AstroChemical Newsletter #123

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Abstracts

A gas-phase “top-down” chemical link between aldehydes and alcohols

Christopher N. Shingledecker, Germán Molpeceres, A. Mackenzie Flowers, Deaton Warren, Emma Stanley, Anthony Remijan

Introduction: Alcohols and aldehydes represent two key classes of interstellar complex organic molecules (COMs). This work seeks to better understand their possible chemical connections, with a focus on such molecules in the sources of the star-forming region Sgr B2 (N). Methods: The gas-phase reaction between ethanol (CH_3CH_2OH) and the halogens fluorine and chlorine was investigated via DFT calculations, with the goal of determining whether astrochemically viable chemical pathways leading to acetaldehyde (CH_3CHO) exist. The studied reactions were then included in an astrochemical model of Sgr B2 (N) to determine their significance under real interstellar conditions. Results: Our DFT calculations revealed that both chlorine and fluorine can react barrierlessly with ethanol to abstract a hydrogen atom. We further found that, following this initial step, the resulting ethanol radicals can undergo further reactions with atomic hydrogen, with some routes leading to acetaldehyde. Incorporation of these novel reactions in astrochemical models of hot cores suggest that they are indeed efficient under those conditions, and can lead to modest increases in the abundance of CH_3CHO during model times where gas-phase ethanol is abundant. Of the ethanol radicals included in our chemical network, we found CH_3CHOH to have the highest abundances in our simulations comparable to that of ethanol at some model times. Discussion: Overall, this work reveals a novel gas-phase “top-down” link from alcohols to aldehydes that compliments the better studied “bottom-up” routes involving grain-surface H-addition reactions yielding alcohols from aldehydes. Moreover, results from our astrochemical models suggest that the ethanol radical CH_3CHOH may be detectable in the interstellar medium.

Front. Astron. Space Sci., 05 February 2026, Sec. Astrochemistry, Volume 12
DOI: 10.3389/fspas.2025.1664349
Full-text URL: https://arxiv.org/abs/2602.03989

Identifying Evolutionary Stages of Molecular Clumps through Unsupervised and Supervised Machine Learning

K. V. Plakitina, M. S. Kirsanova, A. B. Ostrovskii, A. D. Gimalieva, S. V. Salii, A. V. Meshcheryakov

The evolutionary classification of molecular clumps, crucial for understanding star formation, is commonly based on human-assigned categories derived from infrared (IR) emission and well-established morphological criteria. However, due to ambiguous signatures, distance uncertainties or heavily obscured IR emission, a significant fraction of sources often remains unclassified. This work demonstrates the capability of machine learning (ML) as a complementary, data-driven approach to automate the identification and classification of these clumps using data from the MALT90 survey, complemented by Spitzer IR photometry. We applied unsupervised clustering with HDBSCAN on molecular line intensities, revealing distinct groupings that correspond to evolutionary stages. Using only five molecular lines (HCO^+, HNC, N_2H^+, HCN, C_2H), we identified stable clusters of protostars and regions without active star formation, driven primarily by C_2H and N_2H^+ emission. Incorporating $H^{13}CO^+$ gave rise to a distinct UV-dominant cluster, tracing more evolved regions. Infrared properties appeared as non-significant features implying that envelopes of clumps with different masses are similar in their global infrared characteristics. We then employed supervised learning to classify clumps with previously uncertain categories and provided classifications for 522 objects, predominantly as regions without active star formation. Our results show that ML techniques can effectively uncover intrinsic evolutionary structures in complex astrochemical data and assign categories to uncertain sources, providing a powerful, data-driven complement to traditional methods.

