

# Kai'aleleiaika 🌌 THE MILKY WAY

Issue 8 🌌 12 August 2015

Wally Pacholka / AstroPics.com

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# The First Use of ISS Images to Map Light Pollution

*Astronauts looking down from space are now helping to study night-sky brightness.*

By LAURENCE A. MARSCHALL, *Kai'aleleika*

During a press conference at the IAU General Assembly on Tuesday, 11 August, an international team of astronomers described a pioneering survey of terrestrial light pollution that couples images taken by astronauts on the International Space Station (ISS) with observations made by citizen scientists on the ground.

The project, called [Cities at Night](#), is led by researchers from the [Complutense University of Madrid \(UCM\)](#), Spain, and the [Cégep de Sherbrooke \(CDS\)](#) in Canada. It aims to produce a detailed global map of diffuse night-sky brightness caused by artificial lighting.

Cities at Night entails the cataloging of the entire ISS archive of high-resolution color images of the Earth taken with a standard digital camera — more than 130,000 in all — and geo-referencing each image to its precise position on Earth. These data are then calibrated with observations of background stars above the ISS and measurements of sky brightness made by observers on the ground. Prior to this effort, maps of sky brightness could be created only by combining single-point observations from Earth — a tedious process that made it difficult to assemble comprehensive maps and even more difficult to distinguish changes in sky brightness over time. The new method makes it possible to efficiently chart sky brightness over extended areas of the Earth and to see how the sky background tracks changes in urban development.

Earth-observation satellites have been surveying our planet for many years and have easily detected the direct light from unshielded bulbs. But they had limited abilities to measure the diffuse scattered light from artificial illumination scattered by molecules and dust, which contributes most to urban sky brightness. The [Defense Meteorological Satellite Program](#), notably, had

detected this diffuse light in the past, but because of low spatial resolution it could not distinguish it from other instrumental factors. Though the ISS images were not specifically taken for the purpose of light-pollution measurement, their high spatial resolution and multicolor spectral sensitivity make it possible to draw direct connections between diffuse sky brightness and artificial lighting.

Lead scientist Alejandro Sánchez de Miguel (CDS and UCM), who reported on the work along with Jaime Zamorano (UCM) and Martin Aubé (CDS), described the many applications of the new study. A comparison of two color images of Milan, for example, clearly shows a change from soft yellow to harsh blue in the city center. This is a result of the switch from sodium and incandescent lamps to LEDs.

The environmental impacts of artificial lighting are also evident in ISS images. On a typical photograph of northwest Europe, one can easily see the cities of Belgium, with all their roadways lit by low-pressure sodium lamps. Nearby Germany, which doesn't light its roads, barely shows up.

*Kai'aleleika* 🌌 THE MILKY WAY

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Milan, Italy, as seen from the ISS in 2012 (*left*) and 2015, before and after the transition to LED lighting. The amount of blue light increased dramatically in the intervening three years, and it is now more difficult for observers on the ground to see the starry sky. [NASA, ESA]

There are interesting economic conclusions that can be drawn as well. The Cities at Night team concludes that European countries and cities with higher public debt have higher energy consumption for street lighting per inhabitant, and that the total cost of the energy consumption for street lights is 6,300 million euros per year in the European Union.

Last, but not least, the new survey is of great importance for the protection of critical dark-sky sites. A color image of La Palma in the Canary Islands, where outdoor white lights are not permitted near the observatories, provides clear evidence of a source that violates the ban. Using ISS photos, astronomers may be able to monitor and protect observatories, dark-sky preserves, and astronomical heritage sites around the world.

Though it draws on the resources of several space agencies and an active base of citizen scientists, Cities at Night faces an uncertain future. Its next step is to secure funding to continue the mapping and analysis of current data and to coordinate the taking of additional images so that astronomers, environmental-

ists, and policy-makers can benefit from an ongoing mapping of global lighting conditions. 🌸

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# Dynamical Studies Shed Light on Exoplanets

By ALESSANDRO MORBIDELLI

The number of known extrasolar planets has increased considerably in recent years. Today we have cataloged about 2,000 confirmed planets, of which about 500 are in multiplanet systems. These discoveries have raised a number of interesting questions and topics for discussion about the formation and evolution of planetary systems:

- Resonances in multiplanet systems create complex orbital dynamics. Could tidal evolution play a role in extracting planets from resonances, as recent observations suggest?
- The origin of “hot” planets with orbital periods of a few days remains a matter of debate: Did these objects migrate through the protoplanetary disk, or did they arrive at their current positions via scattering and tidal damping?
- The cause of the surprisingly large eccentricities and/or inclinations of many extrasolar planets also remains elusive;



The orbits of three extrasolar planets compared with the orbits of the planets in our solar system. This illustrates the surprising diversity of planetary orbits discovered around other stars. [Gavin Rymill 2006]

planet instabilities, planet-disk interactions, and external perturbations from eccentric or inclined stars are all viable options.

Dynamical models complement observations to provide a better characterization of extrasolar planets. Dynamical maps have been very useful to constrain the orbits of multiplanet systems, for which the uncertainties in the orbital parameters — due to observational errors — are often much wider than the range of orbital configurations permitting the long-term stability of the system. Transit time variations (TTV) are used to confirm planet candidates and allow the determination of their masses. The power and success of this technique is shown by the recent discovery and orbital determination of a non-transiting planet through the analysis of the TTV signal of a transiting companion. The TTV method brings celestial mechanics back to the glorious time when Le Verrier and Adams predicted the existence and the position of Neptune from the analysis of the anomalies of the motion of Uranus.

This nonexhaustive list of

## How to Say It in Hawaiian



- ‘Ahi: yellow-fin tuna
- Huamoa: (chicken) egg
- Kamano: salmon
- Laiki: rice
- Mai’a: banana
- Niu: coconut
- Waiu: milk

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 kahakō), it means you hold the sound an extra beat. A 6-shaped apostrophe, or ‘okina, signals a [glottal stop](#). Source: [Hawaiian Words](#).

open problems and topics for discussion highlights the importance of dynamical studies for understanding the nature of the planetary systems we observe and establishing clues on their origin. Focus Meeting 1 will cover all dynamical aspects in the field of extrasolar planetary science, review recent advances in the field, and, hopefully, announce exciting new results. 🌸



**ALESSANDRO MORBIDELLI** is outgoing President of IAU Commission 7, Celestial Mechanics and Dynamical Astronomy, and works on planetary dynamics at the Côte d'Azur Observatory in Nice, France.

Focus Meeting 1: Dynamical Problems in Extrasolar Planets Science	
Start date	Wednesday, 12 August
End date	Friday, 14 August
Oral sessions	Room 314, Hawai'i Convention Center
Posters	Exhibit Hall 1, Hawai'i Convention Center
Coordinating Divisions	Division A: Fundamental Astronomy Division F: Planetary Systems and Bioastronomy
<i>For details on presenters, topics, and times see the <a href="#">online program</a> or <a href="#">mobile app</a>.</i>	

## FOCUS MEETING 10

# Stellar Explosions in an Ever-Changing Environment

*Bringing together two astronomical research communities.*

By CHRISTINA THÖNE & LISE CHRISTENSEN

Astronomers who study stellar explosions and astronomers who study starburst galaxies have a lot in common, though they usually meet and publish separately. The idea for a conference that would bring these two communities together was born as several of us traveled around China together after the IAU XXVIII General Assembly in 2012 in Beijing, China.

Explosions of massive stars as gamma-ray bursts (GRBs) and supernovae (SNe) are among the most powerful events in the universe. They release energy and heavy elements back into their environment so that each new cycle of star formation begins with different initial conditions. Stellar explosions thus play an important role in the evolution of galaxies across the entire history of the universe.

Though the explosions themselves are visible, it is difficult to study the progenitors of SNe and GRBs, partly because the events are unpredictable, but primarily because SNe and GRBs are sufficiently infrequent that they are usually discovered in

Focus Meeting 10: Stellar Explosions in an Ever-Changing Environment	
Start date	Tuesday, 11 August
End date	Thursday, 13 August
Oral sessions	Room 313C, Hawai'i Convention Center
Posters	Exhibit Hall 1, Hawai'i Convention Center
Coordinating Divisions	Division J: Galaxies and Cosmology Division D: High Energy Phenomena & Fundamental Physics
<i>For details on presenters, topics, and times see the <a href="#">online program</a> or <a href="#">mobile app</a>.</i>	

distant galaxies. Only in a few cases have we been able to actually observe the progenitor of a SN (notably SN 1987A), and GRBs will probably always be out of reach due to their distances. Observing the surroundings of an explosion, however, can give us important information on the properties of the progenitor.



“Supernova factory” NGC 2770 as seen through broadband and narrowband hydrogen-alpha filters. It has already hosted three Type Ib SNe, as well as a luminous blue variable that probably exploded as a Type IIc SN. All are marked here, though they were not all visible at the same time.

Spatially resolved observations of stellar explosion environments outside the Local Group have only been achievable in the past few years. Observations at different wavelengths are now able to resolve individual star-forming regions, gas inflows and outflows from starburst galaxies, ionized regions, and abundances in great detail.

Massive stellar explosions have observable effects on their immediate environments and host galaxies. They can both inhibit star formation and give rise to new (massive) star formation in their neighborhood, and they can both enrich the host galaxy with metals and produce galactic winds that can affect the com-

position of the intergalactic medium.

Last but not least, stellar explosions allow us to trace star formation out to the very first galaxies. GRBs, for example, are good tracers of massive star formation in galaxies and are visible across vast distances. They complement high-redshift galaxy surveys, which are flux-limited and currently can only detect the most massive galaxies. As GRBs are found at any redshift, they are also excellent tools for studying the evolution and composition of star-forming galaxies over the entire history of the universe.

In short, stellar explosions, star formation, and the chemical evolution of galaxies are intimately related. Though the people

who study them are only beginning to communicate with each other, the synergy looks very promising. If you are working in, or interested in, any of these fields, just drop in at one of our sessions. [Focus Meeting 10](#), which began yesterday but continues today and tomorrow, is socially and scientifically diverse: Both the Scientific Organizing Committee and the list of invited speakers is composed of an equal number of men and women, and we have made a particular effort to include young researchers,

whose new ideas will help further our interdisciplinary efforts. 🌸



**CHRISTINA THÖNE** is a Ramón y Cajal Fellow at the Institute of Astrophysics of Andalusia in Granada, Spain, and leader of the High Energy Transients and Their Hosts group. **LISE**

**CHRISTENSEN** is Associate Professor at the Dark Cosmology Centre, Niels Bohr Institute, University of Copenhagen, Denmark.

## FOCUS MEETING 18

# Scale-Free Processes in the Universe

By EDITH FALGARONE & BRUCE ELMEGREEN

[Focus Meeting 18, Scale-Free Processes in the Universe](#), brings together cosmologists, astrophysicists, and statistical physicists to exchange ideas from different perspectives on the puzzling observation that most distribution functions — such as those for mass, energy, and the structure of components like dark matter, galaxy clusters, galaxies, magnetic fields, cosmic rays, star clusters, and stars — have power-law shapes indicating a lack of physical scale in whatever processes determine their formation and organization.

