From the Director

June was an extremely busy month here at IfA. We had two very successful high-profile public events, the transit of Venus and the lecture by Nobel laureate Brian Schmidt, but we also took the time to undergo an external review by a visiting committee. The purpose of the review was to have a group of outside scientists evaluate the IfA’s current condition, and to assess its goals and its projected means to meet those goals.

The visiting committee was headed by Pat Osmer, the former chair of the Astronomy Department at Ohio State and now the vice provost for graduate studies and dean of the Graduate School there, and included scientists who have served in high-level positions at NASA, the University of California Observatories, and national observatories. They looked at IfA’s research program, teaching program, organization, balance between the number of scientific and nonscientific (technical and administrative) positions, and IfA’s public outreach, media relations, and private fundraising.

Prior to the committee’s arrival, the faculty and staff produced a “self-study” document to give the committee an overview of the IfA’s history, current status, and goals. The committee spent two days on Hawai‘i Island visiting Mauna Kea Observatories and IfA Hilo, another day at Haleakalā Observatory and IfA Maui, and a day and a half at IfA Mānoa. At each stop, they interacted with faculty and staff. They also met with UH administrators in Hilo and Mānoa.

At the end of the visit, the committee gave an oral report to the IfA. Overall, they had a very favorable impression of the Institute. However, they also pointed out some issues that need to be addressed if the IfA is to succeed in meeting its goals. We must all agree on our goals and collaborate to attain them. They must be prioritized, since there are not enough resources to do everything. As Director, I look forward to their final written report, and I will strive to implement their recommendations.
Space Observations of Mercury Transits Yield Precise Solar Radius

A group of scientists from Hawai‘i, Brazil, and California has measured the diameter of the Sun with unprecedented accuracy by using a spacecraft to time the transits of the planet Mercury across the face of the Sun in 2003 and 2006.

They measured the Sun’s radius as 432,687 miles (696,342 km) with an uncertainty of only 40 miles (65 km). This was achieved by using the solar telescope aboard a NASA satellite, thereby bypassing the blurring caused by Earth’s atmosphere that occurs when observations are made from the ground.

The measurements of the Sun’s size were made by IfA scientists Marcelo Emilio (visiting from Ponta Grossa, Brazil), Jeff Kuhn, and Isabelle Scholl, in collaboration with Rock Bush of Stanford University. They used the Michelson Doppler Imager (MDI) aboard NASA’s Solar and Heliospheric Observatory (SOHO) to make the measurements.

“Transits of Mercury occur 12–13 times per century, so observations like this allow us to refine our understanding of the Sun’s inner structure, and the connections between the Sun’s output and Earth’s climate,” said Kuhn. Because Mercury is farther from Earth and much smaller than Venus, transits of Mercury are not visible with the naked eye.

More recently, the team observed the transit of Venus across the Sun on June 5. They expect these observations will improve the accuracy of their solar size measurement even further.
Infrared Sensor to Revolutionize Infrared Imaging

by Louise Good

The first image taken with the new sensor shows the Whirlpool Galaxy (M51) in the constellation Canes Venatici. It is gravitationally interacting with the smaller companion galaxy. Spectacular star formation was triggered by this companion coming through the main disk of M51 about 500 million years ago and looping back through it in the last 50 to 100 million years. M51 can be seen through binoculars at a dark sky site and is familiar to amateur astronomers. UH Institute for Astronomy.

The IfA has released the first image obtained using its new 16-megapixel HAWAII 4RG-15 (H4RG-15) image sensor on the UH 2.2-meter (88-inch) telescope on Mauna Kea. This represents a significant step forward in astronomical infrared technology because it is the first time an infrared sensor with anywhere near this many pixels has been trained on the sky.

The image shows the Whirlpool Galaxy, a spiral galaxy 23 million light-years away. “The detail captured all across this extended infrared image really whets our appetite for getting these sensors into cameras at newer, much larger telescopes,” said IfA astronomer Donald N. B. Hall, the principal investigator for the project. “The level of detail revealed by digitally zooming in anywhere in the 16-megapixel image is truly incredible.”

This sensor boasts 16 times the pixel count of an earlier sensor developed by the same team and installed on the Hubble Space Telescope during the astronauts' last refurbishment mission. It also has four times the pixel count of the largest infrared sensors now in use at telescopes around the world.
While the 16-megapixel count is comparable to commercial imagers in today's professional digital cameras, infrared sensors used for astronomy must also overcome two formidable technical challenges: The pixels must be sensitive to infrared colors, and they must be big enough to capture the details in the images from a large telescope.