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Time-dependent chemical evolution during cloud formation: H2-regulated chemistry in diffuse molecular cloud

Y. Komichi, Y. Aikawa, K. Iwasaki, and K. Furuya

We investigate the chemical evolution of a forming molecular cloud behind an interstellar shock wave. We conduct three-dimensional magnetohydrodynamics simulations of the converging flow of atomic gas, including a simple chemical network and tracer particles that move along the local velocity field. Then we perform detailed chemical network calculations along the trajectory of each tracer particle. The diffuse part of forming molecular clouds is CO-poor; i.e., H_2 and CO abundances do not correlate. In diffuse regions of $n_H \le 10^3$ cm^{-3}, we find that the abundances of hydrocarbons and oxygen-bearing molecules are determined by steady-state chemistry reflecting the local H2 abundance, which is determined by the gas density along the trajectory. In denser regions, the abundances are affected by water ice formation, which changes the elemental abundance of carbon and oxygen (i.e., C/O ratio) in the gas phase. Assuming quasi-steady-state chemistry given the abundances of major molecules (e.g., H2) from the simple network, we derive analytic solutions for molecular abundances, which reproduce the calculation results. We also calculate the molecular column densities based on the spatial distribution of tracer particles and their molecular abundances, and compare them with observations of diffuse molecular clouds. We find that the column densities of CH, CCH, and OH are linearly correlated with those of H2, which supports the empirical relation used in the observations. On the other hand, the column density of HCO+ shows non-linear dependence on the H2 column density, reflecting the difference in HCO+ formation paths in CO-poor and CO-rich regions.

Monthly Notices of the Royal Astronomical Society, Volume 546, Issue 2, February 2026, stag027
DOI: 10.1093/mnras/stag027
Full-text URL: https://arxiv.org/abs/2601.03441

Photolysis of interstellar ice analogs containing ethanol: A new approach to forming C2H4O2 isomers

M. Lemaître, L. Krim, L. Pagani

The three most common of the eight isomers of C2H4O2 -- methyl formate (CH3OCHO, MF), glycolaldehyde (CH2OHCHO, GA), and acetic acid (CH3COOH, AA) -- are detected in various interstellar clouds, often with differing abundance ratios. Laboratory experiments simulating astrophysical ice conditions have successfully produced methyl formate and glycolaldehyde from methanol-rich ices, but acetic-acid formation remains poorly understood, with only a few experimental successes. Current gas-grain chemical models can reproduce some observed abundances, whereas gas-phase models alone are insufficient. The aim of this study is to investigate new formation pathways for C2H4O2 isomers through the vacuum-ultraviolet (VUV) irradiation of ethanol (CH3CH2OH) under astrophysically relevant ice conditions. By analyzing the photo-products formed in different environments—ethanol isolated in a neon matrix, in pure form, and mixed with molecular oxygen—we aim to identify mechanisms that could account for the observed abundances of these isomers in interstellar molecular clouds. Fourier-transform infrared (FTIR) spectroscopy was performed on the ice analog before and after VUV irradiation at 3 K and at 5 K intervals from 10 to 300 K. The column density of each isomer in the ice was determined through quantitative FTIR analysis. As the temperature increased, desorption of the sample was monitored using a quadrupole mass spectrometer. The temperature-programmed desorption (TPD) profiles for each mass were used to corroborate the infrared (IR) results and to hypothesize the presence of specific species. Under conditions simulating astrophysical ice environments, we successfully formed the three isomers from CH3CH2OH:O2 ice irradiation. At 160 K, the abundance ratio of MF:GA:AA was determined to be 1.3:1:3.9. At this temperature, MF has already largely begun to desorb, and the associated abundance ratio does not represent the total quantity of MF formed. However, its detection at 160 K in the ice indicates that trapping is taking place in our experiment. Our oxygenated ethanol ice irradiation experiment favors AA formation over GA, a result that can explain some interstellar medium (ISM) cloud observations.