These scale-free behaviors are apparently established without fine-tuning, and they raise fascinating questions about the relative roles of long-range (such as gravity) and short-range (such as collisional) interactions — questions that touch on the interaction between dark matter, baryons, cosmic rays, and magnetic fields. Equally fascinating are the scales where the power laws break down. Computer simulations now include a large enough range of scales to reproduce some of these behaviors.

FM 18 will have 14 invited reviews and 22 contributed talks by top international researchers in fields such as dark-matter profiles and galaxy formation, cosmic magnetism, numerical models, turbulence, and self-organized criticality. Everyone is welcome to

listen, learn, and discuss these challenging questions. 🌸



**EDITH FALGARONE** is CNRS Emeritus Director of Research at the Paris Observatory in France. She is a molecular astrophysicist focused on turbulence, magnetic fields, and diffuse matter

in galaxies. **BRUCE ELMEGREEN** is a research staff member at the IBM Thomas J. Watson Research Center in Yorktown Heights, New York. He studies interstellar matter, star clusters, and galaxies.

### Focus Meeting 18: Scale-Free Processes in the Universe

Start date	Wednesday, 12 August
End date	Friday, 14 August
Oral sessions	Room 313B, Hawai'i Convention Center
Posters	Exhibit Hall 1, Hawai'i Convention Center
Coordinating Divisions	Division J: Galaxies and Cosmology Division D: High Energy Phenomena and Fundamental Physics Division H: Interstellar Matter and Local Universe

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

# Making It All Standard

By CATHERINE HOHENKERK

IAU Division A, Fundamental Astronomy, provides astronomers with software that can be used with space-time reference systems via [Standards of Fundamental Astronomy \(SOFA\)](#). The SOFA service incorporates an authoritative set of algorithms and procedures for implementing standard models used in fundamental astronomy, and for supporting IAU Resolutions regarding standards usage.

The Division I Working Group on Astronomical Standards, chaired by Toshio Fukushima, formed SOFA in 1994. Today SOFA

is organized by a board of international members who come from a wide range of IAU Commissions and Working Groups and who have the knowledge and skills necessary to maintain the software and website.

The SOFA software is available as source code in Fortran 77 or ANSI C and, while not open source, it is freely available to all users. The terms of use restrict users from changing the source code without re-naming affected routines (e.g., removing or replacing the characters “iau” from routine names). To some this violates the definition of “free

```
d2dtf.for
139 *   Yes. We probably need tomorrow's calendar date.
140   CALL iau_JD2CAL ( A1+1.5D0, B1-FD, IY2, IM2, ID2, W, JS )
141   IF ( JS.LT.0 ) GO TO 9
142
143 *   Is today a leap second day?
144   IF ( .NOT. LEAP ) THEN
145
146 *       No. Use 0h tomorrow.
147       IY1 = IY2
148       IM1 = IM2
149       ID1 = ID2
150       IHMSF1(1) = 0
151       IHMSF1(2) = 0
152       IHMSF1(3) = 0
153
154   ELSE
155
156 *       Yes. Are we past the leap second itself?
157       IF ( IHMSF1(3).GT.0 ) THEN
158
159 *           Yes. Use tomorrow but allow for the leap second.
160           TY1 = TY2
```

An excerpt of code taken from subroutine iau\_D2DTF. [SOFA Project]

software.” However, SOFA sets an IAU standard and, as such, the routine name and its contents are bound together. A researcher using SOFA software packages needs the assurance that the particular routines being used adhere to the IAU standard.

The SOFA website allows individual routines to be viewed or copied. Alternatively, the whole library may be downloaded, complete with build procedures and validation tests. Documentation is available with detailed per-routine commenting, but there is also a summarizing manual and three [cookbooks](#): *SOFA Tools for Earth Attitude*, *SOFA Time Scale and Calendar Tools*, and *SOFA Astrometry Tools*.

The current SOFA release contains 219 astronomy routines, 59 of which support IAU Resolutions concerning standards. Since



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### Splinter Meeting: Working Group on Standards of Fundamental Astronomy (SOFA)

Date	Wednesday, 12 August
Time	2:00 to 3:00 pm
Location	Room 326A, Hawai'i Convention Center
Coordinating Division	Division A: Fundamental Astronomy

the last IAU General Assembly, two new categories have been added: Astrometry and Galactic Coordinates. The Astrometry

category consists of 36 routines that deal with the chain of astrometric transformations linking star data from a catalog and the observed direction of the incoming radiation. Galactic Coordinates implements the transformation between the IAU system of galactic coordinates (1958) and coordinates in the International Celestial Reference System (ICRS). ❁



CATHERINE HOHENKERK is Chair of the IAU SOFA Board and President of IAU Commission 4, Ephemerides. She is also Senior Analyst at H. M. Nautical Almanac Office / U.K. Hydrographic Office.

## ASTRONOMY EDUCATION RESEARCH

# Peer-Reviewed Education & Public Outreach

By TIM SLATER

I think we can all agree that one hallmark of being a successful researcher is the publication of peer-reviewed papers in scientific journals. There have, however, traditionally been few choices for astronomers doing research in education and outreach.

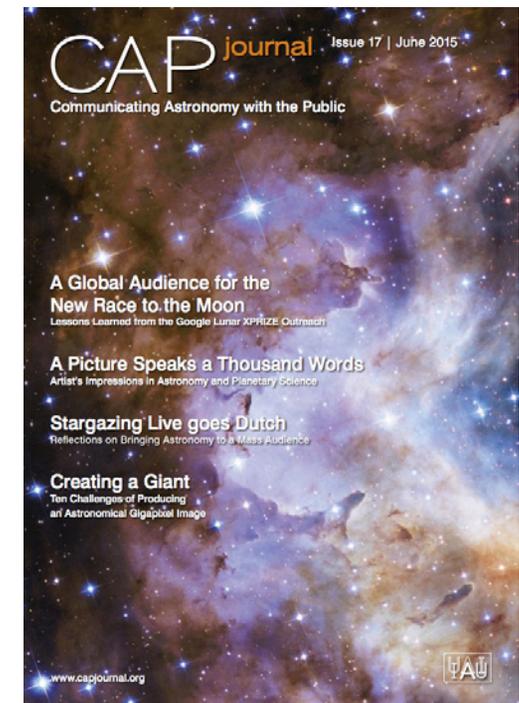
Fortunately there are now several journals available to professional astronomy-education scholars for publishing peer-reviewed research results and materials. The longest-standing journal for astronomy-education research is the [Latin-American Journal of Astronomy Education](#). Abbreviated as RELEA from its title in Portuguese, this journal has published empirical research, theoretical essays, and reviews in a variety of languages (including Portuguese, Spanish, and English) for the past 10 years.

A more recent addition to the portfolio of astronomy-education journals is targeted at people working in scientific communication with the public. The free [Communicating Astronomy with the Public Journal](#) features peer-reviewed articles on different programs and approaches to disseminate our knowledge of the universe to the public, as well as reviews of recent innovations

and best practices.

Launched in December 2014, the [Journal of Astronomy & Earth Sciences Education](#) is a traditional, biannual journal focusing on publishing empirical research studies. All issues (currently two) are open access and available online, but there are both submission fees and page charges for authors that are consistent with many astronomy journal fees.

In addition to these journals for research, peer



review is also being used to vet educational materials for scientific and pedagogical accuracy. [NASA Wavelength](#) hosts materials created to support NASA missions and programs. The IAU has also entered this arena with its support of [astroEDU](#), which is open to new submissions from the astronomy community. Both of these online, database-driven repositories provide an impor-

tant service for educators seeking high-quality materials. 🌸



TIM SLATER is the University of Wyoming Excellence in Higher Education Endowed Professor of Science Education and serves as the Editor of the [Journal of Astronomy & Earth Sciences Education](#).

## A FAN of the Perseids

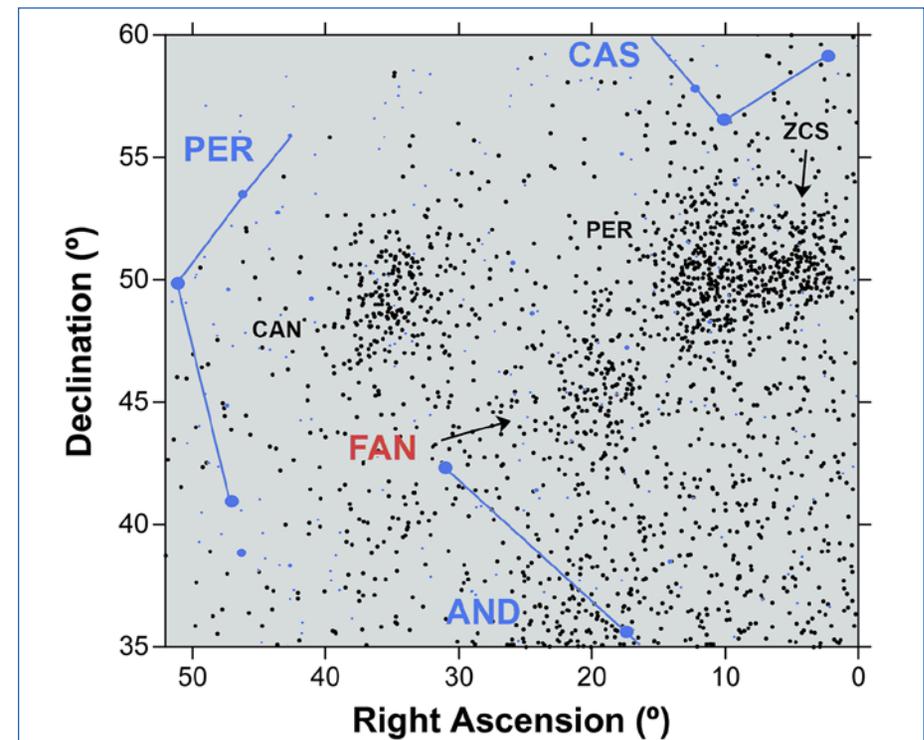
*A new meteor shower joins the August lineup.*

By PETER JENNISKENS

With the Moon out of the way on Wednesday night, 12 August, the Perseid meteor shower is expected to be the best in 10 years. If the skies clear over Honolulu, find a dark location away from city lights with a good view of the sky; see the [companion article](#) by Babak Tafreshi for some suggestions.

Around 11 pm the first grazing meteors will appear, streaking away from the constellation Perseus, which will then be very low in the northeast. Rates and apparent speeds will pick up around 1 am Thursday morning, when you may expect to see around 25 meteors per hour. By around 3 am, rates will double to about 50 per hour, while even higher rates — a little more than 60 per hour — are expected just before dawn, after 5 am. For expert meteor-watching tips, see [Sky & Telescope](#).

