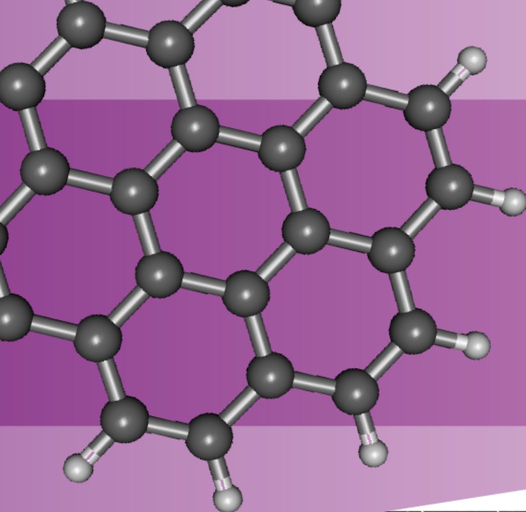
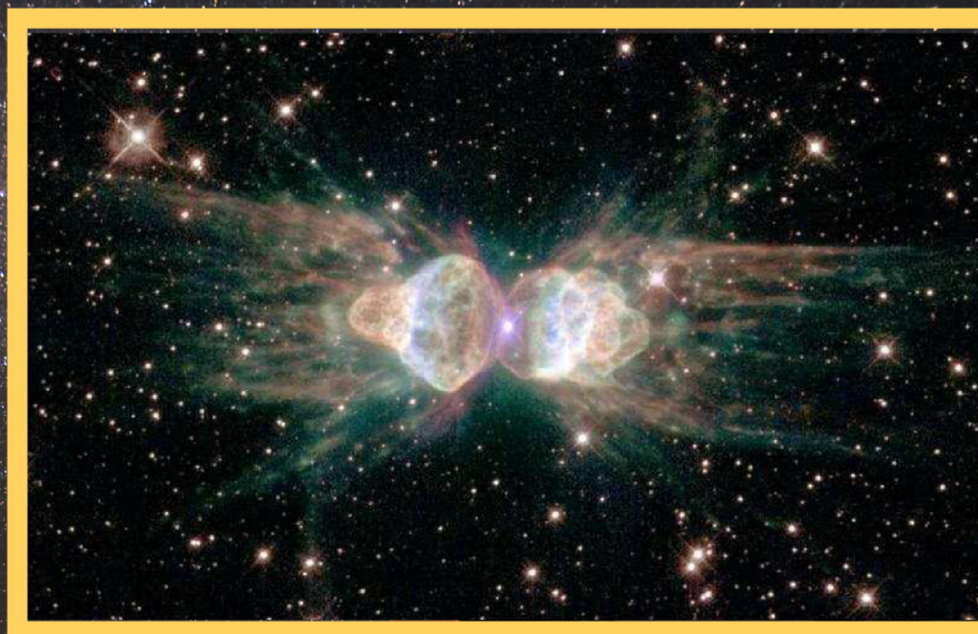


AstroPAH

A Newsletter on Astronomical PAHs

Issue 52 | October 2018



Editorial

Dear Colleagues,

Welcome to the **5th anniversary edition of AstroPAH!** What better way to celebrate this festive occasion with you than with a show of lasers as featured on our cover. This year's Nobel Prize in physics went to Arthur Ashkin, Gérard Mourou and Donna Strickland for their ground-breaking work in creating tools made of light. As the cover reveals, this has been of utmost importance to multiple fields amongst which astronomy and chemistry. Noteworthy is that Donna Strickland is the 3rd woman ever to win a Nobel Prize in physics (and the 1st in over 50 years).

We would further like to celebrate our anniversary with a tribute to our Kavli-price winner Ewine van Dishoeck, who was awarded this "Nobel-price for astronomy" for her "combined contributions to observational, theoretical, and laboratory astrochemistry, elucidating the life cycle of interstellar clouds and the formation of stars and planets" Enjoy our interview with her in the In Focus.

Of course our newsletter itself is also 'In Focus' with some nice numbers from your feedback, showing our impact in the community. Thanks to all of you who responded to our survey! We will take your feedback into account to improve our newsletter and continue to keep you updated on the rich field of PAH-related research.

We also thank everyone who has sent their paper abstracts to us, in this issue and all previous ones. Once again, our abstract section is full of interesting papers on theoretical, experimental, and observational studies of astronomical PAHs and so much more.

Please continue to send us your contributions! For publication in the next AstroPAH, see the deadlines below.

The Editorial Team

Next issue: 22 November 2018.
Submission deadline: 9 November 2018.

Contact us:

astropah@strw.leidenuniv.nl
http://astropah-news.strw.leidenuniv.nl
Click here to Subscribe to AstroPAH
Click here to Contribute to AstroPAH

Contents

PAH Picture of the Month

The importance of lasers in astrochemistry. On the left, four lasers shooting into the sky from Unit Telescope 4 at the Very Large Telescope (VLT) in Chile. The lasers create an artificial guide star for the telescope's adaptive optics system. The system allows for the telescope acquire the sharpest images possible. On the top right, the Ant Nebula (Menzel 3), where hydrogen laser recombination lines have been recently detected. On the bottom right a table-top laser system for molecular physics research.

Credits: ESO/Gregory Lambert; NASA/Hubble; STFC

Newsletter Design: Isabel Aleman
Background image: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)

In Focus

An Interview with Ewine van Dishoeck

Dr. Ewine van Dishoeck just won the 2018 Kavli Prize for Astrophysics. She is a Professor of Molecular Astrophysics at Leiden Observatory, an external scientific member at the Max Planck Institute for Extraterrestrial Physics, and the president of the International Astronomical Union (IAU). She is one of the pioneers of astrochemistry, and her research is aimed at determining the structure of cosmic objects using their molecular spectra. She employs observations, theory, and experiments to explain the evolutionary traits that lead to the formation of stars and planets from interstellar gas and dust, as well as the chemical basis for the origins of life.

Thank you for accepting to do this interview! First of all, can you give us a short description of your professional career path?

Following my undergraduate and PhD studies in Leiden at the boundary of chemistry and astronomy, I went to Harvard as a junior fellow for three years, followed by a year as visiting professor in Princeton. In 1988, I was appointed assistant professor in cosmochemistry in the geology and planetary sciences department of Caltech, the first woman in that department. In 1990, I returned to Leiden University as senior lecturer and was promoted to full professor in 1995. As of 2007, I am also an external scientific member at the Max Planck Institute for Extraterrestrial Physics, MPE (the institute that has led, for example, the PACS instrument on Herschel) where I spend a fraction of my time. Besides having a (very) active research group, I hold many national and international science policy functions, including scientific director of the Netherlands Research School for Astronomy (NOVA) and president of the International Astronomical Union (IAU).

Congratulations on your Kavli prize! What does it mean for you and the Astrochemistry community to receive this prize?

Thanks, I am still on '(Interstellar) Cloud Nine': it is such an honor! I am particularly happy that Astrochemistry is now recognized as an integral part of astronomy and taking center stage, even in the words of the committee. A tribute also to the instrument builders and the many talented young people that I have had the pleasure to work with.

