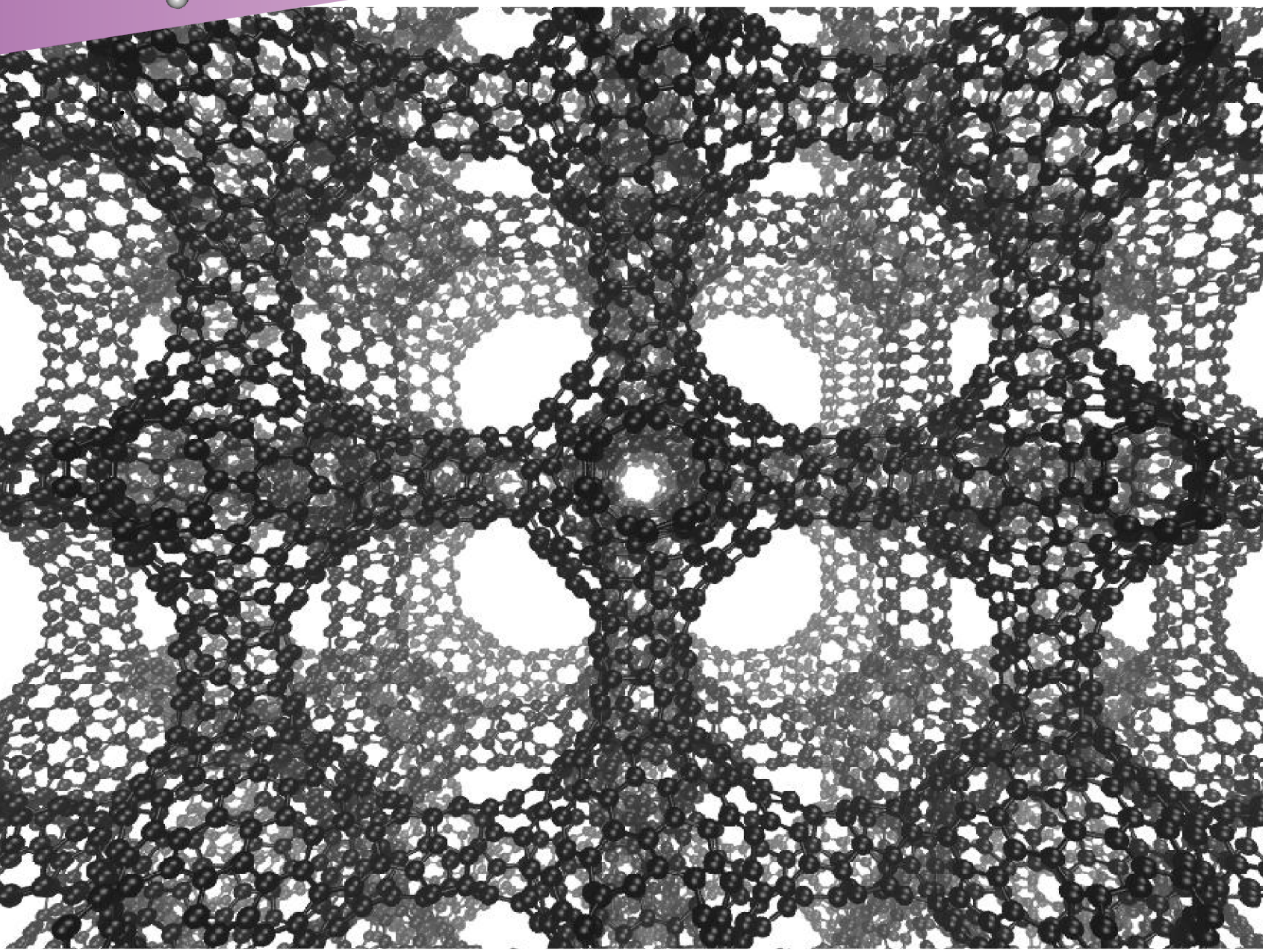
AstroPAH

A Newsletter on Astronomical PAHs

Issue 51 | September 2018



SCHWARZITE

Editorial

Dear Colleagues,

This September issue we would like to draw your attention to two milestones reached this summer. First, our *Picture of the Month* features the allotrope Schwarzite, which like fullerenes, nanotubes and graphene is predicted to have unique electrical and storage properties, and which has now been proven to have been built inside pores of zeolites. Second, August marked the 15^{th} anniversary of the Spitzer Space Telescope and, to celebrate, our *In Focus* presents its history and extraordinary discoveries as well as its impact on the PAH research field, as described by several scientists AstroPAH interviewed.

Another milestone is planned for next year in September with a special symposium to honour Professor Xander Tielens, our editor-in-chief and “GrandPA” to astrochemistry. For those who do not want to miss this, you can save the date now. Details can be found in the announcement section.

We once again have a nice collection of abstracts of new exciting papers on competing pathways in PAH evolution, C_{60} processing, a potential DIB candidate, and the influence of minerals.

Remember to give us your feedback on our survey if you haven't already done so! The deadline is in 2 weeks. We will present the results and more in our 5-year anniversary issue next month.

