Kai'aleleiaka THE MILKY WAY

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IAU XXIX GENERAL ASSEMBLY Hawaii

INTERNATIONAL YEAR OF LIGHT 2015

COSMIC LIGHT IAU

WELCOME ADDRESS

Exploring the Heavens, Discovering Our Humanity

A transcript of remarks by the NSF Director at the General Assembly Opening Ceremony.

By FRANCE A. CÓRDOVA

Let me thank President Kaifu, President Urry, and Director Hasinger for their invitation to deliver the inaugural address of this XXIX General Assembly of the International Astronomical Union.

[Sandy Schaeffer, National Science Foundation]

It is a great honor to represent the Obama Administration at this historic event. As an astrophysicist myself, I am delighted to say "aloha" to my fellow IAU members and welcome all of you to this meeting.

I am also honored to represent the National Science Foundation — the premier U.S. basic scientific research agency and one of the world's leading institutions in astronomy.

For more than six decades, NSF-funded researchers and facilities have been exploring the most intriguing mysteries of the heavens. Today, among those mysteries are the origin and evolution of stars and galaxies, the formation of solar systems, the existence of habitable planets, and the nature of dark matter and dark energy.

And what do we seek to discover from our observations of the heavens?

"To know the unknowable" — this quote will be familiar to native Hawaiians.

In my own case, as a girl I had an early yearning to understand the mysteries of the universe. I didn't know what astrophysics was, but I had always loved looking at the night sky and asking, "Why are there stars? How are they formed? Why are there so many — and no more? Why are some bright, while others are barely visible?"

Thinking about those questions resonated with me, as I am sure it does with you.

I started my career as an X-ray astronomer. Some years later, I was honored to become NASA's first female chief scientist.

And let me take this opportunity to congratulate our NASA colleagues for the spectacular success of their New Horizons Pluto Mission — talk about new mysteries to solve!

As New Horizons has so vividly reminded us, people everywhere have a deep-seated yearning to understand the universe in which we live.

In October 2009, President Barack Obama invited a group of astronomers to the White House to mark the International Year of Astronomy, the 400th anniversary of Galileo's first use of a telescope to observe the night sky.

The President has long emphasized the study of science and astronomy in order to increase understanding of the natural world — and to

Kaiʻaleleiaka THE MILKY WAY

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encourage greater scientific cooperation across national borders.

Nobel Prize-winning chemist Ei-ichi Negishi, in his 2010 speech accepting the award, said “The final reward for any researcher is to see his or her lifetime of work extend beyond academia and laboratories, into the mainstream of global society where it can breathe hope into the world.”

Isn’t that the goal that all of us in the global research community strive to achieve? And let me add that the U.S. is proud to partner with many countries around the world in exploring the heavens.

Basic research is the primary focus of the National Science Foundation, including astronomical breakthroughs that have changed our understanding of the universe.

One significant NSF-funded effort resulted last year in University of Hawai‘i at Mānoa astronomer Brent Tully being awarded the 2014 Gruber Cosmology Prize and the 2014 Victor Ambartsumian International Prize.

Dr. Tully led an international team of astronomers in defining the contours of the supercluster of galaxies containing our own Milky Way.

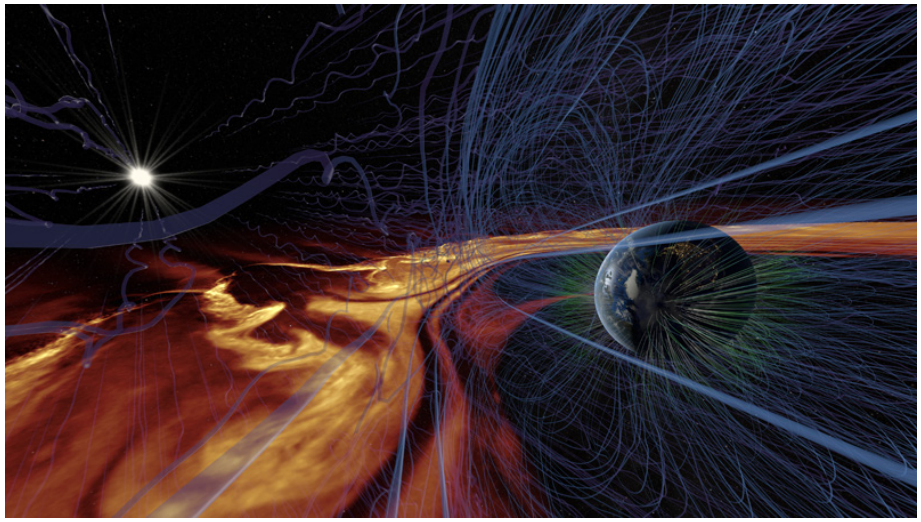
Those astronomers named the supercluster “Laniakea,” meaning “immense heaven” in Hawaiian, to honor Polynesian navigators who used knowledge of the heavens to voyage across the immense Pacific Ocean.

The name was suggested by Nawa’a Napoleon, an associate professor of Hawaiian language at Kapi‘olani Community College.

One new significant challenge for the National Science Foundation is the enormous increase in raw research data resulting from vastly increased computational capabilities — also known as “Big Data.”

The growing field of machine learning — in which computers learn from large data sets and find patterns that humans don’t easily recognize — has great long-term implications for astronomy.

For example, the image at right is from “Solar Superstorms,” an ultrahigh-resolution demonstration that takes viewers into the magnetic fields and superhot plasma surrounding the Sun as it produces dramatic flares, violent solar tornadoes, and coronal



[National Center for Supercomputing Applications]

mass ejections.

This groundbreaking scientific visualization is based on computations from the NSF-supported supercomputing initiative, Blue Waters, at the National Center for Supercomputing Applications at the University of Illinois.

As dramatic as the visualization is, it is only a hint of the advances Big Data may produce in years ahead.

While the National Science Foundation is widely recognized as our nation’s premier basic scientific research agency, we find there are more international partnerships emerging that enable NSF to extend our ability to produce significant scientific research.

We have found that global collaborations accelerate the progress of science and improve health, security, and prosperity throughout the world.

For example, the Atacama Large Millimeter/submillimeter Array — or ALMA — telescope has received more than $1 billion in investments from a broad international coalition including Europe, East Asia — led by Japan — and Chile, with North American funding led by NSF.

ALMA is providing a testing ground for theories of star birth and stellar evolution, and solar system and galaxy formation.

A remarkable ALMA image of the young star HL Tau and its

protoplanetary disk reveals multiple rings and gaps that herald the presence of emerging planets as they sweep their orbits clear of dust and gas.

Another significant NSF partnership involves the Gemini team of twin 8.1-meter optical/infrared telescopes on Cerro Pachón in Chile and on Maunakea here in Hawai‘i.

The International Gemini Observatory is a partnership of the U.S., Canada, Australia, Brazil, Argentina, and Chile, as well as the University of Hawai‘i as the host of the northern site. The Republic of Korea joined the partnership in 2015 as a limited-term collaborator and is expected to become a full partner in 2017.

Gemini’s capabilities — full-sky coverage, rapid response to transients, agile scheduling, and specialized optics — enabled it to capture an image of the Kronberger 61 nebula, showing an ionized shell of expelled gas resembling a soccer ball. Incidentally, the nebula was named for an amateur astronomer in Austria.

The image was made by the Gemini Multi-Object Spectrograph — GMOS — on the Gemini North telescope on Maunakea.

Another cutting-edge, NSF-supported observatory is the Daniel K. Inouye Solar Telescope, now under construction on Haleakalā. This next-generation solar telescope represents a collaboration of 22 institutions, reflecting a broad segment of the solar-physics community.

