Nā Kilo Hōkū
THE ONES WHO LOOK TO THE STARS
A Newsletter from the Institute for Astronomy, University of Hawai'i
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No. 48 - 2013


Günther Hasinger

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From the Director

The Institute for Astronomy is not immune to the budgetary challenges of the University of Hawai'i as a whole. In recent years, the state legislature has cut the appropriations for UH. The university had to pass on these cuts to the colleges, departments, and research institutes. For this fiscal year, which began July 1, IfA has to cope with a budget reduction of $320,000. This reduction, together with union salary increases and other costs, impacts IfA's budget by over $500,000. That's the bad news.

The good news is that NASA has finally awarded funds to support the completion of the second Pan-STARRS telescope, which together with the generous private donation we received at the end of last year will allow PS2 to start operations soon. We very much hope that NASA will also provide funds to operate the Pan-STARRS PS1 and PS2 telescopes in the coming years. The highly successful PS1 first science mission, which began in May 2010 and will end in February 2014, has been supported by the international PS1 Science Consortium, NASA, and the National Science Foundation. PS1 and PS2 will start the second Pan-STARRS mission in March 2014. Together PS1 and PS2 will be by far the most powerful wide-field imaging system in existence and will continue the search for near-Earth asteroids that may pose a threat to our planet.

In the meantime, our own 2.2-meter (88-inch) telescope, one of the oldest telescopes on Mauna Kea, has become our child of sorrow, with many of the old subsystems slowly dying and needing to be replaced or repaired. We have had to defer maintenance and refurbishment of this telescope for many years. Now we hope to obtain some funding from the state and the university for the most urgent upgrades. It is our hope that the 2.2-meter will play a central role in our strategy for the future, as a test bed for new detector development and adaptive optics technology, and also as a reliable workhorse for scientists and students. We have recently received good news in this regard: The National Science Foundation will fund a test bed for an advanced, wide-field ground layer AO system for the 2.2-meter telescope.

We are also planning several new initiatives for the coming year, and we are hoping to raise funds for them. These include new astronomy and astrophysics undergraduate majors at UH Mānoa that, when combined with the existing UH Hilo program, will make UH one of the leading producers of astronomers in the United States; a replacement for the Hōkū Kea Observatory, a 36-inch telescope on Mauna Kea, that will be used by the undergraduate majors; a partnership status for UH in the Thirty Meter Telescope to be built on Mauna Kea; a small robotic telescope on Haleakalā for K–12 education and outreach; and increased outreach to schools and the public.

Your donations to the IfA Advancement Fund of the UH Foundation can make these plans a reality. If you would like to hear more about

Highlights


Gas-Giant Exoplanets Cling to Their Parent Stars


Study Finds Most Centaurs Are "Cometary"

Upcoming Events

Tuesday, October 29, Frontiers of Astronomy Community Event, Nicholas McConnell, IfA Beatrice Watson Parrent Postdoctoral Fellow, "Monsters in the Dark: Supermassive Black Holes and Their Destructive Habits," 7:30 p.m., UH Mānoa Art Building Auditorium (room 132). Free Admission (Campus Parking $6).

More Events>>

these opportunities, please contact our outreach coordinator, Dr. Roy Gal at rgal@ifa.hawaii.edu.

This newsletter is available in pdf format. Use “shrink to fit” or “shrink to printable area” setting for printer.

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Comet ISON Viewing

IfA will sponsor viewing opportunities on O‘ahu just before sunrise in late November at a location on the windward side. For exact times and places, check the IfA website, or our Facebook page or Twitter feed (UHIfA). To get on our special events mailing list, send an email to ifaevents@ifa.hawaii.edu. For events on Hawai‘i island, see the website of the Mauna Kea Astronomy Outreach Committee.