A&A, 706, A314 (2026)
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Full-text URL: https://doi.org/10.1051/0004-6361/202556532

Bottom-up Formation of Phenol (C6H5OH) in Interstellar Analog Ices of Acetylene and Water Exposed to Ionizing Radiation

J. Wang, J. H. Marks, S. Inada, R. I. Kaiser

Although oxygenated benzene derivatives are key precursors in the abiotic synthesis of biorelevant molecules and fundamental building blocks of functionalized polycyclic aromatic hydrocarbons, their formation mechanisms under interstellar conditions have remained largely unexplored. Here, we report the first bottom-up formation of phenol (C6H5OH) in low-temperature interstellar ice analogs composed of acetylene and water (C2H2–H2O). Utilizing vacuum ultraviolet photoionization reflectron time-of-flight mass spectrometry and resonance-enhanced multiphoton ionization, phenol, along with aromatic hydrocarbons including benzene (C6H6), phenylacetylene (C6H5CCH), styrene (C6H5CHCH2), naphthalene (C10H8), and phenanthrene (C14H10), were identified in the gas phase during temperature-programmed desorption. Among these species, styrene, naphthalene, and phenanthrene have not yet been detected in the interstellar medium, suggesting that they are suitable targets for future astronomical searches. These findings reveal viable low-temperature formation pathways for phenol through nonequilibrium chemistry in acetylene-containing interstellar ices, thereby advancing our understanding of the abiotic formation of oxygenated benzene derivatives in extraterrestrial environments.

Astrophys. J., 1000, 76 (2026)
DOI: 10.3847/1538-4357/ae48fa
Full-text URL: https://iopscience.iop.org/article/10.3847/1538-4357/ae48fa

An Efficient Route to Glyceraldehyde (HOCH2CH(OH)CHO)--the Simplest Aldose--via Reactions of Carbon-Centered Radicals in Deep Space

J. H. Marks, J. Wang, R. C. Fortenberry, R. I. Kaiser

The simplest sugar—glyceraldehyde (HOCH2CH(OH)CHO)—represents a central molecule in the biochemistry of all lifeforms (glycolysis/gluconeogenesis). Linking photosynthesis and carbon fixation to sugar metabolism is fundamental to the liberation of energy from sugars and is the point at which glycolysis becomes exothermic—the pay-off phase. By exploiting isomer-selective photoionization reflectron time-of-flight mass spectrometry, glyceraldehyde and its energetic enol isomer 1,2,3-propenetriol (HOCH2C(OH)CHOH) are identified in situ during space-simulation experiments as reaction products of radicals formed in ethylene glycol (HOCH2CH2OH) and carbon monoxide (CO) interstellar model ices exposed to energetic electrons as proxies for galactic cosmic rays. Isotopic substitution demonstrates the mechanism of sugar formation from molecules abundant in the interstellar medium. The stability of the carbon-centered radical intermediates formyl (HĊO) and 1,2-dihydroxyethyl (HOCH2ĊHOH) imply that reactions of carbon monoxide and methanol derivatives like ethylene glycol represent a facile, highly active mechanism of sugar production within ice coated interstellar grains in deep space.

Phys. Chem. Chem. Phys., 28, 4744-4752 (2026)
DOI: 10.1039/D5CP04397B
Full-text URL: https://pubs.rsc.org/en/content/articlelanding/2026/cp/d5cp04397b

Quantum Chemical Insights into the Dissociation of Phenol: Shedding Light on Impact Ionization Mass Spectrometry for Icy Moon Exploration

Thomas R. O’Sullivan, Partha P. Bera, Nozair Khawaja, Maryse Napoleoni, Bernd Abel, Frank Postberg

Ice grains emitted by the Saturnian moon Enceladus were sampled by Cassini’s Cosmic Dust Analyser (CDA) using impact ionization mass spectrometry. CDA revealed that Enceladus hosts a rich organic and inorganic chemical inventory in its subsurface ocean, hinting at its potential habitability. Analysis of fragmentation patterns with laser desorption experiments for the interpretation of CDA data has been essential; however, theoretical insights regarding both fragmentation and ionization processes are often missing. Here, we use density functional theory methods to investigate the energies for dissociation channels of phenol, a model aromatic compound for the features observed by CDA. The fragmentation channels are compared to experimental spectra obtained by using laser-induced liquid beam ion desorption (LILBID) mass spectrometry, an analogue for ice impact mass spectra. Our findings suggest that protonation is the dominant mechanism of ionization, that dissociation from the radical cation and neutral phenol molecule is limited, and that multiple isomers of the protonated molecule act as starting points for dissociation. The highest-intensity organic fragments observed in the LILBID spectrum–arising from the losses of CO, [M + H–CO]+, and water, [M + H–H2O]+–are found to be both thermodynamically and kinetically accessible. We examined water–molecule interactions during the initial production of the protonated molecule. The presence of water significantly influences the preferred site of protonation and causes variation in the relative energy ordering of the protomers. This work builds toward a computational model of ice grain impact ionization mass spectrometry, relevant for missions such as Europa Clipper and ESA’s L4 mission to Enceladus.

