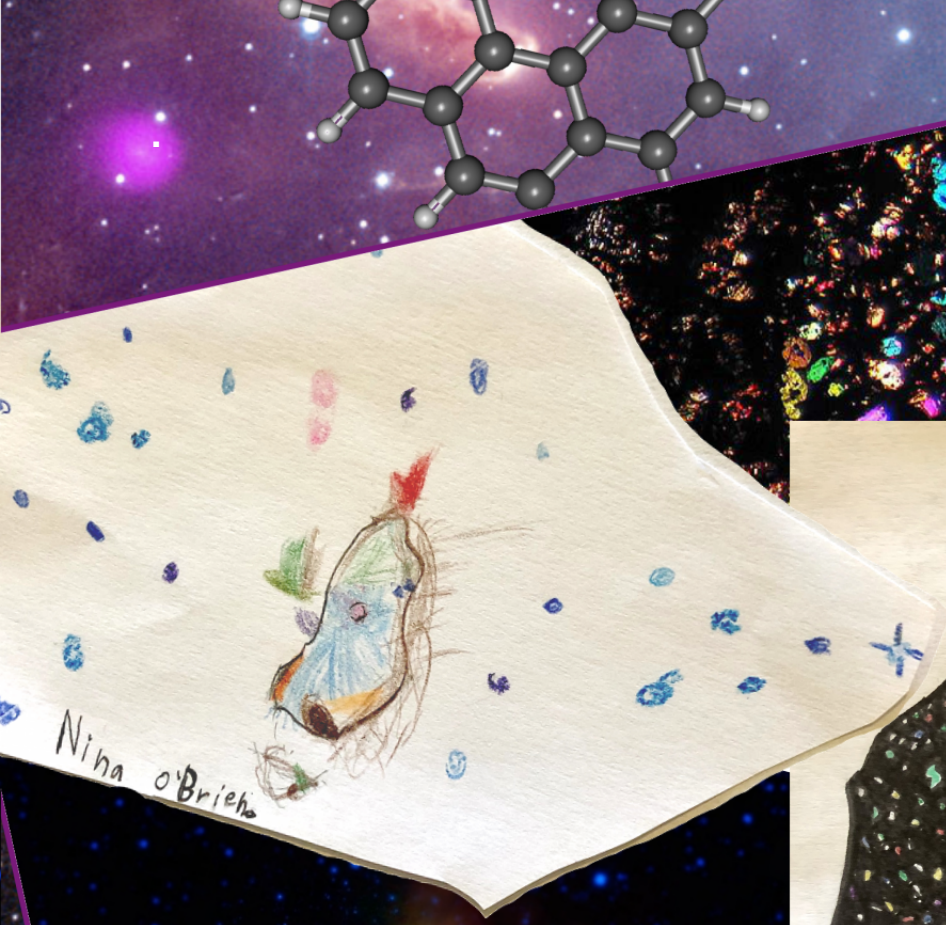
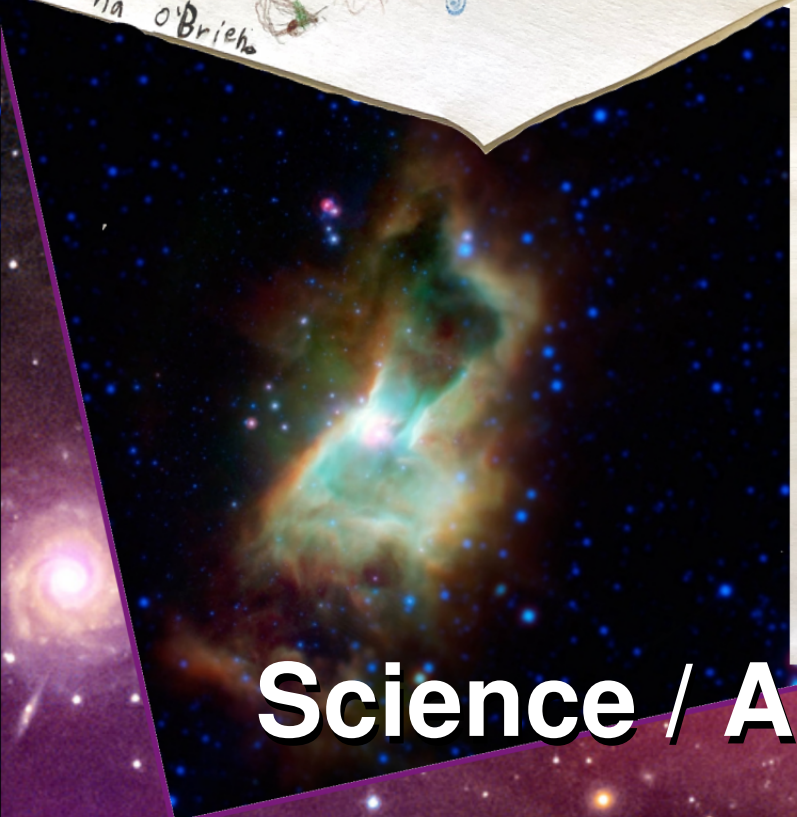