If you've been following this shower since it first became conspicuous in mid-July, when the radiant was actually in Andromeda, you may have noticed that not all of the fast meteors from that direction were Perseids. During its business meeting on Monday, 10 August, old Commission 22 — in its last official act before giving way to new Commission F1 — added 18 showers to the list of established ones at the [IAU Meteor Data Center](#) and moved one back to the working list for more study, bringing the tally of well-established meteor showers to 112. One of the 18 new showers is called the 49 Andromedids, with IAU code FAN.



The newly established 49 Andromedids (FAN) appear as a cloud of radiant points, i.e., directions from which the meteoroids are approaching us, in this plot made during the period 7–28 July. Data are drift corrected for Earth's motion around the Sun. The new shower appears amidst the Perseids (PER), ζ Cassiopeids (ZCS), and c Andromedids (CAN). [Peter Jenniskens]

The shower sits amidst other streams that may, or may not, share a common origin at Comet 109P/Swift-Tuttle. How these streams came about can now become a topic of active research by any fan of the Perseids. ✿



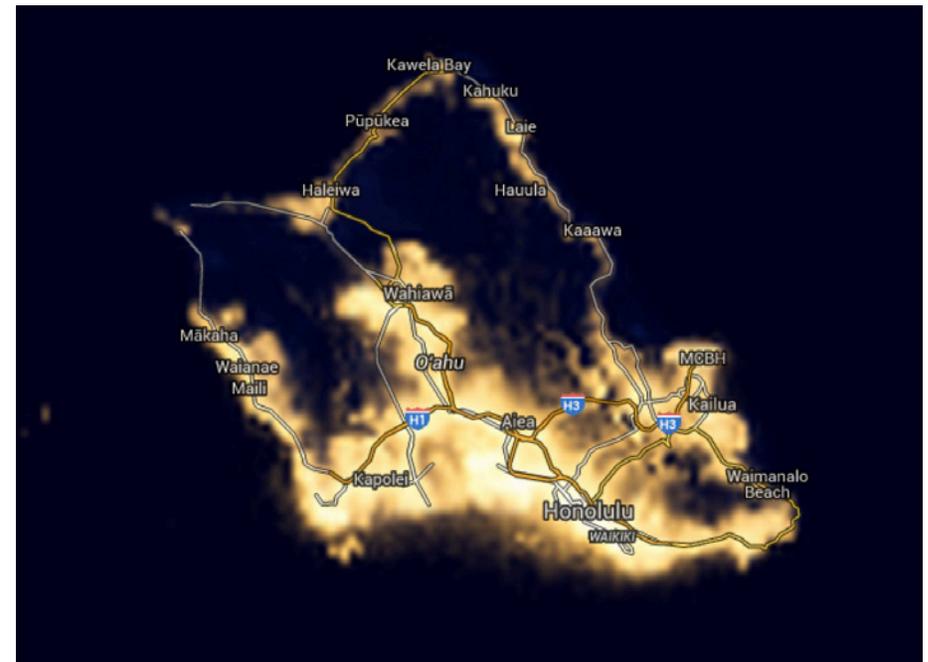
PETER JENNIKENS is the outgoing President of Commission 22, Meteors, Meteorites & Interplanetary Dust, and Senior Research Scientist at the SETI Institute in Mountain View, California.

## Where to Watch Tonight's Perseid Meteor Shower

*There are places on O'ahu, even near Honolulu, where you can find reasonably dark skies.*

By BABAK TAFRESHI

The island of O'ahu is densely populated and light polluted, especially around downtown Honolulu and Waikīkī. If you have a car and don't mind driving an hour or so, the North Shore offers skies that are dark enough to show the Milky Way prominently. Looking at the accompanying [light-pollution map](#), it appears that the northwest tip of the island is perhaps the darkest spot. Kaena Point, not labeled on the map, is located there at the end of State Highway 93; it's a scenic state park known for great snorkeling. Another dark spot is Kualoa Point on the island's east coast, just



[\[http://www.blue-marble.de/nightlights\]](http://www.blue-marble.de/nightlights)



south of Kaaawa on the map.

If you're on foot or on a bike, try [Diamond Head Beach Park](#), a favorite spot for surfers. From there the light of Honolulu is blocked by the mountain, such that the sky in the direction of the ocean is reasonably dark. Diamond Head lighthouse is operating

next to the park, which will cause some local light pollution, but it's quite scenic, so you can just treat it as a "photo op."

If you stay near the hotels and Convention Center, and if the weather cooperates, you can still watch for bright Perseid meteors from a less-illuminated spot along Waikīkī Beach. Meteors can appear anywhere in the sky, so the best advice is to look where it's darkest. 🌸

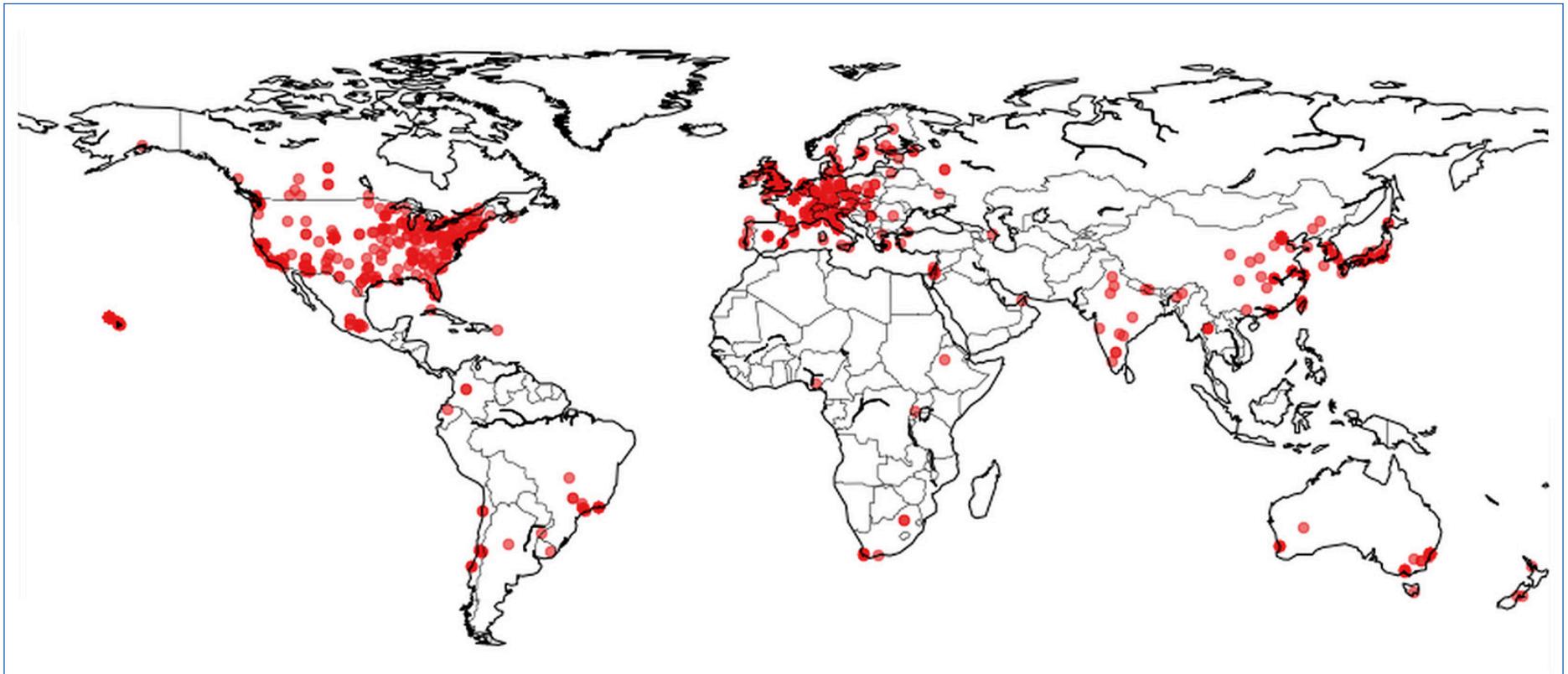


Artist and astrophotographer **BABAK TAFRESHI** is founder and director of [The World At Night \(TWAN\)](#), an international effort to present stunning nightscape photos and time-lapse videos of the world's landmarks against celestial attractions. Originally from Iran, he now lives in Massachusetts, USA.

## Honolulu Almanac 🌐 12 August 2015

Sunrise / set	6:09 am / 7:04 pm
Twilight <sup>1</sup> start / end	4:50 am / 8:22 pm
Moonset / rise	4:34 am / 5:49 pm
Moon phase <sup>2</sup>	● Waning crescent (3% illum.)
Evening planet <sup>3</sup>	Saturn (SSW)
Morning planet <sup>3</sup>	Mars (E)
Special event	<a href="#">Perseid meteor shower</a> (late night)

<sup>1</sup>Astronomical twilight (Sun 18° below horizon). <sup>2</sup>At meridian crossing <sup>3</sup>Naked-eye planets. Source: [timeanddate.com](http://timeanddate.com)



[Kyle Willett](#) (University of Minnesota, USA) created this map of attendees' home institutions from the IAU XXIX General Assembly [registration list](#).

# Solar Radiation and Structure

By GIANNA CAUZZI & NATALIE KRIVOVA

IAU Commission E1, Solar Radiation and Structure, deals with the observational and theoretical aspects of the radiation, structure, and variability of the “quiet” Sun (though there are close interconnections between the Sun’s normal state and occasional outbursts).

The previous incarnation of this Commission, Commission 12, had successfully acted for several decades, coordinated international efforts to maintain long-term solar synoptic observations, and organized numerous Symposia, Special Sessions, Joint Discussions, and Focus Meetings. For example, since 2000 the Commission has proposed and co-organized seven Symposia and five other meetings, including IAU Symposium 320 and Focus Meeting 13 during the present IAU General Assembly.

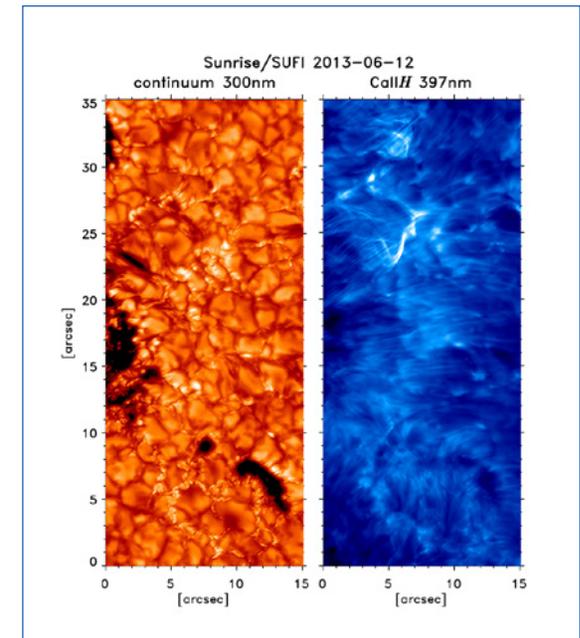
Tremendous advances in solar observations from the ground and from space have marked recent years, propelling progress in data analysis, numerical simulations, and modeling. Numerous complementary telescopes equipped with multiwavelength, spectropolarimetric imaging capabilities have provided an unprecedented view of the complex structure, dynamics, and magnetism of the Sun, from the deep interior to the atmosphere and corona.

