

**University of Hawaii**  
**Institute for Astronomy**  
*Honolulu, Hawaii 96822*  
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This report covers the period from 1 October 2003 through 30 September 2004, and was compiled in October 2004.

## 1. INTRODUCTION

The Institute for Astronomy (IfA) is the astronomical research organization of the University of Hawaii (UH). Its headquarters is located in Honolulu on the island of Oahu near the University of Hawaii at Manoa, the main UH campus. It also maintains offices in Waiakoa on the island of Maui, and in Hilo on the island of Hawaii. The IfA is responsible for administering and maintaining the infrastructure for the Haleakala High Altitude Observatory Site on Maui and for Mauna Kea Observatories (MKO) on Hawaii.

More information is available at the Institute's World Wide Web site: [www.ifa.hawaii.edu/](http://www.ifa.hawaii.edu/).

## 2. STAFF

The scientific staff during this report period consisted of Joshua E. Barnes, Ann M. Boesgaard, Fabio Bresolin, Schelte J. Bus, Kenneth C. Chambers, Mark R. Chun, Paul H. Coleman, Antoinette Songaila Cowie, Lennox L. Cowie, Harald Ebeling, Christ Ftaclas, Donald N. B. Hall, James N. Heasley, J. Patrick Henry, George H. Herbig (emeritus), Klaus-Werner Hodapp, Esther M. Hu, Robert Jedicke, David C. Jewitt, Robert D. Joseph, Nick Kaiser, Rolf-Peter Kudritzki (director), Jeffrey R. Kuhn, Jing Li, Haosheng Lin, Michael Liu, Gerard A. Luppino, Eugene A. Magnier, Eduardo L. Martín, Robert A. McLaren, Karen J. Meech, Roberto H. Méndez, Donald L. Mickey, Tobias C. Owen, Andrew J. Pickles, John T. Rayner, Bo Reipurth, David B. Sanders, Theodore Simon, Alan Stockton, István Szapudi, David J. Tholen, Alan T. Tokunaga, Eric V. Tollestrup, John L. Tonry, R. Brent Tully, Richard J. Wainscoat, Jonathan P. Williams, and Gareth Wynn-Williams.

Postdoctoral fellows included Hervé Aussel, Fabrizio Bernardi, Crystal Brogan (James Clerk Maxwell Fellow), Gang Chen, Gayoung Chon, Yanga R. Fernández (SIRTF Fellow), Pablo Fosalba, Tommy Grav, Lisa Kewley (Hubble Fellow), Jan Kleyna (Parrent Fellow), Andisheh Mahdavi (Chandra Fellow), Jun Pan, Jana Pittichová, Paul Price, Norbert Przybilla, Luca Rizzi, Thomas Stanke (Alexander v. Humboldt Fellow), and Miguel Urbaneja.

James Armstrong, Brian Barris, Peter Capak, Michael Cushing, Catherine Garland, Catherine Ishida, and Scott Sheppard completed requirements for the Ph.D. degree.

The other graduate students during the report period were Sean Andrews, Elizabeth Barrett, Sandrine Bottinelli, Li Hsin Chien, Michael Connelley, Scott Dahm, David Donovan, Luke Dundon, Trent Dupuy, Hai Fu, Ben Granett, David Harrington, Henry Hsieh, Yuko Kakazu, Jeyhan Kartaltepe, Dale Kocevski, Cheng-Jiun Ma, Rita Mann, Joseph

Masiero, Elizabeth McGrath, Nicholas Moskovitz, Megan Novicki, Maria Pereira, Mark Pitts, Steve Rodney, Barry Rothberg, Scott Sheppard, Brian Stalder, Wei-Hao Wang, Kathryn Whitman, Mark Willman, and Bin Yang.

For more information about the graduate program, see [www.ifa.hawaii.edu/gradprog/](http://www.ifa.hawaii.edu/gradprog/).

Visiting colleagues included Amy Barger (University of Wisconsin-Madison), Miwa Goto (Subaru Telescope), Masateru Ishiguro (The Institute of Space and Astronautical Science, Japan), Robert Lupton (Princeton), Nicholas Scoville (Caltech), Paula Skody (University of Washington), and Ana Maria Teodorescu (University of Rome).