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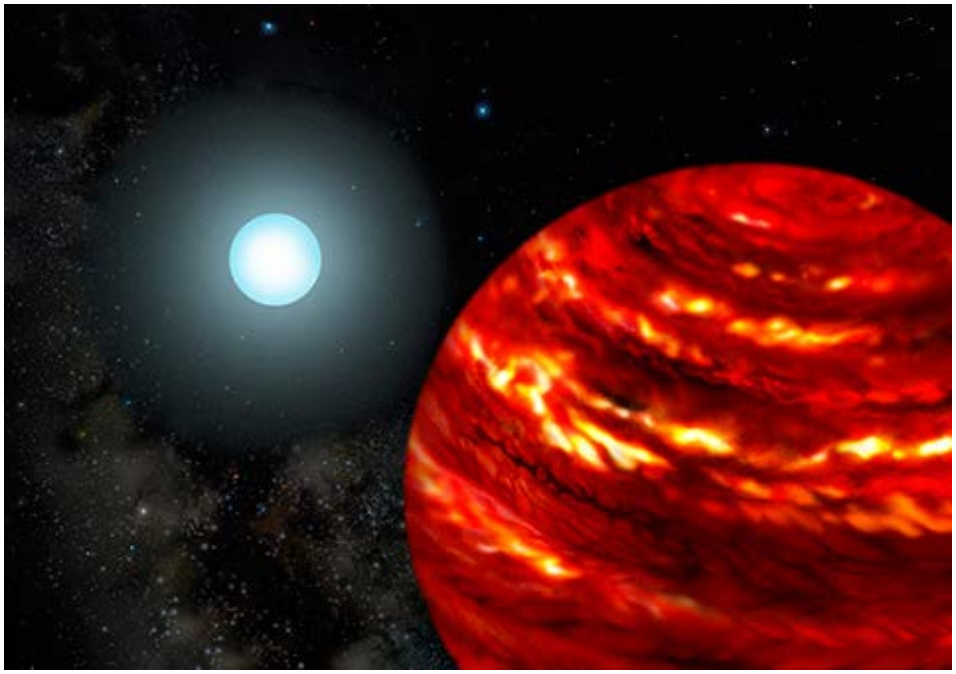
Gas-Giant Exoplanets Cling to Their Parent Stars



Artist's rendering of an exoplanet system with a gas-giant planet orbiting close to a star that is more massive than our Sun. Artwork by Lynette Cook courtesy Gemini Observatory/AURA.

In 2008, astronomers using the Gemini North telescope and W. M. Keck Observatory on Mauna Kea took the first-ever direct images of a family of planets around the star HR 8799. They found gas-giant planets at large orbital separations (about 25–70 times the Earth–Sun distance). This discovery, made after examining only a few stars, suggested such large-separation gas giants could be common. However, more recent Gemini results, from a much more extensive imaging search, show that gas-giant planets at such distances are in fact uncommon. Results from Gemini Observatory's recently completed Planet-Finding Campaign—the deepest, most extensive direct-imaging survey to date—show that the vast outlying orbital space around many types of stars is largely devoid of gas-giant planets.

"It seems that gas-giant exoplanets are like clinging offspring," says IfA astronomer Michael Liu, the leader of the campaign. "Most tend to shun orbital zones far from their parents. In our search, we could have found gas giants beyond orbital distances corresponding to Uranus and Neptune in our own solar system, but we didn't find any." The campaign was conducted at the Gemini South telescope in Chile, with funding from the National Science Foundation and NASA. The results will help scientists better understand how gas-giant planets form, as the orbital distances of planets are a key signature that astronomers use to test exoplanet formation theories.

IfA postdoctoral researcher Eric Nielsen, the first author on the paper about the campaign's search for planets around stars more massive than the Sun, adds that the findings have implications beyond the specific stars imaged by the team. "The two largest planets in our solar system, Jupiter and Saturn, are huddled close to our Sun, within 10 times the distance between the Earth and Sun. We found that this lack of gas-giant planets in more distant orbits is typical for nearby stars over a wide range of masses."