How did you get into the field of Astrochemistry?

I was a MSc student in Leiden in theoretical chemistry working on ab initio calculations of small molecules and wanted to continue in that field. However, the professor had just died and there was not going to be a successor. So I had to look elsewhere. It was my then boyfriend (and current husband) Tim de Zeeuw who had just had an ISM lecture on Interstellar Molecules by Harm Habing and said 'Is that something for you?'. Through Teije de Jong I was introduced to Alex Dalgarno who invited me for 5 months to Harvard to get introduced to astrochemistry. I subsequently continued my PhD in Leiden under supervision of Dalgarno and Habing. My first projects were on photodissociation of small molecules, using my quantum chemistry skills but now applied to astrophysical situations. Interstellar space is a fantastic chemistry laboratory! I also did my first observations at that time, of optical absorption lines of C_2 in diffuse and translucent clouds.

What are you working on right now?

As always, my group is working on a wide range of topics associated with the physics and chemistry in star- and planet-forming regions, from the earliest collapse phase to the protoplanetary disk stage. ALMA is providing us with spectacular images of disks, full of rings, cavities and asymmetric dust traps likely caused by a vortex. A surprise nearly every day!

A specific project that is a lot of fun is the ALMA-PILS Band 7 survey of the solar-mass protostar IRAS16293 -2422, led by my former PhD student Jes Jorgensen. More than 10,000 lines are seen, 1 line every 3 km/s, and each of these lines is imaged with 0.5" resolution, i.e, 40 AU radius, the size of our solar system! PhD student Niels Ligterink has recently focused on the nitrogen-containing organics and detected methyl-isocyanate (CH_3NCO) and perhaps even acetamide (CH_3CONH_2), molecules with functional groups that resemble a peptide bond. Together with Harold Linnartz, we have shown that these molecules can be made in ice mantles and have proposed networks that can be tested with other species. In contrast, methylamine (CH_3NH_2), often postulated as a starting point for making amino acids, is not seen down to very low limits. Making amino acids through CH_2NH is more likely. With former PhD student Maria Drozdovskaya, we are currently comparing the IRAS16293 abundances with those in comets, in particular 67 P/C-G.

Have you ever worked on PAHs?

Most of my work is focused on small molecules or complex organic species made in ices. In Leiden, Xander Tielens is the PAH expert.

However, PAHs were studied in my group from 2003-2009 as part of the Spitzer c2d legacy program, which obtained 5-38 micron spectra of several dozen low-mass protostars and more than 50 disks around T Tauri stars, showing ices, silicates and sometimes also PAHs. Complementary VLT-ISAAC spectra from 3-5 micron were also obtained. In a well-cited paper, PhD student Vincent Geers showed that the detection rate of PAH features toward T Tauri stars is low, < 10 %, much lower than for the more luminous Herbig Ae stars studied up to that time. Detailed disk models coupled with PAH excitation by Ruud Visser quantified that the PAH abundance is a factor 10-100 lower in these disks than in the ISM. Moreover, the features are completely absent in embedded protostars, both low and high mass, and this is not due to a lack of UV to excite the PAHs. This absence of PAH features in the early phases of star formation is in my view underappreciated by the community since it must have significant implications: either all PAHs are frozen out onto the grains or they have grown to larger species in the gas that do not emit in discrete bands.

What was the most important advice somebody gave you?

Take the steepest route early in your career, since that determines where you end up. This was the advice that Martin Schwarzschild, Tim's mentor in Princeton, gave us. It meant that we spent some time living apart in two places during our first postdoc, Tim in Princeton and me in Harvard. Having strong CVs then helped us getting two positions in the same place later on. Fortunately, the Princeton Institute for Advanced Study provided me with a visiting position in this period so that we could still spend considerable time together.

Advice that I often give to students: make sure that you excel in at least one aspect of your work so that you get noticed. And be passionate about your work.

How do you balance work and personal life?

Ironically, the further you progress in your career, the less control you have of your own agenda. The increased responsibilities mean that there is always some deadline or crisis at group, institute, national or international level that requires immediate attention. Or media and press are chasing you. Tim and I make long working days, but we enjoy our work (most of the time, not the administration!). We always make sure to have dinner together; cooking is my relaxation moment, and we make long bicycle rides or walks in the weekend. We do not have children (not by choice) so that makes our life more flexible regarding travel. We balance hard work with real vacations; in particular we go camping and hiking each year in the western US for at least 2 weeks, and my laptop and phone are completely turned off then. Highly recommended!

If you could choose, which Astrochemistry discovery/advance would you like to see in the next 2 decades?

Over the last decades, we have followed the chemical trail from cloud to disk. The next decade should provide deep insight into the journey from disk to planet. ALMA, JWST and ELT (especially the mid-infrared METIS instrument) will be key.

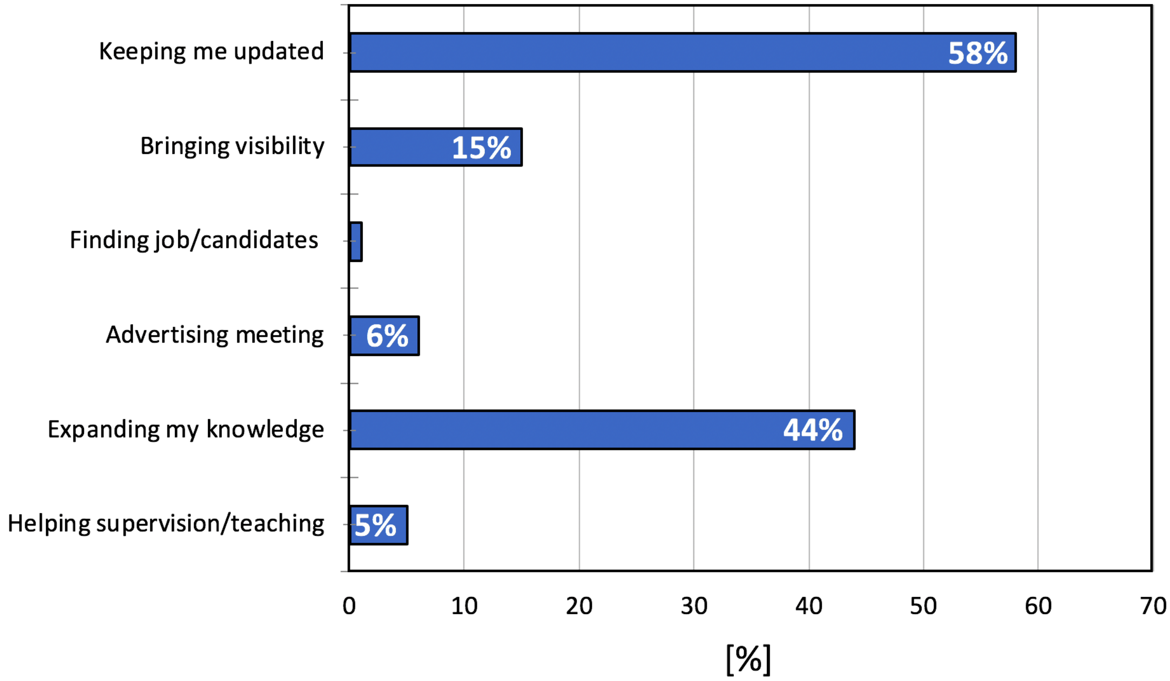
Also, I would like to see the relative importance of bottom-up (starting from C, CO) versus top-down (starting from PAHs, carbonaceous grains) chemistries for making different types of complex organic molecules quantified. That will not be simple, many processes still need to be studied at the basic molecular level in the lab or by calculations.

