulations.

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**11:30 – 11:45**  
**Víctor Sansegundo Romero**  
**Molecular evolution & Life Sciences**  
**CAB**

**Estudio de la adsorción e interacción de biomoléculas en superficies minerales en condiciones ambientales y de Ultra Alto Vacío (UHV)**

El origen y la evolución de la vida representan uno de los mayores enigmas de la humanidad y que ha sido ampliamente estudiado desde diferentes disciplinas. Bajo este enfoque, la química prebiótica desempeña un papel central al estudiar la evolución de las moléculas orgánicas presentes en la Tierra primitiva y los procesos químicos que pudieron dar lugar a las primeras formas de vida. Las teorías de Oparin y los experimentos de Miller-Urey sentaron las bases experimentales de este campo, al demostrar la síntesis abiótica de aminoácidos bajo condiciones simuladas de la atmósfera primitiva. Diversos estudios han propuesto que las superficies minerales pudieron desempeñar un papel clave en estos procesos prebióticos, actuando como soportes capaces de adsorber, concentrar y proteger moléculas orgánicas, así como de catalizar reacciones químicas con baja especificidad. En este contexto se enmarca la hipótesis del “mundo hierro-azufre”, propuesta por G. Wächtershäuser, que plantea que la química primitiva de la vida tuvo lugar sobre superficies minerales de hierro y azufre, como la pirita ( $\text{FeS}_2$ ). Según este modelo, estas superficies facilitaron los primeros estadios de formación de polímeros esenciales para la química prebiótica, resultando fundamental identificar y caracterizar el papel de las biomoléculas que actúan como bloques de construcción (bases nitrogenadas, azúcares y nucleósidos) de ADN. Centrándonos en los nucleósidos y en el mineral de pirita, el estudio de las interacciones biomolécula-superficie mineral en condiciones de Ultra Alto Vacío requiere un enfoque fisicoquímico detallado que permita comprender los procesos que ocurren en las primeras capas del sustrato. Se propone el análisis mediante técnicas espectroscópicas de física de superficies con resolución a escala atómica, como espectroscopia de fotoemisión de rayos-X (XPS), que permite identificar las moléculas orgánicas adsorbidas y las propiedades químicas de los minerales con potencial catalítico.

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## Session 3 – Pico Almanzor

**Monday 19<sup>th</sup> 13:15-14:15**

**13:15 – 13:30**

**Juan A. Molina Calzada  
Astrophysics & Astrochemistry  
CAB**

### **A Massive Star Census in the Magellanic Clouds**

Massive stars are the brightest and bluest stars in the sky but, despite their high luminosity, they are intrinsically rare objects. Several aspects of their nature are still not fully understood. With their short lifetimes and formation in regions of intense star formation, they serve as excellent tracers of environmental structure, and they are the progenitors of some of the most violent phenomena in the Universe, including supernovae and black holes.

The goal of this work is to produce the most complete catalog to date of massive stars in the Magellanic Clouds (MCs), the closest satellite galaxies to the Milky Way. This region is ideal for such a study thanks to its low extinction and high star-formation activity. Moreover, this catalog will form the fourth release of the Alma Luminous Star (ALS) catalog, whose previous parts cover the Milky Way. To achieve this, we will use photometric data from several surveys such as Gaia and VISTA. By complementing these data with information gathered from the literature, we aim to go beyond current massive star catalogs in the MCs, which are typically limited to a single survey and tend to omit heavily extinguished massive stars, which are more difficult to identify.

A comprehensive catalog of massive stars in the MCs will provide a valuable database for the astronomical community, enabling studies ranging from the kinematics and dynamics of the Clouds to studies of peculiar objects (runaway stars or Wolf-Rayet stars), black holes, gravitational waves, and the derivation of a new Initial Mass Function (IMF) for massive stars, among many other applications.

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**13:30 – 13:45**

**Joaquín Delgado Amar  
Astrophysics & Astrochemistry  
CAB**

### **Quantifying UV Photodesorption from Astrophysical CO Ices with FTIR and QMS**

UV photodesorption from astrophysical ices is key to explaining the presence of gas-phase molecules even in very cold regions of space, such as dense molecular clouds. Photodesorption yields (i.e., the amount of ice molecules photodesorbing per incident UV photon) can be experimentally calculated in the laboratory under conditions relevant to the interstellar medium.

In this talk, we present a clear and reproducible calibration method to quantify ice desorption induced over successive irradiation intervals of a pure CO ice sample, combining infrared spectroscopy (FTIR) and quadrupole mass spectrometry (QMS).

