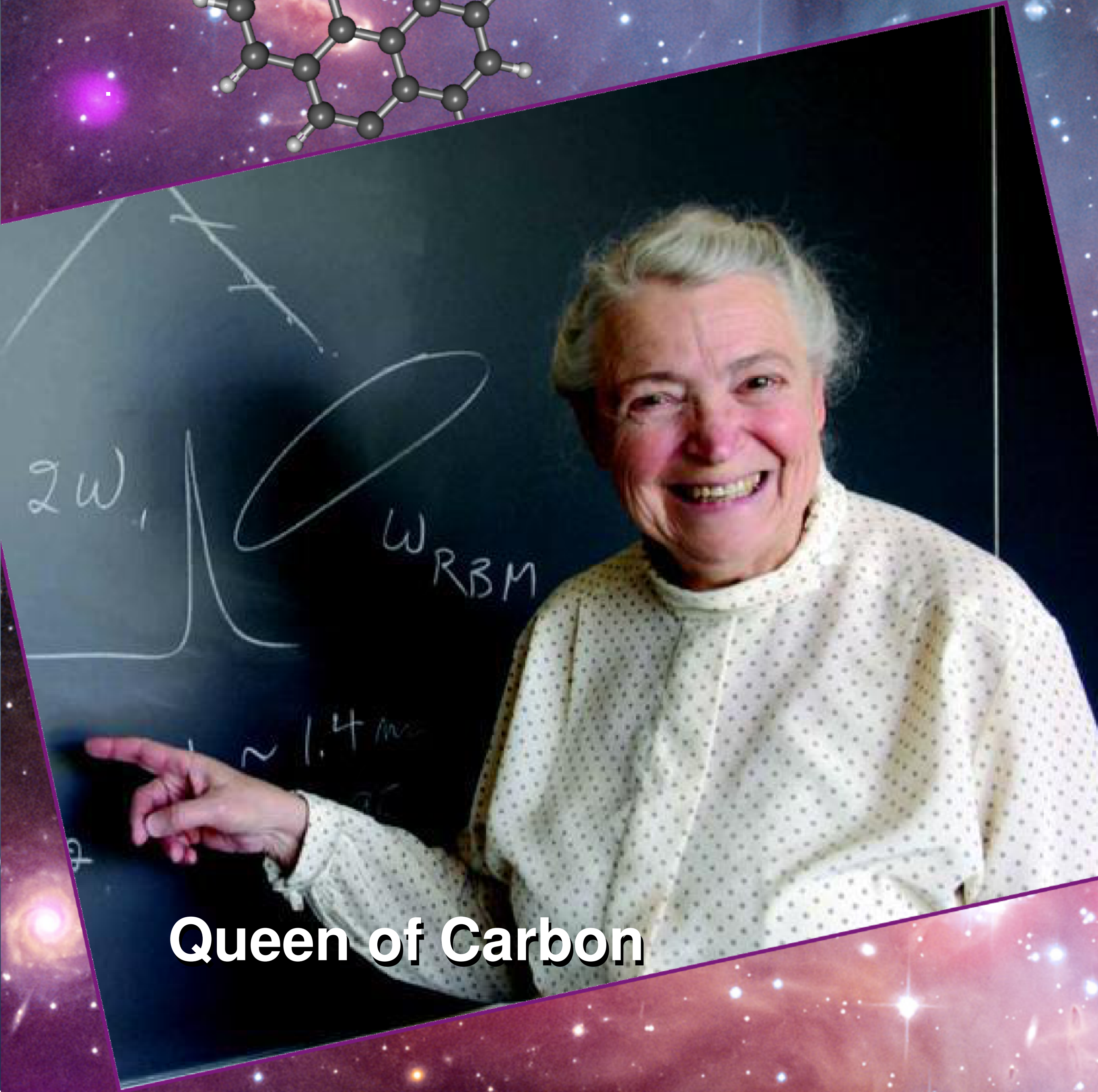
AstroPAH

A Newsletter on Astronomical PAHs

Issue 56 • March 2019



Queen of Carbon

Editorial

Dear Colleagues,

Welcome to the second AstroPAH issue of 2019, delivered to you during the March Equinox. We are glad to have you back with us for this new season.