Here are the results of our survey!

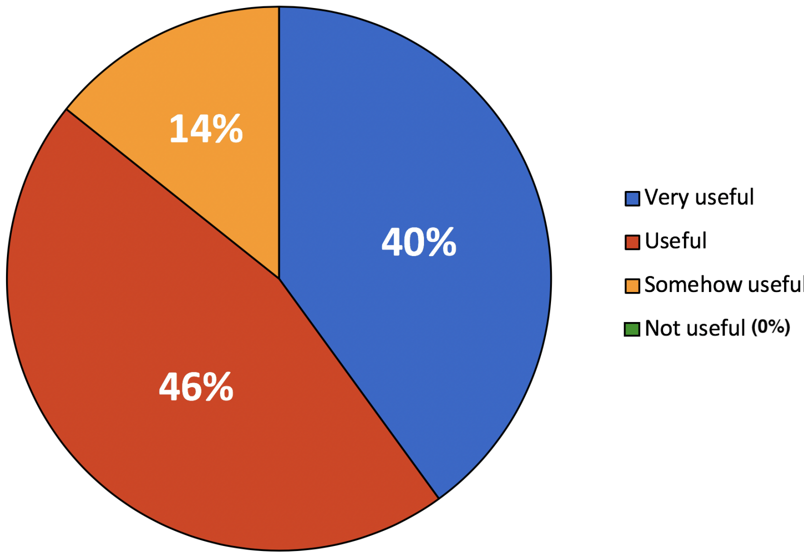
Thank you very much to all of you who spent a few moments to answer our survey. Your feedback is very important to us and will help future improvements to AstroPAH.

How has AstroPAH helped you so far?

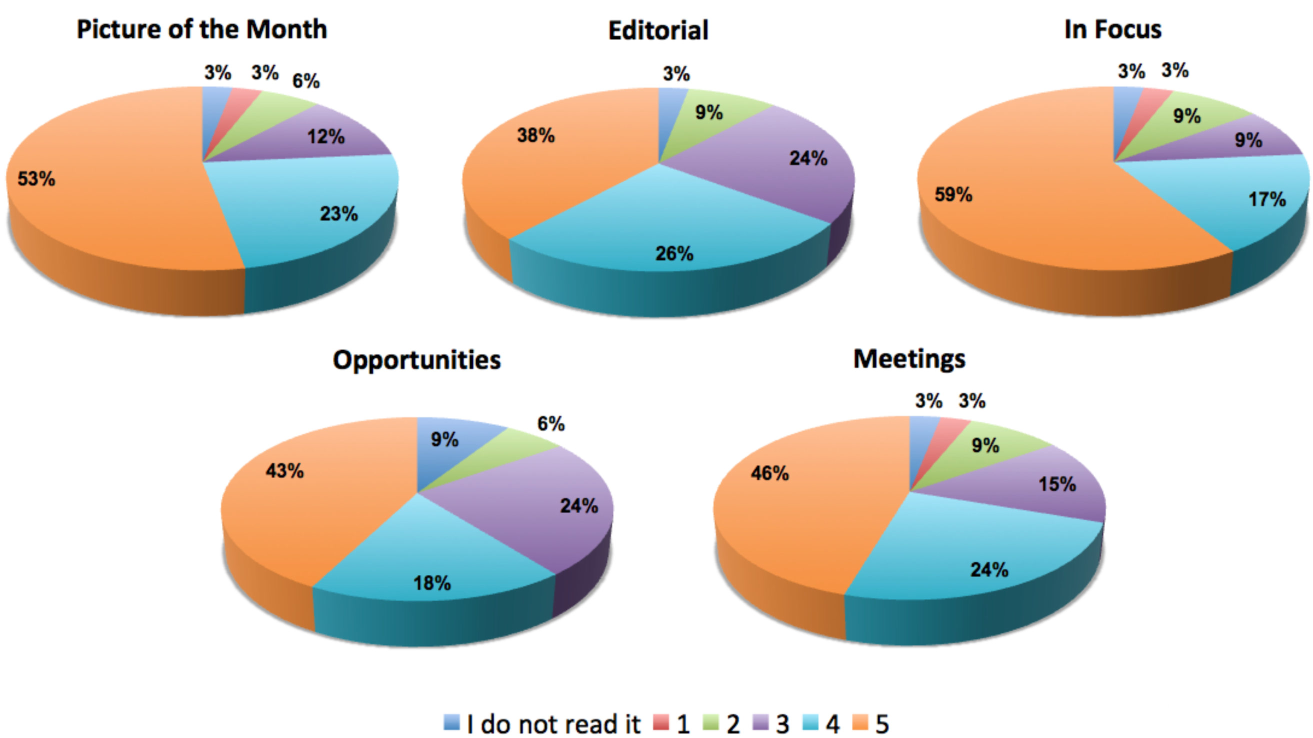
The bars in the plot below indicate the percentage of people that selected the corresponding answer. Multiple answers were possible.