Using FTIR, we compute the ice loss due to photodesorption from the variation in the integrated area of infrared absorption bands. In parallel, we integrate the QMS signal corresponding to the photodesorbing molecules in the gas phase during each irradiation step. From these measurements we derive (1) the photodesorption yield of pure CO ices, and (2) a proportionality constant linking the QMS signal to the ice loss in monolayers.

The proportionality constant is fundamental to calculate photodesorption yields in different ice samples where photodesorption takes place at the same time than photochemistry. In those cases, the ice loss measured with FTIR does not correspond only to photodesorption, but also to the dissociation of molecules. Therefore, photodesorption can only be quantified using the QMS. For CO ice, all methods converge to a mean yield of approximately 0.032 molecules/photon.

The computational analysis pipeline is publicly available on GitHub as a modular, well documented Python codebase, ensuring extensibility and full reproducibility. As a next step, we are incorporating the experimentally measured photodesorption yields into astrochemical simulations with Nautilus, together with literature values, to investigate their impact on predicted abundances and on the interpretation of observations in dense molecular clouds.

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**13:45 – 14:00**

**Sergio Quevedo Caraballo**  
**Molecular evolution & Life Sciences**  
**CAB**

### **Correlating techniques and methods for unequivocal life detection in planetary exploration**

Are we alone in the Universe? This question has driven planetary exploration for decades, yet answering it remains difficult. Although several missions have detected organic molecules on Mars, comets, and icy moons, none has provided unequivocal evidence of life. Many “building blocks of life”, such as amino acids and nucleobases, can be produced through abiotic processes, meaning that detecting organic matter is not equivalent to detecting life. Consequently, no single analytical technique used in planetary exploration can provide unambiguous evidence on its own. This PhD project addresses this limitation by proposing an integrative strategy based on correlating the outputs of multiple independent analytical techniques, rather than relying on individual biomarkers or isolated measurements. The research is framed within the Ladder of Life Detection concept, which ranks biosignatures according to their molecular complexity and diagnostic power. While simple organic molecules are inherently ambiguous, more complex structures, such as peptides, proteins, or molecular patterns unlikely to form abiotically, as well as features like chirality, provide stronger evidence for biological processes. To validate this approach, reference samples will be prepared using Mars and Enceladus simulants, spiked with biomarkers of increasing biological complexity. These will be analyzed using SOLID-LDChip, an antibody microarray-based instrument capable of detecting non-volatile biomarkers from small peptides to complex biopolymers, particularly valuable at the abiotic-biotic boundary, alongside complementary techniques such as GC-MS, Raman spectroscopy, capillary electrophoresis, and proteomics. The strategy will be further tested using terrestrial analog samples and samples subjected to radiation and diagenetic alteration. In parallel, a miniaturized lateral flow immunoassay derived from the LDChip platform will be developed as proof of concept for future life-detection missions.

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**14:00 – 14:15**

**Aitana Tasa-Chaveli**  
**Astrophysics & Astrochemistry**  
**CAB**

### **Refractory and volatile sulfur in massive star-forming regions**

Sulfur is essential for life, but its abundance and distribution in the interstellar medium remain uncertain, with over 90% of sulfur undetected in cold molecular clouds. One possibility is that the remaining sulfur is locked in refractory material. Recently, some gaseous refractory species have been detected in massive star forming regions, opening the possibility of exploring the chemical composition of refractories through gas-phase observations. We find convincing evidence of a reliable detection of

CaS, and tentative detections of KS and KSH in the disk G351.77-mm1. These are the first ever identifications of these species in the interstellar medium. The CaS, KS, and KSH column densities are about 3 orders of magnitude lower than those of the abundant sulfur compounds CH<sub>3</sub>SH, SO<sub>2</sub> and SiS, proving that these species are not the major reservoir of sulfur at the spatial scales probed by our observations. Higher angular resolution observations at different wavelengths are required to confirm these detections, which are of paramount importance to gain insights into the formation of gas-phase refractory molecules.

