Pan-STARRS’s First PHO

The University of Hawai‘i’s Pan-STARRS PS-1 telescope on Haleakalā has discovered an asteroid that will come within 4 million miles of Earth in mid-October. The object is about 150 feet in diameter and was discovered in images acquired on September 16, when it was about 20 million miles away.

It is the first “potentially hazardous object” (PHO) to be discovered by the Pan-STARRS survey and has been given the designation “2010 ST3.”

“Although this particular object won’t hit Earth in the immediate future, its discovery shows that Pan-STARRS is now the most sensitive system dedicated to discovering potentially dangerous asteroids,” said Dr. Robert Jedicke, a University of Hawai‘i member of the Pan-STARRS 1 Science Consortium who is working on the asteroid data from the telescope. “This object was discovered when it was too far away to be detected by other asteroid surveys,” Jedicke noted.

Objects the size of 2010 ST3 usually break up in Earth’s atmosphere, but the resulting blast wave on the surface can still devastate an area covering hundreds of square miles. “There is a very slight possibility that ST3 will hit Earth in 2098, so it is definitely worth watching,” Jedicke said.

Please see PHO, pg 2

Brown Dwarf Found Orbiting a Young Sun-like Star

A team led by IfA astronomers Beth Biller, Michael Liu, and Zahed Wahhaj has taken a picture of a very young brown dwarf (or failed star) in a tight orbit around a young nearby Sun-like star. This discovery is a rare find: The brown dwarf companion, dubbed “PZ Tel B,” has a mass 36 times that of Jupiter and resides only 18 astronomical units (AU) from its primary star, a distance similar to that of Uranus from the Sun.

Most young brown dwarf and planetary companions found by direct imaging are at orbital separations greater than 50 AU—farther than the orbit of Pluto [40 AU]. In addition to observing its small current separation, in just the past year, the researchers saw PZ Tel B moving quickly outward from its parent star. As recently as 2003, PZ Tel B was completely obscured by its parent star, indicating its orbit is more oval than circular.

The host star, PZ Tel A, has a mass similar to that of the Sun, but is only 12 million years old, while our Sun has been shining for about 5 billion years. In fact, PZ Tel is young enough to still possess significant amounts of cold circumstellar dust, which may have been sculpted by the gravitational interaction with the young brown dwarf companion. This makes the PZ Tel system an important laboratory for studying the early stages of solar system formation. PZ Tel B’s orbital motion has significant implications for what type of planets can form (and whether planets can form at all) in the PZ Tel system.

PZ Tel B was discovered using the Near-Infrared Coronagraphic Imager (NICI; see Na Kilo Hōkū no. 35) on the Gemini South Telescope. NICI is a powerful instrument designed for imaging brown dwarfs and planets around other stars. It is the highest contrast camera in operation today and can detect companions 1 million times fainter than the host star at just 1 arcsecond separations. Please see Brown Dwarf, pg 2
An international team of researchers is currently carrying out a 300-star survey with NICI, the largest high-contrast imaging survey conducted to date. NICI Campaign leader Michael Liu says, “We are just beginning to glean the many configurations of solar systems around stars like the Sun. The unique capabilities of NICI provide us a powerful tool for studying their constituents using direct imaging.”

Because PZ Tel B is so close to its parent star, special techniques were needed to distinguish the faint light of the companion from the light of the primary star. PZ Tel B is separated by less than 0.4 arcsecond from PZ Tel A, equivalent to a dime seen at a distance of 5 miles (about 8 km). NICI was able to take pictures PZ Tel B because it has both an advanced adaptive optics system, which corrects for the blurring of astronomical images caused by turbulence in Earth’s atmosphere, and a coronagraph that blocks out excess starlight. The team applied specialized analysis techniques to the images to detect PZ Tel B and measure its orbital motion.

The discovery of PZ Tel B is described in a paper published by the Astrophysical Journal Letters.

Most of the largest PHOs have already been catalogued, but scientists suspect that there are many more under a mile across that have not yet been discovered. These could cause devastation on a regional scale if they ever hit our planet. Such impacts are estimated to occur once every few thousand years.