The campaign revealed similar tendencies around other classes of stars. Liu summed it up this way: "We've known for nearly 20 years that gas-giant planets exist around other stars, at least orbiting close-in. Thanks to leaps in direct imaging methods, we can now learn how far away planets can typically

reside. The answer is that they usually avoid significant areas of real estate around their host stars. The early findings, like HR 8799, probably skewed our perceptions."

A second paper by the team explores systems where dust disks around young stars show holes, which astronomers have long suspected are cleared by the gravitational force of orbiting planets. "It appears that instead of massive planets, smaller planets that we can't detect directly could be responsible," said Zahed Wahhaj (formerly a postdoctoral researcher at IfA and now with the European Southern Observatory), the lead author on the survey's paper on dusty disk stars.

Finally, the team's third new paper looks at the very youngest stars close to Earth. "A younger system should have brighter, easier to detect planets," according to the lead author Beth Biller, a former IfA postdoctoral researcher who is now at the Royal Observatory Edinburgh. "Around other stars, NASA's Kepler telescope has shown that planets larger than the Earth and within the orbit of Mercury are plentiful," Biller explained. "The NICI Campaign demonstrates that gas-giant planets beyond the distance of the orbit of Neptune are rare."

The observations for the campaign were obtained with the Gemini instrument known as NICI, the Near-Infrared Coronagraphic Imager, the first instrument for an 8–10 meter-class telescope designed specifically for finding faint companions around bright stars. Doug Toomey of Mauna Kea Infrared and the IfA's Christ Ftaclas and Mark Chun built NICI with funding from NASA.

A new instrument, the soon-to-be-delivered Gemini Planet Imager, will likely reveal whether giant planets in orbits similar to the gas-giant planets of our own solar system are common.

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Study Finds Most Centaurs Are “Cometary”

This artist’s concept shows a centaur creature together with asteroids on the left and comets at right. NASA/JPL-Caltech.

Centaurs are the small celestial bodies orbiting the Sun between Jupiter and Neptune. Their origin has long been mysterious. Until recently, astronomers were not certain whether centaurs are asteroids flung out from the inner solar system or comets traveling in toward the Sun from afar. Now a study has found that most centaurs are comets. The findings come from the largest infrared survey to date of centaurs by NEOWISE, the asteroid-hunting portion of NASA’s Wide-field Infrared Survey Explorer (WISE) mission.

Centaurs take their name from the creature in Greek mythology whose head and torso are human and legs are those of a horse. “Just like the mythical creatures, the centaur objects seem to have a double life,” said James Bauer of NASA’s Jet Propulsion Laboratory in Pasadena, California. Bauer, who did his PhD work at IfA, is the lead author of the paper about this study. “Our data point to a cometary origin for most of the objects, suggesting they are coming from deeper out in the solar system.” “Cometary origin” means an object likely is made from the same material as a comet, may have been an active comet in the past, and may be active again in the future.

IfA astronomer Karen Meech is also a member of the study team. She noted, “These objects are exciting because they are active at large distances from the Sun, and they can give us a glimpse of the types of ices other than water ice, which is the most abundant ice in inner solar system comets. Water can only be released from a comet when it gets closer to the Sun than about the orbit of Jupiter. Outside of this distance, it is too cold.”

Centaurs orbit in an unstable belt. Ultimately, gravity from the giant planets will fling them either closer to the Sun or farther away from their current locations. Although astronomers previously observed some centaurs with dusty halos, a common feature of outgassing comets, and NASA’s Spitzer Space Telescope also found some evidence for comets in the group, they had not been able to estimate the numbers of comets and asteroids.

Infrared data from NEOWISE provided information on the objects’ albedos, or reflectivity, to help astronomers sort the population. NEOWISE can tell whether a centaur has a matte and dark surface or a shiny one that reflects more light. The puzzle pieces fell into place when astronomers combined the albedo information with what was already known about the colors of the objects. Visible-light

observations have shown centaurs generally to be either blue-gray or reddish in hue. A blue-gray object could be an asteroid or comet. NEOWISE showed that most of the blue-gray objects are dark, a telltale sign of comets. A reddish object is more likely to be an asteroid.