The H4RG-15 development, sponsored by the National Science Foundation, has overcome these challenges through an academic-industrial partnership that draws upon the combined expertise of the IfA, Teledyne Scientific and Imaging, GL Scientific, and ON Semiconductor. This latest sensor is the culmination of a 20-year, $15-million effort that has developed five generations of increasingly larger and more powerful infrared sensors in the HAWAII series. The acronym stands for HgCdTe (mercury-cadmium-telluride) Astronomical Wide Area Infrared Imager.

To overcome the first of these major challenges—that the silicon used to fabricate visible imagers is blind to infrared light—infrared-sensitive crystals must be electrically connected to each of the 16 million pixels.

The second challenge, matching the image scale at the focus of a large telescope, means that the pixels must be huge—several hundred times that of the pixels in an iPhone, resulting in one of the largest silicon chips ever produced.

The HAWAII-4RG-15 pushes the limits of current and foreseeable technology. Larger sensors can likely be constructed only by assembling mosaics of individual arrays, much like tiling a floor. With this technique, 64-megapixel and even gigapixel-class infrared sensors should be possible. GL Scientific, a Hawai'i high-tech company founded by former IfA astronomer Gerard Luppino, is a world leader in mounting the sensors into packages and assembling these into mosaics.

The Infrared-Optical (IO) sensor development program is run out of the IfA's Hilo facility on the Big Island of Hawai'i, where Hall is located. "These detectors are vital to the long-term success of the James Webb Space Telescope and other upcoming space astronomy missions," he commented. "They also greatly improve the infrared sensitivity of ground-based telescopes such as those on Mauna Kea today and are critical for the coming generation of 30-m-class telescopes, including the Thirty Meter Telescope planned for Mauna Kea."
Pan-STARRS Telescope Discovers Main-Belt Comet

An unusual comet discovered by the Pan-STARRS1 telescope on Haleakalā, Maui, is helping astronomers understand how Earth got its water. Initially spotted on November 5, 2011, the comet was first thought to be an asteroid, since its orbit lies in the main asteroid belt between the orbits of Mars and Jupiter. But P/2006 VW₁₃⁹, as it is known, differs from almost all other asteroids in having a cometlike tail that almost certainly consists of water vapor and dust grains that are evaporating from the surface of the object.

“Regular comets are basically enormous snowballs that spend most of their lives in the cold outer regions of the solar system,” said IfA astronomer Henry Hsieh. “What makes P/2006 VW₁₃⁹ so unusual is that it is a comet that orbits within the relatively near asteroid belt. Of the half-million bodies currently known in the asteroid belt, just seven so-called “main-belt” comets are known.

Main-belt comets may be more than a mere curiosity: Astronomers are hoping that they will provide clues to one of the great unsolved mysteries of geophysics, namely, “Where did Earth’s water come from?” In its early days, Earth was so hot that any water it was born with would have evaporated into space. Main-belt comets colliding with the cooling Earth may well have been the source of some of the water in our oceans.

Comet P/2006 VW₁₃⁹ was found while searching the sky for potentially hazardous asteroids—ones that may someday hit Earth. Pan-STARRS software engineer Larry Denneau, with help from Pan-STARRS solar system team leader Richard Wainscoat, fellow IfA astronomer Robert Jedicke, Mikael Granvik of the University of Helsinki, and Tommy Grav of the Planetary Science Institute, designed software that searches each image taken by the Pan-STARRS 1 telescope for moving objects. The software designed to specifically search for comets was developed by Hsieh and Denneau.

The team’s investigation also includes studies of the comet’s composition, orbital properties, and brightness changes by IfA astronomers Bin Yang and Nader Haghighipour, and graduate student Heather Kaluna.
Venus Transit Viewing on Three Islands

by Donna Bebber, IfA Events Coordinator

On June 5, one of the largest public outreach endeavors in the history of the Institute for Astronomy took place on O'ahu, Maui, and Hawai'i Island. Thousands turned out to see the transit of Venus in what was truly a once-in-a-lifetime event, since the next one won’t occur until 2117.

