The Pan-STARRS PS1 telescope on Haleakalā, Maui, discovered 19 near-Earth asteroids on the night of January 29, the most asteroids discovered by one telescope on a single night. “This record number of discoveries shows that PS1 is the world’s most powerful telescope for this kind of study,” said Nick Kaiser, head of the Pan-STARRS project. “NASA and the U.S. Air Force Research Laboratory’s support of this project illustrates how seriously they are taking the threat from near-Earth asteroids.”

Because of recent improvements to software and in observational techniques, Kaiser suggested a time close to the February 1 new moon would be an opportune time to dedicate an entire night to assessing PS1’s ability to discover near-Earth objects (NEOs), especially those possibly hazardous to Earth. A plan called “NEO Demo Night” was formulated, and the night of January 29 was selected. Pan-STARRS software engineer Larry Denneau spent that Saturday night in his UH Mānoa office in Honolulu processing the PS1 data as it was transmitted from the telescope over the Internet. During the night and into the next afternoon, he and others came up with 30 possible new near-Earth asteroids.

Asteroids are discovered because they appear to move against the background of stars. To confirm asteroid discoveries, scientists must carefully reobserve them several times within 12–72 hours to define their orbits, otherwise they are likely to be “lost.” Denneau and colleagues quickly sent their discoveries to the Minor Planet Center in Cambridge, Mass., which collects and disseminates data about asteroids and comets, so that other astronomers can reobserve the objects. “Usually there are several mainland observatories that would help us confirm our discoveries, but widespread snowstorms there closed down many of them, so we had to scramble to confirm many of the discoveries ourselves,” noted IfA astronomer Richard Wainscoat.

Wainscoat, astronomer David Tholen, and graduate student Marco Micheli spent the next three nights searching for the asteroids using telescopes at Mauna Kea Observatories. On Sunday night, they confirmed that two of the asteroids were near-Earth asteroids before snow on Mauna Kea forced the telescopes to close. On Monday night, they confirmed nine more before fog set in. On Tuesday night, they searched for four, but found only one. After Tuesday, the remaining unconfirmed near-Earth asteroids had moved too far to be found again. Telescopes in Arizona, Illinois, Italy, Japan, Kansas, New Mexico, and the United Kingdom, and the Faulkes...

In July 2005, NASA’s Deep Impact spacecraft left a big piece of metal in the path of Comet Tempel 1 so that scientists could observe the collision and, they hoped, see the inside of a comet. While the data from this mission significantly changed their ideas about how comets form and evolve, scientists were unable to see the crater created by the collision because the material ejected from the comet blocked the view.

On February 14, 2011, they received a second chance to view that crater. NASA’s Stardust spacecraft, which had completed its original mission of taking a dust sample from Comet Wild 2 and returning it to Earth, had been redirected to come within 111 miles (178 km) of Tempel 1 and take dozens of high-resolution images. The new mission, called Stardust-NExT (for “New Exploration of Tempel 1”) also gave scientists their first opportunity to get a close look at a comet on successive trips around the Sun.

PS1 Discoveries: Richard Wainscoat (left) and Marco Micheli study a near-Earth asteroid found on January 29. The asteroid is the roundish dot near Wainscoat’s finger.
slowing was changing. During each close passage to the Sun, uneven outgassing from the comet’s nucleus acts like rocket thrusters, both speeding up and slowing down the rotation. The Stardust-NExT encounter occurred during a period of near-maximum outgassing—before the spin rate would settle down. So not only did the team have to get the spin rate right, we had to understand how it was changing while the comet was active. Our predictions were verified during the flyby—a remarkable achievement that would not have been possible without the UH 2.2-meter telescope.”

“We achieved all of our science objectives,” said Joe Veverka, Stardust-NExT principal investigator and a professor at Cornell University, at the post-encounter press conference. He noted that they had accomplished their three imaging goals: First, to look at areas of Tempel 1 imaged with the Deep Impact spacecraft to see “what changes occur on a comet when it comes close to the Sun,” second, to see the Deep Impact crater, and third, to “see areas on Tempel that we had not seen before.” They also obtained data about the dust in Tempel’s coma, the cloud that is a comet’s atmosphere.

Because this mission involved a “recycled” spacecraft, it cost only $29 million, much less than the $500 million needed for a mission that builds and launches a new spacecraft. In November 2010, the Deep Impact spacecraft also visited a second comet, Hartley 2 (see Na¯ Kilo Hōku¯ no. 37). Meech also oversaw the ground-based operations for that mission.

Co-investigator Peter Schultz (Brown University), the impact cratering expert for the Deep Impact and Stardust-NExT missions, characterized the Deep Impact crater as “more subdued than expected” with a small central mound. The crater is 150 meters across (about 500 feet) and indicates “the surface of the comet where we hit is fragile.”