“Comets have a dark, sootlike coating on their icy surfaces, making them darker than most asteroids,” said the study’s co-author, Tommy Grav of the Planetary Science Institute in Tucson, Arizona. “Comet surfaces tend to be more like charcoal, while asteroids are usually shinier like the Moon.” Grav is a former IfA postdoctoral researcher.

The results indicate that roughly two-thirds of the centaur population are comets, which come from the frigid outer reaches of our solar system. It is not clear whether the rest are asteroids. The centaur bodies have not lost their mystique entirely, but future research from NEOWISE may reveal their secrets further.

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Two IfA Students Win UH Research Prizes

Brendan Bowler and Andrew Mann, both doctoral students at the IfA, were the winners of University Research Council student awards for 2013. Both are making significant contributions in the competitive field of exoplanet science—the study of planets around stars other than the Sun.

Brendan Bowler

Bowler's research focuses on identifying new planets through direct imaging, using state-of-the-art adaptive optics techniques on the Keck and Subaru telescopes on Mauna Kea. Bowler has also been working to characterize the atmospheres of giant planets like Jupiter using spectroscopy. At IfA, Bowler published eight first-author refereed papers and has been a major co-author on another eight and a minor co-author on another ten papers. His ability to publish his results quickly puts him at the level normally reserved for top junior faculty members. Bowler just defended his thesis and will continue his career as a Prize Postdoctoral Fellow in Planetary Astronomy at the California Institute of Technology's Joint Center for Planetary Astronomy.

Andrew Mann

Mann studies exoplanets and the properties of the stars that they surround. His thesis work focused on a type of red dwarf star called an M dwarf, which is cooler and dimmer than our Sun. Mann's work includes developing techniques to find new transiting planets around M dwarfs, establishing M dwarf metallicities (the extent to which they contain elements besides hydrogen and helium), and studying statistics, such as the occurrence of planets around M dwarfs, resulting from transiting planet surveys. In the past few years, Mann published five first-authored manuscripts on exoplanet science and one on clusters of galaxies in peer-reviewed astronomical journals. He has also co-authored ten other peer-reviewed publications. Mann was selected for the prestigious Harlan J. Smith Fellowship at the University of Texas at Austin and recently left IfA for Texas.

Each has been awarded a $1,000 prize from the University Research Council and the Research Corporation of the University of Hawai'i (RCUH).

Photos by N. Lyttle and K. Teramura

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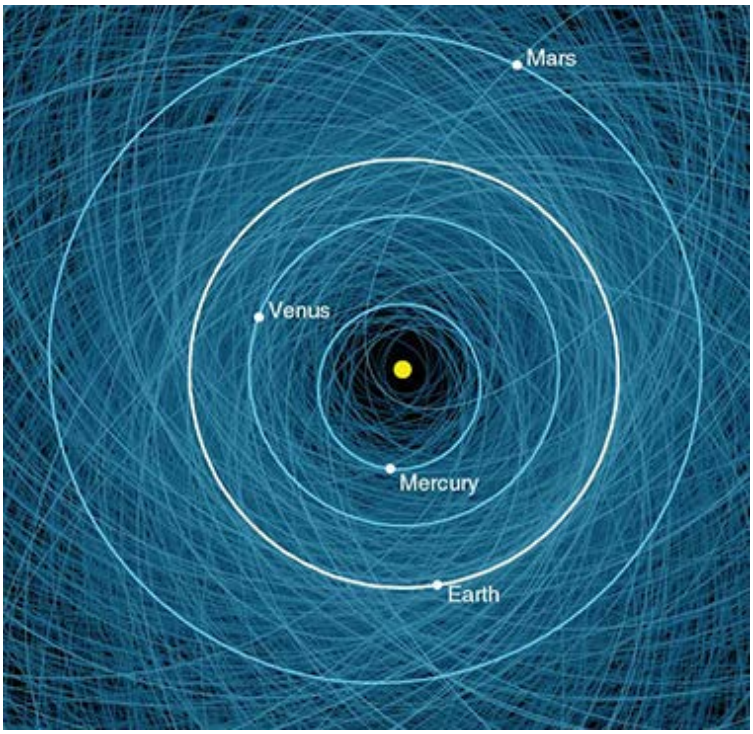
Protecting Earth from Asteroid Impacts

by Louise Good



It's crowded out there: the orbits of over 1,000 known potentially hazardous asteroids that are over 140 meters across and will pass within 4.7 million miles (7.5 million km) of Earth. Credit: NASA, JPL-Caltech.

