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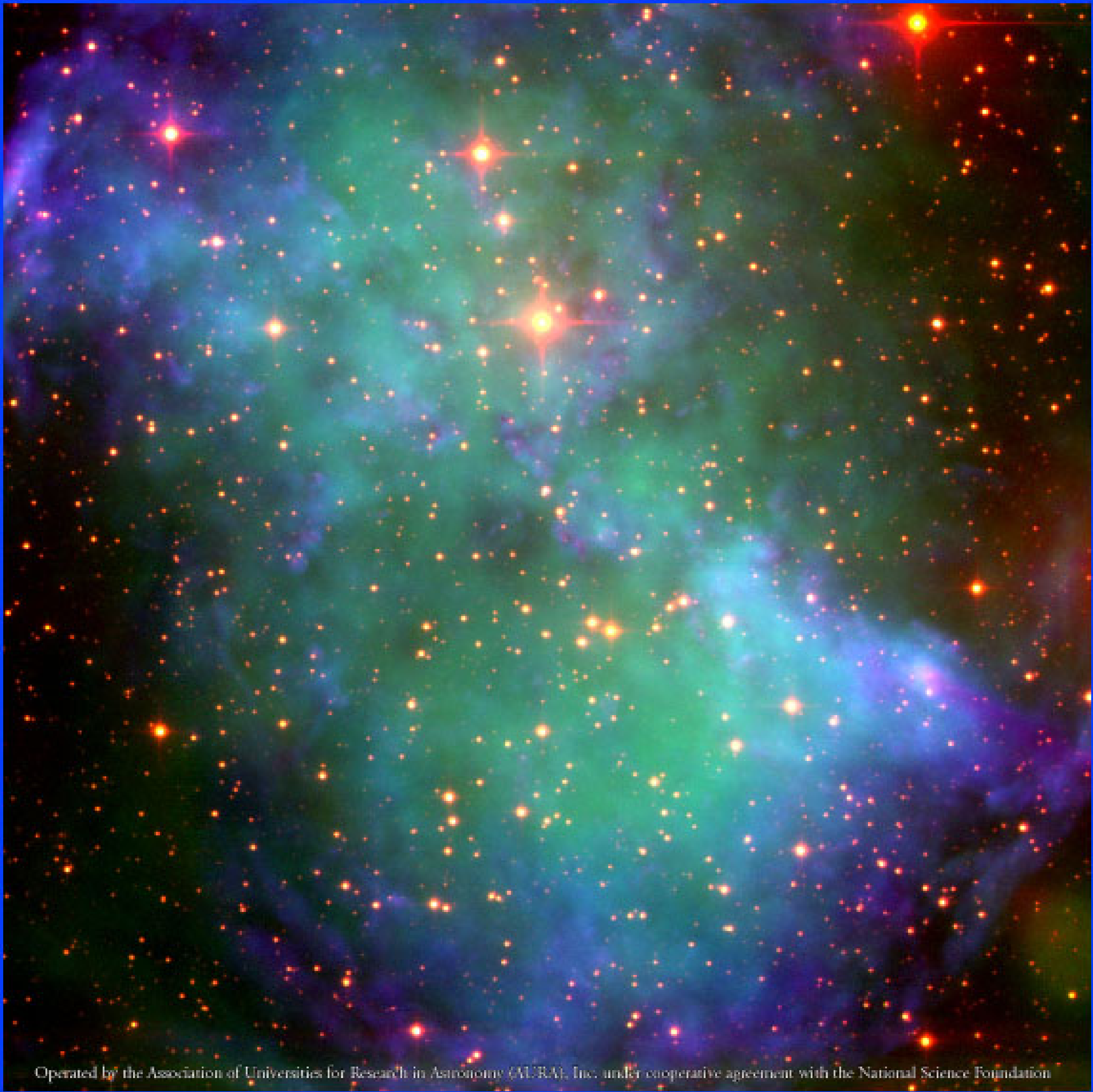
Newsletter 67

September 2001



Operated by the Association of Universities for Research in Astronomy (AURA), Inc. under cooperative agreement with the National Science Foundation

NOAO Newsletter

Issue 67

September 2001







From the Editor:

The landscape of ground-based astronomy will look very different by the end of this decade. National facilities that have been workhorses for thirty years or more will be operated by private groups or closed.

New telescopes on the drawing board promise astounding leaps in sensitivity and sky coverage. Yet, the investments needed to build and operate these large facilities are imposing, and almost certainly stretch beyond the resources of any single institution, public or private.

This newsletter issue, and the brochure that accompanies it, highlights many of the activities that NOAO is pursuing to facilitate this major transition and to help make these new facilities a reality.

The scientific arguments and engineering decisions that emerge during the next three to four years will determine the overall "face" of publicly funded O/IR astronomy for some time to come…perhaps until the first humans on Mars gaze upward at their own unique night sky.

We urge you to become an active participant in these critical decisions.

-- Doug Isbell

On the Cover

This false-color image of the Dumbbell Nebula, NGC 6853, was taken by the 3.5-meter WIYN telescope using new high-resistivity, thick p-channel CCDs from Lawrence Berkeley National Laboratory that are being tested by NOAO.

The image was assembled from images taken through narrow-band filters centered roughly on the H-alpha (blue) and the [SIII] 9532Å emission lines (green), and an intermediate-band filter centered at 1.02 microns that includes emission from HeII at 10124Å (red). The background stars, dimmed by foreground dust at shorter wavelengths, clearly show through in the 1-micron filter image.

The CCDs have excellent quantum efficiency at red wavelengths and are now available for use at Kitt Peak National Observatory. See page 3 for further details.

Photo: Nigel Sharp, Rich Reed, Dave Dryden, ave Mills, Doug Williams, Charles Corson, Roger Lynds, and Arjun Dey.

Notable Quotes

"I wanted to impress each [student's] mind with the incredible beauty and mystery that lies just above our heads. Like moments frozen in time, I can reanimate all of those bright faces wearing red-and-blue 3D glasses, feeling their excitement and hearing the 'OOH's, AHH's,' deep gasps, and an occasional, 'Oh Wow! Cool!'"

-Project ASTRO astronomer Larry Behers, in a thank-you note to NOAO's Educational Outreach Group, describing his work with middle school students.

"It deserves a place right at the top of the list. Because of the time pressure, that is the way the game has to be played."

-Dr. John Bahcall of the Institute for Advanced Study, quoted in the June 15 issue of Science, comparing the value of a proposed $281 million retrofit of the abandoned South Dakota Homestake gold mine to other pending NSF-funded astrophysical research facilities like ALMA. The proposal received $10 million from the Senate Appropriations Committee in their FY02 NSF spending bill for study of the idea.

Have you seen an interesting comment in the news or heard one during a NOAO-related meeting or workshop? *Please share them with the Newsletter Editor, editor@noao.edu.*

The NOAO-NSO Newsletter is published quarterly
by the *National Optical Astronomy Observatory*
P.O. Box 26732, Tucson, AZ 85726

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Seeing Red: An Update on the Red-Hot LBNL CCD's

Arjun Dey, Rich Reed, Roger Lynds, Bill Ditsler, and Barry Starr (NOAO)

The high-resistivity CCDs manufactured by Lawrence Berkeley National Laboratories (LBNL) are 300-mm thick p-channel devices providing excellent quantum efficiency at red wavelengths (see the *NOAO Newsletter* No. 65, p. 37). We have been testing these new devices at KPNO in collaboration with LBNL. The LBNL CCDs appear to offer great improvements in our existing spectroscopic and imaging capabilities at long optical wavelengths (l > 8000Å).

We currently have three working devices in hand. The LB1A and LB2A devices have been used with the RC spectrograph on the Mayall telescope. We have also tested the LB2A device in imaging mode on the WIYN telescope (see cover image and accompanying articles in this section). All devices show excellent red response as advertised and are reasonably free of cosmetic defects. The thick devices are sensitive to cosmic ray events, however, which are detected at a rate of 1.1-1.7 events/cm^2/minute in the 4-m Cassegrain cage, resulting in typically 1-1.5% of the pixels being affected in a one-hour exposure.

LB1A and LB2A are available for use with the Mayall RC spectrograph. We are currently equipping the Mayall Multi-Aperture Red Spectrometer (MARS) with LB1B (see article on page 31) to enhance the red spectroscopic efficiency at KPNO. Since Berkeley Labs have begun packaging their CCDs in a four-side abutable packaging, our team is considering building and testing a small mosaic camera initially made up of two 2K×2K devices with the potential of upgrading to four 2K×2K devices. At the prime focus of the KPNO or CTIO 4-m telescopes, such a camera would provide an imaging FOV of nearly 18′ and a more sensitive option for imaging at long wavelengths.

Observers interested in using LB1A or LB2A with the RC spectrograph in shared risk mode during any upcoming runs should contact Richard Green (*green@noao.edu*) or Nigel Sharp (*sharp@noao.edu*).

The LBNL CCDs described here are on loan to KPNO by LBNL. KPNO acknowledges the generosity of the LBNL CCD development team. For more information on these CCDs, please see S. E. Holland et al. (1996); R. J. Stover et al. (1999); Groom (2000); and the LBL Web site at: *http://ccd.lbl.gov*. The CCD development effort at LBNL was supported by the US Department of Energy (Contract No. DE-AC03-76SF00098), and by the National Science Foundation (grant NSF/ATI 9876605), and by the National Aeronautics and Space Administration (grant NRA-99-01-SPA-040).

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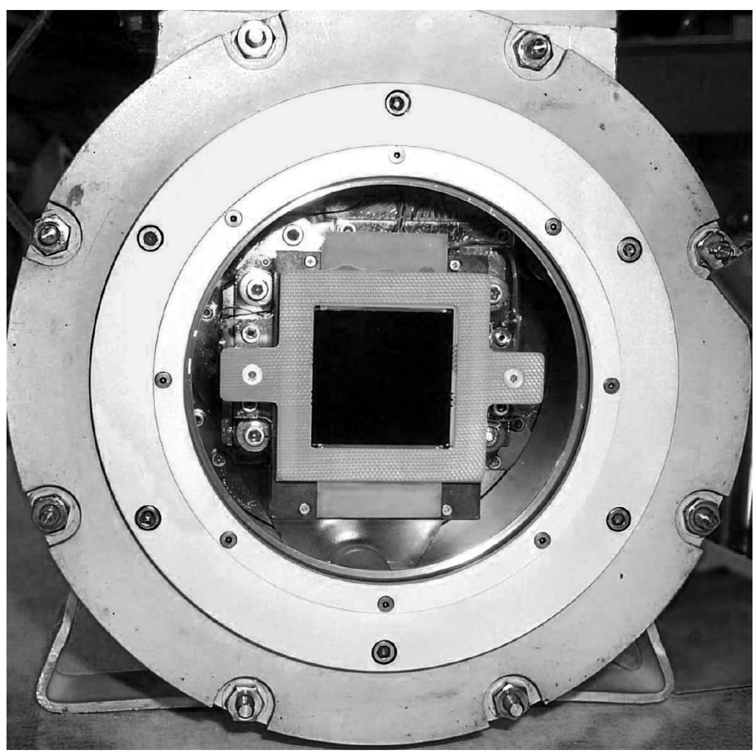


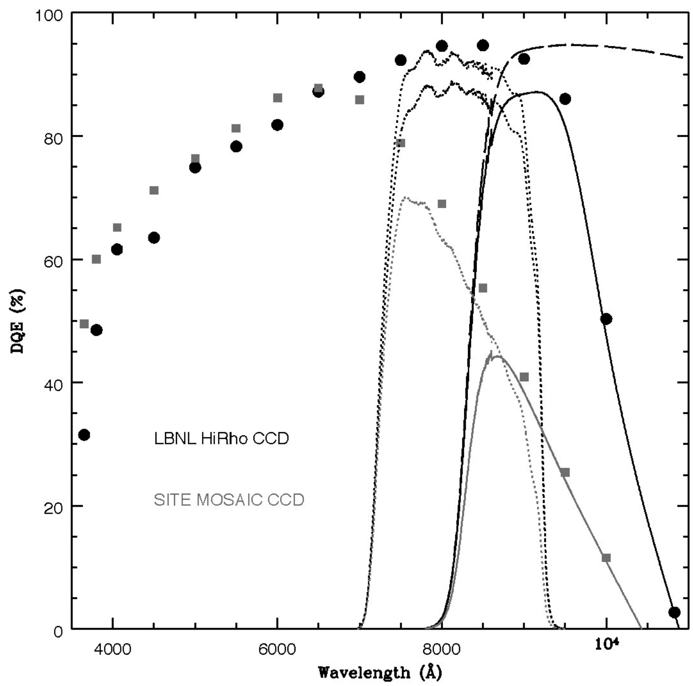
2Kx2K LB2A CCD in its dewar

Seeing Red continued

LBNL CCDs at KPNO

CCD #	Format	Pixel size	Read Noise	Dark Current
LB1A	1980×800	15 µm	6 e-	25e-/hour
LB1B	1980×800	15 µm	12 e-	>300e-/hour*
LB2A	2048×2048	15 µm	8 e-	90e-/hour**

* Due to device defect, erase cycle could not be implemented; dark current remained high even after period of stabilization.
** Due to device defect, erase cycle could not be implemented; measurement taken after device had stabilized.



DQE of LB1A compared with the DQE of one of the Mosaic camera's SITE CCDs. The upper dotted and solid lines show the transmission curves for the I-band and z′-band filters respectively. Other lines show the effective bandpasses and efficiencies of these filters when used with the SITE and LB1A CCD respectively.

Near-Earth Objects in the Near IR

Based on a contribution solicited from Richard Binzel (MIT)

Richard Binzel and Andrew Rivkin (MIT) used the KPNO 4-m RC spectrograph, upgraded with a Lawrence Berkeley National Laboratory (LBNL) CCD, to explore the surface composition of near-Earth objects (NEOs). The enhanced far-red sensitivity of the CCDs is critical for detecting the broad absorption features of the various minerals that may be present in the objects.

The primary goal of the Binzle & Rivkin program is to use the RC spectrograph to reveal the compositional distribution and nature of the population of objects passing near the Earth. More than 1,000 NEOs larger than 1 km are predicted to exist, presenting the Earth with a low (10^{-6}) but nonzero chance of impact per year.

Beyond the practical reasons for wanting to discover and understand this population, these objects provide a scientific opportunity to gain

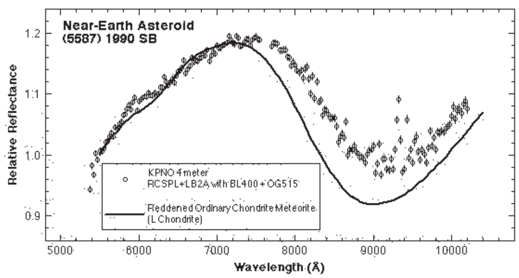
continued

Near-Earth Objects continued

insights into the relationships among asteroids, comets, and meteorites. The NEO population is thought to comprise both escaped asteroids from the main-belt and extinct comet nuclei. Most meteorites are likely samples of asteroids. Expanded search efforts are now providing a sufficient number of NEO targets to allow a detailed spectroscopic reconnaissance of the population. The results are pinpointing the asteroid vs. comet source regions for NEOs and providing long sought correlations between asteroids and meteorites.

The enhanced red sensitivity of the LBNL CCD (LB2A) is particularly well-suited for revealing the compositional properties of NEOs. Mineral constituents within these objects, such as pyroxene and olivine, have broad absorption features centered beyond 9000Å. The sharp fall-off in quantum efficiency for typical CCDs makes high SNR measurements of these features difficult to achieve. Careful definition of the absorption bands is necessary for achieving correlations with meteorites.

An example of the success of LB2A is shown in the spectrum of near-Earth asteroid (5587) 1990 SB obtained at the 4-m in May 2001. The asteroid spectrum is compared with that of ordinary chondrite meteorites. This meteorite class is the most common that falls to Earth, yet reconnaissance of main-belt asteroids has yielded few clues as to their source. However, within the near-Earth population, ordinary chondrite-like objects appear to be relatively common.



LBNL CCD (LB2A) spectrum of near-Earth asteroid (5587) 1990 SB. High SNR measurements beyond 10000Å allow mapping of the width and band center of the pyroxene/olivine absorption feature in the 9000-10000Å region. (Telluric water occurs at 9300Å.) The asteroid spectrum is compared with that of ordinary chondrite meteorites.

Ongoing research is revealing that there may be a size-dependent relationship between the meteorite-matching near-Earth objects and their larger counterparts among the most common main-belt asteroids falling into a category known as S-types. Surface exposure age to the space environment may effectively disguise the common main-belt, S-type asteroids from spectrally matching the most common meteorites. Because of their proximity, the near-Earth objects are the smallest observable bodies in the solar system. Size may be the dependent factor for revealing the true colors and compositions of asteroid surfaces. Small objects have much shorter collisional lifetimes and therefore have the youngest and freshest surfaces. Correlating the spectral properties of "fresh" asteroid surfaces with specific meteorite types remains the missing key necessary to unlock the treasure trove of laboratory data on meteorites and to reveal the processes that occurred on their parent bodies. It appears that this key resides within the NEO population.

The McMath-Pierce Fourier Transform Spectrometer, Iodine Absorption Cells, and Extrasolar Planets

R. Paul Butler (Carnegie Institution of Washington)

The discoveries of the first 60 extrasolar planets have dramatically changed the landscape of astronomy and the mind-set of astronomers. The recently completed Decadal Survey cited the discovery of extrasolar planets as the foremost accomplishment in astrophysics during the last decade, and endorsed NASA and NSF programs to detect and study extrasolar planets, such as the Space Interferometry Mission, the Terrestrial Planet Finder, the Next Generation Space Telescope, and a national 30-m ground-based telescope.

While it is relatively well-known that all of the extrasolar planets have been discovered by precision Doppler spectroscopy, it is less well-known that the Fourier

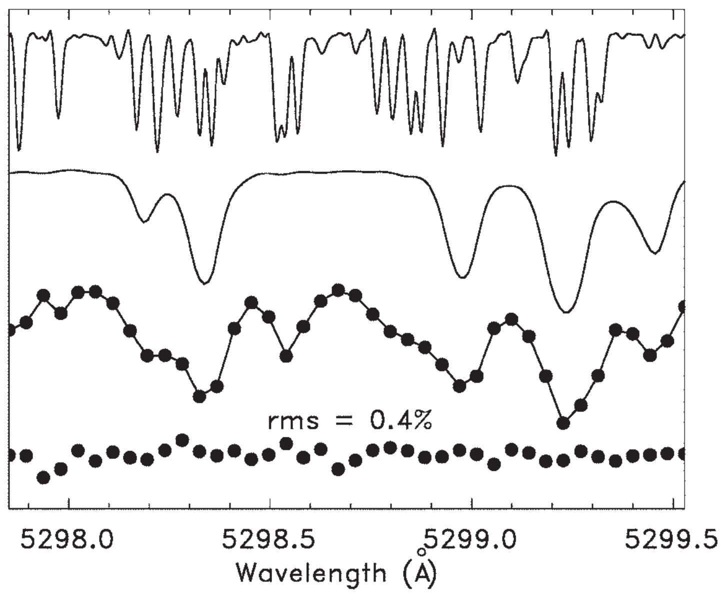
continued

The McMath-Pierce continued

Transform Spectrometer (FTS) at the McMath Solar Telescope has played a crucial role in most of these detections.

