>>>NOAO/NSO Newsletter

NATIONAL OPTICAL ASTRONOMY OBSERVATORY/NATIONAL SOLAR OBSERVATORY

ISSUE 92 — DECEMBER 2007

Big Plans for the January 2008 AAS Meeting

We will be offering multiple ways for you to interact with NOAO staff members and learn more about the newest programs and capabilities at the national observatory during the January 2008 meeting of the American Astronomical Society (AAS) in Austin, Texas.

Our exhibit booth space has been super-sized to include ongoing demos and technical assistance from the NOAO Gemini Science Center and the Data Products Program. We will also be offering mini-presentations during coffee breaks on emerging capabilities such as observing with the NEWFIRM wide-field infrared imager on the Mayall 4-meter telescope at Kitt Peak, adaptive optics on the 8-meter Gemini telescopes, new instruments at the SOAR 4.1-meter telescope in Chile, and the chance to form science collaborations for the Large Synoptic Survey Telescope. See the NOAO booth for a full schedule of talks and events.

In addition, there will be an NOAO town meeting on Thursday, January 10, at 12:30 pm. The town meeting will highlight the future direction of the NOAO program in optical/infrared astronomy, built around our new five-year plan, which responds to the recommendations of the NSF Senior Review. Key issues include:

- The outcome of the Renewing Small Telescopes for Astronomical Research (ReSTAR) committee and their list of capabilities needed on small and mid-sized telescopes
- Improvements happening now to Cerro Tololo Inter-American Observatory and Kitt Peak National Observatory
- A plan for access to an optimized suite of high-performance telescopes of all apertures
- Community participation in the science investigations for the Large Synoptic Survey Telescope
- Community representation in extremely large telescope projects (such as the Thirty Meter Telescope and Giant Magellan Telescope)

This meeting should be of interest to all current and future NOAO users, and to potential partners with NOAO in telescope development and new instrumentation projects. There will also be a chance to win a special raffle prize—and you must be present and have visited the NOAO booth in advance to win!

The new NOAO program establishes a balance among facilities of different scales and capabilities, and that balance must be guided by continuing community input. We look forward to talking with you in Austin.

NOAO TOWN MEETING AT AAS
THURSDAY, JANUARY 10 AT 12:30 PM

FIND OUT ABOUT THE NEW NOAO PROGRAM

LEARN ABOUT NEW INSTRUMENTS,
NEW TELESCOPES, NEW ACCESS!

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

Douglas Isbell, Editor

Section Editors

Abhijit Saha	Science Highlights
Dave Bell	Observational Programs
Mia Hartman	Observational Programs
Christopher J. Miller	Data Products Program
Nicole S. van der Bliek	CTIO
Buell T. Jannuzi	KPNO
Ken Hinkle	NGSC
Sally Adams	NGSC
John Leibacher	NSO
Priscilla Piano	NSO
Douglas Isbell	Public Affairs & Educational Outreach

Production Staff

Sheryl Falgout	Managing Editor
Peter Marenfeld	Design & Layout
Kathie Coil	Production Support

On the Cover

This image of edge-on spiral galaxy NGC 891 was taken during a commissioning run of the new WIYN High-Resolution Infrared Camera (WHIRC) on the WIYN 3.5-meter telescope at Kitt Peak National Observatory. The image was taken on September 27 in seeing conditions of about 0.5 acrsec FWHM, with no tip/tilt correction. The false-color image is a composite of images in the J (blue), H (green) and K_s (red) bands.

The WHIRC instrument, built by Margaret Meixner (Space Telescope Science Institute) and collaborators, will be offered to the community for shared-risk observing in Semester 2008A. For more details, see the article in the Kitt Peak section.

Credit: M. Meixner (STScI), M. Povich (University of Wisconsin), R. Joyce and WIYN/NOAO/AURA/NSF

A 15.65 Solar-Mass Black Hole in an Eclipsing Binary in M33

Jerome A. Orosz (San Diego State University), Jeffrey E. McClintock &
Ramesh Narayan (Harvard-Smithsonian Center for Astrophysics)

Stellar-mass black holes are found in X-ray-emitting binary systems, where their mass can be determined from the dynamics of their companion stars. The masses of more than 20 such black holes have been measured. A recent addition to this family, M33 X-7, is a beauty because it is the only known black hole that is eclipsed by its companion star (Pietsch et al. 2006). Furthermore, its precisely known distance (840±20 kpc) and the sharp eclipse of the X-ray source, constraints that are unavailable for Galactic black-hole binaries, have yielded the most accurate mass measurement that has been achieved for any black hole (Orosz et al., 2007). Finally, with a mass of 15.65±1.45 solar masses, M33 X-7 is the most massive stellar black hole known.

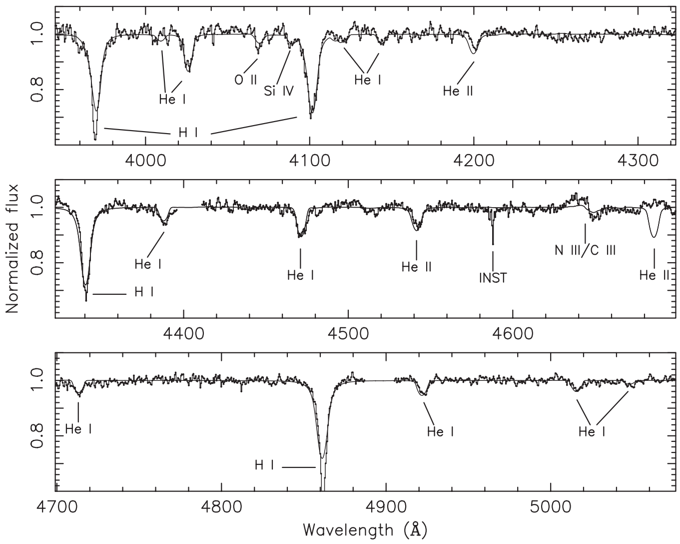


Figure 1. Mean optical spectrum of M33 X-7 shown here is the sum of the individual spectra that have been velocity-shifted to the rest frame of the secondary star. The solid line is a model spectrum for a metallicity of 10% of the solar value and with T_{eff}=35,000 K and log g=3.75, which corresponds to a spectral type of O7–8III. Figure from *Nature* (Orosz et al., 2007).

The determination of a precise mass for M33 X-7, located at a distance of more than 16 times that of any other confirmed stellar black hole, marks a major advance in our capability to study stellar black holes in Local Group galaxies beyond the Milky Way. This advance was made using GMOS on Gemini North in 27 hours of observations during fall 2006. Queue scheduling allowed good sampling of the 3.45-day orbital phase. More importantly, it provided consistently good seeing (always < 0.8 arcsec), which permitted clean observations of the V=18.9 mag optical counterpart of M33 X-7. Two-dozen spectra and corresponding pairs of g' and r' direct images were obtained.

The summed spectrum is shown in figure 1 and the radial velocity curve in figure 2a. The velocity semi-amplitude is K_2=108.9±5.7 km s^{-1} and the corresponding value of the mass function is f(M)=(0.46±0.08) solar masses. Figure 2b shows the optical light curves in the g' and r' filters. The ELC code (Orosz & Hauschildt 2000) was used to find the optimal binary model; the input data include the light curves, the radial velocity amplitude, the radius and rotational velocity of the companion star, and the width of the X-ray eclipse.

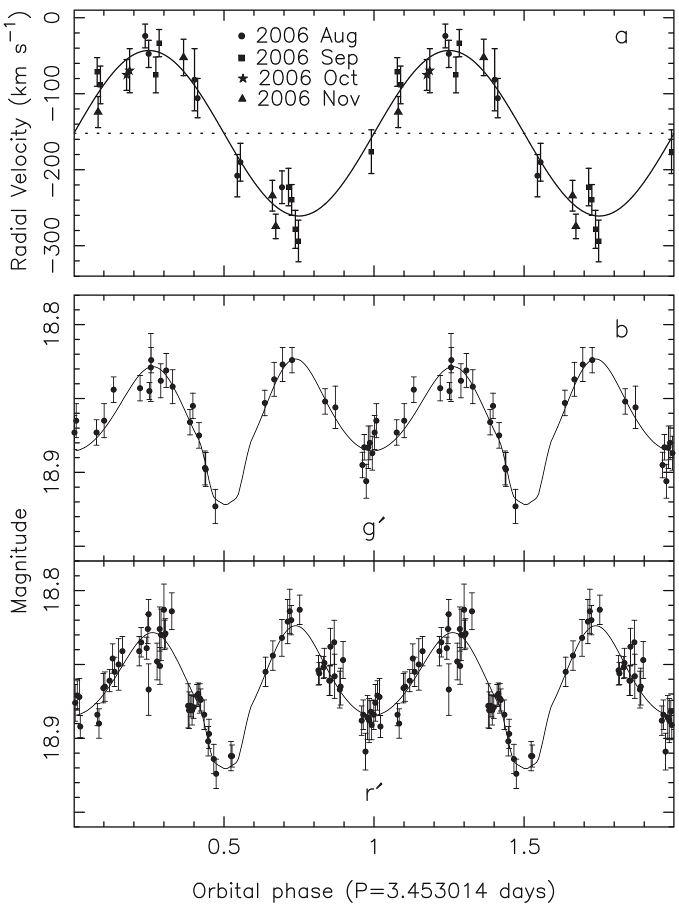


Figure 2. Radial-velocity and light curves for M33 X-7. (a) The best-fitting model is shown as a solid line; the dashed line is the best-fitting sinusoid. (b) Gemini g′ and r′ light curves.

The mass of the companion is M_2=70.0±6.9 solar masses, which puts it among the most massive stars with well-determined masses. A schematic sketch to scale of the binary system is shown in figure 3. M33 X-7 is a key system in the study of high-mass stars, high-mass

continued

15.65 Solar-Mass Black Hole continued

X-ray binaries, and high-mass black holes. A 16 solar-mass black hole paired with a 70 solar-mass secondary with a separation of only 42 solar radii is very difficult to explain using stellar evolutionary models (Orosz et al. 2007).

Using the precise values of black hole mass, distance and orbital inclination as the essential springboard, we have gone on to determine the spin of M33 X-7 (Liu et al. 2007), as we have done previously for three other stellar black holes (Shafee et al. 2006; McClintock et al. 2006). Profoundly, the two parameters that specify mass and spin suffice to completely describe an astrophysical black hole, which is simpler than an electron. With the mass and spin of M33 X-7 in hand, we now have a complete description of this 100-km object that is situated at a distance of about 10^{20} km!

REFERENCES

Liu, J., McClintock, J. E., Narayan, R., Davis, S. W. & Orosz, J. A. 2007, in preparation.

McClintock, J. E., Shafee, R., Narayan, R., Remillard, R. A., Davis, S. W. & Li, L.-X. 2006, *ApJ*, 652, 518.

Orosz, J. A. & Hauschildt, P. H. 2000, *A&A*, 364, 265.

Orosz, J. A., McClintock, J. E., Narayan, R., Bailyn, C. D., Harman, J. D., Macri, L., Liu, J., Pietsch, W., Remillard, R. A., Shporer, A. & Mazeh, T. 2007, *Nature*, 449, 872.

Pietsch, W., Haberl, F., Sasaki, M., Gaetz, T. J., Plucinsky, P. P., Ghavamian, P., Long, K. S. & Pannuti, T. G. 2006, *ApJ*, 646, 420.

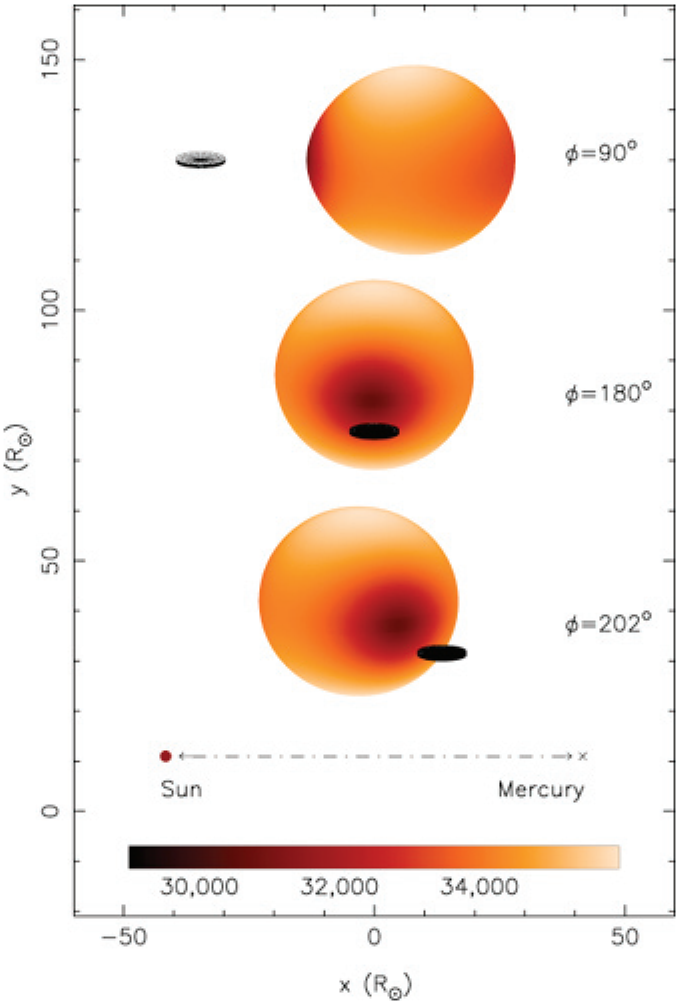


Figure 3. Schematic diagram of M33 X-7. The companion O-star star and the accretion disk surrounding the black hole are shown to scale, as seen projected onto the plane of the sky at three orbital phases. The distance between the Sun and Mercury is indicated, and the figure is scaled in solar radii. Figure from *Nature* (Orosz et al. 2007).

Observations of Mercury's Sodium Tail

Andrew Potter (NSO) & Rosemary Killen (University of Maryland)

Why does Mercury display a tail of escaping sodium atoms? The velocity for escape from Mercury is 4.25 km/sec, corresponding to an energy of about 4.3 eV for sodium atoms. However, the energies provided to sodium atoms by the source processes on Mercury (photosputtering, particle sputtering, and meteoroid impact) are not sufficient to allow the atoms to escape from the planet.

The answer must be that solar radiation accelerates the atoms, adding enough energy to whatever source energy they initially possessed to allow them to escape into the tail. Solar radiation acceleration can be exceptionally large for sodium on Mercury, reaching 54% of surface gravity at maximum radial velocity. The minimum radiation acceleration needed to boost sodium atoms into the tail is a measure of how much energy must be added for escape. The difference between the energy provided by this minimum value and the escape energy is a measure of the initial source energy of the tail atoms.

continued

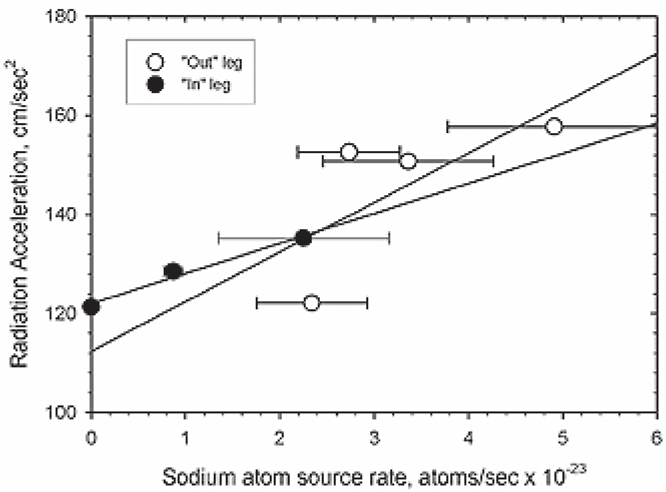


Figure 1. The minimum values of radiation acceleration needed to generate sodium atoms in the tail are represented by the intercepts.

Observations of Mercury's Sodium Tail continued

To find the minimum radiation acceleration needed for tail formation, we used the NSO/Kitt Peak McMath-Pierce Solar Telescope to measure cross-sections of the sodium tail intensity at different distances downstream for a range of values of solar radiation acceleration, both for Mercury approaching the Sun, and Mercury receding from the Sun. These data were used to calculate the rate that sodium atoms were projected from Mercury into the tail in terms of atoms/sec. Over the range of radiation acceleration values studied, the source rates ranged between 2 and 6×10^{23} atoms/sec, corresponding to only 10–20 grams/sec of sodium projected into the tail. This represents somewhere in the range of 1 to 10% of the estimated total sodium generation rate on the planet.

With these data, we were able to find the radiation acceleration value at which the sodium source rate and, consequently, the tail disappear. This is shown in figure 1, where radiation acceleration is plotted against average source rate and extrapolated to zero source rate. For the case that Mercury is moving away from the Sun, the limiting value of radiation acceleration required to produce an observable sodium tail was estimated to be 112 ± 24 cm/sec^2. For observations where Mercury was moving toward the Sun, the emission intensity in the sodium tail decreased very rapidly with distance downstream, disappearing entirely beyond 12,000 kilometers (6 R_m) for radiation accelerations of 128.7 and 135.4 cm/sec^2. For smaller radiation accelerations, the sodium tail was not detectable at all, yielding a limiting value for tail generation of about 122 ± 2 cm/sec^2.

Previous work (Potter, et al., *Icarus* 186, 571, 2007) has shown that sodium atoms on Mercury are exposed to solar radiation acceleration for an average of about 1,700 seconds before they interact with the surface, or are photoionized. We can use this time to calculate the energy added to a sodium atom by solar radiation acceleration. The difference between this energy and the energy required for escape represents the energy that must have been imparted to the sodium atom by the source process in order for the atom to escape. These differences are plotted in figure 2, where the additional energy required for escape is plotted against radiation acceleration.

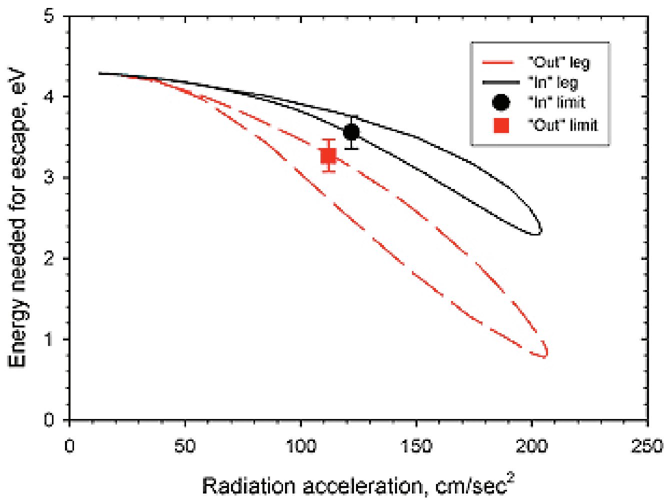


Figure 2. The energy needed for escape from Mercury of sodium atoms accelerated by solar radiation. Data points represent the observed limits for tail generation.

The limiting energies derived from the observed limiting radiation accelerations are plotted as individual points on this graph. Their position shows that the source process for sodium atoms that enter the tail must impart energies in the range 3.2 – 3.5 eV. This range is consistent with the value of 2.9 eV calculated for sputtering of sodium atoms by solar wind particles (Wurz *et al.*, *Icarus,* 2007). We conclude that sodium atoms in the tail have been generated by sputtering from the surface of Mercury by the impact of solar wind particles. These results have been accepted for publication in *Icarus*.

Mesospheric Winds on Venus from High Spectral Resolution Observations of CO_2

G. Sonnabend, M. Sornig, P. Krötz, D. Stupar, R. Schieder
(University of Cologne)

During May and June 2007, we successfully operated the Cologne Tunable Heterodyne Infrared Spectrometer (THIS) at the NSO/Kitt Peak McMath-Pierce Solar Telescope facility to observe CO_2 emission features from Venus in the 10 µm wavelength range. The observations were part of an internationally coordinated ground-based observing campaign in support of the European Space Agency's Venus Express mission.

Ground-based observations are often essential for gathering complementary space-mission data that are not available from the spacecraft. For example, high-altitude winds are a key parameter in understanding the dynamics of planetary atmospheres, but they are difficult to measure.

