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Institute for Astronomy
Honolulu, Hawaii 96822

This report covers the period from 1 October 2000 through 30 September 2001, and was compiled in October 2001.

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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, <http://www.ifa.hawaii.edu/>.

2. STAFF

The scientific staff during this report period consisted of Joshua E. Barnes, Ann M. Boesgaard, Wolfgang Brandner, Fabio Bresolin, Douglas Burke, Schelte J. Bus, Kenneth C. Chambers, Antoinette Songaila Cowie, Lennox L. Cowie, Harald Ebeling, Isabella M. Gioia, Donald N. B. Hall, James N. Heasley, J. Patrick Henry, George H. Herbig, Klaus-Werner Hodapp, Esther M. Hu, David C. Jewitt, Robert D. Joseph, Nick Kaiser, Richard Knabb, Rolf-Peter Kudritzki (Director), Jeffrey R. Kuhn, Barry J. LaBonte, Jing Li, Haosheng Lin, Gerard A. Luppino, Eugene A. Magnier, Eduardo L. Martín, Robert A. McLaren, Karen J. Meech, Donald L. Mickey, Tobias C. Owen, Andrew J. Pickles, John T. Rayner, Claude Roddier, François J. H. Roddier, David B. Sanders, Theodore Simon, Alan Stockton, David J. Tholen, Alan T. Tokunaga, John L. Tonry, R. Brent Tully, William D. Vacca, Richard J. Wainscoat, and Gareth Wynn-Williams.

Postdoctoral fellows included Andisheh Mahdavi (Chandra Fellow), Hervé Aussel (James Clerk Maxwell Fellow), Amy Barger (Hubble Fellow and Chandra Fellow at Large), Pierre Baudoz, Yanga R. Fernandez, Michael Liu (Parrent Fellow), and Jana Pittichova (NATO-NSF Postdoctoral Fellow).

Two students, Kevin Jim and Christopher Mullis, completed requirements for the Ph.D. degree. The other graduate students during the report period were Sean Andrews, James Armstrong, Elizabeth Barrett, Brian Barris, James Bauer, George Bendo, Sandrine Bottinelli, Peter Capak, Michael Connelley, Michael Cushing, Scott Dahm, David Donovan, Cyrus Hall, Henry Hsieh, Catherine Ishida, Yuko Kakazu, Dale Kocevski, Sebastien Lefranc, Elizabeth McGrath, Megan Novicki, Daniel Potter, Barry Rothberg, Scott Sheppard, Brian Stalder, Robert Thornton, and Wei-Hao Wang. For more information about the graduate program, see <http://www.ifa.hawaii.edu/gradprog/>.

Visiting colleagues included Hervé Buoy, Oliver Czoske, Miwa Goto, Olivier Guyon, Sebastien Matte, Steven Miller,

2.1 New Faculty and Retirements

Rolf-Peter Kudritzki became director of the IfA in October 2000. Prior to that, he was professor of astronomy and director of the Institut für Astronomie und Astrophysik (University Observatory) at the University of Munich. Fabio Bresolin, a colleague of Kudritzki's in Munich, arrived in August 2001. Both Kudritzki and Bresolin specialize in the study of hot massive stars.

George Herbig retired and was granted emeritus status. Claude Roddier and François Roddier retired at the end of 2000.

2.2 Honors and Awards Received

Amy Barger received the 2001 Annie Jump Cannon Award. Graduate student Scott Sheppard won the 2001 Helen Jones Farrar/ARCS Scholarship for his work on Jupiter satellites.

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 contract 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); and the 8.1-m Gemini North Telescope, built by an international partnership and managed by the Association of Universities for Research in Astronomy. At the Submillimeter Array (SMA), installation and commissioning of the eight 6-m antennas continued. The SMA is a collaborative project

of the Smithsonian Astrophysical Observatory and the Institute of Astronomy and Astrophysics of the Academia Sinica of Taiwan.

3.1 Mauna Kea Master Plan

The past year has seen the implementation of the new management structure for the Mauna Kea Science Reserve, as called for in the Master Plan adopted by UH in June 2000. The Office of Mauna Kea Management (OMKM) has been established at the University of Hawaii-Hilo with a four-person interim staff. Since March, the OMKM has been located in the IfA Hilo Facility (see Sec. 3.2). In August 2001, Bill Stormont was appointed permanent director of the OMKM, and he was to begin serving in that capacity in October 2001. For the past ten years, Stormont has managed the State's Natural Area Reserve System on the Island of Hawaii. Also established is the Mauna Kea Management Board, representing the various stakeholder constituencies. This seven-person board meets at least once a month and provides oversight for all activities within the Science Reserve. The Board provides policy advice to OMKM and serves as the interface between UH and the community. The third component of the management structure is Kahu Ku Mauna, a council of Hawaiian elders that provides advice on Hawaiian cultural matters.