At the same time, 3-D radiative magnetohydrodynamic (MHD) models of the solar magnetoconvection and emerging magnetic flux are maturing. These are providing, for the first time, realistic descriptions of quiet-surface magnetism, sunspots, spicules, plasma eruptions, and waves in the solar atmosphere. Three-dimensional global-Sun MHD models can now reproduce the basic features of solar convection, differential rotation, meridional circulation, and magnetic field generation by the turbulent dynamo. Among the more remarkable recent advances is the

growing realization that the global dynamics and variability of the Sun are coupled to small-scale processes.

The challenge for the next decade will be to address the multiscale dynamical coupling of the quiet Sun effectively in order to understand the basic mechanisms of solar magnetism and variability. Such a task requires close coordination of long-term synoptic observations and high-resolution campaigns, involving both ongoing and planned facilities, as well as international cooperation among solar observers, modelers, and theorists. Efforts must be pursued to allow community access to these data and to provide sophisticated tools for their interpretation, including spectropolarimetric inversions and 3-D non-local thermodynamic equilibrium (non-LTE) radiative-transfer techniques.

The primary goal of Commission E1 will be to facilitate commu-



The surface of the Sun at highest resolution as seen by the balloon-borne telescope Sunrise. The image covers 1/20,000th of the visible solar surface and depicts small-scale concentrations of magnetic fields on our star. The left panel shows granulation, and the right panel shows the filamentary character of the complex magnetic field lines. *[Sunrise Team]*

nication among the various actors in this complex undertaking. Several Working Groups are planned to address, in particular, the coordination of synoptic observations, helioseismology issues, high-resolution spectropolarimetric observations and analysis, and solar irradiance. Other goals include the development of connections and collaborations with the community studying magnetic and photometric variability of Sun-like stars, and promoting the most up-to-date knowledge of solar variability (past, present, and potentially future) in the terrestrial climate community. 🌸

## INTERNATIONAL YEAR OF LIGHT 2015

# Cosmic Light Awareness

By LINA CANAS

As part of the global celebration of the [International Year of Light 2015 \(IYL 2015\)](#), the IAU is coordinating the [Cosmic Light](#) program. Part of this project focuses on limiting energy waste through the reduction of light pollution and by highlighting the importance of preserving dark night skies.

[The Cosmic Light Awareness](#) cornerstone project focuses on involving schools around the globe in three programs within the framework of the IYL 2015: the Dark Sky Meter app, the Cosmic Light EDU kit, and the Quality Lighting Teaching Kit.

[The Dark Sky Meter app](#) (available only for iPhones) provides users instant information about the quality of the night sky, enabling them to contribute directly to global citizen-science programs, such as [Globe at Night](#). So far the app has attracted 2,900 users and registered 17,100 measurements. [Pedro Russo](#), the Dark Sky Meter app project leader, showcased the app to IAU General Assembly delegates yesterday at the IAU booth in the Exhibit Hall.

With the [Cosmic Light EDU kit](#), teachers have access to an online collection of activities, tools, and other resources on the science of light. Project leader Rosa Doran says the Cosmic Light



GIANNA CAUZZI is an astronomer at the Italian National Institute of Astrophysics, working on the structure of the quiet and active solar chromosphere. She is President of IAU Commission 12 and co-proposer and member of the Organizing Committee of Commission E1. NATALIE KRIVOVA is the leader of the Minerva Research Group on Solar Variability and Climate at the Max Planck Institute for Solar System Research in Germany. She is a member of the Organizing Committee of C12 (2012-15) and incoming President of C.E1.

EDU kit aims to be a “one-stop shop” for educators. Its mission is to support the promotion of global workshops related to light and its importance as a cosmic source of information that brings us awareness about our universe. The team behind this kit has received more than 120 workshop proposals to be implemented between July 2015 and April 2016. More than 40 countries will be using the 50 free light-based educational resources and activities featured in the Cosmic Light EDU kit. Additionally, the [IAU Office for Astronomy Outreach](#) will ship 150 project-related goodie packs



A young visitor to the IAU booth learns that fighting light pollution can be fun! [Lina Canas]

to organizers around the world to support the initiative's success.

[The Quality Lighting Teaching kit](#) will increase student and public awareness of lighting issues through online tutorials, teaching kits, and hands-on activities. The program, along with 100 kits, will be disseminated to formal and informal education venues worldwide. Project leader Constance Walker said, "The six Quality Lighting Teaching kit activities allow middle-school students to address real light-pollution problems that relate to wildlife, the night sky, aging eyes, energy consumption, safety, and light trespass. They also allow learners to apply their solutions to their city of the future."

Want to learn more about Cosmic Light? Drop by Booth 329 in the Exhibit Hall, and we'll show you what the Cosmic Light program can offer you. 🌸



LINA CANAS is Assistant Outreach Coordinator in the IAU Office for Astronomy Outreach (OAO) at the National Astronomical Observatory of Japan (NAOJ) in Tokyo. She is originally from Portugal.

## IAU SYMPOSIUM 318 PLENARY

# Asteroids: The Fossils of Planet Formation

By PATRICK MICHEL & WILLIAM BOTTKÉ

Asteroids are fascinating worlds. The largest — dwarf planet Ceres — was discovered in 1801 and is currently being explored by [NASA's Dawn](#) mission. More than 1 million asteroids larger than 1 kilometer in diameter are thought to occupy the asteroid belt between the orbits of Mars and Jupiter. So far only a fraction of these objects, several hundred thousand, have been discovered.

Asteroids are considered the building blocks of our planets. Their exploration involves ground- and space-based observations, in-situ space missions, and studies that run the gamut from theoretical modeling to laboratory work. Like fossils for paleon-

## Education & Outreach in the Exhibit Hall

On Wednesday, 12 August, the IAU will host about 200 local primary- and secondary-school students at an outreach event in the Exhibit Hall. With generous support from [Associated Universities, Inc.](#), these youngsters and their teachers, parents, and counselors will interact with scientists from some of the observatories, organizations, and institutions that have set up displays at the General Assembly. The students will participate in hands-on educational activities and enjoy a unique opportunity to ask questions of astronomers from all corners of the globe. Please welcome them in the spirit of aloha!

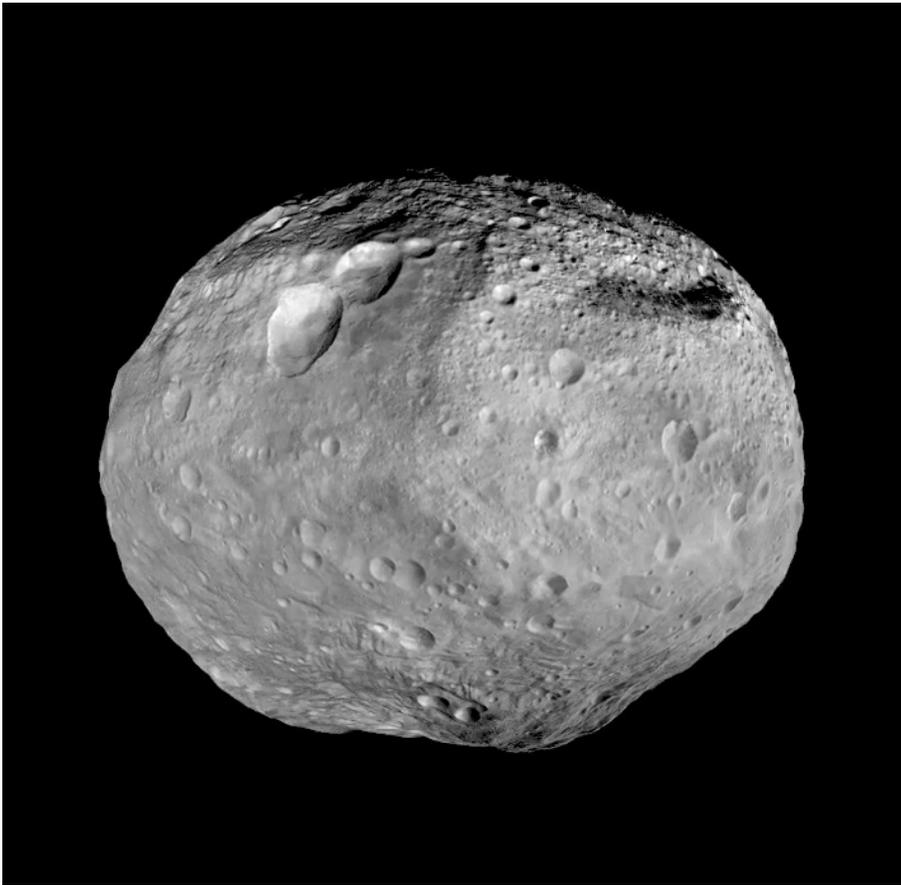


Students who visited the IAU Exhibit Hall last Wednesday used balloons to investigate Hubble's law and the expansion of the universe. [IAU/B. Tafreshi, [twanight.org](#)]

— Rick Fienberg, Kai'aleiaka

tologists, or DNA for geneticists, asteroids allow us to construct a veritable time machine as they provide us with tantalizing glimpses of the earliest appearance of our solar system.

The story of the origin and evolution of life on our planet is also intertwined with the story of asteroids. It is thought that impacts on the primordial Earth may have delivered the basic components for life, with biology favoring attributes that could more easily survive these energetic events. In this fashion, asteroids may have banished some probable evolutionary avenues to relative obscurity. Similarly, they also may have delayed the



This mosaic of Vesta synthesizes some of the best views from NASA's Dawn spacecraft, which studied the asteroid at close range from July 2011 to September 2012. The towering mountain at the south pole — more than twice the height of Mount Everest — is visible at the bottom of the image. The set of three craters known as the “snowman” appears at top left. [NASA, JPL-Caltech, UCAL, MPS, DLR, IDA]

development of a more complex biosphere. The full tale of asteroid impacts on the history of our world, and how human life managed to emerge from the myriad of possibilities, has yet to be fully told.

The hazard posed by asteroid impacts to our civilization is low, but singular. The design of efficient mitigation strategies strongly relies on asteroid detection by ground- and space-based surveys, as well as knowledge of their physical properties. About 1,000 asteroids are characterized as near-Earth objects, and it's

estimated that only 90% of them have been discovered. The proximity of some asteroids to Earth may allow future astronauts to harvest water and rare minerals for use in exploration. A key goal of asteroid science is therefore to learn how humans and robotic probes can interact with asteroids (and extract their materials) in an efficient way.