Historically, astronomical Doppler precision languished at a level of 500 m/s from the early 1920s to the early 1980s. In contrast, Jupiter gravitationally tugs the Sun with a velocity of 12 m/s. Over the last 20 years, a few groups, led by the pioneering efforts of Bruce Campbell and Gordon Walker, have improved Doppler precision by factors of 30 to 200.

The great innovation of Campbell and Walker was the use of a chemical absorption cell. Starlight is passed through the cell prior to entering the spectrograph.



The Precision Iodine Modeling Process. Top) McMath FTS iodine "template" spectrum. Second) The template stellar spectrum (tau Ceti, G8 V). Third) The binned points are an observation of tau Ceti made through the iodine absorption cell. The solid line is a model of the observation. The model is composed of the template iodine and stellar spectra. The free parameters consist of the spectrograph PSF and the Doppler shift of the template star relative to the template iodine. Bottom) 10 times the difference between the model and the observation. The model and observation differ by 0.4% RMS.

The superimposed spectrum of the absorption cell molecule thus provides a "perfect" wavelength scale against which to measure the stellar Doppler shift of the star. This embedded metric is "perfect" in the sense that it samples the spectrograph in exactly the same way as the starlight. Between 1980 and 1992, Campbell and Walker improved Doppler precision from 500 m/s to 13 m/s using a rather hazardous hydrogen-fluoride absorption cell at the 3.6-m Canadian-French-Hawaiian Telescope. Unfortunately, none of the 20 stars they surveyed turned out to yield a detectable planet.

After several months of research and chemical lab work, Geoff Marcy and I built the original Lick Observatory iodine absorption cell system in the summer of 1987. Over eight years we slowly learned how to use the information-rich iodine spectrum to build a model spectrograph, including the variable point-spread-function (PSF). As our goal was the detection of true Solar System analogs --Jupiter analogs--we needed to achieve a precision of 3 m/s. For typical high-resolution astronomical spectrometers such as the Echelles at Lick and Keck (both of which were built by Steve Vogt), 3 m/s corresponds to about one-thousandth of a pixel, or about 80 silicon atoms on the CCD substrate. Small, unaccounted changes in spectrometer PSF lead to errors of 10 to 100 m/s.

In 1991, we brought our original Lick Observatory iodine absorption cell to the McMath-Pierce FTS. It was only with the resulting "sacred" McMath-Pierce FTS atlas that we were able to proceed with our experiments in PSF modeling, which ultimately led to the discovery of five out of the first six known extrasolar planets at Lick Observatory. The Smithsonian Institution has requested this original Lick Observatory iodine cell upon its retirement.

The iodine absorption cell technique has become the *de facto* standard for precision Doppler studies, having been adopted by teams at the University of Texas, Harvard, and the European Southern Observatory. In addition, we have built iodine systems at the Keck and Anglo-Australian Telescopes, both of which have resulted in extrasolar planet discoveries.

Every active astronomical iodine absorption cell has been calibrated at the McMath-Pierce FTS. It is only with the McMath-Pierce FTS calibration spectrum that it is possible to unlock the information-rich iodine spectrum.

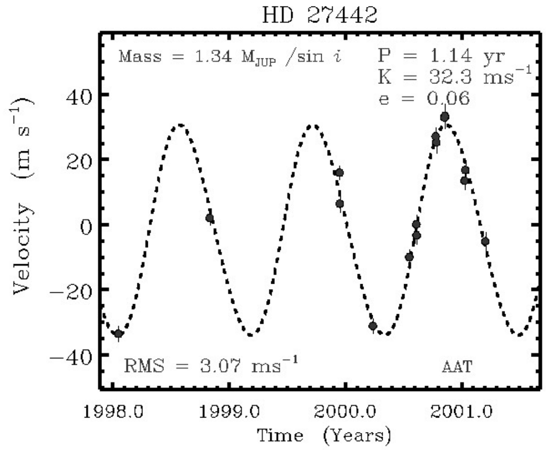
continued

The McMath-Pierce continued

In this sense, about two-thirds of the known extrasolar planets have a direct lineage to the McMath-Pierce FTS.

We are expanding our precision Doppler search to the 6.5-m Magellan telescope in Chile, with the goal of surveying all 2,000 Sun-like stars within 50 parsecs. With a precision of 3 m/s, our surveys are a factor of 3 more precise than those of other groups, and they are the only active surveys with sufficient sensitivity to detect Solar System analogs. Our immediate goal is to improve precision to 2 m/s. We expect these surveys at Keck and Lick in the north and Magellan and Anglo-Australian Telescope in the south to result in the discovery of the majority of the first 200 extrasolar planets and, by the end of the decade, the first discoveries of *bona fide* Solar System analogs. The most immediate pressing question: What fraction of Sun-like stars have Solar System-type planets, with circular orbits and the larger, Jupiter-like planets orbiting beyond 4 AU? Within 20 years, our surveys should allow us to address this question and to place the Solar System in the broader context of planetary systems for the first time.

For more information about the known extrasolar planets, updates on extrasolar planet news, copies of our papers, and related useful links, visit our Web page at: *www.exoplanets.org* .



Discovery data for HD 27442 from the Anglo-Australian Telescope. The RMS to the best-fit Keplerian (solid line) is 3.1 m/s. The period is 419 days and the semi-amplitude is 32 m/s. The minimum mass of the companion is 1.34 Jupiter-masses. The orbit of this planet is similar to the Earth both in semi-major axis, a = 1.2 AU, and eccentricity, e = 0.06. This is the only known planet orbiting beyond 0.15 AU that is in a circular orbit, similar to Solar System planets.

The Sodium Tail of Mercury

Andrew Potter (NSO)

Models of the sodium atmosphere of Mercury predict the possible existence of a comet-like sodium tail (Smyth and Marconi, 1995; Ip, 1986). Detection and mapping of the predicted sodium tail would provide quantitative data on the energy of the processes that produce sodium atoms from the planetary surface. Previous efforts to detect the sodium tail by means of observations obtained during daylight hours have not been successful because scattered sunlight obscured the weak sodium emissions in the tail. At greatest eastern elongations and high declinations, however, Mercury can be seen as an evening star for about half an hour after sunset. At this time, the intensity of scattered sunlight is low enough that sodium emissions as low as 500 Rayleighs can be detected.

The 1.6-m McMath-Pierce Solar Telescope was used to observe Mercury after sunset against a dark sky on 3-4 June 2000 and again on 24-25 May 2001. The stellar spectrograph was used at a resolution of about 150,000 to map Mercury's sodium emission downstream of the planet. At this resolution, sodium emission from terrestrial twilight glow is clearly separated from Mercury sodium emission.

Sodium D_2 emission was detected along the anti-sunward direction from Mercury for a distance of about $4×10^4$ km. The intensity of the

continued

The Sodium Tail

sodium D_2 emission downstream of Mercury for 25 May 2001 is plotted in Figure 1.

The decay of sodium emission with distance results from photoionization of the sodium and lateral spreading of the sodium cloud. The fact that an extended sodium tail can be detected is evidence that sodium is produced with sufficient energy to escape the planet.

Velocities of sodium atoms in the tail were measured from the Doppler shift of the emission lines. Extrapolation of the heliocentric velocities in the tail down to the location of Mercury suggests that sodium escaped Mercury with a residual velocity of about 2 km/sec in the anti-sunward direction.

Observations of the sodium tail on 4 June 2000 yielded the cross-sectional distribution of sodium in the tail. Results are shown in Figure 2, where the sodium emission intensity is plotted normal to the axis of the tail at a downstream heliocentric distance of about 1.75×10^4 km. At this distance, the tail has expanded to a diameter of nearly 4×10^4 km. We estimate that the initial north-south velocity of the sodium must have been 4-5 km/sec to result in the observed spreading of the sodium tail.

The appearance of a sodium tail with velocities in the range 2-5 km/ sec implies a source velocity in the range of 4-7 km/sec, or 2.5-6.0 eV. Particle sputtering is the most likely candidate for production of sodium atoms at these energies. The relatively high sodium velocity at right angles to the Mercury-Sun line suggests that much of the sodium is generated at high latitudes. These results are consistent with the effect of solar wind ions entering the cusp regions of the Mercury magnetosphere when the magnetosphere is opened in response to a southward interplanetary magnetic field (Killen et al. 2001). These ions sputter sodium from the surface at high latitudes.

Figure 1. Emission Intensity in the Mercury Sodium Tail
May 25, 2001

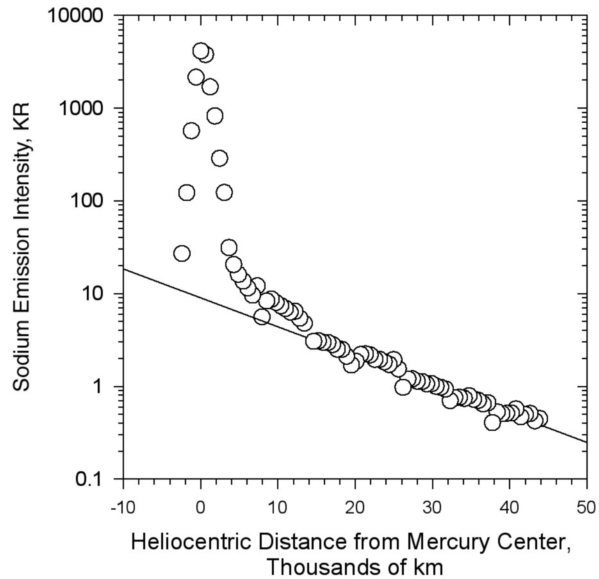
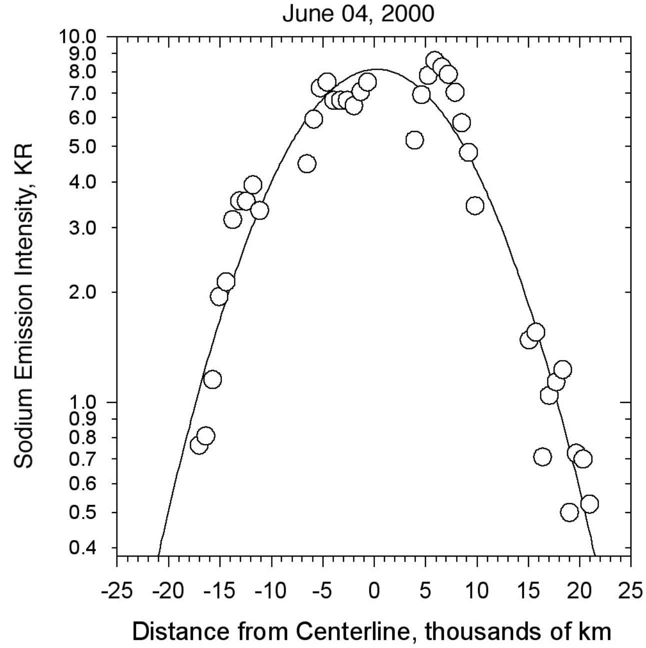


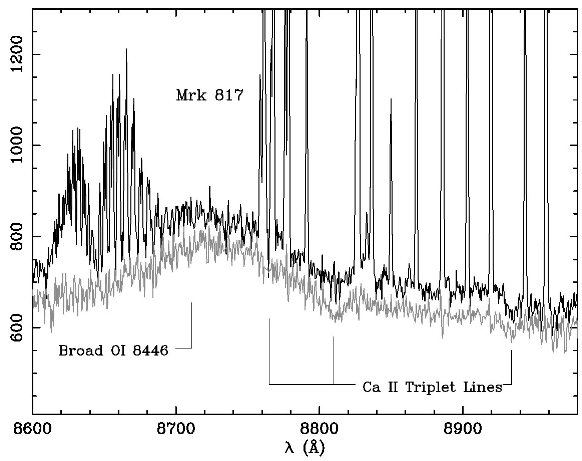
Figure 2. North-South Cross Section of Sodium Tail
17,500 km downstream
June 04, 2000



A Red Look at Reverberating Black Holes

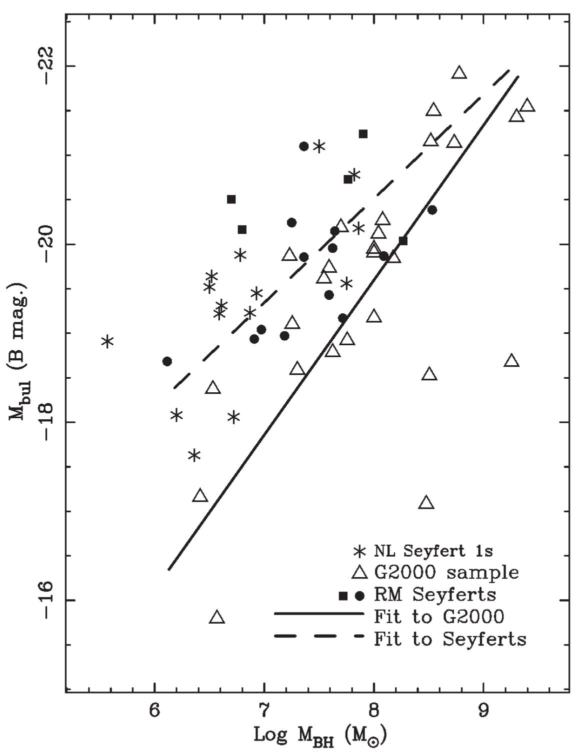
Based on a contribution solicited from Charles Nelson (Drake) and Richard Green (NOAO)

Charles Nelson and a team of collaborators including Gary Bower, Richard Green (NOAO), Karl Gebhardt (Texas), and Donna Weistrop (Las Vegas) used the new LBNL CCD and RC spectrograph combination at the KPNO 4-m to estimate the masses of black holes at the centers of Seyfert galaxies directly from the properties of the galaxies. The masses of the black holes had previously been inferred from the technique of reverberation mapping (see Wandel et al. or Kaspi et al.). Nelson et al. measured the galaxy-bulge velocity dispersions to infer the mass of the black holes through the recently discovered tight relationship between the two properties. The mass estimates inferred from both methods were found to agree extremely well, bolstering the finding of Gebhardt et al. (2000) that black hole masses in AGN were consistent with those found in non-active galaxies.



Spectra of MrK 817 before and after sky subtraction. Note the excellent cancellation of the strong night sky lines.

In the reverberation mapping technique, the time lag of response of emission lines to changes in ionizing continuum level allows an estimate of the distance of the emitting gas from the central source. The velocity widths of the varying component of the emission lines are assumed to result from the motion of the gas in the gravitational potential of the central black hole. If so, the AGN black hole masses thus determined would be expected to follow the same relation to velocity dispersion of the total host galaxy bulge as those objects with quiescent black holes. The latter have masses determined through stellar motions, with the relationship between black hole mass and bulge velocity dispersion discovered by Gebhardt et al. (2000) and Ferrarese & Merritt (2000). Nelson et al.'s goal was therefore to obtain velocity dispersion measurements of AGN host bulges.



Black hole mass vs. bulge absolute magnitude for the reverberation-mapped Seyfert galaxies, normal galaxies from Gebhardt et al. (2000), and Narrow Line Seyfert 1 galaxies from Mathur et al. (2001).

The chosen technique is to observe the Ca II far-red triplet at 8600Å, because of the spectral simplicity of that region, and the relative insensitivity to the details of the spectral type of the stars dominating the integrated light spectrum. The requirement for far-red sensitivity and the necessity for accurate sky emission cancellation provided a perfect test application for the new LBNL CCD. In cases where night-sky emission lines intruded on the absorption-line profiles, Nelson et al. employed the "nod-and-shuffle technique." An example of the clean cancellation is shown in the figure at top right.

Nelson et al. observed 11 Seyfert 1 galaxies plus a number of stellar templates on the nights of 10-14 April 2001.

continued

A Red look continued

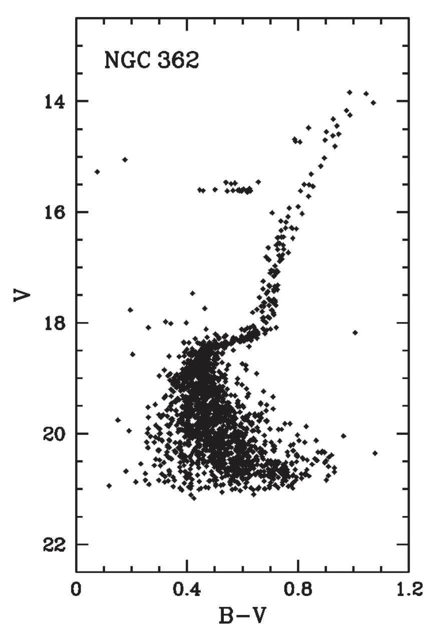
The high DQE of the detector allowed them to choose a higher dispersion grating, the BL 380 giving 0.46Å/pixel, and to use a narrow slit (1”), to achieve a velocity resolution of 40 km/s. By happenstance, Laura Ferrarese and collaborators observed six of the same targets with the RC spectrograph and T2KB while working on an identical program immediately preceding the Nelson run (*ApJL* 555, 79). To get useful S/N with T2KB in the same spectral range, they required a wider slit, set to 2”. Nelson et al. measured velocity dispersions that were systematically 20-30 km/s higher than the Ferrarese results, primarily because they could exclude more of the contribution of dynamically cold disk light with the narrower slit.

The major result was a verification that the black hole masses determined from AGNs fell on the black hole mass-bulge velocity dispersion relation for quiescent black holes. Such a result gives confidence that the velocity width of variable broad emission lines is produced primarily by motion in the gravitational potential of the central source. Another major finding is that the bulge luminosities of the AGN hosts are significantly displaced from the higher-scatter relation between black hole mass and bulge luminosity for quiescent nuclei. Since the black hole masses determined from the reverberation technique and the bulge velocity dispersion relation agree, the best interpretation of this result is that AGN host bulges are systematically and significantly more luminous than host bulges of inactive black holes. The intriguing speculation is that recent activity associated with nearby black holes is accompanied by enhanced star formation, leading to lower mass-to-light ratios.

Quick & Dirty WFPC2 Stellar Photometry

Kenneth J. Mighell (NOAO)

The latest release of the IRAF MXTOOLS package includes the new tasks QDWFPC2, which does quick CCD stellar photometry on two Hubble Space Telescope WFPC2 observations: WFPC2COLOR, which converts HST WFPC2 instrumental magnitudes to standard colors using the Holtzman et al. (1995, *PASP*, 107, 1065) color equations, and QDCMD, which reads the output of WFPC2COLOR and displays a color-magnitude diagram on a user-chosen graphics device.