Much of the effort during this first year was devoted to organizational matters. Other accomplishments include publishing a quarterly newsletter, "Ho'opono Mauna Kea"; creating a ranger/guide program on the mountain to provide advice to visitors and to monitor activities; closing the access road up the Poliahu cinder cone (a sacred Hawaiian site) to vehicular traffic; and establishing a design review process for new projects and starting this process for the Keck Outrigger Telescopes Project.

For more information about the new management organization, see <http://www.malamamaunakea.org/>.

3.2 IfA Hilo Facility and Infrastructure

The 35,000-square-foot (3,300-m²) IfA Hilo Facility, completed in the fall of 2000, provides a state-of-the-art operations base for the IfA's activities on Mauna Kea, plus expansion space for our research, instrumentation, teaching, and outreach programs. The IfA Hilo Facility is now fully operation, with 32 IfA employees based there, including 15 from IRTF. The building also houses 3 UH Hilo astronomers, OMKM, the nascent Mauna Kea Astronomy Education Center, and several other UH Hilo programs.

4. HALEAKALA OBSERVATORIES

4.1 Mees Solar Observatory

Mees Solar Observatory supports IfA solar scientists in data acquisition by running diverse observational programs with its telescope cluster. The observatory regularly co-observes with the satellites *Yohkoh*, *Solar and Heliospheric Observatory (SOHO)*, and *Transition Region and Coronal Explorer (TRACE)*, and also participates in special satellite and ground-based observatory campaigns. One of the unique

observational capabilities at Mees is the ability to perform measurements of the temporal evolution of photospheric vector magnetic fields. The observatory's complement of instruments includes the Imaging Vector Magnetograph (IVM), Haleakala Stokes Polarimeter, Mees CCD Imaging Spectrograph (MCCD), Mees White Light Telescope, and Coronal Limb Imagers.

Active instrumentation projects include adding rapid wavelength selection to the IVM to permit sequential photospheric and chromospheric magnetic observations, and a new CCD camera and data system for the MCCD for high-speed spectral imaging in collaboration with the upcoming *High Energy Solar Spectroscopic Imager (HESSI)*, a Small Explorer Program (SMEX) mission.

4.2 LURE Observatory

LURE is a satellite laser ranging (SLR) observatory. LURE utilizes a high-powered pulsed laser to obtain distance measurements to satellites in Earth orbit. LURE is funded by the Space Geodesy Networks and Sensor Calibration Office of NASA Goddard Space Flight Center. The missions of the target satellites include monitoring of Earth resources and climate parameters, measurements of ocean levels and temperatures, plate tectonics, the improvement of the Global Positioning System (GPS), as well as special missions related to the physics of tethered satellite systems. LURE provides range data to NASA 7 days a week, and improvements to the computer system and to the operational procedures will soon allow LURE to operate on a 24-hour schedule.

4.3 AEOS-Haleakala Atmospheric Characterization Project

Haleakala Observatories is under contract to the Air Force Research Laboratories to conduct a research program known as the AEOS-Haleakala Atmospheric Characterization (AHAC). This program supports the U.S. Air Force Advanced Electro-Optical System (AEOS) Telescope on Haleakala by providing comprehensive atmospheric characterization and timely prediction of inclement weather conditions at the observatory site. The instrument suite that supports these site measurements includes a daytime/nighttime optical seeing monitor and a network of remote meteorological systems linked by radio modems. The optical seeing monitor captures star image data at high frame rates and uses a differential image motion technique to allow the computation of seeing statistics over intervals of a few seconds. Data from the remote meteorology stations are processed using an artificial intelligence program to generate locally specific predictions of adverse weather events on a time horizon of 30 minutes.