Once completed, it will be the premier ground-based solar observatory. Thanks to the people of Hawai‘i, It will enable astronomers everywhere to glean new insights into solar phenomena, including what are the mechanisms responsible for solar storms that ultimately affect the Earth.

Furthermore, we expect that this increased understanding of the Sun will help protect vital space-based assets — such as communication and weather satellites and the power grids here on Earth.

The top recommendation of the 2010 National Academy of Sciences decadal survey of astronomy was the Large Synoptic Survey Telescope — LSST — which is now under construction on Cerro Pachón in Chile. Just a few months ago, I participated in the exciting “first stone ceremony” to launch LSST construction.

[Large Synoptic Survey Telescope]

LSST will be a wide-field “survey” telescope that photographs the entire available sky every few nights. Advanced computers will gather and analyze the millions of gigabytes of data LSST will generate each year.

A pilot project called the Deep Lens Survey uses imaging from NSF’s four-meter telescopes to suggest what half a degree of sky will look like when LSST is in operation, projected to begin in 2022.

An innovative citizen-science program will involve people of all ages in LSST discoveries, making discovery opportunities available to K-12 students as easily as to the professional astronomer. This is just one example of NSF’s commitment to engaging the public in the thrill of discovery and increasing public understanding of scientific research.

Far from the 2,700-meter high Cerro Pachón in Chile lies NSF’s IceCube Neutrino Observatory at the Amundsen-Scott South Pole Station in Antarctica.

IceCube is the world’s largest neutrino detector and is among the most ambitious scientific construction projects ever attempted. It searches for neutrinos from the most violent astrophysical sources: exploding stars, gamma-ray bursts, and cataclysmic phenomena involving black holes and neutron stars.

[HAWC Gamma-Ray Observatory / Jordanagoodman]

The highest-energy neutrino ever observed by IceCube, with an estimated energy of 1.14 peta-electron-volts (PeV), was nicknamed "Ernie" by IceCube physicists.

I recently attended the inauguration of the High Altitude Water Cherenkov — or HAWC — gamma-ray observatory near Puebla, Mexico.

HAWC represents a unique partnership between the National Science Foundation, the U.S. Department of Energy, and CONACYT — Mexico's National Council of Science and Technology. HAWC will give scientists a new window for detecting and recording gamma rays and cosmic rays emitted by black holes, merging neutron stars, streams of hot gas moving at close to the speed of light, and other exotic phenomena in the universe.

HAWC will monitor approximately two-thirds of the sky every 24 hours with unprecedented sensitivity to the highest-energy gamma rays. HAWC will complement the operations of NASA's Fermi Gamma-ray Space Telescope and the VERITAS gamma-ray observatory.

It will also be part of the growing field of "multi-messenger astrophysics" that includes cosmic ray observatories, IceCube, and the Advanced Laser Interferometer Gravitational-Wave Observatory.

Finally, I would like to say a few words about the beautiful setting that the IAU chose for its first General Assembly in the U.S. in nearly three decades.

No doubt the IAU was attracted by Hawai'i's breathtaking beauty, unique cultural heritage, and aloha spirit of its friendly people — all great reasons for holding this assembly here.

The National Science Foundation — and many other scientific institutions worldwide — come to partner in scientific research at an extraordinary site.

With its biodiversity on land and in the surrounding oceans, its unique geological history and formations, and its high volcanic peaks, Hawai'i is one of the Earth's great scientific treasures. It is a treasure that all of us want to see honored, preserved, and protected.

The National Science Foundation has partnered with the people of Hawai'i and Hawaiian institutions for many years and takes seriously its responsibilities to be a good steward of Hawai'i's unique natural resources and cultural heritage — and to be respectful of Hawai'i's people and customs.

We hope to continue our partnerships in order to create opportunity for the next generations of seekers of knowledge — for many years to come.

Let me again thank the International Astronomical Union for the opportunity to be with you for this historic General Assembly. Just as the universe knows no borders, the science community's exploration of its mysteries has always been an international endeavor. We look forward to the promise of even greater cooperation among nations and institutions as we expand scientific understanding of this endlessly fascinating challenge.

Again, I wish you all a productive meeting. Mahalo! ✿

Astrophysicist FRANCE A. CÓRDOVA is Director of the National Science Foundation in Washington, D.C. A former NASA Chief Scientist, she has served in top leadership positions at Purdue University in Indiana and at the Riverside and Santa Barbara campuses of the University of California. The slides from her General Assembly welcome address will be available on the NSF website later this week.

New Office to Support International Schools for Young Astronomers

By ODDBJØRN ENGVOLD

The International Schools for Young Astronomers (ISYA) is an essential and highly valued educational program of the IAU. Normally three weeks long, ISYAs are international postgraduate schools for regions where students have fewer opportunities to be directly exposed to up-to-date astrophysics. The schools are intended for young astronomers who are mainly — but not exclusively — from astronomically developing countries and who have already finished their first-degree studies. The main objective of ISYAs is to provide participants with exposure to modern astrophysics through lectures from an international faculty on selected topics of astronomy, seminars, practical exercises and observations, and exchange of experiences.

Since the first ISYA in 1967, 36 have been organized in 24 countries. The number of students per school has varied between 30 and 50, representing between 5 and 25 different nationalities in the host regions. The current success of the ISYA program is a result of dedicated organization and efforts by a number of individuals under the leadership of the ISYA Director, Jean-Pierre de Greve, and Deputy Director, Kam-Ching Leung.

Group photo from the 2013 ISYA held in Indonesia. *[ISYA]*

Locations where ISYAs have been held once (red stars), twice (blue stars), or three times (purple stars) since 1967. *[ISYA]*

The IAU wishes to establish a robust financial and organizational basis for this highly valued educational program. To this end, the Norwegian Academy of Sciences and Letters' financial contributions to the ISYAs since 2009 allowed the IAU and NASL to establish an Office for Young Astronomers (OYA). The OYA is a virtual office, housed at the NASL in Oslo, Norway, consisting of a Steering Committee with overall responsibility for program operations. An IAU Vice-President chairs the Steering Committee; other members are the ISYA Director and Deputy Director, a representative from NASL, and the President of IAU Division C, Education, Outreach, and Heritage.

The objective of this new OYA is to strengthen the overall organization of the ISYAs by functioning as a supporting structure for the Director and working with the local organizers of each individual school. The schools are organized each year by invitation

of a host country, and the individual ISYAs are prepared in close collaboration with local organizations. The ISYA Director and the local organizer determine the curriculum for each school, in agreement with the OYA Steering Committee. Strong involvement of the local organizers and community of the individual ISYAs will be essential to ensure positive follow-up and growth afterwards.

The establishment of the OYA is one of the latest projects in a history of collaborations between the IAU and the NASL. The IAU Executive Committee has long advised the NASL on appointments of new committee members for the international Kavli Prize in Astrophysics, and the NASL has provided financial support for the ISYAs and for the Young Astronomers Luncheons at recent IAU General Assemblies — including the one at this GA. ✿

ODDBJØRN ENGVOLD was IAU General Secretary from 2003 to 2006 and Chair of the Kavli Prize Committee in Astrophysics from 2008 to 2012. He is Professor Emeritus at the Institute of Theoretical Astrophysics, University of Oslo, Norway.

IAU NATIONAL REPRESENTATIVE BUSINESS MEETING

Votes, Rules & Dues: A World of Policy

By INGE HEYER, *Kaiʻaleleiaka*

The IAU national representatives met on Monday morning, 3 August to discuss public interaction and engagement, voting rules, Union finances, and Union membership.