Please also take a look at further meeting and job announcements in the last section of the newsletter. And as always, do not forget to send us your contributions! For publication in the next AstroPAH, see the deadlines below.

The Editorial Team

Next issue: 18 October 2018.
Submission deadline: 5 October 2018.

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PAH Picture of the Month

The structure of a schwarzite, a nanoscale carbon structure with a negative curved surface investigated by the German physicist Hermann Schwarz in the 1880s. This long-sought material may now be at reach thanks to the concerted efforts of theoreticians and experimentalists; they have now synthetized the right type of zeolites (silicon dioxide in crystalline form) that theory predicts will lead to the formation of schwarzite. More information can be found in the paper Generating carbon schwarzites via polite-templing, by E. Braumnet al, 2018, PNAS, 115, 8116-8124.

Credits: Graphics by Yongjin Lee and Efrem Braun.

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

AstroPAH Needs Your Feedback!

In preparation for our 5^{th} anniversary celebration, we ask for some feedback from you, our readers and contributors.

Please take a few minutes to answer this survey. Your feedback will help us improve AstroPAH and how it serves our community.

Click here to answer the survey.

Deadline 5th October 2018

Thank you!

The Editors

In Focus

Spitzer Turned 15

by the AstroPAH editorial team,
including invaluable contributions from Lisa Storrie-Lombardi, Jan Cami, Jeronimo Bernard-Salas, Els Peeters, Christiaan Boersma, and Eric Lagadec

August 25, 2018 was the **15th anniversary of the Spitzer Space Telescope** and its exploration of space. Along the way, Spitzer has done many remarkable things, not the least of which is the fact that it is still operational 10 years after the end of its primary mission. To celebrate this momentous occasion, we are highlighting in this *In Focus* some of its history and remarkable discoveries, as well as its impact on PAH/fullerene research. To do so, we have asked scientists for testimonials on how Spitzer impacted their research, what we can expect from the future, and how it might still impact Science. Because there is a large amount of legacy data to be combed through, it might be of interest to some of you to get involved and see what other discoveries Spitzer can still bring to the PAH community.

Figure 1: Rendition of Spitzer in front of the IRAS/COBE 100 mm emission of the Milky Way. Credits: NASA/JPL-Caltech/R. Hurt (SSC).

A Little Bit of History

Dr. Lisa Storrie-Lombardi (NASA/JPL, USA) is the Spitzer project manager. In an interview with AstroPAH, Lisa told us about her long connection with Spitzer: "I joined the project in 1999, four years before launch, as the Science User Tools Scientist at the Spitzer Science Center (SSC) at Caltech. In 2004, I became the Assistant Director for Community Affairs and have been responsible for the observing proposal selection process since cycle-2. I managed the SSC from 2009 to 2016 before moving to the Jet Propulsion Laboratory as the Spitzer Project Manager. I have had the opportunity to work with all components of the project and our observing community."

Lisa spoke to AstroPAH about the Spitzer history and the mission motivation: "Spitzer was first envisioned as a facility to fly repeatedly on the Space Shuttles – the Shuttle Infrared Telescope Facility (SIRTF). Then came the resounding success of the Infrared Astronomical Satellite (IRAS), an Explorer-class satellite launched in 1983 to conduct the first infrared survey of the sky. The results of the 10-month mission led to huge interest in a follow-up mission from astronomers around the world. In 1984, NASA selected a team of astronomers to build the instruments and define the science program for a free-flying mission, SIRTF, the Space Infrared Telescope Facility. SIRTF was launched August 25, 2003, as the final element of NASA's Great Observatories program. It was renamed the Spitzer Space Telescope in honor of Dr. Lyman Spitzer, who conceived the idea of telescopes in space and worked tirelessly to make them happen."

When Spitzer was launched in 2003 from Cape Canaveral, it began collecting data in what is known as the **cryogenic mission** phase of the instrument. During this time, the telescope was equipped with liquid helium that allowed for the operation of part of its instruments at very low temperatures to remove contamination from its own thermal emission. The telescope follows a heliocentric orbit in which it trails and then drifts away from the Earths orbit. This was the first time this type of orbit was used, and during the primary phase, it allowed the instrument to use less liquid helium than it would have if it orbited the Earth.

Spitzer's primary mirror is 85 cm in diameter and made from beryllium. Three instruments performed the infrared detection: IRAC, IRS, and MIPS. **IRAC** (InfraRed Array Camera) is an imaging camera that detects infrared light in narrow bands that peak at 3.6, 4.5, 5.8 and 8.0 μm. **IRS** (InfraRed Spectrograph) provides spectroscopy in both high- and low-resolution at mid-infrared wavelengths (5-40 μm). **MIPS** (Multiband Imaging Photometer) is also an imaging camera, but in the far-infrared range, detecting in bands centered at 24, 70 and 160 μm.

Spitzer ran out of liquid helium on May 15, 2009, but luckily the two shortest wavelength modules of the IRAC (at 3.6 μm and 4.5 μm) have continued to operate in the **warm mission** phase (at approximately 30 K) with the same sensitivity that they had during the primary **cryogenic mission** phase. This means that Spitzer has been able to keep sending data for scientists to use over the last 9 years since the telescope ran out of liquid helium.