### 2.1 New Faculty

The UH Astrobiology Lead Team (see sec. 8) added eight postdoctoral fellows, who arrived in June through September 2004. Though most are not astronomers, all have been hired by the IfA. They are Andrew Boal (organic chemistry), Mark Brown (microbiology), Lysa Chizmadia (geochemistry), Audrey Delsanti (astronomy), Brian Glazer (marine biology/biochemistry), Nader Haghhighipour (astronomy), Norbert Schorghofer (astronomy), and Weijun Zheng (chemistry).

### 2.2 Honors and Awards Received

NASA awarded the NASA Public Service Medal to Robert Joseph. The citation, signed by the NASA Administrator Sean O'Keefe, reads, "For outstanding leadership while serving as Director, Infrared Telescope Facility, enabling extraordinary planetary science research and exceptional contributions to the NASA Solar System Exploration mission."

The Royal Society elected IfA astronomer Lennox Cowie a fellow of the society.

The Hawaii chapter of Achievement Rewards for College Scientists (ARCS) selected graduate student Scott Dahm as the winner of both the 2004 Helen Jones Farrar ARCS Scholarship in astronomy and the ARCS Student of the Year award. In addition, IfA astronomer John Tonry was named ARCS Scientist of the Year.

The University of Hawaii Board of Regents awarded Tonry a 2004 Regents' Medal for Excellence in Research.

NASA presented IfA Director Rolf Kudritzki with a certificate recognizing the IfA's Lunar Ranging Experiment (LURE) for its "support and dedication to the NASA Satellite Laser Ranging (SLR) Program and the International Laser Ranging Service."

Kudritzki was elected chair of the Association of Universities for Research in Astronomy (AURA) board of directors for a one-year term, effective 1 July 2004.

### 3. MAUNA KEA OBSERVATORIES

The telescopes in operation during the report period were the UH 2.2-m and 0.6-m telescopes; the 3-m NASA Infrared Telescope Facility (IRTF), operated by the UH under a cooperative agreement with NASA; the 3.6-m Canada-France-Hawaii Telescope (CFHT), operated by the Canada-France-Hawaii Telescope Corporation on behalf of the National Research Council of Canada, the Centre National de la Recherche Scientifique of France, and UH; the 3.8-m United Kingdom Infrared Telescope (UKIRT), operated in Hawaii by the Joint Astronomy Centre (JAC) based in Hilo on behalf of the Particle Physics and Astronomy Research Council of the United Kingdom; the 15-m James Clerk Maxwell Telescope (JCMT), a submillimeter telescope operated by the JAC on behalf of the United Kingdom, Canada, and the Netherlands; the 10.4-m Caltech Submillimeter Observatory (CSO), operated by the California Institute of Technology for the National Science Foundation (NSF); the Hawaii antenna of the Very Long Baseline Array (VLBA), operated by the National Radio Astronomy Observatory (NRAO); the 10-m Keck I and Keck II telescopes of the W. M. Keck Observatory, which is operated by the California Association for Research in Astronomy for the use of astronomers from the California Institute of Technology, the University of California system, NASA, and UH; the 8.3-m Subaru Telescope, operated by the National Astronomical Observatory of Japan (NAOJ); the 8.1-m Frederick C. Gillett Gemini Telescope (Gemini North), operated by AURA on behalf of an international partnership that includes the United States, the United Kingdom, Canada, Argentina, Australia, Brazil, and Chile; and the Submillimeter Array (SMA), operated by the Smithsonian Astrophysical Observatory in collaboration with the Institute of Astronomy and Astrophysics of the Academia Sinica of Taiwan. The SMA, which comprises eight 6-m antennae, was completed during the report period and was officially dedicated on 22 November 2003.

### 4. HALEAKALA OBSERVATORIES

Astronomy facilities on the summit of Haleakala include the Mees Solar Observatory, which supports IfA solar scientists in data acquisition by running diverse observational programs with the Imaging Vector Magnetograph (IVM), Haleakala Stokes Polarimeter, Mees CCD Imaging Spectrograph (MCCD), Mees White Light Telescope, and Coronal Limb Imagers; SOLARC (Scatter Free Observatory for Limb Active Regions and Coronae), a 0.5-m off-axis coronagraphic reflecting telescope; the Advanced Electro-Optical System (AEOS) Haleakala Atmospheric Characterization Project, which supports the AEOS telescope by providing comprehensive atmospheric characterization and timely prediction of inclement weather conditions at the observatory site; the Faulkes Telescope North (see sec. 9.3); and the 2-m Multi-color Active Galactic Nuclei Monitoring (MAGNUM) Telescope, which is a collaboration between the University of Tokyo and UH. More information about these projects can be found at [www.ifa.hawaii.edu/haleakala/](http://www.ifa.hawaii.edu/haleakala/).