While traditionally astronomical objects and features have been named by committees of the IAU, the public has more recently been invited to help name the two most recently discovered moons of Pluto, features on Pluto's surface, craters on Mercury's surface, and exoplanets around other stars. This new trend invites more worldwide participation of the public in astronomical nomenclature.

The current elected members of the Special Nominating Committee were named at the Business Meeting, together with 12 candidates proposed by the Division Presidents. The election rules stipulate that there can be only one member from any given country elected to the Committee. It is also desirable to have diversity in both gender and geography. The Committee consists of the current IAU President, the former President, one member appointed by the Executive Committee, plus four members selected from among the 12 candidates by the national representatives next week. There was some discussion on procedure, given that the United States has several candidates, whereas other countries have only one each. Some mechanism needs to be devised to ensure that the "one member per country" rule is adhered to.

The Finance Committee had sent out a detailed financial report to the national representatives earlier via email. Special expenses were mentioned at this meeting, such as one-off expenses for the restructuring of the Divisions and Commissions, as well as seed funds for projects related to the International Year of Light 2015. Ongoing special expenses were incurred for the Office for Astronomy Outreach (OAO) and the Office of Astronomy for Development (OAD). The IAU uses electronic banking, ensuring that all necessary personnel have access, yet maintaining the security of two independent auditing procedures done by outside auditors. It is vital that this system is robust to successive elected officials, yet flexible enough to adapt to changing circumstances.

It was noted that most of the expenses went toward education (24%), science (16%), and the General Assembly (14%), rather than to operations. The Finance Committee will need membership

How to Say It in Hawaiian

- Makai: toward the sea; the ocean side
- Aloha ʻāina: love of the land; to nurture and care for the land
- Kāne: man
- Wahine: woman
- Hale: house, home, building
- Wikiwiki: fast, speedy

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 ʻokina, signals a glottal stop. Source: Hawaiian Words.

approval for a 2% increase in the budget for the next three years. The members will also have to elect two new Committee members from among three candidates.

A lively discussion ensued around the topic of dues, specifically how much each member country pays to the IAU. The countries are sorted into dues categories, depending on the number of astronomers, the country’s Gross Domestic Product, and its state of economic development. However, this scheme may not always ensure equitable results. For example, although the United States pays much higher dues than Egypt, the dues per member for Egypt are about 20 times higher than for the U.S. It was suggested that a serious discussion about this needs to occur at the 2018 GA in Vienna, Austria, and that a Working Group consisting of members from countries in different dues categories should be formed to study this issue.

The question was raised if there were quotas for each country for IAU membership. The answer is “no, definitely not,” though some countries apparently don’t wish to have too many members for fear that they might be moved into a higher dues category.

The Membership Committee, which controls the nominations process for new members, reported that it had received 1,275 nominations from 49 countries, 93% of which were accepted. An example of a reason for rejection is insufficient experience because the Ph.D. is too recent. While the IAU has certain criteria for membership, individual national committees often add their own rules, some of which are not transparent. The United States is the only country with its own application form. It was suggested that countries should spell out their nomination criteria on their websites, in order to make the process more transparent. The only rule stipulated by the IAU at this time is that candidates have a Ph.D. related to astronomy. The U.S. requires in addition that the Ph.D. is held for three years before applying for IAU membership.

IAU national representatives listen to presentations on public engagement, voting rules, financial accounting, and membership issues. *[Inge Heyer]*

IAU President Norio Kaifu, former IAU President Robert Williams, and IAU General Secretary Thierry Montmerle facilitated the presentations and discussions. *[Inge Heyer]*

Complicating this process is the fact that many people, especially younger ones, move to different countries for professional reasons. While national committees are tasked with keeping track of their members, members relocating or leaving the field makes this task rather difficult. The IAU will not remove any member from its rolls unless requested to do so by that member.

The session adjourned with action items of studying the voting procedures to ensure adherence to the rules, voting in new members for several committees by the national representatives, and investigating in greater detail the issue of dues categories. ✿

Scenes from the IAU GA Opening Ceremony

The IAU XXIX General Assembly in Honolulu officially began with a traditional Hawaiian chant by Daniel Akaka Jr. *(upper left, accompanied by his daughter)* on Monday afternoon, 3 August. Attendees packed into Ballroom B of the Hawai‘i Convention Center then heard welcome addresses from numerous dignitaries, including IAU President Norio Kaifu *(bottom left)*, Hawai‘i Governor David Ige *(upper right)*, and NSF Director France Córdova *(top center)*. All photos are by Babak Tafreshi (twanight.org) except for those of Akaka and Kaifu, which are by *Kai‘aleleiaka*’s Pamela L. Gay.

Hawai‘i and the Thirty Meter Telescope

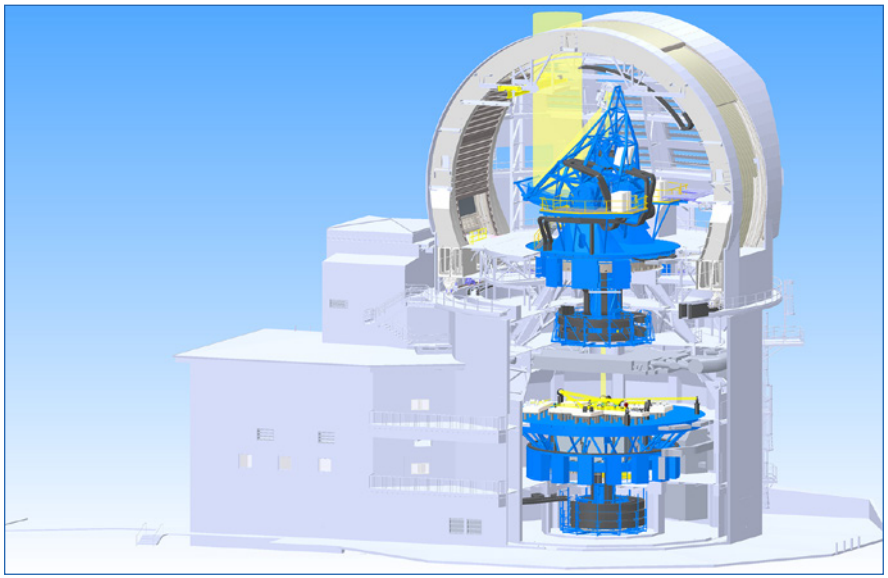
Some thoughts on the Maunakea controversy from the President of the AAS.