This month, In Focus is dedicated to an interview with our new editorial board member, David Dubois, who joined us last month.

A number of papers such as Far-IR and UV spectroscopy of acenaphthene, Titan's ionospheric chemistry and laboratory photochemistry of pyrene clusters are all presented under Abstracts. We also feature the 26th International Symposium on Polycyclic Aromatic Compounds (ISPAC) in Sweden, the Latin American Millimeter Array (LLAMA) Astrochemistry Meeting, and a PAH summer school at the University Paul Sabatier in Toulouse, France, on the theme "PAHs in extreme environments".

Finally, a new Post-doctoral position in laboratory astrophysics has opened at the Institut de Planétologie to work closely with Dr. Véronique Vuitton on the formation and evolution of complex organic matter in the solar system.

We thank you for your dedication and interest in AstroPAH. If you wish to contact us, feel free to use our email: astropah@strw.leidenuniv.nl.

We hope you enjoy reading our March newsletter, and look forward to seeing you again next month, right after the IAU Meeting in Cambridge.

Enjoy reading our newsletter!

The Editorial Team

Next issue: 18 April 2019.
Submission deadline: 5 April 2019.

Contact us:

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http://astropah-news.strw.leidenuniv.nl

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PAH Picture of the Month

Mildred Dresselhaus was the first female Institute Professor and professor emerita of physics and electrical engineering at the Massachusetts Institute of Technology (USA). She is known as the "Queen of Carbon Science" due to her work on graphite, fullerene and carbon nanotubes, which brought her several prizes, including The National Medal of Science (1990) and The Kavli Prize (2012).

Credits: Courtesy of the Institute of Electrical and Electronics Engineers.

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An Interview with David Dubois

The New Member of the AstroPAH Editorial Team

Dr. David Dubois is a postdoctoral research scientist employed through the Bay Area Environmental Research Institute, working at NASA Ames Research Center in the Astrophysics & Astrochemistry Laboratory, with Dr. Ella Sciamma-O'Brien and Dr. Farid Salama. He started working at Ames in November 2018, after completing his PhD carried out in France at the Laboratoire Atmosphéres, Milieux, Observations Spatiales (LATMOS) and in the USA at the NASA Jet Propulsion Laboratory (JPL).

Welcome to the AstroPAH Editorial Board! Can you tell us how you got into PAH-related research?

I did my PhD studying Saturn's largest moon, Titan. Titan's atmosphere is teeming with organic molecules and is quite unique in our Solar System. I see it as an organic chemist's dream laboratory. The simplest hydrocarbon ringed molecule, benzene (C_6H_6), was discovered in the atmosphere by the Cassini mission. By studying Titan's atmospheric chemistry in my work, I have indirectly been involved in PAH-related research through studying the gas-phase reactivity of chemical reservoirs including hydrocarbons, nitriles and N-bearing compounds, positive and negative ions. I remember taking an environmental geochemistry and organic chemistry class at the university, with many courses dedicated to PAHs, I loved it!

What are you working on right now?

Currently, I am focusing mainly on two projects related to characterizing both the gas and solid icy phases of Titan's atmosphere. We want to understand how the gas-phase ion precursors participate in the growth of Titan's aerosols. To do this, I work with the Cosmic Simulation Chamber (COSmIC) at Ames, which uses a pulsed discharge nozzle to ionize

Titan-relevant gases and to form organic molecular ions, neutrals and radicals expanding in a free-jet expansion at low pressure and temperature. We then obtain mass spectra using a Reflectron Time-Of-Flight Mass Spectrometer (ReTOF-MS) in various initial gas conditions. Such an experiment is an extremely valuable tool to help us interpret Cassini observations as well as astrochemical environments of the interstellar medium. I am also involved in a project to study the equilibrium vapor pressure of C_6H_6 and the effect of its condensation on Titan aerosol analogs named tholins. The condensation of benzene occurs lower down in the atmosphere and an icy benzene signature was observed by Cassini in the South polar region. Using a multi-disciplinary approach, we are working towards obtaining laboratory vapor pressure measurements of benzene at Titan-like temperatures in order to improve our understanding of physical and chemical processes involved in the nucleation of these clouds and their composition.