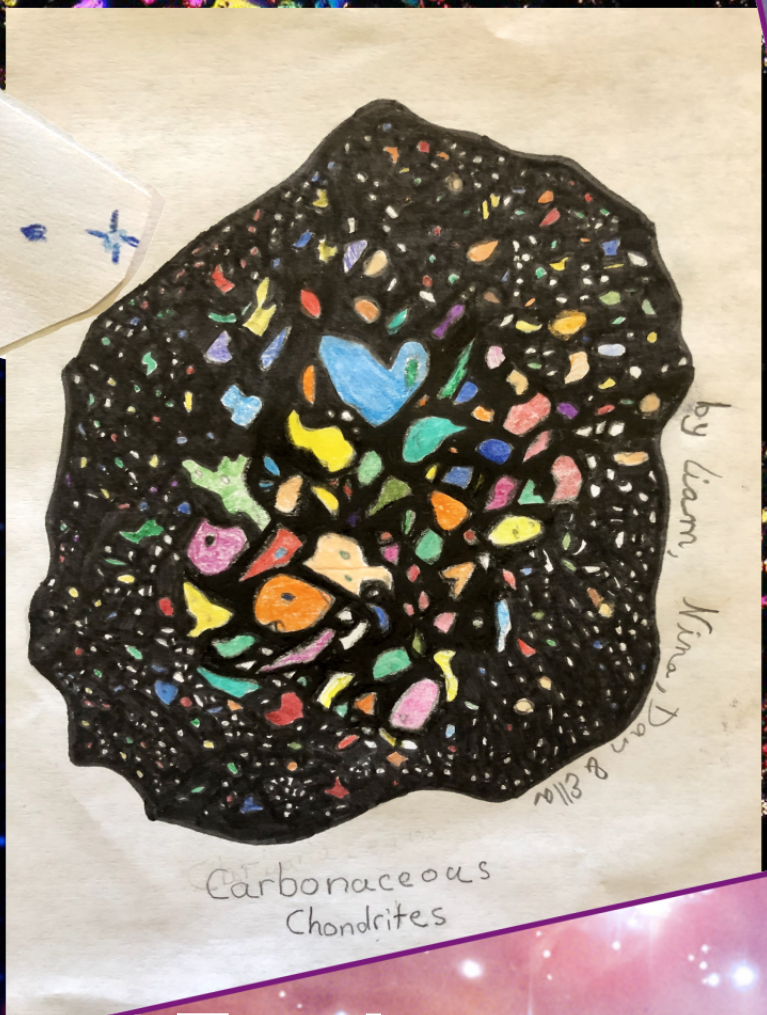
AstroPAH

