

Kai'aleleiaika THE MILKY WAY

Wally Pacholka / AstroPics.com

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Welcome to IAU General Assembly XXIX in Honolulu!

By NORIO KAIFU

It is my great pleasure to welcome IAU members and guests to the General Assembly XXIX in Honolulu, Hawai'i.

Hawai'i is a special cultural and economic center of the Pacific region, and it is one of the most active frontiers of astronomical observations in the world because of its unique geological, meteorological, and geographical features. This is a special occasion for the IAU, to hold the General Assembly in Hawai'i for the first time in its nearly 100-year history.

The Honolulu GA will also be historic because the IAU is completing the reform of its scientific organizational structure by total reconstruction of its Commissions. All [new Commissions](#), which were approved by Executive Committee action in April, were organized through electronic voting in June and July, and they will begin activities for the coming triennium after Honolulu under a fresh, inclusive mandate. Through this reform the role of the [nine Divisions](#) becomes more central to IAU activity, and the Commissions will be flexible in responding to the rapid evolution of astronomy in the 21st century.

The meetings of the Honolulu GA are also organized under a new structure. [Six IAU Symposia](#) covering wide and attractive fields are being held, as usual. However, instead of the previous Joint Discussions and Special Sessions we now support [22 Focus Meetings](#) of 2–3 days duration, in addition to Division Meetings organized by each Division. These changes are an inevitable and beneficial evolution for the IAU as a rapidly growing international union of scientists. Still, we need to observe activities under the new structure carefully, identify any problems



that occur, and find better ways for the IAU of the future.

Throughout its long history astronomy has always been new and exciting. Now in the 21st century we are constructing 30-meter-class telescopes and working on the intercontinental Square Kilometre Array radio observatory. We are discussing how to prove the inflation hypothesis at the beginning of the expansion of the universe, how to reveal the nature of dark energy, and how we can detect evidence for life on other planets, including those in other planetary systems. The IAU remains youthful, with a continuously incoming generation of young members; in Honolulu more than 1,200 new individual members — many of whom are recent PhD's — will be added, which will increase our number of [individual members](#) by more than 10%!

The IAU is also broadening its connection with other communities in the world through education, the promotion of scientific knowledge, and contact with the general public. We are proud that the IAU is among the leading international scientific unions in such activities. The [Office of Astronomy for Development \(OAD\)](#) and the [Office for Astronomy Outreach \(OAO\)](#) have been actively developing cooperation with schoolteachers, students and children,

Kai'aleleiaika 🌌 THE MILKY WAY

EDITORIAL

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Kai'aleleiaika (The Milky Way) is the official newspaper of the XXIX General Assembly of the International Astronomical Union, 3-14 August 2015, Honolulu, Hawai'i. It is published for the IAU by the American Astronomical Society, which thanks the following organizations for providing staff to work on the newspaper: Astronomical Society of the Pacific, Stratospheric Observatory for Infrared Astronomy, and Universe Awareness at Leiden University. © 2015 AAS, all rights reserved.

amateur astronomers, and the general public worldwide. With the increasing scope of astronomy we acknowledge that occasional conflicts between our growing scientific activities and the interests of the public may occur. Here in Hawai'i we hear voices that criticize the development of telescopes atop Maunakea and Haleakalā, and in fact such criticism is not new for astronomers. The history of astronomy and its profoundly positive impact on civilization makes us 100% certain that astronomical observations and research will continue to open a vast new world for humankind, give us a better perspective to understand our world, and provide excitement and dreams to children in the world. In paral-

lel, we truly wish to respect all cultures, to remain entirely open in our activity, and to live with all nations and cultures together.

We anticipate that the IAU General Assembly XXIX in Honolulu will be one of the most active and memorable such meetings in the history of the IAU. I wish all of us an exciting, fruitful, and joyful time during the GA.

Welcome to the GA! Welcome to Honolulu! 🌸

NORIO KAIFU is Director of the National Astronomical Observatory of Japan and will complete his three-year term as IAU President at the second Business Meeting of the General Assembly on 13 August.

A Special Message from the Governor of Hawai'i

By DAVID Y. IGE

Aloha! On behalf of the people of the State of Hawai'i, I send my warmest greetings to all members of the International Astronomical Union (IAU) attending the 2015 IAU General Assembly.

Since 1919 the IAU has been the international authority for assigning designations to celestial bodies and the surface features on them. Representing the vast majority of professional astronomers, its mission is to promote and safeguard the science of astronomy through international cooperation.

I am pleased that the IAU has chosen to hold this year's assembly in Hawai'i, where interest in astronomy is deeply entrenched in our island heritage. The heavens played a central role in ancient Hawaiian culture, and early Polynesians relied on their knowledge of the stars to successfully navigate thousands of miles across the open ocean. Today, Hawai'i continues to be at the forefront of astronomical studies through the observatories



at Maunakea on the island of Hawai'i and Haleakalā on Maui.

This triennial assembly promises to be an exciting and informative event, featuring more than 3,000 professional astronomers, and offering Symposia and Focus Meetings that cover a broad range of astronomical topics.

Mahalo [thank you] to the IAU, American Astronomical Society, University of Hawai'i at Mānoa Institute for Astronomy, and many event organizers for contributing to this worthy event. Please accept my best wishes for an enjoyable and successful meeting. 🌸

Governor DAVID IGE was sworn in on 1 December 2014, becoming the fourth native-born Governor of Hawai'i and the first Governor in the United States of Okinawan descent. He holds a Bachelor of Science in electrical engineering and a Master of Business Administration in decision sciences.



How to Say It in Hawaiian

Hawaiians are proud of their language and culture and tend to appreciate visitors who express interest in learning about them. So why not try to speak a little Hawaiian while you're here? If you say it with a smile in the spirit of aloha, you'll do fine.

This brief guide, and the ones to follow over the next two weeks, are adapted from the website [Hawaiian Words](#), where you can not only find many more words and phrases than we can introduce here, but also hear them pronounced by native speakers.

The Hawaiian alphabet includes five vowels (a, e, i, o, and u) and seven consonants (h, k, l, m, n, p, and w). A consonant is always followed by a vowel, so all Hawaiian words end in a vowel.

Names and words are easier to pronounce when you break them down into one-syllable chunks. Sometimes the letter w is pronounced the same as v, as in the traditional pronunciation of "Hawai'i," which is phonetically pronounced "huh-VAI-ee" rather than "huh-WHY-ee." Both versions are considered acceptable.

Vowels are generally pronounced as follows: a "ah," e "eh," i "ee," o "oh," u "oo." If a vowel has a little horizontal line over it (a macron or, in Hawaiian, a kahakō), it means you hold the sound an extra beat. A 6-shaped apostrophe, or 'okina, signals a [glottal stop](#). This will all make a lot more sense if you go to [Hawaiian Words](#) and play some of the audio files!

We'll dispense with these preliminaries in future installments. To keep this from getting too long, let's just look at three words you've been hearing a lot — and perhaps using a lot — since you arrived in Honolulu:

- Hawai'i: from "ha" (breath), "wai" (water), and "i," (life), i.e., "the breath and water of life."
- Aloha: love, affection, hello, goodbye
- Mahalo: thank you

— Rick Fienberg, Kai'aleleika



Proclamation

WHEREAS, the International Astronomical Union (IAU), founded in 1919, represents more than 10,000 of the world's astronomers; and

WHEREAS, the IAU promotes and safeguards the science of astronomy in all its aspects through international cooperation and is the internationally recognized authority for assigning designations to celestial bodies such as planets and moons; and

WHEREAS, the IAU General Assembly, which is conducted every three years, offers symposia, joint discussions and special sessions; and individual business and scientific meetings of divisions, commissions, and working groups; and

WHEREAS, the 2015 General Assembly, being held for the first time in Hawaii from August 3 through 14 at the Hawaii Convention Center in Honolulu, will recognize our islands' distinct importance to the science of astronomy; and

WHEREAS, this year's General Assembly is expected to be the largest in the history of the organization, with more than 3,000 attendees including nearly a third of the world's astronomers gathering to exchange knowledge and important advancements; and

WHEREAS, student outreach, stargazing, and other public events will be presented by members of the astronomy community,

NOW, THEREFORE, I, KIRK CALDWELL, Mayor of the City and County of Honolulu, do hereby proclaim August 3, 2015, to be

INTERNATIONAL ASTRONOMICAL UNION GENERAL ASSEMBLY DAY

in recognition of the IAU for its significant contributions to furthering our understanding of the universe and our world through scientific research and discoveries in astronomy.

