AstroPAH

A Newsletter on Astronomical PAHs

Issue 63 • November 2019

The Physics and Chemistry of the Interstellar Medium Symposium

September 2-6, 2019, Avignon, France

Editorial

Dear Colleagues,

We are pleased to present our Issue 63 of AstroPAH.

Our In Focus constitutes a summary of The Physics and Chemistry of the Interstellar Medium Symposium, which celebrated Alexander Tielens' contribution to science and was held in September 2019 in France. This In Focus, written by Cecilia Ceccarelli, Chair of the SOC, provides an overview of the important scope of cross-thematic and multi-disciplinary topics discussed and presented during this symposium.

Do not miss out on any of the papers and meeting announcements. This month, our Abstracts section includes a number of papers ranging from the formation of interstellar C_{60}, PAH synthesis on Titan's surface, to metallic endofullerenes. Once again, a very interesting list of new PAH-related publications!

Three upcoming meetings are also announced, including the first release of The life cycle of cosmic PAHs, a meeting which will take place in Denmark next year. A PhD position on the spectroscopic and quantum chemical characterization of molecules and clusters applied to dust formation in the interstellar medium is listed at the end of the issue where you can find the full details.

We hope you enjoy reading our newsletter, and we thank you for your dedication and interest in AstroPAH! Do not hesitate to send us your contributions, and if you wish to contact us, feel free to use our email: astropah@strw.leidenuniv.nl.

Enjoy reading our newsletter!

The Editorial Team

Next issue: 19 December 2019.
Submission deadline: 6 December 2019.

Contact us:

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

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PAH Picture of the Month

Participants of the Symposium "The Physics and Chemistry of the Interstellar Medium - Celebrating the First 40 years of Alexander Tielens' contribution to Science" (Source: Scientific Organizing Committee).

Credits to the background image: Tarantula Nebula HST image by ESA/NASA, ESO and Danny LaCrue

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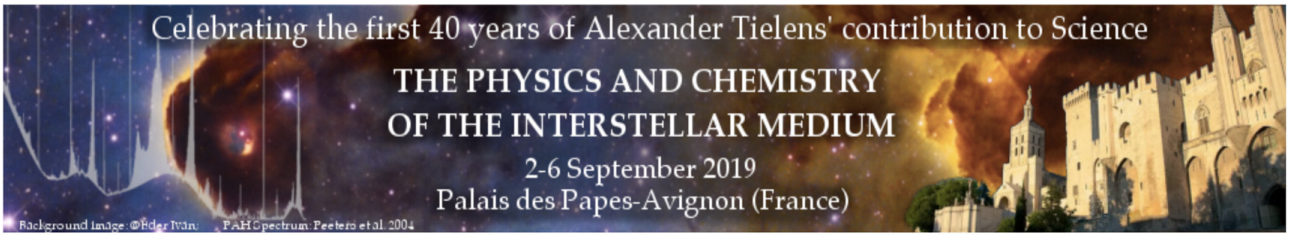
The Physics and Chemistry of the Interstellar Medium

Celebrating the First 40 years of Alexander Tielens' contribution to Science

by Cecilia Ceccarelli
Chair of the SOC



Xander Tielens has been driving research in the fields of interstellar physics and chemistry and the cosmic cycle of matter with outstanding contributions for 40 years. The Symposium celebrated Xander's scientific achievements by discussing the current status of the fields opened up by his contributions, the debates still going-on and the future research directions.

The Symposium focused on the fields strongly influenced by Xander, namely the physical and chemical processes that control the interstellar medium and its life cycle. Five major sections were organized:

- Photo-Dissociation Regions;
- Interstellar and circumstellar dust;
- PAHs;
- Interstellar ices;
- Astrochemistry.

In addition, a final section was devoted to the future opportunities offered by the powerful telescopes at our disposal such as, for example, ALMA, IRAM, SOFIA, and JWST.

The Symposium was organized inside the historical and beautiful Palace of the Popes, in Avignon (France) the 2-6 September 2019. This intrinsically interdisciplinary meeting brought together 120 participants with different backgrounds: theoretical, laboratory, instrumentalists, modelers and astronomers in different fields.