The figure shows the results of a short QDWFPC2 demonstration that analyzes two HST WFPC2 observations of the Galactic globular cluster NGC362. Once the MXTOOLS package has been installed, the QDWFPC2 demonstration can be seen by typing the command “qdwfpc2” and accepting the two default images. *NOAO Newsletter* No. 65 showed the F555W versus (F439W-F555W) instrumental color-magnitude diagram produced by the QDPHOT demonstration task DEMOQDPHOT. The QDWFPC2 task is actually an IRAF script that first does QDPHOT photometry on the WFPC2 images, then converts the F439W and F555W instrumental magnitudes into standard Johnson B and V magnitudes, and finally displays the results as a color-magnitude diagram. The entire process generally takes just a few seconds (typically <10 seconds on a 200 MHz Sun Ultra1 workstation).

The QDWFPC2 task has been designed for ease of use by undergraduates working with HST archival WFPC2 images of stellar population in the Local Group. Anyone interested in using QDWFPC2 to analyze WFPC2 observations of Galactic star clusters in a laboratory setting as part of a senior-level astrophysics course on stellar evolution is encouraged to contact me at: *kmighell@noao.edu* for further discussion.

This research is supported by a grant from the National Aeronautics and Space Administration (NASA), Order No. S-67046-F, which was awarded by the Long-Term Space Astrophysics Program (NRA 95-OSS-16).

Director's Office

Implementing The Decadal Survey: NOAO's Role

Jeremy Mould

Astronomy & Astrophysics in the New Millennium describes the Giant Segmented Mirror Telescope (GSMT) as a powerful complement to NASA's Next Generation Space Telescope (NGST) in tracing the evolution of galaxies, and the formation of stars and planets: "GSMT will use adaptive optics to achieve diffraction-limited resolution in the atmospheric windows between 1 to 25 microns and unprecedented light gathering power between 0.3 to 1 microns. The committee recommends that the technology development for GSMT begin immediately and that construction start within the decade. Half the total cost should come from private and/or international partners. Open access to GSMT by the U.S. astronomical community should be directly proportional to the investment by the NSF." The Decadal Survey goes on to say that "community participation in major national telescope initiatives must be led by an effective national astronomy organization working in concert with universities and similar institutions."

NOAO is moving to take up this role with all available speed. You can read about development of the science case and design studies at: *www.aura-nio.noao.edu.* Our goals are to have a concept study completed this year, partners identified next year, and a Gemini-quality proposal ready for NSF by the end of 2005. Achieving these goals requires resources, and NOAO has planned an allocation sufficient to succeed: 14% of the Observatory-wide effort in 2005.

The ultimate goal is to exploit the synergies between NGST and GSMT by bringing GSMT online very soon after NGST launches. The essence of this complementarity is the adaptive optics angular resolution of GSMT (10 milli-arcsec at 1.5€microns) and its multitude of photons for near-infrared spectroscopy. We've also realized that we should be planning to combine the science of a triad of new facilities. To that end, NOAO and NRAO held a joint workshop in Washington in early July on scientific synergies between the Atacama Large Millimeter Array (ALMA) and GSMT.

NOAO's next highest priority in implementing the Decadal Survey is the Large-aperture Synoptic Survey Telescope (LSST) (see article on page 16) which has a natural linkage with the National Virtual Observatory (NVO). NOAO plans to commence LSST telescope design studies in collaboration with Steward Observatory and others at the end of this month.

You can download a more detailed description of NOAO's plans for these and other projects from our Web site at: *www.noao.edu/future*. NOAO welcomes your comments on our role in implementing the Decadal Survey.

For guidance on implementing the Decadal Survey, NOAO brought members of the Survey Committee and its panels, and Observatory Council members, to Tucson in May to form the Balancing Review Panel. The committee was asked to recommend the optimum level of investment in Decadal Survey projects.

We are grateful to Bob Kirshner, Bob Gehrz, Chris Stubbs, Marcia Rieke, Roger Chevalier, and Bob Joseph.

Farewell to Caty

David De Young

Caty Pilachowski will leave NOAO this fall for Indiana University, where she has accepted an appointment to the Kirkwood Chair in Astronomy. Her presence here will be missed, although we look forward to continuing our close interaction with her as a WIYN partner. During the course of her 22-year tenure at NOAO, Caty has compiled an extraordinary record of service to the Observatory and the astronomical community, while at the same time establishing an international reputation as a leading authority in the field of stellar abundances.

Caty's activities at NOAO could serve as a template for an "ideal" scientific staff member at a national observatory, because they encompass broad areas of accomplishment in research, innovation, and service. A complete list of her achievements would consume many pages, but a few examples come easily to mind. Her knowledge of the relations among abundances in stellar atmospheres and the astrophysical implications of these relations is encyclopedic, and her

ability to communicate that knowledge with clarity and precision is a rare talent. Her vision, insight, and innovation were pivotal in bringing the WIYN telescope into being.

Caty's many activities in the area of general support for NOAO operations are also legendary, ranging from offering personal assistance to new observers to serving as Acting Director of KPNO and Deputy Director of USGP. Her contributions to the community are equally impressive, among them serving as Chair of the AAS Publications Board, being named a Shapley Lecturer, a Council member, and now the President-Elect of the AAS.

In addition to all of this, there are two even more noteworthy contributions that Caty has made to NOAO and all of us. The first is a deep and lasting commitment to the well-being and future growth of the Observatory. The second is the quality of warmth and human concern that graces her interactions with one and all.

We will miss you, Caty, and we wish you well.

Growing Expertise, Expanding Contacts for NIO

Steve Strom

The NOAO-Gemini New Initiatives Office is continuing to build its internal technical expertise, while conducting some significant information exchanges with US and international groups.

Larry Stepp, Program Manager for the Giant Segmented Mirror Telescope (GSMT), has recruited a full-time staff of six engineers, while drawing on significant contributions from other NOAO and Gemini staff (at a level of four FTEs). The NIO team is focused on analysis of a GSMT conceptual "point design" that emerged from initial community workshops on the potential science drivers for a 30-meter telescope. The goal of this analysis is explicit identification of the key technical challenges that must be overcome to build GSMT.

Joan Najita is leading studies of the scientific drivers for GSMT performance. Joan is also planning a broad community workshop for the second or third quarter of 2002 to examine the nominal performance of the point design in the context of community aspirations for all of the large ground- and space-based astronomical facilities of the coming era.

continued

Implementing continued

In parallel, flowing from the initial science drivers, the NIO studies are looking at both the instrumentation and adaptive requirements, as well as the expected performance of these challenging systems as integral parts of the point design studies.

Sam Barden is leading an NIO effort to develop concepts for five GSMT instruments: a prime focus wide-field multi-object multi-fiber optical spectrograph; a near-IR multi-object spectrograph fed by a multi-conjugate adaptive optics (AO) system; a near-IR imager fed by the multi-conjugate AO system; a mid-IR high-resolution spectrograph fed by an AO system; and a wide-field deployable integral-field-unit spectrograph.

Beyond a better technical understanding of the issues involved in designing an instrument of the scale needed for GSMT, this effort will help us to understand how the instrument and telescope must work as an integrated system. In May, Sam met with his counterpart on the California Extremely Large Telescope project (CELT), Keith Taylor, to exchange information and ideas.

Francois Rigaut and Brent Ellerbroek are leading the AO work, looking at possible implementation concepts in combination with advanced simulation techniques. Before the end of 2001, NIO will release an extensive report summarizing its analysis of the point design, instrument concepts, and science cases.

NIO sponsored a small workshop in July in Washington, DC, to generate a better understanding of the potential synergies between the Atacama Large Millimeter Array (ALMA) and GSMT. The ten attendees from both the radio and optical astronomy communities developed an overview of these synergies for a representative sample of problems, along with a series of recommended "next steps" towards quantifying the science cases that require both ALMA and GSMT for major advances.

Attaining a deeper understanding of how these frontier facilities will function as a "system" is important at this early design stage to help guide both the performance requirements for GSMT and its instruments, and the site choice for the telescope. A key conclusion of the workshop was to extend the ALMA/GSMT studies to include potential synergies with the Square Kilometer Array (SKA) and the Next Generation Space Telescope (NGST).

For the past two years, CTIO has been assessing candidate sites in northern Chile. The NIO has incorporated these pioneering efforts and has expanded their charge to include developing criteria for evaluating site quality, as well as defining the computer modeling and in situ measurement methods that will be used to focus the site choice for GSMT.

Progress on all these fronts was reported to the NIO Advisory Committee, which provided helpful commentary on the direction of NIO scientific and technical activities, and its continuing efforts to establish partnerships – national and international – to design and build GSMT.

In May and June, the NIO site team visited Mexico City and met with representatives from the Mexican astronomical community. The goal of these meetings was to establish a collaborative evaluation of sites in Mexico that will enable objective comparison of site performance in Chile, Mexico, and Hawaii.

NIO representatives also visited the Dominion Astrophysical Observatory (DAO) in Victoria, Canada, to share information on the status of the NIO point design effort and hear about the variety of efforts and partnerships underway in Canada to develop a very large optical telescope.

These meetings underline the NIO's commitment to open communication in service of accelerating the formation of the partnerships that will almost certainly be necessary to achieve broad US community access to a 30-meter class telescope during the NGST/ALMA era.

NOAO Support for SIRTF Runs the Gamut

Steve Strom and Doug Isbell

NOAO resources and scientific staff are making fundamental contributions to NASA's upcoming Space InfraRed Telescope Facility (SIRTF) mission. This long-awaited spacecraft, managed by the Jet Propulsion Laboratory, is likely to be viewed by the public as the "infrared cousin" of the Hubble Space Telescope. SIRTF's launch is scheduled for July 2002, but NOAO's role is already well underway, via the SIRTF Legacy Science Program.

The Legacy Program was created to support large, coherent science investigations not readily reproduced by a reasonable number of General Observer programs. The data to be acquired are expected to have general and lasting importance to the broad astronomical community, and will enter the public domain immediately, enabling wide use in defining follow-up observations and in archival research.

In recognition of the potential importance of ground-based optical/infrared (O/IR) data to the Legacy Program's goals, NOAO and the SIRTF Science Center negotiated an arrangement whereby NOAO ground-based telescope resources could be used to carry out essential components of SIRTF Legacy proposals.

The intent was to enable all scientists – whether they have assured access to O/IR telescopes or not – to make competitive proposals for SIRTF Legacy science projects. In this way, the SIRTF Legacy Time Allocation Committee (TAC) could judge entire programs at once, knowing that the acceptance of a program entails all of the telescope time necessary to execute the proposed investigations. This extends the philosophy of allowing investigators to apply to carry out complete, coherent scientific programs with a single review to the realm of ground/space collaborations, and helps avoid the frustrations and delays of "double jeopardy," in which two coherent proposals must be submitted to separate review panels.

NOAO offered up to 10 percent of its telescope resources (except the US fraction of the Gemini telescopes) to support SIRTF Legacy investigations for approximately two years, starting with the Spring 2001 semester. Recommendations regarding time allocation on SIRTF and NOAO were made via a single TAC, which had access to technical advice on the NOAO component of the appropriate proposals through NOAO technical reviews of the relevant proposal sections.

Fifteen of the 28 Legacy proposals requested significant time on NOAO facilities. Four of the six proposals that were ultimately selected use NOAO facilities, amounting to 155 nights of time at KPNO and CTIO. "This collaboration is a really innovative way to combine the strengths of NASA and NSF astronomy," says Michael Bicay, Legacy Science Program Manager at Cal Tech's Infrared Processing and Analysis Center (IPAC) in Pasadena, California.

For example, NOAO observations for the SIRTF Nearby Galaxies Survey (SINGS) will include BVRI and H-alpha imaging for the entire sample of 75 galaxies, along with JHK imaging and long-slit spectrophotometric scans (3600 - 7000Å) for the southern galaxies. When these data are combined with SIRTF infrared imaging and spectra, they will provide a multi-wavelength library of nearby galaxies, covering the entire range from 0.4 to 160 microns, and spanning the full range of galaxy types, luminosities, and O/IR properties found in the local universe. This database will be an important research resource in its own right, and a unique tool for modeling the distant universe, ultraluminous starburst galaxies, and other types of infrared-emitting galaxies.

"The NOAO observations play an especially important role in this project, because the wide-field imagers available in both hemispheres are ideally matched to the objects in SINGS," explains team leader Rob Kennicutt of the University of Arizona.

Joan Najita and Steve Strom of the NOAO scientific staff are members of the Legacy science team called "The Formation and Evolution of Planetary Systems." This program proposes to trace the evolution of planetary systems at all ages, ranging from three million to ten million years, when accretion from circumstellar disks terminates, to 100 million to one billion years, when the final architecture of solar systems takes form. It will also look at mature systems with ages comparable to the Sun in which planet-driven activity of planetesimals continues to generate detectable dust, over a total sample of 300 solar-like stars.

continued

Support for SIRTF continued

"The size of our target list will enable us to characterize the diversity of planetary system architectures, providing a deeper appreciation of the range of possible outcomes of the planet formation process, and placing our own solar system in context," says team leader Michael Meyer of the University of Arizona. This team intends to achieve calibrations with two to three times the precision of standard SIRTF data products.

In addition, NOAO staff member Buell Jannuzi is responsible for providing ground-based R-band optical imaging to the community in support of SIRTF's "First Look Survey," the first science program that SIRTF will execute following its orbital checkout. Jannuzi and Arjun Dey are also collaborating with three SIRTF instrument teams on observations of nine square degrees of the sky being covered by the NOAO Deep Wide-Field Survey (see: *www.noao.edu/noao/noaodeep/*).

Last but not least (!), NOAO Director Jeremy Mould is a member of the science team for the Multi-band Imaging Photometer Instrument.

NOAO and the Great Observatories

Caty Pilachowski

Collaboration between NOAO and NASA's Great Observatories includes not just SIRTF, but Chandra and HST as well. Investigators applying for time in Chandra's Cycle 3 were allowed to include requests for NOAO time in their proposals, and two programs have been approved. NOAO allocations for approved Chandra programs will be scheduled in the 2002A through 2002B semesters.

Investigators applying for HST Cycle 11 observations may also include requests for NOAO time in their proposals to STScI, due September 7. These requests will be reviewed by the HST panels, and allocations for approved Cycle 11 programs will be scheduled in the 2002B-2003A semesters.

For more information about these programs, see the NOAO Web site at: *www.noao.edu/gateway/nasa/*.

October Workshop on "Next Generation Wide-Field Multi-Object Spectroscopy"

Arjun Dey and Jeremy Mould

The pace and breadth of new discoveries in astronomy are strongly limited not only by flux and resolution, but also by sample size. In particular, many astronomical fields would benefit greatly from the ability to spectroscopically study large samples more efficiently.

Recent large-scale spectroscopic surveys have begun placing unique constraints on cosmology, large-scale structure, galaxy evolution, and galactic structure. If the capability for highly multiplexed spectroscopy were available, existing questions could get more robust, perhaps even unambiguous, answers. New avenues of investigation would open, and some programs could be accelerated from timescales of decades or years to just months.

Given the strong interest in highly multiplexed spectroscopic capabilities expressed at the recent Scottsdale workshop on the "O/IR Ground-Based System," and the possibility of university-scale investments in this area, NOAO is holding a community-wide workshop in Tucson on 11-12 October 2001. The workshop will investigate the scientific promise and technical challenges of next generation wide-field multi-

continued

October Workshop continued

object spectroscopy, with the goals of determining what scale of facility is demanded by the science (i.e., what field of view, what multiplexing capability, and on what aperture), and identifying a path toward realizing such a capability. Invited speakers include Roger Angel, Scott Anderson, Sam Barden, Brian Boyle, Alan Dressler, Richard Ellis, Marc Davis, Karl Glazebrook, Olivier LeFevre, Heather Morrison, Jim Oschmann, Craig Smith, Michael Strauss, Alex Szalay, Keith Taylor, Alan Uomoto, and Rosie Wyse.

For more information on the workshop, see: *www.noao.edu/meetings/wfmos/*. Attendance is limited by the size of the conference room, but a few spaces remain. If you are interested in participating, please contact Arjun Dey at: *dey@noao.edu* as soon as possible.

LSST Science Drivers and Conceptual Design Moving Ahead

Sidney Wolff

One of the major initiatives recommended by the Decadal Survey was the construction of the Large-aperture Synoptic Survey Telescope (LSST). This facility would be capable of surveying the entire visible sky every week to much fainter limiting magnitudes than any existing large area surveys. The resulting database and data-mining tools would form a cornerstone of the National Virtual Observatory (NVO) and become the largest nonproprietary data set in the world.

The Decadal Survey highlighted several science problems that could be addressed only through construction of a digital movie of the sky, thereby opening up the time domain in a way that would enable a new window on the Universe. For example, the LSST could find 90 percent of all near-Earth objects down to diameters of 300 meters and pinpoint their orbits, providing a dependable assessment of their threat to Earth.

At a recent workshop in Aspen, Colorado, several other science areas that could be addressed by the LSST were identified, including: the determination of the power spectrum of clustering on scales of 100 Mpc to Gpcs; mass tomography at $z < 1$ through weak-lensing shear; identification of halo stars, including RR Lyrae variables, to distances of 200 kpc in order to study the assembly of our own Galaxy; and the measurement of proper motions and parallaxes for every nearby star out to 100 pc, yielding an unbiased luminosity function.

The Decadal Survey recommended that the LSST be a large-aperture (~6.5-meter) telescope. Roger Angel and his collaborators at the Steward Observatory have established the basic characteristics of the design (see: *www.lssto.org*). Building such an ambitious facility presents a number of technical challenges in optics fabrication, detectors, and data management. NOAO's long-range strategy includes developing the plans and resources necessary to prepare a costed proposal with solutions to the major technical challenges by 2004.

Over the next six months, we expect to define the science requirements further by focusing on three research areas with differing needs: solar system problems, the study of variable objects, and deep imaging. The performance requirements that emerge will guide the engineering design. We will also prioritize the technical work in order to address the highest risk elements first and match the work to the capabilities of the various participating institutions to optimize our limited resources.

Work on the LSST will necessarily be a collective, national effort, since the skills required are so broad, and none of the interested institutions has external funding for the conceptual design phase. We expect to set up the project as a nonprofit corporation with its own governing board, following the models for WIYN and SOAR. The initial members of the corporation will be the parent institutions of NOAO and Steward Observatory.

If you or your organization wish to contribute to the LSST conceptual design or the effort to determine its science requirements, contact Sidney Wolff at: *swolff@noao.edu*.

Observational Programs

NOAO Nighttime Proposals Due for 2002A

Todd Boroson

Proposals for observing time for Semester 2002A (February-July 2002) with the Gemini North and South telescopes, the Cerro Tololo Inter-American Observatory, the Kitt Peak National Observatory, and for community access time at the Hobby-Eberly Telescope and MMT Observatory 6.5-meter telescope are due by Sunday evening, 30 September 2001, midnight MST. Proposal materials and information are available on our Web page at: *www.noao.edu/noaoprop/*. There are three options for submission:

Web submissions. The Web form may be used to complete and submit all proposals. The information provided on the Web form is formatted and submitted as a LaTeX file, including figures that are "attached" to the Web proposal as Encapsulated PostScript files.

