NASA Infrared Telescope Facility
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Abstract
This report covers the period from 1 July through 30 December 2000. The NASA Infrared Telescope Facility (IRTF) is a 3.0 m infrared telescope located at an altitude of 4.2 km on the summit of Mauna Kea in Hawaii. It was established by NASA in 1979 primarily to provide infrared observations in support of NASA's programs. The IRTF is managed and operated by the University of Hawaii (UH) Institute for Astronomy (IfA) under a contract between NASA and UH. Under this agreement, NASA provides the operating costs and NSF provides support for new focal plane instrumentation based on grant applications from IRTF support astronomers. Observing time is open to the entire astronomical community, and 50% of the time is reserved for studies of solar system objects.

1. PERSONNEL

Alan Tokunaga became the IRTF division chief in April 2000. He succeeded Robert Joseph, who had been the division chief since September 1989. The support astronomers were John Rayner, deputy to the division chief; William Vacca, who left in early November to join the Max-Planck group in Garching, Germany; and Shelte (Bobby) Bus, who joined the IRTF on 1 October. Rolf Kudritzki assumed the role of PI of the IRTF contract with NASA on 1 February 2001, after becoming the IfA director on 2 October 2000. Prior to this time, Robert McLaren was the PI, as well as the IfA Interim Director.

Paul Jensen was the IRTF telescope superintendent, and George Koenig was the foreman of the telescope day crew. Other members of the day crew were Lars Bergknut, Imai Namahoe, Sammy Pung, Paul Fukumura-Sawada, and Danley Lee. Telescope operators were Bill Golisch, Dave Griep, and Charlie Kaminski, who left the IRTF for a position at the South Pole on September 29. The engineering/technical staff included Peter Onaka (electronics engineer), Doug Toomey (instrumentation engineer), Greg Ching (electronics technician), Darryl Watanabe (instrument technician), Tony Denault (instrumentation software engineer), and John Sender (observatory software engineer). Karan Hughes was the IRTF secretary/project assistant, and Susan Lemn was the clerk-typist in the IRTF office beginning in September 2000. Chris Kaukali was the IRTF fiscal officer. The total IRTF staff numbered 24 full-time equivalents.

2. COMMITTEES

The NASA Management and Operations Working Group (MOWG) for the IRTF was chaired this year by Yervant Terzian (Cornell). This is an advisory group to NASA that provides direction of IRTF operations. The other members were Martha Hanner (JPL), Jacques Beckers (National Solar Obs.), James L. Elliot (MIT), Samuel Gulkis (JPL), and Robert Millis (Lowell Obs.). Ex-officio members were Morris Aizenman (NSF), Tom Morgan (NASA), and Günther Riegler (NASA).

Caitlin Griffith (Northern Arizona), Richard Binzel (MIT), Timothy Brooke (JPL), Christopher Johns-Krull (Berkeley), Neill Reid (Univ. of Pennsylvania), and David Turnshek (Univ. of Pittsburgh) served on the six-member IRTF Time Allocation Committee. The TAC was chaired by IRTF Division Chief Alan Tokunaga, who does not vote on proposals.

3. USAGE OF THE IRTF

The observing semesters are February–July and August–January, inclusive. Deadlines for observing proposals are 1 October for February–July and 1 April for August–January. The IRTF received 119 applications for observing time for the second semester of 2000. The oversubscription was a factor of 2.6 for solar system programs and 3.2 for non-solar system programs. The scheduled programs involve over 200 U.S. and foreign astronomers each semester. About 22% of the scheduled observing time was lost to bad weather, and 2% to IRTF instrumentation and other facility problems.

4. THE TELESCOPE

The IRTF has an f/37 Cassegrain focus with two secondary mirror structures, one for tip-tilt and one for chopping. A f/120 coudé focus is also available. The Cassegrain instruments are mounted on the Multiple Instrument Mount that allows for the simultaneous mounting of up to four instruments. Under normal circumstances, the IRTF facility instruments are kept mounted and ready for use, so instrument changes can be accommodated in less than 15 minutes. This allows for short programs that require only a partial night.

4.1 Facility Instruments

The present complement of IRTF instruments covers the 1–25 μm spectral range.

SpeX is a 0.8–5.4 μm spectrograph with low to moderate resolving power (100–2500). It was commissioned in August 2000. The spectrograph section uses a 1024$\times$1024 InSb array with $0''.15$/pixel. Five spectroscopic modes are supported:
(1) 0.8–2.4 μm, cross-dispersed, R = 2000, $0''.3\times15''$ slit;
(2) 1.9–5.4 μm, cross-dispersed, R = 2500, $0''.3\times15''$ slit;
(3) 0.8–2.5 μm, single order, R = 2000, $0''.3\times60''$ slit;
(4) 2.7–5.4 μm, single order, R = 2500, $0''.3\times60''$ slit;
(5) 0.8–2.5 μm, prism, R = 250, $0''.3\times60''$ slit.