Extraordinary Discoveries

Since its launch, Spitzer has recorded data on everything from exotic exoplanets to enormous galaxy clusters. **Lisa Storrie-Lombardi** highlighted some significant contributions: "Spitzers impact on our understanding of the universe is profound. We now know more about the TRAPPIST-1 system, seven earth-sized planets orbiting a dwarf star, than any other planetary system besides our solar system. Spitzer was crucial in unraveling the true nature of this amazing system. Spitzer's 360-degree view of our Milky Way, the GLIMPSE (Galactic Legacy Infrared Mid-Plane Survey Extraordinaire) survey provided a stunning panoramic

image of the entire plane of our galaxy. GLIMPSE provides new data on the structure of our galaxy as well as the science of star formation, young stars, massive stars, dark clouds, and the distribution and morphologies of dust and polycyclic aromatic hydrocarbons (PAHs) in the interstellar medium. Spitzer provided the first detection of water in an exoplanet atmosphere and identified a huge dust ring around Saturn. In the distant universe, Spitzer has identified many more clusters of galaxies than previously known and working with the Hubble Space Telescope is key to identifying the most distant galaxies we can currently see."
Figure 2 shows portrayals of some of these discoveries.

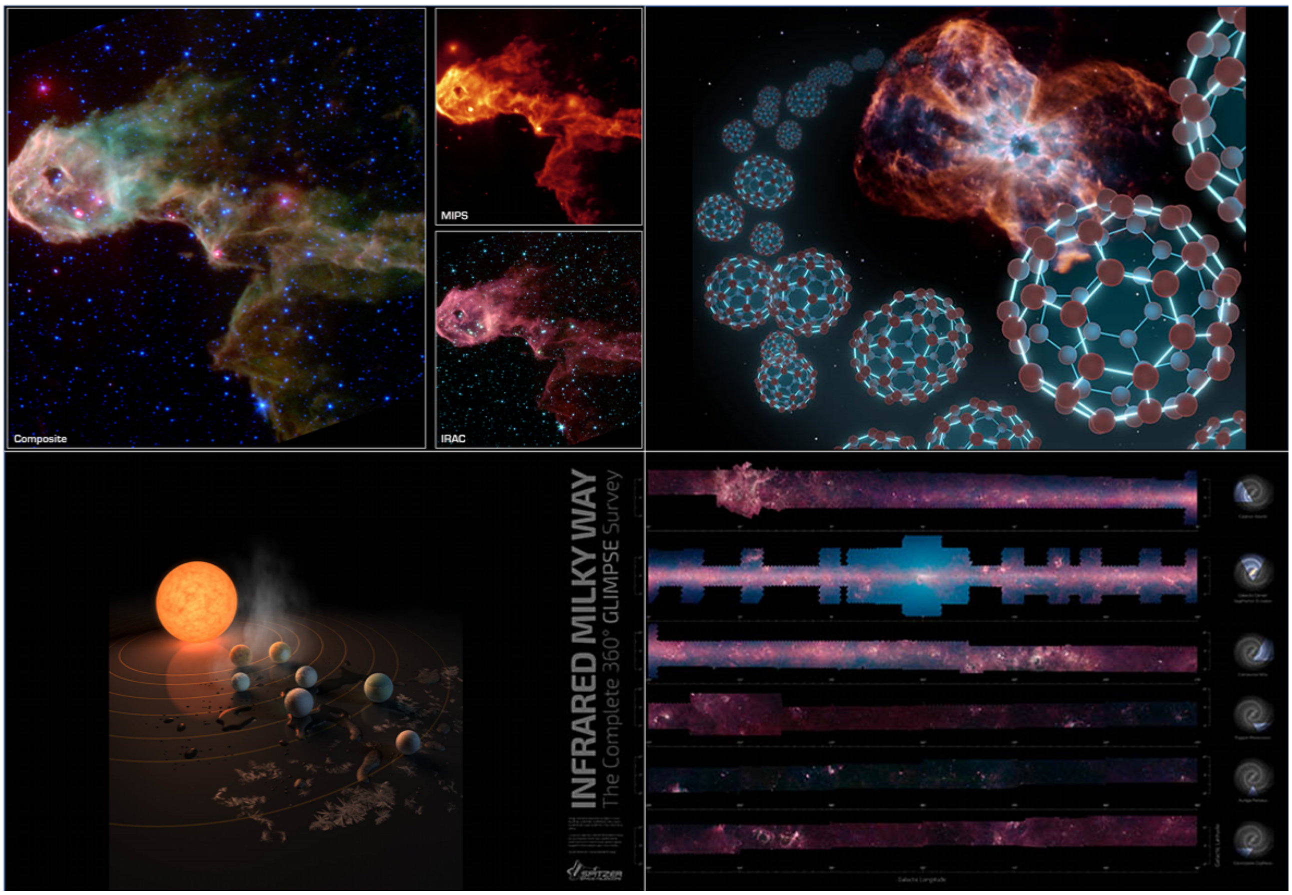

Figure 2: Collage of images of results from successful Spitzer observing campaigns. Starting in the upper left-hand corner and moving clockwise: (1) Image of IC 1396 obtained with the first light of Spitzer in 2003. (2) Depiction of fullerene molecules in space (on top of a planetary nebula image taken by the Hubble Space Telescope). (3) Two million IR images mosaiced together to give a 360-degree image of the Milky Way. (4) Representation of the TRAPPIST-1 galaxy. Credits: NASA/JPL-Caltech/W. Reach (SSC/Caltech).