Asteroids, like planets, are driven by a great variety of both dynamical and physical mechanisms. Images sent back by spacecraft show a collection of small worlds whose characteristics seem designed to overthrow our preconceived notions. Given asteroids' wide range of sizes and surface compositions, it is clear that their formation occurred in different places and times within the solar nebula. A very intriguing asteroid discovery shows evidence of activity, which implies that, based solely on physical properties, asteroids and comets may be less different than originally thought — a continuum may exist between these populations.

The return of samples from these bodies, as planned by

## Honolulu Weather Forecast 🌩️ 12-13 August 2015

### WEDNESDAY, 12 AUGUST

**High: 88°F / 31°C Low: 76°F / 24°C**

#### Morning

Clear to partly cloudy

5% chance of rain

#### Afternoon

Partly cloudy

15% chance of rain

#### Evening

Partly cloudy

10% chance of rain

### THURSDAY, 13 AUGUST

**High: 87°F / 31°C Low: 76°F / 24°C**

#### Morning

Partly cloudy

35% chance of rain

#### Afternoon

Partly cloudy

25% chance of rain

#### Evening

Partly cloudy

20% chance of rain

**Extended forecast:** Hilda has been downgraded to a tropical storm; however, it is expected to bring widespread rain across Hawai'i Island, with some rain expected for the smaller islands. The upper trough north of the state will remain nearly stationary over the next several days, causing unstable conditions across the state. Sources: [Weather Underground](#), [National Weather Service](#).

Japan's [Hayabusa 2](#) mission (launch: December 2014, sample return: 2020) and NASA's [OSIRIS-REx](#) mission (launch: September 2016, sample return: 2023), will greatly help us in our quest. Other space projects, if funded, aim to extend our understanding of the geophysics and compositional diversity of asteroids. For instance, the Asteroid Impact & Deflection Assessment (AIDA) mission, an ESA-NASA collaboration, aims to test deflection of the small moon of the binary asteroid Didymos in 2022, to characterize for the first time the internal properties of a small asteroid, and to rendezvous with Trojan or main-belt asteroids.

Our understanding of asteroids is also crucial to our understanding of circumstellar environments. More than 1,800 extrasolar planets have been found orbiting other stars, along with more than 4,500 Kepler planet candidates. With time, these worlds will be joined by more and more debris-disk discoveries, though we will not be able to observe the detailed properties of these systems in the near future.

Asteroids, along with comets, are the closest analogs we have to the types of objects involved in planet formation. By explor-

ing how asteroids formed and evolved, we glean insights into the history and properties of debris disks and planetary systems around other stars. Asteroids are therefore fascinating, not only because they tell us about our own solar system's provenance and evolution, but also because they can help us better interpret what is going on in newly discovered planetary systems. 🌸



**PATRICK MICHEL** is the leader of the team Theories and Observations in Planetology (TOP) at the Lagrange Laboratory at Côte d'Azur Observatory in Nice, France. He leads

the investigation team of the European component of AIDA and is Co-Investigator on NASA's OSIRIS-REx and JAXA's Hayabusa 2.

**WILLIAM BOTTKE** is the Director of the Department of Space Studies at the Southwest Research Institute in Boulder, Colorado. He is also the Director of the Institute for the Science of Exploration Targets (ISET) of NASA's Solar System Exploration Research Virtual Institute (SSERVI) and Co-Investigator on NASA's OSIRIS-REx asteroid-sample-return mission.

## IAU SYMPOSIUM 321

# The Formation and Evolution of Galaxy Outskirts

By JOHAN KNAPEN & JIN KODA

The study of the properties, formation, and evolution of galaxy outskirts is critical to understanding the fueling and growth of galaxies. Observations of such structures present a true challenge to astronomers at the low-surface-brightness frontier. [IAU Symposium 321, Formation and Evolution of Galaxy Outskirts](#), will review the latest results on the star, gas, and dust content of the outer regions of galaxies — from resolved stellar populations in the Local Group to high-redshift populations. The meeting, to be held in March 2016 in Toledo, Spain, will also explore the possible advances to



The city of Toledo, Spain, will host IAU Symposium 321 in March 2016.

be provided by next-generation facilities.

New large-scale imaging facilities, such as the [Visible and Infrared Survey Telescope for Astronomy \(VISTA\)](#) and the upcoming [Large Synoptic Survey Telescope \(LSST\)](#), will provide enormous gains in depth to map galaxies farther out in distance and time. The [James Webb Space Telescope \(JWST\)](#) will enable studies of individual stars in galaxies well beyond the Local Group. This will be complemented by emerging multi-object spectroscopy from the [K-band Multi-Object Spectrograph \(KMOS\)](#) at the Very Large Telescope (VLT) and, in the near future, from the European Extremely Large Telescope (E-ELT). The molecular gas phase can now be probed with The [Atacama Large Millimeter/submillimeter Array \(ALMA\)](#) and the [Institut de Radioastronomie Millimétrique \(IRAM\) 30-meter telescope](#), while radio surveys with the [Jansky Very Large Array \(JVLA\)](#) and the [Square Kilometre Array \(SKA\) precursors](#) will revolutionize our knowledge of neutral hydrogen in galaxy outskirts.

These facilities are complemented by advancing numerical simulations that, through improvements in modeling baryon-cycle processes, now finally start to reproduce the full Hubble sequence at sufficient resolution to dynamically explore the transport of gas, stars, and metals through the outskirts of galaxies. Hence the time is right to bring together observers and theorists working on the crucial regime of galaxy outskirts to assess

IAU Symposium 321: Formation and Evolution of Galaxy Outskirts	
Start date	14 March 2016
End date	20 March 2016
Location	Toledo Congress Centre, Toledo, Spain
Website	<a href="http://galaxyoutskirts.org">http://galaxyoutskirts.org</a>
Coordinating Division	Division J: Galaxies and Cosmology

the current state of the field and to chart an optimal path forward.

IAU Symposium 321 is sponsored by Complutense University of Madrid; Detailed Anatomy of Galaxies (DAGAL); IAU Division J, Galaxies and Cosmology; and the Space Telescope Science Institute.

Registration and abstract submissions will open in the fall of 2015 after a second announcement. A tentative scientific program has been posted on the [Symposium website](#). The scientific and local organizing committees look forward to welcoming many interested participants! ❀



JOHAN KNAPEN is Research Astronomer at the Astrophysical Institute of the Canary Islands. JIN KODA is Associate Professor at Stony Brook University in New York and Co-Chair of the Scientific Organizing Committee of IAU Symposium 321.



**Jill Lagerstrom!**

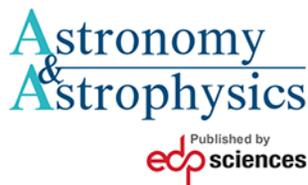
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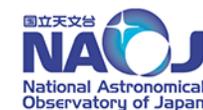


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# Attributing More Value to Public Engagement

By JOSH BORROW & PEDRO RUSSO

An anti-public-engagement atmosphere is discouraging participation of researchers in science outreach at all career stages. Young researchers, in particular, are too often actively dissuaded from “wasting their time” on such activities by more senior colleagues. This is in stark contrast to the so-called third aim of research institutes around the globe, namely, to facilitate knowledge transfer to the public. This issue was discussed last week during [Focus Meeting 19, Communicating Astronomy with the Public in the Big Data Era](#).

Widespread disparagement of public outreach is unsurprising,

as most career development in research institutions is tied directly to research, and, to a lesser extent, teaching. This not only includes training opportunities, but also promotion and pay decisions. If researchers would like to engage with the public, they are disincentivized from doing so; they will have less time to devote to their research and teaching duties, which are directly connected to their salary. This is, perhaps, why one of the most often stated reasons for not engaging with the public is a lack of time.

It is important to note that



Public engagement in action: Maltese students design an alien at the National Student Travel Foundation Malta. *[Universe Awareness]*

we are not suggesting that each and every researcher should engage with the public. Rather, we propose that time spent performing good public-engagement work should be valued similarly with time spent producing good research.

An appraisal system, similar to the one used to determine research output and quality, could be implemented. This would allow researchers to build a public-engagement portfolio that can be presented alongside a research portfolio when career-advancement opportunities arise. Public-engagement work could then be taken into account by the institution — along with research, ser-

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vice, and teaching — when deciding who to hire or promote.

Such a system may be difficult to implement but could be worked into the pre-existing yearly research-appraisal system used in many institutions. To be truly successful, a staff member who is experienced in engagement should be present at meetings where the career progressions of researchers are discussed, so that their public engagement work can be evaluated sensibly.

While all of this may seem drastic, it reflects the changing role of researchers in society. No longer is it enough to produce papers and perform teaching duties; academics are now expected to engage with the public, contribute to scientific computing libraries, and deal with large amounts of administrative work. Such activities are rarely considered when career-development opportunities arise, leaving those who perform these vital

duties behind in terms of pay and position. Research institutions clearly want these duties to be undertaken — so they must value them more highly.

For additional information on this topic, see “A Blueprint for Public Engagement Appraisal: Supporting Research Careers” ([PDF](#)) or contact us by email via the links in our bio. 🌸



[JOSH BORROW](#) is an undergraduate student at Durham University, U.K., and host of [Café Scientifique Durham City](#). He also works for the educational program [Universe Awareness](#) at Leiden Observatory, the Netherlands. [PEDRO RUSSO](#) is International Project Manager for Universe Awareness and incoming President of IAU [Commission C2, Communicating Astronomy with the Public](#).

## COMMISSION G1

# On the Importance of Binary and Multiple Star Systems

By ANDREJ PRSA

The subject of binary and multiple stars has been part of astronomy since the work of John Michell in 1767. These systems are important today, and will be for many future decades, because their formation, evolution, detection, and death are relevant to current hot topics: exoplanets, X-ray sources, black holes, and galactic evolution.

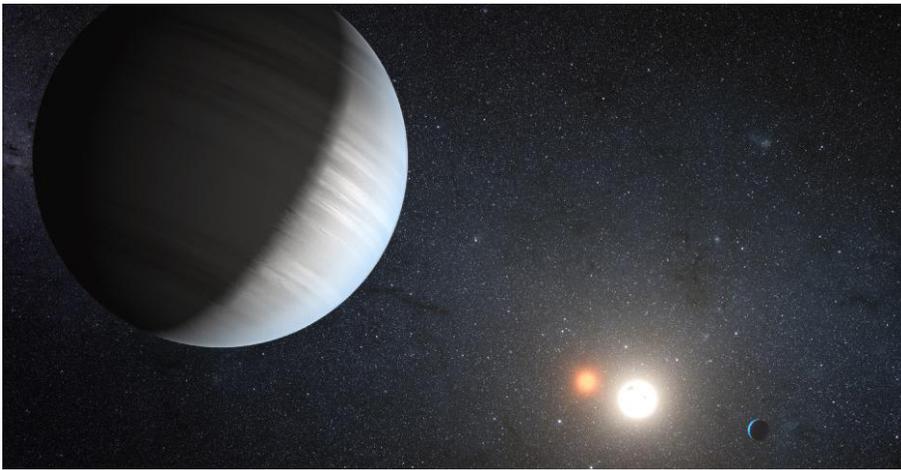
Understanding the science of these systems is an essential part of stellar physics, as single stars like the Sun are in the minority. Further, understanding the science of these systems is entwined with our understanding of the fields of planetary science, stellar structure, and evolution (as calibrators), high-energy astrophysics, supernovae, galactic chemical evolution, and cosmology.