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## Session 4 – Monte Perdido

**Tuesday 20<sup>th</sup> 9:30-10:30**

**9:30 – 9:45**

**Ana Varo O'Ferrall  
Astrophysics & Astrochemistry  
CAB**

### **Attenuation Laws: Looking at Early Galaxies Through a Dusty Window**

Dust represents only a small fraction of the total components of galaxies, yet it has a strong impact on how we observe them. One effect is the attenuation of the light produced by the stars and gas. Over the past decades, attenuation laws have been developed to characterize this phenomenon and to prevent it from biasing the properties derived from observations. They also provide information about the dust itself, making them a key tool for understanding its nature and role in galactic evolution. However, while attenuation laws have been well studied in the Milky Way and nearby galaxies, they remain poorly constrained in more distant systems. Thanks to the James Webb Space Telescope, we can now study attenuation in the first generations of galaxies and begin to uncover how dust behaved in the early universe.

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**9:45 – 10:00**

**Víctor Muñoz Hisado  
Molecular evolution & Life Sciences  
CAB**

### **Microbial Diversity in Pyrenean Ice Caves**

Ice caves constitute fragile cryospheric systems whose persistence depends on cave morphology and ventilation rather than regional climate, reflecting sporadic permafrost occurrences. In the Central Pyrenees, permafrost is currently restricted to high elevations, and recent discoveries of ice caves provide evidence of localized subsurface ice under marginal climatic conditions. These environments are rapidly regressing in response to regional warming, which has increased by  $\sim 1.3^{\circ}\text{C}$  over the last century. Beyond their cryological relevance, ice caves have emerged as key sites for studying cold-adapted microbial communities, revealing structured assemblages shaped by ice age, chemistry, and physical state. Recent studies highlight their value as natural analogues for extraterrestrial icy environments, offering insights into microbial survival under cold, isolated, and energy-limited conditions. Here, we compare microbial communities across four Pyrenean perennial ice caves, assessing the influence of geological and environmental factors on community structure and their astrobiological relevance. When chemical and microbiological data are considered jointly, ice caves host structured, cave-specific microbial communities that cannot be inferred from chemical composition alone. Environmental chemistry contributes to community structuring but does not act as a deterministic driver; instead, microbial patterns reflect the interaction between chemical gradients and additional factors such as sample physical state, cave-specific conditions, and long-term environmental stability.

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**10:00 – 10:15**

**Ángel Ortuño Carrión  
Planetology & Habitability  
INTA**

### **The secrets of Martian corrosion**

The exploration of Mars has advanced from the first images sent by Viking 1 in 1976 to the recent missions of Perseverance and Ingenuity in 2021. These missions have revealed subsurface ice,

complex organic molecules, and evidence of ancient habitable environments, but they have also exposed unexpected challenges, such as the premature wear of the wheels on the Curiosity rover after barely 10 km of travel. This finding, together with the detection of perchlorates and the confirmation of the presence of liquid water thanks to brines formed during nocturnal cycles, raises questions about the interaction of materials with the Martian environment. The CHIMERA project investigates corrosion on Mars, using analogies and methodologies from environmental corrosion studies. Experimentally, the Al 7075-T6 alloy was characterized, detecting precipitates such as  $Al_7CuFe$  or  $Al_3Ti$ . Tests were conducted in a chamber simulating Martian conditions with the aim of replicating a full  $CO_2$  atmosphere and comparing them with their terrestrial equivalents. The results were complemented by a thermodynamic modeling study, which suggested a staged reactivity that was slower than observed. In addition, the salt counterion appears to have a significant influence on the energy required for corrosion to occur. On the other hand, Cu enrichment is observed around the pits, acting as a microcatalyst due to its higher potential than Al. Finally, pH measurements and microscopic observations confirm the corrosion.

In the future, a full understanding of the corrosion mechanisms on Mars will be studied through additional tests in the Martian simulation chamber, the development of protective coatings that extend the service life of materials, and the development of electrochemical and fiber-optic sensors that allow monitoring the corrosion progress under Martian conditions.

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**10:15 – 10:30**  
**Alexandre Legault**  
**Astrophysics & Astrochemistry**  
**CAB**

#### **JWST's View of Massive Stars in the Arches Cluster**

The Arches cluster in the Galactic Centre is a near pristine clustering of young massive stars, showing a unique combination of unevolved massive main sequence stars at super solar metallicity. Since the beginning of my PhD, I have worked on observing and preparing the analysis of the Arches cluster with NIRSpec's IFU. With these observations, we aim to study the high-mass stellar and cluster physics, particularly stellar mass-loss and the initial mass function (IMF) of clusters in a metal rich environment. Moreover, the analysis of the NIR mass-loss sensitive Brackett-alpha, Brackett-beta, Paschen-alpha spectral lines, coupled with several temperature and abundance diagnostics, will deepen our understanding of radiation driven winds of these stars. I will present our group's successful JWST proposal, showcase the recently observed data, and (maybe) briefly introduce the techniques that we hope to use for the analysis of the hundreds of stellar spectra we have obtained with NIRSpec's IFU.