IfA astronomer Karen Meech was the co-investigator in charge of all the Earth- and space-based observing support for the mission, a role she also performed for Deep Impact. This effort used data from 25 telescopes throughout the world, especially the UH 2.2-meter telescope on Mauna Kea, to understand the comet and its rotation. Meech explained just how difficult this was: “It was very important to predict the rotation so that we could see the impact crater made by the Deep Impact mission in 2005. The challenge was to know the rotation speed so precisely that we could predict the side we would see a year later. The last time we could adjust the spacecraft arrival time was during February 2010, when it would take the least amount of energy to change the spacecraft velocity, because the spacecraft had very little fuel left. Ordinarily, this would be daunting, but for this comet it was especially difficult because we knew that the comet’s spin rate was not only slowing, but also the rate at which it was

Orbits of 19 Near-Earth Asteroids discovered January 29, 2011 by Pan-STARRS PS1 telescope

Telescope on Haleakalā also helped to confirm seven of the discoveries.

Two of the asteroids, it turns out, have orbits that come extremely close to Earth’s. There is no immediate danger, but a collision in the next century or so, while unlikely, cannot yet be ruled out. Astronomers will be paying close attention to these objects.

The PS1 telescope is equipped with the world’s largest digital camera (1.4 gigapixels) and an advanced data system that enables it to take pictures of a wider area of the sky than any other large telescope. The U.S. Air Force Research Laboratory funded the design and construction of PS1.
“Our best models of what the Sun is doing don’t work,” said IfA astronomer Jeff Kuhn, while explaining why solar scientists need the Advanced Technology Solar Telescope [ATST] about to be built on Maui. He was the speaker for the Frontiers of Astronomy Community Lecture, “House of the Sun: Bringing the World's Largest Daytime Telescope to Maui,” on February 16, at UH Mānoa.

The ATST, he said, will provide our biggest jump in solar observing capabilities since Galileo’s time and is the largest single investment the United States has ever made in any ground-based optical/infrared telescope (§300 million). Building it on Haleakalā, the best daytime astronomical site in the world, will open new windows to understanding how the Sun works and what changes in the Sun mean for changes here on Earth.

The ATST will have a unique off-axis design that will limit the glare from the Sun. With a mirror 4.2 meters [about 13 feet] in diameter, the ATST will be more than twice as large as the next-largest one, the 1.5-meter McMath solar telescope built in 1962. ATST will be the world's largest coronagraph, which will allow us to see the faint outer solar atmosphere. In addition, it will have an adaptive optics system to compensate for blurring by Earth’s atmosphere.

The key to understanding the Sun is understanding its magnetic fields. Scientists have been measuring solar surface magnetism for many years. What they still don’t understand is how the Sun recycles “magnetic flux” [the net magnetic field] between the surface and its interior using sunspots, and how it ejects this flux out into space in the form of “flares” [brief eruptions of intense high-energy radiation from the Sun’s surface] and “coronal mass ejections” [large-scale releases into space of matter from the Sun's corona]. The ATST will enable scientists to see the details of the magnetic fields and the corona while measuring solar magnetism.

The number of sunspots on the Sun varies from “solar minimum” [few or no sunspots] to “solar maximum” [many sunspots] and back again in a cycle that averages 11 years. Although it seems counterintuitive, when there are more dark sunspots, the Sun’s total brightness is greater.

The Sun is the source of “space weather” in our solar system. The solar wind—the continuous flow of ionized particles from the Sun’s corona—interacts with the magnetospheres of Earth and other planets. The solar wind is stronger when the Sun has many sunspots, thereby providing more protection from deadly cosmic rays coming from outside the solar system. But more sunspots also mean more flares and coronal mass ejections, which can disrupt power and communication systems on Earth and endanger satellites and astronauts. Scientists would like to be able to predict these solar storms much like meteorologists can predict hurricanes, so that satellites could go into “safe mode,” astronauts could be sufficiently sheltered, and terrestrial power and communication systems could take precautions.

The Sun’s brightness changes by only about 0.1 percent during an average solar cycle, and yet what happens on the Sun affects the temperature and climate on Earth. We know this from natural records such as tree rings and ice cores from the Arctic and Antarctic. For example, the period from 1645 to 1715, when there were hardly any sunspots, corresponds roughly with a lengthy cold spell known as the Little Ice Age (1550–1850). Settlements on Greenland founded during the Medieval Warm Period [approximately 950–1250] disappeared during the Little Ice Age.

The ATST is funded by the National Science Foundation and led by the National Solar Observatory with help from the IfA, the High Altitude Observatory in Boulder, Colorado, Big Bear Solar Observatory, which is part of the New Jersey Institute of Technology, and the University of Chicago. Nineteen other international organizations contribute to the ATST mission. ATST is expected to have its “first light” in 2018.
IfA Astronomers Keep Tabs on Asteroid Apophis

On January 31, IfA astronomers used the UH 2.2-meter telescope on Mauna Kea to take the first new images in over three years of the potentially dangerous near-Earth asteroid Apophis as it emerged from behind the Sun.