E-mail submissions. If you prefer to prepare your proposal locally as a LaTeX file and then submit it by e-mail, that option remains available. Investigators using the Web form are requested to fill out certain information on the general information, investigator information, and run information pages (requirements vary with each facility, so read the instructions carefully). After these pages have been completed, a "customized" LaTeX file can be downloaded or returned to you by e-mail for completion and submission by e-mail. Please follow the instructions in the LaTeX template for submitting proposals and figures.

Gemini's Phase-I Tool (PIT). Investigators proposing for Gemini time only may optionally use Gemini's tool, which runs on Solaris, RedHat Linux, and Windows platforms, and can be downloaded from: *www.us-gemini.noao.edu/sciops/P1help/p1Index.html*.

Note that proposals for Gemini time may also be submitted using the standard NOAO form, and that proposals that request time on Gemini plus other telescopes must use the standard NOAO form. PIT-submitted proposals will be converted to LaTeX at NOAO. To ensure a smooth translation, please see the guidelines at: *www.noao.edu/noaoprop/help/web.html*.

The addresses below are available to help with proposal preparation and submission:

Web proposal materials and information	*http://www.noao.edu/noaoprop/*
Request help for proposal preparation	*noaoprop-help@noao.edu*
Address for thesis and visitor instrument letters, as well as consent letters, for use of PI instruments on the MMT	*noaoprop-letter@noao.edu*
Address for submitting LaTeX proposals by e-mail	*noaoprop-submit@noao.edu*
Gemini-related questions about operations or instruments	*usgemini@noao.edu* *http://www.noao.edu/gateway/gemini/support.html*
CTIO-specific questions related to an observing run	*ctio@noao.edu*
KPNO-specific questions related to an observing run	*kpno@noao.edu*
HET-specific questions related to an observing run	*het@noao.edu*
MMT-specific questions related to an observing run	*mmt@noao.edu*

Proposal Form Changes for 2002A

Dave Bell

The following changes have been made to the NOAO observing proposal form for the upcoming semester:

- Information about how the proposed observations complement data from other facilities should now be entered in a new, specific "essay" section. A number of committees, including the TAC, would like to better understand the relationships between the use of NOAO facilities and others, both on the ground and in space. This change is designed to provide the basis for gathering such information.
- The "Why CTIO?" question has been removed.
- New fields request the RA and Dec ranges of principal targets for each instrument run.
- Proposers may now optionally flag their proposal as a resubmission.
- Additional information is now required for multi-partner Gemini proposals (e.g., proposals submitted through both the UK and US TACs should now enter the specific time-request breakdown).

Guidelines for answering these questions can be found on the NOAO Web Proposal Form help pages. Additional help requests can be sent by e-mail to: *noaoprop-help@noao.edu*.

Community Access Time on the MMT and HET

Dave Bell

About 27 classically scheduled nights per year of observing time on the MMT Observatory 6.5-meter telescope are available to the astronomical community through the NOAO proposal process, under a six-year agreement with the National Science Foundation. About 12 nights are expected to be available during the 2002A (February-July 2002) observing semester. For more information, check NOAO's MMT Web page at: *www.noao.edu/gateway/mmt/* and MMT's public-access instrumentation page at: *http://sculptor.as.arizona.edu/foltz/www/public_access.html*.

About 16 equivalent clear nights of community-access queue observations per year will be available on the Hobby-Eberly Telescope at McDonald Observatory once the telescope is in full operation. During 2002A, about four nights are expected to be available for new programs. Instruments will include the Marcario Low Resolution Spectrometer (LRS) with multi-object capability, and the fiber-fed High Resolution Spectrometer (HRS). For more information, please see NOAO's HET Web page at: *www.noao.edu/gateway/het/*.

Proposals for community-access time on both telescopes should be made through the NOAO proposal form at: *www.noao.edu/noaoprop/*, with proposals for 2002A due by 30 September 2001.

MMT Instruments Available

Spectroscopy		Detector	Spectral Range	Scale (″/pixel)	Field
Spectrograph	*Blue Channel*	*Loral 3072 x 1024 CCD*	*0.32-0.8μm*	*0.3*	*150″*
	Red Channel	*Loral 1200 x 800 CCD*	*0.5-1.0μm*	*0.3*	*150″*
MIRAC3		*128 x 128 Si:As BIB array*	*2-25μm*	*0.14, 0.28*	*18.2, 36″*
MiniCam		*2 – EEV 2048 x 4608 CCDs*	*UBVRI*	*0.05*	*3.7′*
FSPEC (Near-IR Spectrometer)		*HgCdTe array*	*JHK*	*1.2*	*Resolving Power ≤ 3500*

Observing Request Statistics for 2001B

GEMINI Observing Request Statistics

	GEM-SQ	GEM-NQ	GEM-N
No. of Requests	31	43	17
No. of Nights Requested	32.6	66.5	27.5
No. of Nights Allocated	12.7	19.2	24
Nights Previously Allocated	0	0	0
No. of Nights Available	12.7	19.2	24
Oversubscription	2.6	3.5	1.1
Average Request	1.05	1.55	1.62

The number of nights allocated for queue programs includes Bands 1-3.

KPNO Observing Request Statistics

	4M	WIYN	2.1M	0.9M
No. of Requests	95	44	60	-
No. of Nights Requested	317.6	111.6	307.2	27
No. of Nights Scheduled	124	60	125	18
Nights Previously Allocated	28	7.5	53	7
No. of Nights Scheduled for New Programs	96	52.5	72	11
Oversubscription for New Programs	3.3	2.1	4.3	2.5
Average Request	3.34	2.53	5.12	-

CTIO Observing Request Statistics

	4M	1.5M	YALO	0.9M
No. of Requests	143	37	10	25
No. of Nights Requested	476.7	202	32.6	165
No. of Nights Scheduled	161	142	-	174
Nights Previously Allocated	20	22	-	36
No. of Nights Scheduled for New Programs	141	120	-	138
Oversubscription for New Programs	3.4	1.7	-	1.2
Average Request	3.33	5.46	3.26	6.60

MMT/HET Observing Request Statistics

	MMT	HET
No. of Requests	9	5
No. of Nights Requested	16	10
No. of Nights Allocated	7	3.5
Oversubscription	2.3	2.9

Instruments Available in 2002A

The tables on the following pages summarize instruments expected to be available during the 2002A semester at the Gemini North and South telescopes, the Cerro Tololo Inter-American Observatory, the Kitt Peak National Observatory, the Hobby-Eberly Telescope, and the MMT Observatory 6.5-meter telescope (see previous page). For further information about the availability and capabilities of these instruments, and links to online instrument manuals, check the NOAO Facilities Web page at: *www.noao.edu/gateway/facilities.html*.

HET Instruments Available

	Detector	Resolution	Slit	Multi-object
Marcario Low-Res Spect.	*Ford 3072x1024 CCD, 4100-10,000Å or 4300-7400Å*	*600* *1300*	*1.0″-10″x4′* *1.0″-10″x4′*	*13 slitlets, 15″ x 1.3″ in 4′ x 3′ field*
High Resolution Spectrograph	*(2) 2Kx4K CCD's, 4200-11,000Å*	*30,000-120,000*	*2″or 3″ fiber*	*single*

Gemini Instruments Possibly Available

GEMINI NORTH	Detector	Spectral Range	Scale (″/pixel)	Field
NIRI (queue & classical)	*1024x1024 Aladdin Array*	*1-5μm*	*0.022, 0.050, 0.116*	*22.5″, 51″, 119″*
GMOS (queue only, after 11/1)	*3 - 2048 x 4068 CCDs*	*0.36-1.1μm*	*0.072*	*5.5′ multislit & imaging*
Hokupa'a AO Camera (classical only)	*QUIRC 1024x1024 HgCdTe*	*1-2.5μm*	*0.020*	*20″*
CIRRASS (classical only)	*1024x1024 or 2048x2048*	*0.9-1.5μm*	*0.12, 0.25, 0.36″*	*4.4″x1.7″, 9.2″x3.5″, 13″x5″* *R ~ 3200 spectroscopy*

GEMINI SOUTH	Detector	Spectral Range	Scale (″/pixel)	Field
FLAMINGOS I (classical only, until 11/30)	*HgCdTe 2048 x 2048*	*0.9-2.5μm*	*0.075″*	*2.5′ x 2.5′ (imager)*
Acquisition Camera (Queue, TOO)	*1K x 1K frame-transfer CCD*	*UBVRI*	*0.12″*	*2′ x 2′*
Phoenix (classical only)	*512 x 1024 InSb*	*1-5μm*	*0.12, 0.25, 0.36″*	*R = 70,000*
T-RECS (queue only, after 5/1)	320 x 420 SI: As BIB	8 -25μm	0.09″	28″x21″; R~ 80-100 @ 10 or 20μm R~ 1000 @ 10μm

*Highest resolution mode of HRS may not be scheduled. See accompanying article.

CTIO Instruments Available

Spectroscopy		Detector	Resolution	Slit
4-m	*Hydra + Fiber Spectrograph*	*SITe 2K CCD, 3300-11,000Å or Loral 3K CCD, 3300-11,000Å*	*300-2000*	*Fiber 120+fibers, 2 arcsec aperture*
	R-C CCD Spectrograph	*Loral 3K CCD, 3100-11,000Å*	*300-5000*	*5.5′*
	Echelle Spectrograph + Blue Air Schmidt	*Loral 3K CCD, 3100-11,000Å*	*15,000*	*5.2′*
	Echelle Spectrograph + Long Cameras	*SITe 2K CCD, 3100-11,000Å*	*98,000*	*5.2′*
	OSIRIS IR Imager/Spectrometer	*HgCdTe (1024^2, 1.0-2.4μm)*	*1200 or 2900*	*1.2′*
1.5-m	*Cass Spectrograph*	*Loral 1200x800 CCD, 3100-11,000Å*	*<1300*	*7.7′*

Imaging		Detector	Scale (″/pixel)	Field
4-m	*Mosaic II Imager*	*8Kx8K CCD Mosaic*	*0.27*	*36′*
	OSIRIS IR Imager/Spectrometer	*HgCdTe (1024^2, 1.0-2.4μm)*	*0.15 or 0.4*	*1.2′ or 3′*
1.5-m	*Cass Direct Imaging*	*SITe 1K/2K CCD*	*0.44/0.24*	*14.8′/8.2′*
0.9-m	*Cass Direct Imaging*	*SITe 2K CCD*	*0.40*	*13.6′*
YALO	*ANDICAM Optical/IR Camera*	*Loral 2K CCD*	*0.3*	*10′*
		HgCdTe 1K IR	*0.2*	*3.3′*

KPNO Instruments Available

Spectroscopy		Detector	Resolution	Slit	Multi-object
Mayall 4-m	*R-C CCD Spectrograph*	*T2KB/LB1A CCD*	*300-5000*	*5.4'*	*single/multi*
	Cryogenic Camera Spectrograh[3]	*LB CCD*	*300-1500*	*5.4'*	*single/multi*
	Echelle Spectrograph	*T2KB CCD*	*18000-65000*	*2.0'*	
	FLAMINGOS[1]	*HgCdTe (2048x2048, 0.9-2.5µm)*	*1000-3000*	*10'*	*single/multi*
WIYN 3.5-m	*Hydra + Bench Spectrograph*	*T2KC CCD*	*700-22000*	*NA*	*~100 fibers*
	DensePak (1)	*T2KC CCD*	*700-22000*	*IFU*	*~90 fibers*
2.1-m	*GoldCam CCD Spectrograph*	*F3KA CCD*	*300-4500*	*5.2'*	
	FLAMINGOS (3)	*HgCdTe (2048x2048, 0.9-2.5µm)*	*1000-3000*	*20'*	*single/multi*

Imaging		Detector	Spectral Range	Scale (″pixel)	Field
Mayall 4-m	*CCD Mosaic*	*8Kx8K*	*3500-9700Å*	*0.26*	*35.4'*
	SQIID	*InSb (4 512x512, 0.9-3.3µm)*	*JHK + L (NB)*	*0.39*	*3.3' circular*
	FLAMINGOS (3)	*HgCdTe (2048x2048, 0.9-2.5µm)*	*JHK*	*0.3*	*10'*
WIYN 3.5-m	*Mini-Mosaic*	*4Kx4K CCD*	*3300-9700Å*	*0.14*	*9.3'*
2.1-m	*CCD Imager*	*T2KA CCD*	*3300-9700Å*	*0.305*	*10.4'*
	SQIID	*InSb (4 512x512, 0.9-3.3µm)*	*JHK +L(NB)*	*0.68*	*5.8' circular*
	FLAMINGOS (3)	*HgCdTe (2048x2048, 0.9-2.5µm)*	*JHK*	*0.6*	*20'*
WIYN 0.9-m	*CCD Mosaic (4)*	*8Kx8K*	*3500-9700 Å*	*0.43*	*59'*

(1) Available February-May only
(2) Integrated Field Unit: 30” x 4” field, 4” fiber spacing.
(3) Shared risk.

C T I O
OPERATIONS

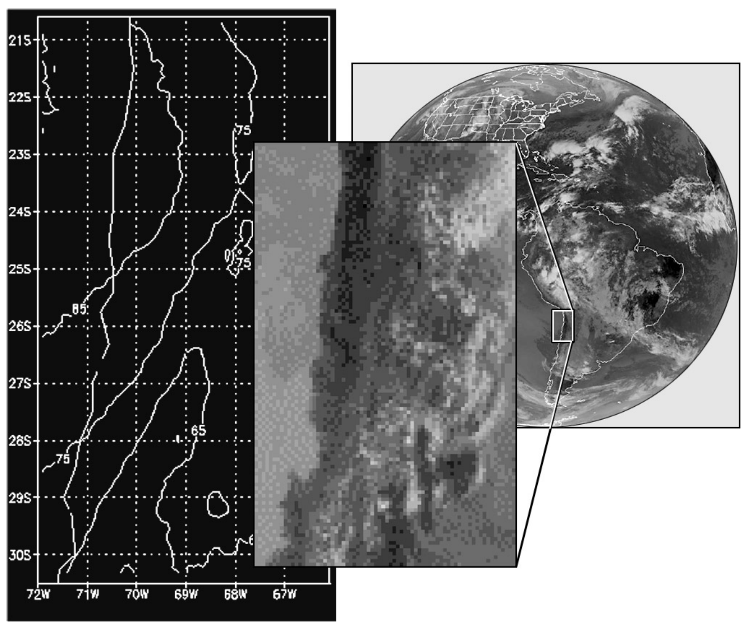
A Satellite Survey of Cloud Cover and Water Vapor in Northern Chile

Alistair Walker and André Erasmus

CTIO and the University of Tokyo commissioned Dr. D. André Erasmus, a consulting meteorologist specializing in issues relating to astronomical sites, to conduct a survey of cloud cover and water vapor in northern Chile. This survey is one of a number of studies originating in the AURA New Initiatives Office (NIO) that relates to the building of the 30-meter Giant Segmented Mirror Telescope (GSMT).

The satellite imagery was obtained from the International Satellite Cloud Climatology Project (ISCCP), a quality-controlled and well-calibrated data set with a ground resolution of ~10 km. The data analyzed consisted of 58 months of archival images at three-hour intervals for the period 1993-1999, in the 6.7 micron (water vapor) and 10.7 micron (cloud cover) bands imaged by Meteosat-3 and GOES-8. There is a 15-month gap in the data starting early in 1996, and a two-month gap in 1995 at the start of the GOES-8 operation. However, comparison with the Southern Oscillation Index (SOI) for 1980-2000 shows that the data set purchased contains conditions ranging from strong El Niño to strong La Niña, but on the average is close to "normal."

The area from latitudes 20.5S to 30.5S and from the coast to the Chile-Argentina border was selected for study. This region includes the present Chilean observatories and the ALMA site, and continues almost 300 km further to the north. Cloud cover statistics and precipitable water vapor (PWV) were derived for the whole region, and could be subdivided in many ways (e.g., correlation with the SOI, variation day-night, variation throughout the year, etc.). Based on these findings and a topographical analysis (available at: *www.ctio.noao.edu/sitetests/survey/map1.html*), 14 existing and potential telescope sites



were selected for detailed analysis. The best sites in terms of cloud cover are located on mountain peaks above the trade wind inversion in the latitude between 21.5S - 24.5S and close to the coast. Cerro Paranal (ESO, VLT) lies at the very south end of this region and was measured to have "clear fraction for the observing night," integrated over the whole data set, of 85%, compared to Cerro Tololo at 65%. All other sites, except one that was slightly better than Paranal, lay in this range. Site quality for infrared astronomy based on the PWV statistic was found to be strongly controlled by the site altitude, and to a lesser degree by latitude. For this reason Cerro Chascón (5548m), in the Conicyt Science Park and adjacent to the ALMA site, was the best site, with median PWV in clear conditions below 1 mm — several times better than relatively low altitude sites such as Tololo and Paranal. Thus the best site depends on the priority attached to the type of science and on other factors not measured here, such as wind

continued

Satellite Survey continued

speed and ground layer turbulence. And, of course, the surrounding environment plays a role, such as difficulty of access and the distance from cities and mines.

We now have quantitative, long-term statistics to prove that the region is superb for ground-based astronomy. The original data set, covering the whole Western Hemisphere, is very valuable and has been used already for a similar study in the Colorado-Arizona region for the Rocky Mountain Observatory Consortium. In addition, a much more extensive study of the Southwest US–Mexico region is being undertaken in a collaboration between NIO and CELT to allow direct comparison between this area and northern Chile.

YALO Operations Extended Through 2002B: Bulge Time for NOAO Observers in 2002

Stefanie Wachter

YALO is the Yale 1-meter telescope at CTIO operated by a consortium consisting of Yale University, AURA, the University of Lisbon (Portugal), and Ohio State University. The instrument is a permanently mounted, dual-channel, optical-IR imager called ANDICAM, built at Ohio State by a group led by Darren DePoy. YALO operates purely in a queue-scheduled mode and thus provides a unique opportunity for synoptic and Target-of-Opportunity observations at CTIO without the necessity of traveling to Chile. NOAO users currently have access to about 27.5% of each night with a few special restrictions (for details, go to: *www.ctio.noao.edu/telescopes/1m/yalo.html*).

On 5-6 July 2001, representatives from the various partner institutions met in La Serena to discuss the future of the project. It was decided to extend the current agreement through the end of the 2002B semester (31 January 2003), with slight changes in the time shares allocated to each partner based on the contributions to the budget for the last six months of operations. In addition, all partners are enthusiastic about the possibility of transferring ANDICAM (and the queue operation) to the CTIO 1.5-meter in 2003, and will explore funding options for this scheme in preparation for the next consortium meeting in 2002.

The YALO telescope has been shown to provide excellent data, both in the optical and infrared. The accompanying figures show two examples of recent results.