A Newsletter on Astronomical PAHs

Issue 68 • May 2020







Science / Art / Fun!

Editorial

Dear Colleagues,

Welcome to the 68^{th} volume of the AstroPAH newsletter.

This month, our cover was provided by our first AstroPAHrtists: Liam O'Brien (9), Nina O'Brien (6) and their parents, Ella and Dan. They were inspired by the cover page of our 14th AstroPAH issue and a picture of a nebula taken by the *Spitzer* telescope. Ella explained: "We wanted to find images that inspired Liam and Nina and were related to AstroPAH. We first looked at all 67 covers of AstroPAH and Liam chose the cover of our 14th issue. Nina wanted to draw a nebula and really liked the *Spitzer* image of the Iris Nebula that we found... in an article about the NASA Ames PAH IR spectroscopic database! What a coincidence!"

The O'Brien family is introducing our In Focus by combining science, art and fun. This month, and as a tribute to all the families dealing with the tasks of teleworking, homeschooling, social isolation, and more, we have prepared an AstroPAH coloring activity for the whole family. We also call on our readers for your science, astro-art and/or PAH-themed art contributions! Your contributions will be featured as part of the June AstroPAH issue. More information about all of this is provided in the In Focus section!

In our Abstract section, we present four recent Astro-PAH-related publications that cover a broad range of topics from DIBs, to the C_{60} fullerene cation, to dust grains, to the ionization fraction of PAHs in astrophysical sources.

We would also like to bring your attention to an opening for a PhD position in experimental astrochemistry in Otto Dopfer's group in Berlin, as well as the upcoming Laboratory Astrophysics Division annual meeting, which will take place virtually between June 1st and June 3rd. The full programme is listed in the Meetings section. Registration is still open until May 29!

We hope you enjoy reading our newsletter, and we thank you for your dedication and interest in AstroPAH! In the meantime, please continue sending us your contributions, and if you wish to contact us, feel free to use our email: astropah@strw.leidenuniv.nl.

Please be safe and stay healthy.

Enjoy reading our newsletter!

The Editorial Team

Next issue (aprox.): 25 June 2020.
Submission deadline: 12 June 2020.

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PAH Picture of the Month

A family project: science, art, and a fun time together. Drawings of a meteorite and a nebula, next to the pictures that inspired the artists: a thin section of meteorite NWA 5958, a carbonaceous chondrite, as seen in cross-polarized light, and the Iris Nebula captured by Spitzer.

Credits: Drawings by Nina and Liam O'Brien (parents Ella and Dan helped only a little with coloring).
Image of NWA 5958 by John Kashuba(www.meteorite-times.com).
Image of the Iris nebula by NASA/JPL-Caltech.

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Newsletter Design: Isabel Aleman
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This page: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)
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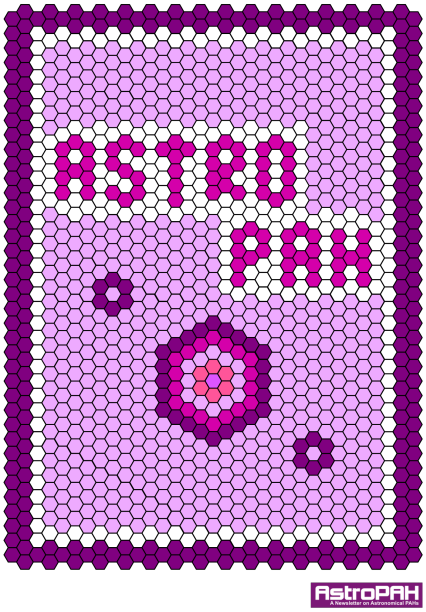
Science, Art and Fun!