More than 13,000 people viewed the transit at four IfA venues on O'ahu. From noon until dusk, the IfA provided safe viewing facilities at Waikiki Beach, the Pacific Aviation Museum Pearl Harbor, Ko Olina Resort, and at IfA Mānoa. IfA faculty, staff, and students handed out solar viewers that allowed people to look at the Sun without damaging their eyes and provided telescopes equipped with solar filters to give people a better view of this event. Additional activities, such as robotics displays and other science and technology activities for children and adults, were available at all locations.

Telescopes with solar filters on Waikiki Beach. Photo by Karen Teramura.

At Waikiki Beach, astronomer Roy Gal tirelessly...
explained what was happening throughout the afternoon from a three-sided tent with a public address system and two screens that showed the webcasts from Mauna Kea and Haleakalā. Numerous faculty and students staffed telescopes on the hot beach. Friends of the IfA handed out solar viewers and information about the IfA, and signed up new members. Scientists from the UH NASA Astrobiology Institute (UHNAI) took the opportunity to talk with members of the public about the transit and their work, members of the UH Math Department’s SUPER-M Outreach Team provided models to explain the geometry of the transit, and IfA graduate students brought the IfA’s infrared camera to give passersby the opportunity to see what they looked like at infrared wavelengths. Altogether, we reached about 10,000 people, both tourists and Hawai‘i residents, in Waikīkī.

At Ko Olina, IfA provided viewing opportunities for more than 1,000 people, while Friends of the IfA provided refreshments, distributed viewers, and passed out information.

At the Pacific Aviation Museum, we expected 1,000–1,500 people, and got over 2,000. In addition to solar viewers and telescopes, IfA astronomers brought the StarLab portable planetarium because there was a safe, indoor location for it. The Kalani High School Robotics Team brought their fantastic robots, and the SUPER-M Outreach Team had their Lego Mindstorms robots and their water rockets out for more fun activities.

Among those viewing the transit with solar viewers at IfA Mānoa were members of the Mānoa Executive Team, including Chancellor Virginia Hinshaw (center). Photo by Karen Teramura.

A last-minute addition to the O‘ahu viewing venues was the IfA building in Mānoa. Eight hundred people showed up, and a quarter of them signed up to receive Friends of the IfA emails about future events.

On Hawai‘i Island, over 1,500 people came to view the transit at the Mauna Kea Visitor Information Station (VIS), and 400 took a free shuttle service to the summit. The VIS also provided three viewing stations at Kea‘au, the Natural Energy Laboratory in Kona, and Mauna Kea State Park that attracted an additional 1,500 viewers. Imiloa Astronomy Center in Hilo also provided viewing opportunities.
On Maui, 2,500 solar viewers were distributed. While the public enjoyed just viewing the transit, scientists there used this rare opportunity to conduct experiments on Haleakalā: One group used the SOLARC telescope to run two scientific experiments on the composition of Venus's atmosphere. A second group used the MOTH (Magneto-Optical filters at Two Heights) II instrument for the first time at Mees Solar Observatory to measure the polarization in that planet's atmosphere.

In addition, millions of people were able to view webcasts of the transit from the summits of Mauna Kea and Haleakalā over the Internet.

Donations to Friends of the IfA made it possible to purchase and distribute over 20,000 free solar viewers on all three islands.

On May 30, in preparation for this event, IfA sponsored a free panel discussion about the transit of Venus in the Art Auditorium on the Mānoa campus to educate the public about the upcoming event and
safe viewing. IfA astronomer Paul Coleman spoke about Hawaiians’ knowledge of the heavens before Western contact and the role of Hawai’i during the 1874 transit of Venus; IfA solar physicist Shadia Habbal spoke about the Sun and its connection to Venus and Earth; Peter Mouginis-Mark, the director of the Hawaii Institute of Geophysics and Planetology at UH Mānoa, talked about Venus itself; and IfA’s Roy Gal spoke about the transit on June 5.
Jewitt Wins Shaw, Kavli Prizes

Former IfA astronomer David Jewitt has received the prestigious Shaw and Kavli Prizes for work done while at the IfA. In 1992, he and Jane Luu discovered what was then considered the first Kuiper Belt object (KBO). Until then, the Kuiper Belt, small objects in the region beyond Neptune, had existed only in theory.

Jewitt and Luu used the UH 2.2-meter (88-inch) telescope on Mauna Kea to find the object called 1992 QB1. It soon became the first of many KBOs discovered by them and others, and eventually led to the demotion of Pluto from planet to dwarf planet when astronomers realized that Pluto is actually a KBO.