Done this 3rd day of August, 2015,
in Honolulu, Hawaii.

KIRK CALDWELL



Inspiration, Appreciation, and Celebration

By LYNNE HILLENBRAND

Welcome to yet another inspiring location for an IAU General Assembly! Hawai'i is a stunning natural environment, with significant diversity among the islands. Its residents boast a rich astronomical heritage — beginning with the Polynesian explorers who navigated the Pacific and arrived here more than a millennium ago, and continuing to today by hosting many of the frontier telescopes on the planet.



The American Astronomical Society (AAS) and an extraordinary inter-island Local Organizing Committee have organized a wonderful two weeks for us. In these pages you will see welcomes

from the [President of the IAU](#), the [President](#) and the [Executive Officer](#) of the AAS, and officials representing the [State of Hawai'i](#) and [City of Honolulu](#). I would like to add my own as Chair of the [U.S. National Committee for the IAU \(USNC-IAU\)](#).

In thinking back over my own history with the IAU (which I realize is limited compared to many of you who have much longer histories in the field), I have now attended General Assemblies in Sydney, Prague, Rio de Janeiro, Beijing, and Honolulu — locations spanning a good fraction of the globe.

Besides being afforded the opportunity through astronomy to explore these cities and the local cultural offerings of each host country, I have also come to appreciate through talking with par-

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ticipants at IAU meetings how astronomy is carried out in different countries around the world.

Among us we have a diverse set of scientific interests, past educational opportunities, current types of jobs, and available resources for conducting our pursuits in astronomical research and education. And we are all here together in this beautiful environment to witness and appreciate Hawaiian culture, and to cele-

brate recent scientific progress and future scientific opportunities.

Let's get started! 🌸

USNC-IAU Chair LYNNE HILLENBRAND is a professor of astronomy at the California Institute of Technology, where she studies star- and planet-formation. She has served on a wide variety of advisory committees, science steering committees, and organizational boards.

Schedule for the Opening Ceremony of the General Assembly

4:00 to 6:00 pm, Ballroom B, Hawai'i Convention Center

Master of Ceremonies: Günther Hasinger, Director, Institute for Astronomy, University of Hawai'i

Oli Chant and Blessing

D. Akaka Jr.

Opening Address

Norio Kaifu, IAU President

Welcome Addresses

Megan Urry, AAS President

David Ige, Governor of Hawai'i

Kirk Caldwell, Mayor of Honolulu

David Lassner, University of Hawaii President

France Córdova, NSF Director

Gruber Foundation Presentations

Thierry Montmerle, IAU General Secretary

- Introduction of the 2015 Gruber Science Fellow in Astronomy

- Award of the 2015 Gruber Cosmology Prize

IAU-NASL Office for Young Astronomers

Oddbjørn Engvold, former IAU General Secretary

Astronomy Talk: East Asia Observatory

Local Organizing Committee Event

- Keiki Hula

- Hanauna Hou

Hawaiian astronomers Paul Coleman, Ka'iu Kimura & Kālepa Baybayan

This Could Be the Start of Something Big

By C. MEGAN URRY

As a young astronomer, still in graduate school, I went to the 1982 IAU General Assembly in Patras, Greece. The colleagues I met at that meeting and its associated Symposia became some of my most important scientific collaborators.

Working with scientists from all over the world to answer profound questions about the universe has made astronomy an incredibly rewarding profession for me. The most difficult experi-



ments, carried out with collaborators from the most countries, have proven to be the most fun. We continually challenge each other to improve upon incomplete or overly simple answers.

As the XXIX IAU General Assembly convenes in Hawai'i — a location that could not be more important to astronomers, nor more beautiful — I extend my welcome to all attendees and my best wishes that you — especially the youngest of you — will find new colleagues and friends with whom you will explore the universe in the future. 🌸

MEG URRY is President of the American Astronomical Society. She works at Yale University in New Haven, Connecticut, where she is the Israel Munson Professor of Physics and Astronomy and Director of the Yale Center for Astronomy & Astrophysics.

The Organization of the General Assembly

The largest gathering of the world's professional astronomers doesn't happen by itself.

By KEVIN B. MARVEL

Aloha, and *thank you* for coming to the XXIX General Assembly of the International Astronomical Union!

It has been a challenge and a pleasure to oversee the organization for this important conference. Without attendees there could be no meeting, of course, but without the efforts of many people handling the innumerable organizational aspects, there could be no meeting either.

The [American Astronomical Society \(AAS\)](#), in partnership with the [Institute for Astronomy \(IfA\)](#) of the University of Hawai'i and the [US National Committee of the IAU](#), presented a bid to the IAU Executive Committee in 2009 to host this General Assembly and was pleased to have our bid selected. The last General Assembly

hosted by the United States was 27 years ago in Baltimore, Maryland, so it's been a long time, and we are thrilled to once again host the conference. With the IAU Executive Committee's acceptance of our proposal came the immediate need to start organizing, and we did so, securing the venue, hotels, and, over time, all the other contractors to make the meeting come to fruition.

Conference infrastructure is something that is often invisible to attendees. Something as simple as the [meeting program](#) in its various printed and electronic formats represents the input and work of many, many people. The IAU leadership had to receive and consider proposals for Focus Meetings, the Symposia organizers had to secure speakers, participants had to submit

abstracts, those abstracts had to be arranged and organized into sessions, errors and typos had to be caught and corrected, and the abstracts and associated metadata had to be converted to suitable formats and ultimately published. From the attendee's — that is, your — perspective, it's just a list of what is going on and the text of presentation abstracts, but it represents many thousands of hours of effort from tens of people. This is just one example of many. Similar levels of effort are needed to arrange for the Exhibit Hall, sponsorships, public-outreach events, security, Wi-Fi, food and beverage, Splinter Meetings, registration details, lodging, tours and special events, and more. It is a *lot* of work!

However, everyone involved has been driven by one overarching goal: to ensure the best possible General Assembly, one that maximizes the positive impact on our shared discipline of astronomy and that fosters scientific collaboration and communication at the highest possible level.

I am confident that we have achieved this goal, and I will be spending most of my time at the conference thanking the innumerable people who helped organize it — at the AAS, the IAU,

the IfA, and elsewhere. I hope you will join me in expressing your thanks to those who helped make the conference possible as well.

Most importantly, I thank *you*, the attendees, who have traveled a great distance, to a remote and special place, to share your time, knowledge, and interest to help move human knowledge forward.

Please have a wonderful and productive time at the meeting and rely on our on-site staff to help with any challenges you might have. 🌸



[AAS photo © 2014 Jason Images]

Next year KEVIN MARVEL will celebrate his 10th anniversary as Executive Officer of the AAS in Washington, DC. Before he began working at the AAS in 1998 he studied at the University of Arizona and New Mexico State University and did research in stellar radio astronomy.

ABOUT THE DAILY NEWSPAPER

Why *Kai'aleiaka*? Why Digital?

By RICK FIENBERG, Editor in Chief

For more than a half century, beginning with the X General Assembly (GA) in Moscow in 1958, each triennial gathering of the IAU has featured a [daily newspaper](#) produced by astronomers and science writers appointed by the host organization. With previews by plenary speakers and session chairs, program updates and travel tips from local organizers, and news reports from each day's meetings and other activities, the GA newspaper is an important source of must-have information for attendees.

Traditionally the GA newspaper has been prepared each day, printed overnight, and distributed each morning. In Honolulu

we are breaking with this tradition and starting a new one: The newspaper is being produced and distributed 100% digitally for viewing on attendees' laptops, tablets, and smartphones — though it is formatted for printing on U.S. standard 8½-by-11-inch paper for the convenience of those who prefer having their newspaper on actual paper.