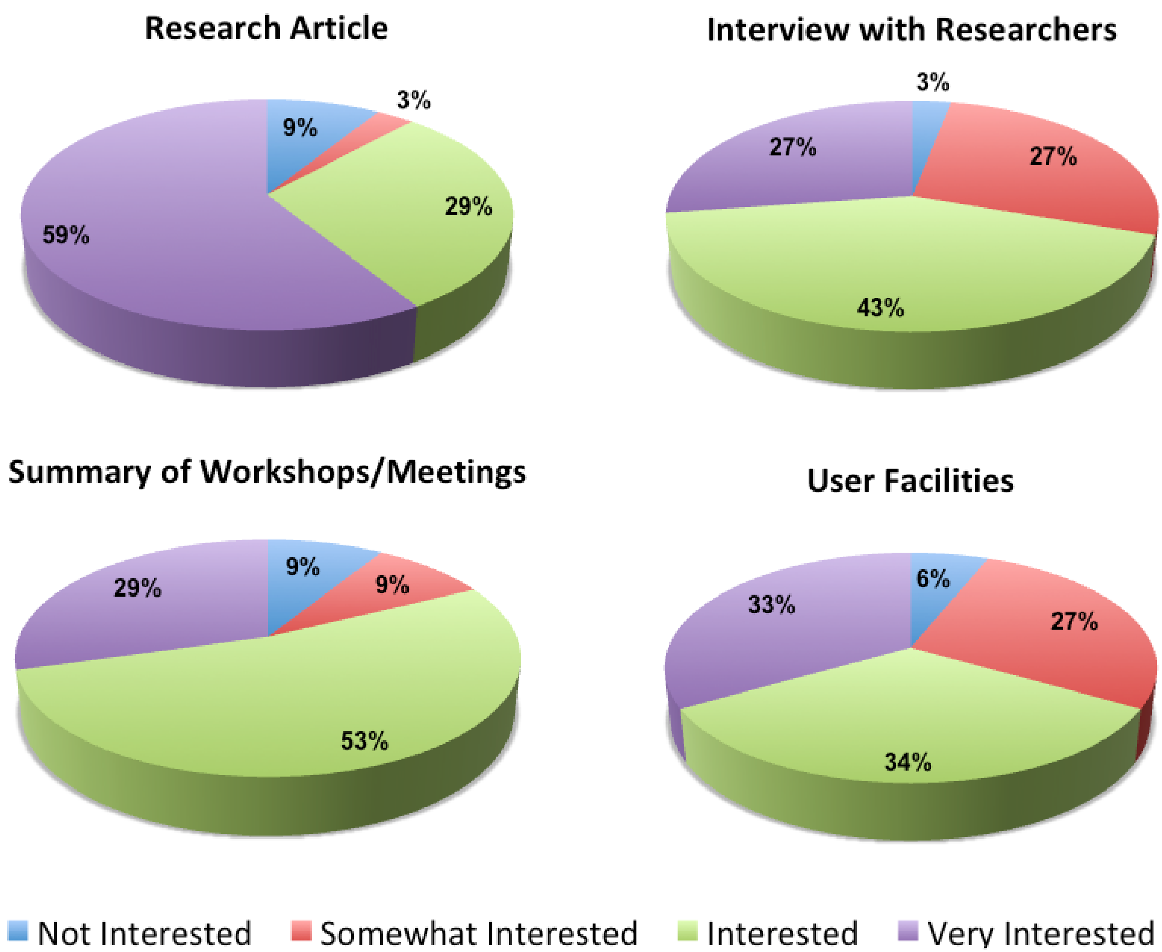
How useful is AstroPAH for your work?



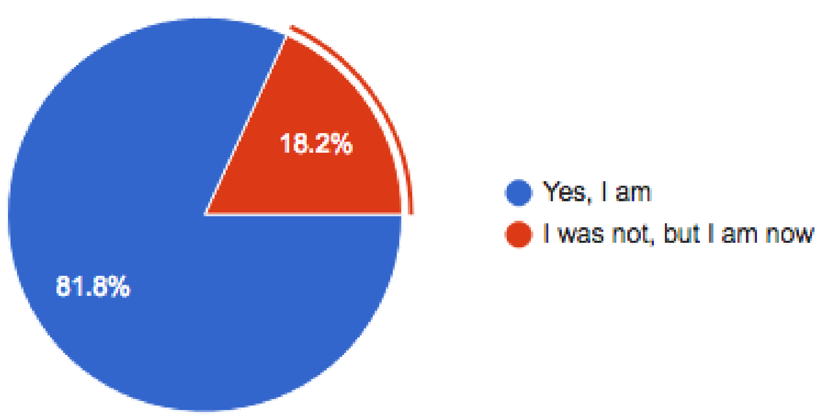
How much do you like the different sections of AstroPAH (on a scale of 1 to 5, 5 being the highest grade)?



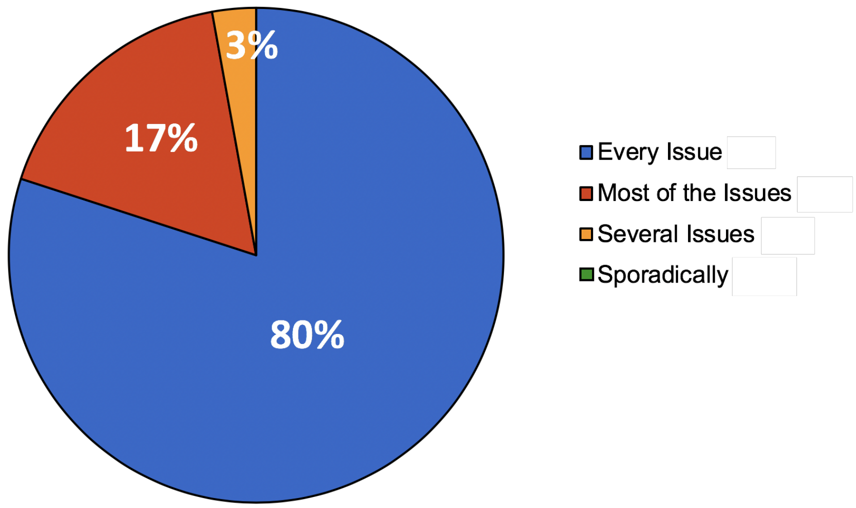
Which type of In Focus are you most interested in?



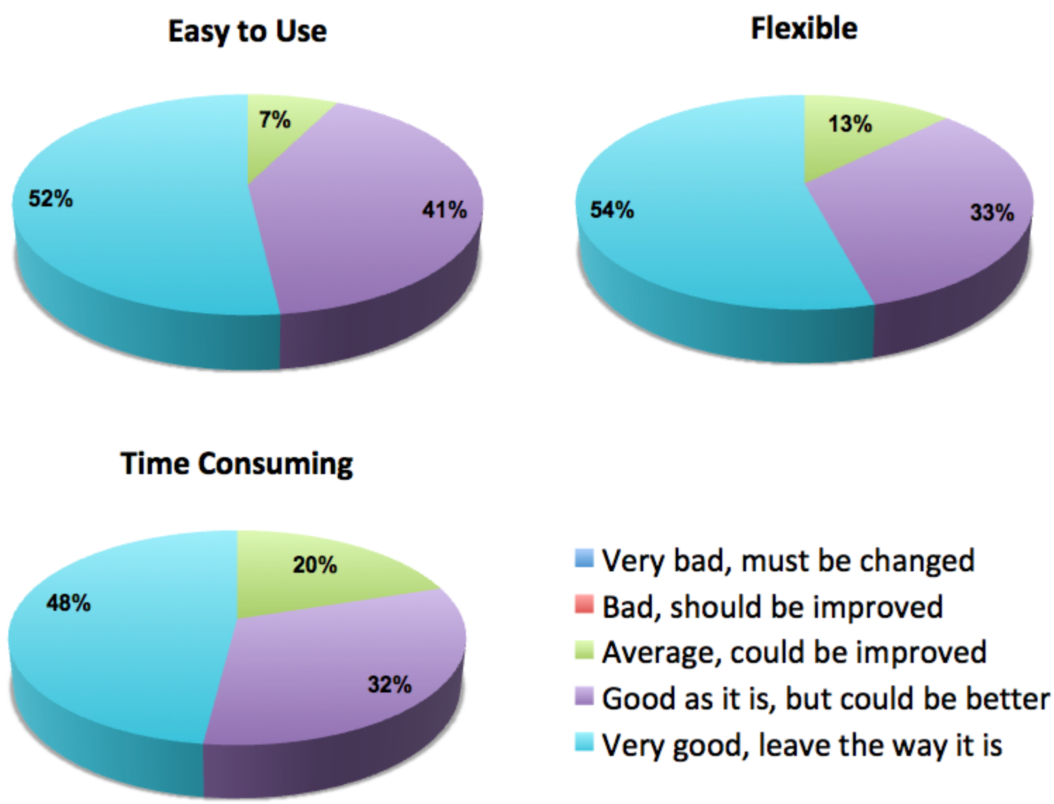
Are you aware that you can send contributions to any of the AstroPAH sections?