The object became famous in late 2004, when it appeared to have a one in 37 chance of colliding with Earth in 2029, but additional data eventually ruled out that possibility.

However, on April 13, 2029, the asteroid, which has a 900-foot (270-m) diameter, will come closer to Earth than the geosynchronous communications satellites that orbit Earth at an altitude of about 22,000 miles (36,000 km). Apophis will then be briefly visible to the naked eye as a fast-moving starlike object.

This close encounter with Earth will significantly change Apophis’s orbit, which could lead to a collision with Earth later this century. For that reason, astronomers have been eager to obtain new data to further refine the details of the 2029 encounter.

Astronomer David Tholen, one of the co-discoverers of Apophis, and graduate students Marco Micheli and Garrett Elliott obtained the new images when the asteroid was less than 44 degrees from the Sun and about a million times fainter than the faintest star that the average human eye can see without optical aid.

"The superb observing conditions that are possible on Mauna Kea made the observations relatively easy," said Tholen.

Astronomers measure the position of an asteroid by comparing its position with the known positions of stars that appear in the same image. As a result, any tiny error in the catalog of star positions, due for example to the very slow motions of the stars around the center of our Milky Way galaxy, can affect the measurement of the position of the asteroid.

"We will need to repeat the observation on several different nights using different stars to average out this source of imprecision before we will be able to significantly improve the orbit of Apophis and therefore the details of the 2029 close approach and future impact possibilities," noted Tholen.

Apophis’s elliptical orbit around the Sun will take it back into the Sun’s glare this summer, inhibiting the acquisition of additional positions. However, in 2012, Apophis will again become observable for approximately nine months. In 2013, the asteroid will pass close enough to Earth for ultraprecise radar signals to be bounced off its surface. ■
Mānoa Open House

Did you know that Earth sometimes has more than one natural moon? You can find out all about it at the IfA’s Mānoa Open House on April 10, when astronomer Robert Jedicke will talk about “Earth’s Mini Moons.”

Ever wonder if those cable TV programs speculating about astronauts visiting Earth in ancient times have any truth to them? Then be sure to catch the talk by IfA scientist Tobias Owen entitled “Visits to Earth? UFOs and Ancient Astronauts.” Other talks will cover dark matter, main-belt comets, the birth of our solar system, supermassive black holes, the search for habitable planets around other stars, and the latest on NASA space missions to comets.

There will also be activities and displays for people of all ages. Come make a comet, or see what you look like at infrared wavelengths. Have your face painted with a planet or two, or watch a planetarium show. Peruse award-winning science fair displays or the 3-D image gallery, which includes close ups of Mars and other heavenly bodies. Ever wanted to ask an astronomer a question? Well, this will be your chance.

The Open House will take place at 2680 Woodlawn Drive, Mānoa from 11 a.m. to 4 p.m. Admission and parking will be free. We hope to see you there. For a complete list of talks and activities, go to the IfA website, www.ifa.hawaii.edu/open-house/.

What do you look in the infrared?

The LEAHI Lego club will again have a display

Seeing sound waves with the Rubens’ tube

A friendly game of Astro-Jeopardy
Walter Steiger, the father of modern astronomy in Hawai‘i, died on February 6 in Hilo. He was born in Proctor, Colorado, and grew up in Texas, Switzerland, and Boston. Service in the army during World War II brought him here. He fell in love with Hawai‘i and its people, and decided to make it his permanent home.

After being discharged from the Army, he finished his physics degree at MIT, received a master’s from UH, and earned a PhD at the University of Cincinnati.

In 1953, he joined the UH Department of Physics as an assistant professor. Soon, he began to think about the potential of Hawai‘i’s high mountains for observing the Sun. Mauna Kea and Mauna Loa on the island of Hawaii had no paved roads and no access to commercial power, but Haleakalā on Maui had both. A site survey soon revealed that Haleakalā would be an excellent site in terms of sky transparency and the number of clear days per year, conditions that would allow observations of the solar corona.

But building a solar observatory on the mountain would take time, and with the International Geophysical Year about to take place in 1957–58, Steiger received a small amount of funding to build a solar observatory at Makapu‘u Point on O‘ahu. There he installed several experiments in a small concrete building that had been abandoned by the telephone company, including a solar flare patrol telescope that took photographs of the Sun every two minutes on 35-mm film and an indirect flare detector that was especially useful when the telescope was clouded out.

Largely as a result of Steiger’s efforts, the National Science Foundation approved and funded a proposal to build a solar observatory on Haleakalā in 1961. In January 1964, the C. E. Kenneth Mees Solar Laboratory was dedicated as part of the Hawai‘i Institute of Geophysics, so it was known as the HIG Haleakalā Observatory, or HIGHO.