Dr. Timothy Spahr, director of the Minor Planet Center (MPC), said, “I congratulate the Pan-STARRS project on this discovery. It is proof that the PS1 telescope, with its Gigapixel Camera and its sophisticated computerized system for detecting moving objects, is capable of finding potentially dangerous objects that no one else has found.” The MPC, located in Cambridge, Mass., was established by the International Astronomical Union in 1947 to collect and disseminate positional measurements for asteroids and comets, to confirm their discoveries, and to give them preliminary designations.

Pan-STARRS expects to discover tens of thousands of new asteroids every year with sufficient precision to accurately calculate their orbits around the Sun. Any sizable object that looks like it may come close to Earth within the next 50 years or so will be labeled “potentially hazardous” and carefully monitored. NASA experts believe that given several years warning, it should be possible to organize a space mission to deflect any asteroid that is discovered to be on a collision course with Earth.

PS1 officially began its science mission on May 13. While scanning the skies nightly to search for asteroids that threaten Earth, it is mapping the Universe and investigating its biggest mysteries, dark matter and dark energy.

Pan-STARRS (short for Panoramic Survey Telescope and Rapid Response System) exploits the unique combination of superb observing sites and technical and scientific expertise available in Hawai’i. Conceived and designed at the IfA, the PS1 sits atop Maui’s Haleakala but is operated remotely from the IfA’s Advanced Technology Research Center in Pukalani, Maui.

“From inside the orbit of the Moon to the most distant quasars, PS1 is taking a census of the contents of our Universe,” said PS1 Director Kenneth Chambers, head of the international PS1 Science Consortium that is funding the initial three-year PS1 science mission. ■ www.ps1sc.org

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There is something about taking your own data that is important to astronomers, including young ones. About twice per year, I spend an evening with students from Ms. O’Connor’s eighth-grade math class at Lokelani Intermediate School on Maui. I refuse to touch the computer controlling the Faulkes Telescope North. I don’t let the students use the telescope’s database to look up targets. I have the right ascension (celestial longitude) and declination (celestial latitude) listed on a slip of paper, and have the students enter the coordinates. After waiting several minutes for the exposure, the students are thrilled with their images. I am always asked, “Can we have the pictures?” The students could find clearer Hubble Space Telescope images of most of the targets, but they want their images.

In 2002, the Dill Faulkes Foundation built the 2-meter (80-inch) Faulkes Telescope North (FTN) on Haleakalā to teach young people about science. It was purchased by the Las Cumbres Observatory Global Telescope Network (LCOGT) in 2005. Technical difficulties hampered observations with the telescope during the first few years, but these have now been fixed. In February 2010, for example, FTN was on the sky 97 percent of the time the weather was clear.

When LCOGT purchased FTN, as well as its twin, the Faulkes Telescope South (FTS) in Australia, it became part of a plan for a global network of observatories. LCOGT is building twenty-four 0.4-meter (16-inch) telescopes and twelve 1-meter (39-inch) telescopes at seven sites around the world. Deployment of the 0.4-meter telescopes has begun, and the first 1-meter telescope is now operational at LCOGT headquarters in Santa Barbara. The network will allow users worldwide nearly continuous access to the night sky, thus their slogan, “We will always keep you in the dark.” Hawai‘i users will have access to the network, the way that they have access to the Faulkes Telescope North.

FTN can operate in two modes. The real-time interface allows users to take images while controlling the telescope over the Internet as the images are being taken, as Ms. O’Connor’s eighth graders do. The queue mode allows users to program the telescope to take the observations at a future time. Most of the science observations use the queue mode because it is more efficient and reliable, but there are some projects, such as asteroid searches, that benefit from live interaction.

Getting pretty images isn’t the only way students use FTN. Students have been using it to research exoplanets, planetary nebula, variable stars, asteroids, and comets. This year approximately 30 students are working with data from both of the Faulkes telescopes. Sixteen students from Hawai‘i have entered science projects in science fairs with data and/or other support from LCOGT. As the renowned astronomer George Herbig told me, “What you are doing here is important. This is where the next generation of scientists will come from.”