Although the number of NOAO proposals submitted for YALO time has slowly increased over the three-year lifetime of the project, the US community has yet to take full advantage of YALO's unique capabilities. This

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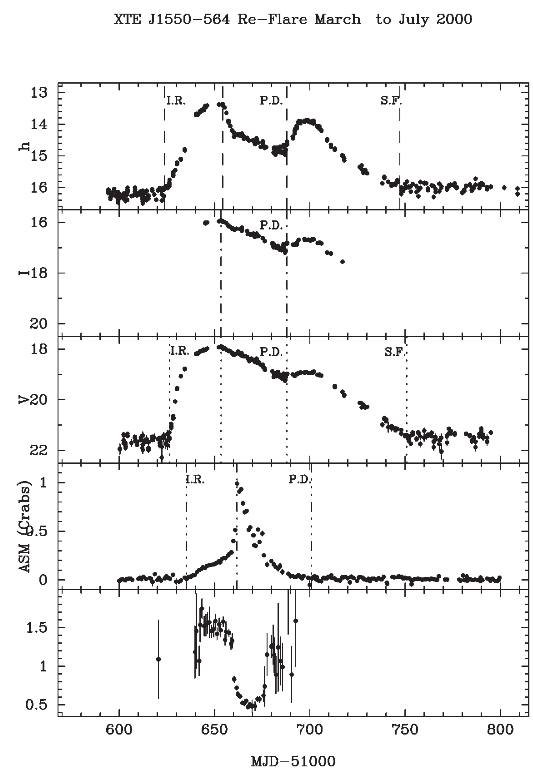


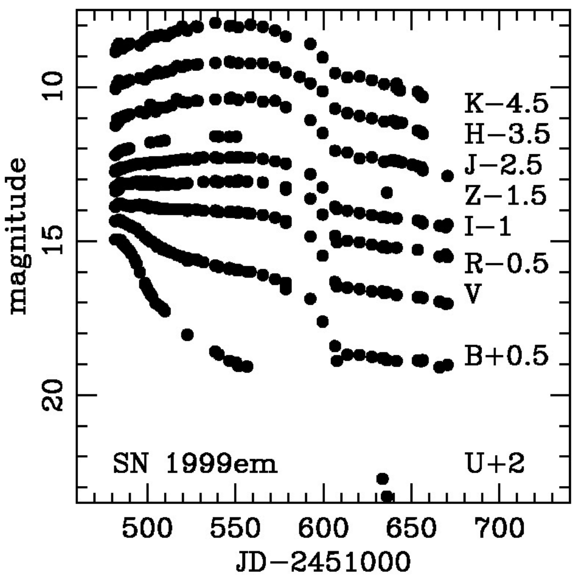
YALO and RXTE light curves of the galactic black hole candidate RXTE J1550-564 covering seven months in 2000. The top three panels are YALO data in H, I and V respectively, and the bottom two are the RXTE ASM light curve and hardness ratio. Note that start of the optical and IR flare precedes the X-ray, and that the modest "plateau" in the optical decline corresponds to a large secondary peak in the infrared. Additional details can be found in Jain et al. (2001, ApJ Letters, 554, L181).

YALO Operations continued

seems to be due partly to a lack of awareness that time on the YALO telescope is available for NOAO users. In the past, the limited access to Galactic Bulge time and the restricted available filter set have also been obstacles. Both of these latter concerns have been addressed:

- **Access to Bulge Time in 2002**: NOAO will have a 15% share during the Bulge time in 2002A and a 30% share of the non-Bulge time during 2002B.

- **Filter Changes**: Due to the high demand from the NOAO community, a Johnson U filter will replace the R filter, changing the available broadband filters from BVRI to UBVI. In addition, an X-filter will be added to the IR filter set. This change will occur during the next engineering break and should be in place for the start of the 2002A semester.



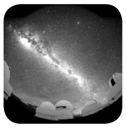
The figure at left shows the UBVRIJHK light curve of the bright Type II Plateau supernova SN1999em in NGC 1637. The BVRIJHK data were taken at the YALO 1-meter telescope with a few data points from six other telescopes. The U and Z data were taken at the CTIO 0.9-meter telescope and will be published by Suntzeff et al. (2001, in preparation). This data set has been used by Hamuy et al. 2001 (astro-ph/0105006) to measure a direct distance to this spiral galaxy of 7.5+/-0.5 Mpc, using the Expanding Photosphere (Baade-Wesselink) Method. The spectral data used to set the velocities of the expanding photosphere were taken at the ESO NTT and VLT telescopes, the CTIO 1.5-meter telescope, and the Steward Observatory 90" telescope. Photometry of Type II supernovae taken on small telescopes, such as the YALO 1-meter telescope, combined with spectroscopy on larger telescopes, can yield accurate distances to objects out to 100 Mpc.

Small Telescope Opportunities at CTIO

Alistair Walker and Charles Bailyn

Small telescopes seem to be an endangered species at most large observatories as the focus changes to exploiting new large facilities, utilizing the extensive databases being produced both from the ground and from space, and working toward the construction of even larger telescopes. However, small telescopes can be very cost-effective when combined with capable, fixed instrumentation at an excellent site. A good example of this is the queue-scheduled YALO 1-meter telescope (see the previous article by Stefanie Wachter).

The possible move of the YALO operation to the 1.5-meter at the end of 2002 opens the opportunity for a new collaboration to operate the Yale 1-meter telescope, starting in 2003. Such a partnership also might participate in using the 1.5-meter, the 2MASS 1.3-meter (currently scheduled to be operated by NOAO with a direct CCD imager), and the 0.9-meter (currently scheduled to be closed). This fall, Yale University will be organizing a workshop in New Haven, Connecticut, to explore the options with potential partners. For more information, please contact Charles Bailyn at: *bailyn@astro.yale.edu*.



Rescue of FLAMINGOS Delays But Improves New Wide-field IR Capability

R. Probst, N. van der Bliek, R. Blum, M. Boccas, M. Bonati, R. Gálvez, M. Martínez, A. Montané, and M. Warner

The flexibility of NOAO's internal "system" and the high priority we place on user support have been demonstrated vividly by a creative response to the loss of a cryogenic optics lens for the University of Florida's FLAMINGOS instrument.

The lens was broken in transit to Gemini South in late July, and prospects for a rapid replacement were grim. In order to get FLAMINGOS back on the air for US users of Gemini, and those who would use it at the MMT and KPNO later this year, CTIO has loaned a similar lens to FLAMINGOS from the optics set for the new Infrared Side Port Imager instrument (ISPI – aka "eye-spy") until a new one becomes available.

This is expected to delay ISPI first light by ~3 months. But in exchange, ISPI will obtain use of the 2K×2K IR "engineering grade" array currently in FLAMINGOS when that instrument receives its science grade array. This array has four working quadrants, compared to only three in the present engineering array in ISPI. Since ISPI is fairly far down the vendor queue for delivery of a final science sensor, we expect this interim upgrade will enhance its science capabilities for a meaningful period.

ISPI is now expected to see first light on the Blanco 4-meter in April 2002, with shared risk science observing starting shortly thereafter.

ISPI is the CTIO-produced successor to OSIRIS for infrared imaging at 1 to 2.4 microns. It uses a 2048×2048 Hawaii 2 array from Rockwell, and provides an 11×11 arcmin field of view with 0.3 arcsec per pixel sampling. ISPI will initially have the standard broadband J, H, Ks, and K filters, with narrowband filters being added subsequently. ISPI's scientific niche is deep wide-field IR

continued

Table 1. Predicted ISPI performance on the Blanco 4-meter

Band	Background Flux (electrons/sec) per sq arcsec	Background Flux (electrons/sec) per pixel	Integrated flux from m=15 star (electrons/sec)	5 σ point source detection limit in 60 sec
J	2700	330	7000	20.5
H	15900	1940	7200	19.5
K'	36200	4440	4700	18.6
K	58400	7200	5200	18.5

The dynamic range in K for a single integration is rather limited on the bright end by sky background. We expect to get approximately two magnitudes of overlap with the 2MASS database.

Rescue of FLAMINGOS continued

imaging at moderate spatial resolution. High angular resolution IR imaging and IR spectroscopy will be supported on the SOAR and Gemini South telescopes to optimize the capabilities mix of facilities operated by the AURA Observatory in Chile. ISPI will be available only on the Blanco 4-meter.

ISPI uses the optical design developed by Charles Harmer (NOAO Tucson) for FLAMINGOS, repackaged to fit space constraints and the simple (imaging only) operating mode of ISPI. It uses an SDSU II four-channel controller for array operation. Apart from the initial optical design, all other design, fabrication, and integration tasks are being performed by the CTIO engineering group in Chile. Further description and technical information can be found on the CTIO Web pages at *www.ctio.noao.edu/instruments/ir_instruments/ispi/* and *www.ctio.noao.edu/instruments/ir_instruments/ispi/ispi.flyer.html*.

For integration time and sensitivity estimates before we have actual on-telescope numbers, the following have been scaled from measurements with CIRIM, which also uses a Rockwell HgCdTe array. Other reasonable assumptions are a well capacity of 100,000 electrons and a read noise of 10 electrons. We expect a frame readout time of 3 to 4 seconds, which sets the minimum integration time in this shutterless system.

SOAR Update

Steve Heathcote, Director/Project Scientist, SOAR

Following a relatively calm interlude due to the Chilean winter, the SOAR site on Cerro Pachón will soon be the scene of hectic, albeit carefully choreographed activity, with the near-simultaneous arrival of components for two major sub-systems. The structural steel work for the dome is scheduled to arrive in late September, while the telescope mount should be delivered during October. Assembly of the dome and installation of the mount are planned to occur simultaneously in order to make efficient use of the large crane that is needed to lift the heavier pieces.

The structural steel work for the dome is seen during the trial assembly at the facility of Equatorial Sistemas, São José dos Campos, Brazil.

The progress of any large project is punctuated by occasional setbacks. In SOAR's case, this has come in the form of delays in the fabrication of the primary mirror. Unfortunately, as with most telescope projects, the primary mirror sits squarely on the critical path. The project team has worked closely with mirror manufacturer B.F. Goodrich to seek ways to make up lost ground and minimize the overall impact on the project. However, it has proven impossible to avoid a slip in the first light date, which has consequently been rescheduled for October 2002.

Other Happenings at CTIO

Now that the National Science Foundation helped us dramatically improve the La Serena-to-mountain portion of the CTIO/Gemini network, the “missing link” remains the international connection out from La Serena. AURA has requested supplemental NSF funding to improve **the international network link** from the US to the facilities of both Gemini and CTIO in Chile. Gemini and CTIO have been working together to define the specifications for this link, which should provide a bandwidth increase of more than 8 Mbps over the new submarine fiber-optic cables installed recently by various companies to link Miami with most of South America. The request for proposals (RFP) to provide this link should be sent out in late summer. If we receive funding, we hope to be on the air with a new faster link before the beginning of 2002. This high-speed international link is an important element in the future plans of both Gemini and NOAO (CTIO, NGSC, and SOAR), which involve extensive remote support and observing capabilities from Tucson, Hawaii, and other locations in the US.

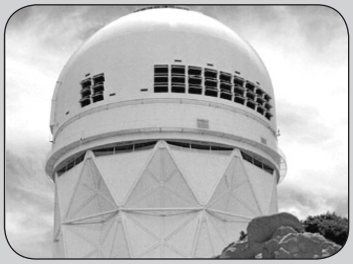
In the meantime, over the last few months we have negotiated with our current international Internet provider (Entel) for an upgrade of our existing international link from 256kbps to 2Mbps. This jump in bandwidth has already enabled some new uses of our link, including multi-party videoconferencing. Although this increase in bandwidth is indeed welcome, its commercial nature limits the actual throughput for data transfer to significantly less than 2Mbps, and it will not allow for the more advanced needs we will have in the near future.

CTIO hosts the only NSF-funded Research Experiences for Undergraduates (REU) Program that takes place during the US academic year, which is the Chilean summer (January through March). This schedule provides an alternative for students who can take advantage of a quarter or semester away from their home campuses and want to participate in an overseas program. The **CTIO REU Program** offers students the unique opportunity to gain observational experience studying objects in the rich Southern Hemisphere sky (e.g., the Magellanic Clouds, the Galactic Center), while also providing them with a chance to work alongside Chilean astronomy and engineering students who come to CTIO to participate in the “Prácticas de Investigación en Astronomía” (PIA) program of summer astronomy internships.

Four students participated in our 2001 REU Program, and all four will attend the January 2002 AAS meeting in Washington to present their work. We look forward to another outstanding program for 2002, when we anticipate offering four undergraduate Research Assistant positions for a ten-week program starting in January.

The application deadline for the 2002 CTIO REU Program is 1 October 2001. The program is open to US citizens or permanent residents who will be enrolled as full-time undergraduate students through January 2002. Please direct inquiries to: *ctioreu@noao.edu*, and check the CTIO REU Web page at: *www.ctio.noao.edu/REU/reu.html* for application materials.

The International Astronomical Observatories in Chile will hold a **workshop on “Galactic Star Formation Across the Stellar Mass Spectrum”** in La Serena from 10-15 March 2002. The workshop will explore the similarities and differences between low, intermediate, and high mass star formation in the context of molecular cloud masses and environments, formation mechanisms and formation of multiple systems, kinematics (accretion, winds, outflows), circumstellar environment, spatial and time scales of star formation, pre-main sequence evolution, interrelations of stars of different stellar masses in a cluster environment, and the implications of future instruments. More information can be found at: *www.ctio.noao.edu/~debuizer/Conference.html*.



KPNO
Operations

KPNO in the New NOAO

Richard Green

The National Science Foundation has articulated a mission for NOAO that is exciting and forward-looking. The NSF expects NOAO to be an engine of progress on Decadal Survey goals by playing key roles in the development of the next generation large-aperture telescope (GSMT), the wide-field facility to open the time domain (LSST), and the powerful software and data structures needed to exploit the explosion in astronomical data (NVO). At the same time, we must provide healthy scientific productivity by getting the most out of the US share of the Gemini Observatory, and continuing to operate our existing sites for peer-reviewed programs on forefront facilities.

The good news: the AURA-endorsed realization of that plan explicitly recognizes the value and importance of KPNO operations. Our wide-field 4-meter telescopes complement and support Gemini North and the bulk of the US investment in large-aperture, ground-based optical telescopes. The entire US complement of cm-wave radio telescopes is in the north, and KPNO forms a network with CTIO for the optical support of NASA's all-sky space assets. For those reasons, AURA supports operation of KPNO through and beyond 2007, the period of the next Cooperative Agreement.

The challenge: the funding envelope offered by NSF is too constrained to underwrite a major suite of new activities and leave the internal support of current operations unchanged. Consequently, as Jeremy Mould explains in his lead article, he has re-prioritized internal allocations, based on the advice of an external balancing committee. Funds will be shifted gradually but steadily away from operations and toward the new initiatives. To adjust to these changing circumstances, KPNO will:

- Ease mountain support burdens by moving to yet longer instrument blocks and longer average observing runs. Low-demand instruments will be retired. For near-term details, please see the article on page 30.
- Complete the current round of telescope performance upgrades and then transition to a much lower rate of major improvements. The telescope engineering group will remain intact for repairs and minor upgrades, but will devote their design talents to other observatory priorities, such as major instrumentation or new telescopes.
- Establish operations partnerships for shares of the 4-meter and 2.1-meter if and when internally provided support drops below a threshold.

At the same time, we know that the value of the facility depends upon state-of-the-art instrumentation. In the short term, we are deploying the red-hot Lawrence Berkeley Labs CCDs for highly competitive spectroscopic performance. For the longer term, we are vigorously pursuing partnerships, funding, and NOAO resources for two major wide-field capabilities: a wide-field 4K×4K near-IR imager for the Mayall 4-meter and a One-Degree Imager with orthogonal-transfer CCDs for the WIYN 3.5-meter. Both will support major deep-sky surveys and individual investigations.

Medieval artists produced masterpieces, even though their choice of subject matter was highly constrained. With your guidance on the best use of increasingly limited resources, we expect KPNO to continue to provide the means to produce scientific masterpieces well into the future.

Changes in KPNO Observing Capabilities for Semester 2002A

Richard Green for the KPNO Staff

Several exciting new capabilities will be offered in the coming semester.

The return of CryoCam. Shared-risk observing will be offered with this fully upgraded instrument, including a Lawrence Berkeley Labs CCD and optics optimized for high throughput in the red.

FLAMINGOS multi-slit mode. The full power of the instrument will be realized with cooled multi-slit masks for low-to-moderate dispersion spectroscopy in the J, H, and K windows. Wide-field imaging in the 2K×2K format remains available as well.

Intermediate-band filters for Mosaic. Rogier Windhorst and collaborators are making a unique set of filters from their system available for your proposals. They cover a large wavelength range, and are valuable for photometric redshifts and spectral classification. For details, see Rogier Windhorst's article on page 34 of this newsletter.

The evolution of the instrument suite brings with it the necessity of retiring some capabilities that are in low demand and have become increasingly difficult to support. As of Semester 2002A, we will retire our IR workhorses of the last decade, IRIM and CRSP. They are about to be superseded by the next generation of imagers and spectrographs. The call on their special capabilities for narrow-band imaging and long-wavelength spectroscopy has been sharply limited in recent semesters. In addition, we will no longer offer the single T2KB CCD as a prime focus imager at the 4-meter. If you require narrow-band imaging that is not suitable for Mosaic, please consider proposing for your program on WIYN with Mini-Mosaic. Although the field of view on WIYN is ~2× smaller in area, the tighter PSF and better sampling may offer other advantages.

Finally, please note some important implications for KPNO telescope usage driven by ongoing budgetary limitations:

- KPNO facility instruments will be scheduled for minimum blocks of two weeks at all telescopes.
- The Mayall 4-meter telescope will typically be scheduled for runs of no less than four nights.
- The 2.1-meter telescope will typically be scheduled for runs of no less than seven nights.

More details can be found on the web at: *www.noao.edu/noaoprop/help/policies.html*.

We recognize that the requested run length has to be based on the science proposed, and note that we must have some flexibility in scheduling. But as we move toward implementing the new priorities of NOAO, the KPNO schedulers and staff will need to adhere more closely to these guidelines.

The implication of a minimum instrument block length is that your proposal's success in getting on the telescope will depend in part on the success of other proposers for the same instrument. If your choice is an instrument that is used less frequently, you can give your proposal a greater chance of scheduling success by letting us know if another instrument can be an acceptable backup. A prime example might be substituting FLAMINGOS, if necessary, for SQIID on the 4-meter. A lower fraction of proposals may be accepted in a given semester because of the longer average and median run lengths. But as a consequence, we anticipate a better chance of completing those that are selected.

We appreciate your cooperation and your feedback as we try to maintain high reliability and productivity along with a manageable workload.

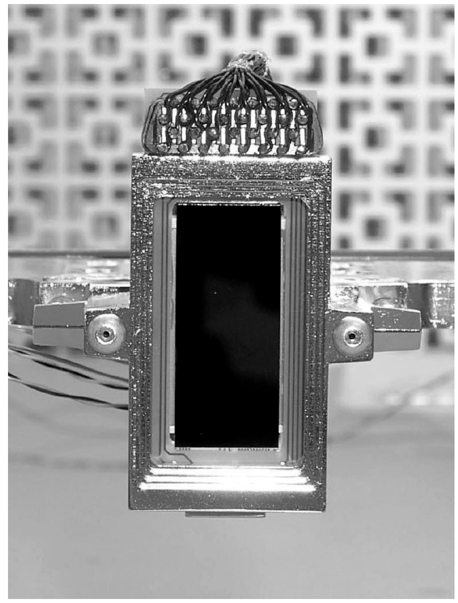
The Multi-Aperture Red Spectrometer: CryoCam Resurrected!