By C. MEGAN URRY

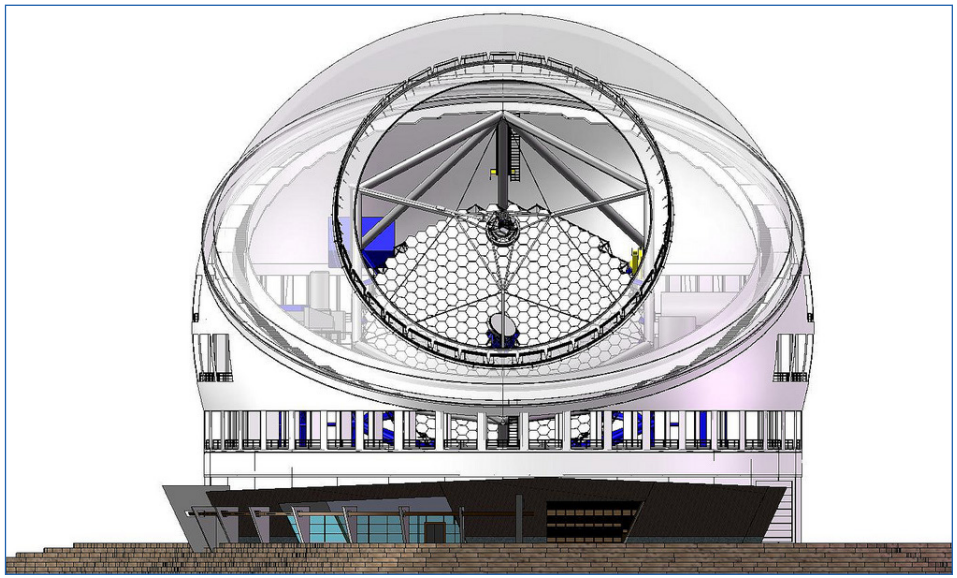
Over the century since the IAU was founded, new telescopes have contributed enormously to our understanding of the universe in which we live. We now know that it mostly consists of the simplest atoms, hydrogen and helium; that atoms essential to life, like carbon, nitrogen, and oxygen — including every such atom in our bodies — were produced inside stars and distributed into space by stellar eruptions and explosions; that most stars like our Sun host planets, some of which are very similar to Earth (rocky and in the habitable zone); that our universe is rapidly expanding; and that the dominant constituent of the universe today is not matter at all but some mysterious kind of energy or anti-gravity that in the current epoch is accelerating the expansion.

Starting with the invention of the telescope by Dutch opticians in the early 1600s, each subsequent technical improvement in astronomers' ability to observe the universe has led inexorably to new discoveries. In modern times, such improvements have included larger telescopes, more sensitive detectors, careful selection of the best observing sites, and improved resolution with adaptive optics.

It is so appropriate that IAU's XXIX General Assembly is in Hawai‘i, home to some of the world's most important telescopes. Maui's Haleakalā summit hosts the innovative Pan-STARRS sky-survey telescope and the forthcoming Daniel K. Inouye Solar Telescope, while Hawai‘i Island's Maunakea summit, one of the very best astronomical sites in the world, hosts the world's largest, most powerful telescopes for studying our galaxy and beyond. The preeminence of Maunakea as an astronomical site



[L. Phelps / Daniel K. Inouye Solar Telescope]



[Thirty Meter Telescope]

A twilight view of the Gemini North Observatory on the summit of Maunakea. Visible behind Gemini is the Canada-France-Hawai'i Telescope, or CFHT. *[Gemini Observatory]*

comes from the smooth airflow over its summit, its height above the usual cloud cover, and its isolation from city lights and air pollution — and it is the only site for a next-generation telescope to view the northern skies.

But, of course, the summits of Hawai'i's mountains are not the exclusive domain of astronomers — they are a shared space of central importance to the people of the islands and to a culture about which I continue to learn. As an astronomer, it is perhaps easiest to focus on the value of mountaintops for astronomy. But we also are driven by a desire to know more about the world around us, and not just in astronomical terms.

The Pan-STARRS 1 Observatory atop Haleakalā on Maui, with Maunakea (left) and Maunaloa on Hawai'i Island visible in the background. *[Rob Ratkowski, © 2009 PS1 Science Consortium]*

Now, as we meet here in Honolulu, we have a wonderful opportunity to listen and learn from local communities about their views of Maunakea and Haleakalā and their most important priorities. I am optimistic that we will learn from each other and be the better for it.

The IAU program is of course focused on astronomy. But astronomers in attendance have several opportunities to listen and learn. On Tuesday morning, a press conference called by a local protest leader, Lanakila Mangauil, will be held in front of the Hawai'i Convention Center. The Common Ground talks organized by the Hilo-Hamakua Community Development Corporation, featuring many local leaders and astronomers talking about Maunakea and the Thirty Meter Telescope (TMT), are another valuable source of information.

Disagreement or conflict is never comfortable, at least not for me. But we should remember that difference carries the seeds of learning and innovation. It is no coincidence that the greatest civilizations arose at the intersections of trade routes, where different peoples encountered new ways of thinking. When we talk to ourselves, we don't learn anything new, so we don't make progress. We need to talk with, and listen to, others.

I am optimistic that astronomers and local communities can together find common ground and move forward in the spirit of aloha. Let us all remember that a broad community reveres Maunakea and that the wishes of one group need not preclude the wishes of another. Let us learn more about each world. Let us find ways to work together for the benefit of all humanity. ✿

MEG URRY is President of the American Astronomical Society and a professor of astrophysics at Yale University in New Haven, Connecticut.

SPLINTER MEETING

Hawai‘i Astronomy: Past, Present, and Future

By PAUL COLEMAN, GÜNTHER HASINGER & MARY BETH LAYCHAK

The summits of Maunakea and Haleakalā are among the best astronomical observing sites in the world, and as a result they now host the largest collection of modern observatories ever assembled. A significant fraction of global astronomical research can be directly traced to Hawai‘i-based facilities, which are geographically at the nexus of leading scientific and economic arenas in North and South America, Asia, and Australia.

The two summits have attracted world-class facilities and astronomers to Hawai‘i and have generated strong collaborations with institutes all over the globe. The unprecedented growth over the last 45 years has allowed astronomy to become one of the State of Hawai‘i’s economic engines. Interestingly, astronomy has always been an important and defining part of Hawaiian culture. Today’s extraordinary fusion of modern astronomical expertise in one of the world’s most remote archipelagos is, in the eyes of many, a tribute to the traditions of the past.

This IAU General Assembly offers an ideal opportunity to present the depth and breadth of connections of astronomy to Hawai‘i’s past, present, and future. The splinter meeting “Hawai‘i Astronomy: Past, Present, and Future,” to be held in Room 313B today, 4 August, will provide a venue for a diverse group of participants to share the rich history of astronomy in Hawai‘i. Topics will include current front-line research efforts and facilities and the vision for the future of astronomy in Hawai‘i.

The session begins with a talk by Paul Coleman from the University of Hawai‘i’s Institute for Astronomy on pre- and post-contact astronomical observations of Native Hawaiians. The

Splinter Meeting: Hawai‘i Astronomy: Past, Present, and Future		
2:00 to 6:00 pm, Room 313B, Hawai‘i Convention Center		
Time	**Title**	**Speaker**
2:00 pm	Astronomy in Hawai‘i (pre-contact/contact)	Paul Coleman
2:25 pm	Unique Seeing Conditions on Maunakea	Mark Chun
2:50 pm	Adaptive Optics on Maunakea	Olivier Lai
3:15 pm	CSO Pioneering the Way to ALMA	Ted Bergin
3:40 pm	Coffee Break	
4:10 pm	Subaru Strategy as Cosmology Machine (HSC & PFS)	Nobuo Arimoto
4:35 pm	Daniel K. Inouye Solar Telescope on Haleakalā	Jeff Kuhn
5:00 pm	The TMT and Its Benefits for Hawai‘i	Mike Bolte
5:25 pm	Future Astronomy and a Pan-Pacific Observatory	Doug Simons

session progresses through the unique seeing conditions of Maunakea that contribute to its premier stature among observational sites worldwide and the utilization of those conditions to advance astronomy through adaptive optics and the precursors to the next-generation telescopes now in development. The second half of the session looks at the future of astronomy in Hawai‘i with the Daniel K. Inouye Solar Telescope on Haleakalā, the Thirty Meter Telescope on Maunakea, and beyond. The session speakers have deep ties to astronomy in Hawai‘i and represent some of the leading astronomical voices in the state. ✿



[Jennifer Boyd]


PAUL COLEMAN is an astrophysicist at the institute for Astronomy (IfA) and a member of the Kuali‘i Council, a group of Native Hawaiians at the University of Hawai‘i’s Mānoa campus. GÜNTHER HASINGER is Director of the IfA. MARY BETH LAYCHAK manages outreach programs at the Canada-France-Hawaii Telescope.