The non-thermal (non-LTE) emission that we observed originates in a thin layer at ≈ 100–120 km altitude in the mesosphere of Venus. Wind speeds can be directly derived from frequency shifts in the line positions relative to the rest frequency of the observed feature.

The Cologne heterodyne instrument consists of an optical receiver and common back-end electronics, including an acousto–optical spectrometer. Inside the receiver, the single-mode emission from a local oscillator laser is superimposed on the infrared radiation

continued

Mesospheric Winds on Venus continued

coming from the telescope and detected on a fast mercury-cadmium–telluride detector. Using this technique, the spectral information is shifted from the mid-infrared to the radio range, allowing amplification, filtering, and frequency analysis of the signal using a high spectral resolution radio frequency spectrometer. A photo of the setup at the McMath-Pierce facility and a schematic are shown in figure 1.

The receiver employs tunable quantum–cascade lasers as local oscillators, which allow operation between 8 and 17 µm wavelength. A spectral resolution of 3×10^7 can be achieved corresponding to 1 MHz or 10 m/s at a wavelength of 10 µm. The bandwidth is 3 GHz. The sensitivity of our instrument is within a factor of two of the theoretical limit for a heterodyne receiver. The frequency stability is in the range of the resolution and actively monitored by periodic detection through a reference gas cell.

During the May–June period, we acquired data from ≈20 positions on the disk of Venus. At 10 µm wavelength, the McMath–Pierce telescope with its 1.5-meter aperture can easily resolve the planet, allowing a high spatial resolution not available, for example, at sub–millimeter wavelengths. A typical spectrum is shown in figure 2, which shows the CO_2 P(2) emission line at 959.39 cm^{-1}. The spectrum is plotted at the full 1 MHz spectral resolution. The fit (red line in color version available online) yields a wind retrieval error of 10 m/s. The offset of the emission peak from the feature's rest frequency yields wind information directly.

The high-atmosphere winds of Venus are believed to consist of two superimposed general flow patterns: a zonal component, which is strongest at the level of the clouds (> 100 m/s at ≈ 65 km) and fades out at higher altitudes, and a strong flow from the sub-solar to the anti-solar point generated by the thermal input from the Sun. The observing geometry was such that a relatively easy separation of the two components is possible. Data analysis is not yet completed, but a first look at the zonal component (see figure 2) suggests an unexpected mid-latitude jet configuration. Until recently, zonal winds were expected to be strongest at the equator, where

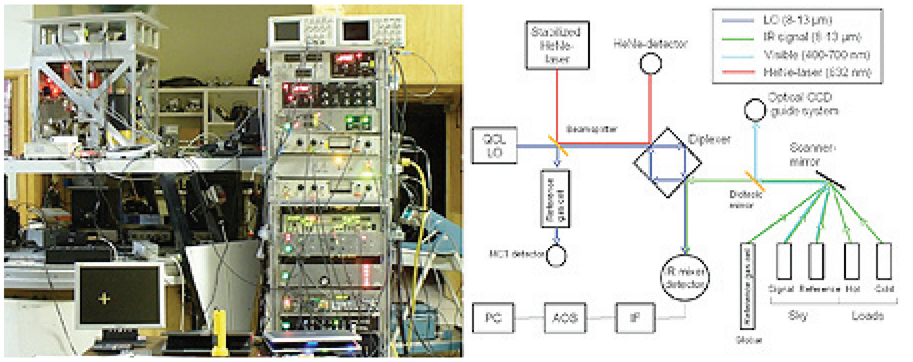


Figure 1: Left: THIS setup at the McMath-Pierce main telescope. The optical receiver (cubic aluminum structure on the left) and back–end electronics (19-inch rack on the right including the AOS). Right: Schematic of the optical receiver: laser (LO) and signal (switchable between telescope and two loads at known temperature for calibration) are combined by a diplexer and focused on the detector. After filtering and amplification, the frequency analysis is done using an AOS.

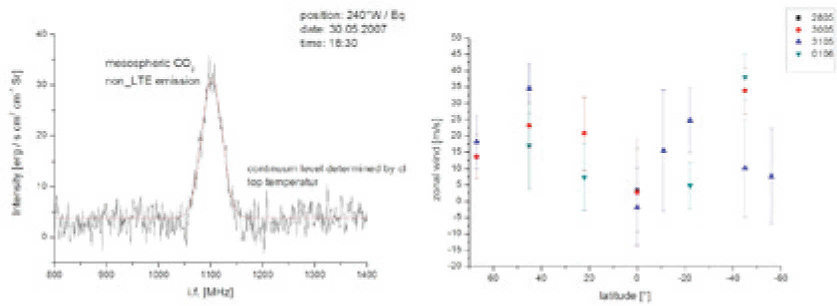


Figure 2: Left: CO_2 P(2) emission line at 959.4 cm^{-1}. The spectrum is shown at a 1 MHz spectral resolution. The fit (red line in color version online) yields a wind retrieval error of ≈ 10 m/s. The offset of the emission peak from the feature's rest frequency directly yields wind information. Right: Preliminary analysis of the zonal wind. Shown are the retrieved wind velocities vs. the latitude on Venus. The values hint at a double jet circulation at mid-latitudes, also detected at lower altitudes by different techniques.

our measurements yield nearly zero winds. One-third of the data have been analyzed as of this writing, and further interesting results are anticipated.

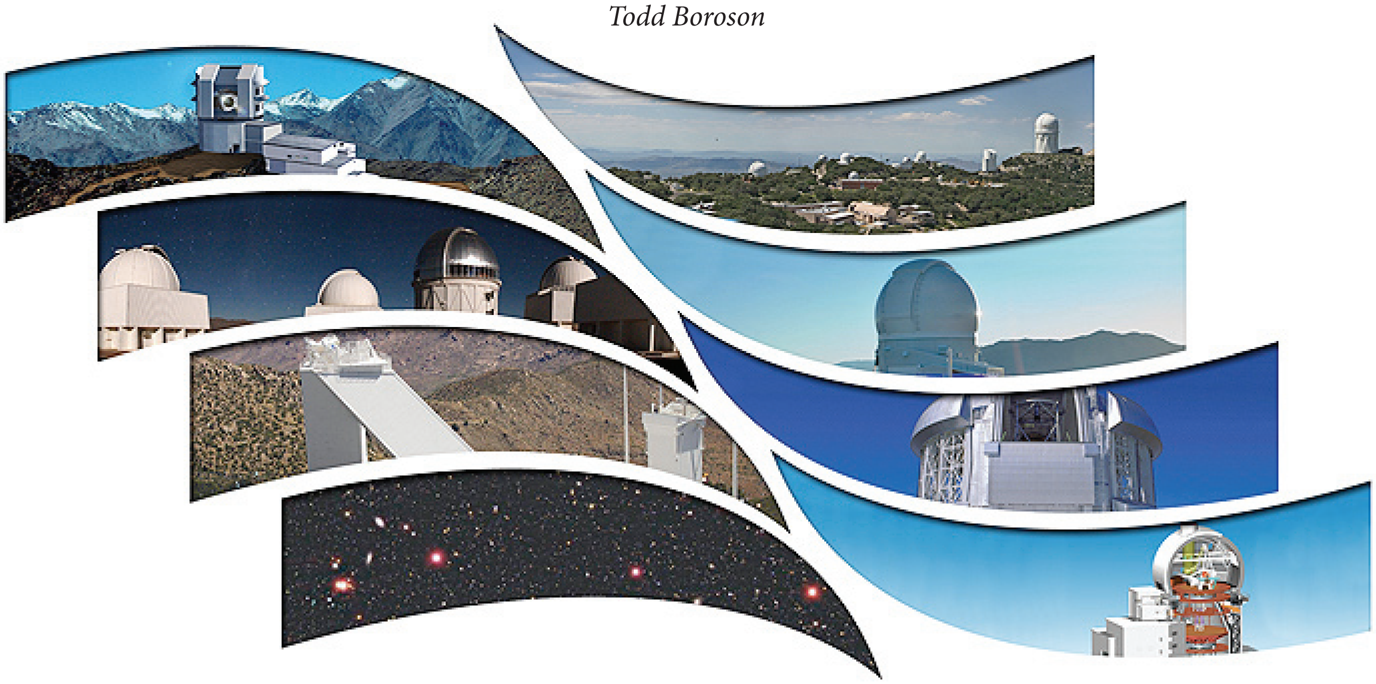
Heterodyne spectroscopy is a versatile tool for studying planetary atmospheres. Future projects include further observations of dynamical properties of the atmospheres of Mars, Venus and Jupiter's moon Io, as well as studies of small hydrocarbons in the atmospheres of the outer planets. In the long run, THIS is planned to be operated on the stratospheric observatory SOFIA. The main goal will be the detection of cold interstellar H_2 against moderately hot infrared sources at wavelengths around 17 µm and 28 µm wavelength. Until SOFIA becomes operational, further ground-based observations of planetary atmospheres, as well as observations of stellar atmospheres from various telescopes, are on the agenda.

Suggestions for further reading:

• Sonnabend, G., et al. 2006, "High Spatial Resolution Mapping of Mars Mesospheric Zonal Winds by Infrared Heterodyne Spectroscopy of CO_2," *Geophys. Res. Lett.* 33, L18201.
• Sonnabend, G., Wirtz, D., Schieder, R., 2002, "THIS – A Tuneable Heterodyne Infrared Spectrometer for Atmospheric and Astronomical Studies," *Appl. Opt.* 41, 2978.

The New NOAO Program: A Synopsis of Our Cooperative Agreement Renewal Proposal

Todd Boroson



By the release date of this *NOAO/NSO Newsletter*, AURA will have submitted its proposal to the NSF to renew our agreement to operate NOAO, running until March 2013. This proposal will not be competed, so we are eager to share its contents with the community now. The development of the new five-year program has been an effort in which the entire staff participated, and so I have asked the *Newsletter* section editors to provide individual reports on the plans for each part of the program. In this article, I will give an overview.

The new NOAO program is guided to a great degree by the recommendations of the NSF Senior Review and subsequent discussions with NSF astronomy division staff. Stripped to its essentials, the program can be summarized in two overarching goals:

1. provide access to an optimized suite of high-performance telescopes of all apertures
2. engage the community to ensure that everyone knows what NOAO is doing and NOAO knows what the community wants.

Each of these goals will be implemented through multiple activities.

The phrase "optimized suite of high-performance telescopes" requires that we make sure that the telescopes we are operating are, in fact, efficient and well-instrumented. Therefore, we are renewing the infrastructure at our Kitt Peak and Cerro Tololo observatories by improving and updating the mountaintops (e.g., roads, utilities), by modernizing the operation of the telescopes (new control systems for telescopes and instruments), and by installing the support facilities (clean rooms, sky monitoring instruments) that will allow us to develop and deploy new, modern instrumentation.

The other 90 percent of the job is to build a complete, robust system of capabilities that are aligned with the community's aspirations. This is a multi-part process that has started already with the Renewing Small Telescopes for Astronomical Research (ReSTAR) committee, which has gathered a great deal of community input and is formulating recommendations that will determine what we need to build and how much of it. That optimized suite—including, potentially, new instruments for NOAO telescopes, new access to existing telescopes, and partnerships to develop new telescopes—will begin to become more obvious when ReSTAR completes its work. I expect to begin informing you about the details at the winter AAS meeting in Austin, Texas, this coming January.

This ground-based optical/infrared system is not limited to the small and mid-sized telescopes that ReSTAR is examining. It includes the Gemini Observatory and other large telescopes, and ultimately, the telescope initiatives of the last decadal survey: the Large Synoptic Survey Telescope (LSST) and the Giant Segmented Mirror Telescope (GSMT). Therefore, the NOAO Gemini Science Center (NGSC) and our LSST and GSMT programs will all be working to fit better into this new context. For NGSC, this will mean a renewed effort to translate community desires into more observing nights, better support, and new instrumental capabilities.

continued

The New NOAO Program continued

The second goal, "engage the community," is less of a recommendation from the Senior Review and more of an observation of what we must do to be successful. It is clear that relegating the breadth of researchers and educators who use our facilities to a single word, "community," is a gross simplification, and this is actually part of the problem.

There are some astronomers who are driven to solve the next big problem; some who want to bring their students along on their observing runs so that they can learn how far to trust the data; others who have found a fascinating object or phenomenon and want to continue to study it to understand it better; and still others who want to remain active researchers because it makes them more effective teachers. There are many people for whom several of these motivations apply. What we have learned is that our program cannot choose one of these above the others. The national observatory must serve the national community.

So, what you will see in the future is a *balanced* program. It will attempt to provide those capabilities needed to carry out the best science, but it will recognize that astronomy is a rich subject in terms of interests and in terms of techniques. As a result, the job of engaging the community is twofold: first, in order to be seen as successful, we must explain what we are doing in a way that leads to trust; second, in order to evolve, we must understand what our constituents and potential constituents want now, and what they will want in the future. The first will involve the renewal of some traditional media, and the use of some new ones. We will work to keep our current activities in public view, and we will do it in ways that will force people to stop thinking of us as the same old NOAO. The second will involve developing new ways to solicit public input. I think that the 150 surveys submitted to the ReSTAR committee are a good start, but what I envision in the longer term is more of a dialogue.

The articles spread throughout this *Newsletter* will give you some idea of the priorities of the new program. Come to the NOAO town meeting at the Austin AAS meeting (Thursday, January 10, at 12:30 pm) for a more complete and detailed description, and the start of this new discussion. NL

Instrumentation for the System

David Sprayberry

Viewing the NOAO instrumentation program in the context of its role as steward of the entire system of ground-based optical/infrared (O/IR) capabilities motivates a new outlook for those efforts. Under AURA's previous cooperative agreement with the NSF, instrument development work at NOAO was directed primarily at building instruments for Gemini. As the flagship publicly available facility, Gemini remains at the core of the US System, and so NOAO will continue whenever appropriate to support the construction of new instruments for it.

However, just as the whole "System" is much broader than Gemini alone, the NOAO instrument program should look to address the broader instrumentation needs of the rich range of telescopes that make up the System. Future NOAO instrumentation projects will address this broader goal of ensuring that the US community has access to a state-of-the-art suite of properly instrumented telescopes of all apertures.

In keeping with this broader role, the instrumentation program will become part of a new System Division at NOAO. Inclusion within the System Division will help ensure that the scientists, engineers and technicians working on instrument projects are aware of and able to support all System-related activities that involve or may affect instruments and their applications. It will also allow the instrumentation program to draw on the strengths of other parts of the System Division when needed to serve an instrument project. In connection with this organizational change, the instrumentation program will also change its name from "Major Instrumentation" to "System Instrumentation."

In the short run, very little will change in terms of the day-to-day work going on within the System Instrumentation Program. As the current AURA cooperative agreement comes to a close, we have just completed the NEWFIRM wide-field infrared imager for the NOAO 4-meter telescopes. We are hard at work on the SOAR Adaptive Module (SAM) and on new development work for applications of the MONSOON controller to support large focal plane imagers (the WIYN-One Degree Imager and the Dark Energy Camera for the Blanco), and we are supporting the infrastructure improvements on existing KPNO and CTIO instruments. Those efforts will continue into the term of the new cooperative agreement and through to completion.

The primary change with the start of the new cooperative agreement will be a refocusing of our scientific and engineering leadership on planning new developments in service of the entire System. We have supported the efforts of the Renewing Small Telescopes for Astronomical Research (ReSTAR) committee to identify the scientific capabilities most urgently needed on mid-sized telescopes throughout the System, and we will continue to apply the conclusions of ReSTAR in proposing for supplemental funding to carry out its recommendations. In addition, we will be working as appropriate with the operating divisions—CTIO, KPNO, and NGSC—and with the other parts of the System Division such as the Telescope System Instrumentation Program and the Giant Segmented Mirror Telescope Project Office to support and promote the aspects of their work that require expertise in instrument development and maintenance.

As we progress through the term of the new cooperative agreement, we anticipate that there will be exciting opportunities to develop one or more new instruments. These developments may be built for a telescope that NOAO operates, such as the Blanco or Mayall, or in which NOAO is a direct partner, such as SOAR or WIYN. Or these developments could be built for other telescopes whose owners/operators have agreed to participate in the national System.

continued

Instrumentation for the System continued

The ReSTAR committee will very shortly release its recommendations for improvements that the System needs, and immediately following that report NOAO will begin seeking funding for such improvements and negotiating arrangements with other interested parties to realize these enlargements and enhancements of the System. The System Instrumentation Program will be a vital part of the whole process of funding, negotiating, and implementing the ReSTAR recommendations.

One thing that will not change is that NOAO's instrument projects will be carried out via partnerships with other institutions, such as university instrument programs. A partnership approach to instrument building makes sense, both as a matter of good policy and as a matter of programmatic necessity. It is good policy because it encourages broader community involvement in the System by engaging the community's talents and providing resources to support those talents. It is necessary for the success of the program because NOAO does not have the in-house resources to complete an entire instrument project of any scale and must supplement its own strengths with those of complementary partners to get a significant project done. By partnering with university groups and other observatories, we are able to take on larger projects and in doing so, we are able to ensure that the goals, designs and executions of the project are connected to the community's needs and strengths.

The new cooperative agreement will be a period of significant and continuing evolution for the System Instrumentation Program. We are confident it will provide a number of exciting opportunities to enhance the capabilities of the US ground-based O/IR system.

The GSMT Program Office – The Next Five Years and Beyond

Jay Elias

The most recent decadal survey recommended national participation in an extremely large telescope (ELT) as its highest priority for ground-based astronomy. The AURA New Initiatives Office was formed in response to this recommendation to pursue a "Giant Segmented Mirror Telescope" (GSMT) with a 20-meter aperture or greater, and began laying the groundwork for such community participation. This effort evolved into a partnership with the Thirty Meter Telescope (TMT) project, as well as provision of some NSF funding for the design and development of the Giant Magellan Telescope (GMT) project, both of which intend to develop and construct an ELT, with first light occurring around 2016. This date is critical because it provides overlap between full science operations of the ground-based ELT and the operational period of the James Webb Space Telescope.

The NSF Senior Review, held last year, recommended that federal participation in TMT and GMT be scaled back, in recognition of the lack of availability of construction funding on the timescale desired by both projects. The NSF followed this recommendation, and directed AURA to withdraw from direct participation from TMT and GMT, although some design and development funding for both will continue through FY 2009. However, eventual community access to a telescope (or telescopes) of this size remains a goal, and the AURA New Initiative Offices morphed into the GSMT Program Office (GSMTPO), with the continued mission of the pursuit of this goal, as outlined below.

Significant federal funding for participation in an ELT project will not be potentially available until after 2010, so the NSF has indicated that the upcoming decadal survey should re-examine the priority for such participation. GSMTPO's first task, therefore, is to revisit the science case for GSMT community access. This effort is being led by the GSMT Science Working Group, which has also been restructured to include a larger proportion of representatives from outside the two US ELT projects.

The revised science case will examine not only large "key project" science efforts, but also the prospects for small "principal investigator-class" programs. It will do so under the assumption that federal participation in an ELT will be as part of a robust system of optical/infrared telescopes including the full range of apertures now supported. The NSF has designated NOAO as its GSMT Program Manager, so GSMTPO is also "observing" the progress of both GMT and TMT by attending major design reviews and scientific working group meetings, in much the same way as other potential partners for the projects. This role may expand to include the European ELT effort as well.

In addition, GSMTPO is in the final phases of a site survey carried out in cooperation with TMT. The work is expected to result in the selection of a specific site for TMT around the middle of next year, and the publication of the survey data for all the sites under study. NOAO may elect to continue work at a site (or sites) not selected by TMT if there is a strong community interest in further characterization of that site.

GSMTPO efforts after the next decadal survey will depend on the survey committee's recommendations, on the prospects for NSF financial support of community ELT access, and—of course—on the status of the two US-based projects. Both projects are currently figuring out how to proceed in the absence of secure NSF funding. If the NSF budget permits it, funding support eventually could come in the late phases of construction, for example for additional instruments (with opportunities for community participation), and in support for operations after construction. GSMTPO would then shift from an observer role to that of a partner, representing the interests of the US community.