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## **Session 5 – Posets**

**Tuesday 20<sup>th</sup> 12:45-13:30**

**12:45 – 13:00**  
**Andrea Hidalgo Arias**  
**Molecular evolution & Life Sciences**  
**CAB**

#### **Molecular adaptations of *Bacillus subtilis* under Mars surface simulation**

Due to its resilience and ubiquity, *Bacillus subtilis* is an excellent candidate for habitability related studies on Mars. The resistance of its spores to a wide range of extreme conditions, including severe dehydration, high levels of UV and ionizing radiation, high vacuum, and broad temperature fluctuations,

has been well documented, establishing it as a model organism in space microbiology. However, the response of the vegetative cells of this microorganism to extreme environments, such as the Martian surface, has not been extensively studied. Therefore, this work investigates the proteomic response of *Bacillus subtilis* following exposure to simulated Martian surface conditions in the MARTE chamber for 5 martian days. The MARTE chamber is a high-vacuum facility capable of reproducing key Martian environmental parameters, including pressure, surface temperature, atmospheric composition, and radiation. Although overall protein production was significantly reduced under these conditions, proteins associated with sporulation, bacterial envelope reinforcement, stress adaptation, and antioxidant protection were detected. These findings demonstrate that *Bacillus subtilis* is able to remodel its cellular machinery to adapt to and survive the environmental conditions of the Martian surface.

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**13:00 – 13:15**  
**Sergio Angulo Cosín**  
**Instrumentation & Space Missions**  
**INTA**

**GNSS SpAmming: ataques de denegación de servicio GNSS basados en spoofing**

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**13:15 – 13:30**  
**Leonor Arriscado**  
**Astrophysics & Astrochemistry**  
**CAB**

**Chasing the dust: what the UV bump tells us about galaxies**

Despite comprising only a minor fraction of a galaxy's baryonic mass, interstellar dust plays a dominant role in shaping observed galaxy spectra through the absorption and scattering of ultraviolet (UV) and optical radiation and its subsequent re-emission in the infrared. A long-standing open question in studies of dust attenuation concerns the origin of the broad UV attenuation feature centered at 2175 Å. This feature is prominent in the extinction curves of the Milky Way and the Large Magellanic Cloud, absent in the Small Magellanic Cloud, and has been detected in the attenuation curves of galaxies out to redshifts as high as  $z \approx 7$ . Polycyclic Aromatic Hydrocarbon (PAH) molecules are widely considered the most likely carriers of the 2175 Å feature; however, empirical constraints linking the UV bump to PAH emission remain limited, with most evidence to date arising from laboratory measurements and theoretical modeling. In this talk, I will present the first observational study that directly investigates the connection between the 2175 Å UV attenuation bump, mid-infrared PAH emission, and gas-phase metallicity inferred from strong nebular emission-line diagnostics. This analysis exploits multi-wavelength observations combining JWST data with ground-based spectroscopy, enabling new constraints on dust composition and evolution in star-forming galaxies at cosmic noon.

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## **Session 6 – Veleta**

**Tuesday 20<sup>th</sup> 13:45-14:30**

**13:45 – 14:00**  
**Sergio Turrado Prieto**  
**Astrophysics & Astrochemistry**  
**CAB**

**Exploring the red side of cool exoplanet-host stars**

M dwarfs are the coldest, least massive stars that can still undergo hydrogen core-burning, and are the most abundant stars in the Universe ( $\approx 75\%$  of all stars). It has been estimated that 15% of M dwarfs have terrestrial type exoplanets in their habitable zone. Furthermore, their low masses and radii make them ideal targets for exoplanet detection and characterization. Like all stars, they share primordial elemental abundances with their exoplanets, inherited from their parent molecular cloud. This makes accurate stellar abundance measurements a key tool to understand the star-planet connection. However, M dwarfs have gaseous molecules in their atmospheres. This makes traditional spectroscopic methods for abundance determination very challenging to use. The goal of my thesis is to develop and validate a suitable method to determine the chemical abundances of early-type M dwarfs by performing spectral synthesis with the iSpec software on high resolution NIR spectra (0.97-1.81  $\mu\text{m}$ ) from NIRPS ( $R > 75000$ ). In this talk, I will present the challenges of spectral synthesis and working with M dwarf spectra, as well as the strategies we are implementing to validate the method. If successfully developed, a reliable method for M dwarf abundance determination would help to better understand these stars, to constrain the internal composition of their planets, to study the correlation between abundances and exoplanet type, and to chemically characterize the stellar populations in the Milky Way.