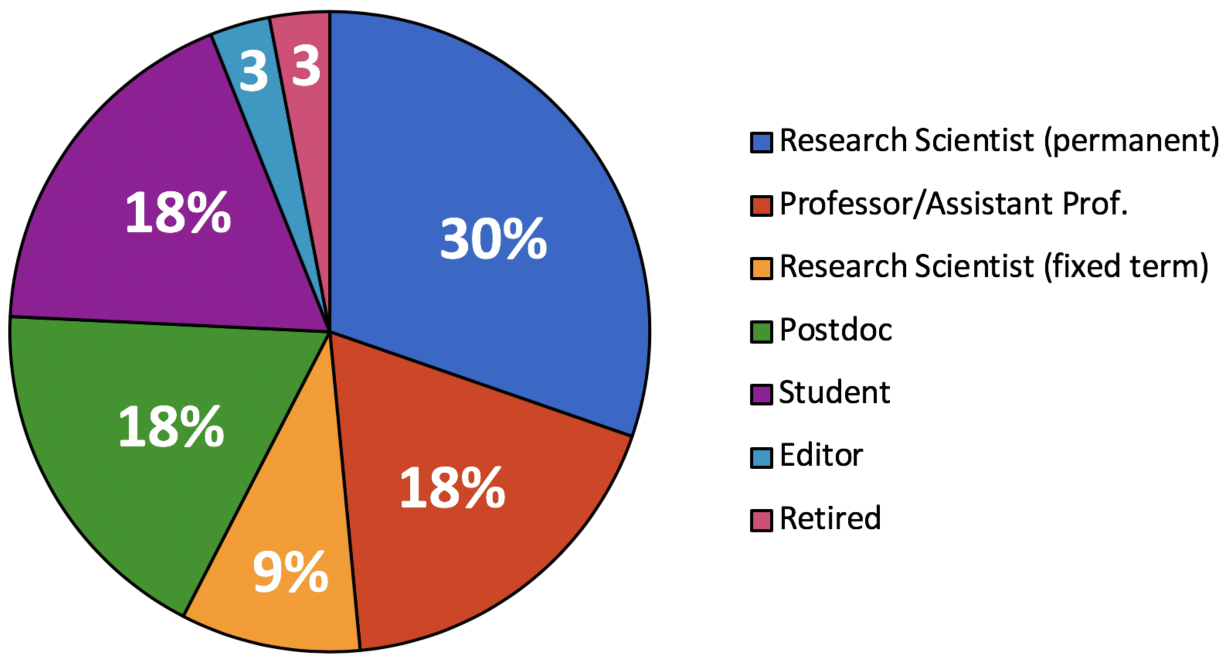
Ten AstroPAH newsletters are published every year. How many of them do you typically read?



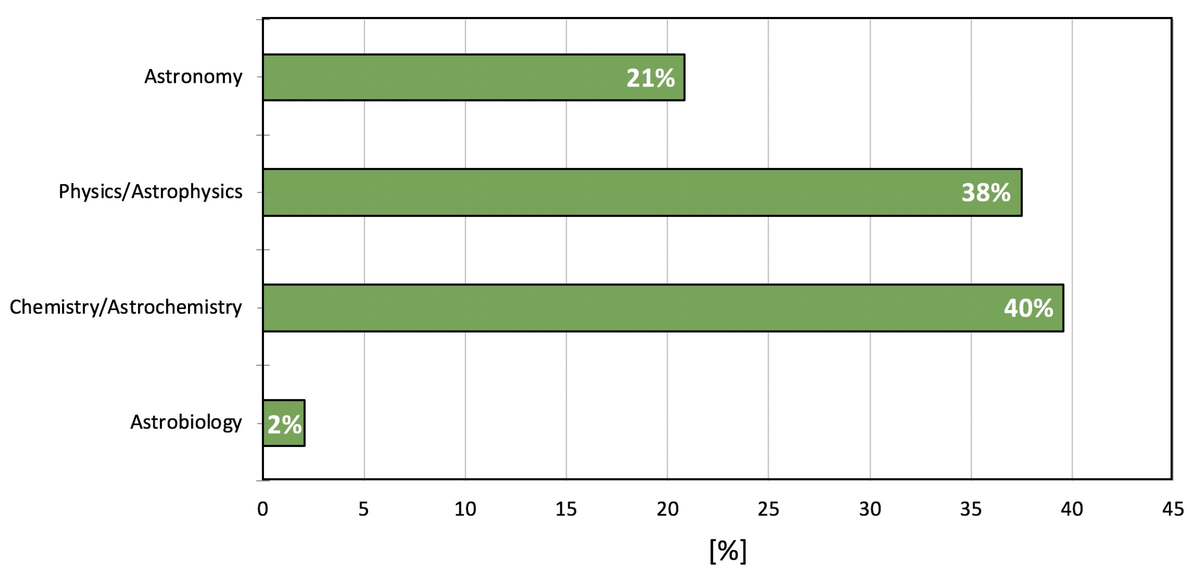
Rate the contribution submission methods made available on the AstroPAH website.



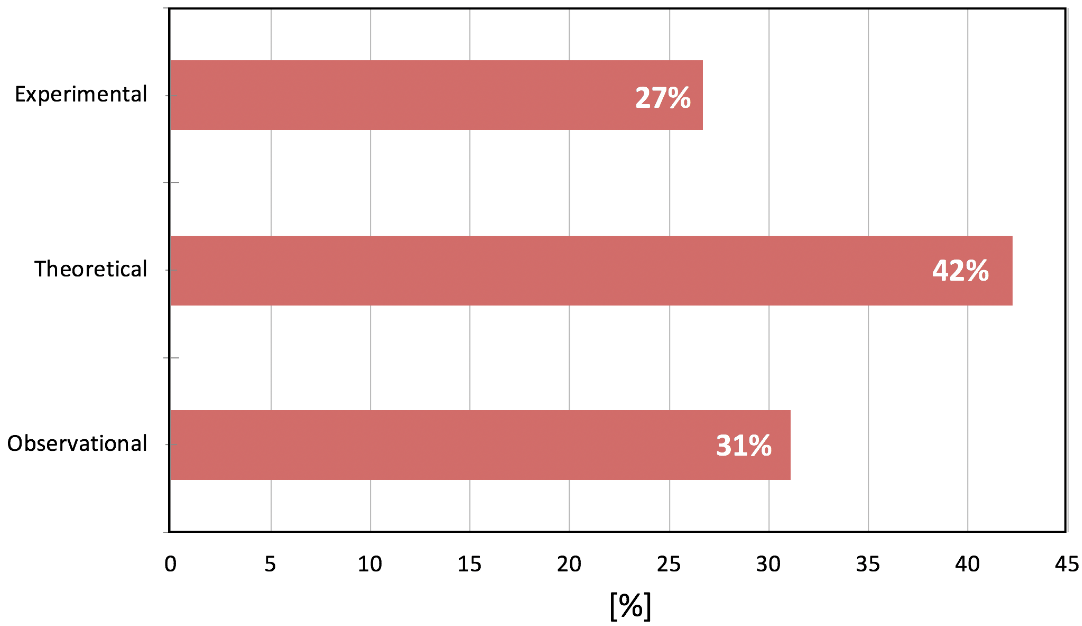
What is your current occupation?