INVITED DISCOURSE 1

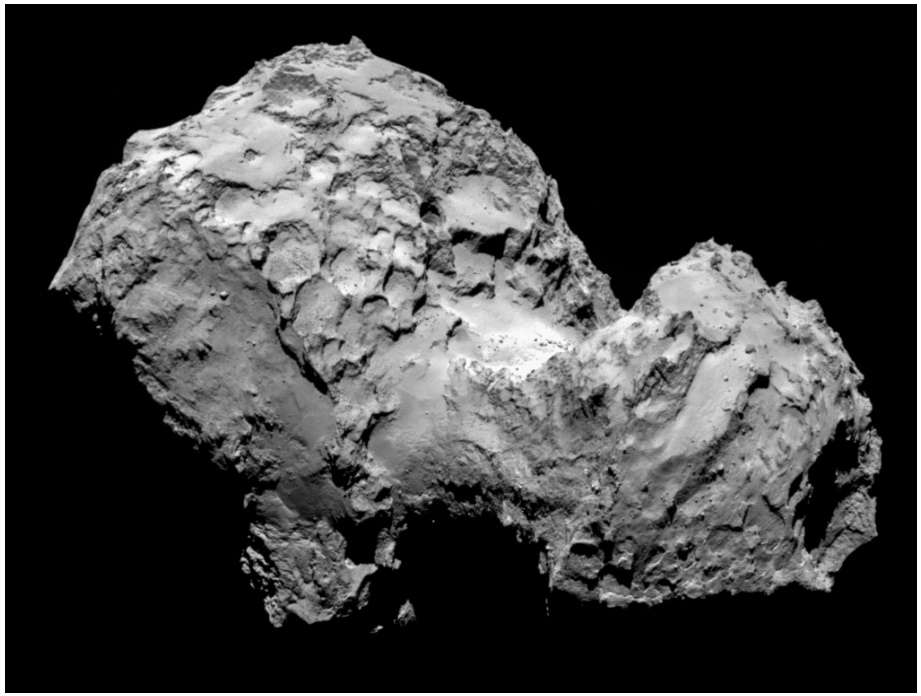
Rosetta and the Origin of the Solar System

By WILLY BENZ

Even though thousands of exoplanets have been discovered, our solar system remains undoubtedly special. Not only is it our home, but it is also the only system in which planetary and smaller bodies can be studied remotely by robotic explorers or analyzed in a laboratory via sample-return missions. Therefore, while exoplanets provide a measure of the existing diversity of planets, our solar system remains a unique testing ground for our understanding of planet formation and evolution.

Among all the small bodies, comets have always received particular attention. Besides at times providing magnificent displays in the sky — which historically were interpreted either as good or bad omens — we know today that comet nuclei are actually leftovers from the formation of the solar system, stored at large distances from the Sun for billions of years. By chance, some of these bodies manage from time to time to enter the inner regions of the solar system, thereby providing us with opportunities to study the building blocks of our own planetary system.

The European Space Agency (ESA) Rosetta spacecraft, which is following the comet 67P/Churyumov-Gerasimenko along its orbit, delivers for the first time a snapshot in time of a comet



The nucleus of comet 67P/Churyumov-Gerasimenko on 3 August 2014, as seen from a distance of 285 kilometers (177 miles) by the Rosetta orbiter. *[ESA]*

Invited Discourse 1: Peter Gruber Memorial Lecture Rosetta and the Formation of the Solar System	
Speaker	Willy Benz (University of Bern, Switzerland)
Date	Tuesday, 4 August
Time	6:00 to 7:30 pm
Location	Ballroom B, Hawai'i Convention Center

nucleus and its full-time dependent evolution as it approaches the Sun. With the lander Philae hopping on the surface of the comet, capturing the imagination of scientists and the public alike, the mission has been a unique success. Just like the stone that gave the name to the mission, the wealth of data recorded should help astronomers decipher the 4.5-billion-year-long story of our solar system.

Reconstituting the formation of our solar system from the data collected by visiting a handful of comet nuclei, even now for an extended period of time, is a difficult challenge. It is only when these data are coupled with the many advances made over the past few years, in particular the discovery of exoplanets, that a consistent scenario is slowly emerging.

Dust and gas, planetary migration, instabilities, collisions, and material properties all seem to have helped shape our solar system into what it is today. Multidisciplinary approaches are therefore essential to make sense of the story that is being told by space missions and ground-based telescopes that are exploring objects in our own planetary system and in the ones beyond. Even if we have not yet gotten to the end of it, this story is fascinating indeed! ✿

WILLY BENZ is a professor and institute director at the Physics Institute at the University of Bern, Switzerland, and president of the Space Science Advisory Committee of the European Space Agency.

IAU SYMPOSIUM 317 PLENARY

The Milky Way, the Galactic Halo, and Halos of Galaxies

By ORTWIN E. GERHARD

The Milky Way, "our" galaxy, is currently the subject of intense study with many ground-based surveys in anticipation of upcoming results from the European Space Agency's Gaia mission. From this work we have been learning about the full three-dimensional structure of the galactic box/peanut bulge, the distribution of stars in the bar and disk, and the many streams in the galactic halo. These data tell us that most of the galactic bulge formed from the disk, and that a large fraction of the galactic halo has been accreted from outside.

Similarly, in many external galaxy halos there is now evidence for tidal streams and accretion of satellites. To see these features requires exquisite data — mostly very deep photometry, but some halo substructures have also been found with kinematic data. These observations illustrate how galaxy halos are still

IAU Symposium 317 Plenary: The Milky Way, the Galactic Halo, and the Halos of Galaxies	
Speaker	Ortwin E. Gerhard (Max Planck Institute for Extraterrestrial Physics)
Date	Tuesday, 4 August
Time	8:30 to 10:00 am
Location	Ballroom B, Hawai'i Convention Center

growing and sometimes can be used to date (approximately!) the accretion events. In comparison with cosmological simulations, these fossils of past events that appear in the structure of galaxy halos vividly illustrate the hierarchical nature of our universe. ✿

ORTWIN E. GERHARD is a group leader at the Max Planck Institute for Extraterrestrial Physics in Garching, Germany. His research interests include stellar dynamics and galactic structure, galaxy formation and evolution, and the nature and distribution of dark matter.

WORKSHOPS

Center for Astronomy Education Comes to the GA

By GINA BRISSENDEN & EDWARD E. PRATHER

The Center for Astronomy Education (CAE), at the University of Arizona's Steward Observatory in Tucson, was established in 2004 to improve the teaching of college-level science courses. CAE is dedicated to helping current and future astronomy, Earth-science, space-science, and physics instructors create effective and productive active-learning classrooms.

The CAE has worked to create a national community of practice with more than 4,000 members who have access to a wide range of resources. These include the CAE Teaching Excellence Workshops, Short Courses, and Regional Teaching Exchanges; the online academic peer-mentoring group AstroIrner@CAE; and research-validated instructional and assessment materials.

Members of the CAE have been national leaders in investigating the difficulties that students have in reasoning about concepts in astronomy, Earth, space science, and physics. Their work has informed many instructional strategies proven to improve students' knowledge, skills, and reasoning abilities in these science domains. In collaboration with science educators across the United States, CAE researchers have developed several research-validated assessment methods and tools to evaluate the effectiveness of classroom instruction.