If you could literally save the world, would you? For former NASA astronaut Ed Lu, the answer is a resounding "yes." Lu, now head of the B612 Foundation, gave a Sheraton Waikiki Explorers of the Universe public lecture, "Protecting Earth from Asteroids, or How Astronomy Saves the World," at the UH Mānoa Kennedy Theatre on August 15. He said there is a 30 percent chance that an asteroid large enough to destroy a large city (about 40 yards across) will hit Earth in a person's lifetime. Such an asteroid would explode with a force 200 times that of the bomb that destroyed Hiroshima. Such an asteroid did hit Tunguska in Siberia in 1908, destroying an area bigger than the Los Angeles basin or larger that the island of Hawai'i. Larger asteroids can do even more damage, but collide with our planet less frequently.

Founded in 2002 by former Apollo astronaut Rusty Schweickart and Lu, the B612 Foundation is working to detect and deflect asteroids headed for a collision with Earth. At first, the group concentrated on researching methods to deflect asteroids. It turns out that is the easy part. With Earth traveling 65,000 mph (100,000 km/hr), it is only necessary to change the speed of an asteroid by 1 millimeter per second, about the speed an ant walks, if you do it many years before the collision would take place. This could be achieved by crashing a spacecraft into the asteroid and then sending another spacecraft called a "gravity tractor" to hover near the asteroid for many years. But finding the asteroids long before they collide with Earth is a more difficult proposition. Although NASA has paid for projects that have discovered an estimated 90 percent of the very large near-Earth asteroids (NEAs) that could end civilization, it is not doing enough to find the smaller ones that could still do serious damage, according to Lu.

A couple of years ago, Lu explained, he gave a talk at Google, and afterward a man asked him, “How do you find all these things?” Lu explained that the best way to find almost all NEAs would be to put an infrared telescope (“a giant set of night-vision googles”) into orbit around the Sun. The man asked him how much it would cost. Lu estimated that if a nongovernment entity did it, it would cost about a third of a billion dollars. The man explained how he had helped to raise $450 million dollars to add a wing to the San Francisco Museum of Modern Art, and he encouraged Lu to raise the money to build and launch the satellite.

So that is what the B612 Foundation is doing— raising money to build, launch, and operate an infrared space telescope called Sentinel to discover the great majority of NEAs. This is not totally unprecedented, Lu explained. Several ground-based observatories, such as the W. M. Keck Observatory on Mauna Kea, Lick Observatory in California, and Lowell Observatory in Arizona were built with private funds. Lu said they hope to launch Sentinel on July 20, 2018, into a Venus-like orbit around the Sun.

According to the B612 Foundation website, the telescope has been designed and will be built by Ball Aerospace, the same people who built the Kepler and Spitzer space telescopes and the Deep Impact spacecraft. It will be launched by SpaceX on a Falcon 9 rocket. NASA will support the mission with its Deep Space Network for communications, navigation, and tracking, and will aid in asteroid orbit calculation and threat assessment.

Someone in the audience asked Lu what will happen if Sentinel finds an asteroid headed for Earth. “Governments … are very, very good at confronting threats that are known,” he answered.