Sam Barden, Arjun Dey, Roger Lynds, Rich Reed, Bill Ditsler, and Charles Harmer

The Kitt Peak Multi-Aperture Red Spectrometer (MARS – known in its previous incarnation as CryoCam) is nearing completion of its recent repair and upgrade. We anticipate on-sky testing of MARS on the Mayall 4-meter telescope during the 2001B semester with shared risk availability for the 2002A observing semester.

In resurrecting CryoCam to create MARS, the following enhancements were made:

- Replacement of the Loral CCD with a Lawrence Berkeley National Laboratory high-resistivity, p-channel CCD detector,
- Construction and installation of a new CCD chip mount with a smaller cross section for greater optical efficiency,
- Application of a high-performance Lawrence Livermore overcoated silver reflection coating on the Schmidt mirror,
- Utilization of a new field flattener lens,
- Implementation of a 450 l/mm volume-phase holographic grism,
- Deployment of a telescope nod/charge shuffle observing mode.



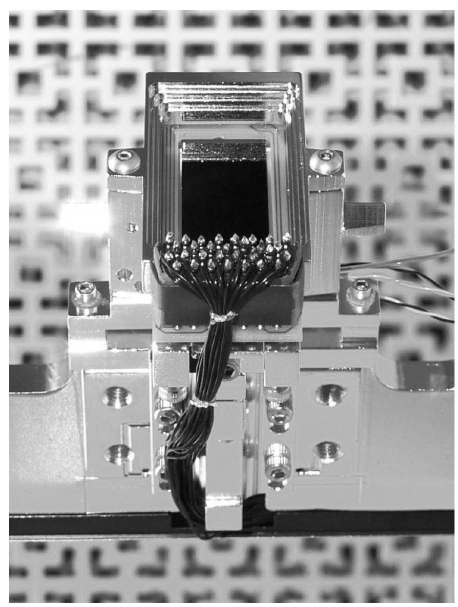


Figure 1a (top) shows the 1980×800 LB1B CCD packaged for MARS. Figure 1b (bottom) shows a different view of the CCD mount and assembly.

CCD Detector, Packaging and Mount

The new CCD is a 1980×800, 15-micron format similar to the device LB1A described in the March 2001 *NOAO Newsletter*. The CCD for MARS was specially packaged by Richard Stover (UCO/Lick) using a package designed and fabricated by Rich Reed at NOAO. Special effort was made to reduce the optical obstruction of the entire assembly.

New Mirror Coating

The Schmidt camera mirror was stripped of its old aluminum coat, and the mirror was recoated by Dr. N. Thomas at the Lawrence Livermore National Laboratory with a special multi-layer coating that was developed for the National Ignition Facility project. Figure 2 displays the measured reflectivity of a witness sample (coated simultaneously with the MARS). The original coating specification is also shown along with the reflectivity of bare silver and fresh aluminum. This particular coating has excellent reflectivity from 300 nm to redward of 2.5 microns.

New Field Flattener Lens

An off-the-shelf lens, purchased from Newport, was thinned, polished and coated with a MgF2 AR coating to make a new field flattener. Within the coming year, we intend to replace this lens with one coated with a higher performance AR coating.

continued

CryoCam Resurrected continued

VPH Grism

The grism (grating manufactured by Kaiser Optical Systems, Inc., and prism wedges produced by Janos Technology Inc.) has been assembled at NOAO (by Al Camacho and Heidi Yarborough). The grism assembly consists of the following elements: two AR-coated SF11 glass prisms, one BK7 substrate, one OG550 filter cover plate, and the gelatin grating that is sandwiched between the BK7 and OG550 plates. The grism's golden color is due to the OG550 long-pass filter, which was made part of the grism assembly to obviate the need for an order separation filter and to minimize the number of air-glass surfaces.

Figure 5 shows an image of a point source and set of He-Ne-Ar lines imaged through the grism. Wavefront analysis shows the presence of about 2 waves of error dominated by astigmatism and power. This most likely arose from the distortions introduced by the optical cementing of the four glass elements. These distortions should not impact the imaging performance of the MARS instrument. Focus adjustment will compensate for the majority of the error.

Telescope Nod/Charge Shuffle Update

The nod-and-shuffle mode was implemented at the Mayall 4-meter telescope last year. During engineering runs last spring, several improvements were made to the system (by N. Sharp, R. Seaman, D. Mills, B. Marshall, A. Dey, and R. Lynds) which resulted in a reduction of the observing overhead from 15 sec per nod to less than 4 sec per nod. The observing mode is now available with the new f/8 guider and will soon be part of the standard ICE observing setup at the Mayall. The nod-and-shuffle mode will be available for use in shared risk mode during Semester 2002A.

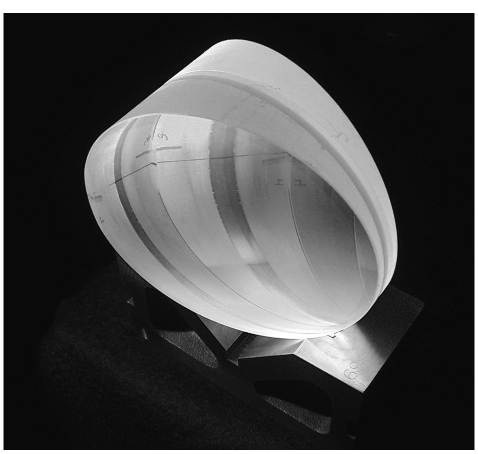


Figure 4: The grism

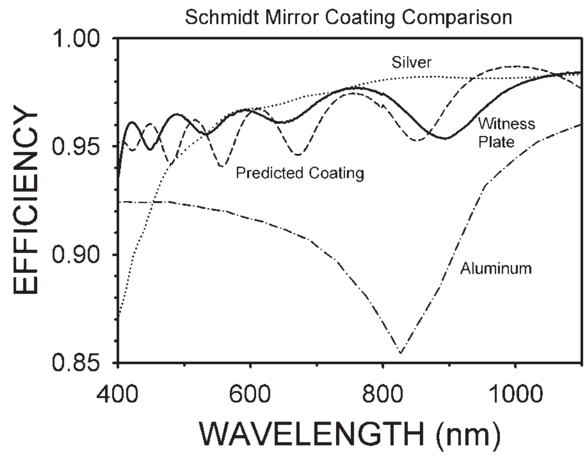


Figure 2: LLNL coating efficiency from witness sample

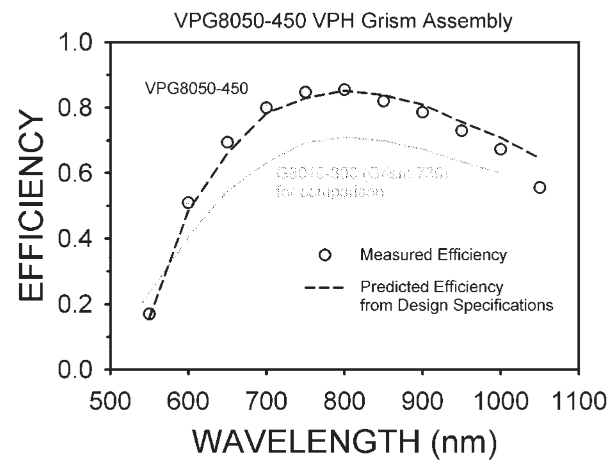


Figure 3: Efficiency curve for grism

Overall Anticipated Performance

All elements are working as originally anticipated. Figure 6 shows how we expect MARS to perform with respect to its spectral sensitivity.

continued

CryoCam Resurrected continued

Availability

MARS will be undergoing telescope testing starting in early September. The first science verification and science runs are scheduled for November 2001. Documentation will be updated over the next couple of months

For those interested in applying for MARS, see: *http://www.noao.edu/kpno/mars/*). We will post early results of the initial telescope tests on this Web site shortly after their scheduled time in September.

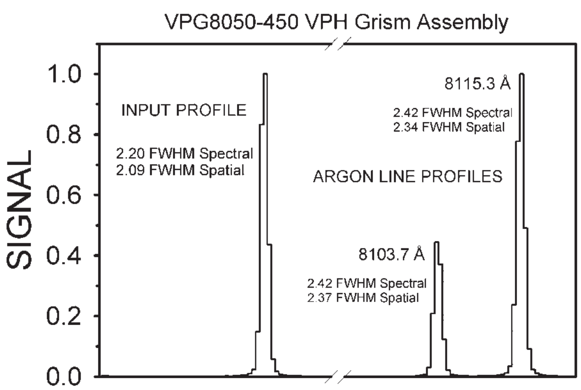


Figure 5: Point source and He-Ne-Ar lines imaged through grism

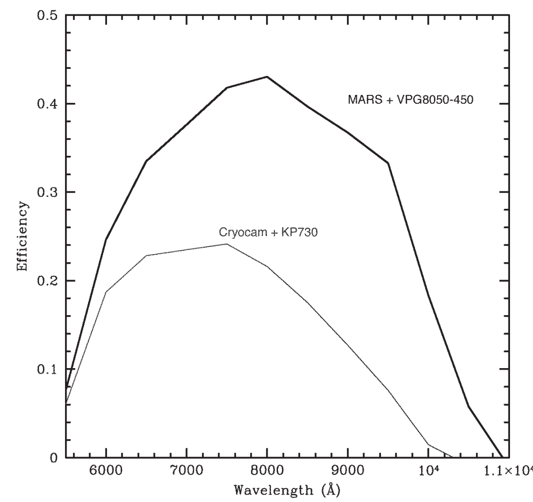


Figure 6: The total system throughput of MARS with the new VPH grism VPG805 (thick curve) is compared here with that of the old CryoCam spectrometer with the KP730 grism (thin curve). The main gains in system throughput are due to the new LBNL CCD, the reduced obstruction of the CCD packaging and mount, the increased reflectivity of the Schmidt camera mirror, and the new VPH grism.

FLAMINGOS Returns to KPNO

Jay Elias

The University of Florida Infrared Imager and Multi-Object Spectrograph (FLAMINGOS) will be returning to Kitt Peak this fall, and will be available to users through mid-May of semester 2002A.

The full suite of instrument capabilities are being offered on both the 4-meter and 2.1-meter telescopes, as outlined in the March 2001 *NOAO Newsletter*. They comprise wide-field imaging as well as long-slit and multi-slit spectroscopy with a 2K×2K HgCdTe array. The science-grade array may be installed at some point during the semester, but proposers should assume only the availability of the current (and quite good) engineering-grade array.

A JH grism has not yet been fabricated. The HK grism used with the JH filter gives H in first order and J in second order, with good efficiency. There is a good chance that the JH grism will be available, but any proposers who cannot carry out their program with the current configuration should indicate this.

Prospective users should read about the details of long-slit and multi-slit spectroscopy posted on the NOAO FLAMINGOS Web page at: *www.noao.edu/kpno/manuals/flmn/*. Look for an update in early September.

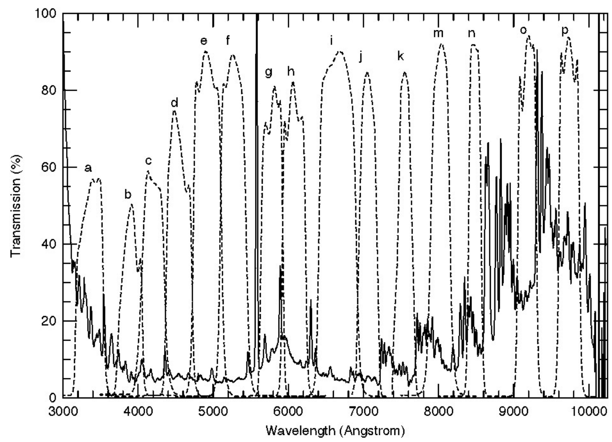
A New Set of Medium-Band Filters for Use with Mosaic

Rogier Windhorst, Arizona State University

In the last few years, the Arizona State University (ASU) group and their collaborators (PI: Rogier Windhorst) had a unique set of 15 medium-band filters made. These have a typical $\Delta\lambda/\lambda \approx 0.05$-$0.10$ and cover the entire atmospheric range of 3200-10,000Å, but are sandwiched between the brightest and most variable night sky lines. Fan et al. (1996, *AJ*, 112, 628) describe the 15 medium-band filter set, which has been used since 1993 at the 0.6-meter Schmidt telescope of the Beijing Astronomical Observatory at Xing Long Station, using a 20482 Loral CCD with 1 sq. degree field. Other results from this Beijing-Arizona-Taiwan-Connecticut survey are described by Shang et al. (1998, *ApJL*, 504, L23), Zheng et al. (1999, *AJ*, 117, 2757), and Yan et al. (2000, *PASP*, 112, 691).

The ASU group and their collaborators will make filters 1-11 of their 15 MOSAIC-size medium-band filters available to KPNO users in the A semesters of each observing year, starting with Semester 2002A. It is the intention to make the full filter set available for community use starting in a future semester, presumably within two years after the 11 bluest filters have been made available. These medium-band filters can be used for a wide variety of purposes, e.g., high-accuracy photometry of stellar populations in our Galaxy and nearby galaxies, the search for Galactic or extragalactic emission-line objects, measurement of accurate photometric redshifts, etc.

Regarding public availability of the medium-band filters, you can propose to use any of the available medium-band filters by specifying 'ASU a…x,' along with your Mosaic time request on your observing proposal. The medium-band filters will permanently reside with the NOAO filter collection in Tucson, under the supervision of NOAO. Please see *http://www.noao.edu/noao/mosaic/* for further details.



Throughput curves for the 2×2-inch 15 medium-band filter set superimposed on the MMT night sky. The 15 MOSAIC-size 5.75×5.75-inch filters have nearly identical throughput curves. As much as possible, all filters are sandwiched in between the night sky lines and avoid the most variable lines to prevent fringing.

Telescope Recast as the "WIYN 0.9-meter"

Ata Sarajedini (Project Scientist), Robert Mathieu (President, WIYN), and Heidi Schweiker (Site Manager)

During the 2001B semester, the former #2 KPNO 0.9-meter telescope returns to service as the "WIYN 0.9-meter." Its instrument suite consists of the wide-field MOSAIC imager (59′×59′ FOV, 0.40″/pixel), as well as the former imaging workhorse at the WIYN 3.5-meter — the 2048 pixel square S2KB CCD (20′×20′ FOV, 0.60″/pixel).

Operations of the Kitt Peak 0.9-meter telescope were handed over to the WIYN Consortium in February 2001 as the result of a competitive proposal process. The WIYN Consortium has joined with partner institutions to renovate and operate the telescope. These partners include Indiana University (Bloomington and South Bend), San Francisco State University, University of Florida, University of Wisconsin-Madison, University of Wisconsin-Oshkosh, University of Wisconsin-Stevens Point, University of Wisconsin-Whitewater, Wisconsin Space Grant Consortium, Wesleyan University, and Charles Bailyn of Yale University. In addition, NOAO receives observing time in exchange for use of the two imagers.

Proposals to refurbish the 0.9-meter were solicited in March 2001, and based on these bids, Astronomical Consultants and Equipment (ACE) of Tucson was selected as the primary contractor. Work began on 17 April 2001 and has included a complete upgrade of the telescope control system; a new filter/shutter/guider assembly; replacement of the RA, Dec, and focus motors and encoders; and weatherproofing of the dome. A number of other minor enhancements have been performed.

Work on the telescope is expected to be completed in mid-August, with re-commissioning soon after; the first shared risk science observations begin in early September. The national community was invited to propose for NOAO Mosaic time last March, and all available time was allocated. Users are invited to submit proposals for Mosaic for Semester 2002A through the usual NOAO application process.

U S G P

U.S. GEMINI PROGRAM

Status of the Gemini Telescopes

Bob Schommer

The first science observations with the Gemini South telescope are now scheduled to begin in September, using a service queue observing program and loaned visitor instruments. Gemini South has undergone the first set of commissioning tests and, in most ways, is at the same level of performance as the northern telescope. Of course, many of the systems need to be checked while performing science observations, with extra help provided by staff from the National Project Offices (the US, Canada, Australia, Brazil, Argentina, and Chile have all offered staff to aid in this effort). While the time is still shared risk, we hope that the goal of 25% science observations can be approached for Semester 2001B. The pointing (rms <1 arcsec over the sky) and imaging performance (FWHM images of <0.3 arcsec have been obtained in the near IR) are well within specifications. Later this semester, the fast chopping secondary system will be tested with OSCIR.

The Gemini North telescope is offering more than 50% of the semester to science observations, both in a queue mode and for classical observers. Much of the work this semester involves the commissioning of two facility instruments, GMOS-N and NIRI. A flexure problem with NIRI is currently being worked on by the instrument team from the University of Hawaii, and we hope that this instrument will be available for science observations in October. GMOS-N arrived in Hilo in April, and the instrument team from the UK and Canada has been working with the Gemini staff, first in the lab in Hilo and now on the summit. The first GMOS images on the telescope are very promising. GMOS is scheduled to be used for science, in queue mode only, starting in November. The observatory has also been working on the high-level software to integrate the facility instruments with the telescope and to improve the overall efficiency of the telescope + instrument system.

For the 2002A semester, see the accompanying articles by Elias, Hinkle, and Telesco; and by Pilachowski and Simons. For specific information, please consult the call for observing proposals for 2002A that will be available on our Web site by early September.

Gemini Observing in 2002A

Caty Pilachowski (NOAO) and Doug Simons (IGO)

The Gemini Operations Working Group has endorsed a tentative plan for observing on Gemini North and Gemini South during the first semester of 2002. This plan will be reviewed and possibly changed before the Call For Proposals for Gemini in late August. Be sure to check the Gemini Web site after the Call for Proposals is issued to obtain the final instrument complements for the 2002A semester.

On Gemini North, the facility instruments are expected to be NIRI and GMOS. Hokupa'a/QUIRC and CIRPASS are expected to be available as visitor instruments in classical mode. The USGP will run "mini-queues" for these visitor instruments if demand warrants. NIRI and GMOS will be available for both queue and classical observing, with a cap of 14 classical nights total. No polarimetry or coronography will be available for NIRI. GMOS will operate with imaging, MOS, and IFU modes. No Quick Response, no target-of-opportunity, and no remote observing will be available for any programs. Minimum queue observations will be one hour, and minimum classical allocations will be one night, as standard.

The maximum percentage of time offered for all science use of Gemini North should be 66% (121 nights). This includes time allocated to all partner countries, as well as science verification, pay-back time, and Gemini staff time.

On Gemini South, facility instruments will be T-ReCS (imaging mode only) after May 1, and the Acquisition Camera, both

continued

Gemini Observing continued

available only in queue mode. The status of T-ReCS will be reviewed in late August, when a final decision will be made whether to offer it in 2002A.