Faulkes Telescope Fulfills Educational Promise
by J. D. Armstrong, Maui Technology Education & Outreach Specialist

Hawai‘i students can control the Faulkes Telescope remotely over the Internet.

http://lcogt.net/en/blog/jdarmstrong
Galaxies Gobble Galaxies

IfA astronomer David Sanders gave the Frontiers of Astronomy Community Lecture, “Galactic Cannibalism: The Ultimate Fate of Our Milky Way,” on Thursday, September 23, at the UH Mānoa Art Building Auditorium.

Sanders explained that detailed surveys of the sky reveal that galaxy formation is often a messy process. As big galaxies grow by gobbling up smaller ones, their shapes change from picturesque spirals with their bluish young stars into more rotund, reddish elliptical galaxies with their mostly “red and dead” old stars.

Our home galaxy, the Milky Way, is a relative latecomer to this process of galactic cannibalism. First it will merge with small nearby dwarf galaxies such as the Small and Large Magellanic Clouds. Eventually, it will undergo a spectacular merger with our nearest big neighbor, the Andromeda Galaxy (also called M31). When this happens, in four to five billion years, the pattern of bright stars in the nighttime sky will take on a dramatic new appearance, and much of the gas and dust that would have formed new stars in the Milky Way’s spiral disk will instead be swept into the center of the new merged system, where it will build a billion-solar-mass black hole that will signal the birth of a quasar.

Sanders tried to give the audience a sense of the intergalactic distance scale. He said that if the island of O’ahu were the Milky Way Galaxy, our solar system would have the diameter of a pinhead and the thickness of a fingernail. If the solar system were located in the Art Auditorium, then nearby star-forming regions would be at Bachman Hall, and the Galactic Center containing a black hole of 6 million solar masses would be in Mililani.

He also explained the history of our understanding of galaxies. In the 1770s, the French astronomer Charles Messier published an astronomical catalog of deep sky objects that included nebulae and star clusters to help comet hunters distinguish between permanent and transient objects in the sky. We now know that some of these nebulae, including the one called “Messier 31” (M31), are galaxies. It was the American astronomer Edwin Hubble who figured out in the 1920s that some of these nebulae were galaxies outside the Milky Way. In the 1950s, Halton Arp looked at some of the weirdly shaped galaxies and theorized they were falling apart. We now know that these unusually shaped galaxies are result of mergers. ■

Many colorful pictures and movies of galaxies in the process of merging are on the Web:

www.ifastransform.html

Bowler Receives ARCS Award

IfA graduate student Brendan Bowler has won the 2010 Columbia Communications Award in Astronomy given by the Achievement Rewards for College Scientists (ARCS) Foundation for his studies of exoplanets.

In his work with John Johnson, Bowler studied planets orbiting stars more massive than one and a half times the mass of the Sun. While over 450 exoplanets have been discovered, very few of them orbit these intermediate-mass stars, and none of them orbit at a distance less than 0.6 astronomical units (about 56 million miles or 90 million km). What is surprising is that the frequency of planets orbiting these intermediate-mass stars is significantly higher than for planets around Sun-like stars. This suggests that planet formation is more efficient than expected in these systems, a concept that challenges current models of planet formation.

Now, for his PhD dissertation under the direction of Michael Liu, Bowler is doing direct imaging of nearby low-mass stars (ones smaller than the Sun) to search for giant planets orbiting them. This research may help to clarify which of the two competing models of planet formation, core accretion or disk instability, is correct.

The award is $5,000. ■
Zahid Wins Research Award

IfA graduate student Jabran Zahid has won a University Research Council Student Excellence in Research Award for a project that measured the luminosity, masses, and chemical enrichment of distant galaxies. The light we see from these galaxies left them seven billion years ago and therefore studying them gives us a glimpse of the population of star-forming galaxies at about half the current age of the Universe. Metals in galaxies are created and accumulated through the process of massive star formation and subsequent death.