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**14:00 – 14:15**

**Raúl Rodríguez Veloso**  
**Instrumentation & Space Missions**  
**INTA**

**Aerosol optical properties observed by MEDA Radiation and Dust Sensor (RDS) at Jezero Crater, Mars**

Aerosols on Mars are a primary element for studying the interaction between the solar radiation and the atmosphere and surface. Depending on properties such as aerosol number density, particle radius, or refractive index, the aerosols can provide positive or negative radiative feedbacks on the atmospheric dynamics. Previous studies have revealed large temporal and spatial variability in the aerosol optical properties, emphasizing the need for continuous monitoring throughout the day and at multiple locations. To address these measurements, the Radiation and Dust Sensor (RDS) was included as part of the Mars Environmental Dynamics Analyzer (MEDA) payload onboard the Perseverance rover of the Mars 2020 mission. The RDS instrument is composed of two sets of eight photodiodes (RDS-DP) and a sky-pointed camera (RDS-SkyCam). One set, oriented toward the zenith, captures radiation from 190 to 1200 nm, while the other, inclined  $20^\circ$  above the horizon at  $45^\circ$  azimuthal intervals, samples a single wavelength. The analysis of these observations, through a radiative transfer model, allows for the retrieval of key aerosol parameters such as aerosol opacity at different wavelengths and particle radius. However, the continuous deposition of dust over the sensors, since the beginning of the mission, introduces modifications in their optical response. In particular, the zenith-pointed photodiodes require angular response calibration due to the progressive accumulation of dust on their optical surfaces. This calibration is essential to ensure the accuracy of aerosol property retrievals and the reliability of long-term atmospheric monitoring. Here, we present the ongoing development of our radiative transfer model for signal calibration, incorporating dust deposition corrections, along with preliminary results from the analysis of the initial sols of the Mars 2020 mission.

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**14:15 – 14:30**

**Julián José Miranzo Pastor**  
**Astrophysics & Astrochemistry**  
**CAB**

**Looking for  $\text{H}_2\text{S}$  in young protostellar systems**

Sulfur is a key element for biological systems. However, sulfur-bearing molecules are very elusive in star-forming regions, and how sulfur is delivered to planetary systems is still not well understood.  $\text{H}_2\text{S}$  is

one of the main carriers of sulfur during the first steps of star formation and to unveil its behaviour could help us solve the known in astrochemistry as the "Missing sulfur problem". We used observations from the PRODIGE large program in order to study H<sub>2</sub>S and its isotopologues in 30 young protostars from the Perseus Molecular Cloud. In this talk I will present some of our latest results from our research.

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## Session 7 – Aneto

**Wednesday 21<sup>st</sup> 9:30-10:30**

**9:30 – 9:45**

**Alejandra Fernández Rio  
Astrophysics & Astrochemistry  
CAB**

### **Where are all the runners? Red supergiant runaway stars in the LMC**

Red supergiants (RSGs) are massive stars in the final stages of their evolution, yet little is known about those that have been ejected from their birth environments, the so-called runaway stars. These objects are particularly significant because, when they explode far from star-forming regions, their supernovae can inject energy and nuclear processed elements into low-density areas. In doing so, runaway RSGs may play a crucial and often overlooked role in shaping galactic ecosystems and dispersing the fundamental elemental ingredients required for the emergence and sustainability of life. Massive stars are known to be closely related to the synthesis of the CHNOPS elements and uniquely produce phosphorus, an element considered essential for life as we know it.

In this project, I present the first systematic search for runaway RSGs. To do this we study RSGs in the Large Magellanic Cloud using high-precision Gaia DR3 astrometry and combine this with a near-complete catalogue of around 4000 RSGs in this galaxy. To identify potential runaways, I developed a local kinematic method: for each RSG, I compared its motion to the velocities of its nearest neighbours, which allows a determination of whether a star moves significantly faster than expected for its region of the galaxy. This locally adaptive approach accounts for the complex rotation and internal motions of the LMC and avoids biases from global velocity thresholds. After applying quality and radial-velocity cuts to ensure reliable measurements and LMC membership, I identified around 140 runaway candidates. Further analysis is being conducted about the nature of these candidates.