Which open question in Laboratory Astrophysics would you like to see answered in the near future?

Fascinating measurements by the Cassini spacecraft have revealed the unexpected presence of large negative ion compounds in the upper atmosphere. Their composition and role in molecular growth are still largely unknown. Laboratory Astrophysics studies of anions, low temperature kinetics, interactions with PAHs and theoretical calculations could in tandem help in improving our knowledge of this chemistry before we return to Titan with a new mission. Another aspect will be the photochemical evolution of the organic aerosols and ices on Titan's surface. Could photochemistry be conducive to the formation of prebiotic-relevant molecules on the solid surface or lakes? More generally, I think exciting and important questions that I would like to see answered in the future will be those that we have not yet thought of, questions that will be revealed as we progress with new astrochemical discoveries, notably with the advent of ground-based observations and theoretical calculations. Those usually turn out to be the most stimulating questions.

What does it mean for you to be part of the AstroPAH editorial team?

Being a new member of the AstroPAH editorial team is an honor and a thrilling endeavor which I am happy to be part of. As a member of an already international team spread out over three continents, I look forward to learning more from my peers as well as contributing new results within the overarching field of PAHs and astrochemistry. Newsletters such as AstroPAH are wonderful ways of staying in touch with our peers, in spite of our busy lives, and even the public in general.

We heard you are a NASA Solar System Ambassador. Can you tell us more about it and about the outreach activities you have led in the past and plan to lead in the future?

Educational outreach is an activity I always try to dedicate time for. Recently, it has taken me to India to give presentations and interact with extremely curious and passionate children. It has always been a humbling and learning experience for me, and hopefully for the audience as well. I was recently selected to become a NASA Solar System Ambassador, a volunteering educational space outreach program managed by JPL. As an Ambassador, my duty is to engage with the public and especially under-represented minorities in STEM, in the scope of my knowledge, through activities (talks, stargazing, roundtables...). A number of these will be accessible here throughout this year. Most of these events will be in the Bay Area in California.

What was the most important advice somebody gave you?

From my mother, to do what I love and to love what I do.

What do you do outside of work?

I teach and practice the piano and Karate. Music and martial arts are two passions that are dear to me. I am always trying to find ways to combine lessons that I learn from them and explore new venues that can potentially have a fruitful impact in my scientific work. I also love to travel, read and engage in spontaneous adventures where I can learn more from people and nature. In my downtime, I also love to listen to podcasts such as StarTalk and TED Radio Hour.

How do you balance your professional and personal life?

Having the opportunity of working on fascinating topics related to astrochemistry and planetary science, I see my work as a passion only. Therefore, it is sometimes delicate to differentiate between both, as one can overlap over the other. I find that taking a break one whole weekend every once in a while, for instance without even checking my emails, is an efficient way of starting the following week anew. I learned this during my PhD. Deadlines or self-defined objectives in both areas are also ways for me to try to stay consistent with everything I love doing. That said, my productivity curve increases as the day goes by, and I find myself being more productive after a certain hour later at night. The quiet and stillness at night helps me focus and reassess my ongoing work.

Electron correlation driven non-adiabatic relaxation in molecules excited by an ultrashort extreme ultraviolet pulse

Alexandre Marciniak[1], **Victor Despré**[2], **Vincent Loriot**[1], **Gabriel Karras**[1], **Marius Hervé**[1], **Ludovic Quintard**[3], **Fabrice Catoire**[3], **Christine Joblin**[4], **Eric Constant**[1,3], **Alexander I. Kuleff**[2], **Franck Lépine**[1]