Jewitt, who left IfA for UCLA in 2009, is now a professor and director of the Institute for Planets and Exoplanets there. Luu, then an assistant professor at Harvard, is now a technical staff member in the Active Optical Systems Group at MIT Lincoln Laboratory.

Jewitt and Luu received the Shaw Prize for discovering “an archeological treasure dating back to the formation of the solar system and the long-sought source of short period comets.” The Shaw Prize was established by Run Run Shaw, a Hong Kong media magnate, in November 2002. It honors individuals who have made significant breakthroughs in scientific research and whose work has had a profound impact on the world.

The Kavli Prize, a partnership between the Norwegian Academy of Science and Letters, the Kavli Foundation (US), and the Norwegian Ministry of Education and Research, recognizes those who have made outstanding advances in astrophysics, nanoscience, and neuroscience. It was awarded to Jewitt and Luu, and Michael E. Brown (California Institute of Technology) “for discovering and characterizing the Kuiper Belt and its largest members, work that led to a major advance in the understanding of the history of our planetary system.”
IfA Student Wins Harvard Computer Competition

by Chris Beaumont, IfA Graduate Student

Academic research occasionally gets a reputation for being impractical. As astronomers, we sometimes respond to this by emphasizing the practical aspects of our work, such as our searches for potentially dangerous near-Earth asteroids. However, if these were our only justifications for doing research, there would be more efficient ways of achieving our goals. After all, most of us don’t look for asteroids, and most of our research focuses on esoteric questions that will not percolate back to the larger community. I think we can better justify our work by appealing to the unique culture of open-ended exploration and collaboration that academia encourages. Academia is unique in its ability to incubate and cross-pollinate ideas from diverse fields. I recently experienced this firsthand.

For the past year, I have been carrying out my PhD research in Cambridge, Mass., where I collaborate with researchers at Harvard. This January, I participated in a competition to develop computational strategies for responding to natural disasters. The competition organizers—professors who study disaster relief at the Harvard Institute for Applied Computational Science (IACS)—presented us with a database of the roads in Cambridge. These roads had been littered with debris, simulating the aftermath of a major hurricane. This debris rendered the roads impassable, and cut off aid workers from sick and injured residents.

Our goal was to develop a strategy for clearing these roads in as efficient manner as possible, given limited resources. On each simulated day, we were given a certain number of trucks to clear roads. These trucks had to clear their way into the city, opening access to as many people as possible. At regular intervals, we were penalized for the number of residents still without access to an open road. This mimics real-world considerations, where common health concerns like dehydration and cholera progress on timescales of hours to days.

We had to synthesize all of this information—the finite resources, the layout of roads and debris, the varying population density throughout the city—into a strategy for clearing debris. We had a week to design our algorithm, and three hours of computing time on one of Harvard’s supercomputers to come up with a solution.

I realized that this problem, while seemingly unrelated to astronomy, overlaps with the problems I solve every day in my research. For example, the idea of finding a good strategy for clearing debris is similar to searching for a good model for describing astronomical data—the underlying computation is the same.
I decided to use an approach called simulated annealing. This method tries to improve upon an initial, arbitrary road-clearing solution by considering whether slight modifications to the plan lead to a better outcome. Repeating this process millions of times leads to a very efficient road-clearing plan. I knew about simulated annealing because I had used it to design a strategy for Pan-STARRS to take repeated images of the sky in such a way that the regions it misses in a single image (due to gaps in the camera’s huge array of detectors) are filled in by subsequent images.

This strategy turned out to be highly effective. Not only did it produce the winning solution, but it outperformed the solution designed by the contest organizers. If the simulated disaster were a real emergency, this difference could easily translate to dozens or hundreds of saved lives.

It is hard to imagine this situation occurring outside of academia. I would not have participated in the contest if my PhD advisor had not encouraged me to collaborate with researchers at Harvard. I would not have known about simulated annealing had it not been for my work with Pan-STARRS. And the competition would not have been held if it weren’t for the newly commissioned IACS, set up to encourage collaboration between engineers and physical scientists. Components of academia can indeed be impractical. But the ideas generated in this unstructured environment can trickle out into the larger world in surprising ways.

*In addition to winning the IACS Computational Challenge, Chris Beaumont was also named 2012 ARCS Scholar of the Year by the Honolulu Chapter of the Achievement Rewards for College Scientists and received the UH 2012 Student Excellence in Research Award at the doctoral level.*
In Memoriam: Karen Rehbock

Karen Rehbock, who served as assistant to the director of the IFA from April 1989 until her retirement at the end of 2010, died on May 19 at St. Francis Hospice.