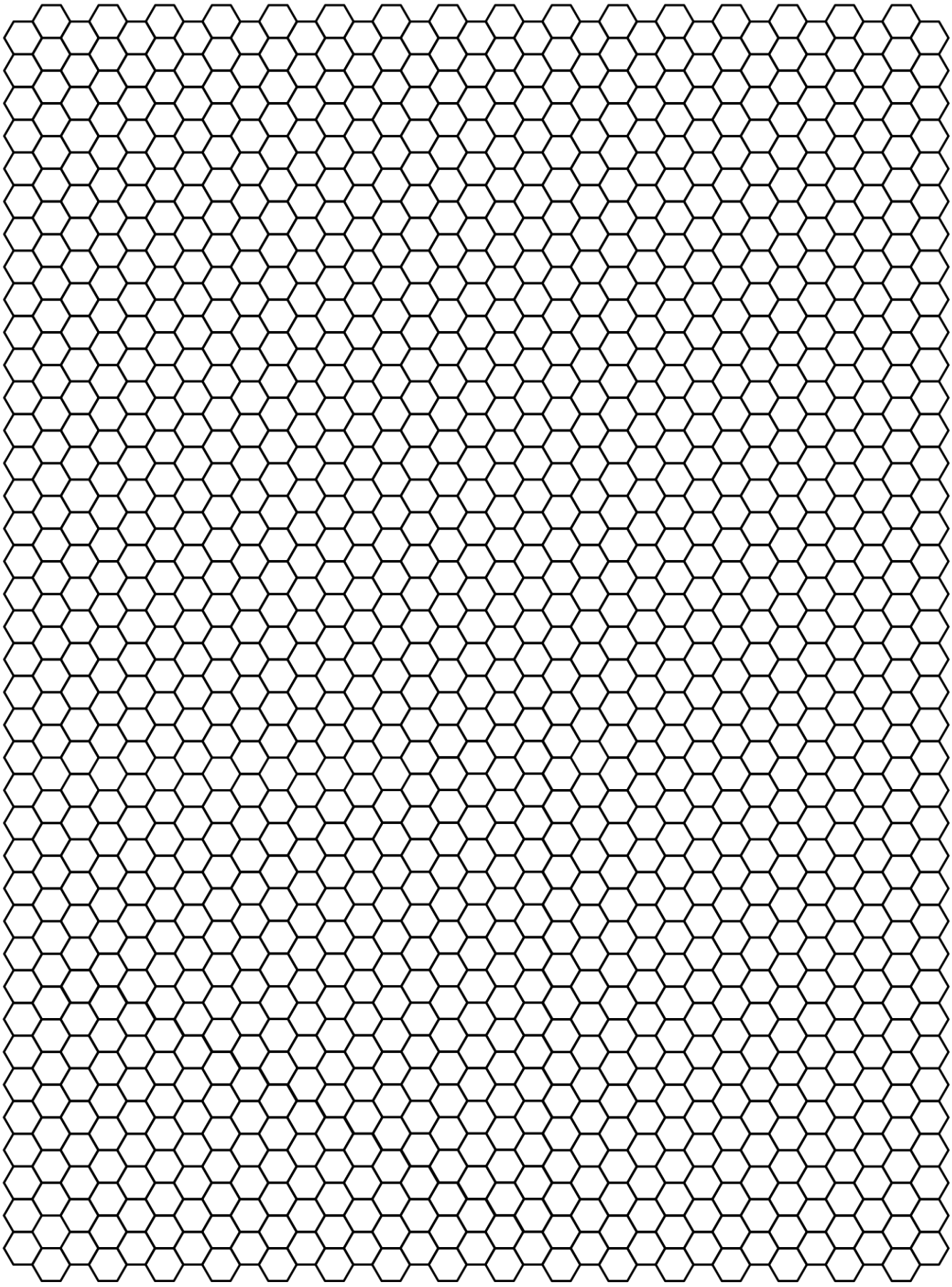


As all (or most) of us are still under quarantine, how about some family fun with a science twist? This is what we are proposing here! This In Focus is all about combining science, art and fun while we are all at home. In the next page, we provide a template you and your family can use for coloring for fun or reducing stress... with benzene rings! You can print the page or use the png image available here to colour with your computer. You may color it out according to the example we have provided above, or just go with your own imagination!

As part of this project, we would like to expand this activity by asking for your own science and/or PAH-themed astro-art contributions. They do not necessarily have to be based on this template, but can expand to anything your imagination comes up with. So whether it is just yourself or you and your family, by hand or digitally, we hope you can come together and use your imagination to share your nicest art with us! Be an AstroPAHrtist!

You can send your contributions to our email: astropah@strw.leidenuniv.nl.

The AstroPAH Team



AstroPAH
A Newsletter on Astronomical PAHs

Abstracts

Detection of PAH Absorption and Determination of the Mid-Infrared Diffuse Interstellar Extinction Curve from the Sightline Toward Cyg OB2-12

Brandon S. Hensley[1], **B. T. Draine**[1]

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The sightline toward the luminous blue hypergiant Cyg OB2-12 is widely used in studying interstellar dust on account of its large extinction ($A_V \simeq 10$ mag) and the fact that this extinction appears to be dominated by dust typical of the diffuse interstellar medium. We present a new analysis of archival *ISO*-SWS and *Spitzer* IRS observations of Cyg OB2-12 using a model of the emission from the star and its stellar wind to determine the total extinction A_λ from 2.4–37 μm. In addition to the prominent 9.7 and 18 μm silicate features, we robustly detect absorption features associated with polycyclic aromatic hydrocarbons (PAHs), including the first identification of the 7.7 μm feature in absorption. The 3.3 μm aromatic feature is found to be much broader in absorption than is typically seen in emission. The 3.4 and 6.85 μm aliphatic hydrocarbon features are observed with relative strengths consistent with observation of these features on sightlines toward the Galactic Center. We identify and characterize more than sixty spectral lines in this wavelength range, which may be useful in constraining models of the star and its stellar wind. Based on this analysis, we present an extinction curve $A_\lambda/A_{2.2\,\mu\mathrm{m}}$ that extrapolates smoothly to determinations of the mean Galactic extinction curve at shorter wavelengths and to dust opacities inferred from emission at longer wavelengths, providing a new constraint on models of interstellar dust in the mid-infrared.