In this way, measuring the metallicity of a galaxy—the proportion of the gas mass that is made up of elements other than hydrogen or helium—provides a record of its star formation history, a crucial aspect of galaxy evolution. Metallicity increases with increasing luminosity and stellar mass, so the more luminous or massive a galaxy, in general, the higher its metallicity. However, the mass-metallicity and luminosity-metallicity relations evolve with time, and this evolution provides important constraints on the process of galaxy evolution as a whole.

Zahid worked on this project with IfA astronomers Lisa Kewley and Fabio Bresolin. Their paper, “The Mass-Metallicity and Luminosity-Metallicity Relation from DEEP2 at $z \sim 0.8$,” has been submitted to the Astrophysical Journal, and a subsequent paper examining the origin and evolution of these relations will be submitted soon.

IfA Alum Receives Teaching Award

Michael Nassir, who received his M.S. in astronomy from UH in 1996 and is now an instructor in the Department of Physics and Astronomy, has received the University of Hawai‘i at Mānoa Chancellor’s Citation for Meritorious Teaching, which recognizes Mānoa faculty members who have made significant contributions to teaching and student learning.

Nassir was instrumental in developing the Astronomy 110 laboratory course. A lively and enthusiastic instructor, he engages his students by demonstrating the significance of physics in his students’ daily lives. In addition to teaching three to four physics and astronomy courses each semester, his workload includes physics lab supervision, astronomy lab coordination, lecture-demonstration improvement, undergraduate physics-major advising, student professional club advising, and service on both campus and departmental committees. During the summer, he participates in the Hawai‘i Student/Teacher Astronomy Research (HI STAR) program for secondary school students and teachers.

Nassir serves as a member of the Faculty Senate’s General Education Committee and provides analytical skills in dealing with trends in student behavior and improving undergraduate education. In 2005 he won the Frances Davis Award for Excellence in Undergraduate Teaching from UH Mānoa.
This summer the IfA Research Experiences for Undergraduates (REU) program celebrated its tenth year. Each summer, the National Science Foundation (NSF) has supported undergraduate students from colleges and universities throughout the United States who spend about 10 weeks during the summer working with IfA scientists and engineers on research programs. Many of the students have reported on their projects at scientific meetings, and some have published papers in scientific journals.

Some REU students have gone on to astronomy graduate school, including five who chose to attend graduate school here at IfA. Mark Pitts (REU 2001) and Trent Dupuy (2003) were the first REU students to become IfA graduate students. Other former REU students now at IfA are Garrett Elliott (2006), Kirsten Larson (2007), and first-year graduate student Kimberly Aller (2009). Caitlin Casey (2006) has returned to IfA as a Hubble postdoctoral fellow.

Asked about his time as an REU student at IfA, Pitts says, “The experience with Bob Joseph was a great one. I got to know many of the then-IfA-grads, and they gave me a rough idea of what being a grad student here was like.” Elliott adds, “Having an REU program helps to bring IfA to the attention of the many undergraduates who are becoming more active in seeking summer research programs. I chose to pursue graduate work at the IfA because it provided a positive research experience that I used as a benchmark when considering other graduate schools. I felt none of my alternative options matched up.”

IfA’s REU program began in 2001 after the faculty asked Jim Heasley to apply for an NSF grant to start the program. IfA received a five-year grant, and for the first year, NSF provided supplementary funds for a Research Experiences for Teachers program that brought Mary Kadooka from McKinley High School and Tom Chun from Kamehameha Schools. Kadooka now works at IfA as the astronomy research/education specialist. She organizes and teaches astronomy workshops for middle and high school students and teachers. Chun has also maintained an interest in astronomy education at Kamehameha Schools.

The program has grown from a one-island operation to encompass all three IfA offices. This year the program supported three students on Maui, three on O‘ahu, and four in Hilo. In addition, the University of Hawai‘i NASA Astrobiology Institute (UHNAl) supported four students, two more were supported by other grants, and one student paid her own way.
The IfA Wish List
The Friends of the IfA strive to support the outreach, education, and research missions of the Institute through donations, events, and volunteerism. To expand these efforts, IfA faculty and staff have created a wish list of items that would strongly benefit our outreach and education programs. The items listed here are the most difficult to purchase with state funds or federal grants. If you are interested in providing a donation to fund, in full or in part, any of these items, please contact us at friends@ifa.hawaii.edu. We would love to speak with you.