Clearly there is much uncertainty involved, but if plans to double the NSF budget over the next decade materialize, and if this increased budget is reflected in funding for astronomy facilities, there is a real and exciting prospect for community GSMT access and the science opportunities it would provide. In the meantime, GSMTPO will be working to ensure that NOAO and the community are ready to take advantage of the opportunity when it arises.

The Next Five Years at Gemini: Opportunities for the US Community

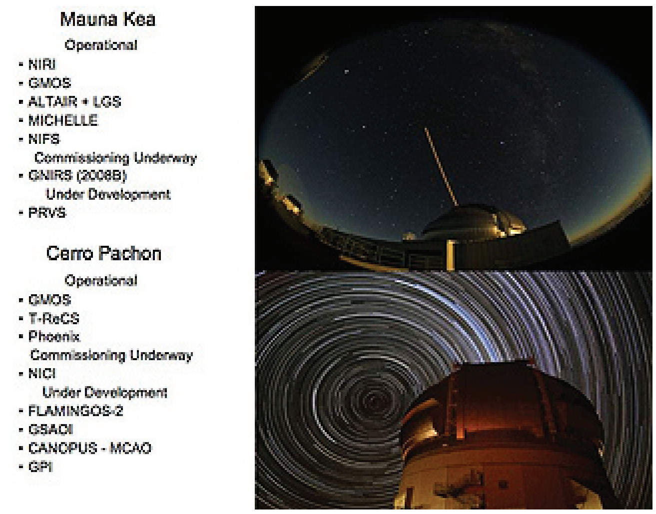
Verne V. Smith

The Gemini Observatory offers the US astronomical community significant amounts of time on twin 8-meter telescopes, with full-sky coverage from the two Gemini sites at Mauna Kea, Hawaii and Cerro Pachón, Chile (near La Serena). The observatory is an international partnership comprising the US, United Kingdom, Canada, Australia, Brazil, Argentina, Chile, and Hawaii. Each partner maintains a National Gemini Office (NGO), with each NGO responsible for managing that partner's share of observing time on the Gemini telescopes. As the US NGO, the NOAO Gemini Science Center (NGSC) supports the US user community, from the preparation of Gemini observing proposals to the implementation of their approved programs on the telescopes. NGSC also offers help and answers questions about general topics, such as observational capabilities or data reduction.

Over the next five years, the US user community can expect to have access to about 40 percent of the available science observing time on each of the Gemini telescopes. Viewed in terms of aperture-area times available nights of observing, Gemini represents the largest single component of the ground-based "system" of telescopes that the US user community can access via open peer-reviewed observing proposals. Gemini is not simply a major resource, but a unique one as well: it is the only full-sky coverage 8-meter class observatory that is capable of supporting as much as 100 percent queue observing, if so requested by observers. Astronomers with Gemini programs are thus free to request queue and classical observing as they see fit, with the only restriction being that classical programs must be for one or more integer nights.

At the moment (Semester 2008A), the two Gemini telescopes each host a versatile and diverse set of instruments that include imagers and spectrographs, as well as an operational laser guide star adaptive optics (LGS AO) system at Gemini North, nicknamed Altair. The telescopes themselves were optimized to excel in the infrared (IR), particularly in the thermal-IR at wavelengths from about 5 microns out to 26 microns, and are the most sensitive ground-based systems at these thermal-IR wavelengths. The current suite of instruments includes a multi-purpose optical imager and spectrograph (with single-slit, multi-object, and IFU modes) at both sites, along with thermal-IR imaging and spectroscopy. In addition, Gemini North offers near-IR (from a wavelength of 1 to 5 microns) imaging, spectroscopy, and IFU spectroscopy, all of which can be fed by the Altair AO system. Gemini South also offers high-resolution near-IR spectroscopy.

Beyond its already powerful set of capabilities, new (and in many cases unique) observational possibilities will be coming online at the Gemini telescopes at a rapid pace, making the next five years opportune ones for US users. Beginning in late-2008/early-2009, Gemini South will offer a near-IR coronagraphic AO imager (NICI) that is optimized for detecting faint companions near bright stars. Also in



Images of the Gemini North (top panel) and Gemini South domes, with the beam from the laser guide-star system shown for Gemini North. The text panel lists the current and future instruments that will be active or will appear in the 2008–2013 timeframe.

late-2008/early-2009, the newly refurbished near-IR spectrograph GNIRS will be deployed at Gemini North and provide its unique capabilities, such as cross-dispersed H- to K-band spectroscopy working behind the Altair AO system.

Looking further ahead, it is currently planned that sometime in 2009–2010, Gemini South will offer an exceptional multi-conjugate laser AO system (MCAO; recently named Canopus). The five-beam laser system will provide an AO-corrected 2-arcminute field-of-view and will feed two near-IR instruments: the Gemini South Adaptive Optics Imager (GSAOI) and the multi-object IR spectrograph FLAMINGOS-2. The deployment of Canopus, GSAOI, and FLAMINGOS-2 on Gemini South will provide the US community with an unmatched LGS-AO-capable imaging/spectroscopic system that will enable a large set of new ground-based observational projects.

The years 2011–2013 will find a Gemini Observatory fielding additional observational opportunities provided by a next generation of instruments, now in various stages of design. Currently planned for a probable 2011 deployment to Gemini South is the Gemini Planet Imager (GPI), an extreme-AO coronagraphic imager. At the same time, the Precision Radial Velocity Spectrometer (PRVS) will work from Gemini North. Looking past the next five years toward the middle of the next decade, the Gemini partners are working on a major scientific collaboration to build and deploy a Wide-Field Multi-Object Spectrograph (WFMOS). This instrument would provide an

continued

The Next Five Years at Gemini continued

unmatched combination of large numbers of targets and a wide field of view with which Gemini users could tackle an impressive array of fundamental scientific questions.

Because astronomy is such a rapidly evolving field, forecasting opportunities five years or more into the future contains some degree of uncertainty. The US community should keep in mind that the current operating agreement for Gemini ends in 2012, so the middle of the next decade may find the observatory functioning within a somewhat different operational framework. Therefore, the view from our crystal ball may not be as sharply defined for the end of the coming five-year window as it is for the next year or two. It is also important to note that any changes in Gemini operations will be influenced by input from the community.

What is very clear, however, is that Gemini is one of the most powerful and flexible astronomical facilities in the system of ground-based observational capabilities available to the US user community. It provides unique opportunities now and will continue to do so in the future. This capability will be there for the US community to use, and NGSC is committed to working with you in order to exploit this capability to its fullest extent.

NGSC is happy to receive input from you via email (*vsmith@noao.edu*). We also invite you to visit the following Web sites, which contain detailed information about observing with Gemini, its instruments and future projects, and all manner of observing or publication statistics.

International Gemini Observatory (*www.gemini.edu*)
NOAO Gemini Science Center (*www.noao.edu/usgp/*)
NOAO (*www.noao.edu*) NL

NGSC Works For You!

Verne V. Smith & Ken Hinkle

A major focus of NGSC is the output and "scientific health" of Gemini. To track this, we monitor community time pressure, the Time Allocation Committee (TAC) process, project completion rates, and refereed publications, as well as feedback from the community. Ultimately, this enhances the scientific productivity of your Gemini observing time.

We are always seeking ways to connect the user community with the Gemini Observatory and invite you to make suggestions to us at any time for other things that we might do. We will be at the upcoming January 2008 AAS meeting in Austin (see article in this section). We invite you to visit us at the NOAO booth to discuss your concerns and suggestions for increasing your Gemini-related scientific output.

Here are some of the major highlights of NGSC's role as the gateway for the US astronomical community to the Gemini telescopes:

Community Education/Awareness

- *NOAO/NSO Newsletter*. The NGSC section of the newsletter contains articles written by staff or solicited from others about instruments, new capabilities, science verification, science campaigns, calls for proposals, and other items of interest to users. The *Newsletter* is available at *www.noao.edu/noao/noaonews.html*.
- *NGSC Web Site*. The Web site (*www.noao.edu/usgp*) contains links to recent news, Gemini publications, NGSC staff contact information, meetings, etc.
- *Instrument Brochures*. NGSC produces brochures on Gemini instruments, the Gemini Science Archive, and How to Propose for US Gemini Time, which are available at various meetings and by request.
- *Email announcements*. US Gemini users are sent timely announcements of calls for proposals and other special opportunities.
- *AAS Meetings*. The NGSC has a booth at the winter AAS meetings, with staff available to meet with you and answer your questions—a major part of our mission as the gateway to Gemini for US astronomers. Featured information includes guidance on how to apply for time on the Gemini telescopes, details about currently available instrument capabilities, and tips on the Phase II process, including one-on-one tutorials.
- *Major Meetings*. The NGSC funds the travel of US delegates to major meetings such as the Gemini Science Committee, Gemini Operations Working Group, Gemini science and users meetings, Gemini National Gemini Offices meetings, and the Aspen Workshop.

Technical Help

- *HelpDesk Requests*. NGSC staff respond to HelpDesk Requests from the US community at the Tier 1 level and on certain assigned topics at the Tier 2 level.
- *usgemini@noao.edu*. NGSC staff respond to emails directed to the contact address on our Web site.

Proposal Process Support

- *Proposal Technical Reviews*. Before the TAC meetings, NGSC staff read all proposals submitted for US Gemini time and assess their technical feasibility based on the information provided by the Principal Investigator (PI); staff then write a summary report which is made available to the TAC panel members.
- *Pre-Submission Technical Reviews*. NGSC staff will also work with PIs before they submit a proposal to review its technical feasibility.
- *Gemini "Awareness" and Education*. The NGSC Director briefs the TAC panels on relevant Gemini issues, including recent developments, current instruments, completion statistics, and the Phase I Tool (PIT).
- *Technical Issues*. NGSC staff answer questions from the TACs regarding any technical issues that may arise.

continued

NGSC Works for You! continued

Phase II Support

- *Phase II Review*. Everyone granted time on the Gemini telescopes must complete a Phase II observing plan, which is a script executed at the telescope. One of the functions of the NGSC is to check all of the US Phase II submissions. This is an iterative process and often involves working together with the PI to produce several "drafts" of the plan before it is completed. Following NGSC review, each Phase II is again reviewed by Gemini staff. This may result in further interaction with NGSC staff.
- *Instrument Expertise*. The NGSC staff who review the Phase II plans also share their knowledge of the instruments with the PIs, helping them to get the best data from their program.

Observational Completion

- *Review of Projects*. NGSC tracks the number of hours requested vs. the number of proposals submitted, US success rates by instrument, program size distributions for successful proposals, and program size distributions of submitted and forwarded proposals, among others.
- *Staff Visits to Gemini Facilities*. NGSC staff visit both the Gemini North and Gemini South telescopes in order to familiarize themselves with the instruments and the queue process, and to interact with Gemini staff. For example, in 2006 NGSC logged 41 person-days at Gemini North facilities (Hilo Base Facility and Mauna Kea).
- *NOAO South and Gemini La Serena Facilities*. The close proximity of NOAO South and Gemini South facilities allows NGSC staff to interact easily with Gemini staff and quickly obtain answers to questions from the US community.

Data Reduction and Archive

- *User Support*. NGSC staff assist with data reduction and use of the archive via HelpDesk Requests.
- *Gemini Data Reduction Working Group*. This group, which is chaired by an NGSC staff member, advises the Gemini director on issues relating to tools and methods used to process the data produced by the observatory.

NGSC Contacts

- NGSC Director Verne Smith – *vsmith@noao.edu*
- NGSC Instrument Scientists – see *www.noao.edu/usgp/noaosupport.html*
- General Questions – *usgemini@noao.edu*
- Gemini HelpDesk – *www.gemini.edu/sciops/helpdesk/helpdeskDirectIndex.html*

Visit NGSC at the January 2008 AAS Meeting

Ken Hinkle

NGSC staff member Tom Matheson works with Marcel Agüeros (Columbia University) and Nicole Silvestri (University of Washington) on their Phase II preparation during the January 2007 AAS meeting in Seattle.

The NOAO Gemini Science Center will have a strong presence at the winter AAS meeting in Austin. This year we will be part of the larger NOAO booth, so look for us there in January. High-speed Internet access will be available so we can help you with Semester 2008A Phase II preparation. The majority of our staff plans to attend and will be able to answer detailed Phase II questions about all instrument and telescope combinations.

NGSC is different from the other branches of NOAO in that we seldom meet our users. Since the AAS meetings are one of the few opportunities that we have to meet you in person, please stop by and introduce yourself. We are always ready to talk about observing opportunities at Gemini, and we will have a number of handouts, including brochures describing each available Gemini instrument. Enter the drawing at our booth! We hope to raffle off an item that we expect will be of interest to you.

The Gemini Phase One Tool – PIT

Tom Matheson & Katia Cunha

Two forms can be used to apply for US observing time on the Gemini telescopes. For standard proposals asking only for US time, either the Web-based or emailed NOAO proposal form can be used. The Gemini Phase I Tool (PIT) can also be used for such proposals, but the PIT must be used in cases where time is requested from multiple partners, for Director's Discretionary (DD) time, or for programs designed specifically for poor weather. The PIT must also be used for Gemini demo science and science verification proposals.

There have been some recent changes to the PIT. There are now options on the "Submit" tab for the subset of proposals that go directly to the Gemini Observatory rather than to the NOAO Time Allocation Committee. This tab should be used for DD time, poor-weather programs, demo science, and science verification proposals. Note that DD requests should be submitted via the PIT rather than emailed as they have been in the past. Poor-weather programs can be submitted throughout the semester.

Starting with Semester 2007B, a tab was added to the PIT to specify how a program might be altered if it has a Band 3 ranking. Recall that observing programs that are scheduled on the telescope are scientifically ranked, and these programs are separated into three priority groups: Bands 1, 2, and 3. Band 1 (containing the most highly ranked programs) and Band 2 each contain 30 percent of the available time. Band 3 thus holds 40 percent of the available telescope time. Using the "Band 3" tab, one can indicate how observing constraints might be relaxed or how the number of targets could be reduced. A recent change has included entry boxes for the total time requested if in Band 3, and the minimum time necessary in Band 3. The minimum time will be used as the criterion of successful observation by Gemini. Programs with small minimum required times will be more likely to be observed.

For Semester 2008A, there will be a new tab for programs intended to be observed classically. Proposers will have to provide backup programs. In addition, observing conditions for the primary and backup programs must be specified. If conditions worsen beyond the constraints for the classical program, the night may revert to the queue.

In the essay sections of the PIT, LaTeX formulae cannot be used, unlike in the standard NOAO proposal form. In addition, the font used is slightly larger, occasionally leading to scientific justifications that are longer than prescribed for NOAO proposals in the printed versions. There is a "Save as PDF" option which will allow you to see how the proposal will appear in the printed version that will be evaluated by the TAC. Please look at this version of the proposal before submission to make sure that it meets all of the NOAO requirements.

You can learn more from the PIT Web pages (*www.gemini.edu/sciops/P1help/p1Intro.html*). In addition, advice on using the PIT for NOAO proposals is posted on the NOAO Web site (*www.noao.edu/noaoprop/help/pit.html*).

Gemini Science Staff Meetings

Ken Hinkle & Verne V. Smith

The Gemini Observatory, like other major observatories, has a fixed schedule of meetings to discuss various facets of observatory operations. Every Tuesday, Gemini has a joint meeting of North and South scientific staff via video conference. For the past year, many of the meetings have been open to the partner National Gemini Office (NGO) staff as well. The meeting typically takes less than an hour. Each meeting starts with a brief summary of the weekly telescope operations, typically followed by a report on a topic of general interest.

In the last few months, we have heard reports on topics such as calibrations and the long-term monitoring of calibrations, progress on the Multi-Conjugate Adaptive Optics (MCAO) system, Web page revisions, the call for proposals, and updates on the Near-Infrared Coronagraphic Imager (NICI) and Gemini Near-Infrared Spectrometer (GNIRS). The Gemini/NGO staff meeting is one of the ways that NGSC keeps up to date with new developments at the observatory. While this is a Gemini meeting, we, as well as any user through us, can suggest topics of discussion through us for future meetings. Your suggestions can be sent to *vsmith@noao.edu* or *usgemini@noao.edu*. The material discussed is frequently reported in this *Newsletter*.

The Updated Gemini Web Pages

Rachel Mason (Gemini Observatory)

With the bulk of Gemini observations taken in queue mode, the observatory Web site plays many roles traditionally filled by face-to-face interactions between the user community and observatory staff. Perhaps to a larger extent than with many other observatories, our Web pages really are the "face" of Gemini. A good set of Web pages is essential to help our users write technically sound proposals, optimize their Phase II setups, reduce their data with a minimum of fuss, and generally make the most of the capabilities that Gemini has to offer.

With this in mind, a small group from both Gemini sites and the UK National Gemini Office (NGO) has been overhauling the science operations Web pages (i.e., pages that live below *www.gemini.edu/sciops*: instruments, schedules, helpdesk, data, etc.). The single largest and most complicated section of this vast collection is the instrument pages, so we have concentrated our initial efforts on these.

In reorganizing the instrument pages, we sought to bear in mind the path taken by a Principal Investigator (PI) from initial idea to final publication, the kind of instrument information that would be needed at each stage, and where a "typical" user might look for that information. Pages are grouped according to instrument mode (e.g., NIFS coronography, T-ReCS imaging) and the steps a PI takes in preparing a proposal, defining observations, and reducing data. The pages use a menu system to keep important links from being buried in paragraphs of text. To help us maintain the pages and not confuse the user, duplication of information is avoided wherever practical. To enable proper version control, the new pages use the Drupal open-source content management system.

At the time of this writing, the entire Gemini science staff and NGOs have been asked to use the new pages as their "default" Gemini instrument pages for a period of a few weeks of intensive testing, so that we can uncover and fix as many bugs, mistakes, and generally undesirable features as possible. The new instrument pages will then be integrated with the existing site and made public. This is the first phase of a redesign that will eventually include all of the Gemini public Web pages.

We'd like to emphasize that all of the Gemini Web pages are yours every bit as much as they are ours, and your feedback helps us to improve them. If you spot inaccuracies, inconsistencies or other points that need attention, tell us (*rmason@gemini.edu*), and we'll do our best to address your concerns!

Changes to Classical Mode Observations at Gemini

Verne V. Smith

Prior to Semester 2008A, any classical observing programs to be conducted on either of the Gemini telescopes were required to have a minimum length of three nights. Beginning with the 2008A Gemini Call for Proposals, however, classical programs may now request a minimum of one night. This change opens up the possibility of many more potential Gemini programs being eligible for classical observing time, if so desired by the Principal Investigator. Please note that classical proposals must request integer nights.

A second change is that classical proposers must specify both the observing conditions required to achieve the primary scientific goals of the program, and an alternative set of poor weather observations. During the classical run, if conditions are worse than those required by the main or alternate program, the time may be used for queue observations. In such an event, the classical time will not be rescheduled.

NGSC Instrumentation Program Update

Verne V. Smith & Mark Trueblood

The NGSC Instrumentation Program continues its mission to provide innovative and capable instrumentation for the Gemini telescopes in support of frontline science programs. This article gives a status update on Gemini instrumentation being developed under the oversight of the NGSC, with progress since the September 2007 *NOAO/NSO Newsletter*.

FLAMINGOS-2

FLAMINGOS-2 is a near-infrared multi-object spectrograph and imager for the Gemini South telescope. FLAMINGOS-2 will cover a 6.1-arcmin-diameter field at the standard Gemini f/16 focus in imaging mode, and will provide multi-object spectra over a 6.1 × 2-arcmin field. It will also provide a multi-object spectroscopic capability for Gemini South's multi-conjugate adaptive optics system. The University of Florida is building FLAMINGOS-2 under the leadership of Principal Investigator Steve Eikenberry.

The NGSC held a quarterly review of the FLAMINGOS-2 instrument with the University of Florida team on October 22 at Gainesville. Shortly before this meeting, the Instrument Team developed a revised schedule showing the Pre-ship Acceptance Test occurring in April 2008 and the instrument being shipped in May 2008.