Newspaper files are PDFs suitable for viewing in [Adobe Acrobat Reader](#) or any other PDF-compatible application. We chose PDF as our file format because PDFs can be read on machines of all types running all popular operating systems,

including Mac OS, iOS, Windows, Android, and Unix. Each daily edition will be available for downloading early each morning or perhaps late the preceding evening.

Note that even if we had wanted to print the newspaper in the traditional way, we would not have been able to do so, as no commercial printer on the island of O‘ahu has enough press capacity to print another daily paper in addition to their regularly scheduled publications.

The XXIX GA newspaper is called *Kai‘aleleiaka* (“kah-EE ah lay-lay-ee AH-kah”), which means “the Milky Way” in Hawaiian. As seen from Hawai‘i in August, the galactic center stands high in the south during prime evening skygazing hours, and later at night you can trace the Milky Way from the southern horizon, through the zenith, to the northern horizon — though not necessarily from brightly lit Honolulu!

There are other ways to say “the Milky Way” in Hawaiian, but *Kai‘aleleiaka* is especially well suited for our astronomical purpose, since it is a term commonly used by Polynesian voyagers who navigated the Pacific Ocean by the stars. The literal translation of *Kai‘aleleiaka* is “the fish jumping [or flopping] in shadows,”

BEHIND THE BYLINES

Meet the Staff of *Kai‘aleleiaka*

By RICK FIENBERG, Editor in Chief

Kevin Marvel, the American Astronomical Society’s Executive Officer, didn’t have far to look to find someone to manage the preparation and production of the XXIX General Assembly’s daily newspaper. Before I joined the AAS staff as Press Officer, I spent 22 years at [Sky & Telescope](#) magazine, including 9 as Publisher and 8 as Editor in Chief. So I was thrilled when Kevin asked me to lead the newspaper team in Honolulu.

One reason I was excited to accept this responsibility was the opportunity that came with it, namely, to hand pick my



Both 10-meter telescopes of the W. M. Keck Observatory use their adaptive-optics lasers to study the supermassive black hole at the center of the Milky Way galaxy. [Sean Goebel / [sgphotos.com](#)]

an apt description of the dark-cloud-studded band of starlight rising in the east, culminating high overhead, and descending in the west. ❁

staff of writers, editors, and designers. I think I’ve assembled a supremely capable team, and once I’ve introduced them to you, I’m sure you’ll agree.

Ink-Stained Wretches

Every newspaper needs a managing editor to “keep the trains running on time,” and in that role is **Sarah Reed**, Press Officer at the University of Leeds, UK. She has held a [variety of positions](#) in science journalism and communication. Most rel-

evant here, Sarah was the first Coordinator at the IAU Office for Astronomy Outreach in Tokyo and did a stint as Editor in Chief of [CAPjournal](#), published under the auspices of (old) IAU Commission 55 (new number: C2), Communicating Astronomy with the Public. She also has IAU GA newspaper experience, having worked on *Inquiries of Heaven* at the XXVIII GA in Beijing, China, in 2012.

Our half dozen staff writers/editors will do a bit of everything: report and write stories about sessions, events, and activities; edit material submitted by meeting organizers, presenters, and other attendees; and even shoot some pictures. In alphabetical order we begin with **Gina Brissenden**, Associate Director of the [Center for Astronomy Education](#) at the University of Arizona in Tucson; she is also the AAS's Education and Outreach Coordinator. Gina regularly conducts astronomy-education workshops — she'll present three of them here in Honolulu — and is co-editor of *Spark*, the AAS education newsletter.

Pamela Gay is an astronomer, writer, and podcaster who uses new media to engage people in learning and doing science. Formerly an editor at *Astronomy* magazine and now on the faculty of Southern Illinois University Edwardsville, she co-hosts the popular [Astronomy Cast](#) podcast, directs the [CosmoQuest](#) citizen-science hub, and seems to be everywhere at once on social media.

Inge Heyer collected a spectacular assortment of aloha shirts during her five years as Public Information Officer at the Joint Astronomy Centre in Hilo. Since then she has earned her PhD in science education at the University of Wyoming; she now teaches at Loyola University Maryland. For more than a decade Inge, who originally hails from Berlin, Germany, has managed the newsroom at AAS meetings as volunteer Deputy Press Officer. An avid *Star Trek* fan, she blogs about astronomy for science-fiction enthusiasts at [StarTrek.com](#).

Susanna Kohler recently joined the AAS staff as Editor of [AAS Nova](#), a new online publication about which you'll hear more during the course of the GA. She has done outreach in astronomy

and physics for more than a decade. While working toward her PhD at the University of Colorado, Boulder, she wrote for [astro-bites.com](#), where she is now an administrator. Susanna is also a founding organizer of [ComSciCon](#), a science-communication workshop series for graduate students.

Larry Marschall is Professor of Physics, Emeritus, at Gettysburg College, Pennsylvania. He is an accomplished (and [award-winning](#)) educator, researcher, science writer — and bluegrass musician! Larry has written three books, many articles, and countless columns for *Natural History* and *The Sciences*. He is Newsletter Editor of IAU Commission 46, Astronomy Education and Development, and was Editor of *CCD Astronomy* magazine. He has volunteered as AAS Deputy Press Officer even longer than Inge — for more than 20 years.

Iris Nijman studied biomedical sciences at Leiden University in the Netherlands, where she also works in the [Universe Awareness](#)

How to Contribute to the Conference Newspaper



Kai'aleleika welcomes news, reviews, and opinions from attendees. Articles should be 300 to 500 words. Please also supply a relevant photo or illustration with a brief caption, as well as a photo and brief bio of you, the author. In case of multiple authors (no more than three, please), we'll need photos and bios of all of you.

We prefer receiving a Microsoft Word document, but a plain text file or even an email message will suffice. Graphics should be in TIFF, JPG, or PNG format; author photos can be 250 pixels wide by 300 pixels tall, but larger photos or illustrations should be at least 800 pixels wide and tall.

Please email your materials to newspaper@astronomy2015.org or bring them to our office, Room 302, in the Hawai'i Convention Center, Monday through Friday, 8 am to 6 pm. Note that if you want an article to appear on a particular day, you need to get it into our hands a day or two earlier.

We reserve the right to reject contributed materials for any reason and to edit all contributions for length, style, and clarity.

Rick Fienberg, Editor in Chief

([UNAWE](#)) outreach program. Having discovered that she very much enjoys writing about science for the general public, Iris specializes in science communication and has written numerous articles for the science page of her local Dutch newspaper.

Designing Women

One of the things I liked most about working at *Sky & Telescope*, where all the editors were amateur or professional astronomers, was interacting with our colleagues in art and design. These are the folks who help turn words into stories through the creative use of typography, layout, images, and illustrations. For this first-ever all-digital GA newspaper, I'm fortunate to have found two designers with vast experience in astronomy communication and digital production.

Design Director **Leslie Proudfit** is Media Specialist for Education & Public Outreach at NASA's [Stratospheric Observatory for Infrared Astronomy \(SOFIA\)](#), where she creates exhibits, flyers, brochures, and other materials for scientists, teachers, students, and the public. Leslie also maintains the SOFIA Science Center's website and serves as Senior Designer and Webmaster for the [Astronomical Society of the Pacific \(ASP\)](#), which promotes science literacy through astronomy.

Crystal Tinch is Communications Manager at the AAS and, having worked there for more than 13 years, knows more about Society operations than almost anyone else on the staff. She produces most of our print and online publications, including the popular [AAS Wall Calendar](#) and our biweekly e-newsletter for members. Crystal also manages many of the AAS social-media accounts.