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Astrophysical Journal
https://ui.adsabs.harvard.edu/abs/2020arXiv200202457H/abstract

VUV Photoionization Dynamics of the C_{60} Buckminsterfullerene: 2D-Matrix Photoelectron Spectroscopy in an Astrophysical Context

Helgi Rafn Hróðmarsson[1,2], Gustavo A. Garcia[1], Harold Linnartz[2] and Laurent Nahon[1]

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[2] Laboratory for Astrophysics, Leiden Observatory, Leiden University, Niels Bohrweg 2, 2333 CA Leiden, The Netherlands

We present the photoionization dynamics of the C_{60} Buckminsterfullerene from threshold up to 14.0 eV recorded with VUV synchrotron radiation at the DESIRS beamline at the SOLEIL synchrotron. The recorded data is obtained using a double-imaging photoelectron photoion coincidence spectrometer and is presented as a two-dimensional photoelectron matrix which contains a wealth of spectroscopic data. We present these data in an astrophysical context which relates to (i) the threshold photoelectron spectrum which is compared to data relevant to the diffuse interstellar bands (DIBs), (ii) the kinetic photoelectron distribution at the Lyman-alpha line which is relevant to the dominant heating source in the ISM, and (iii) the absolute photoionization cross section of C_{60} up to approx. 10.5 eV. The photoelectron spectrum implies that the symmetry of the ground state is different than previous theoretical models have predicted, and this result is discussed in context of recent experimental and theoretical findings. Also presented are partial photoionization cross sections of the first two photoelectron bands and their anisotropy parameters. These data are compared with previous theoretical values and discussed where appropriate.

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Physical Chemistry Chemical Physics (PCCP)
https://pubs.rsc.org/en/content/articlelanding/2020/cp/d0cp01210f/unauth#!divAbstract
https://doi.org/10.1039/D0CP01210F

Probing the size and charge of Polycyclic Aromatic Hydrocarbons

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[4] Space Science & Astrobiology Division, Astrophysics Branch, Mail Stop 245-6, NASA Ames Research Center, Moffett Field, CA 94035, USA

We present a new method to accurately describe the ionization fraction and the size distribution of polycyclic aromatic hydrocarbons (PAHs) within astrophysical sources. To this purpose, we have computed the mid-infrared emission spectra of 308 PAH molecules of varying sizes, symmetries, and compactness, generated in a range of radiation fields. We show that the intensity ratio of the solo CH out-of-plane bending mode in PAH cations and anions (referred to as the "11.0" μm band, falling in the 11.0–11.3 μm region for cations and anions) to their 3.3 μm emission, scales with PAH size, similarly to the scaling of the 11.2/3.3 ratio with the number of carbon atoms (N_C) for neutral molecules. Among the different PAH emission bands, it is the 3.3 μm band intensity which has the strongest correlation with N_C, and drives the reported PAH intensity ratio correlations with N_C for both neutral and ionized PAHs. The 6.2/7.7 intensity ratio, previously adopted to track PAH size, shows no evident scaling with N_C in our large sample. We define a new diagnostic grid space to probe PAH charge and size, using the (11.2+11.0)/7.7 and (11.2+11.0)/3.3 PAH intensity ratios respectively. We demonstrate the application of the (11.2+11.0)/7.7 – (11.2+11.0)/3.3 diagnostic grid for galaxies M82 and NGC 253, for the planetary nebula NGC 7027, and the reflection nebulae NGC 2023 and NGC 7023. Finally, we provide quantitative relations for PAH size determination depending on the ionization fraction of the PAHs and the radiation field they are exposed to.

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MNRAS, Volume 494, Issue 1, pp.642-664

https://doi.org/10.1093/mnras/staa681

https://arxiv.org/abs/2003.02823

Correlation between UV resilience and wavelength of narrow diffuse interstellar bands

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[2] Institut für Organische Chemie, Universität Tübingen, Auf der Morgenstelle 18, 72076 Tübingen, Germany