The new Commission G1, Binary and Multiple Star Systems, extends the science that was previously covered by Commission 26, Double and Multiple Stars, and Commission 42, Close Binary

Stars. The intent of our Commission is to curate all of the relevant observations of individual systems and populations, along with statistical studies (both analytical and numerical), and to provide database maintenance.

The goals of Commission G1 are to encourage additional research to identify and examine the following:

- Best possible values of fundamental stellar parameters (M, R, L, T) and surface compositions for important calibrator systems — in particular, well-detached, double-lined spectroscopic eclipsing binaries;
- Accurate statistical samples of a wide range of binary star populations;
- Degrees of co-planarity of multiple systems;
- Improved theories of star formation and spatial distribution;
- Improved theories of stellar and orbital evolution;



Artist's rendition of Kepler-47, the first multiplanet circumbinary system. [NASA, JPL-Caltech, T. Pyle]

- Implications for the habitability of exoplanets and exomoons around binary and multiple systems;
- Expected numbers of Type Ia supernovae and their inputs to galactic chemical evolution and for use as standard

candles for cosmology.

We will provide long-term service to the community by maintaining several catalogs in the tradition of Commissions 26 and 42, namely the Spectroscopic Binary Catalog, the Visual Double Star Database, the Information Bulletin on Variable Stars, and the Bibliography of Close Binaries, which are all important resources used by both amateur and professional astronomers. There is currently minimal overlap in the content of these catalogs.

C.G1 will also provide education and public outreach (EPO) services to the international community. In particular, regular monitoring of eclipsing binaries with small telescopes is an excellent opportunity for students and amateur astronomers to be involved in astronomy. 🌸



ANDREJ PRSA is Associate Professor of Astrophysics and Planetary Science at Villanova University, Pennsylvania, and the incoming President of Commission G1. He is past chair of the Kepler Eclipsing Binary Working Group.



This was the scene on Tuesday afternoon at a session of IAU Symposium 319, Galaxies at High Redshift and Their Evolution Over Cosmic Time. [IAU/B. Tafreshi, [twanight.org](http://twanight.org)]

# Exploring Astrochemistry Near and Far

By TOM MILLAR

[Commission H2, Astrochemistry](#), is a new Commission and an upgrade of a long-running and successful Working Group of the same name. The topic is one of growing importance within

## How to Contribute to the Conference Newspaper



*Kai'aleiaka* 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.

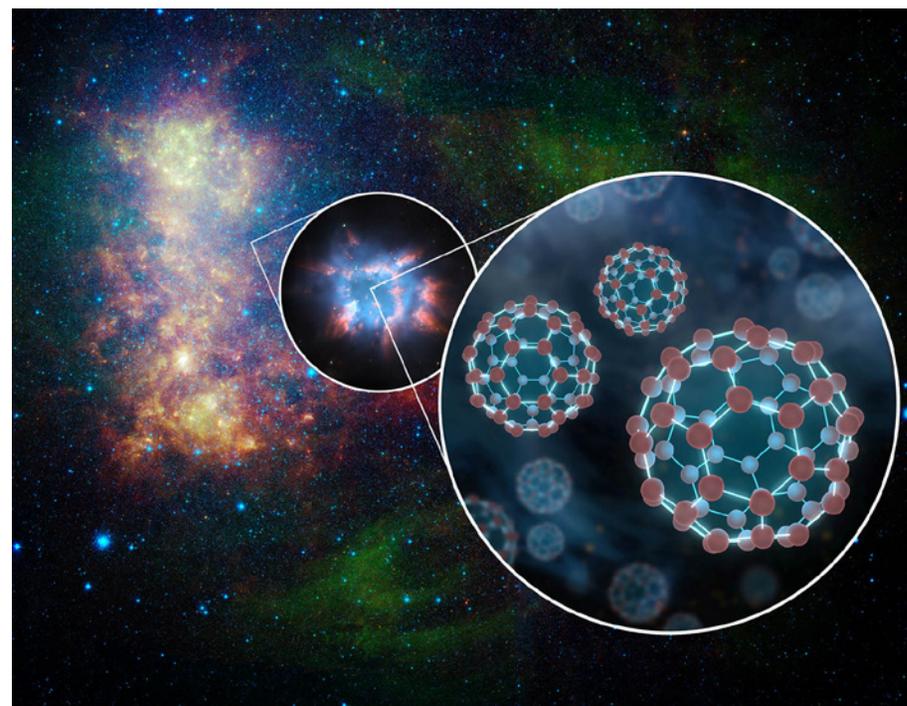
Please email your materials to [newspaper@astronomy2015.org](mailto:newspaper@astronomy2015.org) or bring them to our office, Room 302, in the Hawai'i Convention Center, Monday through Friday, 8 am to 6 pm. Note that if you want an article to appear on a particular day, you need to get it into our hands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

astronomy: the use of molecular emission and absorption lines to probe objects as diverse as planetary atmospheres and comets within our solar system and distant galaxies at redshifts greater than  $z = 6$ .

Studying astrochemistry is not only intrinsically valuable to astronomy, but also to chemistry. The interstellar medium is an extreme environment in terms of temperature, density, size, and time-scales, and these conditions are not easily accessible



Representation of fullerenes inside a planetary nebula. [NASA, JPL-Caltech, T. Pyle]

to terrestrial laboratories. Astrochemistry also attracts scientists from a number of other disciplines, such as planetary science, astrobiology, and the study of exoplanets and their atmospheres.

Because of this broad appeal, astrochemistry is a rich and vibrant field, with many adherents throughout the world and the potential for huge growth as new and more powerful telescopes search for molecules. Collaboration spanning several countries is now commonplace, and large-scale international cooperation occurs in the construction of expensive telescopes, such as the [Herschel Space Observatory](#) and the [Atacama Large Millimeter/](#)

[submillimeter Array](#), for which the initial scientific cases were largely driven by astrochemists.

Major aims of the new Commission H2 are to develop close links with related national bodies, such as the [Astrochemistry Subdivision of the American Chemical Society](#) and the [Astrophysical Chemistry Group of the Royal Chemical Society](#), as well as to plan for a major IAU Symposium to be held, hope-

fully, in Chile sometime in 2017. 🌸



**TOM MILLAR** is Professor of Astrophysics at Queen's University Belfast, U.K., former President of IAU Division VI (Interstellar Matter), and incoming President of IAU Commission H2. He has been involved in the study of **astrochemistry** for more than 40 years.

## FOCUS MEETING 21

# Astronomers Needed to Save the World from Blinding Itself

By RICHARD GREEN & CONSTANCE WALKER

Rapidly advancing technology threatens to make the glare from powerful LEDs and the radio-frequency transmissions for control and communications ubiquitous. We therefore cannot assume that our current and next-generation telescopes will be automatically blessed with pristine dark skies and radio quiet-zone protection through only the occasional attention of observatory directors. We, as astronomers, have a responsibility to become informed and engaged to assure that our access to the cosmos from the ground is not diminished.

[Focus Meeting 21](#) provides such an opportunity. Commissions [46, Astronomy Education and Development](#), and [50, Protection of Existing and Potential Observatory Sites](#), invite you to participate in the remaining sessions of FM 21, Mitigating Threats of Light Pollution & Radio Frequency Interference, today and tomorrow. There will be technical talks on LED technology and spectral energy output, as well as on the pressures facing the protected radio-frequency spectrum and radio-quiet zones.

A number of talks will focus on measurement of artificial sky glow, and many speakers will address efforts for protection of individual observatory sites around the world. Two of the sessions will be held jointly with Focus Meeting 2 to discuss protection of dark skies in relation to UNESCO World Heritage status,

Focus Meeting 21: Mitigating Threats of Light Pollution & Radio Frequency Interference	
Start date	Tuesday, 11 August
End date	Thursday, 13 August
Oral sessions	Room 316B, 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 <a href="#">online program</a> or <a href="#">mobile app</a> .	

both for astronomical sites in Chile and in other World Heritage locations. There will also be sessions devoted to raising public awareness of the environmental damage of light pollution. We intend to close with a discussion to update the Commission 50 action plan on implementing the IAU Resolution on the world's right to starlight.

During this [International Year of Light 2015 \(IYL 2015\)](#), astronomers' voices must be heard to make the case for quality lighting and sensible radio-spectrum management to preserve our view of the cosmos. As an international community of researchers,



Star trails over Kitt Peak National Observatory in Arizona. *[James Lowenthal]*

we can leverage the respect and admiration of the public for our discoveries to make an impact on critical policy. We look forward to seeing you at FM 21. 🌸



**RICHARD GREEN** is Assistant Director of Steward Observatory at the University of Arizona, incoming President of Commission B7, and Chair of the [IAU Cosmic Light Working](#)

[Group](#). He has served as Director of Kitt Peak National Observatory and the Large Binocular Telescope Observatory. **CONNIE WALKER** is the incoming Vice-President of Commission B7. She works in the Science Education Department at the National Optical Astronomy Observatory in Tucson, Arizona, and serves on the Board of Directors of both the [International Dark Sky Association](#) and the [Astronomical Society of the Pacific](#). She is the Director of the GLOBE at Night citizen-science program, which measures night-sky brightness worldwide.

## For Your Consideration

*Adoption of Resolutions B2 and B3 will minimize confusion among stellar and planetary astronomers.*

By ERIC MAMAJEK

Aloha, astronomers! The Inter-Division (A, G) Working Group on Nominal Units for Stellar & Planetary Astronomy has drafted two Resolutions, B2 and B3, for your vote tomorrow at the Business Meeting of the General Assembly II from 4:00 to 6:00 pm in Ballroom B of the Hawai'i Convention Center. The wording of the Resolutions and the adopted values of the units therein are the result of many months of discussion by astronomers from a range of backgrounds and IAU Divisions.

**Resolution B2** defines exact SI values for luminosity (in watts) and irradiance (in watts/meter<sup>2</sup>) that would set an IAU *absolute* and *apparent bolometric magnitude* scale, respectively. Astronomers have used bolometric magnitudes for at least eight decades, but there has been surprisingly little standardization of the zero points of the bolometric magnitude scales. This has led to different *bolometric correction* (BC) scales, confusion, and unnecessary systematic errors.