4.4 MAGNUM Telescope Project

The 2-m Multicolor Active Galactic Nuclei Monitoring (MAGNUM) Telescope is dedicated to studying the variation of light from active galactic nuclei (AGNs). The project is a collaboration between the University of Tokyo and UH. The main scientific objective of MAGNUM is to measure distances to AGNs and quasars up to $z=1$. The telescope is designed to be operated remotely and to conduct observa-

tions autonomously. For more information, see <http://merope.mtk.nao.ac.jp/~yuki/mage/.html>

4.5 Solar-C

The Solar-C instrument is a 0.5-m off-axis coronagraphic reflecting telescope adjacent to the Mees Solar Observatory. It had its first light in August 2001. This instrument (1) allows coronal observations that have not been realized, even from space, (2) develops technology that IfA scientists believe will be used for future satellite observations, and (3) supports several long-term coronal observing platforms that extend intermittent coronal space observations. Unlike most telescopes, light strikes the Solar-C mirrors off axis, at an angle to their surfaces. No light is blocked, reflected, scattered, or diffracted by the mirrors or their support structure aside from the superpolished optical surfaces.

4.6 Faulkes Telescope

See Sec. 6.2.

5. INSTRUMENTATION

The visible arm of the AEOS spectrometer is now working and saw its first research program in a worldwide campaign to study the spectral signature of M dwarf flare stars. The infrared arm of the echelle has been cold-tested and will be assembled on the summit of Haleakala by the end of 2001.

The UH/IfA adaptive optics system, Hōkūpa‘a, continued to be used as a visitor instrument on the Gemini North telescope. It is available to the entire Gemini community. Work on a new curvature-sensing AO system, similar to Hōkūpa‘a but with 85 actuators instead of 36, continued at the IfA. The intention now is to mount this new system on Gemini South toward the end of 2002 or beginning of 2003.

New MIT Lincoln Labs CCDs have been obtained to replace the detectors currently used in the UH 8K mosaic camera. The new devices will improve the quantum efficiency over most of the spectral range by a factor of between 2 and 3, with much better cosmetic quality.

6. OUTREACH

Heasley was appointed outreach coordinator. He initiated the publication of monthly star charts and a quarterly newsletter to be sent to members of the Friends of Hawaii Astronomy and other interested parties. Open houses for the general public were held at the Manoa and Hilo facilities, and included lectures, tours, and displays.

6.1 TOPS Teacher Enhancement Program

The summer of 2001 marked the third year of support under a five-year NSF grant for the TOPS (Toward Other Planetary Systems) teacher enhancement program. Originally developed by Meech as a one-week program in 1993, the workshops are now three weeks of intensive astronomy training for teachers and high school students. This year 26 teachers and 20 students participated in the workshop.

TOPS emphasizes incorporating astronomy into physics, math, chemistry, biology, and earth sciences classes. Teachers are introduced to classroom tools, techniques, and activities they can employ in their own classes. Computer skills development and student assessment and evaluation techniques are also emphasized.

The teachers and students participate in a wide variety of hands-on activities ranging from archeoastronomy to grinding telescope mirrors. Every clear night during the program, they engage in observing projects that use small telescopes. Their observing projects vary from simple visual observations of the moon, planets, and nebulae to deep-sky astrophotography to sophisticated variable star observations using a CCD camera. One of the highlights of the workshop is a tour of Mauna Kea Observatories.

IfA faculty members are frequent lecturers for the TOPS program. This year, Heasley, Joseph, Kudritzki, Kuhn, LaBonte, Lin, and Tokunaga made presentations to the TOPS teachers. TOPS also benefits from a core of volunteers from the Bishop Museum (Honolulu) and the Hawaiian Astronomical Society.

Support for the TOPS workshops also comes from private donations and in-kind support from NASA. For the second year in a row, three staff members from the Astrobiology Institute at NASA Ames Research Center worked, at NASA's expense, with the TOPS teachers and students. Gretchen Walker (University of Maryland), the outreach coordinator for NASA's "Deep Impact" mission to Comet/P Temple 2, worked with the teachers on demonstrations of cratering processes. The NASA IRTF also provided support.

Another long-standing supporter of TOPS is Janet Mattei, the director of the American Association of Variable Star Observers (AAVSO). She spends two weeks each summer with the TOPS teachers and students to lecture on variable stars, to introduce them to the Hands On Astrophysics exercises AAVSO has developed, and to assist with observing projects.

Additional information about TOPS is available at <http://www.ifa.hawaii.edu/tops>.

6.2 Faulkes Telescope

The IfA and the Faulkes Telescope Corporation are collaborating to locate a 2-m telescope facility at the University's Haleakala High Altitude Observatory site on Maui. The telescope's construction will be financed by the Dill Faulkes Educational Trust of the United Kingdom (UK) and will be named in honor of Dr. Martin "Dill" Faulkes, the founder of the trust.