If you are interested in learning more about Spitzer and its accomplishments, NASA has put together several websites outlining its discoveries. In celebration of the 15^{t}h anniversary of Spitzer, they have, for example, highlighted 15 discoveries that were made with Spitzer.

NASA has also created several fun tools to help ring in Spitzer's birthday. One of them is a virtual reality tour of the TRAPPIST-1 system. This famous planetary system contains 7 Earth sized planets, 3 of which are within the habitable zone of the star. Spitzer assisted in the discovery of 5 of the 7 planets, which involved several observatories. Another fun feature is the Selfie App, which allows you to take a selfie with Spitzer by uploading a picture of yourself in an astronauts suit in front of thirty Spitzer relevant backdrops. Kids of all ages will love this one! Check **Figure 3**.

Figure 3: A selfie with Spitzer.

More information can be found in webpage dedicated to Spitzer 15th Anniversary: www.spitzer.caltech.edu/spitzer15.

PAHs and Fullerenes Research

Spitzer had a major impact on molecular astrophysics and dust mineralogy research. Along with Dr. Lisa Storrie-Lombardi, we interviewed Dr. Jan Cami (University of Western Ontario, Canada), Dr. Jeronimo Bernard-Salas (ACRI-ST, France), Dr. Els Peeters (University of Western Ontario, Canada), Dr. Christiaan Boersma (NASA/Ames, USA), Dr. Eric Lagadec (Observatoire de la Côte d'Azur, France), asking them to describe their research and the impact Spitzer had on it.

Jan Cami told us about the first detection of fullerenes in space, which was made using the Spitzer observation of the planetary nebulae Tc 1 **(Fig. 4)**. Jan led the paper that presented this discovery in *Science*: "My research was primarily focused on molecules and dust around AGB stars, through IR spectroscopy, although I had also done a bit of PAH research when we were fortunate enough to discover fullerenes in space. That resulted in a new research field to which I turned my attention. An identified large aromatic in space is cool in itself, but it has pointed to the importance of top-down photochemistry – something we didn't really consider much before."

Jeronimo Bernard-Salas, who co-authored the Science paper, commented: "The detection of fullerenes has had a major impact in the field of molecular astrochemistry, offering indisputable evidence that large molecules form readily in space. Their formation has important ramifications for understanding carbon chemistry and how complex organics assemble in space. The question remains: do large molecules arise from a bottom-up or top-down chemistry?"

Els Peeters remarks that "The detection of fullerenes in space using Spitzer data presents the culmination of a 25-year search for fullerenes in space."

The detection of fullerenes was chosen as one of the "15 Most Outstanding Spitzer Science Discoveries" (see the other 14 here).

Christiaan Boersma (NASA/Ames, USA) told us about his research, which focuses on the role PAHs play in a multitude of astronomical environments, with special interest for star-forming regions: “This research provides insight into the prevailing physical conditions in these environments and allows for a better understanding of the governing astrophysical processes. The NASA Ames PAH IR Spectroscopic Database plays a key part in my research.” Christiaan explained the impact Spitzer had on PAH research: “With Spitzer, without a doubt, we know that PAHs are ubiquitous in space and are present at every stage of the star- and planet forming process. Even more so, Spitzer’s superb sensitivity has allowed it to detect the emission from PAHs beyond galaxies, in the inter-galactic medium and in the very early Universe.”

Eric Lagadec commented on the Spitzer impact to evolved star studies. “The Spitzer Space Telescope helped us doing a huge leap forward for the study of dust formation around evolved stars at different metallicities. Indeed, thanks to its sensitivity, we were able to obtain spectra of extragalactic evolved stars for the first time and study their dust composition.” Eric also highlighted the study of post-AGB stars in the Magellanic Clouds with Spitzer that revealed a new class of PAH emission (class D).

Els Peeters explained that “One of the major contributions of Spitzer to PAH research are the studies, and their results, of spectral maps of (nearby) extended regions, such as reflection nebulae and star forming regions. These hyperspectral images allow to simultaneously probe the spectral and spatial characteristics of the PAH emission. This, in turn, reveals the photo-chemical evolution of the PAH population in these environments and the relationship of PAHs with other carbonaceous materials such as fullerenes and carbonaceous nanoparticles. While great progress has been made thanks to Spitzer, it only illustrates the tremendous power of hyperspectral imaging and gives us a sneak preview into the JWST era.”