LURE Observatory ceased operations and closed at the end of the contract period in June 2004. LURE Observatory had operated as a Lunar and Satellite Laser Ranging Station

(LLR/SLR) since the early 1970s. Since its founding, NASA/Goddard Space Flight Center funded LURE Observatory with a series of five-year contracts.

Unfortunately, severe budget cuts forced NASA to drastically reduce support for LURE, and the IfA decided to not pursue a contract after the end of the 1999–2004 contract. The LURE site will be used by the prototype Pan-STARRS telescope (PS1) now in development (see sec. 6).

In addition, the Air Force Research Laboratory operates the Maui Space Surveillance System (MSSS), a state-of-the-art electro-optical facility combining operational satellite tracking facilities with a research and development facility. The MSSS houses the largest telescope in the Department of Defense, the 3.67-m Advanced Electro Optical System (AEOS), as well as several other telescopes ranging from 0.4 m to 1.6 m.

During the report period, in December 2003, Haleakala was selected by the National Solar Observatory and its partners as one of three possible sites for the 4-m Advanced Technology Solar Telescope (ATST).

### 5. INSTRUMENTATION

Hōkūpa‘a-85, the curvature-sensing adaptive-optics system being built by the IfA for Gemini South, was essentially completed within the report period. Laboratory tests indicate that it should be capable of  $\sim 80\%$  Strehl ratios under normal seeing conditions at  $2.2 \mu\text{m}$ .

NSFCAM, a 1–5.5  $\mu\text{m}$  camera with a  $256 \times 256$  InSb array, is a NASA IRTF facility instrument. Work started in May 2004 to install a  $2048 \times 2048$  array for use with the adaptive optics system.

### 6. PAN-STARRS

The Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) project will create a wide-field imaging system with an innovative design. It is supported by a grant from the Air Force Research Laboratories. Kaiser is the principal investigator.

Pan-STARRS will be composed of four 1.8-m telescopes observing the same region of sky simultaneously. Each telescope will have a  $3^\circ$  field of view and be equipped with a CCD focal plane mosaic with  $10^9$  pixels. The spatial sampling of the sky will be about 0.3 arcsec. In survey mode, e.g., searching for potential killer asteroids, Pan-STARRS will cover  $6,000 \text{ deg}^2$  per night. The whole available sky as seen from Hawaii will be observed three times during the dark time in each lunation.

Development of a prototype telescope, PS1, in the former LURE Observatory on Haleakala is underway. PS1 will be a full-scale telescope with a full focal plane. It is intended to stimulate the development of and to shake down the numerous software and hardware subsystems and to allow integration of these subsystems prior to deployment of the full Pan-STARRS array. First light for PS1 is scheduled for January 2006, with deployment of the full array within another two years. See [pan-starrs.ifa.hawaii.edu/public/](http://pan-starrs.ifa.hawaii.edu/public/) for more information.

## 7. CENTER FOR STAR AND PLANET FORMATION

IfA astronomers and their colleagues at other observatories in Hawaii inaugurated the Center for Star and Planet Formation (CSPF) in 2002. Colleagues at the Hawaii Institute of Geophysics and Planetology provide additional expertise about meteorites. The CSPF strives to facilitate communication among researchers who specialize in different disciplines, each of which provides insight into important but limited aspects of how stars and planets form.

During the report period, CSPF held about 35 weekly seminars by IfA staff and visitors to keep CSPF members abreast of the latest research and developments in the field. The seminars take place in Manoa or Hilo, with a video link between the two sites. A program to bring long-term visitors to IfA is underway. For more information, see [www.ifa.hawaii.edu/CSPF/](http://www.ifa.hawaii.edu/CSPF/).

The CSPF is organizing a major international meeting, Protostars and Planets V, to be held in October 2005. See [www2.ifa.hawaii.edu/CSPF/ppv/ppv.html](http://www2.ifa.hawaii.edu/CSPF/ppv/ppv.html).

## 8. UH ASTROBIOLOGY LEAD TEAM

The UH Astrobiology Lead Team is one of 16 funded by NASA's Astrobiology Institute (NAI). Astrobiology research at UH focuses on water, including its origins in space, how it helps form biologically important molecules, its part in the planet formation process and its delivery to Earth, and its role as the habitat of, and chemical enabler for, life. In June through September, eight astrobiology postdoctoral fellows arrived to begin their research at UH (see sec. 2.1).