That's a lot of talent and experience! Oh, I almost forgot to mention that Larry and I are also veterans of a previous GA newspaper: *IAU Today* in Baltimore, Maryland, in 1988. I doubt either of us will be available to do it a third time when the U.S. next hosts a GA, so we're going to savor our two weeks in Honolulu and will, along with the rest of the *Kai'aleleiaka team*, do everything we can to help make your GA experience a great one! 🌸



The *Kai'aleleiaka* team (sitting, left to right): [Leslie Proudfit](#), [Crystal Tinch](#), [Rick Fienberg](#), and [Inge Heyer](#); (standing, left to right): [Iris Nijman](#), [Larry Marschall](#), [Gina Brissenden](#), [Susanna Kohler](#), [Pamela Gay](#), and [Sarah Reed](#). [AAS]

Honolulu Almanac 🌙 3 August 2015

Sunrise / set	6:06 am / 7:09 pm
Twilight ¹ start / end	4:45 am / 8:29 pm
Moonset / rise	9:32 am / 9:59 pm
Moon phase ²	☾ Waning gibbous (87% illum.)
Evening planets ³	Jupiter (W), Saturn (SSW)
Morning planets ³	—

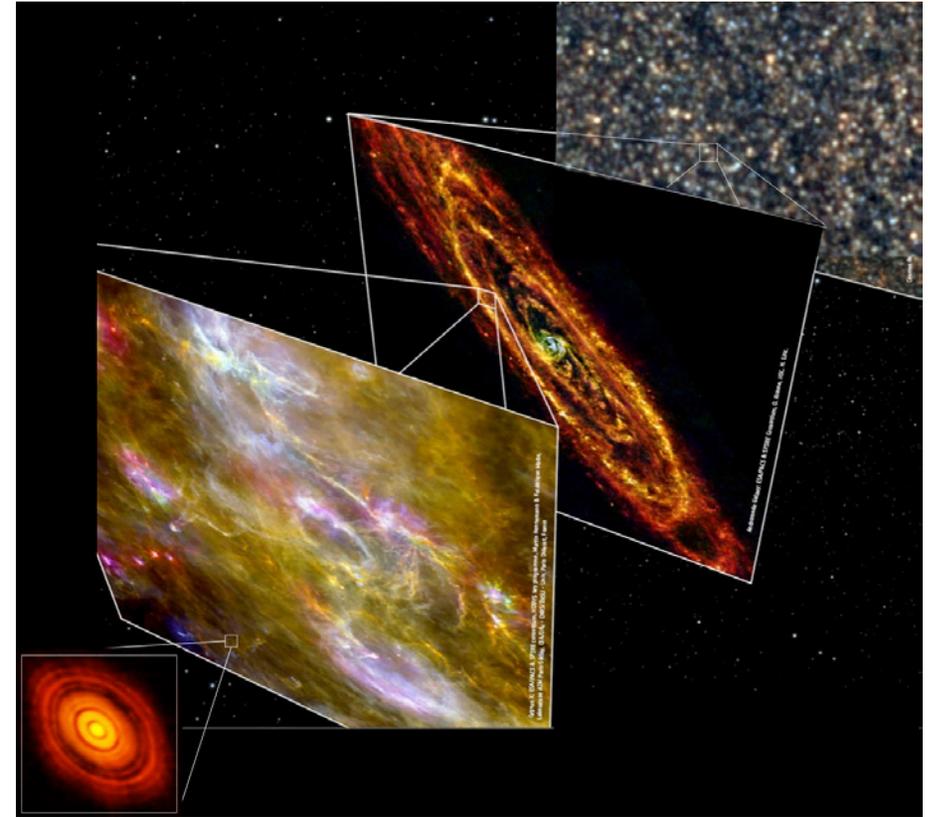
¹Astronomical twilight (Sun 18° below horizon). ²At meridian crossing ³Naked-eye planets. Source: timeanddate.com

From Interstellar Clouds to Star-Forming Galaxies: Universal Processes?

By PHILIPPE ANDRÉ, PASCALE JABLONKA & FLORIS VAN DER TAK

The link between the structure of the interstellar medium in galaxies and the star-formation process on both local and global scales is one of the fastest-growing areas of astrophysical research. [IAU Symposium 315](#) will center around this theme in an effort to make connections between the most recent observations with, e.g., Herschel and ALMA, and the most advanced numerical simulations, on scales ranging from protostellar disks to the first star-forming galaxies in the universe.

The availability of wide-field far-infrared and submillimeter surveys with, e.g., the Spitzer, Herschel, Planck, WISE, and Akari space observatories, coupled with the much-improved capabilities of ground-based millimeter and submillimeter interferometers, has recently led to spectacular and decisive steps forward in our understanding of star-formation modes from solar-system scales (tens of astronomical units) to global (kiloparsec) scales in galaxies. In particular, it has been suggested that star formation in dense molecular gas may be governed by essentially the same “laws” in nearby galactic clouds and distant external



Star-forming structures on scales large and small. From top right to bottom left: High-redshift star-forming galaxies as observed by Herschel in the GOODS-N deep field [*HerMES project*]; the Andromeda galaxy as imaged by Herschel [*HELGA project*]; structure of the Cygnus X giant molecular cloud in our own galaxy as revealed by Herschel [*HOBYS project*]; and detailed substructure in the protoplanetary disk surrounding the young star HL Tauri as revealed by ALMA [*NRAO/ESO/NAOJ*].

galaxies. This raises the possibility of a unified picture of star formation in the universe from small scales (e.g., protostellar cores and disks, filaments, and molecular clouds) to galaxy-wide scales

IAU Symposium 315

From Interstellar Clouds to Star-Forming Galaxies: Universal Processes?

Start date	Monday, 3 August
End date	Friday, 7 August
Oral sessions	Room 311, Hawai'i Convention Center
Posters	Exhibit Hall 1, Hawai'i Convention Center
Related event	S315 Plenary: Wednesday, 5 August, 8:30 to 10:00 am, Ballroom B, Hawai'i Convention Center
Coordinating Division	Division J: Galaxies and Cosmology

For details on presenters, topics, and times see the [online program](#) or [mobile app](#).

Keep in Touch!

Enhance and share your experience at the IAU General Assembly via social media! Use the hashtag #IAU2015 on Twitter, Facebook, and Instagram.



#IAU2015

(e.g., giant molecular clouds and galactic disks).

The goal of Symposium 315 is to debate this possibility and to start building up a coherent picture of how star formation is fuelled on a wide range of scales. Our ambition is to bring together observers and theorists working on star formation throughout the universe from nearby clouds, to local galaxies, to the first star-forming galaxies at high redshift, and to foster discussions around the fundamental question of whether the dominant mode of star formation is quasi-universal or environment-dependent.

With the advent of powerful observational facilities such as ALMA and high-resolution, multiscale numerical simulations, we believe the time is ripe for such a symposium aimed at establish-

ing bridges between the galactic and extragalactic star-formation communities. ALMA will soon enter full operations, and the legacy of Herschel observations has now become fully clear. We therefore look forward to the wealth of exciting new results that will undoubtedly be presented and discussed.

We envision the Symposium as a starting point for a continuing discussion involving experts from the “local” to the “high-redshift” star-formation communities on a number of critical issues such as the origin and universality of the stellar initial mass function, the nature of star formation “laws,” and the role of feedback and environmental effects. ❀



PHILIPPE ANDRÉ is Director of Research in the Astrophysics Laboratory of the Alternative Energies and Atomic Energy Commission (CEA) in Saclay, near Paris, France, and principal investigator of the Herschel Gould Belt Survey. **PASCALE JABLONKA** is Director of Research at the French National Centre for Scientific Research (CNRS) and on leave of absence from Paris Observatory in the Astrophysics Laboratory at the Swiss Federal Institute of Technology in Lausanne (EPFL). **FLORIS VAN DER TAK** is Senior Scientist at the Netherlands Institute for Space Research (SRON) and Professor in Submillimeter Astronomy at the University of Groningen.

General Assembly Draft Resolutions Announced

By THIERRY MONTMERLE

The four resolutions to be presented for voting at the XXIX General Assembly have been announced. They are currently in draft form, and some of the wording may change before the vote takes place during the second General Assembly session on Thursday afternoon, 13 August.

Resolution B1 addresses the 10-year IAU Strategic Plan for astronomy in the developing world. This strategic plan extends

from 2010 to 2020, and this resolution looks to confirm the continuing pursuit of these goals, as well to plan for what comes next, in the form of an extended strategic plan, addressing the future of the [Office of Astronomy for Development](#) and its activities beyond 2021.

Resolution B2 is on the recommended zero points for the absolute and apparent bolometric magnitude scales. This is a

problem in astronomical literature, with pervasive variance in the zero points for bolometric magnitudes and bolometric corrections. This resolution seeks to adopt a standardized absolute and apparent bolometric magnitude scale that acts independently of the Sun.