Carriers of diffuse interstellar bands (DIBs) still need to be identified. In a recent paper, we reported a correlation between the DIB wavelength and the apparent UV resilience (or boost) of their carriers. We proposed that this might be an indication of the important role of conjugated elongated molecules among the DIB carriers. The aim of this paper is to further understand the origin of this correlation. The analysis of 509 optical DIBs on the lines of sight of HD 183143 and/or HD 204827 reported in the literature shows that this correlation mainly implies the 386 narrow DIBs with a band width < 1.1 Å, which include most of the identified DIBs of the C_2 and ζ families, while the majority of the 123 broader DIBs, including the identified σ DIBs, do not display such a correlation. We present a possible origin of this correlation from very strong bands of large conjugated elongated molecules, such as carbon chains, polyacenes, or other catacondensed polycyclic aromatic hydrocarbons. The total amount of carbon contained in all the carriers of these narrow DIBs is a very small fraction of the interstellar carbon if their oscillator strengths are ≥ 1. The amount of carbon locked in the carriers of the broader DIBs is higher, especially if their oscillator strengths are significantly weaker.

E-mail: omont@iap.fr

Astronomy & Astrophysics 637, A74 (2020)

https://arxiv.org/pdf/2003.12118.pdf

Announcements

PhD Position in Laboratory Astrochemistry

Berlin, Germany
Deadline for application: 30 May 2020

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. Evaluation of the applications will start June 1 (2020) and continue until the position is filled.

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

Webpage: https://www.ioap.tu-berlin.de/menue/arbeitsgruppen/ag_dopfer/open_phd_position_application_deadline_31052020/parameter/en/

Meetings

AAS LAD 2020 Annual Meeting: Bridging Laboratory and Astrophysics

Virtual Meeting
1 - 3 June 2020

In response to the coronavirus outbreak and the steps taken worldwide to limit its spread, the annual meeting of the Laboratory Astrophysics Division (LAD) has been converted to a fully virtual conference. It will be held jointly with the 236^{th} American Astronomical Society (AAS) virtual meeting. The LAD meeting is devoted to the interplay between laboratory astrophysics and other fields in astronomy, planetary science and related sciences.

Registration for the meeting is still open until May 29. Please join us!
https://aas.org/meetings/aas236/register

This year, **the LAD plenary session will be given on June 2 by Paula Caselli** on *"The Crucial Interplay of Laboratory Experiments, Observations and Theory to Unveil our Astrochemical Origins."* We will also have our **Business meeting** on June 1.

The LAD meeting will be divided into 6 sessions covering a broad range of topics:

- **Cosmochemistry and Dust**
- **Astrochemistry**
- **Nuclear, Plasma and Particle Astrophysics**
- **Atomic Data for XRISM**
- **Ocean Worlds**
- **Planetary Atmospheres, Protoplanetary Disks, and Small Bodies**

The agenda for the LAD 2020 annual meeting is given on the next pages (**EDT Time**).

The LAD Executive Committee:
Phillip Stancil (Chair – Univ. of Georgia)
Murthy Gudipati (Vice-Chair – JPL)
Christiaan Boersma (Treasurer – NASA ARC/SJSU)
Rachel Smith (Secretary – NC Museum of Natural Sciences/Appalachian State University)
and the Members-at-Large of LAD

Monday June 1

11:00 AM – 12:30 PM: Session 105 – Cosmochemistry and Dust

Chair: Rachel Smith (NC Museum of Natural Sciences/Appalachian State University)

- 11:00 AM – 11:30 AM: **Pierre Haenecour** – *From Stars to the Solar System: Analysis of Stardust Grains in the Laboratory*
- 11:30 AM – 11:45 AM: **Ella Sciamma-O'Brien** – *Scanning Electron Microscopy Study of Cosmic Grain Analogs produced at Low Temperature in the COsmic SImulation Chamber (COSmIC)*
- 11:45 AM – 12:00 PM **Thomas Zega** – *Phosphorous in Chondritic Meteorites: Beyond Schreiberiste?*
- 12:00 PM – 12:30 PM **Lia Corrales** – *Astromineralogy and Dust Grain Growth with X-ray Imaging and Spectroscopy*

02:50 PM – 04:20 PM: Session 119: Astrochemistry

Chair: Michael McCarthy (Harvard-Smithsonian Center for Astrophysics)