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The many-body quantum nature of molecules determines their static and dynamic properties. Novel ultrashort extreme ultraviolet (XUV) pulse sources offer a means to reveal such molecular dynamics at ultrashort timescales. Here, we report the use of time-resolved photoelectron spectroscopy (TR-PES) involving XUV attosecond pulses to study highly excited naphthalene cations. Counter-intuitively, we found that the relaxation timescale is in the order of tens of femtoseconds and increases with the internal energy of the cation. High-level quantum calculations show that these dynamics are intrinsic to the time-dependent many-body molecular wavefunction, in which multi-electronic and Post-Born-Oppenheimer effects are fully entangled. It has also been observed hints of vibronic coherences that persist despite the molecular complexity and the high-energy excitation. These results raise the question of the role of the non-trivial quantum mechanical effects in the context of astrochemistry, for example, regarding the radiation damage in PAHs. XUV pump-probe techniques thus constitute a promising tool for the investigation of PAHs but also of prebiotic molecules, as we recently demonstrated in caffeine [1].

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Nature Communications **10**, 337 (2019)

https://www.nature.com/articles/s41467-018-08131-8

[1] J. Phys. Chem. Lett. **9**, 6927 (2018)

https://pubs.acs.org/doi/10.1021/acs.jpclett.8b02964

Far-IR and UV spectral signatures of controlled complexation and microhydration of the polycyclic aromatic hydrocarbon acenaphthene

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In this work we report on the experimental and theoretical investigations of the progressional complexation of the polycyclic aromatic hydrocarbon (PAH) acenaphthene with itself and with water. In the interstellar medium, PAH complexes are an important link between molecular gas and solid state configurations of carbon, and in the form of grains they are postulated to serve as chemical catalysts. However, no direct detection of PAHs or their (microhydrated) complexes in interstellar space has been achieved as of yet. Therefore, we provide UV and far-infrared ion dip spectra of homogeneous PAH multimers and their hydrated clusters. The far-IR region of the IR spectrum is especially interesting since it contains the most spectral features that arise due to complexation or microhydration. We present microhydrated PAH complexes up to the third order, where we show that the water clusters are locked with little perturbation on the different PAH platforms. Density functional theory (DFT) calculations involving hydrogen bond interactions still seem challenging for predicting the far-IR frequency range, although applying anharmonic corrections leads to slight improvements.

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Phys. Chem. Chem. Phys., 2019, 21, 3414-3422

https://pubs.rsc.org/en/content/articlelanding/2019/cp/c8cp04480e#!divAbstract

Laboratory formation of large molecules in the gas phase

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We report the experimental study on the formation process of large molecules (e.g. a family group of molecular clusters and graphene) in the gas phase. The experiment was carried out using a quadrupole ion trap in combination with time-of-flight mass spectrometry. As the initial molecular precursor, dicoronylene (DC, $C_{48}H_{20}$)/anthracene ($C_{14}H_{10}$) cluster cations, the results show that large PAH cluster cations (e.g., $(C_{14}H_{10})C_{48}H_n^+$, n = [1-19] and $(C_{14}H_{10})C_{62}H_m^+$, m = [1-25]) and PAH-graphene cluster cations (e.g., $(C_{14}H_{10})nC_{48}^+$, n = 0, 1, 2, 3 and $(C_{14}H_{10})mC_{62}^+$, m = 0, 1, 2) are formed by gas-phase condensation under laser irradiation conditions. We infer that these results present in here provide a formation route for interstellar large molecules under the influence of a strong radiation field in the ISM. The relevance of newly formed species to the nanometer-sized dust grain in space is briefly discussed.

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A&A 623, A102 (2019)

https://www.aanda.org/articles/aa/abs/2019/03/aa34847-18/aa34847-18.html

Laboratory Photochemistry of Covalently Bonded Fluorene Clusters: Observation of an Interesting PAH Bowl-forming Mechanism

Weiwei Zhang[1,2,7], Yubing Si[3], Junfeng Zhen[1,2], Tao Chen[4,6], Harold Linnartz[5], and Alexander G. G. M. Tielens[6]