Karen had a wide range of duties over the nearly quarter century that she was in the Director's Office. Faculty will perhaps remember her best as the person who helped them understand the arcane aspects of the tenure and promotion process. Throughout her career at IfA, Karen assisted with the drafting of correspondence and official documents, such as observatory agreements, legislative testimony, press releases, and countless reports and plans. She served as recording secretary for both the Executive Committee and the Faculty Advisory Committee.

During the late 1980s and the 1990s, Karen played a leading role in organizing telescope groundbreakings and dedications, including those for Keck I and II, Subaru, Gemini, and the Submillimeter Array on Mauna Kea, and the Advanced Electro-Optical System (AEOS) telescope on Maui. She was also a key member of the IfA group that organized the VIP and media aspects of the 1991 total solar eclipse.

Karen will be missed by her former co-workers at IfA, who were looking forward to seeing her at future IfA events and celebrations.
The Institute for Astronomy and the Sheraton Waikiki launched a new lecture series on June 7 at Kennedy Theatre on the University of Hawai'i Mānoa campus. The Sheraton Waikiki Explorers of the Universe lecture series will be presented two or three times each year and will feature Nobel-laureate-level speakers. All lectures will be free and open to the public.

The first lecture featured Nobel laureate Brian Schmidt speaking on “The Accelerating Universe.” Schmidt gave an outstanding presentation. He made difficult material understandable for the nonastronomers in the audience. During the lecture, he acknowledged IfA astronomer John Tonry, who was a member of the team that received the 2011 Nobel Prize in Physics. Tonry was in Stockholm with Schmidt and his team when the award was presented.

Schmidt shared the Nobel prize with Adam Riess, also a member of Schmidt's High-Redshift Supernova Search Team, and Saul Perlmutter, a leader of a competing team studying the same phenomenon. In 1998, both teams used distant exploding stars to trace the expansion of the Universe back over billions of years and discovered—to their surprise—that this expansion is accelerating, which suggests that more than 70 percent of the cosmos is contained in a previously unknown form of mass/energy called “dark energy.” During his lecture, Schmidt described this discovery and explained how astronomers have used observations to track our Universe’s history back more than 13 billion years, leading them to ponder the ultimate fate of the cosmos.

Raised in Montana and Alaska, Schmidt received undergraduate degrees in physics and astronomy from the University of Arizona in 1989, and a PhD in astronomy from Harvard University in 1993. He joined the staff of the Australian National University in 1995, and is now a laureate fellow at the ANU's Mount Stromlo Observatory.

Schmidt is continuing to use exploding stars to study the Universe, and is leading Mount Stromlo’s effort to build the SkyMapper telescope, which will provide a comprehensive digital map of the Southern sky from ultraviolet through near-infrared wavelengths.
Tiantian Yuan wins Soroptimist Fellowship

IfA graduate student Tiantian Yuan is the winner of the Soroptimist Founder Region Fellowship, an award of $10,000. District VI Fellowship Director Judy Lee presented the award to her at the Pacific Club on May 22. Soroptimist is an international organization for business and professional women who work to improve the lives of women and girls in local communities and throughout the world.

Upcoming Events

O‘ahu Events: call (808) 956-8566 www.ifahawaii.edu/specialevents/

Maui Events: call (808) 573-9516
Maui Maikalani Community Lectures usually occur on the second Friday of the month.

Hawai‘i Island Events:
(808) 932-2328 or fujihara@ifahawaii.edu

Imiloa Astronomy Center of Hawai‘i features the “Maunakea Skies” lecture series on the third Saturday of the month at 7:00 p.m. (808) 969-9700, info@imiloahawaii.org

VISITING MAUNA KEA
The Onizuka Center for International Astronomy Visitor Information Station (VIS) at Hale Pōhaku (9,300-foot level of Mauna Kea) is open daily, 9:00 a.m. to 10:00 p.m. “The Universe Tonight” features recent discoveries, 6:00 p.m., first Saturday of every month. Lecture on the cultural aspects of Mauna Kea, 6:00 p.m., third Saturday of every month. Public stargazing nightly from 6:00 to 10:00 p.m.

Escorted summit tours begin at the VIS at 1:00 p.m. on Saturday and Sunday. For essential information, www.ifahawaii.edu/info/vi/vis/visiting-mauna-kea/summit-tours.html
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Published by
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