Despite and likely because of its great multi-disciplinary and multi-thematic characteristics, the Symposium was a site of intense exchanges and discussions. The program consisted of ten reviews, thirteen invited and nineteen contributed presentations for a total of 42 talks. In addition, a large amount of time was devoted to looking at and discussing the almost sixty presented posters. The wide range of presentations and posters provided a spectacular overview of the huge progress on the understanding of the physics and chemistry of the Interstellar Medium in the last forty years, as well as the open questions and the new challenges to answer them. Mostly important, it showed the importance of the cross-thematic and multi-disciplinary approach to keep advancing in our understanding of how the Interstellar Medium is shaped and shapes the Galaxy, and how it influences the whole life of Universe at large and small scales.

Scientific organizing committee

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Fanny Vazart
Aline Bellosguardo
Caroline Borye
Marie-Helene Sztefek

PRESENTATIONS ARE ON-LINE AT THE WEB CONGRESS SITE

https://tielens2019.sciencesconf.org/

Acknowledgments

The Symposium was sponsored by: European Research Council (ERC) “Dawn of Organic Chemistry” (DOC); Observatory of Leiden; ERC “EuroPAHs”; NOVA; NWO; SRON; Université Grenoble Alpes. The author would like to thank the members of the SOC who did a great job in setting up a great program and for the extremely pleasant collaborative ambiance. The author thanks as well the members of the LOC who did work hard to have a wonderful and perfectly organized Symposium.

A final and huge thank goes to Xander Tielens who gave us so much science!

Abstracts

Formation of Interstellar C_{60} from Silicon Carbide Circumstellar Grains

J. J. Bernal[1], P. Haenecour[2], J. Howe[3], T. J. Zega[2,4], S. Amari[5], and L. M. Ziurys[1,6,7]

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We have conducted laboratory experiments with analog crystalline silicon carbide (SiC) grains using transmission electron microscopy (TEM) and electron energy-loss spectroscopy (EELS). The 3C polytype of SiC was used—the type commonly produced in the envelopes of asymptotic giant branch (AGB) stars. We rapidly heated small ($\sim$50 nm) synthetic SiC crystals under vacuum to $\sim$1300 K and bombarded them with 150 keV Xe ions. TEM imaging and EELS spectroscopic mapping show that such heating and bombardment leaches silicon from the SiC surface, creating layered graphitic sheets. Surface defects in the crystals were found to distort the six-membered rings characteristic of graphite, creating hemispherical structures with diameters matching that of C_{60}. Such nonplanar features require the formation of five-membered rings. We also identified a circumstellar grain, preserved inside the Murchison meteorite, that contains the remnant of an SiC core almost fully encased by graphite, contradicting long-standing thermodynamic predictions of material condensation. Our combined laboratory data suggest that C_{60} can undergo facile formation from shock heating and ion bombardment of circumstellar SiC grains. Such heating/bombardment could occur in the protoplanetary nebula phase, accounting for the observation of C_{60} in these objects, in planetary nebulae (PNs) and other interstellar sources receiving PN ejecta. The synthesis of C_{60} in astronomical sources poses challenges, as the assembly of 60

pure carbon atoms in an H-rich environment is difficult. The formation of C_{60} from the surface decomposition of SiC grains is a viable mechanism that could readily occur in the heterogeneous, hydrogen-dominated gas of evolved circumstellar shells.

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Low-temperature synthesis of polycyclic aromatic hydrocarbons in Titan's surface ices and on airless bodies Matthew

M. J. Abplanalp[1,2], R. Frigge[1,2], R. I. Kaiser[1,2]

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[2] Department of Chemistry, University of Hawaii at Manoa, Honolulu, HI 96822, USA.