This work provides the first galaxy-wide catalogue of extragalactic runaway red supergiants and introduces a reproducible framework for studying massive-star ejection mechanisms with current and future astrometric surveys.

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**9:45 – 10:00**

**Leo Pérez Peña  
Molecular evolution & Life Sciences  
CAB**

### **The role of autocatalytic chemistry on protocell growth**

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**10:00 – 10:15**

**Gonzalo José  
Instrumentation & Space Missions  
CAB**

### **Overleaf is evil and you should not use it**

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**10:15 – 10:30**

**Gabriel Jaimes-Illanes**

**Astrophysics & Astrochemistry  
CAB**

**Machine Learning-Based Automated Interpretation of Interstellar Molecular Spectra**

In recent years, the detection of molecules in the interstellar medium has advanced significantly, enabled by the enhanced sensitivities of state-of-the-art astronomical facilities. However, tools to analyze and interpret the complex datasets remain in their early stages. To overcome the limitations of traditional analysis techniques, the development of new innovative tools to efficiently exploit this vast amount of information is mandatory. This is the goal of our project Artificial Intelligence Integral Tool for AstroChemical Analysis (AI-ITACA). In the present work, we present a framework that allows automatic analysis of the gas-phase emission spectra from astronomical observations. The trained models perform the retrieval of molecular parameters: column density, excitation temperature, velocity, and linewidth, from complex spectra with minimal user input. Two Machine Learning (ML) approaches were implemented: 1) Dimensionality reduction, an unsupervised technique for data representation, and 2) Regression, a supervised method for predictive modeling. The training database comprises thousands of synthetic spectra generated by the tool MADrid Data CUBe Analysis (MADCUBA), under Local Thermodynamic Equilibrium (LTE) conditions. Both methods were applied to chemically rich astronomical datasets, reproducing molecular parameters obtained with classical analysis. The tool is hosted online providing a user-friendly interface to analyze spectral datasets and provide intuitive visualization of the results. This work presents a novel application of ML techniques that will allow to significantly increase the computational efficiency of molecular spectral analysis, which is important to digest the large volume of data provided by the current, and especially, by the new generation of astronomical facilities like the ALMA Wideband Sensitivity Upgrade (WSU) and the next generation Very Large Array (ngVLA).

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**Session 8 – Mulhacén**

**Wednesday 21<sup>st</sup> 11:00-11:45**

**11:00 – 11:15**

**Marta Rey Montejo  
Astrophysics & Astrochemistry  
CAB**

**Chemical complexity in the Galactic Center**

The extreme phenomena in the Galactic Center such as intense UV radiation, large-scale shocks and enhanced cosmic-ray ionization rates, drive a very rich chemistry in carbon chains, complex organic molecules and metal-bearing species. In particular, the Galactic Center molecular cloud G+0.693-0.027 is distinguished by its chemical richness where a wide range of molecules, including molecules of prebiotic interest, have been discovered. Recently, we have reported in this cloud the first detection of the metal-sulfide molecules MgS and NaS in the interstellar medium (Rey-Montejo *et al.* 2024). This detection suggests that these species may represent important reservoir of sulfur, known to be heavily depleted in dense molecular clouds. In this contribution, we present the results from a new chemical model that includes the chemistry of metal-sulfides. The comparison of the observations with the models provide essential information about the formation and destruction routes of these species and it constrains the amount of sulfur locked into dust grains.

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**11:15 – 11:30**

**Adrián Barriopedro Pérez  
Molecular evolution & Life Sciences**

**CAB**

**Size matters: Host density and population size shape viral evolution**

RNA virus populations are an excellent model for experimental evolution studies, as they consist of very large populations with high genetic diversity that grow rapidly and are easy to handle in the laboratory. This type of experiment allows us to control evolutionary pressures and, therefore, to establish relationships between genotype, phenotype, and changes in virus–host interactions. In this presentation, I will discuss some of the initial results of my thesis, focusing on how host density affects virus population size, using the *Escherichia coli*–Q $\beta$  system as a model. To do this, we replicate the phage at optimal temperature (37 °C) under different host densities (CFU, colony-forming units) and virus population sizes (PFU, plaque-forming units). We then analyze the consensus sequence to identify which mutations prevail in the population. Some of these mutations may be beneficial; however, in certain cases, they can cause the virus to become unstable. This is the case for two mutations found in some evolutionary lines generated under conditions of low host density.