Resolution B3 is on recommended nominal conversion constants for selected solar and planetary properties. It recommends the adoption of nominal values for the solar radius, total solar irradiance, solar luminosity, solar effective temperature, heliocentric gravitational constant, and solar mass. These nominal values would function as conversion factors only, allowing a uniform conversion to SI units. The resolution recommends that the same be done for the equatorial and polar radii of the Earth and Jupiter, as well as for the geocentric and jovian gravitational constants.

Resolution B4 addresses the protection of radio astronomy observations in the frequency range 76–81 GHz from interference caused by car radars, which have various applications, like determining distances and relative speeds of objects in front of, beside, or behind a car. It seeks to request that the World

Radio Communication Conference 2015 takes all possible steps to protect radio astronomy observations in this frequency band that suffer as a result of car radars. Separating the observatories geographically from the radiation would seem the most effective method of protection, but in a world of ever-expanding technology that requires different wavelengths to operate, this is a pressing concern for astronomy.

Here are links to the full text of the draft resolutions and two related documents:

- [Draft resolutions](#) (zip archive, 175 KB)
- [IAU Strategic Plan 2010–2020](#) (PDF, 3.4 MB)
- [Resolution B4 briefing paper](#) (PDF, 94 KB)

Once the resolution language has been finalized, we'll let you know where to find it online. 🌸



THIERRY MONTMERLE will wrap up his three-year term as IAU General Secretary next week. He is based at the Institute of Astrophysics in Paris, France. This article is adapted from [IAU Announcement ann15023](#).

IAU SYMPOSIUM 317

The General Assembly of Galaxy Halos: Structure, Origin & Evolution

By MAGDA ARNABOLDI & ANGELA BRAGAGLIA

The quest for understanding the physics of galaxy halos begins with a statement from O. J. Eggen, D. Lynden-Bell, and A. R. Sandage (1962, *ApJ*, **136**, 748): “The time required for stars in the [Milky Way’s halo] to exchange their energies and momenta is very long compared with the age of the galaxy. Hence knowledge of the present energy and momenta of individual objects tells us something of the initial dynamic conditions under which they were formed.” This statement, now more than a half century old, illustrates very clearly the motivation to study the dynamics and chemical composition of stars in galaxy halos and their impli-

cations for models of galaxy formation. This quest starts right at our doorsteps with the study of the Milky Way (MW) galaxy. Because we live inside it and its light dominates our skies, we can study its stars with state-of-the-art instrumentation out to its farthest outskirts.

Measuring the physical parameters of the structural components of the MW — the thin and thick disk, bulge, and halo — with imaging and spectroscopic surveys from the ground tells us when these components formed and whether they were dominated by accretion or by dissipative collapse of the MW’s own gas. These

IAU Symposium 317

The General Assembly of Galaxy Halos: Structure, Origin & Evolution

Start date	Monday, 3 August
End date	Friday, 7 August
Oral sessions	Room 310, Hawai'i Convention Center
Posters	Exhibit Hall 1, Hawai'i Convention Center
Related event	S317 Plenary: Tuesday, 4 August, 8:30 to 10:00 am, Ballroom B, Hawai'i Convention Center
Coordinating Division	Division H: Interstellar Matter and Local Universe

For details on presenters, topics, and times see the [online program](#) or [mobile app](#).

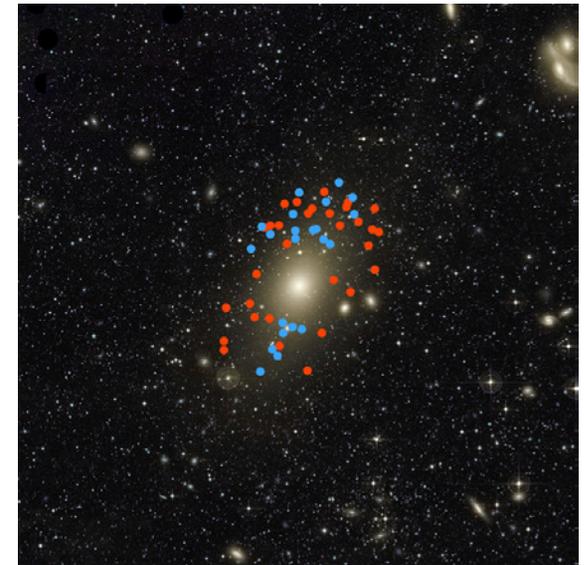
surveys also tell us about the generations of stars that emit the light we see today in our sky, and about these stars' progenitors, which are responsible for their chemical content. Furthermore, the future is looking bright: astronomers are now preparing for a revolution to be brought about by the European Space Agency's [Gaia satellite](#), which will measure the parallaxes and proper motions for a billion MW stars with exquisite precision. Gaia's three-dimensional map of the solar neighborhood will yield a kinematical and chemical census of all galactic components and strongly constrain models of the formation of the Milky Way.

What about the MW's halo? It turns out to be a livelier environment than we once thought. Accreted stars found in the halo are associated with several different substructures, such as the disrupted Sagittarius dwarf, which provides about 20% of all the debris of the MW's stellar halo, including multiple extended stellar streams. The modeling of these streams constrains the galaxy's potential and its associated mass to about $5\text{--}8 \times 10^{11} M_{\odot}$ within 200 kiloparsecs (kpc), in agreement with the kinematics of halo stars and satellites in the Local Group. The halo of the Andromeda galaxy (Messier 31) has a similarly complex network of structures. Numerous dwarf galaxies and globular clusters, but also streams without clear progenitors, contribute to this network, as shown by a map of the red giant stars in M31's

halo from [PAndAS, the Pan-Andromeda Archaeological Survey](#) ([McConnachie et al. 2009, *Nature*, 461, 66](#)).

Are halos and streams found only around disk galaxies? No — halos are ubiquitous in luminous galaxies, and we now know that they also extend out to 100 kpc; that they have complex morphologies with a mazy web of tails, plumes, and spurs; and that they harbor multiple stellar components with different chemical contents and ages. Vivid testimony of these intricate luminous substructures are shown by very deep images, reaching surface brightness levels to 1% of the night sky. Also, two-dimensional maps of discrete tracers such as planetary nebulae and globular clusters allow us to see substructures both in space and in velocity. A recent study of the giant elliptical galaxy Messier 87, shown below, reveals the debris of a satellite disrupted in its halo and provides evidence that the outer halo is still growing.

To understand how galaxy assembly took place we need to combine observations with theoretical modeling. This is because we deal with a long sequence of events, where mass accretion, i.e., stars and gas brought in by smaller satellites, and dissipative collapse of the galaxy's own gas have both played important roles, leading to the formation of different structural components that we see today in our own Milky Way and in external galaxies.



The “crown” of Messier 87's halo. Red and blue dots mark the positions of planetary nebulae whose motions reveal that M87 has been struck by another, smaller galaxy, which has now fully merged with it. Objects colored red/blue are moving away from/toward us with respect to the galaxy as a whole. [[Longobardi et al. 2015, *A&A*, 579L, 3 / *ESO PR 1525*](#)]

IAU Symposium 317 provides a vibrant forum where experts will discuss many different aspects of the assembly, formation, and evolution of galaxy halos. We share the enthusiasm of our colleagues: by bringing together observers and theorists we endeavor to make progress toward a coherent picture of the formation and evolution of halos in the Milky Way, Andromeda, and other galaxies! 🌸



MAGDA ARNABOLDI is an observational astronomer at the European Southern Observatory in Garching, Germany, where she works on the dynamics and evolution of galaxies. **ANGELA BRAGAGLIA** studies resolved stellar populations at the Italian National Institute of Astrophysics (INAF) Astronomical Observatory of Bologna.

IAU SYMPOSIUM 318

The Asteroid Belt: Crossroads of the Solar System

By STEVEN CHESLEY

Asteroids are the small, usually rocky bodies that reside primarily in a belt between Mars and Jupiter, though they have been scattered throughout the solar system to varying degrees. They carry the signature of the birth of the solar system in the way that they are organized, both individually and as a population, and so, in a real sense, form the fabric of our solar system. Their observed compositional, structural, and dynamical properties enable testing of current theories and facilitate development of new theories regarding the evolutionary processes that brought the solar system to its present state and that continue to act to reshape our planetary neighborhood. Thus the main asteroid belt can be considered a “crossroads” in the solar system, connected either genetically or dynamically to a host of other populations of small bodies.