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The fullerene C_{60}, one of the largest molecules identified in the interstellar medium (ISM), has been proposed to form top-down through the photochemical processing of large (more than 60 C atoms) polycyclic aromatic hydrocarbon (PAH) molecules. In this article, we focus on the opposite process, investigating the possibility that fullerenes form from small PAHs, in which bowl-forming plays a central role. We combine laboratory experiments and quantum chemical calculations to study the formation of larger PAHs from charged fluorene clusters. The experiments show that with visible laser irradiation, the fluorene dimer cation–$[C_{13}H_9\text{-}C_{13}H_9]^+$–and the fluorene trimer cation–$[C_{13}H_9\text{-}C_{13}H_8\text{-}C_{13}H_9]^+$–undergo photodehydrogenation and photoisomerization, resulting in bowl-structured aromatic cluster ions, $C_{26}H_{12}^+$ and $C_{39}H_{20}^+$, respectively. To study the details of this chemical process, we employ quantum chemistry that allows us to determine the structures of the newly formed cluster ions, to calculate the dissociation energies for hydrogen loss, and to derive the underlying reaction pathways. These results demonstrate that smaller PAH clusters (with less than 60 C atoms) can convert to larger bowled geometries that might act as building blocks for fullerenes, because the bowl-forming mechanism greatly facilitates the conversion from dehydrogenated

PAHs to cages. Moreover, the bowl-forming induces a permanent dipole moment that-in principle-allows one to search for such species using radio astronomy.

E-mail: jfzhen@ustc.edu.cn
The Astrophysical Journal, 872:38 (8pp), 2019 February 10
https://iopscience.iop.org/article/10.3847/1538-4357/aafe10/meta

Laboratory Photochemistry of Pyrene Clusters: An Efficient Way to Form Large PAHs

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In this work, we study the photodissociation processes of small PAH clusters (e.g., pyrene clusters). The experiments are carried out using a quadrupole ion trap in combination with time-of-flight (QIT-TOF) mass spectrometry. The results show that pyrene clusters are converted into larger PAHs under the influence of a strong radiation field. Specifically, pyrene dimer cations (e.g., [$C_{16}H_{10}$-$C_{16}H_9^+$] or $C_{32}H_{19}^+$), will photodehydrogenate and photo-isomerize to fully aromatic cations (PAHs) (e.g., $C_{32}H_{16}^+$) with laser irradiation. The structure of new formed PAHs and the dissociation energy for these reaction pathways are investigated with quantum chemical calculations. These studies provide a novel efficient evolution routes for the formation of large PAHs in the interstellar medium in a bottom-up process that will counteract the top-down conversion of large PAHs into rings and chains, and provide a reservoir of large PAHs that can be converted into C_{60} and other fullerenes and large carbon cages.

E-mail: jfzhen@ustc.edu.cn
The Astrophysical Journal, 863:128 (6pp), 2018 August 20
https://iopscience.iop.org/article/10.3847/1538-4357/aad240/meta

Titan's ionospheric chemistry, fullerenes, oxygen, galactic cosmic rays and the formation of exobiological moleecules on and within its surfaces and lakes