Titan's equatorial dunes represent the most monumental surface structures in our Solar System, but the chemical composition of their dark organics remains a fundamental, unsolved enigma, with solid acetylene detected near the dunes implicated as a key feedstock. Here, we reveal in laboratory simulation experiments that aromatics such as benzene, naphthalene, and phenanthrene—prospective building blocks of the organic dune material—can be efficiently synthesized via galactic cosmic ray exposure of low-temperature acetylene ices on Titan's surface, hence challenging conventional wisdom that aromatic hydrocarbons are formed solely in Titan's atmosphere. These processes are also of critical importance in unraveling the origin and chemical composition of the dark surfaces of airless bodies in the outer Solar System, where hydrocarbon precipitation from the atmosphere cannot occur. This finding notably advances our understanding of the distribution of carbon throughout our Solar System such as on Kuiper belt objects like Makemake.

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Science Advances, 5, 10
https://doi.org/10.1126/sciadv.aaw5841

Photo-ionization and fragmentation of $Sc_3N@C_{80}$ following excitation above the Sc K-edge

Razib Obaid[1], Kirsten Schnorr[2], Thomas J. A. Wolf[3], Tsukasa Takanashi, Nora G. Kling[1], Kuno Kooser[5,6], Kiyonobu Nagaya[7,8], Shin-ichi Wada[9], Li Fang[10], Sven Augustin[2], Daehyun You[4], Eleanor E. B. Campbell[11], Hironobu Fukuzawa[4,8], Claus P. Schulz[12], Kiyoshi Ueda[4,8], Pascal Lablanquie[13], Thomas Pfeifer[2], Edwin Kukk[5], and Nora Berrah[1]

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We have investigated the ionization and fragmentation of a metallo-endohedral fullerene, $Sc_3N@C_{80}$ using ultrashort (10 fs) x-ray pulses. Following selective ionization of a Sc ($1s$) electron ($h\nu$ = 4.55 keV), an Auger cascade leads predominantly to either a vibrationally cold multiply charged parent molecule or multi-fragmentation of the carbon cage following a phase transition. In contrast to previous studies, no intermediate regime of C_2 evaporation from the carbon cage is observed. A time-delayed, hard x-ray pulse ($h\nu$ = 5.0 keV) was used to attempt to probe the electron transfer dynamics between the encapsulated Sc species and the carbon cage. A small but significant change in the intensity of Sc-containing fragment ions and coincidence counts for a delay of 100 fs compared to 0 fs, as well as an increase in the yield of small carbon fragment ions, may be indicative of incomplete charge transfer from the carbon cage on the sub-100 fs timescale.

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https://aip.scitation.org/doi/10.1063/1.5110297

Prevalence of non-aromatic carbonaceous molecules in the inner regions of circumstellar envelopes

L. Martínez[1], G. Santoro[1], P. Merino[1,2], M. Accolla[1], K. Lauwaet[3], J. Sobrado[4], H. Sabbah[5,6], R. J. Peláez[7], V. J. Herrero[7], I. Tanarro[7], M. Agúndez[2], A. Martín-Jimenez[3], R. Otero[3], G. J. Ellis[8], C. Joblin[5], J. Cernicharo[2] and J. A. Martín-Gago[1]

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[3] IMDEA Nanociencia, Ciudad Universitaria de Cantoblanco, Madrid, Spain
[4] Centro de Astrobiología (CAB, INTA-CSIC), Madrid, Spain
[5] IRAP, Université de Toulouse, CNRS, CNES, Toulouse, France
[6] LCAR, Université de Toulouse, UPS-IRSAMC, CNRS, Toulouse, France
[7] Molecular Physics Department, Instituto de Estructura de la Materia (IEM-CSIC), Madrid, Spain
[8] Instituto de Ciencia y Tecnología de Polímeros (ICTP-CSIC), Madrid, Spain

Evolved stars are foundries of chemical complexity, gas and dust that provide the building blocks of planets and life, and dust nucleation first occurs in their photosphere. The circumstellar regions enveloping these stars, despite their importance, remain hidden to many observations, and dust formation processes are therefore still poorly understood.