References over the past 50 years adopt solar  $M_{\text{bol}}$  values anywhere between 4.64 and 4.77! This long-standing problem was discussed by [Bessell, Castelli & Plez \(1998, A&A 333, 231\)](#) and [Torres \(2010, AJ 140, 1158\)](#). They found that adopting incompatible combinations of solar absolute bolometric magnitude and bolometric-correction scale can easily lead to systematic errors at the 0.1-magnitude level. Unfortunately, some popular references present incompatible combinations of solar  $M_{\text{bol}}$  and BC. Resolution B2 connects the stellar bolometric magnitude scale to the solar irradiance scale, which is now absolutely SI calibrated to about 0.03%, but permanently disconnects the scale from the variable Sun (variable at about the 0.1% level).

In the Gaia era, the luminosity estimates for many stars will be



IAU members cast their votes on a Resolution at the XXVII General Assembly in Rio de Janeiro, Brazil, in 2009. [IAU]

dominated no longer by distance uncertainties, but by uncertainties in the bolometric flux and/or apparent bolometric magnitude. Now is an opportune time for standardization of the bolometric magnitude scales so as to reduce systematic errors in the calculation of luminosities and related properties.

**Resolution B3** defines a set of *nominal conversion constants* for stellar and (exo)planetary astronomy. It is common for astronomers to quote stellar and planetary properties (e.g., radii) in units of that parameter for the Sun, Jupiter, or Earth. Some parameters are (or will be) measured so accurately that it may matter which value one adopts for the corresponding solar, Jovian, or terrestrial parameter. Resolution B2 defines exact constants in SI units that are close to the current best estimates to

provide useful rulers for astronomical calculations for the foreseeable future. The constants are rounded to a convenient number of significant figures based on modern uncertainties in the current best estimates. While the estimates of the actual parameters for the Sun and planets will improve and bounce around

## IAU XXIX General Assembly Resolutions

The four Resolutions to be considered at the second Business Meeting of the General Assembly on Thursday, 13 August, are available on the [conference website](#). There you'll find brief summaries, a link to a [PDF](#) of the complete texts, and two related documents. We encourage all IAU members to review the four Resolutions carefully before coming to Ballroom B at 4:00 pm on Thursday, 13 August, to cast your votes.

— Rick Fienberg, Kai'aleiaka

at the 1- to 2-sigma level in the future, the community will have useful nominal constants to use as rulers. A similar Resolution in 2012 set the astronomical unit to an exact SI length in meters, permanently disconnecting it from improvements in the measured GM value for the Sun.

The members of our Working Group expect that adoption of Resolutions B2 and B3 by the international astronomical community will reduce the incidence of systematic errors and avoid the necessity of recalculating values due to differences in the adopted parameters among different investigators. ❀



ERIC MAMAJEK is chair of the Inter-Division (A, G) Working Group on Nominal Units for Stellar & Planetary Astronomy, and Associate Professor of Physics & Astronomy at the University of Rochester, New York.

## Revised Working Rules for IAU Divisions

By THIERRY MONTMERLE

The [Statutes](#) of the International Astronomical Union (IAU) define the goals and organizational structure of the Union, while the [Bye-Laws](#) specify the main tasks of the various bodies of the Union in implementing the provisions of the Statutes. The [Working Rules](#) are designed to assist the membership and governing bodies of the Union in carrying out these tasks in an appropriate and effective manner.

The [IAU Executive Committee](#) updates the Working Rules as necessary to reflect current procedures and to optimize the services of the IAU to its membership. In the wake of the recently enacted Division and Commission Reform, the Executive Committee has revised the Working Rules for Divisions as follows. (See [page 32](#) for the revised Working Rules for Commissions.)

New text is in blue type. Strikethrough (whether blue or black) indicates deleted text. *For clarity, in case of significant modifica-*

*tions to a paragraph, the original paragraph from the Working Rules follows in italics.*

### IX. TERMS OF REFERENCE FOR DIVISIONS

The Divisions are the scientific backbone of the IAU. They have a main responsibility for monitoring the scientific and international development of astronomy within their subject areas, and for ensuring that the IAU will address the most significant issues of the time with maximum foresight, enterprising spirit, and scientific judgment. To fulfill this role IAU Divisions should maintain a balance between innovation and continuity. The following standard Terms of Reference have been drafted to facilitate that process, within the rules laid down in the Statutes § X and the Bye-Laws § V.

37. As specified in Bye-Law 18, the scientific affairs of the Division are conducted by a [Division Steering Committee](#) of up to 12 members of the Division, headed by the Division President, Vice-President, and Secretary. [In addition](#), the Division Steering Committee is composed of the [Presidents of their affiliated Commissions or their representatives \(in the case of “Cross-Division” status of the Commission\) \(see § 41b\)](#), and 6 at-large members [elected by the Division membership](#). Thus, All significant decisions of the Division require the approval of the [Steering Committee](#), and the President and Vice-President are responsible for organizing the work of the Committee so that its members are consulted in a timely manner. [The Division Secretary is designat-](#)

[ed among the members of the Division Steering Committee \(see §39e\)](#), but cannot be a [Commission President](#). Contact information for the members of the [Steering Committee](#) shall be maintained at the Division web site.

Unless agreed otherwise by the Executive Committee on a case-by-case basis, the President of a Division cannot be President of another Division or of a Commission, or be Chair of a Working Group.

*37. As specified in Bye-Law 18, the scientific affairs of the Division are conducted by an Organizing Committee of up to 12 members*



At sunset on Maunakea, Hawai'i Island, Babak Tafreshi captured this telephoto view of the neighboring island of Maui. The summit of Haleakalā, home to several astronomical observatories, reaches above the clouds. *[Babak Tafreshi/NAOJ]*

of the Division, headed by the Division President, Vice-President, and Secretary. Thus, all significant decisions of the Division require the approval of the Organizing Committee, and the President and Vice-President are responsible for organizing the work of the Committee so that its members are consulted in a timely manner. Contact information for the members of the Organizing Committee shall be maintained at the Division web site.

Unless agreed otherwise by the Executive Committee on a case by case basis, the President of a Division cannot be President of another Division or of a Commission, or be Chair of a Working Group.

38. Individual Members of the Union can freely join or leave the Division(s) of their choice, but must belong to at least one Division. If they want to change their affiliation, members of a Division must inform immediately the Division Secretary, and notify the IAU Secretariat so that the membership database is kept up to date at all times.

38. Individual Members of the Union are admitted to membership in a Division by its Organizing Committee (cf. Bye-Laws § 18). Individual Members active within the field of activity of the Division and interested in contributing to its development should contact the Division Secretary, who will consult the Organizing Committee on the admission of the candidates.

38.a. The membership of the Division is regularly updated by the IAU Secretariat, and can be exported from the IAU membership database for the purposes of communication within the Division. Alternatively, the IAU Secretariat may provide help in disseminating information among Division members (via e-newsletters, etc.).

38.a. The Division Secretary shall maintain a list of Division members for ready consultation by the community, including their Commission memberships if any. Updates to the list shall

be provided to the IAU Secretariat on a running basis.

~~38.b. Members may resign from a Division by so informing the Division Secretary.~~

~~38.c. In the event of a Division being newly formed, Individual Members can themselves elect to join the Division. Before the General Assembly following that at which the new Division was created its Organising Committee shall scrutinise and confirm the Division membership.~~

39. The effectiveness of the Division relies strongly on the scientific stature and dedication of its President and Vice-President to the mission of the Division. The Executive Committee, in proposing new Division Presidents and Vice-Presidents for election by the General Assembly, will rely heavily on the recommendations of the **Steering** Committee of the Division. In order to prepare a strong slate of candidates for these positions, and for the succession on the **Steering** Committee itself, the following procedures shall normally apply:

39.a. Candidates are proposed and selected from the membership of the Division on the basis of their qualifications, experience, and stature in the fields covered by the Division. In addition, the **Steering** Committees should have proper gender balance and broad geographical representation.

39.b. At least six months before a General Assembly, the outgoing **Steering** Committee submits to the membership of the Division a list of candidates for President, Vice-President (for which there should be the names of **at least** two persons willing to serve), and for the incoming **Steering** Committee, according to the composition defined in §37 and ~~heads of Program Groups for the next triennium~~. The outgoing **Steering** Committee devises the procedure by which the requisite number of candidates is elected by the membership, and

requests nominations from the entire membership in preparing this list or may call for self-nomination. It is desirable that more names are proposed than there are eligible positions to be filled on the new Steering Committee. A vote is then organized, normally electronically, among all the members for the above offices. The results of the elections are reported to the General Secretary for information at least three months before the General Assembly.

Electronic voting may be arranged by the Secretariat.

*39.b. At least six months before a General Assembly, the Steering Committee submits to the membership of the Division a list of candidates for President, Vice-President (for which there should be at least two persons willing to serve), Secretary, and the Steering Committee for the next triennium. The Steering Committee requests nominations from the entire membership in preparing this list, and then conducts a vote, normally electronically, among all Division members for the above offices, the results of which are reported to the General Secretary at least three months before the General Assembly. The Vice-President*



[IAU/B. Tafreshi, [twanight.org](http://twanight.org)]

*is normally nominated to succeed the President. The outgoing President participates in the deliberations of the new Steering Committee in an advisory capacity.*

39.c. The Vice-President is normally nominated to succeed the President. The outgoing President participates in the deliberations of the new Steering Committee in an advisory capacity. Members of the Steering Committee normally serve a maximum of two terms, unless elected Vice-President of the Commission. Presidents normally serve for only one term.

*39.c. It is desirable that more names are proposed than there are eligible positions to be filled on the new Steering Committee. The outgoing Steering Committee devises the procedure by which the requisite number of candidates is elected by the membership. The resulting list is communicated to the General Secretary at least two months before the General Assembly. The General Secretary may allow any outstanding issues to be resolved remotely or at a business meeting of the Division during the General Assembly. If for any reason the Steering Committee has not been able to arrange for the election of new officers and a Steering Committee by two months before the GA, the EC will nominate a VP and Steering Committee at its first General Assembly meeting.*

39.d. A member of the [Steering](#) Committee normally serves a maximum of two terms, unless elected Vice-President of the Division in her/his second term. [Presidents may serve for only one term.](#)

[39.e. The Steering Committee decides on the procedures for designating the Division Secretary, who is responsible for maintaining the Division web site and for providing relevant information to the IAU Secretariat, such as records of the business of the Division, and procedures for conducting its business by physical meetings or remotely.](#)

*39.e. The Organizing Committee decides on the procedures for*

*designating the Division Secretary, who maintains the web site, records of the business and membership of the Division, and other rules for conducting its business by physical meetings or by correspondence.*

39.f. In the event of a newly formed Division, paragraphs 39a — 39c do not apply. The Executive Committee shall consult the [Steering](#) Committees of the relevant predecessor Divisions on possible candidates for President and Vice-President of the new Division for the next triennium. The Executive Committee shall select the names to be proposed to the General Assembly for election.