There is a slit viewer that can also provide infrared guiding and imaging capability. It has a 512$\times$512 InSb array with $0''.12$/pixel, a $60''\times60''$ field of view, and a 15-position filter wheel. Currently, SpeX is scheduled for 45% of all observing time.

NSFCAM is a 1–5 μm camera with a 256×256 InSb array. It has three selectable image scales of 0.″06, 0.″15, and 0.″30/pixel, and 24 filters. A unique feature of NSFCAM is that it has circular variable filters (CVFs) that provide 1%–2% spectral resolution from 1 to 5 μm. NSFCAM also features two grisms that provide long-slit spectroscopy. One covers the 0.9–1.8 μm range at a resolution of R = 100, while the other works in the *H*, *K*, or *L* bands at R = 300 (double sampled). A warm waveplate rotator assembly allows linear polarization measurements to be obtained. The DSP-based array controller, developed by the IRTF staff, provides real-time shift-and-add for image sharpening and a movie mode for high duty-cycle, short-exposure observations such as occultations. It is scheduled for about 25% of all observing time.

CSHELL is a high-resolution spectrograph that covers the 1–5.5 μm spectral range with 0.″20 pixels. It has a 30″ long slit and can also image a 30″×30″ area for easy object acquisition. Slits from 0.″5 to 4.″0 wide can be selected, and the 0.″5 slit provides a spectral resolution of R = 43,000. An internal science-grade CCD is used for guiding.

MIRLIN is a 10–20 μm camera that is available as a facility instrument for up to 4 months per semester by arrangement with its developer, Mike Ressler (JPL). The camera utilizes a 128×128 Si:As BIB array. The pixel scale is 0.″46/pixel. The user interface is similar to that of NSFCAM and CSHELL.

4.2 Visitor Instruments

The IRTF supports a number of visitor instruments and has encouraged the collaborative use of these instruments by advertising them on its Web site and in the semiannual announcements of observing time.

TEXES is a high-resolution spectrograph for 8–25 μm. J. Lacy and M. Richter (Univ. of Texas) are the PIs on this instrument. It provides four observing modes:

(1) high-resolution, cross-dispersed, with R = 100,000, 0.5% spectral coverage, and an 8″ slit length (varying with wavelength);

(2) medium-resolution long-slit, with R = 15,000, and a 60″ slit;

(3) low-resolution long-slit, with R = 4,000, 0.2 μm coverage, and a 60″ slit;

(4) source acquisition imaging with 0.4″ pixels and 25″ ×25″ field of view.

BASS is a low-resolution spectrograph that can cover the entire 3–13.5 μm spectral range in a single exposure with R = 25–120. It employs two 58-element BIB arrays. D. Lynch (Aerospace Corp.) is the PI.

CELESTE is a high-resolution 5–25 μm spectrograph. D. Jennings (GSFC) is the PI.

4.3 Image Quality

Work on improving the image quality has been ongoing for several years. It has involved improvement of the primary mirror support system, installation of a tip-tilt secondary mirror, improvement of the dome cooling system, and improvement of the dome air flushing. Work continues on the following areas: (1) A mechanism to remove stiction between the primary mirror and mercury supporting ring was installed. Testing will be completed during the first half of 2001. (2) An adaptive optics system is being fabricated and should be ready for engineering tests by the end of 2001. (3) Further improvements to the dome and primary mirror thermal environment will be made.

4.4 Software

The standard design for instrument control and data acquisition of all IRTF array-based instruments features an X Windows graphical user interface (XUI) for instrument control and real-time "quick-look" data analysis (vf). SpeX, NSFCAM, CSHELL, and MIRLIN interfaces have a similar look and feel, making it relatively easy for IRTF users to observe with these instruments.

4.5 Remote Observing

We have started to implement remote observing using the Internet. Two observing runs using NSFCAM and one run using SpeX were conducted over the Internet. The observer controlled the instrument from his or her office on the Mainland with assistance from the telescope operator. Based on the success of these experiments, we are planning for remote observing both from our Hilo office, and from the observer's home office.

5. BUDGET

The IRTF had an operating budget of $3.1 million, which includes support for 24 full-time equivalents. This includes the personnel devoted to fabrication and maintenance of instruments. Additional funds are secured from the NSF for instrument development, and this typically averages about $300,000 per year.

6. WEB-BASED INFORMATION ACCESS

The IRTF World Wide Web site (http://irtf.ifa.hawaii.edu/) provides convenient access to IRTF information and the anonymous ftp site. Available information includes public IRTF data (such as from the *Galileo* Jovian monitoring program), IRTF photometric catalogs, observing time application forms, instrument and telescope manuals, and the telescope schedule.

Alan Tokunaga