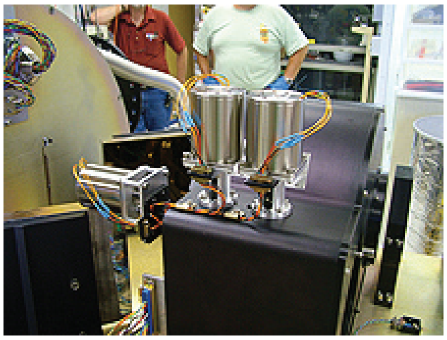


Figure 2: FLAMINGOS-2 camera mechanism shown with two Phytron steppers mounted on top and one on the side.

The instrument integration and testing phase of the project continues. Although software remains a significant item on the Integration and Test agenda, figure 1 shows that significant progress has been made in this area, with all mechanisms and housekeeping under software control. Furthermore, past issues with mechanisms appear to have been resolved with the replacement of the previous motors with commercial cryovac stepper motors on all mechanisms (see figure 2).

As of October, the University of Florida team reports that 95 percent of the scheduled work to FLAMINGOS-2 final acceptance by Gemini has been completed.

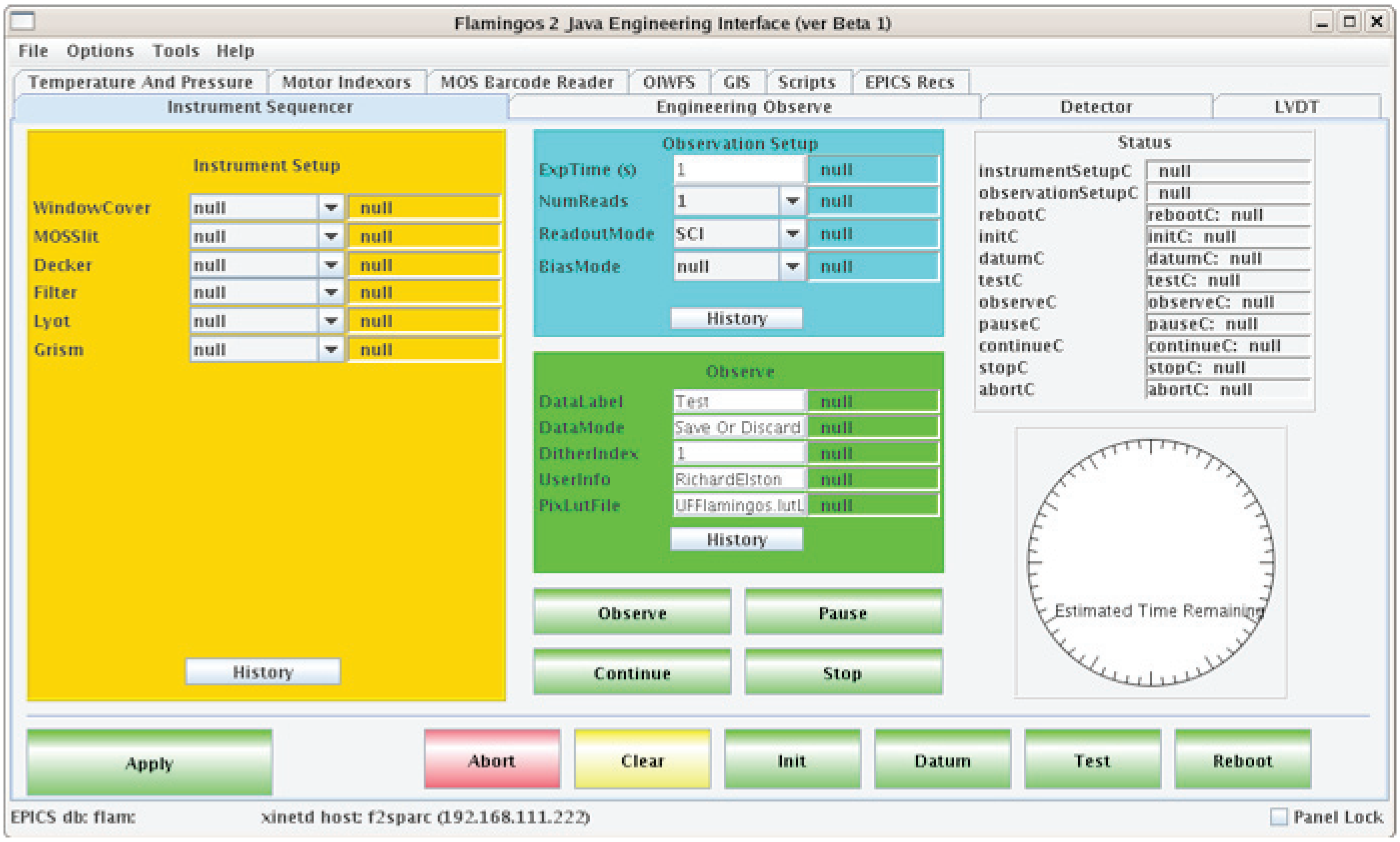


Figure 1: FLAMINGOS-2 engineering GUI used to control a high-level instrument sequence.

2008A Proposal Process Update

Dave Bell

NOAO received 425 observing proposals for telescope time during the 2008A observing semester. These included 177 proposals for Gemini, 114 for KPNO, 87 for CTIO, 38 for Keck, 13 for MMT, eight for Magellan, and seven for HET. Thesis projects accounted for 26 percent (110 proposals) of those received, 18 proposals requested long-term status, and 22 proposals requested survey status. Time-request statistics by telescope and instrument appear in the tables on the following pages. Subscription rate statistics will be published in the March 2008 *NOAO/NSO Newsletter*.

As of this writing, proposals are being reviewed by members of the NOAO Time Allocation Committee (see the following listing). We expect all telescope schedules to be completed by 7 December 2007, and plan to notify proposers of the status of their requests at that time. Mailed information packets will follow the email notifications by about two weeks.

Looking ahead to Semester 2008B, Web information and forms will be available online around February 28. The March issue of this *Newsletter* will contain updated instrument and proposal information.

2008A Time Allocation Committee Members

Survey (22-23 October 2007)
Tod Lauer, Chair, NOAO
Eric Agol, University of Washington
Alison Coil, University of Arizona, Steward
Erica Ellingson, University of Colorado
Barry Madore, Carnegie Observatories
Daniel McIntosh, University of Massachusetts
Ed Olszewski, University of Arizona, Steward
Sidney Wolff, NOAO

Solar System (1-2 November 2007)
David Trilling, Chair, University of Arizona, Steward
Travis Barman, Lowell Observatory
Anita Cochran, McDonald Observatory
Drake Deming, NASA GSFC
Renu Malhotra, University of Arizona, LPL
Beatrice Mueller, Planetary Science Institute

Extragalactic (5-6 November 2007)
Mark Dickinson, Chair, NOAO
Richard Green, Chair, Large Binocular Telescope Observatory
Tod Lauer, Chair, NOAO
John Blakeslee, Washington State University
John Feldmeier, Youngstown University
Andy Fruchter, STScI
Karl Gebhardt, University of Texas, Austin
Michael Gregg, Lawrence Livermore National Laboratory
Lisa Kewley, University of Hawaii, IfA
Mark Lacy. Spitzer Science Center
Tom Matheson, NOAO
Knut Olsen, NOAO
Casey Papovich, University of Arizona, Steward
Alice Shapley, Princeton University
Tom Statler. Ohio University
Daniel Stern, Caltech/JPL
Alan Stockton, University of Hawaii, IfA
Louis Strolger, Western Kentucky University

Galactic 1 (7-8 November 2007)
Ata Sarajedini, Chair, University of Florida
Jeff Valenti, Chair, STScI
Kim Venn, Chair, University of Victoria
Timothy Beers, Michigan State University
Bob Blum, NOAO
Geoffrey Clayton, Louisiana State University
Orsola de Marco, American Museum of Natural History
Moshe Elitzur, University of Kentucky
Don Garnett, University of Arizona, Steward
Inese Ivans, Carnegies Observatories
Chris Johns-Krull, Rice University
Jennifer Johnson, Ohio State University
Greg Laughlin, University of California, Santa Cruz
Kevin Luhman, Pennsylvania State University
Mario Mateo, University of Michigan
Nathan Smith, University of California, Berkeley
Stefanie Wachter, Spitzer Science Center
Lisa Young, New Mexico Tech

2008A Instrument Request Statistics by Telescope Standard Proposals

Kitt Peak National Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
KP-4m		**51**	**63**	**228.9**	**84.5**	**37**	**3.6**
	ECH	3	3	32	0	0	10.7
	FLMN	4	4	12	0	0	3
	MARS	4	8	16	6	38	2
	MOSA	16	19	58.2	52	89	3.1
	NEWFIRM	13	13	44.5	0.5	1	3.4
	RCSP	14	15	61.1	26	43	4.1
	VIS	1	1	5	0	0	5
WIYN		**28**	**32**	**107.8**	**50**	**46**	**3.4**
	HYDR	15	16	63	28	44	3.9
	MIMO	7	7	19.8	10	51	2.8
	OPTIC/Other	2	3	9	6	67	3
	SPSPK	3	4	12	4	33	3
	WHIRC	2	2	4	2	50	2
KP-2.1m		**17**	**20**	**108.9**	**12**	**11**	**5.4**
	CFIM	4	4	18	1	6	4.5
	ET	1	1	1.7	0	0	1.7
	FLMN	1	1	12	0	0	12
	GCAM	6	7	27	11	41	3.9
	SQIID	3	3	16.2	0	0	5.4
	VIS	2	4	34	0	0	8.5
KP-0.9m		**6**	**6**	**27**	**6**	**22**	**4.5**
	MOSA	6	6	27	6	22	4.5

Gemini Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
GEM-N		**121**	**155**	**187.7**	**70.9**	**38**	**1.2**
	GMOSN	57	76	99.3	61.7	62	1.3
	MOIRCS	4	4	4	0	0	1
	Michelle	12	13	10.7	0	0	0.8
	NIFS	14	15	18.1	3.2	17	1.2
	NIRI	40	43	50.5	3.2	6	1.2
	SuprimeCam	4	4	5.2	2.9	55	1.3
GEM-S		**61**	**71**	**105.1**	**15.8**	**15**	**1.5**
	GMOSS	25	28	33.4	13.5	41	1.2
	Phoenix	22	24	53.7	0	0	2.2
	TReCS	16	19	18.1	2.2	12	1

Cerro Tololo InterAmerican Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
CT-4m		**44**	**49**	**169.7**	**39**	**23**	**3.5**
	HYDRA	13	14	50.5	13	26	3.6
	ISPI	4	4	13	0	0	3.2
	MOSAIC	12	14	43.2	20	46	3.1
	RCSP	15	16	59	6	10	3.7
	VIS	1	1	4	0	0	4
SOAR		**10**	**10**	**29.1**	**0.5**	**2**	**2.9**
	OSIRIS	6	6	22	0	0	3.7
	SOI	4	4	7.1	0.5	7	1.8
CT-1.5m		**5**	**6**	**25.3**	**7**	**28**	**4.2**
	CSPEC	5	6	25.3	7	28	4.2
CT-1.3m		**3**	**3**	**12.9**	**8.5**	**66**	**4.3**
	ANDI	3	3	12.9	8.5	66	4.3
CT 1.0m		**8**	**11**	**94**	**31**	**33**	**8.5**
	CFIM	8	11	94	31	33	8.5
CT-0.9m		**12**	**15**	**44.5**	**21.5**	**48**	**3**
	CFIM	12	15	44.5	21.5	48	3

Community Access Observatories

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Keck-I		**19**	**19**	**27.6**	**6**	**22**	**1.5**
	HIRES	14	14	21.1	1	5	1.5
	IF	2	2	1.5	0	0	0.8
	LRIS	3	3	5	5	100	1.7
Keck-II		**20**	**23**	**28**	**4**	**14**	**1.2**
	DEIMOS	4	4	6	4	67	1.5
	ESI	2	2	3	0	0	1.5
	NIRC2-NGS	3	6	7.5	0	0	1.2
	NIRSPEC	10	10	10	0	0	1
	OSIRIS-LGS	1	1	1.5	0	0	1.5
Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
HET		**6**	**6**	**8.4**	**0.6**	**7**	**1.4**
	HRS	5	5	7.8	0	0	1.6
	LRS	1	1	0.6	0.6	100	0.6
Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Magellan-I		**1**	**1**	**2**	**2**	**100**	**2**
	IMACS	1	1	2	2	100	2
Magellan-II		**7**	**7**	**12**	**0**	**0**	**1.7**
	LDSS3	1	1	2	0	0	2
	MIKE	5	5	8	0	0	1.6
	MagIC	1	1	2	0	0	2
Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
MMT		**12**	**12**	**27**	**19**	**70**	**2.2**
	BCHAN	4	4	8	3	38	2
	Hectochelle	1	1	1	0	0	1
	Hectospec	6	6	13	11	85	2.2
	MegaCam	1	1	5	5	100	5

Data Management & Science Support for the System

Chris Smith

On any given night, more than a trillion bits of astronomical data flow from instruments operating in the US ground-based "System" of optical/infrared telescopes. In most cases, these bits are of greatest interest to the astronomers at the telescopes making the observations. But, the scientific potential of these bits does not stop with the astronomers and their focused observational programs.

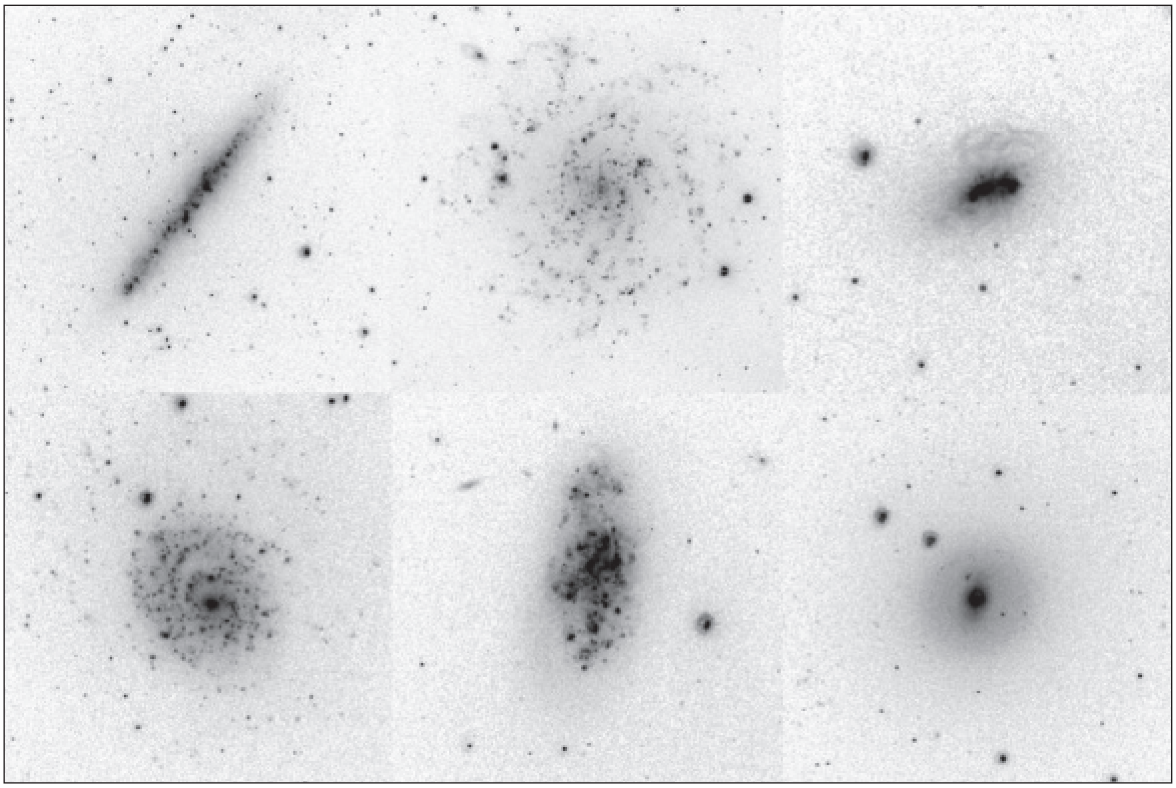
Those same images and spectra can be of great value for other astronomers pursuing different research programs. In order to realize the full scientific potential of the data taken each night throughout the System, a coordinated program of data management must be developed to capture, archive, and deliver these data to the wide community of potential users. This effort must also support the scientific analysis of the data with highly effective tools and services, which should take advantage of both the strong existing foundation of IRAF and the promise of new platforms (both desktop and Web-based).

A well-coordinated data management program would have a multiplicative effect on the efficiency of the System. The NOAO Data Products Program (DPP) has developed an evolutionary vision to meet this challenge.

We have focused our initial efforts on developing the infrastructure necessary to capture data from NOAO telescopes and affiliated observatories, safely preserve it, and deliver both raw and some reduced data products from the NOAO Science Archive (NSA) to Principal Investigators and other users through the NOAO National Virtual Observatory (NVO) Portal. Over the next few years, our operational efforts must grow to support both the users of the NSA and Portal, and more generally, the users of the broader NVO. The NSA and Portal are important components of the NVO, and we will ensure that they remain so.

As the Virtual Observatory evolves, our development efforts will shift from fundamental infrastructure to a more general effort. In this phase of our vision, the DPP will be capable of supporting a broader range of sources of data from instruments throughout the System, while simultaneously providing effective means to exploit the petabytes of data that will be accumulating in the NVO (even before LSST arrives!)

This combination—a strong operational infrastructure, and the development of tools and services that take full advantage of the Virtual Observatory and its distributed resources—will provide users of NOAO and the System with a dynamic platform from which to pursue the next generation of astronomical discoveries.



IRAF V2.14 and Ximtool Releases

Mike Fitzpatrick and Chris Smith

In the September 2007 *NOAO/NSO Newsletter*, we announced the beta release of a new version of IRAF software version 2.14, along with our plans for continued investment over the next year. The first phase of this plan is now complete with the full release of IRAF version 2.14 for PC-IRAF systems (Mac OSX, Linux, and Cygwin) as well as several new external packages. The new release is available for immediate download from *iraf.noao.edu*.

We expect that the final release of the version 2.14 system, which includes ports to SunOS and Solaris (sparc CPU), FreeBSD and Solaris (Intel CPU), will be ready in the first quarter of 2008.

The initial PC-IRAF release was delayed slightly by the announcement of Mac OSX Leopard in order to address any problems present in what will certainly be a common upgrade for many users. The ongoing support for SunOS/Solaris is driven by the continued use of IRAF on these platforms at the Kitt Peak National Observatory and Cerro Tololo Inter-American Observatory telescopes and elsewhere. No other platform ports are planned at this time, as we believe these PC-IRAF and Sun operating systems sufficiently cover the vast majority of IRAF systems in use today.

Major Features of IRAF 2.14

The version 2.14 release formalizes much of the work contributed in the context of *iraf.net* into an official release from NOAO. Specific changes to note include:

- New platform support (both OS and GCC compiler support)
- Numerous bug fixes
- ECL (with cmdline history and editing capability) is now the default
- FITS is now the default image format

Additional new tasks and features:

BPMEDIT - Examine and edit bad pixel masks associated with images
SKYSEP - Compute angular separation between two RA/Dec values
SKYGROUP - Group a list containing RA/Dec into spatial sublists
RAVERAGE - Compute running average, standard deviation, and envelope
ZPN projection supported in WCS interfaces
New XTOOLS procedures for expanding MEF image extensions
Access to 2MASS and USNO-B1 catalogs from ASTCAT package

New external packages:

ACE - Astronomical Catalog Environment
FITSUTIL - Includes new FITS compression capabilities
MSCRED - Mosaic reductions (enhanced/generalized capabilities)
NEWFIRM wide-field infrared imager- General infrared data reduction and analysis
National Virtual Observatory (NVO) - Virtual Observatory tools and applications

These enhancements were made in support of new NOAO instrumentation and other projects such as the NVO (see accompanying article) and NOAO pipeline processing. These packages will continue to be developed as needed by the NOAO program, and some tasks are expected to be included in the core system in a future release.

X11IRAF version 2.0 Release

The X11IRAF package has also seen some recent development, most noticeably in the addition of support for “24-bit” displays in XImtool. Overall the X11IRAF tools have been upgraded with changes needed to support new platforms and compilers, but they remain functionally much the same.