The CAE has provided one of the most comprehensive professional development programs for astronomy and space-science educators in the United States:

- More than 3,000 instructors, postdocs, graduate students, and education and public outreach professionals have participated in CAE workshops and short-courses;
- Participants have come from every U.S. state (plus Washington, D.C.), Puerto Rico, Canada, South America, Europe, Asia, and Africa;
- CAE educational professional development events have been held in nearly three-quarters of U.S. states;
- More than 25,000 students use instructional and assessment materials developed by the CAE in hundreds of classrooms each year.

For the first time ever, the CAE is bringing its professional

We Need More Classroom Astronomers!

Astronomy and Hawai'i share a long and deep connection. The IAU General Assembly affords a great opportunity for Hawaiian schoolchildren to interact with astronomers from around the world.

Public schools are already in session, and teachers representing more than 2,000 students have invited GA attendees to come share a talk or activity with them. So far, we have only enough volunteers to serve a quarter of these requests.

If you're willing to spend an hour in a classroom while you're in Honolulu, please sign up at on the conference website. We can reimburse your local travel costs. Questions? Contact me at rgal@ifa.hawaii.edu.

— Roy Gal (Institute for Astronomy, University of Hawaii)

In 2013 the CAE held a special Teaching Excellence Workshop on Hawai'i Island for rising stars in astronomy, Earth science, and space science — an elite group of graduate students and postdocs dedicated to excelling as educators. *[Wayne Schlingman]*

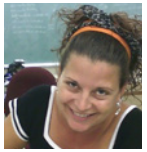
development efforts to an IAU General Assembly. We cordially invite you to attend one of three different short courses, all being held from 10:00 to 11:30 am in Room 318B:

1. Tuesday, 4 August: Best Teaching Practices for Using Think-Pair-Share/Peer Instruction
2. Wednesday, 5 August: Best Teaching Practices for Using Lecture Tutorials
3. Thursday, 6 August: Best Teaching Practices for Using Animations and Simulations

By participating in these workshops, you will learn ways to help your students increase their conceptual understanding and critical-thinking abilities and to better be able to interpret discipline representations, reason about quantitative data, and appropriately predict and explain physical outcomes.

You will be provided with experiences that have been shown to help instructors increase their implementation knowledge and abilities. You will also have ample opportunity to put your new knowledge to use during several microteaching events in which you will assess and critique many different examples of using these instructional strategies.

The CAE's professional development programs are sponsored and supported by the NASA Exoplanet Exploration Program. ✿



GINA BRISSENDEN is Associate Director of the Center for Astronomy Education (CAE) at the University of Arizona, Tucson, and serves as AAS Education and Outreach Coordinator. ED PRATHER is Executive Director of the CAE and outgoing AAS Education Officer. He was recently awarded the Astronomical Society of the Pacific's 2015 Richard H. Emmons Award for excellence in college astronomy teaching.

WORKSHOPS

Improve Your Teaching Skills

Several short courses precede the first meeting of the IAU Working Group on Astronomy Education.

By TIMOTHY F. SLATER

Everyone knows that the IAU provides a unique opportunity for scientists from across the planet to work together to do astronomy. What you might not know is that the IAU also provides numerous opportunities for astronomers to become better astronomy teachers. Several intensive teaching-improvement workshops are scheduled throughout the first week of the

General Assembly for scientists interested in enhancing their teaching skills and expanding their teaching toolkits.

At 10:00 am on Tuesday, 4 August, in Room 318B, Ed Prather and his colleagues will demonstrate how astronomy professors can improve class discussion by asking students to vote on astronomy questions, just like the GA did in 2006 when categorizing Pluto as a dwarf planet. Following, from 12:30 to 3:30 pm, Stephanie Slater and her colleagues will provide a hands-on workshop on teaching non-science students how to mine online astronomy databases to conduct authentic research. Participants are encouraged to bring their laptops to that workshop. The following day, at 10:00 am on Wednesday, 5 August, also in Room 318B, Ed Prather's team will teach attendees how to reallocate lecture time to more effective, collaborative group-learning activities.

Sky, a 20-year-old hyacinth macaw from Brazil, spent Monday hanging out in the Speaker Ready Room (317A), supervising the upload of speakers' presentations. He may come back another day, or he may send one of his friends. If you happen to encounter a magnificent feathered creature in Room 317A, be sure to keep your fingers to yourself. Among his many talents, Sky can easily and instantly crack raw Macadamia nuts with his beak. *[Lisa Idem, AAS]*

Later in the week, at 10:00 am on Thursday, 6 August, in Room 318B, Ed Prather and his colleagues will show how digital animations, movies, and simulations can be used to improve students' understanding of complex ideas in astronomy. At 10:30 am that same day, in Room 328, Sharon Schleigh and her colleagues will teach professors interested in improving their astronomy courses how to educate students in the art of scientific argumentation.

At Keaukaha Elementary School on Hawai'i island, Stephanie Slater teaches a class about the solar system. *[Inge Heyer]*

All of these open-attendance teaching workshops are leading up to the education-focused Division and Commission meetings held on Friday of the first week and Monday of the second week. These meetings look and feel much like the science-specific subgroup and Working Group meetings occurring at the GA but are completely dedicated to improving the understanding of astronomy across the globe.

Finally, on Tuesday, 11 August, the first meeting of the IAU Working Group on Astronomy Education: Research on Theory & Methods will be held. Chaired by Paulo Bretones, this group is charged with creating an international database of astronomy education research, much of which is not published in traditional venues, and with planning IAU Symposium 326, "Future Directions of Astronomy Education Research," to be held 3-7 October 2016 in Heidelberg, Germany. The Working Group meeting is open to any registered GA attendee interested in international astronomy education research, IAU member or not.

Taken together, these activities reflect the enormous interest the IAU community has in working collaboratively on enhancing teaching in order to improve the world's enthusiasm for astronomy. ✿

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*.

FOCUS MEETING 3

Scholarly Publication in Astronomy: Evolution or Revolution?

By LANCE D. UTLEY

Do you want a peek at what's next in scholarly publishing? Do you have an unrealized need or service you've always wished astronomy publishing offered? Are you excited about the opportunity to grow collaboration between the professions of publishing, astronomy, and librarianship? Focus Meeting 3 is the place to gain new insight into what's evolving in scholarly publishing.

Scholarly publishing is an indelible part of academic astronomy, but it is ever changing. Technology, government mandates, institutional pressures, and individual preferences are all driving new publishing paradigms for sharing information. The need to adapt while maintaining quality in publishing provides opportunities for astronomers, librarians, and publishers alike, particularly in partnership with each other. Focus Meeting 3 (FM 3) is a venue for anyone interested in the future of scholarly publishing in astronomy.

FM 3 offers attendees the chance to peek behind the scenes of the publishing industry and discover what new things are ahead. Our invited speaker, Jeffrey Beall, a noted expert on open access and predatory publications, will provide an analysis of publishers whose motivations are not rooted in the pursuit of academic quality and research integrity. Other talks will also focus on what publishers do behind the scenes and on what their operations cost, how publishers are adapting to offer new services to the scientific community, and publishers' perspectives on what the future of scholarly publishing has in store.

One of the growing demands on scholarly publication is the need for openness between the published work and the data related to the work. Tying data to the published work isn't a new demand in astronomy, but it's one that is surging in large part due to government mandates for transparency. Talks will also detail how scientific publishing can add value and deliver greater impact through integrating other media with the published text, how these media should inter-operate, what challenges arise in making publications more dynamic, and how these needs inform next-generation publishing.

Partnership opportunities abound as scientific publishing evolves. Astronomers, publishers, and librarians have a long history of collaboration between one group and another, but perhaps less so as a larger community across all three disciplines. Librarians are already involved in many of the institutional

Focus Meeting 3: Scholarly Publication in Astronomy: Evolution or Revolution?	
Start date	Wednesday, 5 August
End date	Thursday, 6 August
Oral sessions	Room 320, 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.