IAU Symposium 318, “Asteroids: New Observations, New Models,” brings together more than 100 experts in the asteroid-research community to describe our current and evolving understanding of asteroids and related processes. The emphasis of the Symposium is on the main asteroid belt and related populations, including near-Earth asteroids.

The main asteroid belt is a lively place where the physical, rotational, and orbital properties of objects are governed by a

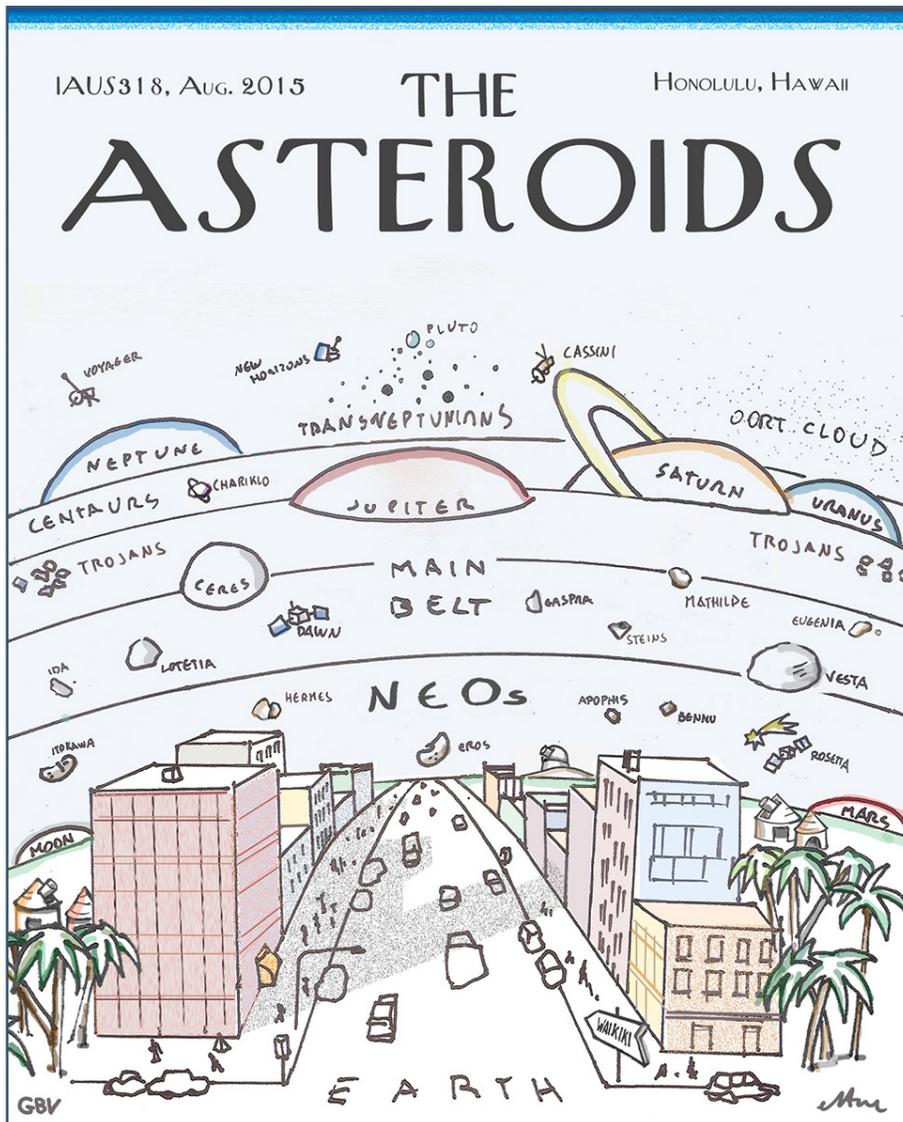
IAU Symposium 318: Asteroids: New Observations, New Models

Start date	Monday, 3 August
End date	Friday, 7 August
Oral sessions	Room 315, Hawai‘i Convention Center
Posters	Exhibit Hall 1, Hawai‘i Convention Center
Related event	S318 Plenary: Wednesday, 5 August, 6:00 to 7:30 pm, Ballroom B, Hawai‘i Convention Center
Coordinating Division	Division F: Planetary Systems and Bioastronomy

For details on presenters, topics, and times see the [online program](#) or [mobile app](#).

complicated interplay of collisions, planetary resonances, radiation forces, and the formation and fission of secondary bodies. The collisional, orbital, and rotational evolution are each individually complex and rich in detail, and yet they are each coupled to the others in ways that make the complete evolutionary picture for asteroids truly fascinating.

Recent and forthcoming observational surveys and space missions are affording new constraints on asteroid characteristics and tests of current theories, even as theories are developed and revised in order to describe what the asteroids are like and



IAU Symposium 318 focuses on the main asteroid belt and related populations, as suggested by the symposium artwork, which was inspired by a [famous New Yorker cover](#). [Ettore Perozzi & Giovanni Valsecchi]

how they came to be so. The result of such work informs our understanding of the evolutionary processes taking place in other planetary systems at various stages of development across the Milky Way and thus has relevance to diverse cosmogonical fields, from circumstellar debris disks to exoplanets.

Right: Asteroids Ida (left) and Gaspra (right) are shown at the same scale in these images captured by the Galileo spacecraft while en route to Jupiter in the early 1990s. Since then many other asteroids have been visited by spacecraft, culminating in Dawn's current exploration of Ceres from a low orbit. Gaspra is about 10.5 miles (17 km) long, and Ida is about 18.6 miles long. [NASA, JPL, USGS]



The study of asteroids is fed by an immense and growing stream of data from systematic asteroid surveys, often operated in conjunction with astrophysical surveys. This wealth of data represents an exciting challenge to ensure that the data are processed, archived, and distributed in a way that maximizes the scientific return. This is the intersection of computer science and astronomy, and we are past the age where simple solutions suffice. Symposium 318 includes a Q&A (question-and-answer) panel session designed to bring representatives of data-processing centers and data producers together with the asteroid-research community to communicate capabilities and plans, as well as to understand the future data demands. ❀



STEVEN R. CHESLEY is Senior Research Scientist in NASA's Near-Earth Object Program Office at the Jet Propulsion Laboratory in Pasadena, California, and President of Commission 20. His research focuses on impact hazard assessment and precision orbit determination and ephemeris prediction for small bodies.

Statistics and Exoplanets

By SUZANNE AIGRAIN

Twenty years after the discovery of 51 Pegasi b, the era of exoplanets is well and truly under way. Thousands of planetary systems have been discovered, including many that are utterly unlike our own. We know that most stars in the Milky Way host at least one planet, and that planets smaller than Neptune are particularly common. Although we will never obtain images of most of the planets we know today, we are nonetheless able to study some of them in astonishing detail, even measuring how hot, moist, or cloudy their atmospheres are. We are on the cusp of robustly understanding the frequency of Earth-like planets, and it is not unreasonable to hope that genuine evidence for life outside the solar system might be found in our lifetimes.

However, exoplanets are much smaller and fainter than their host stars. The signals that we rely upon to detect and characterize them are often minute and dwarfed by random or systematic noise sources. Many of the exciting discoveries made to date have relied on very careful analyses of noisy data sets, and advanced statistical methods are increasingly being used to



[xkcd.com]

push back the limits of detectability, from radial-velocity and transit searches to atmospheric observations. With extensive data sets now available from large exoplanet surveys, the statistics of exoplanet populations is also a hot topic.