These releases mark the beginning of a longer-term strategy which aims to satisfy the short-term needs of the DPP program, NOAO operations, and the astronomical community, while providing a bridge to the development of future scientific software tools and environments in coordination with STScI, Gemini, and other astronomical software development groups. While NOAO will provide direct support for specific project-related packages (e.g., NEWFIRM and NVO), overall IRAF user support will still be the main responsibility of the *iraf.net* community site. DPP staff will be active participants at both the internal project helpdesk as well as the broader *iraf.net* forums, and future announcements of new releases will be made online and in this *Newsletter*.

IRAF and UNIX Tools for the VO

Mike Fitzpatrick

VOClient is a new software package developed for the National Virtual Observatory (NVO) that provides an easy-to-use interface between desktop applications and remote Virtual Observatory (VO) data and services, without requiring the developer to know the details of the underlying technologies. The VOClient library has allowed us to not only integrate the Image Reduction and Analysis Facility (IRAF) system with the VO, but to also create a set of UNIX tools that make the package immediately useful to users.

Because VOClient is a C-language interface, using it within the IRAF Command Language (CL) and SPP languages to create new VO functions was straightforward. The result is the new IRAF NVO external package that contains a CL interpreter with VO capabilities (called *VO-CL*) and a variety of script and compiled tasks that provide tools for remote data query and retrieval and several demonstration science applications.

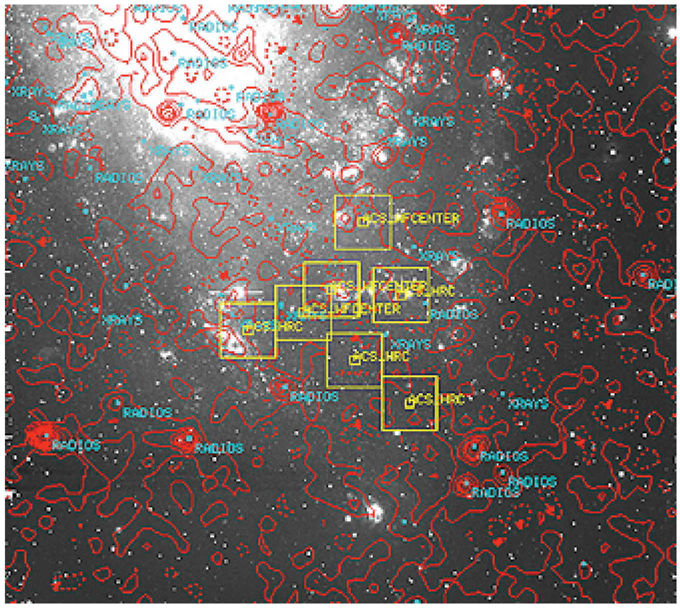
The IRAF NVO package tasks are built using standard VO protocols, allowing new VO resources to be discovered and used by tasks without requiring a new package release. These tools provide access to hundreds of catalogs and image archives, as well as thousands of tables published in journals. Aside from data access, toolbox tasks supply convenient applications to simplify the process of, for example, overlaying radio contours on an image display, identifying catalog sources in a field, or finding complementary data taken at other observatories.

Tasks use the native IRAF support for sexagesimal values to allow users to work naturally in terms of Right Ascension/Declination, or positions can be resolved from names automatically. The familiar *@-file* syntax supports list processing, and in cases where a search position and size are required, an image's World Coordinate System can be used to derive the information. For example, to access the Guide Star Catalog (GSC2.2) about a given point on the sky, these three commands are equivalent:

```
nvo> vocatalog gsc2.2 ngc4528
nvo> vocatalog gsc2.2 12:34:06 11:20:00
nvo> vocatalog gsc2.2 ngc4528.fits
```

The UNIX command-line tools in VOClient, dubbed *VO-CLI*, provide much of the same functionality as their IRAF counterparts, but they are much easier to use from non-IRAF scripting environments and can parallelize large queries to greatly speed up data query and retrieval. Additionally, these tools may be used within the IRAF NVO package to take advantage of the faster query speeds.

There are three *VO-CLI* tasks at present. The VOSESAME task provides a simple object name-to-position resolution function. The VOREGISTRY task permits a user to search the VO for data resources using keywords or by specifying options that define a constraint such as "any x-ray image archive." Optional output includes a simple count of the results or a complete description of the tables that would be returned.



An example image created from tasks in the new IRAF NVO package showing radio contours, NED radio sources, and HST observations (squares) overlayed on an image of M33. The background image and associated data were all downloaded dynamically from the Virtual Observatory.

The heart of the *VO-CLI* tasks is VODATA which combines the other tasks' abilities to create and resolve resource and object lists with the query and retrieval of actual data. Output tables may be saved in a variety of formats (even Google Sky), and the concepts of being able to use common names for VO services and user-friendly input formats are a key part of the interface. For example, to retrieve all XMM-Newton data for a particular object use the command:

```
% vodata -get xmm-newton 3c273
```

Once completed, the user will have 27 new images downloaded from the XMM-Newton archive service.

Further information about the IRAF NVO package, the *VO-CLI* tools and VOClient library may be found at *iraf.noao.edu* and *nvo.noao.edu/vo-cli*.

The *VO-CLI* site also includes a demonstration Web interface to each of the tasks including enhanced interfaces to environments such as Java, Python, and IDL.

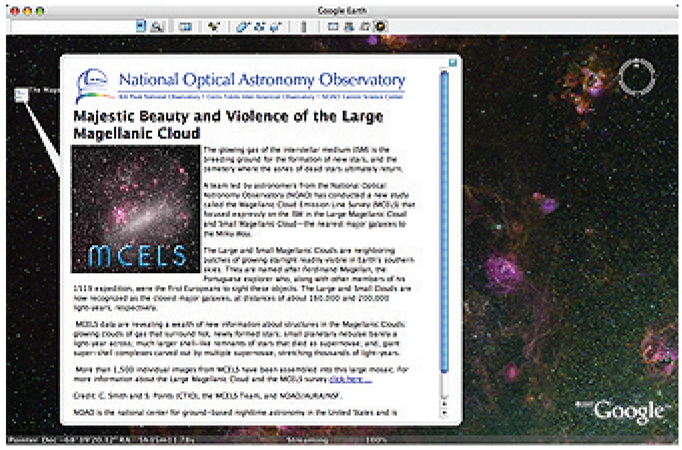
NOAO Helps Bring the Night Sky to Google Earth

Christopher J. Miller & Douglas Isbell

Google recently released version 4.2 of its popular Google Earth software, which allows Internet users to explore the night sky in color and in various levels of detail via an interface known as Sky for Google Earth.

NOAO and DPP have started to integrate many of the amazing color-composite images taken with NOAO telescopes and instruments into Sky for Google Earth. As step one, we have worked with Andy Connolly at the University of Washington and his collaborators Jeremy Brewer, Ryan Scranton, and Simon Krughoff, to include two surveys from the NOAO Science Archive: the Magellanic Clouds Emission Line Survey (MCELS; Chris Smith of NOAO is the Principal Investigator) and the Local Group Survey (led by Principal Investigator Phil Massey of Lowell Observatory). Many thanks go to Sean Points and Knut Olsen, both of NOAO, for providing the color composites. Step two this winter will see about two dozen press release-quality images from the online NOAO Image Gallery integrated into the Google system.

To see some of NOAO's signature images in Sky for Google Earth, visit *www.noao.edu/dpp/ge/* and download the NOAO Showcase "KML" file and open it in your Google Earth version 4.2. For more information or to download Google Earth, visit *earth.google.com/sky/skyedu.html*.



DPP Releases a New FITS Library for Ruby

David Gasson

The NOAO Data Products Program (DPP) announces the initial release of RFits, an object-oriented wrapper, written in Ruby, around the NASA High-Energy Astrophysics Science Archive Research Center's CFITSIO library (*heasarc.gsfc.nasa.gov/docs/software/fitsio/fitsio.html*).

The Flexible Image Transport System (FITS) is a data format designed to provide a means for convenient exchange of astronomical data between installations whose standard internal formats and hardware differ.

RFits leverages the flexibility and expressiveness of the scripting language Ruby (*www.ruby-lang.org/*) to allow basic manipulation of FITS files. It is released under the Gnu General Public License (version 2) and is available to anyone in the community from *rubyforge.org/projects/rfits/*.

Here is a small code example that shows how a user might use the RFits module:

```
RFits::File.open('m31.fits', 'rw') do |fits|
 img = fits[0] # first extension is an image

 # retrieve/write header values using hash syntax
 header = img.header
# print the value within the TELESCOP field:
 puts header['TELESCOP']
# place a new keyword into the header called MY_HDR
 header['MY_HDR'] = 'Hello, world!'

 # retrieve/write pixel values using array syntax
 pixels = img.data
 first_pixel = pixels[0]
 pixels[10] = 5  # ninth pixel set to 5
end
```

NOAO DPP at ADASS XVII and the IVOA Meetings

Christopher Miller

The Astronomical Data Analysis Software and Systems (ADASS) conference is held each year to provide a forum for scientists and programmers concerned with algorithms, software, and software systems employed in the acquisition, reduction, analysis, and dissemination of astronomical data. The ADASS meetings are an important venue for the NOAO Data Products Program (DPP) to announce or demonstrate the tools and services being developed, and to collect information and ideas on what other developers are doing.

This year's meeting was held in London and had a strong DPP presence:

- **Mike Fitzpatrick** *IRAF: Developing in a New Age (poster)*
- **Christopher J. Miller** et al. *The NOAO NVO Portal and the Web 2.0 (talk)*
- **Rob Seaman** *Embedded Processing for the Virtual Observatory (poster)*
- **R. Chris Smith** et al. *The Ground-based O/IR Data Preservation Challenge at NOAO: Scaling up from Terabytes to Petabytes (poster)*
- **Frank Valdez** et al. *The NOAO Pipeline Applications (talk)*
- **Nelson Zárate and Mike Fitzpatrick** *The NEWFIRM Data Handling System (poster)*
- **Brian Thomas and Ed Shaya** (University of Maryland and affiliated with NOAO DPP) *A User Interface for Semantically Oriented Data Mining of Astronomy Repositories (poster)*
- **Robert Swaters** et al. (University of Marlyand and affiliated with NOAO DPP) *The NOAO NEWFIRM Pipeline (poster)*

There were also a number of extra sessions sponsored by NOAO DPP staff. Rob Seaman co-sponsored a "Birds-of-a-Feather" (BOF) entitled "Transient Event Reporting and Response with VOEvent," and Mike Fitzpatrick, Rob Seaman, Frank Valdez and Nelson Zárate sponsored an IRAF users and developers BOF. Both BOFs were well attended.

The NOAO ADASS meeting abstracts are available to the public at the ADASS Web site *www.adass.org*.

Last year's ADASS XVI meeting presentations have recently been published by the Astronomical Society of the Pacific as volume number 376 and are electronically available at: *www.aspbooks.org*. The editors of this edition of the ADASS proceedings are NOAO staff members Richard Shaw, Frank Hill and Dave Bell.

The International Virtual Observatory Alliance (IVOA) held its bi-annual interoperability meeting in Cambridge, UK, directly after the ADASS XVII meeting. DPP attendees included Chris Smith, Mike Fitzpatrick, and Rob Seaman. Presentations included *The VO-CLI: Command-line Tools for the VO* and *Looking to VOEvent 2.0.*

CTIO – Modernization and New Capabilities Ahead

Alistair Walker

In response to the report of the NSF Senior Review, NOAO is strongly reaffirming its commitment to keeping the telescopes and instruments at Kitt Peak National Observatory (KPNO) and Cerro Tololo Inter-American Observatory (CTIO) performing optimally, and to providing state-of-the-art facilities for the user community. In this article, I summarize telescope-related activities planned for the near future at CTIO. Activities can be broadly divided between New Capabilities, and Modernization & Infrastructure improvements, so I will deal with these two topics in turn. Regular progress reports will appear in future editions of this *Newsletter*, and on our Web site.

New Capabilities

The evolution of the System of telescopes and instruments available to the US astronomical community via NOAO will be guided by the report of the Renewing Small Telescopes for Astronomical Research (ReSTAR) committee, due at year-end. This report will also specifically help us plan the instrumentation future for the NOAO-operated telescopes, and can be expected to influence the developments presented below.

Regular readers of this *Newsletter* will be familiar with two major instruments that will transform the imaging capability of the Blanco 4-meter telescope: NEWFIRM and the Dark Energy Camera (DECam). NEWFIRM is a wide-field near-infrared (IR) imager that is beginning science operations at the Mayall telescope on Kitt Peak. After 2.5 years (i.e., early 2010) we plan to move NEWFIRM to the Blanco telescope, likely for a similar period of time. Our plans are described in detail in *www.noao.edu/ets/newfirm/NEWFIRM_info.pdf*. NEWFIRM will be mounted at the *f*/7.5 RC focus of the Blanco telescope, and will alternate with Hydra at that focus.

DECam is a very wide field CCD imager that will replace the Mosaic imager at prime focus of the Blanco telescope in late 2010. As a facility instrument, it will be available for all users; however, 30 percent of the time between September and February will be devoted for five years to the Dark Energy Survey (DES), a project to be carried out by the Fermilab-led consortium that is building the instrument.

Both NEWFIRM and DECam will come with data-reduction pipelines that will deliver flat-fielded frames, together with astrometric and photometric information, to the NOAO Science Archive (NSA). Additionally, after a 12-month proprietary period, the similarly processed data frames from the DES will be available from the NSA. Following the completion of the DES in 2015, high-level science products such as object catalogs will also be made generally available from the NSA.

continued

Credit: T. Abbott

CTIO - Modernization and New Capabilities Ahead continued

The Southern Astrophysical Research (SOAR) 4.1-meter telescope has an exciting instrument program as well (see *www.soartelescope.org/release/06observing/eng_observing/instruments/main_instruments.html*). Toward the end of 2008, we expect both the Goodman Spectrograph and the Spartan IR imager to become available, with the IFU spectrograph to follow in 2009. Depending on arrangements made with Gemini, the high-resolution IR spectrograph Phoenix will be either moved to or shared with SOAR, likely in late 2008.

These instruments will be followed to the telescope by the SOAR Adaptive Module (SAM), which is now in construction (see the related article in this *Newsletter*). Finally, the SOAR TELescope Echelle Spectrograph (STELES), a high-resolution optical spectrograph being built in Brazil, is estimated to be available for users in 2010-2011. SOAR can mount all these instruments simultaneously at its Nasmyth and folded-Cassegrain ports, together with the present instruments, the SOAR Optical Imager (SOI) and the Ohio State InfraRed Imager/Spectrometer (OSIRIS).

The small telescopes at CTIO continue to be operated by the Small and Moderate Aperture Research Telescope System (SMARTS) consortium. The focus of instrumentation activities in the near-term is at the 1.5-meter telescope where, led by Andrei Tokovinin, we are planning to install a high-resolution optical spectroscopic capability during 2008. This initially will be a fiber feed to the Blanco Echelle spectrograph, which would sit on the floor of the 1.5-meter coudé room, but a definitive instrument could be a updated version of the Bench Mounted Echelle (BME) we offered some years ago. Other instrument possibilities for this telescope include replacing the RC spectrograph with a high-throughput multi-object optical spectrograph. Initial discussions among consortium members on this subject are underway.

We are also attending to a number of items that can best be classified as "instrumentation infrastructure." Apart from trying in the short term to improve the reliability of our present instruments by attending mostly to computer and controller issues, we intend to phase out the Arcon controllers on all instruments (except Mosaic) and replace them with MONSOON controllers.

Finally, we would like to install a laser calibration system and new high-tech flat field screen at the Blanco telescope. These developments are led by Chris Stubbs (Harvard University), and a similar system is expected to be first implemented on Pan-STARRS. To guide our activities in this area, we have formed a Calibration Working Group, with representation from CTIO, SOAR, DES and the community. This group will also consider the suite of auxiliary instruments needed on Cerro Tololo and Cerro Pachón that are indispensable for the operation of a modern observatory, and which provide essential metadata for the archived data, such as DIMMS, all-sky cameras, instruments to measure ground-layer turbulence, and weather stations.

Blanco Telescope Modernization

Our CTIO modernization activities mostly involve the Blanco telescope. We have begun a project to replace the Telescope Control System (TCS) and encoders with a modern implementation based on the system at SOAR. This project can be considered a milestone for the TCS being developed for the Large Synoptic Survey Telescope (LSST). An expert team, involved in both the SOAR and LSST projects, is engaged in this effort, which is mostly software. Development and installation can proceed in parallel with present operations, with full switchover to the new system in early 2010.

To aid in installation and maintenance of new large instruments such as DECam and NEWFIRM, we will build a clean room in the ex-coudé room of the Blanco dome. A number of projects can be classed as repairs and maintenance. Chief among these is redesigning and replacing components of the primary mirror radial supports, which have been delaminating from the primary mirror since the telescope was built. This task requires a major shutdown to re-glue. Other more facility-oriented activities include a new control system for the elevator, new telescope and instrument UPS, and attending to a multitude of maintenance issues that has been set aside for the last few years due to lack of funds. We will also accelerate replacement of computers and peripherals.

Attending to hardware and software issues as outlined above requires considerable staff time and energy, which will be obtained both from existing CTIO staff and via outsourcing. However we are also very aware that our Telescope Operations staff, in particular, has suffered attrition over the last several years, and to operate our facility properly we need to hire into all the critical engineering skills—electronics, electrical, optics and software. We have made four new technical hires in the past few months. We also need to increase the scientific staff devoted to telescope operations and instrument development, and advertisements have been placed.

With this increased commitment to operating the NOAO telescopes as a critical part of the US system of facilities, we are confident that there are exciting times ahead for both our users and our staff. NL

CTIO Observing Modes

Alistair Walker

The scientific productivity of an astronomical facility is a function of several factors: the telescope size and performance, the instrumentation, the quality of the observing site, and how the scientific programs are matched to all of the above.

We have been considering how to enhance the observing mode options at the Blanco 4-meter and SOAR 4.1-meter telescopes to allow execution of science programs that are currently run rather inefficiently, or are not possible at all. We present what we plan to offer for Semester 2008B —your input over the next few months prior to the proposal announcement on 1 March 2008 will guide our thinking and be very much appreciated.

I will also discuss how we will go about investigating whether we can offer options that would provide time or cost advantages to those scientists who might not presently propose due to the geographical remoteness of CTIO.

Some definitions - At the present time, our users are offered only *classical observing* (astronomer at telescope) on the Blanco and SOAR telescopes. Other possible modes include *service observing*, here defined as a program carried out at a pre-scheduled time by a local staff member, and *queue observing*, where the program can specify observing conditions and it is executed, also by local staff, only in those conditions or better. Additionally, for *remote observing,* the astronomer operates the instrument and some of the telescope functions from an off-mountain site, perhaps their home institution, instead of being at the telescope. It is useful to differentiate between *active* and *passive remote observing*. The latter, also called *eavesdropping* or *over-the-shoulder observing*, would be the situation when the astronomer participates over a video link, communicating with an operator/service observer (or graduate student!), but does not directly control the telescope or instrument.

More details, and what others do - Classical observing at Blanco and SOAR will surely remain the choice for many programs, for example for programs that are complex, or where real-time control by the astronomer is a priority, or where student training is an important part of the project. We intend to continue to schedule the Hydra spectrograph on the Blanco in classical mode only, because of the complexity of the instrument and its operation. Classical mode discriminates against small programs or non-conformist programs such as time domain and target-of-opportunity astronomy; however, the alternate modes have staffing and cost implications as more people are required to handle both the actual observing and the increased observing infrastructure.

Large telescopes and their instrumentation are generally complex. The staff levels required to support queue operation at the Very Large Telescope and Gemini are very high, and sophistication is needed all the way from the proposal to the image archive.

Two somewhat more modest examples are worth presenting. The first example is the Small and Moderate Aperture Research Telescope System consortium operating the small telescopes on Cerro Tololo with a mixture of classical, service and simple queue (photometric or non-photometric) for both NOAO users and consortium partners. Here the service/queue observer also operates the telescope, with pre- and post-observing astronomer support off-site.