Spitzer technical specifications were key for its many discoveries on PAHs, as pointed out by Jeronimo Bernard-Salas, Els Peeters, and Christiaan Boersma:

“A key feature of Spitzer was its sensitivity, enabling the study of PAHs in many diverse environments. Studies of different sources at low metallicity showed that the PAH family is more varied than we thought. The original PAH classification by Peeters et al. has now been extended, and Spitzer detected more of those ’weird’ class C PAHs, which are proven to be key to understanding how aliphatics and aromatic material are processed and how PAHs form. It is worth pointing that while Spitzer made some landmarks detections of PAHs at high-z, 95% occurred in the Local Universe.”, said **Jeronimo Bernard-Salas**

The impact of Spitzer sensitivity was also mentioned by **Els**: “Due to its sensitivity, Spitzer provided a wealth of observations of PAH emission in galaxies near and far, thus greatly extending the limited number of detections provided by ISO. This allowed PAHs to be investigated in unique conditions barely explored before going from low-metallicity environments to galaxies hosting active galactic nuclei, amongst others. This in turn reveals other aspects and parameters governing the PAH population in space.”

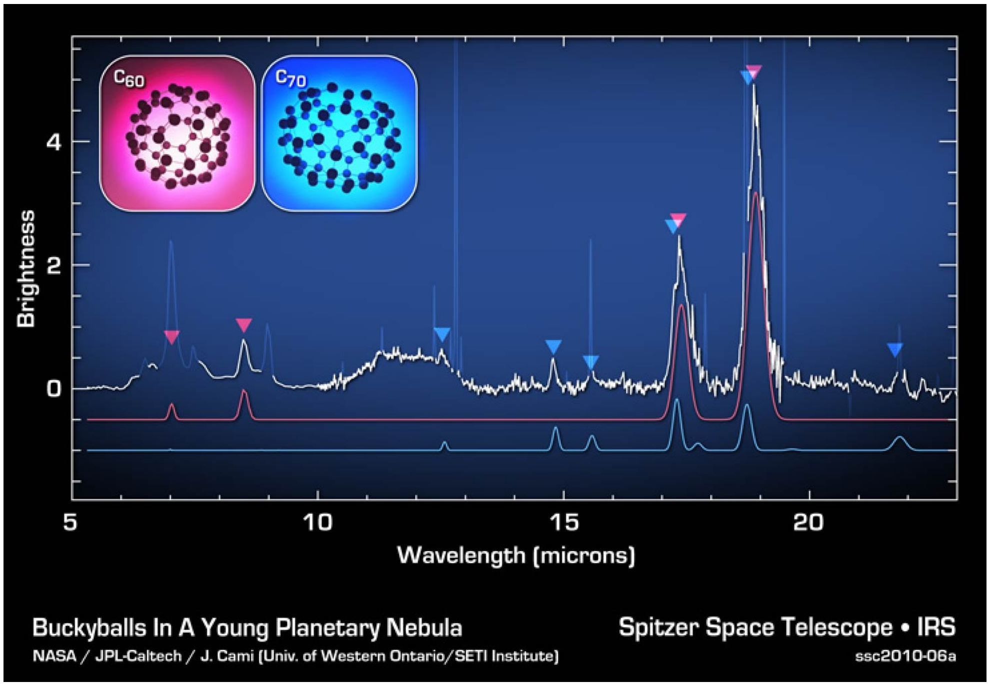

Figure 4: The notorious Spitzer IRS spectrum of the Tc 1 planetary nebula showing the features due to C_{60} and C_{70} molecules. The spectrum appeared in Cami et al. (2010).

Christiaan Boersma commented on the advantages of the Spitzer resolution: "Spitzer's sublime spatial resolution combined with its sensitivity have allowed the detailed (spectral) mapping of many transition regions, e.g., crossing from the molecular cloud through the PDRs into the diffuse media, which offered unprecedented means to connect the varying astrophysical environment with the state of the PAH population. More than ever it has become clear that PAHs in space are not only witnesses of their surroundings, but also active participants in determining the astrophysical environment."

Spitzer Legacy

The work that Spitzer has done will have a lasting impact on the scientific community for decades to come. The Spitzer legacy programs and public databases are largely responsible for that.

"Spitzers Legacy Science Program was the first allocation of time to the general astronomical community. The primary requirement for Spitzer was a 2.5-year cryogenic mission lifetime. The cryogenic mission lasted 5.5 years but the Legacy programs were defined to ensure a powerful scientific Legacy even if the mission lifetime was short. In the first call for proposals, over 3,000 hours was awarded to six programs that each had specific science goals but also provided coherent datasets suitable for other science, hence providing a legacy for the mission. Each team also returned high-level data products from their surveys to the archive. Similar Large programs continued throughout the mission. The results have been far greater than anyone could have imagined. To date, Spitzer has over 8,000 refereed publications. Over half of these publications have utilized data from the Legacy and Large programs. The Legacy programs were unique when implemented for Spitzer but these types of programs are now common for large, community observatories.” - **Lisa Storrie-Lombardi**