FLAMINGOS I will be available as a visitor instrument after June 1. FLAMINGOS modes will be imaging, long slit, and, after July 1, MOS. The USGP will operate a mini-queue if demand warrants.

Phoenix is also expected to be available as a visitor instrument in the 2002A semester, in classical mode only (the US intends to offer a mini-service mode for the partnership). The Acquisition Camera will still be available as a Quick Response mode for targets of opportunity.

The total amount of time available for all science use on Gemini South should be no more than 50% (90 nights).

Gemini Instruments Expected to be Available in 2002

Jay Elias and Ken Hinkle (NOAO), and Charles Telesco (University of Florida)

CIRPASS on Gemini North

CIRPASS (Cambridge InfraRed Panoramic Survey Spectrograph) is an IFU-fed spectrograph with 4 pixel scales; the IFU lenslet array is roughly rectangular on the sky. The smallest scale (which would require use with an adaptive optics feed) is 0.05 arcsec/lens and a 1.8×0.7 arcsec field of view; the largest scale is 0.36 arcsec/lens, with a 13×5 arcsec field of view.

The instrument is not fully cryogenic, so its utility is limited to the non-thermal infrared. Best performance is expected over the region 0.85-1.5 microns. Some cooling of the instrument may be possible, which would extend its long wavelength limit to roughly 1.8 microns. The spectrograph provides a resolution (2 pixels) of ~3200, which implies coverage of about 0.4 microns for a Hawaii-2 2K×2K HgCdTe detector.

Further information can be found on the Gemini Web site (and related links) at: *www.gemini.edu/sciops/instruments/cirpass/cirpassIndex.html*. The CIRPASS science team encourages direct contacts, with a view toward collaboration.

Phoenix at Gemini South

At the recommendation of the Gemini Science Committee, it is expected that Phoenix, NOAO's high-resolution spectrograph for the 1-5 micron region, will be offered as a Gemini South instrument in the 2002A semester.

An exposure time calculator, a FAQ page, a list of available order-sorting filters, and other documentation can be found at: *www.noao.edu/usgp/phoenix/phoenix.html*. Users requiring order-sorting filters that are not available should contact K. Hinkle at *khinkle@noao.edu* as soon as possible.

Prospective users should note that, at this writing, the overhead in moving to a new star and setting up the guide probes is typically about 30 minutes. Clearly, it is currently not practical to use Phoenix on Gemini to observe a list of bright stars quickly. Prospective observers are also reminded that standard observing procedure with Phoenix requires at least two observations of each program object at different slit positions and, for the removal of the telluric lines, observation of a hot star at similar air

The coupling unit that mounts between the Gemini instrument mounting surface (ISS) and the Phoenix dewar is shown with the senior technical associate for Phoenix, Paul Schmitt (right), and the manager of detector R&D, Barry Starr. Unlike the Kitt Peak interface, which was an aluminum weldment, this unit is made of thick steel plates. The steel adds some of the weight needed to make Phoenix conform to the Gemini weight and moment specification. The coupling is required to provide the correct spacing of the telescope focal plane inside the instrument.

continued

Gemini Instruments continued

mass to the program star. Flats also must be observed, but this typically takes only a few minutes of telescope time.

Phoenix, along with the required handling and mounting assemblies, will be shipped to Gemini South by September 1. All the mounting hardware is new. The most complicated new unit is the spacer/coupling that attaches Phoenix to the Gemini telescope. The new coupling unit contains a hollow cathode lamp for focusing and wavelength calibration, and a window cover. Both mechanisms are under computer control.

T-ReCS on Gemini South

The University of Florida's Thermal Region Camera and Spectrograph (T-ReCS) is expected be available on Gemini South sometime in 2002. T-ReCS provides diffraction-limited 8 to 25 micron imaging and moderate-resolution slit spectroscopy. The detector is a Raytheon 320×240-pixel Si:As blocked-impurity-band (BIB) device. Each pixel subtends 0.09 arcsec, which provides Nyquist sampling of the diffraction-limited point-spread-function at 8 microns and a 28×21 arcsec detector field of view. The initial filter complement includes broadband N and Q filters spanning the 10 and 20 micron atmospheric windows, respectively. A set of six narrowband ($\Delta\lambda \approx 1$ micron) "silicate" filters samples the 7.8 to 12.5 micron region, and two narrowband filters are centered near 18 and 24 microns.

T-ReCS contains three plane gratings for long-slit (21 arcsec) spectroscopy through the entire 10 micron or 20 micron atmosphere windows in one exposure, with spectral resolutions as high as $R \equiv \lambda/\Delta\lambda \approx 80\text{-}100$ or in the 10 micron region with $R \approx 1000$. To maximize system throughput and achieve the best imaging or spectroscopic performance permitted by atmospheric conditions at a particular time, any one of several T-ReCS entrance windows can be selected during the observing session. A window-imaging mode permits inspection of the entrance window's outer surface at any time in order to monitor its condition. Finally, the entrance pupil can be imaged to ensure proper optical alignment during system setup and to monitor the pupil's thermal environment.

The predicted point-source imaging sensitivity (S/N = 1) in the N-band filter (λ = 5.3 microns, $\Delta\lambda$ = 10.8 microns) is ~0.05 milliJanskys, for 1 hour of chopped integration, which corresponds to 2 to 3 hours of elapse, or "clock" time, depending on overheads and observational efficiency. This sensitivity estimate is supported by exploratory science and engineering observations at Gemini North with the Florida mid-IR imager OSCIR. To first order, sensitivities for imaging in the narrowband filters scale from this value inversely as the square root of the bandwidth.

T-ReCS has been completely assembled. Its mechanisms have been operated successfully at cryogenic operating temperature and under software control. The MUX has imaged successfully and has revealed good optical performance. The team is in the midst of system testing and optimization, which will culminate in T-ReCS's Pre-Ship Acceptance Test in early autumn.

US Gemini Instrumentation Program Update

Taft Armandroff and Mark Trueblood

Much work is underway in the US on instrumentation for the Gemini telescopes, both at NOAO and in the wider community. This article gives an update as of late July.

GNIRS

The Gemini Near-Infrared Spectrograph is a long-slit spectrograph for the Gemini South telescope that will operate from 1 to 5 microns and will offer two plate scales and a range of dispersions. The project is being carried out at NOAO Tucson under the leadership of Jay Elias

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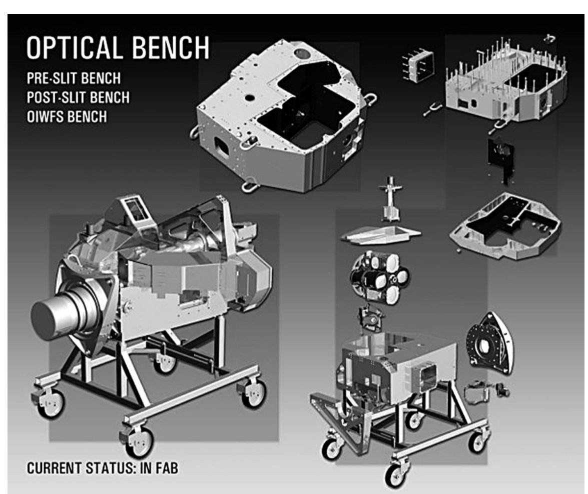


The GNIRS Optical Bench, showing the Pre-Slit, Post-Slit, and On-Instrument-Wavefront-Sensor Benches assembled, exploded, and on the handling cart. Note the GNIRS camera turret.

Gemini Instrumentation continued

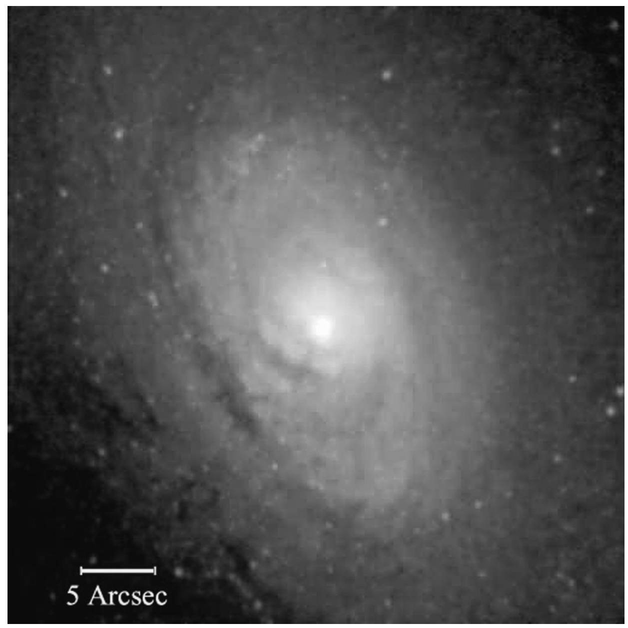
(Project Scientist) and Neil Gaughan (Project Manager). A large amount of parts fabrication is underway, and mechanism assembly and testing has begun. The parts for the GNIRS on-instrument wavefront sensor were delivered in July by the University of Hawaii's Institute for Astronomy. Subsystem integration and testing has begun; integration of subsystems into the instrument will begin in the fall. Overall, 69% of the work from the Restart Review to delivery has been completed.

NICI

The Near Infrared Coronagraphic Imager is funded by monies from the NASA Origins Program to NOAO. NICI will provide a 1 to 5 micron infrared coronagraphic imaging capability on the Gemini South telescope, featuring two science channels and an integrated adaptive optics system. NICI is being built by Mauna Kea Infrared (MKIR) in Hilo under the leadership of Doug Toomey. The NICI fabrication contract commenced on March 1. The NICI team has made significant progress in the areas of optical design, mechanical design, electronics design, systems engineering, and software design. In particular, the optical layout of the instrument is complete. The NICI Preliminary Design Review is scheduled for March 2002.

Abu

Abu is an infrared imager that has been used on the NOAO telescopes and at the SPIREX facility at the South Pole. NOAO has modified Abu for use solely as a commissioning imager on Gemini, and installed an IGP-provided ALADDIN InSb array. Abu was shipped to Gemini South in April 2001. Nigel Sharp and Bill Ball of NOAO worked with Gemini staff to install Abu and integrate it with the Gemini South telescope systems. Abu was then used to obtain the first infrared images from Gemini South, including some particularly spectacular images.



This image of the Circinus Galaxy was taken with NOAO's Abu infrared camera during testing at the Gemini South telescope on Cerro Pachón, Chile. The telescope's active optics and fast-guiding systems were in operation during the test, resulting in an angular resolution of 0.4 arcsec. At this resolution, details of the galaxy's dusty spiral arms are visible, while its bright, compact nucleus remains unresolved. The image is 43×43 arcsec in size. North is up and east is to the left.

Proposals Solicited for Design Study for Gemini Adaptive Optics Imager

Taft Armandroff

The Gemini Observatory is planning an adaptive optics (AO) system for the Gemini South telescope. In its full realization, the system will provide a multi-conjugate AO capability using laser guide stars and three deformable mirrors. The system is designed to provide a relatively stable point spread function over a 1-2 arcmin field. The Gemini Observatory seeks groups to conduct conceptual design studies of a near-infrared imager that will be used in conjunction with the planned AO system on Gemini South.

The announcement calls for the design of a 4K×4K near-infrared imager. The conceptual design study will be an approximately 6-month effort starting in November 2001. One product of the design study contract will be a fixed-

continued

Proposals Solicited continued

price proposal to build the imager. The total funding available for conceptual design studies is $300,000, which includes funding for both direct and indirect costs. Gemini envisions this funding being divided between two competing groups. The total funding available for this instrument program, which includes the costs of the design studies, parts, labor, benefits, and overhead, is $4.25 million. This amount does not include the cost of the detector and controller package, which will be funded separately by Gemini. The deadline for the completion of proposals for this design study is 15 September 2001. The Gemini announcement of opportunity is available at: *www.gemini.edu/science/mcao_ao/*.

This is the first Gemini instrument procurement in which proposals are submitted directly to the International Gemini Observatory. The contact for this instrument procurement is Andy Flach, Gemini Contracts Manager.

A message about this opportunity was circulated to a list of 148 US instrumentalists and interested individuals by the USGP on June 19. The announcement was also placed on the NOAO and USGP Web pages. If you did not receive the announcement and wish to be placed on the USGP e-mail distribution list for future Gemini instrumentation opportunities, please send a message to me at: *armand@noao.edu.*

Gemini Observing in 2001B

Caty Pilachowski

Gemini Science Programs

Nearly 40 US science programs have been scheduled or forwarded for queue observing in the 2001B semester on the Gemini twin telescopes. Twenty-one nights of Gemini North time have been scheduled classically for 12 programs with the Near IR Imager (NIRI) and Hokupa'a adaptive optics (AO) imager, with an additional four short programs included in the Hokupa'a mini-queue program. Eleven programs have been accepted for queue observations with NIRI or GMOS (the Gemini Multi-Object Spectrograph) on Gemini North, with allocations ranging from 5 to 50 hours. Twelve more programs have been accepted for the Gemini South queue program using the instruments FLAMINGOS I, OSCIR, and the Acquisition Camera.

While it is difficult to predict from one semester to the next what the best strategy might be for getting time on Gemini, in 2001B, classical time on Gemini North was the easiest to get, with an oversubscription factor of only 1.1. The US obtained more classical time in 2001B because of the very small amount allowed in 2001A. Queue time on both Gemini telescopes suffered high oversubscription factors. It remains true, however, that strong science programs that can be carried out in less than perfect conditions during queue time have a good chance of getting data. Submission of such programs is particularly encouraged for the Gemini telescopes.

Gemini Mini-Queue Continues

The USGP conducted a highly successful mini-queue program for Gemini programs requiring small amounts of telescope time with the AO imager Hokupa'a and the mid-IR imager OSCIR during the 2001A semester. Data were obtained for several programs by USGP staff and visiting observers on Gemini North, and the data were distributed to principal investigators.

The mini-queue will be continued in the 2001B semester, with three nights scheduled in December to carry out four programs submitted during the March proposal round. The mini-queue program allows US investigators to propose for small amounts of time (less than one night of classical time) or for programs that require short observations on a few nights.

Other Gemini Partner countries, including Canada and the UK, will also be running mini-queue programs during the 2001B semester.

Gemini Demonstration Science

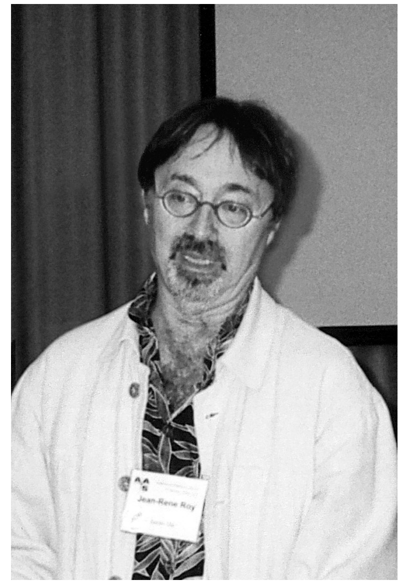
In the late spring, the International Gemini Observatory announced the opportunity to submit letters of intent for Demonstration Science programs with visitor instruments on the Gemini telescopes. About one week of telescope time will be available for each of three visitor instruments: FLAMINGOS I, Phoenix, and CIRPASS. Letters of Intent were due by July 15, and Gemini staff will consult with the national Project Scientists to select a team for each instrument. Forty-four proposals and letters of intent were received. International Demonstration Science teams are being formed for each instrument, and the data obtained by the teams will be made available to the community within two months of the completion of observations.

First Science Results from Gemini North

Caty Pilachowski

Early science results from the Gemini North telescope were presented at a Special Session at the AAS meeting in Pasadena in June. The program included a diverse collection of results, from massive star cluster formation in galaxies to the detection of planets and brown dwarfs around nearby young stars.

The session was well attended, and the excitement of these early science results bodes well for the future scientific productivity of the Gemini telescopes. There were also several poster papers describing additional science results.



Jean-René Roy, Associate Director for the Gemini North telescope, presents the first talk on "The Start of Scientific Observations with the Gemini North Telescope."

US Gemini Science Advisory Committee Meets in Pasadena

Robert Schommer

The US Gemini Science Advisory Committee met in Pasadena in early July at the Observatories of the Carnegie Institution of Washington to discuss issues related to operations and future plans for the Gemini telescopes. The meeting was hosted by Gus Oemler, a US representative to the Gemini Board of Directors. New members of the US SAC include Lori Allen (CFA), Laird Close (U. Arizona), Andy McWilliam (OCIW), and Bob Williams (STScI). (The full membership of the USSAC is available on the USGP Web site at: *www.noao.edu/usgp/staff.html.*

The US SAC reviewed the status of the telescopes and instruments, as well as USGP operations for Gemini proposals and user support. The committee was encouraged by the coming start of science operations on Gemini South in Semester 2001B. The completion of the commissioning of the telescopes and the facility instruments, and the attainment of high observing efficiencies at both telescopes, are considered to be the highest priority of the project.

The US SAC found that the ongoing instrumentation program offers exciting scientific opportunities. Nevertheless, the arrival schedule and sheer number of these instruments present a challenge to the Observatory staff in integrating and commissioning this breadth of capability. The US SAC suggested that IGO seek additional assistance from the National Project Offices in the implementation of these instrumentation capabilities.

Two issues were of particular concern. One was the deployment and evolution of adaptive optics capabilities on both Gemini North and Gemini South. The other was the evolution of the High Resolution Optical Spectrograph (HROS) into the much higher spectral resolution bench HROS (bHROS) instrument and its impact on a major science goal of the Gemini telescopes, the measurement of cosmic abundances in the Milky Way and nearby galaxies. The US SAC considered efforts to acquire an R~30-60,000 spectroscopic capability for the Gemini community to be a very high priority.

National Solar Observatory

From the NSO Director's Office

Steve Keil

The past three months have been busy and exciting for NSO on a number of fronts. The cooperative agreement with NSF for operating the national ground-based optical observatories (NOAO and NSO) is being recompeted, and AURA's proposal was submitted on July 19. NSO has worked hard the past two years in collaboration with the solar community to establish a forward-looking long-range plan (see: *www.nso.noao.edu/lrp/*). The plan includes designing and building the 4-meter Advanced Technology Solar Telescope (ATST) and strengthening the quality and quantity of the Observatory's synoptic data. The major goal of NSO during the recompetition process is to ensure an orderly continuation of the long-range plan and to retain the momentum established during the past several months. The competing proposals for management of NSO and NOAO will be reviewed over the next few months, and selection of the managing organization for operating the observatories is expected to occur by January 2002.

Meanwhile, back at the Observatory, the restless NSO natives have completed the first few production units of the ATST site survey instruments. The towers that will house the instruments have been designed, and the first tower was delivered in August. The Site Survey Working Group (SSWG), under the leadership of Frank Hill, is working hard to define the final list of selection criteria for determining the best site for the telescope. A site survey project review was held on August 21, while the ATST Science Working Group (ASWG) met in Tucson on July 24-25 to draft the science requirements document needed to finalize the telescope requirements. As the various ATST project documents and minutes of meetings are assembled, they will be placed on the ATST Web site at: *www.sunspot.noao.edu/ATST/*. Comments on the project plans and progress are always welcome. (You know a project is well underway when the acronyms start to pile up!)