The second example is of a 4-meter class telescope, the Telescopio Nazionale Galileo (TNG), which is perhaps closer to what might be achievable for the Blanco and SOAR telescopes. The TNG is a 3.5-meter telescope on La Palma, and is operated 50 percent classical and 50 percent non-classical. The non-classical observing is mostly queue observing, with multiple "hot" instruments, very similar to the situation that SOAR will be in by late 2008 or early 2009. Eight support astronomers spend almost all their work hours supporting telescope operations at the TNG. While CTIO is ramping up its scientific staff support level, and we have 30 percent of SOAR time rather than 100 percent, this level of support will not be easily available.

Remote observing experiments - Remote Observing is the observing mode of choice on the SOAR telescope for the university partners Michigan State University and University of North Carolina. Both have constructed remote observing rooms on campus, and once astronomers are familiar with the telescope and equipment, observing proceeds very efficiently from the point of view of both observers and observatory.

A telescope operator is still present at the telescope for safety reasons, with communication between operator and observer by video or computer. Generalizing this concept to the NOAO community clearly involves issues of training. For example, one could stipulate that an observer must have previously observed classically at SOAR before observing remotely would be permitted. Also, from experience with SOAR, solving network and firewall problems is time-consuming. Given the additional requirement of good bandwidth and preferably video equipment to allow face-face communication, the best solution may be setting up a small number of remote observing centers that are geographically dispersed. Over the next few months we will gain experience by connecting up remote observing center at NOAO North in Tucson and go from there. We have ordered a multi-user Polycom to upgrade the present single-user system in the Blanco control room, plus a better television monitor.

Service observing for 2008B? - We propose to offer service observing on both Blanco and SOAR beginning in semester 2008B. Instruments offered would be restricted to Mosaic and the Infrared Side Port Imager on the Blanco, and the SOAR Optical Imager and Ohio State Infrared Imager/Spectrometer on SOAR. The service observing would be scheduled in advance on fixed nights, and the number of nights available will depend on user demand and availability of staff, both those doing pre- and post-observing tasks and carrying out the observing itself. Data frames are expected to be able to be accessed post-run by the Principal Investigator (PI) from the NOAO Science Archive. PI's and Co-Investigators will be able to participate via our upgraded video link.

We wish to particularly encourage short scientific programs of length from an hour to 1-2 days. Initially, we anticipate not offering longer programs in service mode, unless they were time domain in nature, such as one night per month over a semester.

We would like to hear from people who would plan to write proposals for short or time-domain programs. More general comments on any of the above will be of great value to aid our planning. Send your comments to me at *awalker@noao.edu*.

Laser Guide Star System for SAM Passes PDR

Nicole van der Bliek & SAM team

The SOAR Adaptive Module (SAM) project successfully passed the Preliminary Design Review (PDR) for its Laser Guide Star System. SAM will be an adaptive optics instrument for SOAR, working at visible wavelengths. It will primarily be a ground-layer adaptive optics (GLAO) instrument, using a low-altitude, Rayleigh laser guide star (LGS).

SAM will deliver improved-seeing images with a typical FWHM of 0.3 instead of 0.7 arcsec, over a fairly large field of view (3x3 $arcmin^{2}$). Two sensitive natural guide star probes for tip-tilt sensing assure complete sky coverage. The laser itself operates at ultraviolet wavelengths, and because the resulting power density encountered in the sky it is not hazardous to the eyes or skin, it should not require spotters for aircraft avoidance.

The PDR review panel consisted of Gabriel Perez and Maxime Boccas (Gemini Observatory), Steve Heathcote (SOAR), Michael Lloyd-Hart (University of Arizona) and Thomas Stalcup (MMT), chair. Francois Rigaut (Gemini Observatory) participated in the review as observer, and Bob Fugate (formerly of the Starfire Optical Range), who unfortunately could not be present at the September 28 review, read the presentations and provided written comments.

The panel was pleased with the documentation and presentations provided by the team, and in general approved the design of the LGS system. Their immediate feedback was very constructive and to the point, particularly as all committee members (except for the "customer" Steve Heathcote) have extensive experience with the design and operation of existing LGS systems. The committee will provide the team with a written report containing more detailed comments.

Design and fabrication of the SAM main module have been underway since the end of 2005, following the PDR of the main module on 2 December 2005. Integration and alignment of the main module will start in 2008, and commissioning, operating initially in Natural Guide Star (NGS) mode, is expected to take place mid-2009.

In parallel to the integration and alignment of the main module, the team will proceed with design and fabrication of the LGS system. This includes the Laser Launch Telescope, Beam Transfer Optics and a Laser Box, containing the laser and a beam expander. It is anticipated that following the commissioning of the NGS mode of SAM, the team will proceed with the integration and alignment of the LGS system. Commissioning of the LGS mode will take place in 2010.

Five Years of ISPI

Nicole van der Bliek

September 2007 marked five years since the Infrared Side Port Imager (ISPI) saw first light at the Blanco 4-meter telescope at Cerro Tololo. ISPI is a near-infrared (IR), wide-field imager with a 10.25x10.25$arcmin^2$ field of view and 0.3-arcsec pixels. ISPI is equipped with the broadband $YJHK_s$ filters and a set of narrowband filters. A full description of ISPI can be found on the ISPI Web pages at *www.ctio.noao.edu/instruments/ir_instruments/ispi*.

During these five years, ISPI has been used for 287 nights to conduct more than 100 observing programs. These included several programs to observe star-formation regions, like the search for young, Jupiter-mass objects by Allers et al., 2006 (*ApJ* 644, 364), observations of the Galactic bulge and Galactic Center, and observations of red-clump stars to determine the distances to clusters in the Magellanic Clouds (Grocholski et al., 2007, *AJ* 134, 680). ISPI was also used for various high-redshift programs like the Multiwavelength Survey by Yale-Chile (MUSYC; see more below), as well as for target-of-opportunity observations such as a program by Rhoads, Fruchter et al., to observe afterglows of gamma-ray bursts.

ISPI has been used to go as deep as J=22.5, H=21.5, and K_s=21 (cf. Quadri et al., 2007, *AJ* 134, 1103). The efficiency of the instrument is about 70 percent for observations in bands with a low sky background, the J band and the narrow bands. For background limited observations in the K band, when several co-adds are being used, the overhead goes up to 50 percent, and in case of extended objects, when sky frames have to be taken outside the ISPI field of view, the overhead can be as large as 100 percent.

Some highlights of results obtained with ISPI are:

MUSYC: deep near-infrared imaging and the selection of distant galaxies (Paulina Lira & Ryan Quadri)
MUSYC has imaged 1.2 square degrees spread over four fields in UBVRIzK down to R~25 and K~22 (AB). MUSYC is unique among the current generation of wide-deep surveys in having been optimized for the study of the high-red shift Universe at z~2-4 (Gawiser et al. 2006, ApJS 162, 1). Information at near-IR wavelengths is essential as these bands provide very useful information for photometric redshifts and traces the rest-frame optical light. Each 30x30 $arcmin^2$ field was imaged using ISPI to a magnitude limit of K_s~22 and additionally the central 10x10 $arcmin^2$ regions were observed in JHK to a limit ~22 (Blanc et al., 2007 in prep.; Quadri et al., 2007, *AJ* 134, 1103). The IR sources were used to construct a mass-selected sample of 294 galaxies

continued

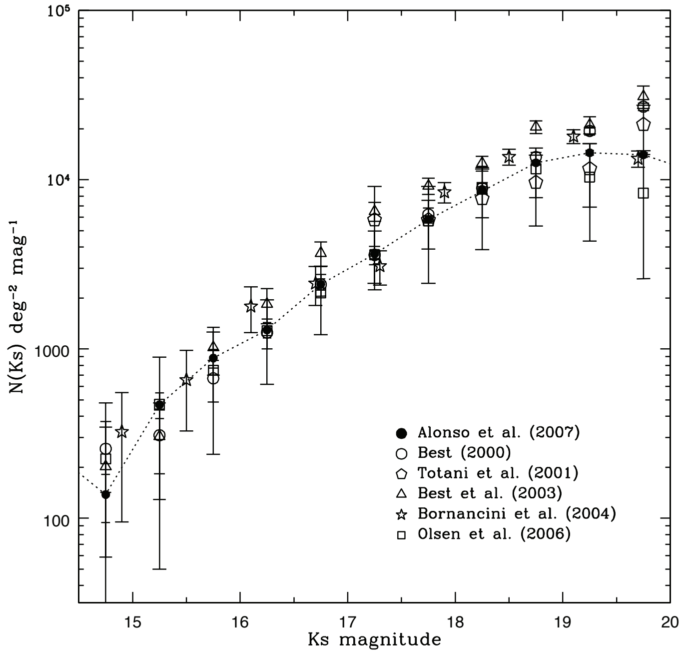
Five Years of ISPI continued

with $M>10^{11}$ M_{sun} at 2<z<3 (van Dokkum et al., 2006 *ApJL* 638, L59). Seventy percent of these galaxies classify as Distant Red Galaxies (DRGs), which represent a mix of passive galaxies with low star-formation rates and dusty active galaxies (Kriek et al., 2006, *ApJL* 649, L71). The survey team determined the rest-frame optical luminosity function of K-selected galaxies at 2<z<3.5 and found them to be 1.2 magnitudes brighter than in the local universe, but with a space density five times smaller (Marchesini et al., 2007, *ApJ* 656 42). A clustering analysis found that they reside in massive dark matter halos of 5e12 M_{sun} while the subset of DRGs reside in ever more massive halos of 3e13 M_{sun} (Quadri et al., 2007, *ApJ* 654, 138).

The XMM-Newton Distant Cluster Project's Southern Cluster Survey (SCS) with Mosaic-2 and ISPI
(René Fassbender, Joe Mohr, J. Song, W. Barkhouse, and H. Boehringer)

We successfully used the ISPI camera in September 2006 to complement Mosaic-2 follow-up observations of X-ray selected galaxy cluster candidates in the South Pole Telescope (SPT) survey region. We obtained ISPI H-band images of a total of 25 high-redshift galaxy cluster candidates with no or only a weak optical counterpart in the shallower Mosaic bands. A preliminary photometric analysis confirmed about 18 systems at redshifts z>~0.8, of which 6-10 candidates are expected to be at redshifts beyond unity. The ISPI observations have been invaluable for pinning down the high-redshift tail of the cluster population for which we have submitted spectroscopic follow-up proposals to Gemini South and the Very Large Telescope. The successful start of the project will be continued this fall toward the final goal of compiling a large sample of high-redshift clusters for detailed structure formation studies.

Target-of-Opportunity observations of GRBs
(David Bersier)
GRB 050401 was observed with ISPI as part of a multi-observatory campaign (European Southern Observatory, CTIO, United Kingdom Infra-Red Telescope (UKIRT), Nordic Optical Telescope and Telescopio Nazionale Galileo on La Palma). This burst, at a red shift z=2.9, has a very high column density (inferred from X-ray data and from the Lyman-alpha line seen in the optical spectrum) but low extinction. The infrared data (obtained at CTIO with ISPI and at UKIRT) provide strong constraints on the level of extinction in this burst. Fitting the optical/near-IR energy distribution yields a value of the visual extinction A_V that is much lower than what is inferred from the X-ray spectrum. One strong conclusion based on the spectral energy distribution is that the dust-to-metals ratio has to be very low. The high metal column density and little extinction may be interpreted as possible evidence of dust depletion.



Number of galaxies as function of magnitudes per unit area in the neighborhoods of triplets of quasars.

Multicolor photometry of the neighbors of high-redshift triplets of quasars
(Maria Victoria Alonso)
In 2006, a team formed by Maria Victoria Alonso (Observatorio Astronomico, Universidad Nacional de Cordoba (OAC), Argentina), Ilona Söchting (Gemini), Georgina Coldwell (OAC), Malcolm Smith (NOAO/AURA), Diego Garcia Lambas and Carlos Bornancini (OAC) obtained multicolor photometry of the neighborhoods of high-redshift triplets of quasars using ISPI and Mosaic. The existing studies of quasar environments suggest their association with forming structures, marking merging clusters and filaments. Consequently, groupings of quasars can be expected to trace regions of extraordinary activity. Preliminary results of the number of galaxies as a function of the magnitudes per unit area in the neighborhoods of the studied triplets of quasars are shown in the figure (from Alonso et al., 2007, *MNRAS*, in prep.). These results allow us to check the characteristics of our catalog in both homogeneity and depth. These counts were compared with the results of Best (2000, *MNRAS* 317, 720), Totani et al., (2001, *ApJ* 559, 592), Best et al., (2003, *MNRAS* 343, 1), Bornancini et al., (2004, *AJ* 127, 679), and Olsen (2006, *A&A* 456, 881), and showed excellent agreement. Our catalog is complete until $K_s \approx 19$, and it will allow us to analyze the over-densities and the galaxy population in the neighbors of the triplets of quasars.

Getting Ready for the Next 50 Years – Part 2

Buell T. Jannuzi

In the June 2007 *Newsletter,* we described how Kitt Peak National Observatory (KPNO) has begun a program of modernization projects in response to the recommendations of the NSF Senior Review. Since then, we have also benefited from the advice of the NOAO Users Committee. Our continuing efforts are part of the NOAO commitment to provide the community with outstanding research opportunities through the instruments and telescopes of Cerro Tololo Inter-American Observatory (CTIO) and KPNO. This article provides an update on the modernization activities planned for KPNO, as well as brief descriptions of the new capabilities coming to KPNO in the near future. Progress reports will appear in future editions of this *Newsletter* and on our Web site.

New Capabilities

This semester, KPNO is welcoming two near-infrared imagers to our telescopes. The NEWFIRM wide-field infrared imager has begun shared-risk observations at the Mayall 4-meter telescope, and the WIYN High-Resolution Infrared Camera (WHIRC) is undergoing commissioning tests at the WIYN 3.5-meter. WHIRC will begin shared-risk observing during the 2008A semester and is anticipated to become a facility instrument by semester 2008B. NEWFIRM will be shared between the Mayall and Blanco telescopes, with the first move of the instrument to Chile currently scheduled for early 2010 (see *www.noao.edu/ets/newfirm/NEWFIRM_info.pdf*). The first NOAO Survey Program observing campaigns using NEWFIRM are anticipated to begin in semester 2008A.

The second half of 2010 will see the commissioning of the One-Degree-Imager (ODI) at WIYN. Following in the path of OPTIC and QUad OTA (QUOTA), ODI will use similar orthogonal-transfer CCDs to deliver superb images, but over a much wider field of view. Both NEWFIRM and ODI will come complete with data-reduction pipelines that will deliver flat-fielded frames, together with astrometric and photometric information, to the NOAO Science Archive (NSA).

The evolution of the system of telescopes and instruments available to the US astronomical community via NOAO will be informed by the report of the Renewing Small Telescopes for Astronomical Research (ReSTAR) committee, due at year-end. This report will influence our plans for the future of instrumentation for the System of telescopes accessible through the NOAO observing-time allocation process, and for KPNO in particular.

Ron Probst, NOAO project manager for the NEWFIRM wide-field infrared imager (*top photo*), provides operational advice to Xiohui Fan (University of Arizona) and collaborators prior to the start of the first visitor program with the new instrument at the Mayall 4-meter telescope in early November.

We will also use the ReSTAR report and input from the community (including the Users Committee) to inform our consideration of restarting queue and/or service observing at one or more of the KPNO telescopes. Your thoughts regarding either new instruments or the utility of non-classical observing modes to your science goals are welcome--send them to me at *bjannuzi@noao.edu*.

KPNO Modernization

Several projects to modernize KPNO are underway. To aid in the installation and maintenance of large new instruments such as NEWFIRM and ODI, we have begun renewing our ability to support engineering activities on the mountain, including the purchase of new instrument-handling equipment and planning for the construction of a new instrument-handling facility. Equipped with a clean room suitable for all needed maintenance of the next generation of large instruments represented by NEWFIRM and ODI, the new facility will reduce the risk of damage to these valuable instruments and increase the amount of time the instruments can be used on the telescope.

New instruments are being deployed on Kitt Peak to help all the telescopes on the mountain keep better track of observing conditions and to aid in the long-term characterization of the site and archived data products. See the related article titled "The KPNO Site Monitoring Suite" for more details.

The telescopes are also receiving attention. We are restocking depleted stores of spare parts for all three of our main telescopes. New computers and networking hardware are being purchased for the Mayall and other telescopes to improve communications between subsystems and improve reliability. A preventative maintenance plan is being expanded and, coupled with inspections and testing of key sub-systems, will lead to the identification of additional modernization projects during the next three years.

Some of our existing instruments are being considered for upgrades and modernization, and we welcome your suggestions for improvements. Plans are being developed to replace aging detector controllers with new MONSOON systems, with the Mayall spectrographs and Mosaic-1 imager among the possible instruments to be upgraded. New guiders are also being considered in order

continued

Getting Ready for the Next 50 Years - Part 2 continued

to improve the performance of our existing instruments.

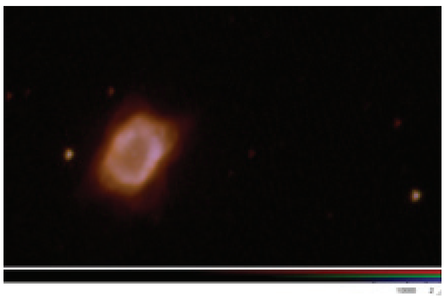
In addition to modernizing our instruments and telescopes, we also continue to renew our staff. New technical and engineering positions have been created, and you will be introduced to the new hires in future *Newsletters*. The additional staff are essential not only for the successful completion of our modernization efforts, but will be needed to properly support complex instruments like ODI in the years ahead.

NOAO is committed to operating KPNO at the highest level of performance in partnership with the Tohono O'odham Nation, on whose land we are fortunate to locate our observatory. We will continue to support the tenant observatories on the mountain as a critical parts of the US system of observing facilities, and we look forward to continuing to work closely with the community as we start another 50 years of operations.

WHIRC at Work on WIYN

Dick Joyce & Margaret Meixner (STScI)

The WIYN High-Resolution Infrared Camera (WHIRC), built by Margaret Meixner (Space Telescope Science Institute) and collaborators, has been delivered to Kitt Peak and has begun commissioning tests on the WIYN telescope. WHIRC employs a 2K x 2K Raytheon "Virgo" HgCdTe array to cover the 0.9–2.5 micron range with a pixel scale of 0.1 arcsec. The instrument is installed on the WIYN Tip/tilt Module (WTTM) port.

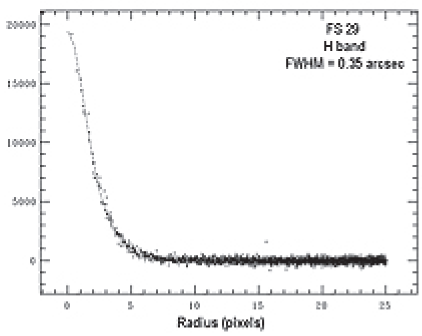


A JHK_s image of the planetary nebula NGC 7027 taken with WHIRC.

When operating with WTTM correction under good seeing conditions, we anticipate image quality approaching 0.2–0.25 arcsec in the K_s band. In addition to the standard J, H, and K_s broadband filters, WHIRC contains 10 narrowband (typically 1 percent fractional bandwidth) filters covering a variety of atomic and molecular features. A description of the instrument can be found at *www.noao.edu/kpno/manuals/whirc/WHIRC_0708.htm*.

WHIRC was delivered to WIYN in July 2007 and has undergone three short integration and testing runs in July, August, and September, resulting in significant progress toward the commissioning of the instrument. Most of the software and computer integration with the telescope has been completed. The observing interface and observer's planning tool have been tested, and suggestions based on the commissioning tests are being incorporated.

Science verification testing of WHIRC included observations of photometric standards and flat fields in all 13 filters to determine the optical throughput of the entire system, which was very close to the prediction during the design phase. Photometric and astrometric precision were tested by observation of well-studied clusters. Linearity, persistence and scattered moonlight tests all gave satisfactory results.



Plot of the radial profile of a star taken with the WTTM turned on yielding an image FWHM = 0.35 arcsec in the H band.