“The publicly available databases from Spitzer include the Spitzer Heritage Archive (SHA), data products from large programs, legacy programs, and exploration science programs, CASSIS (Combined Atlas of Sources with Spitzer IRS Spectra) as well as user-contributed data products. These datasets provide raw, processed and enhanced data products. [They] greatly enhance the scientific return of Spitzer as they make the wealth of Spitzer data universally accessible – to the Spitzer user, novice or experienced, – and allow the dataset to be investigated in detail and to be employed as comparison data for observations from other wavelength regimes as well as theoretical models and laboratory experiments now and in the distant future.” - **Els Peeters**

“Following the fullerene discovery paper, fullerenes have been detected in many diverse environments, and all Spitzer fullerene detections to date were made by looking at archival IRS data. This is a testament as to how incredibly rich the database is, and the best part is that there are still many observations to be mined.” - **Jeronimo Bernard-Salas**

“There are still some interesting study to do about the dust composition for AGB stars in the bulge, as well as the study of dust around cepheids. On top of that, the spectra obtained with the IRS will be more than useful to prepare JWST observations. From the cold mission, one could expect more interesting results coming about the detection of AGB stars in the Local Group.” - **Eric Lagadec**

Another part of the Spitzer legacy is the laboratory astrophysics (experiments and theory) progress that were made to meet the needs in interpreting Spitzer’s observations. “Spitzer has shown variations in the PAH emission at fairly small spatial scales. This allows interesting studies to figure out what physical properties drive the PAH emission, and what changes this implies in the underlying PAH population. The enormous progress in laboratory astrophysics in the last 10 years can then be used to connect these variations to molecular properties. And of course, also for PAHs, photo-processing turns out to be important.” points out **Jan Cami**

As we can see, Spitzer has played a crucial role in various aspects of PAH research. From surveys like SAGE, MEGASAGE, SINGS, FEPS, and C2D, we can begin to get a better understanding of the role of PAHs in different environments, as three of our contributors point out.

More information on Spitzer resources can be found at the IRSA Portal (NASA/IPAC Infrared Science Archive). For general information visit the Spitzer website.

Acknowledgments

We thank Lisa Storrie-Lombardi, Jan Cami, Jeronimo Bernard-Salas, Els Peeters, Christiaan Boersma, and Eric Lagadec for their interviews, which tremendously enriched this In Focus article.

Atomic hydrogen interactions with gas-phase coronene cations: hydrogenation versus fragmentation

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Sequential hydrogenation of polycyclic aromatic hydrocarbon (PAH) cations drives a gradual transition from a planar to a puckered geometry and from an aromatic to an aliphatic electronic structure. The resulting H-induced weakening of the molecular structure together with the exothermic nature of the consecutive H-attachment processes can lead to substantial molecular fragmentation. We have studied H attachment to gas-phase coronene cations in a radiofrequency ion trap using tandem mass spectrometry. With increasing hydrogenation, C_2H_i loss and multifragmentation are identified as main de-excitation channels. To understand the dependence of both channels on H-exposure time, we have simulated the molecular stability and fragmentation channels of hydrogenated PAHs using a molecular dynamics approach employing potential energies determined by a density functional based tight binding method. As the coronene fragmentation patterns depend on the balance between energy deposition by H-attachment and the extent of cooling in between subsequent attachment processes, we investigate several scenarios for the energy distribution of hydrogenated PAHs. Good agreement between experiment and simulation is reached, when realistic energy distributions are considered.

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Physical Chemistry Chemical Physics, 20, 35, 22427 (2018)

http://dx.doi.org/10.1039/C8CP03024C

The threshold displacement energy of buckminsterfullerene C_{60} and formation of the endohedral defect fullerene He@C_{59}

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We have measured the threshold center-of-mass kinetic energy for knocking out a single carbon atom from C_{60}^- in collisions with He. Combining this experimental result with classical molecular dynamics simulations, we determine a semi-empirical value of 24.1±0.5 eV for the threshold displacement energy, the energy needed to remove a single carbon atom from the C_{60} cage. We report the first observation of an endohedral complex with an odd number of carbon atoms, He@C_{59}^-, and discuss its formation and decay mechanisms.

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Carbon 139, 906 (2018)

https://doi.org/10.1016/j.carbon.2018.07.073
https://arxiv.org/abs/1804.04374

Solid State Photochemistry of Hydroxylated Naphthalenes on Minerals: Probing Polycyclic Aromatic Hydrocarbon Transformation Pathways under Astrochemically-Relevant Conditions

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Oxygenated derivatives of polycyclic aromatic hydrocarbons (PAHs), or oxyPAHs, recently captured the interest of the scientific community for their photochemical reactivity in a water-ice matrix mimicking the interstellar medium. Furthermore, oxyPAHs are interesting molecules for the study of the origin of life for their prebiotic potential. However, their stability and transformation pathways under astrophysically relevant conditions have remained largely

unexplored. Herein we report the photochemical behavior of 1-naphthol (1-HN) and 1,6- and 1,8-dihydroxy-naphthalene (DHN) either as pure powdered solids or adsorbed on forsterite or anatase surface. All the compounds showed an extensive decrease of main vibrational bands, accompanied in the case of DHNs by the formation of new molecular species. Irradiation of 1,8-DHN at 80 K resulted in the IR-detectable generation of CO_2 (2340 cm^{-1}), a process reported by other authors following irradiation of PAHs in water-ice analogues at 14 K. These results, when compared to model autoxidation experiments, indicated a high susceptibility of hydroxylated naphthalene derivatives to UV radiation leading to free radical and carbonyl-containing extended quinone intermediates (preliminary DFT calculations) with partial degradation and decarboxylation. On the basis of these results, oxyPAH formation and photoprocessing on minerals is proposed as a plausible pathway of PAHs transformation under astrochemical conditions of prebiotic relevance.