Other significant activities include signing a contract with Mauna Kea Infrared for the development and delivery of an array controller and data acquisition system for the 1024×1024 Aladdin IR array camera. With 16 times as many pixels, higher quantum efficiency, lower read-out noise, and better immunity from electronic interference, the large-format Aladdin-based camera will be superior to the current 256×256 camera in every respect. The Aladdin IR camera will enable new types of scientific observations, such as vector magnetograms of weak field concentrations and high-cadence studies of chromospheric and coronal dynamics as seen in the IR. NSO has also signed a contract with Rockwell Science Center to produce two high-speed cameras using silicon sensors bump bonded to CMOS readout devices (a spinoff from Rockwell's well-known infrared devices). We plan to use these cameras as an interim solution for bringing the SOLIS vector spectromagnetograph on line during FY 2002.

As most of you are aware, the Committee on the Organization and Management of Research in Astronomy and Astrophysics (COMRAA) has been given the charge of assessing the organizational effectiveness of Federal support of astronomical sciences. From the NSO perspective, the main issues facing ground-based solar physics at NSF focus on long-range planning for new ground-based capabilities and obtaining stronger support from the Astronomy Division for research at universities. A major project like the ATST needs a sound long-range plan for both funding its development and for operation and research support to the user community. The plan should include mechanisms to promote cooperation among the various divisions within NSF and with other agencies involved in solar research, and to coordinate with the Major Research Equipment Program for timely completion of the project. We have seen several signs that planning is improving on the working level at NSF, even before the committee was given its charge. We would like to see a strong recommendation by the committee for the continuation of this level of planning and that NSF strengthen its high-level, long-range planning process.

The NSO Users' Committee met briefly in May at the joint AGU-AAS/SPD

continued

Director's Office continued

meeting in Boston to review issues facing NSO. Discussion centered on planning for the ATST and the impact the project will have on other user support, the status of the SOLIS project, and other user support issues. Tim Brown (HAO) and Dick Shine (Lockheed-Martin) have rotated off the committee, and Phil Judge (HAO) and Tom Berger (Lockheed) have joined. Our thanks to both Tim and Dick for their support and insights over the past few years.

NSO welcomes two new observing support staff. Eric Galayda and Bill Asprey are at the McMath-Pierce and Sac Peak telescope facilities, respectively. In addition, we welcome Rick Dunbar, who has joined the Sac Peak instrument shop, and Deging Ren, who is the new optical/mechanical engineer for the joint NJIT/NSO AO program.

Michael Sigwarth, who had been a strong addition to the NSO staff, both for science and instrumentation, left in August to head the Technology Department (and for better beer!) at the Kiepenheuer Institute for Solar Physics (KIS) in Freiburg. We will miss Michael. Fortunately, he remains as a co-investigator on the project to upgrade the Advanced Stokes Polarimeter – a collaborative HAO/NSO effort to match the ASP to the diffraction-limited images provided by the AO system at the Dunn Solar Telescope.

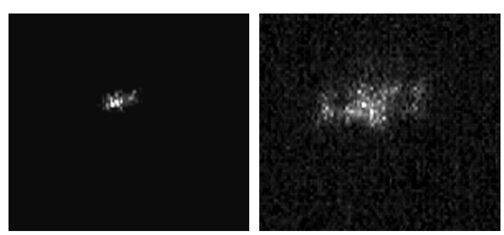
McMath-Pierce Adaptive Optics: Loop Closed in the Lab

Christoph Keller (NSO), Mark Ammons (REU, Duke), Claude Plymate (NSO)

An adaptive optics (AO) system is currently being developed for the 1.5-meter McMath-Pierce main telescope. A low-cost approach, using off-the-shelf components, will provide diffraction-limited images in the thermal infrared under most seeing conditions. Articles in previous issues of this newsletter focused on the successful tests of a correlating Shack-Hartmann wavefront sensor with several hundred subapertures. Images between 1 and 5 microns were deconvolved with the measured wavefront to demonstrate the quality of the wavefront sensing. Initial tests of the processing algorithm showed that 200 subapertures can be evaluated at a rate of about 1 kHz using a single Pentium III processor, thanks to a new instruction that speeds up motion estimation as needed.

The 37-actuator electrostatic membrane mirror from Okotech was integrated with a 36-subaperture Hartmann wavefront sensor. A complete AO system was built using a Webcam and a surplus PC. The loop on this system has been successfully closed. The figures at right are images of a point source before and after corrections have been applied with the flexible mirror. While it takes a few seconds for the corrections to take full effect, the goal of the system is not speed but to understand the operations and limits of this inexpensive, flexible mirror and the calibration of the mirror and wavefront sensor characteristics.

Current activities include optimizing the laboratory setup and the calibration procedures as well as studying the optical design of the final system, which will make use of the same flexible mirror. After purchasing a fast CCD camera running at many hundred frames per second and a fast industrial PC with a digital frame grabber, we expect to operate the laboratory setup at a speed of several hundred Hz. An operational system at the telescope should be delivered by 2003.



A laboratory point source (illuminated by a laser), through a bad piece of optics before (left) and after (right) correction by the AO system. The remaining aberrations are due to the limited quality of the point source itself.

SOLIS

Jack Harvey

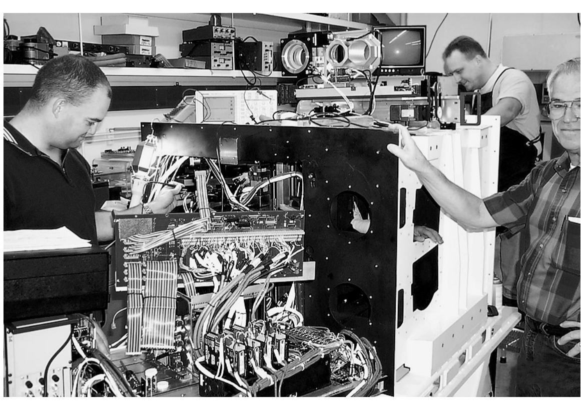
Assembly and testing of the SOLIS instruments continues. The Vector Spectromagnetograph (VSM) is presently located in a basement lab where it is being wired before being turned over to the software group for comprehensive testing. The Full Disk Patrol (FDP) housing is out for painting. The Integrated Sunlight Spectrometer (ISS) is being used to collect data and for development of flat field algorithms. The SOLIS mount, located at the Tucson GONG prototype site, is about to be turned over to the software group for final testing.

High-reflectivity coatings were applied to the VSM optics, but the two largest optics (primary mirror and a folding flat) need to be redone because they were not sufficiently cleaned by the vendor prior to coating. The recoating is scheduled at the vendor for mid-August. Ferroelectric liquid crystal modulator packages have been assembled for the FDP, and so far they are working as expected. A contract was signed with Rockwell Science Center to provide two interim cameras for the VSM by the end of this calendar year. Resulting required modifications of the VSM camera data acquisition system are being made. An ad hoc group of experts in vector magnetic field data reduction was convened to review initial plans for VSM vector field data reduction. Several excellent suggestions were made and are being pursued. Two types of reduction are planned: quick-look and high-quality. Three different quick-look algorithms are now being compared, and two high-quality algorithms are being considered. The interesting challenge of meaningfully displaying millions of vector measurements in a single image is also under investigation.

The FDP 1083 nm filter has been assembled but not yet tuned. Liquid crystal variable retarders for tuning the FDP visible filter were received and tested, and they were found to perform properly. This procurement was at risk since the manufacturer is moving into a different business area. Alternative cells used for stereo display goggles were obtained but did not meet our requirements. The temperature control system for the birefringent filters was greatly simplified as a result of a new commercial controller beocoming available.

The raw data storage system (a Storage Area Network) achieved a sustained throughput of more than 66 MB per second. The OCS software track continues to develop basic functionality for the creation and implementation of observing programs and schedules. The OCS has developed a persistent store database for observing programs. Several examples of core programs for the FDP and VSM have been used to create the database. Programs for the ISS core science are next.

The recent NAS/NRC Decadal Survey recommended building two additional SOLIS VSM units to be placed at widely separated longitudes. As a prerequisite to such a project, face-to-face exploratory contacts were made with potential partners from Spain and China with encouraging results.



The SOLIS Vector Spectromagnetograph is assembled at NSO Tucson by: (left to right) George Luis, Dave Hauts and Jim Harper

GONG

John Leibacher

The GONG+ network is complete! The deployment schedule unfolded pretty much as planned, and the transition has generally been smooth. In addition, the new camera system installations have provided the opportunity to catch up on long-delayed site maintenance. After the Big Bear installation in March, the CTIO, Learmonth, Udaipur, and Mauna Loa sites were visited in the following three months. The final GONG+ installation took place at El Teide.

Plans for the high spatial resolution processing capability (GONG++) are well underway, and the first round of hardware purchases should be in place by the fall of 2001. The 2002 annual GONG meeting will take place at the Big Bear Solar Observatory in October.

The GONG+ Deployment

Big Bear Solar Observatory was the site of our first GONG+ installation. Both deployment teams joined in to verify that our procedures were adequate and to provide task familiarity for all of the participants. After the team's departure from the site, the camera developed a problem that has since been fixed.

The CTIO upgrade went smoothly, but the visit revealed a problem with the GPS system, which, while a nuisance to troubleshoot, has been corrected.

The Learmonth transplant proceeded well, and subsequent operation has been very good. There is continuing concern about the toll the salt air is taking upon the steel shelter. Besides the usual maintenance actions taken along with the upgrade, corrosion control measures were taken to slow the rate of deterioration.

The GONG+ teams visited the Udaipur and Mauna Loa sites almost simultaneously. Except for extraordinarily bad weather at Mauna Loa, the work there went very well.

The Udaipur deployment was delayed due to shipping, which caused the installation visit to slip into the monsoon season. While more than welcomed by the local population, the extreme weather made our sunlight-dependent work a bit difficult, and resolution of some of the outstanding issues will have to wait until after the seasonal rains. After a brief stop in Tucson, the Udaipur team headed to El Tiede in the Canary Islands where they put into effect the lessons learned at Udaipur.

Because the conversion to GONG+ includes replacing Exabyte drives with DLT tape drives, the long series of reports of Exabyte failures has finally come to an end. GONG Classic is glorious history, and the era of GONG+ has begun!

Data Management and Analysis

During the past quarter, the DMAC produced month-long (36-day) velocity, time series, and power spectra for GONG Months 55 and 56 (ending in November 2000), with respective fill factors of 0.91 and 0.83, and tables of mode frequencies, which were computed from the power spectra using the three-month-long time series centered at GONG months 53 and 54.

The DMAC continued upgrading and testing systems and applications for the routine reduction of GONG+ data, and began calibrating data acquired by the GONG+ network sites. Katrina Gressett and Simon Kras have joined the DMAC GONGsters.

continued

GONG continued

Data Algorithm Developments (and some science)

Cliff Toner continues to develop methods of measuring the periodicities in the camera rotator gear train using the Ronchi ruling installed in the filter wheels. He has found that the same angular cross-correlation used to register the images themselves works equally well with the Ronchi images. A day of Ronchi images obtained at the Tucson site shows angular errors in the gears with periods of 10°, 90° and 360°. We will be performing similar observations at all of the sites to characterize the errors around the network, and will also repeat the Tucson measurements to verify the expected temporal invariance of the error.

David Landy has used Peakfind II to measure the asymmetry of the peaks in the spectrum and to assess the impact of neglecting this effect on inferences of the internal rotation rate. Comparison of the measured low-ℓ asymmetries with previous work shows good agreement, and we now have the first measurements of intermediate-ℓ asymmetries. Fortunately, a comparison of inversions using frequency splittings from symmetric and asymmetric fits indicates that the neglect of asymmetries does not introduce significant errors in the inferred internal rotation rate. David presented his results at the Boston AGU/SPD meeting and is preparing a paper.

Rudi Komm and Rachel Howe are continuing to work on localizing the activity-related variations in mode parameters to specific regions on the Sun, and Caroline Barban is proceeding on the comparison of spectra obtained in velocity and intensity.

The GONG+ instrument team during a rare moment with everyone in Tucson: (from left to right) Jean Goodrich, Roberta Toussaint, Roy Tucker, Sang Nguyen, Guillermo Montijo, Lana Britanik, Bert Villegas, Ron Kroll, and Jack Harvey.

The *Astronomy Education Review*

Sidney C. Wolff

NOAO plans to provide "seed funding" to launch the *Astronomy Education Review*, a lively electronic compendium of research, news, resources, and opinions relating to astronomy education.

The recent Decadal Survey recommended "expanding and improving engagement of astronomers in outreach to the K-12 community through training and professional recognition of the value of this work by the scientific community." The report also recommended "a national examination of effective ways to improve the understanding of fundamental scientific concepts delivered in popular introductory astronomy classes." However, it went on to note that even more difficult than the development of new curricular materials are the tasks of "(1) finding the best way to ensure that excellent materials are widely disseminated and adopted, and that teachers know how to use them, and (2) educating astronomers who are eager to reach out to their local communities so they can make the most effective use of their time." Both tasks "include the goal of preventing astronomers and educators from unnecessarily duplicating past efforts and thus 'reinventing the wheel.'"

In research, of course, we use journals as a mechanism of communicating results and preventing duplication of effort. Astronomy is one of the few major science fields with no journal to facilitate communication among educators, despite nearly a decade of talk. Now, NOAO proposes to use its existing infrastructure for electronic publication -- supplemented, we hope, with external funding to launch a journal that will meet the goals of the Decadal Survey.

The journal will consist of four distinct sections: 1) refereed papers on research in astronomy education (both new work and papers reprinted from other journals), along with specific ideas about how to apply the results of education research to "real life"; 2) short reports on innovative techniques, approaches, activities, and materials; 3) annotated lists of useful resources plus announcements of opportunities in education (funding, employment, workshops and symposia, materials testing, etc.); and 4) editorials, resource reviews, opinion pieces, and interactive discussion.

How will it work? We intend to serve five educational arenas: K-12, undergraduate, graduate, informal, and public outreach. There will be a strong board of editors with members from each arena, and every published article will be reviewed either by an editor or an expert reader selected by the editor. The publication will be electronic in order to avoid the costs of paper, printing, and distribution. The goal is to make the journal available free of charge so that it can reach as large an audience as possible. After an initial start-up period, we will require readers to register so that we can track the size and interests of the audience as a measure of the journal's impact and success. The material will be presented in a printer-friendly format and designed to resemble a journal publication, with volume and page numbers that can be listed in bibliographies. In addition, each article will be classified by topic and become part of a searchable database on the NOAO Web site. Articles will be posted as soon as they are reviewed and accepted, but we will publish quarterly issues. Whenever an issue is released, we will send registered readers an electronic message describing briefly what is in the issue, along with abstracts of major articles and links to the main journal, so that readers can easily follow up on matters of interest.

The Astronomical Society of the Pacific has agreed to be a co-sponsor of the journal, and we will seek additional sponsorship from other appropriate professional societies. The journal will be launched by NOAO, but after it has proved its value and reached a steady state in terms of costs and effort, it may be appropriate to transfer management of the journal to one of the societies.

The initial start-up effort is being carried out mainly by Andrew Fraknoi and Sidney Wolff, who will serve as lead editors, with a great deal of assistance from David Bruning. We will appoint an editorial board soon.

If you have suggestions for content, ideas for specific articles, or if you would like to help out, please contact: *swolff@noao.edu*. Watch the NOAO Web site for an announcement of the first issue in the next few months.

Educational Outreach Update

Suzanne Jacoby

Project ASTRO continues to grow strong at NOAO/Tucson, having formed more than 250 ongoing partnerships since 1996 between astronomers and teachers to bring hands-on activities into science classrooms. We recently signed a Memorandum of Understanding with the Astronomical Society of the Pacific to continue for the sixth year as lead institution for the expansion of Project ASTRO into the Tucson area. As reported by Connie Walker at the Pasadena AAS Meeting, the Project ASTRO-Tucson Web pages have been updated to include video demonstrations of Moon-related Project ASTRO activities, including Phases of the Moon and crater formation. Check them out at: *www.noao.edu/outreach/astro/*.

Recent copies of the quarterly *ASTROgram Newsletter* included application materials for the fall workshop, which will be held in Tucson in September. For the third consecutive year, Joni Chancer and Gina Rester-Zodrow, authors of *Moon Journals: Writing, Art, and Inquiry through Focused Nature Study*, will present at the workshop.

The National Science Foundation's Educational and Human Resources Directorate has awarded up to $1.8 million to NOAO Educational Outreach over the next five years to develop Teacher Leaders in Research Based Science Education (TLRBSE). Under the direction of Suzanne Jacoby and co-investigators Travis Rector (NOAO), Jeff Lockwood (TERC), and Don McCarthy (UA), the program will develop a summer institute and year-round distance learning courses promoting skills in leadership, inquiry-based pedagogy, and authentic research experiences for middle and high school teachers.

Ten graduates of our previous RBSE Teacher Enhancement Program came to Tucson in July to assist with the development of the new program. Key features of this summer's institute were observing experiences at Kitt Peak National Observatory and the National Solar Observatory at Sacramento Peak, New Mexico, as well as numerous focus groups with participants to determine the priorities and essential elements of TLRBSE. Recruitment for the 2002 TLRBSE program has already begun.

In Brief

Major efforts are underway to improve the appearance of the **Kitt Peak Visitor Center**, both externally and internally. New projects include replacement of the front patio for both aesthetic and safety reasons, revised lighting and wall coverings inside the Visitor Center, and the addition of more interactive exhibits. A related marketing push (including a new brochure with wider distribution) began this quarter to increase popular awareness about the interesting things to see and do on Kitt Peak, and it has already led to a noticeable increase in mountain guests.

An NOAO **press release** about the discovery of a **Charon-sized Kuiper Belt Object** by the Deep Ecliptic Survey team, led by Lowell Observatory Director Robert Millis, received extensive news media coverage. An Associated Press wire story appeared in numerous locations in early July, along with stories in USA TODAY, CNN.com, CBS.com, BBC.com, and nearly every major space news-oriented website.

A **Gemini North NIRI image** of the young, massive star AFGL 2591 that was released to the media on July 23 received good coverage on the Web. Its visual appeal helped the Gemini home page be named as an Internet "Hot Site" by USA TODAY's Web site.

The September issue of ***Sky & Telescope*** magazine features a four-page story on the **NOAO Deep Wide-Field Survey**, triggered by a NOAO press release and a large exhibit display image at the January 2001 AAS meeting.

Vincent Davis, a junior at Elizabeth City State University in North Carolina (LEFT), and Nelvin Thomas, a recent graduate of the University of the Virgin Islands (RIGHT) worked with GONG's Roy Tucker on a Research Experiences for Undergraduates (REU) summer project to search for near-Earth objects using Tucker's backyard observatory west of Tucson. Their efforts were featured on the front page of the Tucson section of the Arizona Daily Star newspaper.

The students reported 18 detections to the Minor Planet Center. All of the detections turned out to be previously discovered objects, but the students were complimented on the high quality of their astrometry data.