The WHIRC image quality is excellent. Tests with the pinhole array at the WTTM input gave 0.17-arcsec images, demonstrating that the WHIRC /WTTM optics should not be a limiting factor to obtaining the best possible on-sky image quality. The commissioning runs so far have not included the testing of WTTM in active tip/tilt mode, although the combination was tested briefly in September, resulting in H-band images as good as 0.35 arcsec.

WHIRC Principal Investigator Margaret Meixner (STScI) and WHIRC in July during the testing and integration phase on the WIYN 3.5-meter telescope.

One major remaining issue is the identification and mitigation of excess detector readout noise. NOAO engineer Maureen Ellis is leading the effort to resolve this remaining noise issue. Commissioning tests of WHIRC with WTTM are planned for the late 2007A and early 2008A semesters, with the anticipation that WHIRC will meet its final acceptance criteria during the 2008A semester. WHIRC is being offered for shared-risk observing, but without WTTM in active tip/tilt mode, during the 2008A semester.

The KPNO Site Monitoring Suite

Bob Blum

Kitt Peak National Observatory (KPNO) has embarked on a project to deploy a modern site-monitoring suite to aid observers in real-time site characterization and to provide long-term site quality data.

The initial system will deploy a differential image motion monitor (DIMM) with a multi-aperture scintillation sensor (MASS) upgrade path, similar to the system in place at Cerro Tololo Inter-American Observatory (CTIO). The DIMM uses two independent images of the same star formed through separate pupil-plane apertures to track image motion. The relative image motion between the two images is used to estimate the variance in image motion due to the atmosphere, which is related through theory to the "seeing" or image FWHM. The DIMM will be deployed on a 3-meter tower south of the KPNO 2.1-meter telescope and will operate in robotic mode. Site work has begun, and contracts have been let or bids sought for all the major components. First light is expected in early 2008.

The MASS is a low-resolution turbulence profiler used to indicate where the turbulent layers are located at any given time. The MASS is sensitive to turbulence in six logarithmically spaced layers from 0.5 kilometers to 16 kilometers in altitude, and can be used in concert with the DIMM (a MASS-DIMM) to determine the strength of the ground-layer turbulence. The MASS was developed via a collaboration between the University of Moscow's Sternberg Institute and CTIO.

KPNO is also deploying an all-sky camera, known as KASCA, which will provide images every 30 seconds of the entire night sky over Kitt Peak in red and blue filters, as well as a sodium filter to aid in the tracking of light pollution near the horizon. The KASCA has been built at CTIO and is used to observe thin clouds and OH air glow by generating movies throughout the night. Clouds are seen in silhouette by their motion across star fields or the OH airglow itself. The KASCA is completed and will soon be deployed on the roof of the Kitt Peak mountain administration building.

The data from both the DIMM and KASCA will be available in real time to all KPNO and tenant observatory observers, as well as after the fact through nightly summary plots and a public database.

Elizabeth Alvarez del Castillo and John Glaspey Rejoin NOAO

Buell T. Jannuzi

Elizabeth Alvarez del Castillo has joined the KPNO management team as assistant to the KPNO Director. Many of us know Elizabeth from her previous term with NOAO as part of our planetary sciences group with Michael Belton. During her subsequent service as associate director of the International Dark-Sky Association, she collaborated extensively with our observatories in the US and Chile, and our NOAO outreach programs.

Most recently, she worked with the director's office at the University of Arizona's astronomy department (Steward Observatory) and with the Large Binocular Telescope (LBT) project. She has been involved in many aspects of the astronomy community on local, national and international levels, and has worked on a diverse set of projects. Elizabeth is already contributing to several key issues important to KPNO, including the active protection of the quality of the site (outdoor lighting issues), relations with tenant observatories, and general operations. We are fortunate to have Elizabeth join our team.

John Glaspey has accepted a Visiting Scientist position with KPNO and the NOAO Public Affairs and Educational Outreach (PAEO) office. We are pleased that John will be helping with important aspects of our programs for FY08. Known to many at NOAO from his years as supervisor of mountain scientific support, John brings to us his numerous skills, infectious enthusiasm, and years of experience in the operation of observatories, including L'Observatoire astronomique du mont Megantic, the Canada-France-Hawaii Telescope, the Hobby-Eberly Telescope, KPNO, and the MMT.

John will be assisting with various aspects of improvements to the WIYN Bench Spectrograph (including the deployment of a new detector/controller/Dewar), and he will be working to solve some long-standing pointing issues with the Mayall 4-meter telescope. John will be helping KPNO and the PAEO group with outreach to the Tohono O'odham Nation, including a new partnership between NOAO and the Indian Oasis-Baboquivari Unified School District called "Reach for the Stars" (see related article in the PAEO section of this *Newsletter*). John has also been integrated into the ongoing Hands-On Optics informal science education activities conducted by PAEO with the Boys & Girls Clubs on the Nation in Sells and elsewhere, led by Connie Walker.

From the Director's Office

Steve Keil

The mission of the National Solar Observatory (NSO) is to advance our knowledge of the Sun, both as an astronomical object and as the dominant external influence on Earth. The NSO achieves this mission through its role as the primary provider of forefront, ground-based observational capabilities to the scientific community. These innovative facilities allow solar astronomers to probe all aspects of the Sun, from its deep interior to the interface in the outer atmosphere with the interplanetary medium. In collaboration with the community, NSO provides leadership in scientific research and instrument development, particularly in the areas of helioseismology, synoptic observations of solar variability, and high-resolution studies of the solar atmosphere in the visible and infrared.

NSO has developed a long-range strategy for the logical and optimal transition from the operation and support of our current national solar facilities to the era in which our primary solar telescopes are both replaced and surpassed in capability by the Advanced Technology Solar Telescope (ATST). In parallel with ATST construction and development, resources will be required for the ongoing support and operation of the scientifically essential and productive synoptic program, including support of the expansion of the SOLIS Vector Spectromagnetograph (VSM) to a three-site global network in collaboration with international partners. As the ATST approaches its operational phase, NSO will consolidate its staff at a single headquarters location while also maintaining an on-site staff to support ATST operations.

During the course of the proposed cooperative agreement between the National Science Foundation and AURA for continued operation of NSO for the period from mid-FY2009 through mid-FY2014, NSO will implement its strategic plan. The principal actions that NSO intends to pursue in order to advance solar physics during the term of the agreement include:

- Begin construction of the Advanced Technology Solar Telescope through the NSF Major Research Equipment Facilities Construction (MREFC) program. The ATST will be the next-generation, ground-based facility for high-resolution studies of solar magnetism and dynamics in the solar atmosphere for several generations to come. With an ATST construction start in the 2009-2010 time frame, commissioning should occur in approximately 2015, with full operations by 2016

- Engage the national and international community to develop a multi-station synoptic network based on experience gained with SOLIS and GONG. Long-term synoptic observations are critical to fully understanding the Sun's variable output and its effects on space weather and Earth's climate

- Develop an NSO structure that effectively operates new capabilities, consolidates the scientific staff currently separated in Sunspot and Tucson, and provides effective support for the observational and data needs of the solar research community

- Maintain existing facilities as needed to ensure continued scientific productivity until future capabilities (i.e., ATST) are in operation. We will work with the helioseismology community to find alternative funding to help support the GONG helioseismology network, as recommended by the NSF Senior Review

- Use the opportunities provided by ATST development, SOLIS, the enhanced GONG network, and the new adaptive optics and infrared capabilities to promote the establishment of a strong foundation for solar physics in the university community. University partnerships will be formed (through such programs as the new NSF Partnerships in Astronomy and Astrophysics Research and Education Program) to increase the diversity of NSO and the solar community by contributing to the scientific development of students from underrepresented communities

- Take a leadership role to develop a community-wide roadmap for ground-based solar facilities that will include collaboration with NASA to link space-based and ground-based facilities to maximize their synergy for advancing understanding of the Sun

- Through the development and operation of innovative observing capabilities (e.g., continual near-real-time GONG magnetograms, SOLIS vector magnetic field maps, calibrated GONG farside images), the NSO will provide the space weather community with the data needed to monitor, understand and, ultimately, predict solar activity and variability

- Continue to enhance the NSO Digital Library so that all NSO data collected on behalf of the community are available online. NSO will also continue to partner with NASA and universities to develop the Virtual Solar Observatory, which provides community access to all aspects of solar data, including NSO data

Together, these actions should provide a logical transition from the current support the NSO offers to the solar community to an era of new ground-based capabilities. Our facilities, together with other ground-based solar assets throughout the world and those of NASA and the European Space Agency, such as the Transition Region and Coronal Explorer, Solar Heliospheric Observatory, Hinode, Solar Terrestrial Relations Observatory, Solar Dynamics Observatory, Solar Orbiter, and Solar Probe, will form a powerful "solar system" for the exploration of the mysteries of our nearest and most important star—the Sun.

ATST to Use Venerable Observatory as Testbed; Software Systems Advance

The ATST Team

The Hilltop Facility at NSO/Sacramento Peak, built in 1962, may be pressed into service to help develop the high-order adaptive optics (HOAO) for the Advanced Technology Solar Telescope (ATST). The combination of old and new will help the ATST team develop the HOAO and resolve problems before transferring the system to the new observatory.

ATST work will not use the dome itself, but rather the optics lab in the middle of the building, where the developers will have access to the light feed from the Hilltop's coelostat. The optics lab is now used by the Air Force Research Laboratory's Optical Solar Patrol Network (OSPAN) project, so final approval is pending.

"Once construction funding arrives, we're going to need office space and a laboratory for people to work in and to develop the wavefront correction system," explained Steve Hegwer, the ATST AO project manager. The first steps will be hiring two or three additional people to work on the HOAO, and then ordering components that will be assembled into the wavefront correction system. These include the deformable mirror (M9), fast tip/tilt mirror (M5), wavefront sensor camera, and the HOAO control system.

"While we're waiting for those to arrive, we'll design the optics for the light feed and make room in the lab for our setup," Hegwer explained. The lab has a 4 × 12-foot optical bench that should accommodate the HOAO system.

The HOAO system will be based on the Shack-Hartmann correlation system pioneered at the Dunn Solar Telescope at Sunspot, with some changes.

"We're building on what we did before," Hegwer said. "It's still a Shack-Hartmann lenselet array scaled up from the Dunn's AO76. It's most different in that it will have much bigger optics." The ATST will have a 215-millimeter deformable mirror (M9), as compared to 77 millimeters on the Dunn's AO76 system, and a 230-millimeter tip/tilt mirror (M5), versus 35 millimeters. In addition, the HOAO system will have 1,236 subapertures and 1,369 actuators on the mirror's back face (compared to 76 subapertures and 96 actuators on the Dunn). Other elements will be correspondingly larger to handle the wider light beams. The overall configuration (see figure 1) is currently being refined to ensure the best possible fit into the coudé lab, where the HOAO and science instruments will be located.

Because the aperture on the Hilltop's coelostat is small, imaging through the HOAO system will not be noteworthy. The purpose of the testing is to ensure that the system delivers a flat wavefront to the science instruments. As the HOAO system matures, the team may move it to the Dunn Solar Telescope for more advanced testing before shipping to ATST around 2013.

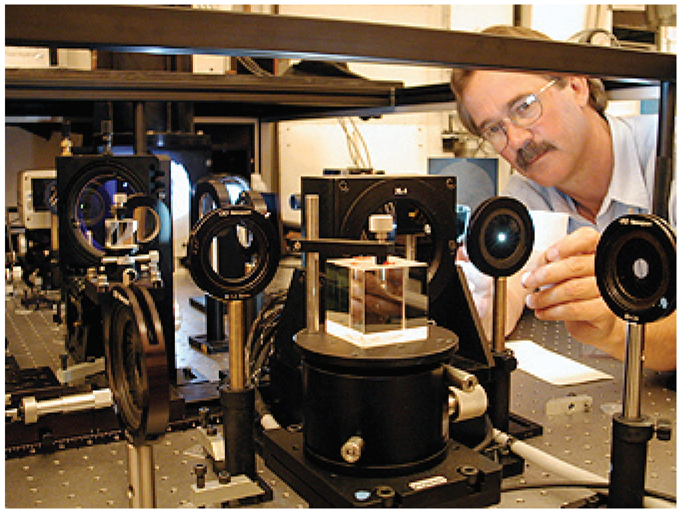


Figure 1. ATST AO project manager Steve Hegwer adjusts the AO76 system during a test run at the Dunn Solar Telescope.

On the software front, the ATST Common Services reached a milestone this quarter with the successful completion of the Sacramento-2 software release. This newest version of the ATST infrastructure framework provides C++ support for components, containers, and basic services. Contractor Observatory Sciences, Ltd., of Cambridge, United Kingdom, delivered the software, documentation, and test procedures on time and with all specified functionality. During acceptance testing, no major problems were identified, minor problems were fixed, and performance numbers were calculated.

The Observatory Control System and Data Handling System (DHS) are ready for a preliminary design review, which has been tentatively scheduled for February 2008. The project is starting to assemble the external review committee for these systems. In preparation for the reviews, the project will be performing an internal review and walk-through of the DHS for the NSO science and engineering staff. The goal is to identify any technical problems or deficiencies in the design during this period.

An internal workshop on the DHS was held in June at Sunspot, where the ATST staff discussed the specifications for the DHS, the expected performance of the proposed ATST first-generation instruments, and the preliminary design of the DHS facility. This meeting resulted in a new specifications document and several major changes to the DHS design (see figure 2). The design now includes a more versatile "camera line" framework, allowing resources to be added to the DHS as cameras and instruments are brought online. The necessary storage and pro-

continued

ATST to Use Venerable Observatory as Testbed continued

cessing for the data handling infrastructure will be delivered at commissioning, along with software for the bulk data transport, data delivery, quick-look display, and data processing pipeline subsystems.

Several subsystems of the Telescope Control System M2CS have progressed to a preliminary design level. The M2 Control System and Heat Stop Control System designs were reviewed as part of the Top End Optical Assembly PDR in July. The M2CS has also been implemented in the software simulator, allowing the testing of control and event responses between the user interface and the low-level components. The M1, Mount, and Enclosure Control Systems are currently under preliminary design development, with reviews expected for each in the coming months. NL

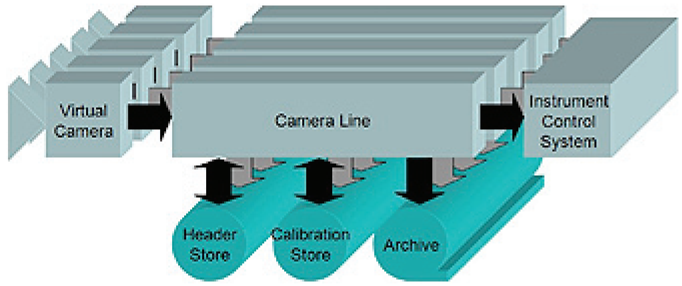


Figure 2. Scalable camera line architecture for the ATST Data Handling System.

SOLIS

Mark Giampapa & The SOLIS Team

We are happy to report that Aimee Norton has enthusiastically agreed to commit a majority of her time to the SOLIS project as the new SOLIS Program Scientist. The welcome addition of Aimee to the project will allow Carl Henney—who has served during the past year simultaneously in the roles of SOLIS Data Scientist, SOLIS Program Scientist, and SOLIS Co-Project Manager (with Dave Jaksha)—to focus his efforts on the development of SOLIS data products for the community as the SOLIS Data Scientist. The NSO is grateful to both Carl and Aimee for their dedicated service to the NSO and the community.

The SOLIS team continues to work toward achieving the full operational capacity of the telescope and its instruments. The Integrated Sunlight Spectrometer (ISS) is now producing science-quality data for many of its intended wavelengths and these data can be accessed online. The Vector Spectromagnetograph (VSM) is taking high-quality observations daily. Quick-look results from VSM observations of sufficiently strong magnetic field are available in a three-dimensional format online while efforts continue to finalize the full vector data processing. The Full-Disk Patrol (FDP) system is still being assembled. Further instrument status details, examples of the data, and data handling efforts are summarized as follows.

Quick-look vector magnetic field, FITS-formatted data and JPEG image files from the Vector Spectromagnetograph are available for recent observations (see sample set, figure 1). The VSM quick-look vector data are also available in ×3d format such that the data can be explored as a 3D model. A sample 3D snapshot of the magnetic field for an active region (AR 10921), using VSM data observed on 3 November 2006, is shown in figure 2. All of the VSM quick-look data are corrected for the 180° ambiguity using the Non-Potential Field Calculation (NPFC) method developed by Manolis Georgoulis (Johns Hopkins).

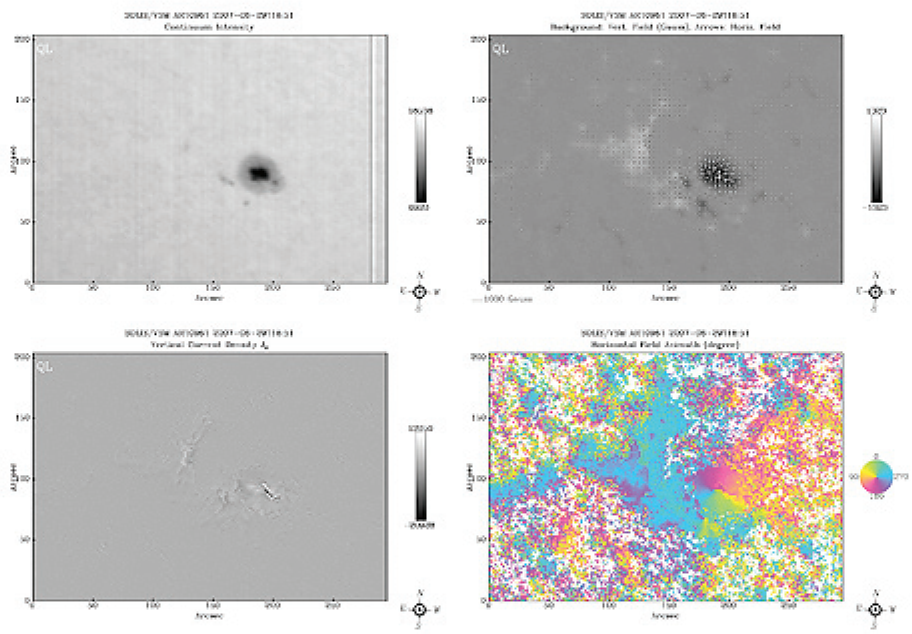


Figure 1: These quick-look images of AR 10960, observed with the VSM on 8 June 2007, highlight some of the parameters publicly available daily: continuum intensity (upper left), vertical field strength with arrows indicating the horizontal field strength and direction (upper right), vertical current density (lower left), and field azimuth (lower right).
The quick-look parameters have been corrected for the 180° azimuth ambiguity.

Science-quality data from the ISS have recently become available and can be accessed online *(solis.nso.edu)*. The ISS is taking daily observations with the following wavelengths: 388.4 nanometers, 393.4 nanometers, 396.8 nanometers, 538.0 nanometers, 539.4 nanometers, 656.3 nanometers (H-alpha), 854.2 nanometers, and 1083.0 nanometers; although only the Ca II K , Ca II K H, and 1083.0 nanometers are

continued

SOLIS continued

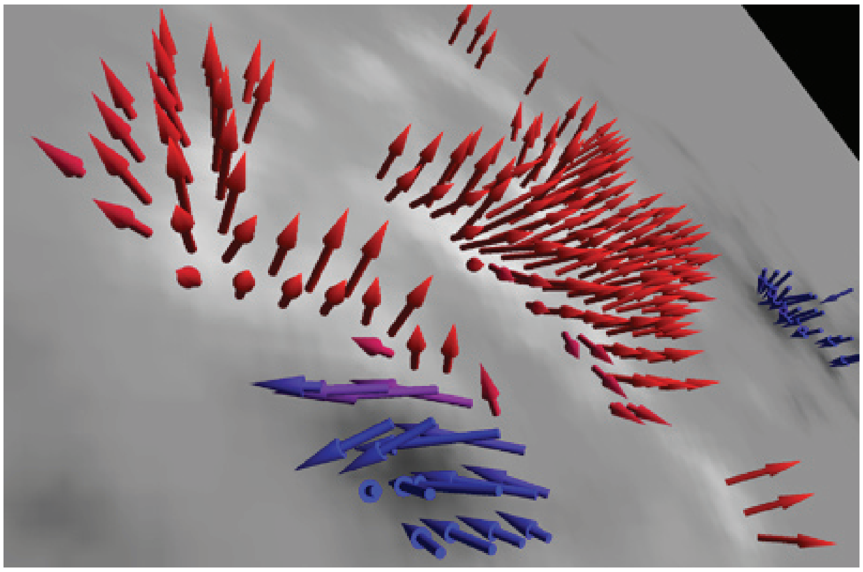


Figure 2: A sample snapshot of VSM quick-look x3d formatted data. The x3d formatted data allow the VSM vector data to be explored as a 3-D model. This snapshot exhibits the magnetic field orientation of active region AR 10921 using VSM data observed on 3 November 2006.