- 02:50 PM – 03:10 PM: **Adwin Boogert** – *Molecular Complexity of Interstellar Ices*
- 03:10 PM – 03:35 PM: **Lucy Ziurys** – *Laboratory Detection of the SiP Radical and Astronomical Search*
- 03:35 PM – 03:50 PM **Sommer Johansen** – *Investigating Astrophysical N-heterocycle Formation with Rotational Spectroscopy and Computational Chemistry*
- 03:50 PM – 04:05 PM **Alessandra Ricca** – *Probing the Size and Charge of Polycyclic Aromatic Hydrocarbons*
- 04:05 PM – 04:20 PM **Emtiaz Shahnewaz** – *Infrared Spectroscopic Investigation of Segregation in CH_4:N_2 Ice Mixtures: Application to TNO (Trans-Neptunian Objects)*

05:30 PM – 06:30 PM: Session 145: LAD iPoster Session I

06:40 PM: LAD Business Meeting

Tuesday June 2

10:00 AM – 10:50 AM: Session 200 – LAD Plenary Lecture

Chair: Phillip C. Stancil (University of Georgia)

- 10:00 AM – 10:50 AM: **Paola Caselli** – *The Crucial Interplay of Laboratory Experiments, Observations and Theory to Unveil our Astrochemical Origins*

11:00 AM – 12:30 PM: Session 204: Nuclear, Plasma and Particle Astrophysics

Chair: Phillip C. Stancil (University of Georgia)

- 11:00 AM – 11:45 PM: ***LAD Laboratory Astrophysics Prize Lecture*, John Cowan** – *Jim Truran's Contributions to Nuclear and Laboratory Astrophysics*
- 11:45 PM – 12:00 PM: **Ken Nollett** – *Evaluating Astrophysical Nuclear Rates and their Errors with Halo Effective Field Theory*
- 12:00 PM – 12:15 PM **Justin Vandenbroucke** – *Performance of the Prototype Schwarzschild-Couder Telescope for TeV Gamma-Ray Astronomy*
- 12:15 PM – 12:30 PM **Amy Gall** – *Linear Polarization Measurement of Satellite Transitions Produced in an EBIT Ar Plasma*

02:50 AM – 04:20 PM: Session 220: Atomic Data for XRISM

Chair: Randall Smith (Harvard-Smithsonian Center for Astrophysics)

- 02:50 PM – 03:20 PM: ***LAD Dissertation Prize Lecture*, Natalie Hell** – *Atomic Physics Measurements at the Livermore Electron Beam Ion Traps and their Application to X-Ray Astrophysics*
- 03:20 PM – 03:35 PM: **Richard Kelley** – *The X-Ray Imaging and Spectroscopy Mission*
- 03:35 PM – 04:05 PM **Adam Foster** – *X-ray Astronomy and the Lab: Past Achievements and Future Needs*
- 04:15 PM – 04:20 PM **Javier Garcia** – *X-ray Reflection from Highly Dense Accretion Disks*

05:30 PM – 06:30 PM: Session 247: LAD iPoster Session II

Wednesday June 3

11:00 AM – 12:30 PM: Session 303 – Ocean Worlds

Chair: Murthy Gudipati (Jet Propulsion Laboratory)

- 11:00 AM – 11:30 PM: **Andrew Mattioda** – *From the Interstellar Medium to Ocean Worlds: New Challenges for Laboratory Astrophysics*
- 11:30 PM – 12:00 PM: **Shannon MacKenzie** – *Dragonfly: a Rotorcraft Mission to Explore Titan's Organic Factory*
- 12:00 PM – 12:15 PM **David Dubois** – *Investigating the Condensation of Benzene (C_6H_6) in Titan's South Polar Cloud System*
- 12:15 PM – 12:30 PM **Reika Yokochi** – *Experimental Study of Clathrate Hydrate Formation at Low Temperature*

02:50 AM – 04:20 PM: Session 318: Planetary Atmospheres, Protoplanetary Disks, and Small Bodies

Chair: Silvia Protopapa (Southwest Research Institute)

- 02:50 PM – 03:20 PM: ***LAD Early Career Award Lecture*, Sarah Hörst** – *Planets in a Bottle: Exploring Planetary Atmospheres in the Lab*
- 03:20 PM – 03:50 PM: **Karen Meech** – *Using Small Solar System Bodies to Trace Processes in the Early Solar System*
- 03:50 PM – 04:05 PM **Sukrit Ranjan** – *New Near-UV H2O Cross-Sections Dramatically Affect Photochemistry of Anoxic Abiotic Rocky Planet Atmospheres*
- 04:15 PM – 04:20 PM **Perry Gerakines** – *Laboratory Study of Ammonium Cyanide NH4CN at Low Temperatures: IR Optical Properties and Sublimation Behavior*

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