An Astrobiology Winter School will be held in Hawaii in January 2005 and 2007. The theme for the 2005 Winter School is Water on Earth and in Space. The school is open to both graduate students and postdoctoral fellows from institutions throughout the world, with graduate students being given priority.

Karen Meech, the principal investigator for the UH Astrobiology Lead Team, inaugurated a graduate-level astrobiology seminar during the UH fall 2004 semester. The course covered research in a variety of areas related to the water theme.

See [www.ifa.hawaii.edu/UHNAI/](http://www.ifa.hawaii.edu/UHNAI/) for more information.

## 9. OUTREACH

### 9.1 Manoa Open House

The annual open house at IfA Manoa took place on 18 April to begin the AstroWeek observance. There were lectures, hands-on activities, and exhibits aimed at people of all ages. About 1,400 people attended.

### 9.2 Activities on Hawaii

The Hilo-based Office of Science Education and Public Outreach (SEPO), under the direction of Gary Fujihara, began operations in October 2003. Science education endeavors consisted of recurrent visits to 13 public, private, and charter primary, secondary, and post-secondary schools in

East Hawaii and Waimea. Forty-one visits featured activities ranging from multimedia presentations to interactive projects, and have reached over 350 students.

SEPO participated in the Workplace Readiness Program, mentoring a student intern in the production of promotional videos for the IfA and the Onizuka Memorial Foundation.

Along with staff in electronics technology, machining, and software engineering, SEPO participated in six career fairs, which were attended cumulatively by more than a 1,000 high school and college students.

Public outreach activities included interaction with several civic groups and membership on six committees, including the Hawaii Island Economic Development Board Science and Technology Committee and the Hawaii Island Chamber of Commerce Education Committee.

SEPO participated in and coordinated several public events that have reached over 30,000 people, including the "Got Sol?" Solar Viewing Day, AstroDay, Onizuka Science Day, the Perseids Meteor Program, the Venus Transit Remote Program, Mauna Kea Observatories Open House in University Park, the Waimea Aloha Festival, the St. Joseph Country Fair, and the Hawaii County Fair.

An informal public lecture series entitled "AstroTalks" was created in collaboration with the University of Hawaii at Hilo Physics and Astronomy Department. AstroTalks feature live video webcasting and streaming video archiving capabilities utilizing UHH's Tegrity hardware and software package.

Mauna Kea Observatory tour packages that included meals at the Hale Pohaku mid-level facility, and nature walks and Hawaiian culture presentations at the Visitor Information Station were provided to over 325 visitors in 32 groups.

### 9.3 Faulkes Telescope North

The 2-m Faulkes Telescope North (FTN) captured its first image with its three-color CCD scientific camera on 22 December 2003. A joint project of the Institute for Astronomy and the Faulkes Telescope Corporation, FTN is one of the two largest telescopes in the world exclusively for the use of students in kindergarten through college. The second is FTN's twin located in Australia.

The main aim of the FTN project is to stimulate students' interest in science, math, and technology through use of a real, research-grade, telescope.

FTN operates in two modes: real time and off-line. Both have been run from the United Kingdom (UK), but the Hawaii real-time operating system was scheduled to be acquired, installed, and tested in October 2004 so that students in Hawaii, as well as those in the UK, will be able to control the telescope through a Web interface. In the real-time mode, the user has direct control of the telescope and is able to point it at any object in the sky. An image can be displayed within minutes of completing an observation, and webcam images of the telescope are displayed to show users what is happening at FTN.

During the report period, a spectrograph developed at the University of Leicester was installed and was being integrated into the telescope operating system. This new instrument will allow students to take spectra of astronomical objects in addition to imaging them.

An infrared camera called QUIRC (Quick Infrared Camera) that has worked extremely well on the UH 2.2-m and Canada-France-Hawaii telescopes on Mauna Kea has been donated to FTN by IfA. It will be transported to Haleakala and installed in late 2004. This will give children in Hawaii the ability to observe in the infrared from their classrooms during the early school day.

A series of pilot programs, mostly in preparation for science fair projects, are being carried out by selected teachers and their students. A pool of teachers, primarily graduates of the TOPS program (Towards Other Planetary Systems; see previous annual reports or [www.ifa.hawaii.edu/tops/](http://www.ifa.hawaii.edu/tops/)), has been assembled and is being queued up for observing time.

After a “grand opening” in January 2005, the FTN should be fully available to all schools in Hawaii. Development of support materials, lesson plans, observing projects, etc., is continuing, and an effort to translate all materials into the Hawaiian language has begun.