Video of Lu’s talk

B612foundation.org

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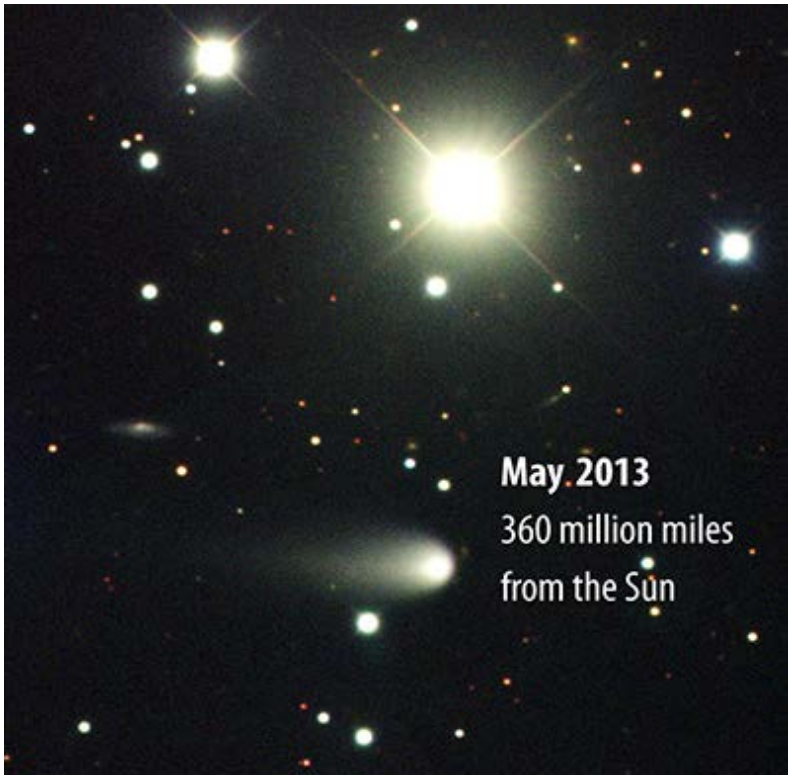
Comet ISON Update



Comet ISON. Gemini Observatory/AURA.

Comet ISON will probably be bright enough for naked-eye viewing from mid-November until the end of the year. Current predictions are for it to shine at magnitude –4.5, about the brightness of Venus, around November 28, when it comes closest to the Sun. Comets that are making their first pass by the Sun, like ISON, are notoriously unpredictable, although many have become quite spectacular. Even if it's not the comet of the century, it will certainly be beautiful, and astronomers around the world are excited to see how it develops.

IfA will sponsor viewing opportunities on O'ahu just before sunrise in late November at a location on the windward side. For exact times and places, check the IfA website, or our Facebook page or Twitter feed (UHIfA). To get on our special events mailing list, send an email to ifaevents@ifa.hawaii.edu. For events on Hawai'i island, see the website of the Mauna Kea Astronomy Outreach Committee.