From 3 to 5 August, Focus Meeting (FM) 8, “Statistics and Exoplanets,” will bring together exoplanet and computational-statistics experts to discuss and address key challenges, including:

- The detection of exoplanets using a variety of methods, including radial velocity, astrometry, transits, direct imaging, and microlensing;
- The detailed modeling of planetary signals to extract information on planets’ orbital, bulk, and atmospheric properties;
- Inferring the properties of the underlying planet population

Focus Meeting 8: Statistics and Exoplanets	
Start date	Monday, 3 August
End date	Wednesday, 5 August
Oral sessions	Room 312, Hawai‘i Convention Center
Posters	Exhibit Hall 1, Hawai‘i Convention Center
Related event	Software Hack Day: Thursday, 6 August, 9:00 am to 4:30 pm, Room 324, Hawai‘i Convention Center
Coordinating Divisions	Division B: Facilities, Technologies and Data Science Division F: Planetary Systems and Bioastronomy
<i>For details on presenters, topics, and times see the online program or mobile app.</i>	

from incomplete and biased samples from a range of surveys. Although exoplanets are a particularly fertile ground for cross-disciplinary work, the increased importance of statistical methodology is a trend that extends across much of astronomy, and we hope to attract a broad spectrum of participants taking part in the IAU General Assembly.

To build on what we hope will be a productive exchange of ideas, we have also organized a day of tutorial-style and hands-on experimentation with algorithms and software packages. “Statistics and Exoplanets: Software Hack Day” is Thursday, 6 August, from 9:00 am to 4:30 pm in Room 324 of the Convention Center.

FOCUS MEETING 12

Bridging Laboratory Astrophysics and Astronomy

By FARID SALAMA, LYUDMILA MASHONKINA & STEVE FEDERMAN

Astronomy is primarily an observational science, detecting photons generated by atomic, molecular, chemical, and condensed-matter processes. Our understanding of the universe also relies on knowledge of the evolution of matter (nuclear and particle physics) and of the dynamical processes shaping it (plasma physics). Planetary science, involving in-situ measurements of solar-system bodies, requires knowledge from physics, chemistry, and geology. Exploring the question of life elsewhere in the universe draws on all the above as well as biology. Hence, our quest to understand the cosmos rests firmly on theoretical and experimental research in many different branches of science. Taken together, these astrophysically motivated theoretical and experimental studies are known as laboratory astrophysics.

Laboratory astrophysics is the Rosetta stone that enables astronomers to understand and interpret the cosmos. IAU Commission 14, Atomic and Molecular Data, and the AAS Laboratory Astrophysics Division (LAD) have coordinated their efforts to bring together expert providers and users of laboratory

FM 8 is sponsored by the [International Astronomical Union](#), the [International Statistical Institute](#), the [International Astrostatistics Association](#), and the [Institute of Mathematical Statistics](#). For more information, see the [FM 8 website](#) and follow the hashtag [#ExoStats15](#) on Twitter. 🌸



SUZANNE AIGRAIN (@AirborneGrain) is Professor of Astrophysics at the University of Oxford, United Kingdom, and co-chair of the FM 8 Scientific Organizing Committee. Her research interests lie at the interface between exoplanets, stellar variability, and statistics.

Focus Meeting 12: Bridging Laboratory Astrophysics and Astronomy

Start date	Monday, 3 August
End date	Wednesday, 5 August
Oral sessions	Room 316C, Hawai'i Convention Center
Posters	Exhibit Hall 1, Hawai'i Convention Center
Coordinating Division	Division B: Facilities, Technologies and Data Science

For details on presenters, topics, and times see the [online program](#) or [mobile app](#).

and astronomical data for [Focus Meeting 12](#), “Bridging Laboratory Astrophysics and Astronomy.” At this multidisciplinary meeting astronomers will join with theoretical and experimental chemists and physicists to discuss the state of the art in their respective disciplines and how their combined expertise can address important open questions in astronomy and astrophysics.

Numerous next-generation facilities and projects, including the Jansky Very Large Array (JVLA), Square Kilometre Array (SKA), Atacama Large Millimeter/submillimeter Array (ALMA), Panoramic

Survey Telescope & Rapid Response System (Pan-STARRS), Large Synoptic Survey Telescope (LSST), and James Webb Space Telescope (JWST) will produce a torrent of new data. FM 12 will consider how laboratory studies can best address the needs of astronomy during this new era as well as how to stimulate new observations with these telescopes. Attendees are encouraged to discuss the types of laboratory data they will need to properly interpret the astronomical phenomena that the next-generation facilities will likely reveal.

FM 12 is divided into topical sessions on atomic and molecular data, plasma physics, nuclear physics, and particle physics and their application to various domains, such as interplanetary, interstellar, and intergalactic matter; planetary surfaces; planetary and stellar atmospheres; the heliosphere; meteors, meteorites, and

interplanetary dust; high-energy astrophysics; astrochemistry; and bioastronomy.

We would like to welcome all attendees to our multidisciplinary Focus Meeting. It will, no doubt, be of interest to the broad IAU community and promises to be a very exciting event! ❀



FARID SALAMA of NASA's Ames Research Center in California is the founding President of new IAU Commission B5, Laboratory

Astrophysics, and incoming AAS LAD Chair. **LYUDMILA MASHONKINA**, current President of IAU Commission 14, works at the Institute of Astronomy of the Russian Academy of Sciences. **STEVE FEDERMAN** of the University of Toledo, Ohio, is the current AAS LAD Chair.

FOCUS MEETING 15

Search for Water and Life's Building Blocks in the Universe

By SUN KWOK

Water is the common ground between astronomy and planetary science, as the presence of water on a planet is universally accepted as essential for its potential habitability. Water assists many biological chemical reactions, leading to complexity by acting as an effective solvent. It shapes the geology and climate on rocky planets and is a major or primary constituent of the solid bodies of the outer solar system.

Water ice seems ubiquitous in space and is by far the most abundant condensed-phase species in our universe. Water-rich icy layers cover dust particles within the cold regions of the interstellar medium, and molecular ices are widespread in the solar system. The poles of Earth and Mars, and most of the outer-solar-system satellites, are covered with ice. Smaller solar-system bodies, such as comets and Kuiper Belt objects (KBOs), contain a significant fraction of water ice and trace amounts of organics.

Focus Meeting 15: Search for Water and Life's Building Blocks in the Universe	
Start date	Monday, 3 August
End date	Wednesday, 5 August
Oral sessions	Room 316A, Hawai'i Convention Center
Posters	Exhibit Hall 1, Hawai'i Convention Center
Coordinating Division	Division F: Planetary Systems and Bioastronomy
<i>For details on presenters, topics, and times see the online program or mobile app.</i>	

And liquid-water oceans probably exist beneath the icy crusts of several moons of Jupiter and Saturn.

In addition to water, another requirement for life as we know it is organic compounds. Our understanding of the evolution of organic molecules and their journey from molecular clouds to the early solar system and Earth provides important constraints on the



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emergence of life on Earth and possibly elsewhere. Astronomical observations have shown that carbonaceous matter is ubiquitous, and a significant number of molecules that are used in contemporary biochemistry on Earth are found in interstellar and circumstellar regions as well as protoplanetary environments.

To date about 180 molecules have been detected in interstellar and circumstellar gas. In circumstellar envelopes, small carbon compounds are converted to larger species and into solid organic compounds with mixed aromatic (ring)

and aliphatic (chain) structures. During the formation of our solar system, this interstellar organic material was chemically

processed and later integrated into the presolar nebula from which planets and small bodies formed. The large quantities of extraterrestrial material — both water and organics — delivered to young planetary surfaces may have played an important role in life's origin.

In [Focus Meeting 15](#) we will discuss the development of simple organics in space to provide the initial context for understanding their subsequent evolution within a young planet-forming disk. Among the topics of presentation are discussions of water and organic formation in space, their transport to a forming disk, their delivery to forming terrestrial planets, and their incorporation into giant-planet atmospheres. The various potential sources of volatile delivery — such as comets, asteroids, and volcanism — will be presented along with a discussion of the early development of life on Earth. 🌸



SUN KWOK, of the University of Hong Kong, China—Nanjing, works on the synthesis of organic compounds in the late stages of stellar evolution. He is the author of several books, including [Stardust: The Cosmic Seeds of Life](#) (Springer 2013). He acknowledges assistance with this article from Edwin Bergin and Pascale Ehrenfreund, his co-chairs on the FM 15 Scientific Organizing Committee.