Laboratory astrophysics provides complementary routes to unveil these chemical processes, but most experiments rely on combustion or plasma decomposition of molecular precursors under physical conditions far removed from those in space. To reproduce and characterize the bottom-up dust formation process, we have built an ultra-high vacuum machine combining atomic gas aggregation with advanced in situ characterization techniques. We show that carbonaceous dust analogues that formed from low-pressure gas-phase condensation of carbon atoms in a hydrogen atmosphere, in a ratio of carbon to molecular hydrogen similar to that reported for evolved stars, lead to the formation of amorphous carbon nanograins and aliphatic carbon clusters. Aromatic species and fullerenes do not form effectively under these conditions, raising implications for a revision of the chemical mechanisms taking place in circumstellar envelopes.

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Nature Astronomy (2019)

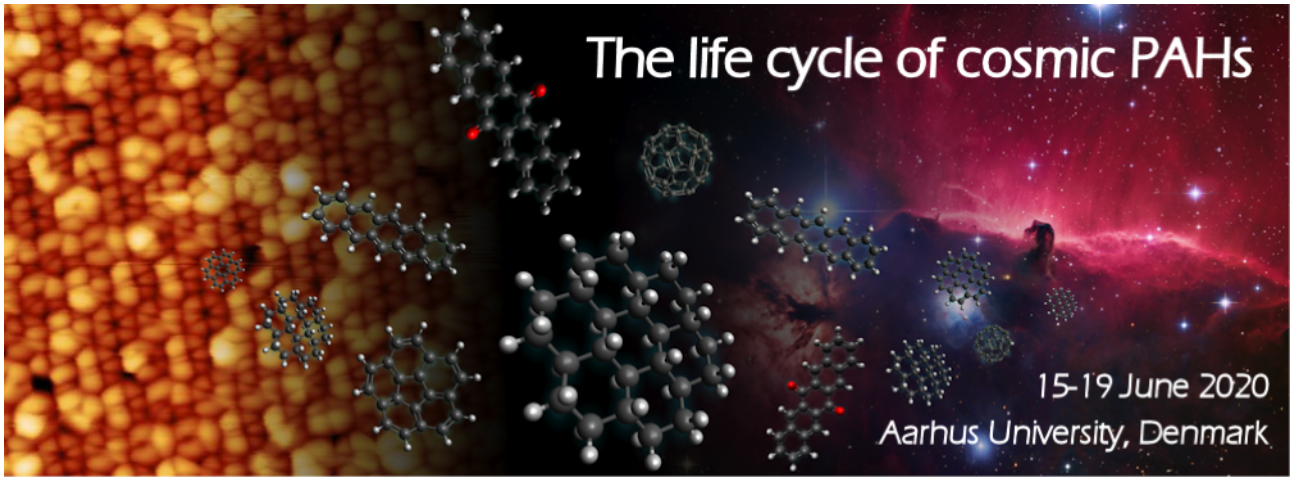
https://www.nature.com/articles/s41550-019-0899-4
https://www.csic.es/en/node/1144818
https://insu.cnrs.fr/fr/cnrsinfo/des-nouvelles-sur-la-formation-des-molecules-et-poussieres-detoiles

Meetings

First announcement

The lifecycle of cosmic PAHs

Department of Physics & Astronomy, Aarhus University, Denmark
15-19 June 2020



The symposium is the third installment in a series of meetings on interstellar polycyclic aromatic hydrocarbons (PAHs) with previous meetings held in Toulouse in 2010 and in Noordwijk in 2016.

Polycyclic Aromatic Hydrocarbons (PAHs) are ubiquitous in space where they play a key role in heating of interstellar gas via the photoelectric effect, in setting the ionization balance of the interstellar medium (ISM) and potentially also as catalysts for formation of interstellar molecular complexity and as a component of interstellar organic material and dust. PAHs are identified as carriers of the aromatic infrared bands (AIBs) and are observed in a diverse range of interstellar environments. Yet, their lifecycle in interstellar space is still not well understood.

The aim of this symposium is to bring observational astronomers, theoreticians and experimentalists working on PAH observations, formation, fragmentation, photo-physics, spectroscopy, surface science and chemistry together to shed light on the lifecycle of cosmic PAHs and to explore the future opportunities for PAH research provided by novel theoretical and experimental methods and future observational missions with focus on JWST and ELT.