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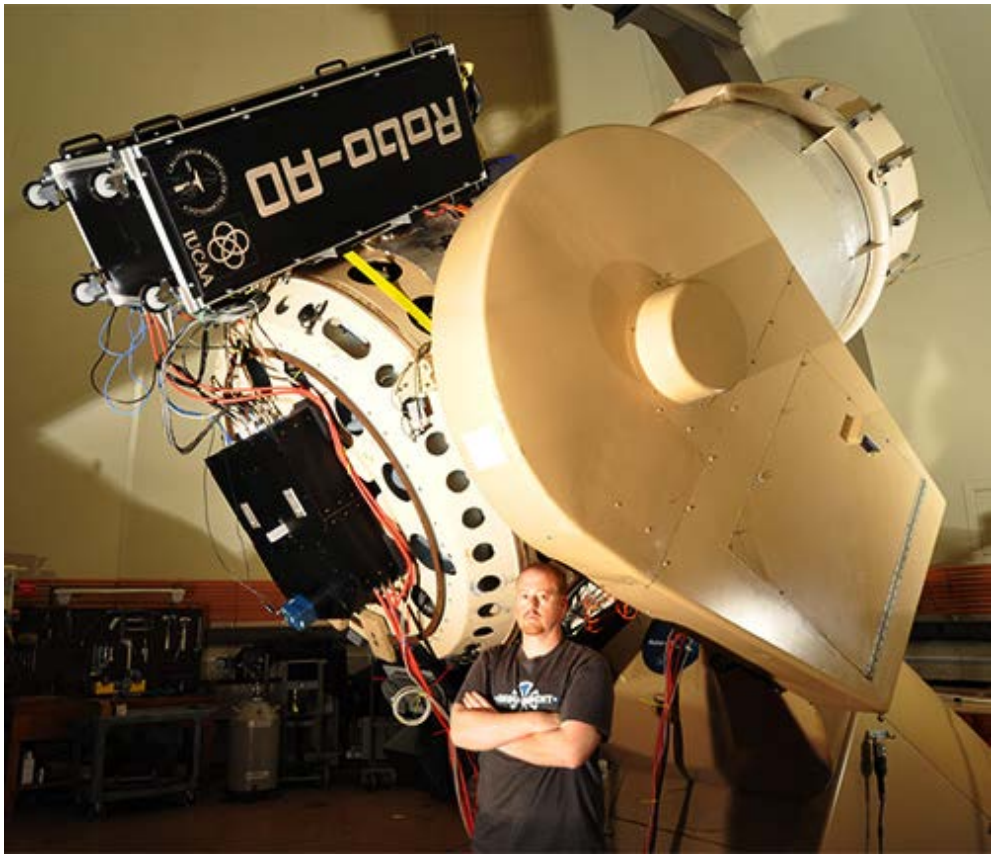
New Faculty: Christoph Baranec



Christoph Baranec with Robo-AO on the 60-inch Palomar telescope. Photo courtesy C. Baranec.

Christoph Baranec joined the IfA faculty at the beginning of July. Although his bachelor's degree is in astronomy, his PhD is in optical sciences, and he specializes in creating adaptive optics systems, which compensate for turbulence in Earth's atmosphere that normally blurs light from celestial bodies. (See "Adaptive Optics: Taking the Twinkle Out of Stars" in Nā Kilo Hōkū no. 21.) He is particularly interested in using adaptive optics systems to study exoplanets and their environments.

While most large telescopes with mirrors 5 meters (16 feet) in diameter or more are equipped with adaptive optics systems, most smaller telescopes forgo the enhancing technology due to complexity and cost. As a postdoctoral researcher at Caltech, Baranec led an international team that created an innovative laser adaptive optics system called Robo-AO for the 60-inch (1.5-meter) telescope on Mt. Palomar in California. Because this system is automated, it can be used to carry out large-scale surveys with maximum efficiency, respond to new discoveries such as supernovae, or observe the same target over and over to see how it changes over time. The system is currently being used to take high-resolution images of all the candidate exoplanet host stars identified by NASA's Kepler mission.

He also helped create the Palomar Observatory's PALM-3000 adaptive optics system, the first of the so-called extreme adaptive optics systems, which allow astronomers to peer ever closer to the area around nearby stars to find planets. The system has already been used to take simultaneous spectra of the four extrasolar planets orbiting a star called HR 8799. For his PhD research at the University of Arizona, he worked on building and commissioning a multiple-laser wide-field adaptive optics system for

the MMT Observatory.

While at IfA he plans to bring his expertise to the telescopes of Hawai‘i. He intends to deploy an improved version of Robo-AO on the UH 2.2-meter telescope, as well as develop new technologies and techniques for the existing large telescopes. This technology will ultimately be used on the future Thirty Meter Telescope.

Aside from research, Baranec is interested in surfing, canoeing, and mountain biking on the Big Island. He also has a passion for electronic music and enjoys building his own stereo equipment.

Video about Robo-AO

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New Faculty: Jessica Lu

Jessica Lu studies star formation in extreme environments, including the region near the supermassive black hole at the center of the Milky Way, an unusual population of young stars near the central supermassive black hole of the Andromeda Galaxy, and the cores of young star clusters with masses ten thousand times the mass of the Sun. These environments are excellent laboratories for testing whether all stars and star clusters form in a manner similar to the Sun and the local solar neighborhood.