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We discuss the formation of aerosols within Titan's thermosphere-ionosphere and the different chemical pathways. Negative ion measurements by the Cassini Plasma Spectrometer (CAPS) Electron Spectrometer (ELS) give evidence for formation of unsaturated anion carbon chains, while positive ion measurements of the Cassini Ion Neutral Mass Spectrometer (INMS) indicate formation of more aromatic cation hydrocarbons. There is presently no direct observational evidence for large neutral molecule growth in Titan's thermosphere-ionosphere. The hydrocarbon cations are expected to form Polycyclic Aromatic Hydrocarbons (PAH), those with the addition of nitrogen being called PAHNs. We theorize anion carbon chains can eventually become long enough to fold into fullerene $C_{60,70}$ carbon shells, of various charge states. Based on laboratory data the fullerenes can trap incoming O^+ magnetospheric ions that have relatively high energy collisions with the fullerenes and, once trapped, protect the oxygen atom from Titan's reducing thermosphere-ionosphere. The fullerenes can form into larger onion fullerenes and condense into larger embryo aerosols (i.e., m/q>10,000 amu/q anions as observed by CAPS/ELS) eventually falling onto Titan's surface and precipitating to the bottom of its hydrocarbon lakes. Molecule production composed of H, C, N is known to occur in Titan's atmosphere with energy input from the magnetosphere, solar UV, and deep-penetrating irradiation from galactic cosmic rays (GCR). Space radiation effects by GCR irradiation of Titan's surface and lakes can lead to the manufacture of exobiological molecules with oxygen as the new ingredient. We have developed a model of galactic cosmic ray irradiation of Titan's atmosphere, surface, subsurface and bottoms of Titan lakes. GCR would provide further energy for processing of the aerosols into more complex organic forms such as tholins and precursor molecules for amino acids. A second process called hydrolysis then converts the precursor molecules into amino acids. Hydrolysis is provided via meteor impacts with size $>$10 km and cryovolcanism both which can produce liquid water on Titan's surface for episodic periods $>$ several 100 to 1000 years. Our model shows that GCR secondary particles can penetrate $\sim$ 100 m below the ice surface (including the bottom of Titan's less dense hydrocarbon lakes $\sim$ 150 m depths) and produce chemically significant dosages over very long timescales $\sim$ 450 Myrs. The GCR model is combined with laboratory data from experiments in which dry methyl ices were irradiated to doses producing prebiotic amino acids such as glycine. The model calculations show glycine can form to $\sim$ 2.5 ppb levels near the surface after $\sim$ 450 Myrs of GCR proton irradiation and potentially to 5 ppb if heavy-ion GCRs up through Fe are included. If such molecules were detected, this would not only confirm this model but indicate that life forms different from ours may not be required.

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Icarus, In Press, Accepted Manuscript, 2019 March 14
https://doi.org/10.1016/j.icarus.2019.03.023

26th International Symposium on Polycyclic Aromatic Compounds (ISPAC)

Örebro, Sweden
9 – 12 September 2019

The electronic submission of abstracts for the 26th International Symposium on Polycyclic Aromatic Compounds (ISPAC) is now open! You can submit your abstracts using the abstract submission page on our website: https://www.oru.se/ISPAC2019.

We welcome submission of abstracts related to PACs in any research area for both platform and poster presentations.

We are also happy to announce the roster of speakers for this years meeting:

- Prof. Dr. Christine Achten, Institute of Geology and Paleontology Applied Geology, University of Münster, Germany
- Dr. Staci Massey Simonich, Department of Environmental and Molecular Toxicology and Chemistry, Oregon State University, United States of America
- Dr. Volker Arlt, School of Population Health & Environmental Sciences, Department of Analytical, Environmental and Forensic Sciences, King's College London, United Kingdom
- Dr. Lene Duedahl-Olesen, National Food Institute, Technical University of Denmark, Denmark
- Dr. Olivier Berné, Research Institute in Astrophysics and Planetology, France

We look forward to receiving your abstracts! Thank you.

Med vänliga hälsningar,

Maria Larsson and Ivan A. Titaley
26th ISPAC local organizing committee

Key deadlines:

- Abstract submission open: March 1, 2019
- Abstract submission close: May 1, 2019
- Early bird registration open: April 1, 2019
- Early bird registration close: May 31, 2019
- Late registration open: June 1, 2019
- Late registration close: August 12, 2019
- Hotel: Pre-reserved rooms are kept until July 15 and August 20, 2019

For further information about the conference, please visit our website:
https://www.oru.se/ISPAC2019

Practical questions and questions about the registration are answered by Jeanette Andersson: jeanette.andersson@oru.se

Questions about the conference content are answered by Maria Larsson (maria.larsson@oru.se) and Ivan Titaley (ivan.titaley@oru.se).

The Scientific Organizing Committee:
Maria Larsson - Institutionen för naturvetenskap och teknik, Örebro Universitet, Örebro, Sweden (local host)
Ivan Titaley - Institutionen för naturvetenskap och teknik, Örebro Universitet, Örebro, Sweden (local host)
Jan Andersson - Institute of Inorganic and Analytical Chemistry, Universitt Münster, Münster, Germany
Philippe Garrigues - Institut des Sciences Moléculaires, Université de Bordeaux, Bordeaux, France
Staci Simonich - Department of Environmental and Molecular Toxicology, Oregon State University, Corvallis, USA
Stephen Wise - Chemical Sciences Division, National Institute of Standards and Technology, Gaithersburg, USA