Abstract submission deadline for contributed talks and posters: 10 February 2020

Scientific Organizing Committee: Liv Hornekær, Els Peeters, Alessandra Candian, Xander Tielens, Olivier Berné, Annemieke Petrignani

Local Organizing Committee: Liv Hornekær, Andrew Cassidy, John Thrower, Frederik Simonsen, Rijutha Jaganathan, Georgios Pantazidis

Unifying Planetary System Formation Out of Elementary Building Blocks:

from dust, gas and ice to our Solar System and exoplanets

43rd COSPAR Scientific Assembly
Sydney, Australia
15-22 August 2020

Scientific Rationale: The assembly of planetary systems can no longer be considered a process exclusive to mature circumstellar (i.e. protoplanetary) disks, as strings of evidence are pushing its onset to the earliest phases of star formation. These findings require previously separate communities to come together and to exchange expertise. This event offers the venue for such exchange in the form of a unique interdisciplinary platform for discussing the full evolutionary sequence of our Solar System and of exoplanetary systems that may be analogous and different from our own. The event is open to experts on the Solar System, its small and large bodies; exoplanets; protoplanetary disks, embedded and prestellar phases of star formation. It will cover studies of gas, ice, dust and larger bodies from theoretical, observational and experimental perspectives. This science is stimulated by the increasing amount of in-situ measurements from past missions such as Cassini and Rosetta, present missions like New Horizons, and upcoming missions such as JUICE and Europa Clipper. Simultaneously, the field is being revolutionized with interferometric observations from powerful facilities such as ALMA, exoplanet demographics from transits and radial velocities (e.g., TESS, ESPRESSO) and with experimental studies in state-of-the-art laboratories simulating the various space environments. This event is sponsored by and coordinated with Commissions B1, E4 and F3.

Abstract submission deadline: 14 February 2020

Main Scientific Organizers:
- Maria Drozdovskaya (CSH; Switzerland)
- Diego Turrini (INAF-IAPS; Italy)

Scientific Organizing Committee:
- Michael Ireland (ANU, Australia)
- Stavro Ivanovski (INAF-OATS, Italy)
- Niels Ligterink (CSH, Switzerland)
- Gianfranco Vidali (Syracuse, U.S.A.)
- Eric Herbst (UVA, U.S.A.)
- Martin Rubin (UniBe, Switzerland)
- Trevor Ireland (ANU, Australia)
- Raphael Marschall (SwRi, U.S.A.)
- Sho Sasaki (Osaka, Japan)
- Sean Andrews (CfA, U.S.A.)

Confirmed Invited Speakers:

- Fred Ciesla (University of Chicago, U.S.A.)
- Joanna Drażkowska (Univ. Observ. of the Ludwig Maximilian Univ. of Munich, Germany)
- Davide Fedele (INAF/Osservatorio Astrofisico di Arcetri, Italy)
- Mark Krumholz (ANU, Australia)
- Jeong-Eun Lee (Kyung Hee University, South Korea)
- Yamila Miguel (Leiden University, The Netherlands)
- Paola Pinilla (Max Planck Institute for Astronomy in Heidelberg, Germany)
- Alessandro Sozzetti (INAF/Osservatorio Astronomico di Torino, Italy)
- Frances Westall (CNRS in Orléans, France)
- Makoto Yoshikawa (JAXA, Japan)

PacifiChem 2020
Misconceptions in Astrochemistry: A Chemist's Guide

Hawaii Convention Center, Honolulu, HI, USA
15-20 December 2020

Organizers:
Ryan C. Fortenberry (University of Mississippi, USA)
Ralf I. Kaiser (University of Hawaii-Manoa, USA)
Naoki Watanabe (Hokkaido University, Japan)
Weijun Zheng (Chinese Academy of Sciences, China)
Timothy Schmidt (University of New South Wales, Australia)