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**11:30 – 11:45**

**Julio Martínez Giménez  
Planetology & Habitability  
CAB**

**Exploring the Origin of Phobos: the MMX Mission and Raman Spectroscopy**

Phobos, the larger of Mars' two moons, is one of the most enigmatic bodies in the Solar System due to its irregular shape, extremely dark surface, and low bulk density. Two main hypotheses have been proposed for its origin: gravitational capture of a primitive asteroid, similar to carbonaceous chondrites, or formation from Martian ejecta following a large impact, analogous to the Moon's formation. Distinguishing between these scenarios is essential for understanding satellite formation, the early evolution of Mars, and processes in the primitive Solar System. The Mars Moons eXploration (MMX) mission, led by the Japan Aerospace Exploration Agency (JAXA), aims to resolve this question through detailed exploration of Phobos and Deimos, including a controlled landing on Phobos and the first sample return from a Martian moon. Returned samples will allow high-precision mineralogical, isotopic, and organic analyses using laboratory techniques. Prior to sample return, MMX will perform in situ characterization of Phobos' surface using several instruments, including the Raman spectrometer (RAX), developed by the Spanish National Institute for Aerospace Technology (INTA). Raman spectroscopy is a non-destructive optical technique that identifies minerals and molecular compounds through their vibrational signatures without sample preparation and under extreme environmental conditions. The presence of organic matter, disordered carbon, and hydrated minerals would support an asteroidal origin, whereas a mineralogy dominated by feldspars, pyroxenes, and olivines would be consistent with a Martian impact origin. Overall, MMX will provide key insights into the origin of Phobos and planetary evolution.

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**Session 9 – Teide**

**Wednesday 21<sup>st</sup> 13:15-14:00**

**13:15 – 13:30**

**Paula López Dones  
Astrophysics & Astrochemistry  
CAB**

**Más allá del sesgo observacional: análisis de la componente molecular de las nebulosas preplanetarias “olvidadas”**

Las estrellas evolucionadas juegan un papel clave en el ciclo de la materia del Universo, siendo contribuyentes esenciales al ISM con material procesado en sus núcleos y envolturas. En el caso de estrellas de masa baja e intermedia, se denomina nebulosa preplanetaria a las envolturas circunestelares que atraviesan una rápida transformación ( $\sim 10^3$  yr) entre la fase AGB y la nebulosa planetaria, transitando desde un régimen frío, molecular y de geometrías esferoidales hacia envolturas calientes, ionizadas y con una amplia variedad de geometrías. Hasta la fecha, el conocimiento sobre las nebulosas preplanetarias se ha construido mayoritariamente a partir del estudio de una serie de objetos que, entre otras características, presentan morfologías deslumbrantes en el espectro óptico. Sin embargo, existe un número significativo de candidatos que, pese a mostrar indicadores similares, son sistemáticamente excluidos de estos estudios debido a su apariencia de fuente puntual o a no ser detectados en longitudes de onda visibles. Esto plantea la posibilidad de la existencia de un sesgo observacional en el campo, al asumirse como canónico lo aprendido exclusivamente de las nebulosas más llamativas. En esta charla presentaré un primer estudio de 26 de estas envolturas “olvidadas”, comparando los resultados preliminares obtenidos hasta el momento con las nebulosas preplanetarias clásicas. En esta primera fase, nos centramos en determinar parámetros fundamentales de la componente molecular de las envolturas, como son la densidad, la temperatura y la velocidad de expansión, así como en identificar la posible existencia de diferentes componentes cinemáticas. Abordamos este análisis mediante la combinación de líneas moleculares de emisión, principalmente  $^{12}\text{CO}$  y  $^{13}\text{CO}$ , medidas con el interferómetro ALMA, junto con la construcción de modelos de transferencia radiativa utilizando el programa Shape.

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**13:30 – 13:45**

**Samuel Aguilera Cortés**  
**Molecular evolution & Life Sciences**  
**CAB**

**Exploring Prebiotic Pathways toward Alternative RNA Worlds: Experimental Approaches to Heterocyclic Nucleobase Synthesis**