39.g. As soon as possible after their election at a General Assembly, the President and Vice-President of the new Division shall request nominations to the [Steering](#) Committee from the membership of the Division and then conduct a vote among Division members, the results of which are reported to the General Secretary. The [Steering](#) Committee designates a Secretary from its membership.

40. A key responsibility of the [Steering](#) Committee is to maintain an internal organization of Commissions and Working Groups in the Division which is conducive to the fulfillment of its mission. The [Steering](#) Committee shall take the following steps to accomplish this task in a timely and effective manner:

40.a. Within the first year after a General Assembly — with a business meeting of the Division at the General Assembly itself as a natural starting point — the [Steering](#) Committee shall discuss with its Commissions, and within the [Steering](#) Committee itself, if changes in its Commission and Working Group structure may enable it to accomplish its mission better in the future. As a rule, Working Groups [may](#) be created (following the rules in Bye-Law 21 and Bye-Law 23) [at any time](#) for new activities that are either of a known, finite duration or are exploratory in nature. If experi-

ence, possibly from an existing Working Group, indicates that a major section of the Division's activities require a coordinating body for a longer period (a decade or more), the creation of a new Commission may be in order ([Statutes, § 22](#)), and a [corresponding Call for Proposals for Commissions considered](#).

40.b. Whenever the [Steering Committee](#) is satisfied that the creation of a new [Division Working Group or Commission](#) is well motivated, it may take immediate action as specified in [Bye-Law 21 or Bye-Law 23, independently of General Assemblies](#). However, in preparation for [General Assemblies](#), the [Steering Committee must submit for approval](#) its complete proposal for the continuation, discontinuation, or merger of its Commissions and Working Groups to the General Secretary [at least two months in advance of the Executive Committee meeting being held](#) before the relevant General Assembly.

40.b. Whenever the [Steering Committee](#) is satisfied that the cre-

ation of a new Working Group or Commission is well motivated, it may take immediate action as specified in [Bye-Law 21 or Bye-Law 23](#). In any case, the [Steering Committee](#) submits its complete proposal for the continuation, discontinuation, or merger of its Commissions and Working Groups to the General Secretary at least three months before the next General Assembly.

40.c. The President and [Steering Committee](#) maintain frequent contacts with the other IAU Divisions to ensure that any newly emerging or interdisciplinary matters are addressed appropriately and effectively. 🌸



**THIERRY MONTMERLE** (Institut d'Astrophysique de Paris, France) is the outgoing General Secretary of the IAU. He has been actively involved in promoting interactions between astronomers and the public, in particular in the area of World Heritage and in celebration of the 2015 International Year of Light.

## Revised Working Rules for IAU Commissions

By THIERRY MONTMERLE

The [Statutes](#) of the International Astronomical Union (IAU) define the goals and organizational structure of the Union, while the [Bye-Laws](#) specify the main tasks of the various bodies of the Union in implementing the provisions of the Statutes. The [Working Rules](#) are designed to assist the membership and governing bodies of the Union in carrying out these tasks in an appropriate and effective manner.

The [IAU Executive Committee](#) updates the Working Rules as necessary to reflect current procedures and to optimize the services of the IAU to its membership. In the wake of the recently enacted Division and Commission Reform, the Executive Committee has revised the Working Rules for Commissions as fol-

lows. (See [page 27](#) for the revised Working Rules for Divisions.)

New text is in [blue](#) type. ~~Strikethrough~~ (whether [blue](#) or black) indicates deleted text. *For clarity, in case of significant modifications to a paragraph, the original paragraph from the Working Rules follows in italics.*

### X. TERMS OF REFERENCE FOR COMMISSIONS

The role of the Commissions is to organize the work of the Union in specialized subsets of the fields of their parent Division(s), when the corresponding activity is judged to be of considerable significance over times of a decade or more. Thus, the [Executive](#)

Committee, upon the recommendation of one or more Divisions, may decide to issue a public Call for Proposals for Commissions, when fields emerge that are clearly in sustained long-term development and where the Union may play a significant role in promoting this development at the international level (Statutes, § 22). Similarly, Commissions may be discontinued by the Executive Committee upon the recommendation of the parent Division(s) when their work can be accomplished effectively by the parent Division. In keeping with the many-sided activities of the Union, Commissions may have purely scientific as well as more organizational and/or interdisciplinary fields. They will normally belong and report to one of the IAU Divisions, but may be common to two or more Divisions (see Bye-Laws, § 23). The Commissions within a Division are not expected to cover all the scientific areas of the Division, therefore some specific areas may not be covered by Commissions for some period of time.

A Division may temporarily have no Commission.

The following rules apply if a Division has one or more Commissions.

*The role of the Commissions is to organize the work of the Union in specialized subsets of the fields of their parent Division(s), when the corresponding activity is judged to be of considerable significance over times of a decade or more. Thus, new Commissions may be created by the Executive Committee with the agreement of all the Divisions when fields emerge that are clearly in sustained long-term development and where the Union may play a significant role in promoting this development at the international level. Similarly, Commissions may be discontinued by the Executive Committee upon the recommendation of the parent Division when their work can be accomplished effectively by the parent Division. In keeping with the many-sided activities of the Union, Commissions may have purely scientific as well as more organizational and/or interdisciplinary fields. They will normally belong and report to one of the IAU Divisions, but may be common to two or more Divisions. The following rules apply if*



With a digital camera and wide-angle lens, Fred Bruenjes recorded a series of 30-second exposures spanning about six hours on the night of 11-12 August 2004 to produce this dramatic composite of the Perseid meteor shower. [Fred Bruenjes, NASA]

*a Division has more than one Commission.*

41. The activities of a Commission are directed by an Organizing Committee of 4-8 members of the Commission, headed by a Commission President and Vice-President (cf. Bye-Laws § 22). A member of the Organizing Committee normally serves a maximum of two terms, unless elected Vice-President of the Commission in her/his second term. Presidents normally serve for only one term. All members of the Organizing Committee are expected to be active in this task, and are to be consulted on all significant actions of the Commission. The Organizing Committee designates a Commission Secretary who maintains the records of ~~the membership and~~ activities of the Commission in co-operation with the Division Secretary and the IAU Secretariat. Contact information for the members of the Organizing Committee shall be maintained [at the IAU Secretariat](#).

Unless agreed otherwise by the Executive Committee on a case-by-case basis, the President of a Commission cannot be President of a Division or of another Commission, or be Chair of a Working Group.

41a. [Commission Presidents, or their representatives, are ex-officio members of the Steering Committees of the Divisions to which they are affiliated \(Working Rules, § 37\), as specified in the next section.](#)

41b. [In their relations with Divisions, Commissions fall in three categories:](#)

- (a) [Regular Commissions are affiliated to one “parent” Division only. The Commission President is a member of the Steering Committee of its parent Division.](#)
- (b) [Inter-Division Commissions are affiliated to more than one Division, but one is the “primary” Division. The Commis-](#)

[sion President is a member of the Steering Committee of its primary Division.](#)

- (c) [Cross-Division Commissions are affiliated to more than one Division on a parity basis. The Commission Organizing Committee will send one representative as ex-officio member in each Steering Committee of its parent Divisions.](#)

*No §41a and 41b in the current Working Rules.*

42. [Individual Members of the Union may join or leave a Commission at any time, while belonging to no more than three Commissions. They should notify immediately the relevant Commission Secretary and the IAU Secretariat. The Commission Secretary should keep at all times an up-to-date list of the Commission members, in coordination with the IAU Secretariat. If a change in Commission affiliation implies a change of Division affiliation, this change must also be notified to the relevant Division Secretaries, and to the IAU Secretariat, to keep the membership database updated at all times.](#)

*42. Individual Members of the Union, who are active in the field of the Commission and wish to contribute to its progress, are admitted as members of the Commission by the Organizing Committee. Interested Members should contact the Commission Secretary, who will bring the request before the Organizing Committee for decision. Members may resign from the Commission by notifying the Commission Secretary. Before each General Assembly, the Organizing Committee may also decide to terminate the Commission membership of persons who have not been active in the work of the Commission; the individuals concerned shall be informed of such planned action before it is put into effect. The Commission Secretary will report all changes in the Commission membership to the Division Secretary and the IAU Secretariat.*

43.a. At least six months before a General Assembly, the outgoing Organizing Committee submits to the membership of the Commission a list of candidates for President, Vice-President (for which there should be the names of **at least** two persons willing to serve), **and for the incoming Organizing Committee, according to the composition defined in Bye-Laws §22a.** The outgoing Organizing Committee devises the procedure by which the requisite number of candidates is elected by the membership, and requests nominations from the entire membership in preparing this list **or may call for self-nominations. It is desirable that more names are proposed than there are eligible positions to be filled on the new Organizing Committee.** A vote is then organized, normally electronically, among all the members for the above offices. The results of the elections are reported to the General Secretary for information at least three months before the General Assembly.

**Electronic voting may be arranged by the Secretariat.**

43.b. The Vice-President is normally nominated to succeed the President. The outgoing President participates in the deliberations of the new Organizing Committee in an advisory capacity. Members of the Organizing Committee normally serve a maximum of two terms, unless elected Vice-President of the Commission. Presidents normally serve for only one term.

*43. At least six months before a General Assembly, the Organizing Committee submits to the membership of the Commission a list of candidates for President, Vice-President (for which there should be the names of two persons willing to serve), and for the Organizing Committee, and heads of Program Groups for the next triennium. The Organizing Committee requests nominations from the entire membership in preparing this list, and then conducts a vote, normally electronically, among all the members for the above offices, the results of which are reported to the General Secretary at least three months before the General Assembly. The Vice-President is normally nominated to succeed the Presi-*

*dent. The outgoing President participates in the deliberations of the new Organizing Committee in an advisory capacity. The outgoing Organizing Committee devises the procedure by which the requisite number of candidates is elected by the membership. The resulting list is submitted to the Organizing Committee of the parent Division(s) for approval before the end of the General Assembly. Members of the Organizing Committee normally serve a maximum of two terms, unless elected Vice-President of the Commission. Presidents may serve for only one term.*

44. At least six months before each General Assembly, the Organizing Committee shall submit to the parent Division(s) a report on its activities during the past triennium, with its recommendation as to whether the Commission should be continued for another three years, or merged with one or more other Commissions, or discontinued. If a continuation is proposed, a plan for the activities of the next triennium should be presented, including those of any Working Groups which the Commission proposes to maintain during that period.

45. The Organizing Committee decides its own rules for the conduct of its business by physical meetings or (electronic) correspondence. Such rules require approval by the **Steering** Committee of the parent Division(s).

~~46. The procedural rules applying to the establishment of a new Division shall also apply to the establishment of a new Commission. Where there is no 'relevant predecessor Commission(s)' the parent Division(s) shall submit to the potential membership of the new Commission a list of candidates for President, Vice-President and Organising Committee for the next triennium. ❀~~



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