Astrochemisty LLAMA Meeting
- ALLAM 2019 -

IAG-USP, University of São Paulo, Brazil
8 - 9 August 2019

In the last years, we have been witnessing a fast development in the field of Astrochemistry. Such advances are largely due to the improvements to existing instruments and new observational facilities. Ground-based and space observatories as ALMA, APEX, IRAM and Herschel have made enormous contributions to the field. With the advent of the LLAMA project, the Large Latin American Millimeter Array (LLAMA), the community will be in position to carry out new explorations and amazing discoveries on the Molecular Universe.

The Astrochemistry LLAMA (ALLAM) Meeting 2019 is pleased to invite the community to participate of two days of lectures, posters and discussions that will take place on August 8-9 2019 in the Institute of Astronomy, Geophysics and Atmospheric Sciences (IAG), University of São Paulo (USP), São Paulo (SP) Brazil.

This 2-days meeting aims to provide some continuity to the discussions that started at the Campinas workshop in 2016 (https://www1.univap.br/gaa/iswa). In particular, we are willing to bring to the discussions people with diverse of backgrounds, including (but not limited to) radio astronomy, laboratory experiments, theoretical studies of molecular structure, and this time bio structures of molecules, thanks to the participation of Prof. Marcos Buckeridge (Institute of Biosciences – USP).

During the ALLAM 2019, we will have the opportunity to present and discuss astrochemistry by means of invited and contributed oral presentations, poster sessions during the coffee breaks, and a social break to take the lunch during our short meeting.

- There is no registration fee.
- The meeting website is http://www.allam2019.iag.usp.br/
- The official email is allam2019@iag.usp.br, where you can send any questions about the meeting.
- Please, feel free to distribute this announcement to any potentially interested colleague.

Scientific Organizing Committee

- Jacques Lépine (IAG-USP, Brazil)
- Marcos Buckeridge (IB-USP, Brazil)
- Edgar Mendoza (IAG-USP, Brazil)
- Isabel Aleman (UNIFEI, Brazil)
- Amaury Almeida (IAG-USP, Brazil)
- Bertrand Lefloch (IPAG, France)

- Heloisa Boechat-Roberty (OV-UFRJ, Brazil)
- Nicolas U. Duronea (IAR, Argentina)
- Leonardo Bronfman (Universidad de Chile, Chile)

Local Organizing Committee (IAG-USP)

- Carla Canelo
- Pedro Beaklini
- Manuel Merello
- Daniele Ronso

Looking forward to meeting you at ALLAM2019.

Best regards,
The ALLAM2019 team

Summer School
PAHs in extreme environments

University Paul Sabatier, Toulouse, France
June 24 – 28, 2019

A summer school on the topic of "**PAHs in extreme environments**" is organized at the University Paul Sabatier, in the beautiful city of Toulouse, in the South West of France, from 24 to 28 June 2019.

The scientific goal of this one week school is to provide young scientists (Masters, PhDs, and Postdocs) with key concepts and tools regarding the physics and chemistry of Polycyclic Aromatic Hydrocarbons (PAHs) in extreme environments (low density, low pressure, high temperature). The participants will be given a comprehensive introduction of several aspects, ranging from astronomical observations to experimental studies and quantum simulations. Lectures and hands-on will be given by experts in the different fields of interest. More information, as well as registration and abstract submission forms, can be found at the following address:

https://europah-school.sciencesconf.org/.

The **application deadline is May 1st 2019**, with strong encouragement to present a poster on the research topics. There are possibilities of financial support for students with limited funding resources that must be requested during registration.

Post-doctoral Position in Laboratory Astrophysics

Institut de Planétologie et d'Astrophysique de Grenoble, France

Université Grenoble Alpes invites applications for a 2-year postdoc position in laboratory astrochemistry. The position will be hosted at the Institut de Planétologie et d'Astrophysique de Grenoble (IPAG) with a preferred starting date of July 1, 2019. The postdoc will be expected to carry out original research related to the formation and evolution of complex organic matter in the solar system (and beyond) through the characterization at molecular level (Orbitrap mass spectrometry / liquid chromatography) of laboratory analogues (tholins / yellow stuff) and/or extraterrestrial samples (carbonaceous chondrites / micrometeorites).