What is you main research topic?



Which methods do you use?



Abstracts

The Widespread Presence of Nanometer-size Dust Grains in the Interstellar Medium of Galaxies

Yanxia Xie[1], Luis C. Ho[1,2], Aigen Li[3] and Jinyi Shangguan[1,2]

[1] Kavli Institute for Astronomy and Astrophysics, Peking University, Beijing 100871, China

[2] Department of Astronomy, School of Physics, Peking University, Beijing 100871, China

[3] Department of Physics and Astronomy, University of Missouri, Columbia, MO 65211, USA

Interstellar dust spans a wide range in size distribution, ranging from ultrasmall grains of a few Ångströms to micronmeter-size grains. While the presence of nanometer-size dust grains in the Galactic interstellar medium was speculated six decades ago and was previously suggested based on early infrared observations, systematic and direct analysis of their properties over a wide range of environments has been lacking. Here we report the detection of nanometer-size dust grains that appear to be universally present in a wide variety of astronomical environments, from Galactic high-latitude clouds to nearby star-forming galaxies and galaxies with low levels of nuclear activity. The prevalence of such a grain population is revealed conclusively as prominent mid-infrared continuum emission at $\lambda \lesssim 10$ µm seen in the *Spitzer*/IRS data, characterized by temperatures of ~ 300–$400\,\mathrm{K}$ which are significantly higher than the equilibrium temperatures of common, submicron-size grains in typical galactic environments. We propose that the optimal carriers of this pervasive hot dust component are very small carbonaceous (e.g., graphite) grains of nanometer size that are transiently heated by single-photon absorption. This grain population accounts for $\sim 1.4\%$ of the total infrared emission at ~ 5–3000 µm and $\sim 0.4\%$ of the total interstellar dust mass.

E-mail: yanxia.xie@pku.edu.cn, lho.pku@gmail.com, lia@missouri.edu, shangguan@pku.edu.cn

Astrophys. J., in press (2018)

http://arxiv.org/abs/1809.06552

Direct Evidence of the Benzylium and Tropylium Cations as the two long-lived Isomers of $C_7H_7^+$

Pavol Jusko[1], Aude Simon[2], Shreyak Banhatti[3], Sandra Brünken[4], Christine Joblin[1]

[1] Institut de Recherche en Astrophysique et Planétologie (IRAP), Université de Toulouse (UPS), CNRS, CNES, 9 Av. du Colonel Roche, 31028 Toulouse Cedex 4, France.

[2] Laboratoire de Chimie et Physique Quantiques LCPQ/IRSAMC, Université de Toulouse (UPS) and CNRS, 118 Route de Narbonne, 31062 Toulouse, France.

[3] I. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany.

[4] Radboud University, Institute for Molecules and Materials, FELIX Laboratory, Toernooiveld 7c, 6525 ED, Nijmegen, The Netherlands.

Disentangling the isomeric structure of $C_7H_7^+$ is a longstanding experimental issue. We report here the full mid-infrared vibrational spectrum of $C_7H_7^+$ tagged with Ne obtained with infrared-predissociation spectroscopy at 10 K. Saturation depletion measurements were used to assign the contribution of benzylium and tropylium isomers and demonstrate that no other isomer is involved. Recorded spectral features compare well with density functional theory calculations. This opens perspectives for a better understanding and control of the formation paths leading to either tropylium or benzylium ions.

E-mail: christine.joblin@irap.omp.eu

Chem. Phys. Chem. Accepted (2018)

http://dx.doi.org/10.1002/cphc.201800744
https://hal.archives-ouvertes.fr/hal-01880438
https://arxiv.org/abs/1809.09375

DFT study of five-membered ring PAHs

Gauri Devi[1], Mridusmita Buragohain[1] and Amit Pathak[2]

[1] Department of Physics, Tezpur University, Tezpur 784 028, India

[2] Department of Physics, Banaras Hindu University, Varanasi 221 005, India

This work reports a Density Functional Theory (DFT) calculation of PAH molecules with a five-member ring to determine the expected region of infrared features. It is highly possible that fullerene molecule might be originated from five-membered ring PAH molecules in the ISM. Effect of ionization and protonation on five-membered ring PAH molecule is also discussed. A detail vibrational analysis of five-membered ring PAH molecule has been reported to further compare with observations and to identify any observational counterpart.

E-mail: ms.mridusmita@gmail.com

Planetary and Space Science (2018)

https://doi.org/10.1016/j.pss.2018.09.003

Fully anharmonic infrared cascade spectra of polycyclic aromatic hydrocarbons

Cameron J. Mackie[1,2], Tao Chen[2,3], Alessandra Candian[2], Timothy J. Lee[4] and Alexander G. G. M. Tielens[2]

[1] Chemical Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA

[2] Leiden Observatory, Leiden University, PO Box 9513, 2300 RA Leiden, The Netherlands

[3] Department of Theoretical Chemistry and Biology, School of Biotechnology, Royal Institute of Technology, 10691, Stockholm, Sweden

[4] NASA Ames Research Center, Moffett Field, California 94035-1000, United States

The infrared (IR) emission of polycyclic aromatic hydrocarbons (PAHs) permeates our universe; astronomers have detected the IR signatures of PAHs around many interstellar objects. The IR emission of interstellar PAHs differs from their emission as seen under conditions on Earth, as they emit through a collisionless cascade down through their excited vibrational states from high internal energies. The difficulty in reproducing interstellar conditions in the laboratory results in a reliance on theoretical techniques. However, the size and complexity of PAHs requires careful consideration when producing the theoretical spectra. In this work we outline the theoretical methods necessary to lead to a fully theoretical IR cascade spectra of PAHs including: an anharmonic second order vibrational perturbation theory (VPT2) treatment; the inclusion of Fermi resonances through polyads; and the calculation of anharmonic temperature band shifts and broadenings (including resonances) through a Wang–Landau approach. We also suggest a simplified scheme to calculate vibrational emission spectra that retains the essential characteristics of the full IR cascade treatment and can directly transform low temperature absorption spectra in IR cascade spectra. Additionally we show that past astronomical models were in error in assuming a 15 cm^{-1} correction was needed to account for anharmonic emission effects.