#### 9.4 Research Experiences for Undergraduates

The Research Experiences for Undergraduates program, funded mainly by a five-year grant from NSF, continued for a fourth year. Eight students from the mainland spent 10–12 weeks in the summer as full-time research assistants under the supervision of a faculty member. The students, their home institutions, and faculty mentors were Meredith Hughes (Yale, Williams), Eric Bellm (Harvard, Electronics Engineer P. Onaka and Tokunaga), Jonathan Blazek (Harvard, Sanders), Joshua Ruderman (Stanford, Ebeling), Zuzana Srostlik (Vermont, Hu), Charlotte Christensen (Carleton, Simon), Bonnie Meinke (Berkeley, Jedicke), and Chase Ellis (Redlands, Fernández).

#### 9.5 ALII Program

ALII, the Astrobiology Laboratory Institute for Instructors, is the K–12 formal education outreach program of the UH NASA Astrobiology Institute Lead Team. ALII held its inaugural course, Instructional Strategies for Astrobiology I, 14–18 June at UH Manoa. Fourteen teachers from Oahu and Tennessee participated. The goal of the workshop, which was organized by IfA Curriculum Development Specialist Mary Kadooka, was “to introduce the teachers to astrobiology research findings and inspire them to want to learn more.”

#### 9.6 Friends

The Friends of Hawaii Astronomy, the institute’s affiliated private support group for education and outreach, increased its membership from 30 to more than 90 during the

report period. Friends and donors contributed over \$70,000 to the IfA during that period, both for discretionary purposes and specific projects.

The Friends enjoyed several activities and events, ranging from their first annual meeting, talks exclusively for the Friends and others open to the public, stargazing, the annual Open House, and tours and field trips, all of which were geared toward educating members and the broader community about astronomy and the graduate education and research programs of the IfA. They also received the second edition of the IfA’s poster calendar, quarterly newsletter, monthly star charts, a reprint of a research report, and periodic e-mailed, mailed, or faxed bulletins of late-breaking astronomy news.

Planning over the course of the year involved the creation of a master Friends events calendar to be coordinated with annual gift solicitations.

### 10. SCIENTIFIC RESEARCH

Listed below are the major areas of research at the IfA, followed by the names of those active in that area (some names are listed more than once). Further information about research activities can be found at [www.ifa.hawaii.edu/research/](http://www.ifa.hawaii.edu/research/), on the home pages of individual faculty members (accessible through [www.ifa.hawaii.edu/faculty/](http://www.ifa.hawaii.edu/faculty/)), and in the list of publications (see sec. 11).

*Galactic and extragalactic astronomy:* Aussel, Bresolin, Brogan, Chambers, Coleman, Cowie, Ebeling, Henry, Hu, Joseph, Kaiser, Kudritzki, Luppino, Mahdavi, Pickles, Price, Rizzi, Sanders, Songaila, Stockton, Szapudi, Tonry, Tully, and Wainscoat.

*Star formation and interstellar matter:* Aussel, Brogan, Ftaclas, Herbig, Hodapp, Liu, Magnier, Martín, Rayner, Reipurth, Sanders, Tokunaga, Williams, and Wynn-Williams.

*Stellar astronomy:* Boesgaard, Bresolin, Heasley, Herbig, Méndez, Przybilla, Rayner, and Simon.

*Solar system astronomy:* Bernardi, Bus, Delsanti, Fernández, Haghighipour, Jedicke, Jewitt, Meech, Owen, Pittichová, Schorghofer, and Tholen.

*Astrobiology:* Boal, Brown, Chizmadia, Delsanti, Glazer, Haghighipour, Jewitt, Kudritzki, Meech, Owen, Reipurth, Schorghofer, and Zheng.

*Solar physics:* Kuhn, Li, Lin, and Mickey.

*Theoretical studies of cosmology and galaxy formation:* Barnes, Chon, Fosalba, Kaiser, Pan, and Szapudi.

*Instrumentation:* Chun, Ftaclas, Hall, Hodapp, Luppino, Mickey, Rayner, Stockton, Tokunaga, Tollestrup, and Tonry.

### 11. PUBLICATIONS

For a list of recent publications, as well as links to lists of preprints and publications of past years, go to [www.ifa.hawaii.edu/publications/pubslstcurrent.html](http://www.ifa.hawaii.edu/publications/pubslstcurrent.html).

Rolf-Peter Kudritzki, Director