2026, ACS Earth and Sapce Chemistry
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Full-text URL: https://pubs.acs.org/doi/10.1021/acsearthspacechem.5c00318

Astrochemistry prefers the biomolecule: isomer-selective production of ethanolamine (HOCH2CH2NH2) in interstellar model ices

J. H. Marks, A. A. Nikolayev, J. Wang, I. O. Antonov, A. M. Mebel, R. I. Kaiser

A crucial molecule in the chemistry of life, ethanolamine (HOCH2CH2NH2) is among the most prevalent biomolecules. It serves as a ubiquitous hydrophilic head group for the molecules comprising cellular membranes and it functions as both precursor and intermediate in the biological synthesis of neurotransmitters among other metabolites, protein folding, and post-translational modification. Because of the out-sized biological importance of this molecule ethanolamine is expected to serve as a signature for prebiotic chemistry in space, highlighting the importance of its recent discovery. Here, we show that model interstellar ices containing methanol (CH3OH) and methylamine (CH3NH2) produce ethanolamine upon exposure to an environment simulating that of dense interstellar molecular clouds. Ethanolamine was identified in the gas phase during temperature-programmed desorption utilizing vacuum ultraviolet photoionization reflectron time-of-flight mass spectrometry. Despite irradiation by electrons with energy far exceeding any covalent interaction, reactions toward C2H7NO isomers are selective for ethanolamine while its isomers are not detected. Computations provide support that polar solvation destabilizes nitrogen- and oxygen-centered radicals while lowering the barrier to intramolecular hydrogen transfer, resulting in the selective stabilization and formation of carbon-centered radicals. These findings explain the unexpected abundance of ethanolamine in the interstellar medium, and the apparent isomer-selectivity of this reaction may represent a mechanism by which ice-phase astrochemical reactions are preferential toward the building blocks of life.

Phys. Chem. Chem. Phys., 28, 5516-5526 (2026)
DOI: 10.1039/D5CP04639D
Full-text URL: https://www.uhmreactiondynamics.org/publication_papers/p660.pdf

Spatial distribution of organics in the Horsehead nebula: Signposts of chemistry driven by atomic carbon

Claudio Hernández-Vera, Viviana V. Guzmán, Jérôme Pety, Ka Tat Wong, Javier R. Goicoechea, Franck Le Petit, Maryvonne Gerin, Aquiles den Braber, John M. Carpenter, Vincent Maillard, Emeric Bron, Pierre Gratier, Evelyne Roueff

(Abridged) Complex organic molecules (COMs) are considered essential precursors to prebiotic species. While COMs were once expected to be efficiently destroyed under UV-irradiated conditions, detections in photodissociation regions (PDRs) have challenged this view. However, the mechanisms by which UV radiation contributes to their formation are still uncertain. Here, we present moderately resolved maps of simple and complex organic molecules at the UV-illuminated edge of the Horsehead nebula, obtained by combining ALMA and IRAM 30m single-dish observations at ~15" resolution. We analyze the spatial distribution of species such as C17O, CH2CO, CH3CHO, HNCO, CH3CN, and HC3N. By incorporating previous C17O and C18O single-dish data as well as PdBI maps of H2CO and CH3OH, we derive profiles of gas density, temperature, thermal pressure, and column densities of the organic species as a function of distance from the UV source. Our results show that most organic species, particularly H2CO, CH2CO, CH3CHO, HNCO, and CH3CN exhibit enhanced column densities at the UV-illuminated edge compared to cloud interiors, possibly indicating efficient dust-grain surface chemistry driven by the diffusion of atomic C and radicals produced via photodissociation of CO and CH3OH, as supported by recent laboratory experiments. The exceptions, HC3N and CH3OH, can be attributed to inefficient formation on dust grains and ineffective non-thermal desorption into the gas phase, respectively. Additionally, contributions from gas-phase hydrocarbon photochemistry, possibly seeded by grain-surface products, cannot be ruled out. Further chemical modeling is needed to confirm the efficiency of these pathways for the studied species, which could have important implications for other cold, UV-irradiated environments such as protoplanetary disks.