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ACS Earth Space Chem., Article ASAP

https://pubs.acs.org/doi/abs/10.1021/acsearthspacechem.8b00060

Infrared Spectrum of Protonated Corannulene $H^+C_{20}H_{10}$ in Solid para-Hydrogen and its Potential Contribution to Interstellar Unidentified Infrared Bands

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Polycyclic aromatic hydrocarbons (PAH) and their derivatives, including protonated and cationic species, are suspected to be carriers of the unidentified infrared (UIR) emission bands observed from the galactic and extragalactic sources. We extended our investigations of infrared (IR) spectra of protonated planar PAH to a nonplanar PAH, corannulene ($C_{20}H_{10}$), which is regarded as a fragment of a fullerene, C_{60}. The protonated corannulene $H^+C_{20}H_{10}$ was produced on bombarding a mixture of corannulene and para-hydrogen (p-H_2) with electrons during deposition at 3.2 K. During maintenance of the electron-bombarded matrix in darkness the intensities of IR lines of protonated corannulene decreased because of neutralization by electrons that was slowly released from the trapped sites. The observed lines were classified into two groups according to their responses to secondary irradiation at 365 nm. Eighteen lines in one group are assigned to the lowest-energy species among five possible isomers, hub-$H^+C_{20}H_{10}$, and seventeen in another group to rim-$H^+C_{20}H_{10}$, the species of second lowest energy. Spectral assignments were derived based on a comparison

of the observed spectra with those predicted with the B3PW91/6-311++G(2d,2p) method. The observed IR spectrum of hub-$H^+C_{20}H_{10}$ resembles several bands of the Class-A UIR bands.

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ACS Earth Space Chem., Article ASAP

https://pubs.acs.org/doi/pdf/10.1021/acsearthspacechem.8b00089

Catalytic conversion of methanol to larger organic molecules over crystalline forsterite: laboratory study and astrophysical implications

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Laboratory catalytic reactions of methanol over heated crystalline silicates (forsterite) lead to the formation of gas-phase olefinic and polycyclic aromatic hydrocarbon (PAH) molecules, and are of potential importance in astrophysical environments including hot molecular cores, protoplanetary disks and shocks. In our experiments the methanol reagent, together with intermediate and product gas-phase molecular species were detected using time-of-flight mass-spectrometry (TOF-MS). A solid deposited on the crystalline forsterite surface was examined subsequently using high-resolution transmission electron microscopy and thermal gravimetric techniques and found to comprise amorphous and graphitic carbon. The chemical players in this work - gas-phase methanol, crystalline silicates and PAHs, have been identified spectroscopically in a range of astrophysical environments including young and evolved stars, protoplanetary disks, comets, captured dust particles and meteorites. It is envisaged that reactions on bare dust grains as studied here both experimentally and theoretically through DFT calculations, can have implications for chemical transformations and conversions, in forming PAH molecules and potentially in the synthesis of prebiotic molecules.

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Accepted for publication in Molecular Astrophysics

https://www.sciencedirect.com/science/article/pii/S2405675818300216

Meetings

Celebrating 40 Years of Alexander Tielens' Contribution to Science:
The Physics and Chemistry of the ISM

Centre International de Congres du Palais des Papes, Avignon, France
September 2 - 6, 2019

Dear colleagues,

We are happy to announce the conference:

CELEBRATING 40 YEARS OF ALEXANDER TIELENS' CONTRIBUTION TO SCIENCE:
THE PHYSICS AND CHEMISTRY OF THE ISM

to be held September 2 - 6, 2019 in Avignon, France.

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. With this meeting, we wish to celebrate his scientific achievements and discuss future research directions opened up by his contributions.

The meeting will focus on the fields strongly influenced by Xander involving the physical and chemical processes that control the interstellar medium and its life cycle: PDRs, interstellar and circumstellar dust, PAHs, ices and astrochemistry. We will especially emphasize future opportunities offered by the powerful telescopes at our disposal such as, for example, ALMA, SOFIA, and JWST.

The meeting will consist of invited reviews, invited and contributed talks, and posters. The second announcement will be made in December 2018.

Date: September 2 - 6, 2019

Location: Centre International de Congres du Palais des Papes, Avignon, France (http://www.avignon-congres.com/)

Scientific Organizing Committee:
Cecilia Ceccarelli (chair)
Alessandra Candian (co-chair)
Jan Cami
Carsten Dominik
Liv Hornekaer
Kay Justtanont
Els Peeters
Mark Wolfire

Local Organizing Committee:
Bertrand Lefloch (chair)

Announcements

PhD Position in Astrochemistry, Star and Planet Formation at CSH – Universität Bern

Full-time, 4 years
47 000 50 000 CHF per year (Brutto, as set by the SNSF)
Full package of social benefits included

Starting date: between **November 1st, 2018** and **April 30th, 2019**

The Center for Space and Habitability (CSH) is a multi-disciplinary center for scientists working on the formation, detection and characterization of other worlds, the definition of life and our search for it elsewhere in the Universe. It is home to astronomers, atmospheric, climate and planetary researchers, geologists and geophysicists, biologists, chemists and philosophers.