She began her faculty appointment in August, but she has been at the IfA since 2011 as a National Science Foundation Astronomy and Astrophysics Postdoctoral Fellow. She received her undergraduate degree from MIT and her PhD from UCLA and then spent the next three years as a Millikan Postdoctoral Scholar in Observational Astronomy at the California Institute of Technology before coming to Hawai'i.

Lu is also interested in developing telescopes' adaptive optics (AO) systems, which counteract the blurring turbulence in Earth's atmosphere, and other telescope instruments. She has served on committees working on next-generation AO systems for the Keck telescopes and on instruments for the Thirty Meter Telescope that is scheduled to begin scientific operations on Mauna Kea in 2022.

Concerned with furthering astronomy education and outreach, Lu is a cofounder and contributing member of the AstroBetter website (www.astrobetter.com), which seeks to build a knowledge base of best research and educational practices for professional astronomers and astronomy graduate students. She notes, "Often new classroom materials are created by one person and then only that person uses them. I would like to not only develop and implement new classroom activities, but also to package them and make them available to other astronomy teaching assistants and professors." During the summer of 2012, she developed and taught a short course to undergraduate students attending the Research Experiences for Undergraduates (REU) program at the IfA. The course included statistics, abstract writing, research methods, and how to read the scientific literature efficiently.

In addition to her astronomical pursuits, Lu trained as a ballet dancer and attended the High School for Performing and Visual Arts in Houston, TX. She and her family enjoy all of the aquatic activities that Hawai'i provides, especially kayaking, snorkeling, and scuba diving.

Photo by K. Teramura

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Aloha Pat Henry

Long-time IfA faculty member J. Patrick Henry retired on September 1. An expert on the cosmological evolution of clusters of galaxies, he pioneered the use of X-ray observations of clusters to understand how the Universe grows. His work provided some of the earliest evidence for what has become the standard description of that growth, notably that there is less matter in the Universe and it is more evenly distributed than previously thought. He was also known for his lively Astronomy 110 classes, including paying students for correct answers during class.

Henry won several international awards, including a 2003 Humboldt Research Award for Senior U.S. Scientists from the German Alexander von Humboldt Foundation and the 2008 Bruno Rossi Prize of the High Energy Division of the American Astronomical Society, the most prestigious international award in the field of high-energy astrophysics. In 2011, he received the Regents' Medal for Excellence in Research from the University of Hawai'i. He was recognized as a "Highly Cited Researcher" by the publishers of Science Citation Index in 2003.

Henry received his PhD from the University of California, Berkeley in 1974. Before coming to Hawai'i in 1981, he worked at the Smithsonian Astrophysical Observatory in Cambridge, Mass., where he developed the High Resolution Imager for the Einstein X-ray Observatory.

Henry intends to learn to sail and to read all the books he hasn't had time to read over the last 40 years.

Photo by K. Teramura

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Upcoming Events

Please check with the sponsoring organization to confirm times and locations for all events.

O'ahu Events: call (808) 956-8566

Tuesday, October 29, Frontiers of Astronomy Community Event, Nicholas McConnell, IfA Beatrice Watson Parrent Postdoctoral Fellow, "Monsters in the Dark: Supermassive Black Holes and Their Destructive Habits," 7:30 p.m., UH Mānoa Art Building Auditorium (room 132). Free Admission (Campus Parking $6).

Sunday, April 6, 2014, Mānoa Open House, 11 a.m. to 4 p.m. at the IfA, 2680 Woodlawn Drive in Mānoa. Family event with activities for all ages. Free.

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

Hawai'i Island Events: email fujihara@ifa.hawaii.edu or see the Mauna Kea Astronomy Outreach Committee website

VISITING MAUNA KEA

The Onizuka Center for International Astronomy Visitor Information Station (VIS) at Hale Pōhaku (9,200-foot level of Mauna Kea) is open daily, 9:00 a.m. to 10:00 p.m.

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. Read this before going.

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