Camera mounts for lab/outreach telescopes, $500: Capturing an image of a celestial object through a telescope truly personalizes the astronomy experience. It is now possible to mount an inexpensive digital camera on a telescope eyepiece and take remarkable images of planets, the Moon, and other objects. A set of such mounts would allow our undergraduate lab students and members of the public at stargazing events to take their astronomy experiences home with them.

StarLab portable planetarium upgrade and maintenance for five years, $1,500: The StarLab is taken to dozens of K–12 schools every year by IfA graduate students who volunteer their time and expertise. We would like to continue and even expand this program.

Portable high-resolution LCD projector, $2,000: The beauty of astronomy is conveyed through magnificent images taken with telescopes. Unfortunately, the current LCD projectors used in our classes and at outreach events provide only low-resolution images with poor contrast. A high-contrast, high-resolution projector would allow us to share our splendid images with a broader audience.

Components for, upgrades to, and maintenance of outreach telescopes for five years, $2,500: The IfA has six telescopes that are used for undergraduate lab classes and public stargazing events. These telescopes, the most fundamental of our outreach tools, require periodic maintenance, new eyepieces, and other accessories. Some need cases and tripods to be fully usable.

CCD camera and laptop, $3,500: Modern astronomy uses digital imaging to observe astronomical objects. A portable setup with a CCD camera and a laptop would allow us to capture images of deep sky objects invisible to the unaided eye and thus provide a more authentic astronomy experience for our lab students.

Thermal infrared camera, $4,500: This camera will be used to demonstrate that what we perceive as heat is really light at infrared wavelengths that are invisible to the human eye. It will be used to demonstrate that the electromagnetic spectrum contains far more information than we perceive, and to show how the temperatures of celestial objects can be measured.

Portable spectroscopy demonstration kit, with laptop, USB spectrograph, gas lamps, and accessories, $5,000: This setup will allow us to expand K–12 outreach and education from the night sky via the StarLab to the basic physics of light. Carried in a single case, this setup would allow students to explore how we use spectroscopy to determine what stars, planets, and galaxies are made of. This kit could also be used in our astronomy labs.

Extended-length van, $40,000: A full-size van with an extended body could transport 12 students and the six telescopes to dark locations for outdoor observing. Today, we rely on having enough students with their own vehicles to permit undergraduate lab classes to observe. This van, when used with an existing IfA minivan, would alleviate the need for most personal vehicles and ensure that students would be able to engage in hands-on time with the telescopes.

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www.ifa.hawaii.edu/friends/
Dear Friends of the Institute for Astronomy,

It is always exciting when a long-term project finally begins to bear fruit. In this case, I am referring to the Pan-STARRS prototype sky survey telescope PS1, which began making regular science observations last May. Principal investigator Nick Kaiser and his team have been working on the design and execution of this project for almost 10 years. It was originally called the Panoramic Optical Imager, and the team, then known as the UH IfA Small-Telescopes Working Group, authored a 66-page proposal to build an array of four small telescopes equipped with huge CCD cameras to take wide-field images of the sky.

When you set out to do something new in science, it often takes longer than initially expected, but the rewards make overcoming unforeseen difficulties worthwhile. Such has been the case with PS1. The telescope and its unique Gigapixel Camera are making some very significant and exciting discoveries, including new types of supernovae, the extremely bright explosions that occur when stars die, and the detection of hitherto unknown near-Earth objects, which are asteroids with the potential to hit Earth. With the stream of data now coming in after every night of PS1 observations on Haleakalā, there are many more exciting discoveries to come. Now, after many years of extremely hard work, the Pan-STARRS team can start to bring in the scientific harvest.

Aloha!
Rolf-Peter Kudritzki
Director, Institute for Astronomy