Big Data initiatives, some of which will be discussed in FM 3. As publishers create new opportunities to bring data to the scholarly literature, the larger community can work together to evolve scholarly astronomy publishing in a way that makes it more dynamic without losing integrity. Presenters will discuss ways librarians can enhance author attribution, author and institutional impact factors, and bibliometric tools to evaluate how effective new paradigms are on the quality of the research record.

FM 3 will also feature a panel discussion in which publishers, astronomers, and librarians can gain insight into each other's perspectives and how roles can evolve to best support one another. ✿

LANCE UTLEY is a librarian with the National Radio Astronomy Observatory in Charlottesville, Virginia. He edited the proceedings of the 2012 meeting of the IAU Division XII Commission 5 Working Group on Libraries, held in Beijing, China.

SPLINTER MEETING

Identification of the Diffuse Interstellar & Unidentified IR Bands

By FRED JOHNSON

It took 60 years of experimental research to discover a complete solution to the identity of the chromophores responsible for the diffuse interstellar bands (DIBs) and unidentified infrared (UIR) bands.

Come to this Splinter Meeting on Wednesday, 5 August, from 1:30 to 4:30 pm in Room 326B, to explore the methodology utilized and the surprises encountered while conducting this research. Several implications will go against the grain of present-day cosmology. There were indeed many unexpected surprises that finally led to the solution of a long-standing astronomical enigma.

Enormous efforts are presently under way using large telescopes and advanced spectroscopic techniques to measure these DIBs — all to no avail in providing a solution, thus far. One of the reasons for these failures is traceable to Mother Nature's trickery: With few exceptions the majority of the more than 400 DIBs are observed as absorption bands, but in reality they arise from fluorescence signals that are lost in the interstellar fluffy dust cocoons. The transmitted radiation therefore has missing energy, and thus the signals will appear as absorption bands.

Honolulu Almanac 🐟 4 August 2015

Sunrise / set	6:06 am / 7:09 pm
Twilight[1] start / end	4:46 am / 8:29 pm
Moonset / rise	10:34 am / 10:44 pm
Moon phase[2]	❍ Waning gibbous (77% illum.)
Evening planets[3]	Jupiter (W), Saturn (SSW)
Morning planets[3]	—

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

Many questions remain, and important implications will be addressed at the session:

- Where and are how are these complex molecules produced?
- How did they end up in the interstellar medium?
- What are the implications of the chromophore identification on the early evolution of the solar system? ✿

FRED M. JOHNSON is Emeritus Professor of Physics at California State University, Fullerton. He chaired the physics department at the university and is a Fellow of the American Physical Society.

IAU COMMISSION H3

A New IAU Commission: Planetary Nebulae

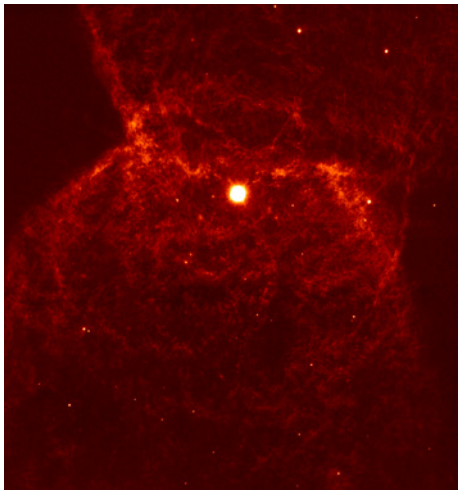
By LETIZIA STANGHELLINI

The IAU has recently approved a new Commission, H3, "Planetary Nebulae." Previously, the Planetary Nebulae Working Group represented this field within the IAU, organizing periodic Symposia.

The field of planetary nebula research, while focused, does interconnect with many areas of astronomical exploration and astrophysical interpretation. Planetary nebulae are tools and probes in astrophysics. In a broad sense, it is very difficult to do astrophysics without knowledge of them, and vice-versa. This goes well beyond the interest of the objects themselves, which are nonetheless remarkable.

The founders of the Commission H3 are You-Hua Chu (Taiwan), Arturo Manchado (Spain), Silvia Torres-Peimbert (Mexico), and me. With the support of Sun Kwok (Hong Kong) and the IAU Planetary Nebulae Working Group, we are working toward continuing the field's traditions, exploring new avenues of research, and exploiting interconnections between planetary nebula research and other science fields.

Commission H3 will propose and organize general and focused Symposia, engage the international student community, and work toward the publication of a Commission white paper. To this end, the IAU Planetary Nebulae Commission is ideally suited to solicit feedback from the community via broad surveys and other specific actions. ✿



This new image of planetary nebula NGC 2346 from one of the Gemini 8.1-meter telescopes shows unprecedented resolution of the molecular hydrogen gas. *[Gemini Observatory]*

LETIZIA STANGHELLINI is an associate astronomer at the National Optical Astronomy Observatory in Tucson, Arizona. She has worked on a variety of planetary-nebula subjects, both galactic and extragalactic, since the 1980s and is the President of the new IAU Commission H3, Planetary Nebulae.

SPLINTER MEETING

Celebrating Radio Astronomy's Golden Years

By KEN KELLERMANN

The 1960s were truly the golden years of radio and radar astronomy. That decade saw a number of major discoveries that transformed our understanding of the universe and its contents. Discoveries included quasars, pulsars, the cosmic microwave background (CMB), cosmic masers, radio recombination lines, interstellar molecules, extragalactic radio source variability, and the rotation of Mercury and Venus.

The 1960s also heralded a new generation of radio telescopes: the Parkes 64-meter dish, the Haystack 37m dish, the Green Bank 42m and 91m dishes, and the Owens Valley Radio Observatory interferometer. The latter made the first full aperture-synthesis observations, introduced the CLEAN algorithm, and completed the first very-long-baseline-interferometry observations. Interestingly, the major discoveries listed above and the introduction of these large dishes were unrelated events. The scientific breakthroughs were mostly serendipitous, and often occurred while observers were looking for something else, and theory played little or no role.

To mark the 50th anniversary of these discoveries, the IAU Working Group on Historical Radio Astronomy has organized two sessions: Wednesday, 5 August, 10:30 am – 12:30 pm and 4:00 – 6:00 pm in Room 328. Sessions will include a series of historical talks, often given by the history makers themselves.

Jocelyn Bell-Burnell at the 4.5-acre telescope at Mullard Radio Observatory in England. *[University of California, Berkeley]*

Jocelyn Bell-Burnell will reflect on her discovery of pulsars, and Dave Jauncey will discuss the circumstances surrounding the Parkes Telescope's 3C 273 lunar-occultation observations that led to the discovery of quasars by Maarten Schmidt. Jim Moran will review how high angular, temporal, and spectroscopic resolution led to the recognition of cosmic masers. Bob Wilson will discuss the events that led to his and Arno Penzias's discovery of the CMB. Jack Welch and Richard Wielebinski will talk about the astrochemistry of interstellar molecules and cosmic magnetism, respectively. Sergei Gulyaev and Leonid Gurvits will describe how Western scientists were initially skeptical of the Russian discovery of radio recombination lines and radio source variability. In addition, Ron Ekers will review the impact of the new generation of user-oriented radio telescopes and how they changed the culture of astronomy, and of radio astronomy in particular.