On September 7, 2001, the UH Board of Regents approved the Operating & Site Development Agreement for the Faulkes Telescope Project and the lease for the telescope site. On September 14, the State of Hawaii Board of Land and Natural Resources approved the IfA's Conservation District Use Application to place the Faulkes Telescope on Haleakala. With the achievement of these two milestones, the site work for the telescope was scheduled to begin in the fall of 2001. Plans call for the telescope to be operational in 2002.

The Faulkes Telescope Project will draw on young people's interest in astronomy to teach them what science is. It will offer students in the UK and Hawaii hands-on research

experience. Students will conduct research projects under the mentoring of their teachers and professional astronomers. In Hawaii, access to the telescope will be available to public and private schools and to the science programs of the UH system and other local colleges. The Faulkes Telescope will be the world's largest dedicated to K–12 and undergraduate education, and outreach. It will be operated remotely from control centers in the UK and on Maui.

The first instrument to be installed will be a state-of-the-art electronic camera with 4 million pixels. Later, funds will be sought to add an infrared camera to allow operation of the telescope during daylight hours.

Heasley is the IfA project scientist for Faulkes Telescope Project.

6.3 Research Experiences for Undergraduates and Teachers

Two new outreach programs at the IfA, Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET), began in the summer of 2001. The REU program is supported by a five-year grant from the National Science Foundation (NSF). The NSF is also providing supplementary funds for the RET program. Heasley is the principal investigator, and Meech is the co-investigator.

The REU students spent 10–12 weeks as full-time research assistants to a faculty mentor. The students received travel money and a stipend to cover living expenses.

The two teachers in the RET program were both former participants in the TOPS Teacher Enhancement workshops. They worked with Meech and Heasley on the analysis of observations of Kuiper Belt objects obtained at the UH 2.2-m telescope and participated in this ongoing observing program. The purpose of this project is to begin developing a science curriculum that will use observations taken with the Faulkes Telescope. Since the UH telescope is about the same size as the Faulkes Telescope, the observations are approximately equivalent.

The REU and RET programs received additional support from Sun Microsystems, which loaned the IfA a Sunray server and eight workstation displays for participants' use.

7. 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 <http://www.ifa.hawaii.edu/research/>, on the home pages of individual faculty members (accessible through <http://www.ifa.hawaii.edu/faculty/>), and in the list of publications. See Sec. 5 for more information about instrumentation projects.

Galactic and extragalactic astronomy: Aussel, Barger, Bresolin, Burke, Chambers, Cowie, Ebeling, Gioia, Henry, Hu, Joseph, Kaiser, Kudritzki, Luppino, Mahdavi, Pickles, Sanders, Songaila, Stockton, Tonry, Tully, Vacca, and Wainscoat.

Star formation and interstellar matter: Aussel, Brandner, Hodapp, Liu, Magnier, Martín, Rayner, Tokunaga, and Wynn-Williams.

Stellar astronomy: Boesgaard, Bresolin, Heasley, Herbig, and Simon.

Solar system astronomy: Bus, Fernandez, Jewitt, Meech, Owen, Pittichova, and Tholen.

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

Theoretical studies: Barnes, Kaiser, and Szapudi.

Instrumentation: Baudoz, Brandner, Hodapp, Luppino, Mickey, Rayner, C. Roddier, F. Roddier, Stockton, Tokunaga, and Tonry.

PUBLICATIONS

The following articles and books were published during calendar year 2000. The names of IfA authors are in **bold-face**. More recent publications are listed at <http://www.ifa.hawaii.edu/publications/preprints/>.

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Blakeslee, J. P.; Davis, M.; **Tonry, J. L.;** Ajhar, E. A.; Dressler, A. Comparing the SBF Survey Velocity Field with the Gravity Field from Redshift Surveys. In *Cosmic Flows 1999: Towards an Understanding of Large-Scale Structure*, ed. S. Courteau, M. A. Strauss, & J. A. Willick. ASP Conf. Ser. 201, 352–359 (2000)

Block, D.; Puerari, I.; **Stockton, A.;** Ferreira, D., eds. *Toward a New Millennium in Galaxy Morphology*. Reprinted from *Ap&SS*, Vols. 269–270, Nos. 1–4 (Kluwer) 828 pp. (2000)

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- Boesgaard, A.M.**; **Stephens, A.**; King, J.R.; Deliyannis, C.P. Chemical Abundances in Globular Cluster Turn-Off Stars from Keck/HIRES Observations. *Proc. SPIE*, 4005, 274–284 (2000)
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