A&A, 707 (2026) A120
DOI: 10.1051/0004-6361/202557383
Full-text URL: https://arxiv.org/abs/2601.20146

A 3D physico-chemical model of a pre-stellar core. II. Dynamic chemical evolution in a pre-stellar core model using tracer particles

S. S. Jensen, S. Spezzano, P. Caselli, T. Grassi, O. Sipilä, T. Haugbølle

This work explores the differences between static and dynamically evolving physico-chemical models of pre-stellar cores. A 3D MHD model of a pre-stellar core embedded in a dynamic star-forming cloud is post-processed using sequentially dust radiative transfer, a gas-grain chemical model, and a non-LTE line-radiative transfer model. The chemical evolution is modeled along 20,000 tracer particle trajectories to capture the impact of a realistic dynamical evolution as the core is formed. The emission morphology of CH3OH and c-C3H2 and the intensities of CH3OH, c-C3H2, CS, SO, HCN, HCO+ and N2H+ are compared with observations of L1544. Our results show a distinct difference in chemical morphology between the dynamical and static models. The dynamical model reproduces the observed spatial distribution of CH3OH and c-C3H2 toward L1544, whereas the static model fails to reproduce this morphology. In contrast, when comparing modeled and observed intensities across a broad range of molecules, the static model shows good agreement with observations for L1544. The dynamical model systematically predicts lower abundances and modeled intensities for six of the seven species presented here. For sulphur-bearing species, the intensities are in better agreement with observations when the initial abundances are undepleted in heavier elements. This study reveals distinct differences between dynamical and static physico-chemical models. The static model predicts higher abundances and intensities for the majority of the molecules studied here, compared with the dynamical model. This discrepancy may stem from the specific choices of initial conditions, which could limit the dynamical models ability to fully capture the physical and chemical history. The intensities predicted by the static model are comparable to those observed toward L1544.

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Abiotic formation of nitrile precursors to amino acids and nucleobases in interstellar ice analogues

J. Wang, S. Inada, C. Zhang, J. H. Marks, Z. Wang, A. Bergantini, M. McAnally, A. K. Eckhardt, R. I. Kaiser

Amino acids and the five canonical nucleobases have been identified in carbonaceous meteorites such as Murchison and Murray; however, their formation mechanisms under interstellar conditions have remained largely elusive. Here, we report the synthesis of biorelevant nitriles, key precursors to amino acids and nucleobases, in low-temperature interstellar model ices composed of hydrogen cyanide (HCN) irradiated with galactic cosmic ray proxies in the form of energetic electrons. Ammonia (NH3), diazene (HNNH), methylamine (CH3NH2), ammonium cyanide (NH4CN), ethanimine (CH3CHNH), and nitriles including isocyanogen (CNCN), cyanamide (NH2CN), iminoacetonitrile (HNCHCN), N-cyanomethanimine (H2CNCN), and methyl cyanamide (CH3NHCN) were identified utilizing vacuum ultraviolet photoionization reflectron time-of-flight mass spectrometry combined with Fourier-transform infrared spectroscopy and quadrupole mass spectrometry. These results suggest that previously astronomically undetected diazene, ammonium cyanide, and methyl cyanamide represent suitable targets for future astronomical searches. Furthermore, our findings provide fundamental insights into the non-equilibrium formation pathways leading to nitrogen-bearing molecules including complex nitriles in HCN-rich interstellar ices, thereby advancing our understanding of the abiotic origins of amino acids and nucleobases in extraterrestrial environments.