Under the guidance of Dr. Maria Drozdovskaya, a **PhD research project is available**, which aims to understand the chemical processes that link the different stages of star and planet formation, and that determine the composition of forming cometary and planetary embryos. The insights gained during this project will enhance our understanding of the early history of our Solar System. The work is funded by a Swiss National Science Foundation (SNSF) Ambizione grant (PI: Drozdovskaya) entitled "The Planetary Cookbook: Chemical Composition of Volatiles and Refractories from Star-Forming Regions to Comets and Planetesimals".

Primary features of the project include:

- theoretical physicochemical modelling work,
- possibility of working with observational data from, e.g., ALMA, JWST,
- active participation in the scientific life of the CSH,
- exposure to the largest group of planetary scientists in the world via associate membership in the NCCR PlanetS (http://nccr-planets.ch/),
- sufficient funds for participation in national and international conferences, and collaborator visits.

Must-haves of candidates are a Master-level degree (or analog) in quantitative science or engineering (e.g., astronomy, physics, chemistry, mathematics, computer science or a related field) by the starting date; and competence in spoken and written English.

Nice-to-haves of candidates are programming experience, and exposure to at least basic astronomy. However, applications from students in other fields of quantitative science or engineering that are interested in learning astronomy are very welcomed.

Work-life balance is important; and the Canton of Bern offers 5 weeks of vacation per year (excluding national and cantonal holidays). The CSH is dedicated to equal opportunities, geographical and gender balance, and inclusivity.

How to apply

Applicants should send all application materials in **one PDF file** to:

maria.drozdovskaya@csh.unibe.ch

by the deadline of **November 1st, 2018**. Note that applications are considered on a **rolling basis**,implying that the position may be filled earlier or that late applications may also receive partial consideration. A complete application consists of:

- cover letter (max. 1 page),
- curriculum vitae (CV),
- personal statement detailing, but not limited to: past research experience and the skills obtained; reasons for pursuing a 4-year PhD in general and this research project in specific; aspirations for the future (max. 2 pages),
- full list and transcripts (grades) of all university-level courses (Bachelor- and Master-level) and a translated version, if not in English, German, French, Russian or Dutch (notarized translation is not needed),
- up-to-date contact information of two references that may be contacted for a reference letter.

Contact: Dr. Maria N. Drozdovskaya
Center for Space and Habitability (CSH)
Universität Bern
Gesellschaftsstrasse 6 (G6),
3012 Bern, Switzerland
http://www.csh.unibe.ch/index_eng.html
E-mail: maria.drozdovskaya@csh.unibe.ch
Telephone: +41 31 631 34 43

Postdoc Position at the University of Hawai'i

Advertised by Prof. Ralf I. Kaiser

The Reaction Dynamics Group, Department of Chemistry, University of Hawai'i at Manoa, invites applications for postdoctoral positions in the areas of i) gas phase reaction dynamics and combustion chemistry, ii) condensed phase chemistry (astrochemistry), and iii) planetary sciences (water formation on the Moon). The prime directive of the experimental gas phase studies is to investigate the formation of polycyclic aromatic hydrocarbons (PAHs) in extreme environments (combustion systems; deep space) exploiting crossed molecular beams along with mass spectrometry (QMS; ReTOF) and ion imaging (Hawaii) and a pyrolytic micro reactor (Advanced Light Source, Lawrence Berkeley Laboratory). The condensed phase (ice) studies aim to untangle the formation of complex organic molecules on interstellar nanoparticles by ionizing radiation exploiting fragment free photoionization techniques. The planetary science project seeks to elucidate the formation of water on the lunar surface. For each position, the appointment period is initially for one year, but can be renewed annually based on availability of funds and satisfactory progress. The salary is competitive and commensurate with experience. Successful applicants should have a strong background in one or more of the following: experimental reaction dynamics, molecular beams, combustion chemistry, UHV technology, pulsed laser systems, low temperature chemistry. Solid communication skills in English (written, oral), a publication record in internationally circulated, peer-reviewed journals, and willingness to work in a team are mandatory. Only self-motivated and energetic candidates are encouraged to apply.

Please send a letter of interest, three letters of recommendation, CV, and publication list to Prof. Ralf I. Kaiser, Department of Chemistry, University of Hawai'i at Manoa, Honolulu, HI 96822-2275, USA [ralfk@hawaii.edu].

The review of applications will start October 1, 2018 and continues until the positions are filled. A description of our current research group can be found at http://www.chem.hawaii.edu/Bil301new/index.html

AstroPAH Newsletter

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

Next issue: 18 October 2017
Submission deadline: 5 October 2017