The Historical Radio Astronomy Working Group will also hold an open session on 5 August from 2:00 to 3:30 pm. This session will include a brief business meeting and three contributed papers: Tony Tyson will describe Karl Jansky's relatively unknown 1937 return to radio astronomy, Miller Goss will describe his discovery of the original data from Joe Pawsey's 1945 detection of the million-degree solar corona, and George Miley will discuss the scientific and political impact of the Jodrell Bank Long Baseline Interferometer. ✿

KEN KELLERMANN is the chair of the C40/C41 Working Group on Historical Radio Astronomy and a Senior Scientist at the National Radio Astronomy Observatory in Charlottesville, Virginia.

PUBLIC TALK

In Losing Sight of the Land, You Discover the Stars

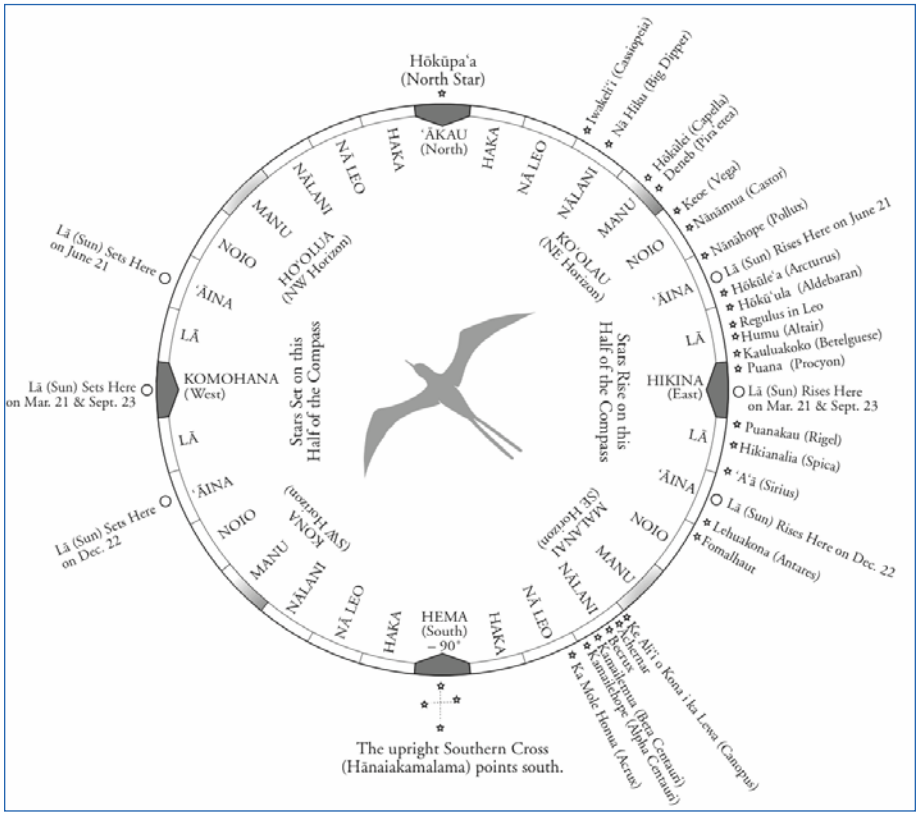
Native Hawaiian Chad Kālepa Baybayan sees wayfinding as a way of living.

By IRIS NIJMAN, *Kaiʻaleleiaka*

Chad Kālepa Baybayan, born on Maui and captain and navigator of the Hawaiian deep-sea voyaging canoes Hōkūleʻa, Hawaiʻiloa, and Hōkūalakaʻi, will give a public talk on the indigenous system of orientation and navigation at sea on Tuesday evening, 4 August.

Baybayan is an expert in ancient ways of navigation without modern instruments and Navigator in Residence at the ʻImiloa Astronomy Center of Hawaiʻi, where he develops wayfinding activities, curricula, and education materials. The ʻImiloa Astronomy Center is a gathering place that advances the integration of science and exploration, indigenous culture, and the wonders of astronomy to inspire and give hope to generations. Indeed, Baybayan, who has a master's degree in education, wants to engage learners and educators of all ages to explore the universe and realize their full potential. Baybayan first started sailing in 1975, when he was 19, and has since sailed on all the major voyages of Hōkūleʻa throughout the South Pacific, along the West Coast of North America, and around Micronesia and Japan. In 2007 Baybayan and four other Hawaiian men were initiated into the Order of Pwo, a 3,000-year-old society of master deep-sea navigators by their teacher, Master Navigator Mau Piailug, on the island of Satawal. During all his years of sailing, Baybayan learned the skill of navigation and seamanship from qualified navigators on the canoe. But he learned more than how to navigate without the use of instruments of charts; he integrates all he has learned into the general philosophy of wayfinding. "Wayfinding is a natural orientation process that uses surrounding environmental clues — Sun, Moon, stars, waves, and animals — to help set direction," says Baybayan in a National Geographic interview. As quoted on the website Hawaiian Voyaging Traditions, Baybayan calls wayfinding "a way of organizing the world; a way of leading, of finding a vision; a set of values; a way to take care of the Earth," and, in general, "a model for living my life." Baybayan says that the key to wayfinding is to employ a set of

Chad Kālepa Baybayan, ʻImiloa's Resident Navigator. *[ʻImiloa Astronomy Center]*



This Hawaiian star compass can be used for navigation. All the stars have a house: the place where they come out of the ocean and go back into the ocean. If you can identify the stars as they rise and set, and if you have memorized *where* they rise and set, you can find your direction. *[Nainoa Thompson, "On Wayfinding," Hawaiian Voyaging Traditions]*

values, like a strong background in ocean sciences, oceanography, meteorology, and environmental sciences. You need to know how to run a ship and get a cohesive crew that works together with deep respect for each other. You need vision, planning, training, discipline, and aloha for others. "After a while, if you apply all those values, it becomes a way of life," he says.

Today the ancient philosophy of wayfinding is finding its way from the ocean to the shore, as lessons learned at sea are now being applied to the land. "Here in Hawai'i we are surrounded by the world's largest ocean," says Baybayan on the Hawaiian Voyaging Traditions site. "But Earth itself is also a kind of island, surrounded by an ocean of space. In the end, every single one of us — no matter what our ethnic background or nationality — is native to this planet. As the native community of Earth we should all ensure that the next century is the century of pono — of balance — between all people, all living things, and the resources of our planet." ✿

Public Talk: He Lani Ko Luna, A Sky Above	
Speaker	Chad Kālepa Baybayan, 'Imiloa Astronomy Center
Date	Tuesday, 4 August
Location	Ballroom B, Hawai'i Convention Center
Time	7:30 to 8:30 pm

Regular registered attendees of the IAU GA will be admitted upon showing their meeting badges. Registered guests, anyone with an Exhibit Hall Only badge, and unregistered members of the public must register online.

Honolulu Weather Forecast 4–5 August 2015

TUESDAY, 4 AUGUST		***High: 86°F/30°C Low: 75°F/24°C***
Morning	**Afternoon**	**Evening**
Sunny	Sunny	Scattered clouds
0% chance of rain	15% chance of rain	45% chance of rain
WEDNESDAY, 5 AUGUST		***High: 85°F/29°C Low: 75°F/24°C***
Morning	**Afternoon**	**Evening**
Scattered clouds	Scattered clouds	Scattered clouds
35% chance of rain	50% chance of rain	25% chance of rain

Extended forecast: Guillermo has weakened from a category 2 hurricane to a tropical storm and will reach O'ahu on Thursday, bringing heavy rainfall. A high surf advisory with a warning of rip currents for east-facing shores of O'ahu was issued on Sunday and will remain in effect until at least 6 pm on Tuesday. Source: Weather Underground.