E-mail: mackie@lbl.gov

J. Chem. Phys. 149, 134302 (2018)

http://arxiv.org/abs/1810.01975

PAHs and star formation in the HII regions of nearby galaxies M83 and M33

A. Maragkoudakis[1], N. Ivkovich[1], E. Peeters[1,2], D. J. Stock[1], D. Hemachandra[1] and A. G. G. M. Tielens[3]

[1] Department of Physics and Astronomy, University of Western Ontario, London, ON, N6A 3K7, Canada

[2] SETI Institute, 189 Bernardo Avenue, Suite 100, Mountain View, CA 94043, USA

[3] Leiden Observatory, Niels Bohrweg 2, 2333 CA Leiden, The Netherlands

We present mid-infrared (MIR) spectra of H II regions within star-forming galaxies M83 and M33. Their emission features are compared with Galactic and extragalactic H II regions, H II-type galaxies, starburst galaxies, and Seyfert/LINER type galaxies. Our main results are as follows: (i) the M33 and M83 H II regions lie in between Seyfert/LINER galaxies and H II-type galaxies in the 7.7/11.3 – 6.2/11.3 plane, while the different sub-samples exhibiting different 7.7/6.2 ratios; (ii) Using the NASA Ames PAH IR Spectroscopic database, we demonstrate that the 6.2/7.7 ratio does not effectively track PAH size, but the 11.3/3.3 PAH ratio does; (iii) variations on the 17 µm PAH band depends on object type however, there is no dependence on metallicity for both extragalactic H II regions and galaxies; (iv) the PAH/VSG intensity ratio decreases with the hardness of the radiation field and galactocentric radius (R_g), yet the ionization alone cannot account for the variation seen in all of our sources; (v) the relative strength of PAH features does not change significantly with increasing radiation hardness, as measured through the [Ne III]/[Ne II] ratio and the ionization index; (vi) We present PAH SFR calibrations based on the tight correlation between the 6.2, 7.7, and 11.3 µm PAH luminosities with the 24 µm luminosity and the combination of the 24 µm and Hα luminosity; (vii) Based on the total luminosity from PAH and FIR emission, we argue that extragalactic H II regions are more suitable templates in modeling and interpreting the large scale properties of galaxies compared to Galactic H II regions.

E-mail: amaragko@uwo.ca

Accepted for publication in MNRAS

https://arxiv.org/abs/1809.10136

Detection of Prebiotic Molecules in Plasma and Photochemical Aerosol Analogs Using GC/MS/MS Techniques

Joshua A. Sebree[1], Madeline C. Roach[1], Emma R. Shipley[1], Chao He[2] and Sarah M. Hörst[2]

[1] Department of Chemistry and Biochemistry, University of Northern Iowa, Cedar Falls, IA, USA

[2] Department of Earth and Planetary Sciences, Johns Hopkins University, Baltimore, MD, USA

The formation and identification of prebiotic compounds in the organically rich atmospheres of Titan and Pluto are of great interest due to the potential implications such discoveries may have on theories of the origins of life on the early Earth. In past work, hindrances in detecting

prebiotic molecules in lab-generated aerosol analogs have been the large number of products formed, often compounded by limited sample amounts. In this work, we detail a GC/MS/MS protocol that is highly selective ($>$30 simultaneously detectable compounds) and highly sensitive (limits of detection $\sim$1 picomole). Using this method to analyze aerosol analogs (tholins) generated by either cold plasma or photochemical irradiation of 1:1 mixtures of methane and carbon monoxide in nitrogen, this work has expanded the number of identifiable compounds in Titan/Pluto analog aerosols to include the nonbiological nucleobases xanthine and hypoxanthine in plasma aerosols and the first identification of glycine as a product in photochemical aerosols produced under reducing atmospheric conditions. Several species (glycine, guanidine, urea, and glycolic acid) were found to be present in both plasma and photochemical aerosols. Such parallel product pathways bring new understanding to the nature of plasma and photochemical aerosols and allow for new insights into the prebiotic chemistry of organically rich atmospheres including Pluto, Titan, and the early Earth.

E-mail: Joshua.sebree@uni.edu

ApJ, 2018, 865, 133

http://iopscience.iop.org/article/10.3847/1538-4357/aadba1/meta

Infrared Signatures of Protonated Benzonitrile

K. Chatterjee[1] and O. Dopfer[1]

[1] Institut für Optik und Atomare Physik, TU Berlin, Hardenbergstr. 36, D-10623 Berlin, Germany

Aromatic hydrocarbons and their protonated ions are important constituents of the interstellar medium (ISM). The recent discovery of benzonitrile (BN; cyanobenzene, C_6H_5CN) in the ISM suggests that its protonated ion (H^+BN) is also present. Herein, we present vibrational signatures of H^+BN obtained via infrared photodissociation (IRPD) spectra of its clusters with up to four nonpolar ligands (L = Ar/N_2) recorded in the NH ($\nu_{\rm NH}$) and CH ($\nu_{\rm H}$) stretch range. Protonation of BN occurs at the N atom of the nitrile group. Systematic complexation shifts ($\Delta\nu_{\rm NH}$) observed in the IRPD spectra of $H^+BN\text{-}L_n$ are assigned to cluster structures by comparison to quantum chemical calculations. In the most stable $H^+BN\text{-}L_n$ structures, the first ligand (n = 1) forms a NH^+... L ionic hydrogen bond (H-bond), while additional ligands (n = 24) are attached to the aromatic ring via π stacking. For L = Ar, a less stable π-bonded H^+BN-Ar isomer is also detected, and its IR spectrum provides an accurate experimental estimate of $\nu_{\rm NH}$ = 3555 $\pm$ 3 cm^{1} for bare H^+BN, an intense characteristic fingerprint of this ion in the 3 µm range. Comparison of $C_6H_5CNH^+$ with $HCNH^+$ and CH_3CNH^+ reveals that the acidity of the NH proton in $RCNH^+$ ions increases in the order R = $C_6H_5 < CH_3 <$ H.

E-mail: dopfer@physik.tu-berlin.de

ApJ, 2018, 865, 114

http://iopscience.iop.org/article/10.3847/1538-4357/aad462/meta

Low-temperature formation of polycyclic aromatic hydrocarbons in Titan's atmosphere

Long Zhao[1], Ralf I. Kaiser[1], Bo Xu[2], Utuq Ablikim[2], Musahid Ahmed[2], Mikhail M. Evseev[3], Eugene K. Bashkirov[3], Valeriy N. Azyazov[3] and Alexander M. Mebel[3,4]

[1] Department of Chemistry, University of Hawaii at Manoa, Honolulu, HI, USA

[2] Chemical Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

[3] Samara University, Samara, Russia

[4] Department of Chemistry and Biochemistry, Florida International University, Miami, FL, USA

The detection of benzene in Titan's atmosphere led to the emergence of polycyclic aromatic hydrocarbons (PAHs) as potential nucleation agents triggering the growth of Titan's orange-brownish haze layers. However, the fundamental mechanisms leading to the formation of PAHs in Titan's low-temperature atmosphere have remained elusive. We provide persuasive evidence through laboratory experiments and computations that prototype PAHs like anthracene and phenanthrene ($C_{14}H_{10}$) are synthesized via barrierless reactions involving naphthyl radicals ($C_{10}H_7^{\bullet}$) with vinylacetylene (CH_2=CH-C CH) in low-temperature environments. These elementary reactions are rapid, have no entrance barriers, and synthesize anthracene and phenanthrene via van der Waals complexes and submerged barriers. This facile route to anthracene and phenanthrenepotential building blocks to complex PAHs and aerosols in Titan–signifies a critical shift in the perception that PAHs can only be formed under high-temperature conditions, providing a detailed understanding of the chemistry of Titan's atmosphere by untangling elementary reactions on the most fundamental level.