Earth provides only a small cross-section of the rich environments where molecules form, react, excite, and are studied. The origin of molecules in extraterrestrial environments, in particular, has fascinated scientists since the pioneering detection of CH, CH^+, and CN in interstellar space more than 80 years ago. More than 200 species are known, ranging in complexity from carbon monoxide (CO) to cyanobenzene (C_6H_5CN) and buckyballs (C_{60}). Nevertheless, many facets of astrochemistry remain unanswered or contentious. The elucidation of how molecules form in non-terrestrial environments brings together chemists from across the subdisciplines and even researchers from across the sciences at large. Such a fast-growing and significantly interdisciplinary field naturally brings practitioners together who often seem to speak different scientific languages and who approach similar problems in surprisingly different ways. Consequently, critical errors, disagreements, and misconceptions have arisen.

This symposium will provide a forum to address findings that have been misinterpreted, improperly utilized, or otherwise ignored. By working to eliminate misconceptions and exploring the current boundaries of astrochemical knowledge, new experiments and models can be more effectively designed to resolve key unanswered aspects of molecular synthesis in extraterrestrial space.

Abstract submission opens 1 January 2020.

This symposium is ***open to contributions*** and will consist of half-day oral sessions with topics including:
1. Gas Phase Astrochemistry
2. Condensed Phase Astrochemistry
3. Computational Astrochemistry & Astrochemical Modeling
4. Emerging Trends in Astrochemistry
5. When Chemists and Astronomers Disagree

Confirmed speakers:

1. Yuan-Pern Lee (National Chiao Tung University, Taiwan)
2. Amanda Stockton (Georgia Tech, USA)
3. Brett McGuire (NRAO, USA)
4. Timothy J. Lee (NASA Ames, USA)
5. Ella Sciamma-O'Brien (NASA Ames, USA)
6. Mike McCarthy (Harvard University, USA)
7. Susanna Widicus Weaver (Emory University, USA)
8. Toshiki Sugimoto (Kyoto University, Japan)
9. Thomas Pino (Université Paris-Sud 11, France)
10. Laura McKemmish (University of New South Wales, Australia)
11. Alexander Mebel (Florida International University, USA)
12. Heather Abbott-Lyon (Kennesaw State University, USA)
13. Robin Garrod (Virginia, USA)
14. Yuji Nakao (Hokkaido University, Japan)
15. Yasuhiro Oba (Hokkaido University, Japan)
16. Heon Knag (Seoul University, Republic of Korea)
17. Musahid Ahmed (LBNL, USA)
18. Stefanie Milam (NASA Goddard, USA)
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21. Ewen Campbell (University of Edinburgh, UK)
22. Nadia Balucani (University of Perugia, Italy)
23. Cristina Puzzarini (University of Bologna, Italy)
24. Kunihiro Okada (Sophia University, Japan)
25. Nigel Mason (University of Kent, UK)
26. Wolfram Sander (Bochum University, Germany)
27. Qian Gou (Chongqing University, China)
28. Arthur Suits (University of Missouri, USA)

E-mail for contact: r410@olemiss.edu

Webpage: https://pacifichem.org/technical-program/2020-approved-symposia/#physical

Announcements

PhD Position in Molecular Physics/ Physical Chemistry/Laboratory Astrophysics at Technische Universität Berlin

Advertised by Prof. Dr. Otto Dopfer

Deadline for application: December 31, 2019.

A **PhD position (3 years)**, fully funded by the German Science Foundation (DFG), is available in the **laser molecular spectroscopy group** of **Otto Dopfer** at **Technische Universität Berlin, Germany**.
This project deals with the spectroscopic and quantum chemical characterization of the geometric, electronic, optical and chemical properties of silicon- and carbon-bearing molecules and clusters in the context of dust formation in the interstellar medium.

Email: dopfer@physik.tu-berlin.de

https://www.ioap.tu-berlin.de/menue/arbeitsgruppen/ag_dopfer/offene_stelle/parameter/en/

AstroPAH Newsletter

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Next issue: 19 December 2019
Submission deadline: 6 December 2019