The objective is to recruit an outstanding candidate motivated in developing a research topic as part of the Université Grenoble Alpes project "Origin of Life".

The cross-disciplinary project "Origin of Life" (funded by Univ. Grenoble Alpes IDEX, https://origin-life.univ-grenoble-alpes.fr) brings together the expertise of astrophysicists, astrochemists, planetary scientists, prebiotic chemists, biologists, geologists and paleontologists. It aims to understand the chemical processes that have led to life on Earth, to define habitability conditions for both Solar System planets and exoplanets, and to detect the most favorable exoplanets where to search for a putative existence of life in a near future. The partner laboratories and the main science topic of "Origin of Life" are IBS (extremophile science and metallo-prebiotic chemistry); DCM (prebiotic chemistry); GRESEC (media science); PCV (photosynthetic organisms); IPAG (Interstellar medium, star and planet formation, Exoplanets, Solar System); ISTerre (Earth Science, Solar System) and LECA (Evolutionnary sciences, Paleogenetics).

Applicants must hold a Ph.D. with a solid background in laboratory astrophysics and/or analytical chemistry and have strong interest in planetary sciences and/or cosmochemistry and/or astrobiology. Experience in mass spectrometry and/or liquid chromatography and/or scientific programming (Python, C++, IGOR) is an asset. The successful candidate will join the mass spectrometry group of the "planeto" team ($\sim$20 faculties, technicians, postdocs and students) and will closely work with Dr. Véronique Vuitton (PI of the research project) and with other colleagues at IPAG (F.-R. Orthous-Daunay, L. Flandinet). The mass spectrometry group has a solid experience in Titan's atmospheric chemistry as well as in the evolution of the organic matter present in small bodies (comets, meteorites) and is currently expanding its interests to Pluto and extrasolar planets. It has also significantly contributed to several space missions (e.g. Cassini-Huygens and Rosetta). Before applying, we encourage candidates to contact veronique.vuitton@univ-grenoble-alpes.fr.

Application files should include a research project (2-3 pages), a detailed curriculum vitae with a description of past research, a list of publications and the names of at least two persons who can be contacted for letters of references. Short-listed candidates will be interviewed in May (by video-conference if desired).

Annual gross salary is 28500 euros for a candidate without research experience after PhD. The position is accompanied with a financial support to carry out the research project consisting of up to 10000 euros for basic equipment and travel resources. The postdoc will be employed by the Université Grenoble Alpes that is a major player in higher education and research in France (http://www.univ-grenoble-alpes.fr/en/). The position is located in Grenoble, which is a university town located in a beautiful alpine environment.

- REQUIRED LANGUAGE: English
- TYPE OF CONTRACT: temporary, 24 months
- JOB STATUS (Full time or part time): Full time
- HOURS PER WEEK: 35
- OFFER STARTING DATE: 1 July 2019
- APPLICATION DEADLINE: 15 April 2019 at 17h00 (CET)

ELIGIBILITY CRITERIA

Applicants must hold a PhD degree (or be about to earn one) or have a University degree equivalent to a European PhD (8-year duration).

Applicants will have to send an application letter in English and attach:

- Their last diploma
- Their detailed CV
- Their list of publications
- Their research projects
- Letters of recommendation are welcome.

Applications have to be sent to **veronique.vuitton@univ-grenoble-alpes.fr**

SELECTION PROCEDURE

Applications will be evaluated through a three-step process:

1. Eligibility check of applications on *20 April 2019*
2. 1st round of selection: the applications will be evaluated by a Review Board. Results will be given on *15 May 2019*.
3. 2nd round of selection: shortlisted candidates will be invited for an interview session in Grenoble (or by video-conference) before *1 June 2019*.

AstroPAH Newsletter

http://astropah-news.strw.leidenuniv.nl
astropah@strw.leidenuniv.nl

Next issue: 18 April 2019
Submission deadline: 5 April 2019