FOCUS MEETING 22

The Frontier Fields: Transforming Our Understanding of Cluster and Galaxy Evolution

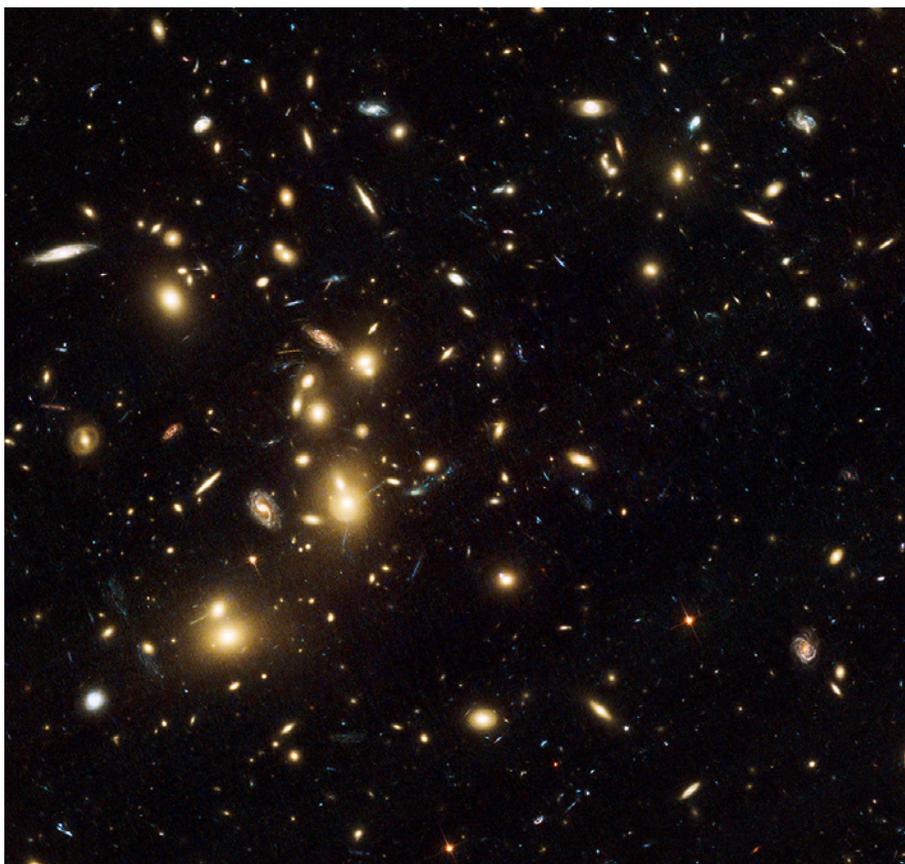
By HARALD EBELING, PRIYA NATARAJAN & JEAN-PAUL KNEIB

Perhaps we should be embarrassed by our choice of words in the title of Focus Meeting 22. Along with “unique,” “transformational” is probably the most overused (and abused) qualifier in astronomy. Then again, this is an exceptional program, certainly

in its design and in the ambitiousness of its goals. Whether it is as transformational as we envisaged will hopefully become clear in the course of FM 22, which attempts to review the program's progress and results after 1½ years of data gathering.

Clusters of galaxies, the most recently assembled and most massive structures in the universe, are nature’s most efficient telescopes. Predicted by Einstein’s general theory of relativity, gravitational lensing — light deflection by matter — is copiously produced by clusters. It is a fitting tribute to Einstein as we celebrate the centennial of the publication of his theory this year. Clusters are crowded places: violent, dynamic, and evolving. Lensing by clusters has opened new windows to observe structure formation and evolution in action.

Devoting almost 600 hours (840 orbits) of Hubble Space Telescope (HST) Director’s Discretionary Time to a novel, deep,



Abell 2744 is one of six galaxy clusters targeted by the Frontier Fields program. The blue streaks and arcs are gravitationally lensed images of remote background galaxies. [NASA, ESA, R. Dupke et al.]

Focus Meeting 22	
The Frontier Fields: Transforming Our Understanding of Cluster and Galaxy Evolution	
Start date	Monday, 3 August
End date	Wednesday, 5 August
Oral sessions	Room 314, Hawai‘i Convention Center
Posters	Exhibit Hall 1, Hawai‘i Convention Center
Coordinating Division	Division J: Galaxies and Cosmology
<i>For details on presenters, topics, and times see the online program or mobile app.</i>	

extragalactic imaging effort, the [Frontier Fields \(FF\) Program](#) targets six massive galaxy clusters at redshift $z > 0.3$ in seven filters. At a total of more than 90 hours (140 orbits) per cluster, the FF reach to apparent magnitude ~ 29 across the entire optical and near-infrared window, an unprecedented depth for cluster observations with HST — deeper than even the [Hubble Ultra-Deep Field](#) if lensing magnification is accounted for.

Complemented by 600 hours of Spitzer time for deep infrared imaging, hundreds of hours of Chandra ACIS-I X-ray observations, and extensive investments of observing time on ground-based facilities, the FF project certainly deserves the label “unique” based on invested resources alone. Just as exceptional is the rationale behind this initiative, namely, to fully exploit the magnifying power of gravitational lensing by the FF clusters to probe the population of background galaxies to greater depth than ever before, both in redshift and in luminosity.

IAU [Focus Meeting 22](#), “The Frontier Fields,” held at roughly the midpoint of the FF observing schedule, was conceived to bring together scientists — junior as well as seasoned — from the enormous range of research topics addressed by the FF observations. The subjects of talks and posters run the gamut of extragalactic astronomy, from transient phenomena (among them the spectacular discovery of multiple occurrences of [Supernova Refsdal](#)); through properties of the lensing clusters (specifically the dynamics and distribution of dark and luminous matter, but also the physics of galaxy evolution in clusters), and cutting-edge techniques

for precise lens modeling; to a slew of studies of the lensed background universe. FM 22 presentations cover all modes of research: theory, numerical simulations, and, of course, observations.

We aimed specifically at giving the next generation of researchers ample opportunity to present their results, leaving time for discussion, and focusing not just on present-day findings from this invaluable data set but also on how to leverage them best for future space- and ground-based explorations of the early universe. ❀



HARALD EBELING of the University of Hawai'i's Institute for Astronomy is an expert in X-ray cluster surveys and a developer of image-analysis software. **PRIYA NATARAJAN** is a professor of astronomy and physics Yale University, where she maps dark matter and dark energy via gravitational lensing. **JEAN-PAUL KNEIB** works on cosmological surveys at the EPFL Laboratory of Astrophysics in Switzerland.

Honolulu Weather Forecast 🌩️ 3-4 August 2015

MONDAY, 3 AUGUST

Morning	Afternoon	Evening
Sunny	Sunny	Clear skies
0% chance of rain	0% chance of rain	0% chance of rain

TUESDAY, 4 AUGUST

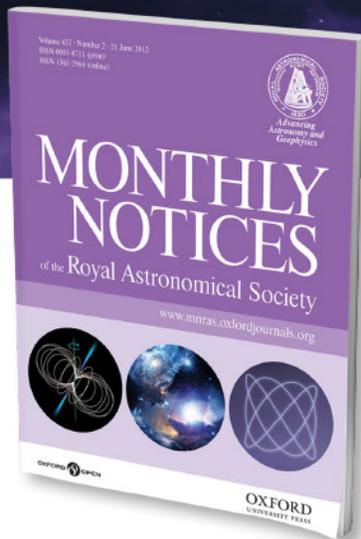
Morning	Afternoon	Evening
Scattered clouds	Scattered clouds	Scattered clouds
20% chance of rain	40% chance of rain	17% chance of rain

Extended forecast: Current forecasts indicate that category 2 Hurricane Guillermo will reach O'ahu on Wednesday or Thursday, 5 or 6 August, bringing heavy rainfall and 40 mph gusts. A high surf advisory with a warning of rip currents for east-facing shores of O'ahu was issued on Sunday, 2 August, and will remain in effect until at least 6 pm on Tuesday. Source: [Weather Underground](#).

Calling all authors

If you have published in one of our astronomy journals, **visit the Oxford University Press booth #300** and we will make your paper freely available for the duration of the conference.

We look forward to meeting you!



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