Chem. Sci., 17, 4966–4977 (2026)
DOI: 10.1039/D5SC08569A
Full-text URL: https://pubs.rsc.org/en/content/articlelanding/2026/sc/d5sc08569a

Unconventional Formation of Cyanamide, a Key Intermediate in Prebiotic Chemical Evolution, in

Interstellar Ice Analogues

J. Wang, J. H. Marks, A. K. Eckhardt, R. I. Kaiser

The interstellar origin and chemistry of the NCN moiety, a critical molecular backbone of nucleobases, is central to the RNA world hypothesis for the Origins of Life; however, its formation mechanisms under astrophysical conditions remain largely unexplored. Here, we report the first laboratory preparation of cyanamide (NH2CN), a key intermediate in prebiotic chemical evolution, in low-temperature ammonia–methylamine (NH3–CH3NH2) interstellar ice analogs exposed to energetic electrons, simulating secondary electrons generated by galactic cosmic rays. Utilizing tunable vacuum ultraviolet photoionization reflectron time-of-flight mass spectrometry combined with isotopic labeling, cyanamide was identified isomer-selectively in the gas phase during temperature-programmed desorption. These findings reveal nonequilibrium pathways to cyanamide in methylamine-containing interstellar ices, highlighting the pivotal role of galactic cosmic rays in forming the biorelevant NCN backbone and shedding light on the abiotic synthesis of nucleobases in astrophysical environments.

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The binding energies of atoms on amorphous silicate dust: A computational study

K. Hansson, W. M. C. Sameera, C. J. Esmerian, D. Bossion, S. Andersson, S. Aalto, W. Vlemmings, K. K. Knudsen, and G. Nyman

Context. We investigate the binding energies of atoms to interstellar dust particles, which play a key role in their growth and evolution, as well as for the chemical reactions on their surfaces. Aims. We aim to compute the binding energies of abundant atoms in the interstellar medium (C, N, O, Mg, Al, Si, S, Ca, Fe, and Ni) to silicate dust. Methods. We used the Geometries, Frequencies, and Non-covalent Interactions Tight Binding (GFN1-xTB) method to compute the binding energies. An FeMgSiO_4 periodic surface model, containing 81 local minima on the surface, was used. Results. A range of binding energies was found for each element. The median of the binding energies follows the order Si (14.8 eV) > Al (12.8 eV) > Ca (12.7 eV) > C (9.5 eV) > O (8.1 eV) > N (6.2 eV) > Fe (6.0 eV) > S (5.2 eV) > Mg (2.4 eV). The probability distribution of binding energies for each element except Ca is statistically consistent with a log-normal distribution. Conclusions. In general, Si, Ca, and Al atoms have large binding energies. Thus, these atoms can stay on the silicate dust particles at high temperatures. The binding energies of the other atoms, C, N, O, Mg, S, Fe and Ni, are relatively weak. However, the computed binding energies for these elements are still far stronger than the energies associated with dust temperatures typical of the ambient interstellar medium (ISM), suggesting that silicate grains are generally stable against sublimation. We estimate sublimation temperatures for silicate grains to range from 1600 K to 3000K depending on assumed grain size and lifetime. These binding energies on silicate dust grains, estimated from first principles for the first time, provide invaluable input to models of dust evolution and dust-catalyzed chemical reactions in the interstellar medium.