E-mail: ralfk@hawaii.edu

Nature Astronomy (2018)

https://www.nature.com/articles/s41550-018-0585-y#Abs1

Dusting the Universe

University of Arizona, Tucson, AZ
March 4-8, 2019

Summary: The aim of this conference is to bring together the local and high-redshift observational and theoretical communities to share new research and ideas and have productive discussions on dust in galaxies near and far, particularly in light of future infrared facilities. The conference will consist of a series of invited review talks, discussion sessions, contributed presentations, and meetings on future missions including OST.

Contributed Talks and Posters: Abstract submission for contributed talks and posters is currently open and abstracts are due November 1, 2018. Posters will be displayed in the main conference room and each poster will have a short poster talk.

Registration: Conference registration will open in mid-October 2018. Registration is limited to 75 participants. Please note that abstract submission and registration are separate processes. Attendance at the conference is not guaranteed until you have completed registration, including paying the registration fee. Conference registration will close January 15, 2019.

Venue: Dusting the Universe will be held on the University of Arizona (UA) campus, a 15-minute walk from Steward Observatory and NOAO. The conference is being held during UA Spring Break, following the Tucson Festival of Books (March 2-3 on the university campus). Tucson is beautiful in winter, with average temperatures of $\sim$20 C ($\sim$70 F) during the day, providing a great opportunity to experience the desert vibes of the city and visit the surrounding desert and national parks. Read more about Tucson attractions here: https://www.visittucson.org/.

You can find more details about the scientific rationale, travel information, important dates, etc, on our website: https://www.noao.edu/meetings/dust2019.

E-mail for contact: **tucson.dust2019@gmail.com**

Confirmed Invited Speakers and Discussion Leaders:
Caitlin Casey (UT Austin)
Elisabete da Cunha (ANU)
Mark Dickinson (NOAO)
Bruce Draine (Princeton)
Cornelia Jäger (FSU-Jena)
Ed Jenkins (Princeton)
Rob Kennicutt (UA)
Allison Kirkpatrick (U. Kansas)
Desika Narayanan (U. Florida)
Alex Pope (UMass-Amherst)
Cristina Popescu (UCLan)
Naveen Reddy (UC Riverside)
JD Smith (U. Toledo)
Justin Spilker (UT Austin)
Svitlana Zhukovska (MPA)

SOC:
Stacey Alberts (UA, co-chair)
Irene Shivaei (UA, co-chair)
Arjun Dey (NOAO)
Stephanie Juneau (NOAO)
Aigen Li (U. Missouri)
William Reach (SOFIA, USRA)
Karin Sandstrom (UCSD)
Benjamin Weiner (UA)
Christina Williams (UA)

Sponsors: Dusting the Universe is made possible through generous contributions from the University of Arizona/Steward Observatory, the National Optical Astronomy Observatory (NOAO), The ORIGINS Space Telescope (OST), and the National Radio Astronomy Observatory (NRAO).

Announcements

Ph.D. and Post-doctoral Positions at Nicolaus Copernicus University in Toruń, Poland

Star-Forming Regions in the Outer Galaxy

Advertised by: Agata Karska

The Faculty of Physics, Astronomy and Informatics at the Nicolaus Copernicus University in Toruń, Poland, invites applications for a 3-year post-doctoral research fellow and two 3-year Ph.D. candidates in studies of star-forming regions in the Outer Galaxy. The aim is to characterize gas and dust properties of star-forming regions in a variety of environments within our Galaxy and to create a 'template' to interpret emission from star-forming regions in more distant, younger galaxies. The post involves working on the project funded by the Foundation for Polish Science within the First TEAM program awarded to Dr. Agata Karska in the Toruń Center for Astronomy. The project is supported and will be carried out in a close collaboration with researchers from University of Copenhagen, NASA Goddard Space Flight Center, and Space Telescope Science Institute.

Ph.D. I A complete census of protostars in the outer Galaxy star-forming regions using sub-mm dense gas tracers and maser emission at radio wavelengths.

Ph.D. II Properties of warm and hot gas using spectral mapping at infrared.

The candidates applying for the positions should have a strong motivation for pursuing Ph.D. studies, have a Master-level degree in physics or astronomy, good knowledge of written and spoken English, and at least basic programming skills. The Ph.D. stipends in the project are 3500 PLN (820 euro) / month for 3 years. Additional funding options and extension to the 4th year are possible as part of a regular Ph.D. program at Nicolaus Copernicus University. See also: https://euraxess.ec.europa.eu/jobs/342149.

Post-doc Cold gas reservoir and chemical complexity of star-forming regions.

The candidates applying for the position should have a PhD in physics or astronomy, or in a related field awarded not earlier than in 2013, and good knowledge of written and spoken English. Motivation to work in a young, developing research team and to co-advise undergraduate and Master level students will be welcomed. Prior experience with interferometer data will be a strong asset. The gross salary is 15000 PLN (3500 euro) / month for 3 years. Multiple options for additional funding are in place for strongly motivated young researchers in Poland.

All interested candidates should send their curriculum vitae, list of publications, a cover letter outlining their research interests and motivation to join the project, and arrange for up to three letters of reference. Applications received before **November 23, 2018** will be given full consideration, but will continue to be accepted until the positions are filled. Please send questions regarding the post, applications and reference letters to: agata.karska@umk.pl. The appointments are expected to start on February 1, 2019, but a later date may be negotiated.

Ph.D. Position in Experimental and Computational Astrochemistry

Advertised by: Jordy Bouwman

A 4-year fully funded PhD student position in the field of experimental and computational astrochemistry is available. Chemical reactions of interstellar relevance will be characterized by means of imaging photoelectron photoion coincidence spectroscopy at the Swiss Light Source and supplementary quantum chemical computations will be performed. Frequent visits to the Vacuum Ultraviolet Beamline of the Swiss Light Source at Paul Scherrer Institute are integral part of the project. Candidates with a background in (physical) chemistry and strong affinity with astronomy/astrochemistry are strongly encouraged to apply. Basic knowledge of quantum chemical computations and spectroscopy is beneficial.

See *e.g.* Bouwman et al. PCCP (2015) 17, 20508 and
Bouwman et al. JPCA (2015) 119, 1127.

Appointment: The PhD student will be appointed at the Sackler Laboratory for Astrophysics, part of Leiden Observatory, at the Faculty of Science of Leiden University, the Netherlands. The position is funded within the framework of a recently awarded NWO VIDI grant

Applications: The deadline for applications is October 31st 2018 but applications are accepted until the position is filled. Please send a cover letter, a resume and contact information of two persons willing to provide a letter of support to Dr. Jordy Bouwman (bouwman@strw.leidenuniv.nl).

Additional information can be obtained here:
http://home.strw.leidenuniv.nl/∼bouwman/index.html or
http://home.strw.leidenuniv.nl/∼linnartz/start.html

AstroPAH Newsletter

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

Next issue: 22 November 2017
Submission deadline: 9 November 2017