Understanding how life began is one of the most profound questions faced by humankind, and it continues to challenge philosophy and science alike. Most scientific attempts to explain the origin of life take current forms of life as a source of inspiration, as exemplified by the “RNA World” hypothesis. The “RNA World” hypothesis envisions a prebiotic Earth in which nucleic acids, especially RNA, played a central role in the emergence of biological processes. RNA is capable of storing genetic information and can function as a catalyst for chemical reactions, attributes considered highly consistent with those expected for the earliest biomolecule on the early Earth. Despite its conceptual appeal, the challenging prebiotic synthesis of canonical RNA components has prompted a progressive reformulation of the hypothesis. Present-day scenarios suggest that modern RNA was preceded by alternative ancestral polymers designated as pre-RNAs. Considerable debate surrounds the composition and structure of such predecessor molecules. One intriguing possibility is that pre-RNAs contained alternative nitrogenous bases rather than the canonical ones. These alternative bases, referred to as heterocyclic compounds, display structural similarities to contemporary nucleobases and are more readily synthesized in experimental simulations of prebiotic environments. Building upon these findings, this project seeks to investigate the laboratory synthesis of several heterocyclic bases from simple precursors that were likely present on the early Earth, such as hydrogen cyanide (HCN). The polymerization of HCN will be studied under conditions that mimic early Earth, including minerals and the formation of aqueous aerosols. The project further aims to assess the reactivity of the synthesized bases with sugars to promote the formation of nucleosides and nucleotides. Finally, the ability of these bases to pair with each other and organize into more complex structures will be evaluated.

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**13:45 – 14:00**

**David Haasler García**  
**Astrophysics & Astrochemistry**  
**CAB**

## Multi-transition spatial analysis of phosphorus-bearing molecules towards the solar-like protostellar system IRAS 16293-2422

The study of the chemical composition of star- and planet-forming regions is a fundamental step to understand how prebiotic chemistry could proceed on early Earth. In particular, phosphorus (P) is a critical element for life, although the formation mechanisms of P-bearing molecules in the interstellar medium still remain poorly understood. We used high spatial resolution (35 au) observations carried out with the Atacama Large Millimetre/sub-millimetre Array (ALMA), to search for phosphorus nitride (PN) and phosphorus oxide (PO) towards IRAS 16293-2422, the prototypical analogue of the precursor of the Solar System, to disentangle the spatial distribution of P-bearing molecules. We used the MAdrid Data CUBe Analysis (Madcuba) software to analyse the emission of three rotational transitions of PN and PO assuming Local Thermodynamic Equilibrium conditions, and compared their emission and molecular abundance with other molecular species such as SO, SO<sub>2</sub>, and CH<sub>3</sub>OH. We analysed in detail the emission of PN and PO towards 22 emission spots, finding a total of 31 velocity components featuring PN emission. By observing three sets of rotational transitions of PN and PO, we could derive their excitation temperature and discover the higher energy transitions are being excited closer to the protostars. We found that the emission of PN and PO arises from shocked gas produced by a protostellar outflow, and that it only correlates with the emission of SO at low velocities. Throughout the source we measure PO/PN ratios between 0.99-2.4, and (PO+PN)/CH<sub>3</sub>OH ratios between 0.2%-1.5%, similarly to previous observations in other star-forming regions. Our findings support the formation of P-bearing molecules in shocked gas where a yet unidentified P-carrier is desorbed from the dust grain surface and gas phase reactions produce PN and PO. The results motivate the need for further P-bearing observations to constrain the chemical models and discover the main carriers of P in the ISM.

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## Posters

- P1 The impact of UV/X-ray emission in AGB circumstellar envelopes**  
Jaime Alonso Hernández  
Astrophysics & Astrochemistry  
CAB
- P2 A Massive Star Census in the Magellanic Clouds**  
Juan A. Molina Calzada  
Astrophysics & Astrochemistry  
CAB
- P3 Following PAHs across cosmic time with PRIMA**  
Leonor Arriscado  
Astrophysics & Astrochemistry  
CAB
- P4 Revealing the spatially resolved ISM in the lensed galaxy A1689-zD1 at  $z \sim 7.13$ : Combining JWST RIOJA with ALMA**  
Carmen Blanco Prieto  
Astrophysics & Astrochemistry  
CAB
- P5 A fast machine learning tool to predict the composition of astronomical ices from infrared absorption spectra**  
Andrés Megías Toledano  
Astrophysics & Astrochemistry  
CAB
- P6 Microbial communities from a Pyrenean ice cave**  
V́ctor Muńoz Hisado  
Molecular evolution & Life Sciences  
CAB
- P7 Can microorganisms from a volcanic englacial ecosystem survive the environmental conditions of mars?**  
María Martínez Carrancho  
Molecular evolution & Life Sciences  
CAB
- P8 A Standalone MEDA-TIRS Algorithm for Continuous Aerosol Optical Depth Retrieval on Jezero Crater, Mars**  
Teresa Moya Blanco  
Instrumentation & Space Missions  
CAB