Astronomy and Astrophysics 707:A54 (2026)
DOI: 10.1051/0004-6361/202556997
Full-text URL: https://arxiv.org/abs/2508.19339

Quantifying the C/O Ratio in the Planet-forming Environments around Very Low-mass Stars

J. K. Díaz-Berríos, C. Walsh, and E. F. van Dishoeck

The material in planet-forming disks determines the composition of planets; hence, it is crucial to understand the physical and chemical processes that set the abundance and distribution of key volatiles. James Webb Space Telescope observations of disks around very low-mass (∼0.1 Msun) stars (VLMSs) have revealed their hydrocarbon-rich inner regions (e.g., C2H2), with column densities significantly higher than predicted. We employ chemical kinetics models using the physical structure of the inner disk around an M dwarf star with an X-ray luminosity of LX ∼ 10e29 erg s−1. We adopt initial abundances that mimic the effects of carbon enhancement and oxygen depletion (C/O from 0.44 to 87.47) and quantify how the abundances and distributions of key volatiles respond. The column density and number of molecules (N) of hydrocarbons and oxygen-bearing species are highly sensitive to the C/O ratio, with the largest increases in hydrocarbons occurring when carbon increases by a factor of 2, and/or oxygen decreases by a factor of 10, relative to solar. In the IR-emitting region (Tgas > 200 K), a range of C/O ratios can reproduce the observed N and ratios relative to CO2. The disk integrated molecular ratio with respect to CO2 is highly sensitive to the underlying C/O ratio. However, our results apply only to a source with a single X-ray luminosity value at the middle of that observed for VLMSs; hence, a degeneracy between the stellar L_X and the C/O ratio cannot be discarded. Nonetheless, our findings support that an enhanced C/O is required to drive the hydrocarbon-rich chemistry observed in the inner disks around VLMSs.

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Full-text URL: https://arxiv.org/abs/2601.23069

Announcements

PhD position in Experimental Research on Exoplanet Atmospheres

A new PhD position is available in the Analytical Mineralogy Group at the Institute of Geosciences, Friedrich Schiller University Jena, Germany, under the supervision of Dr. habil. Alexey Potapov and Prof. Dr. Falko Langenhorst. The position is within the framework of the German Research Foundation (DFG) project “Dust Clouds in Exoplanetary Atmospheres: A Laboratory View”. The project will address a crucial gap in exoplanet atmospheric research by systematically studying the near- and mid-infrared spectral properties of porous silicate grains and gas-grain interactions at high temperatures relevant to exoplanet atmospheres. The experimental data will be used to analyse and interpret observational spectra of exoplanet atmospheres, particularly James Webb Space Telescope (JWST) spectra, in collaboration with colleagues from the Max Planck Institute for Astronomy. Various experimental techniques will be employed within the framework of the project, such as laser ablation, infrared spectroscopy, mass spectrometry, transmission and scanning electron microscopy, and energy dispersive X-ray spectroscopy.
Your responsibilities:
- Learn and apply experimental and analytical techniques
- Presentation of your results at international conferences
- Publication of your results together with partners in internationally renowned journals
- As part of the project, you will have the opportunity to complete your doctorate

Your profile:
- A Master’s degree in experimental physics or chemistry
- Very good written and spoken English skills are required
- You have an interest/knowledge in the field of physics and chemistry of exoplanet atmospheres
- You like to work in a multicultural environment
- Your duties will require traveling and participation in scientific conferences in Germany and abroad

For informal enquiries and expressions of interest, candidates are encouraged to contact Dr Alexey Potapov.
Applications should be sent to Dr Alexey Potapov and include a brief cover letter, CV including academic transcripts and grades, and a support letter from the supervisor of candidate’s master thesis.
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Deadline: 31 March 2026
E-mail for contact: alexey.potapov@uni-jena.de
Webpage: https://www.chemgeo.uni-jena.de/en/53570/team

Postdoc in Astrophysics and Planetary Science at the Niels Bohr Institute

We are looking for a highly motivated and dynamic postdoc for a 2.5-year position. As postdoc you will investigate the chemical composition of protoplanetary disks to place robust constraints on the origin and evolution of life-enabling molecules during star and planet formation.

The position will start on the 1st of January 2027. The job is in the New Niels Bohr Building (NBB) at the Niels Bohr Institute, Copenhagen, Denmark.

Information on the department can be found at: https://nbi.ku.dk/english/research/astrophysics

Link to the job ad: https://candidate.hr-manager.net/ApplicationInit.aspx/?cid=3010&departmentId=19985&ProjectId=158317&MediaId=4917&SkipAdvertisement=false