Aloha, Walter Steiger (1923–2011)  
by Louise Good

Walter Steiger, the father of modern astronomy in Hawai‘i, died on February 6 in Hilo. He was born in Proctor, Colorado, and grew up in Texas, Switzerland, and Boston. Service in the army during World War II brought him here. He fell in love with Hawai‘i and its people, and decided to make it his permanent home. After being discharged from the Army, he finished his physics degree at MIT, received a master's from UH, and earned a PhD at the University of Cincinnati.

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For a more detailed history of Steiger’s involvement with Hawai‘i astronomy:  
wwwifa.hawaii.edu/users/steiger/introduction.html
Thirty Meter Telescope Receives Permit

The University of Hawai‘i has been granted a Conservation District Use Permit (CDUP) to build and operate the Thirty Meter Telescope (TMT) on Mauna Kea. The Board of Land and Natural Resources (BLNR) of Hawai‘i’s Department of Land and Natural Resources (DLNR) granted the permit at the BLNR’s meeting on February 25. At this meeting, the BLNR also granted a contested case hearing at the request of petitioners. It will be addressed at a separate meeting.

The TMT will enable astronomers to detect and study light from the earliest stars and galaxies and test many of the fundamental laws of physics. It will have a segmented mirror like those on the Keck telescopes atop Mauna Kea, but with a total of 492 segments, compared with 36 segments in each Keck mirror. The TMT will also have an adaptive optics system to correct for the blurring effect of Earth’s atmosphere, enabling it to see the Universe as clearly as if the telescope were in space. The TMT’s presence on Mauna Kea will ensure that Hawai‘i remains a leader in astronomy well into this century. UH scientists will receive a guaranteed share of the observing time on TMT.

The CDUP is the final step in a multiyear process that began in July 2009, when TMT’s Board of Directors selected Mauna Kea as the preferred site for the telescope. This selection followed an unprecedented five-year global campaign to identify locations with the best atmospheric and environmental conditions for observing. IFA played a major role in assisting with the site testing on Mauna Kea, and has been advising the project on the many technical aspects of site design and development.

UH and the TMT completed an environmental impact statement that was finalized and approved in 2010, and followed by the conservation district use application. UH Hilo, through its Office of Mauna Kea Management (OMKM), took the lead on these activities. OMKM has also conducted the design review process for TMT, as required by the Mauna Kea Science Reserve Master Plan. The TMT now requires a sublease from UH, which leases the Science Reserve from the DLNR. The sublease requires approval by the UH Board of Regents, the TMT Board, and the BLNR.

The TMT has pledged to give $1 million per year for the lifespan of the observatory to the Hawai‘i Island community for education, and promised to focus on developing local talent and hiring local people for staff positions. Details are still being worked out, but it is expected that TMT will also contribute substantially to the cost of managing the Mauna Kea Science Reserve.

The TMT project is an international partnership among the California Institute of Technology, the University of California, and the Association of Canadian Universities for Research in Astronomy, joined by the National Astronomical Observatory of Japan, the National Astronomical Observatories of the Chinese Academy of Sciences, and the Department of Science and Technology of India.
Dear Friends of the Institute for Astronomy,

It is a great pleasure to write my first contribution to this page, following the tradition started by Rolf Kudritzki. IfA is one of the premier astronomy institutes in the world, and I believe it will have a great future. In particular, it is well positioned to assume a leadership role in the development of the next generation of the world’s most powerful ground-based telescopes because the Thirty Meter Telescope, the Advanced Technology Solar Telescope, and Pan-STARRS are all slated for Hawai’i. I am very pleased that this issue contains articles about these exciting new projects and several other IfA activities.

I became IfA director in January, but until July it is only a part-time appointment because I must smoothly wind down my responsibilities as a director at the Max Planck Institute for Plasma Physics. This interim period is difficult for me—my heart and my brain are already fully engaged with IfA, but my time is rather limited. The large time difference, the cost in time and money of traveling between Europe and the United States, and the preparations for our move to Hawai’i place a substantial burden on efficiency. I am therefore particularly grateful to Associate Director Bob McLaren and the Director’s Office, and also the many committees working so efficiently at IfA, for their help and patience during this difficult period. Starting in July, my wife Barbara and I will be in Hawai’i for good, and we are very much looking forward to it.

After the devastating earthquake and tsunami hit Japan on March 11, Barbara and I followed the tsunami warnings for Hawai’i by the minute and would have loved to be with you, especially those sheltering at IfA. Fortunately, the damage in Hawai’i was relatively minor. However, I am very concerned about our colleagues, and all the people, in Japan. As we continue to follow developments in Japan and their potential consequences for our islands, let’s keep our fingers crossed!

Aloha!

Günther Hasinger, IfA Director