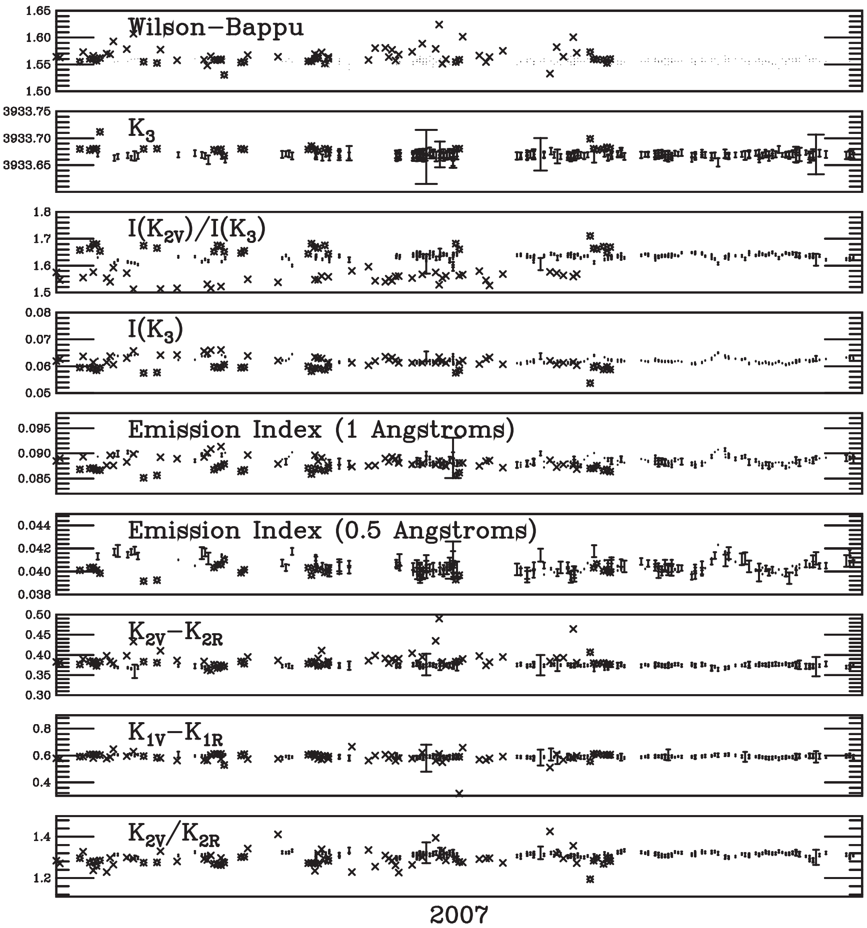


Figure 3: Preliminary analysis, comparing SOLIS ISS Ca II K parameter data with data from various synoptic programs.

currently available on the Web. These spectral lines correspond to wavelengths that Bill Livingston (NSO) used to monitor the solar cycle with the McMath-Pierce Solar Telescope spectrometer (see figure 3). ISS observations are spatially unresolved, which means that the Sun is observed as a star. Scientists will use the data taken with the ISS to understand how the solar cycle modulates the energetic output of the Sun as a function of wavelength. Ultimately, this is one piece in the puzzle of how long-term variations in solar irradiance may affect terrestrial climate. In addition, these data will be compared to similar data from solar-type stars in studies of stellar cycles and their dynamo origin. Preliminary analysis, shown in the figure, comparing the Ca II K parameters (December 2006–May 2007) from the ISS (blue in the color version online) with data from the synoptic programs at the Evans Coronal Facility (green) at Sac Peak and at the McMath Pierce Spectrometer (red) at Kitt Peak shows excellent agreement.

The Full-Disk Patrol (FDP) system has recently been used to test a hardware system used in the VSM that has had intermittent failures. In addition, the FDP will be used to do preliminary testing of the new guider design. The current status of the FDP is that all major hardware has been purchased and is in the final 20 percent of software development. Work over the next quarter will include assembly of the final Lyot filter unit and alignment of all optical components.

The SOLIS data pipeline now is in regular, daily use. Recent improvements have reduced the time required by the observers to manually process a 6302 full-scan from 45 minutes to 5 minutes when the pipeline is running the same processing. The pipeline code has been made more robust in numerous ways that allow the processes to run on a continuous basis without problems from runtime errors or crashed processes. These improvements have greatly increased the duty cycle of the instrument.

Work on the new SOLIS Data Acquisition System (DAS) and Sarnoff cameras is nearing completion. The cameras were recently delivered and are currently undergoing qualification tests. Delivery was slightly delayed due to mechanical modifications on the camera faceplate required for VSM environmental control. New camera-mounting hardware has been designed and is currently in fabrication. Installation of the new camera system is expected before the end of the first quarter in FY 2008.

Using the Near-Infrared to Study Sunspot Umbral Dynamics

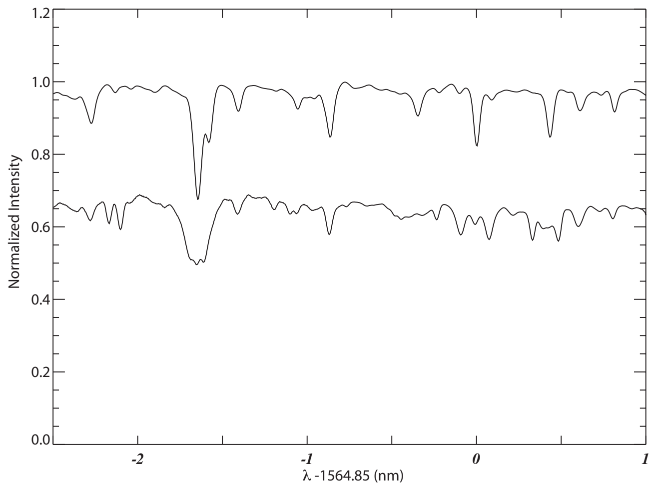
Aimee Norton, Matt Penn, Claude Plymate & Eric Galayda

The National Solar Observatory (NSO) has developed a robust infrared (IR) instrumentation development program at the NSO/Kitt Peak McMath-Pierce Solar Telescope facility. A 1024^2 indium antimonide (InSb) array camera is now available as a facility instrument for use in the 15-micron thermal infrared. Known as the NSO Array Camera (NAC), it can be used with the telescope's very high dispersion spectrograph. The imaging capability is enhanced with a low-order IR adaptive optics (IRAO) system designed to correct seeing to the diffraction limit of the telescope at infrared wavelengths. Liquid crystal retardation modulators and polarizing optics have been added to the spectrograph to enable the NAC to record IR Stokes polarimetry data.

We use the NAC with adaptive optics to search for a dependence of magnetohydrodynamic (MHD) wave speeds on the average field strengths in several sunspot umbrae. We measure velocity signals with the Fe I 1564.8 nanometer line and the molecular OH lines at 1562.7 nanometers. The OH lines are formed approximately 90 kilometers higher than the Fe line in the solar atmosphere. We identify the characteristics of oscillatory signals and any associated propagation speeds.

Since the dominant umbral oscillations are the slow MHD waves, acting similar to a pure acoustic wave, they should not show a dependence on umbral field strength. We tested this hypothesis by obtaining time-series with a duration of 3,040 minutes and a 20-second sampling resolution for different active regions. The near-IR data are especially interesting because so few sunspot studies have been conducted at this wavelength, and it is not adversely affected by scattered light.

Wave coupling between Alfvén and the fast and slow MHD waves, as well as transformations of wave properties during propagation through the region of the atmosphere where the magnetic pressure begins to dominate gas pressure, make identification of individual wave modes difficult. As observers, we are still searching for ways to disentangle the MHD wave signatures in the lower solar atmosphere.



Sample spectra observed with the NSO Array Camera in the 1564-nanometer region. A quiet-Sun spectrum is plotted in the top line and an umbral spectrum plotted below. The spectral lines of interest are the OH molecular lines near 1562.7 nanometers and the Fe I magnetically sensitive line at 1564.8 nanometers. Note that the molecular OH lines at 1562.7 nanometers are only formed in cool umbrae. The Fe I 1564.8 nanometer line is magnetically sensitive with an effective Landé factor of three. The splitting of the line is obvious in the umbral spectra.

In our preliminary results, we find that the dominant umbral signal has a periodicity of 23 minutes and phase lags between the Fe and the OH lines are positive, meaning the Fe signal leads the OH signal. This indicates upward propagation of waves with phase speeds of 15–30 kilometers per second. We plan to continue our observational efforts and determine if the wave characteristics show a dependence on field strength. We may have to wait until the new solar cycle has truly begun before we can complete this study.

NSO Observing Proposal Submission Deadlines:

- **Spring Quarter (April – June) FEBRUARY 15**
- **Summer Quarter (July – September) MAY 15**
- **Fall Quarter (October – December) AUGUST 15**
- **Winter Quarter (January – March) NOVEMBER 15**

Instructions and Web-based observing request forms are available at:
www.nso.edu/general/observe/

GONG++

Frank Hill & the GONG++ Team

Over the last quarter, the GONG++ team has continued to develop products for use by space weather forecasters. Our magnetic field products, especially the hourly synoptic maps, are now considered to be the best currently available by the general solar physics community. Groups that are integrating our products into their models, simulations, and forecasts include the Air Force Research Laboratory, the Science Applications International Corporation (SAIC) in San Diego, the Center for Integrated Space Weather Modeling (CISM) in Michigan, the University of California, Berkeley Space Sciences Laboratory (SSL), and the University of Alabama, Huntsville. In addition, the NASA Johnson Space Center Radiation Analysis Group has expressed interest in the helioseismic predictors. The excitement generated by the magnetic field products demonstrates that a ground-based network is an extremely valuable asset for general solar observations in addition to helioseismology.

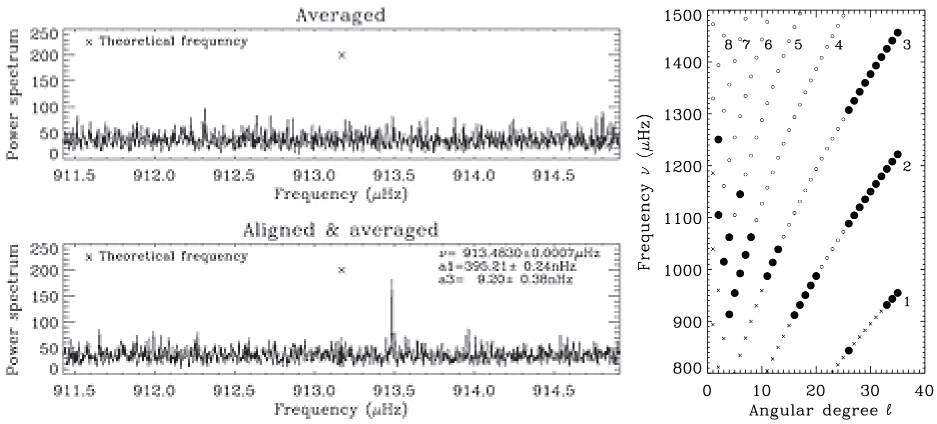


Figure 1. Traditionally, global helioseismic analysis based on the fitting of individual modes has been limited to modes with frequencies above approximately 2000 μHz, as at lower frequencies, the mode amplitudes decrease rapidly and the background arising from solar convective motions increases. However, for each radial harmonic (*n*) and spherical harmonic degree (ℓ), there are actually 2 ℓ +1 modes with different values of the azimuthal order (*m*), whose degeneracy is broken by differential rotation and asphericities of the internal structure. By optimally shifting the individual *m* spectra and averaging over *m*, we have been able to detect many modes never seen before, which because of their long lifetimes can be measured with exquisite precision, substantially improving our knowledge of the structure and dynamics throughout the solar interior. (Left panel) The ℓ = 4, *n* = 4 multiplet, which is very clearly detected from ten years of GONG data in the aligned *m*-averaged spectra (lower panel) compared with the unaligned spectrum (upper panel). The estimated central frequency and shift (*a*) coefficients are indicated. The cross indicates the position of the corresponding theoretical central frequency calculated from Christensen-Dalsgaard's model S suggesting that we still have a ways to go in refining the model of solar internal structure. (Right panel) ℓ-ν diagram of the "never-before-seen" modes (1 ≤ ℓ ≤ 35) detected in the GONG data (•) along with already known modes ( ) and predicted modes (×).

Science Highlights

GONG++ scientists attended a two-day workshop on data assimilation techniques hosted by Robert Schunk's ionosphere research group at Utah State University in Logan. Along with research teams from UC Berkeley SSL and the University of Alabama, Huntsville, GONG++ staff were introduced to the methods and challenges of continually merging observations with sophisticated numerical simulations. Data assimilation has been a vital component of meteorology for decades, but it is just beginning to be developed for solar physics and space weather applications. The ultimate goal is to assimilate the GONG++ subsurface flows, far-side images, and high-cadence magnetograms into the Berkeley SSL and Huntsville simulation packages to forecast active region evolution.

While much of our current effort is focused on space weather products and local helioseismology, the field of global helioseismology is still thriving. Recently, David Salabert, John Leibacher, and Thierry Appourchaux (Institut d'Astrophysique Spatiale, Orsay, France) developed a new way to estimate the parameters of oscillation modes at low frequencies, below 1.5 megahertz. This region of the spectrum is dominated by power from non-oscillatory solar phenomena, such as convection, which makes it difficult to identify and fit the peaks from the *p* modes. The new method, illustrated in figure 1, exploits the three-dimensional nature of the oscillation spectrum by shifting in frequency and then averaging the spectra as a function of azimuthal degree *m.* The magnitude of the frequency shift is adjusted until the resulting averaged peak for the mode is as narrow as possible, providing an estimate of the mode parameters. This method has added about 30 extremely precise modes to the set that can be fitted, and has improved the precision of the inversions below the convection zone.

Network Operations & Engineering

During the third quarter of 2007, GONG operations staff made routine preventive maintenance trips to Big Bear and Udaipur. The CCD camera at Big Bear was replaced; however, within two weeks of installation, the internal cooling fan failed, forcing the thermoelectric cooler to work at its limit to stabilize the temperature. The data indicate that temperature stability is adequate until another replacement camera can be made available. The Udaipur trip included resolving problems associated with the synchronization of the data acquisition system. The problems seemed to be resolved after installing a new camera and cables, but reappeared in a different guise when the upgraded waveplate rotator amplifier hardware was installed. On-site troubleshooting led to a modification to a set of cables disabling multiple grounds, which solved the problem. The backup diesel generator issues were also resolved and the system is now fully operational.

Significant improvements to the camera thermoelectric cooler assembly and camera case are being made to the cameras as they rotate in from the field sites. The cameras are much

continued

GONG++ continued

easier to maintain and assemble and the cooling performance is greatly increased. Two of the Lyot Filter/Michelson Interferometer assemblies have been rebuilt. The oil between the optical elements has dried and is being replaced with an optical-coupling grease. This will be done with all of the assemblies as they too rotate in from the field. Other upgraded hardware being tested at the Tucson site and subsequently installed at the sites are the data, instrument and amplifier chassis, waveplate rotator amplifiers, turret pitch heads, and clean-air systems.

Testing of the replacement candidate for the GONG++ camera began in late October. This camera is a smaller-format version of the camera proposed for collecting H-alpha images, so valuable experience has been gained in working with this camera and software. A replacement candidate for the GONG workstation is being configured and tested.

Data Processing, Software Development & Analysis

The data storage and distribution system (DSDS) continues to mold itself around the ever-growing GONG pipelines. Several terabytes of disk space have been added, while archive and distribution tools are receiving constant upgrades to support the flood of data products. Processing to date includes time series, frequencies, merged velocity, and rings for GONG Month 122 (centered at 17 April 2007), with a fill factor of 0.9. Last quarter, the DSDS and *gong.nso.edu* FTP site distributed 522 gigabytes of data to the science community.

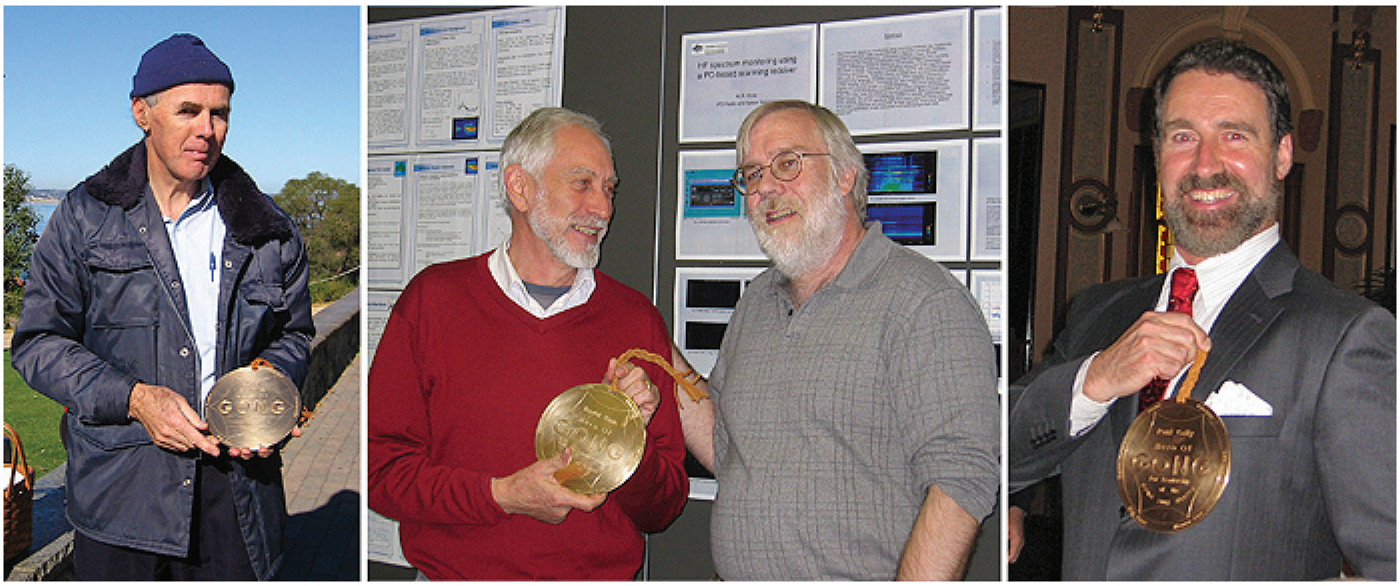
Progress continues on the porting of several production pipelines to Linux. The port of our calibration pipeline is complete and ready to deploy pending final acceptance tests.

The magnetogram pipeline products continue to be a big hit with the community. Work is in progress to add Integral Modeling with the magnetogram pipeline. World Coordinate System and SolarSoft keywords have been added to the magnetogram synoptic map headers to better accommodate compatibility with the community.

Program

We mentioned in the September 2007 *Newsletter* that David Cole and John Kennewell of the Australian Ionospheric Prediction Service have retired. In recognition of their outstanding service to the GONG++ Program over the last 20 years, we presented both of them with the highly coveted Hero of GONG (HOG) award in Sydney and Perth, Australia, respectively, shortly after the GONG 2007 Meeting in Melbourne (see photos).

The GONG++ and SOLIS programs are starting to take advantage of synergisms between the two programs. A number of GONG technical staff members have started to work with SOLIS counterparts on data processing tasks. Near-term plans include ongoing software support for SOLIS/VSM calibration, real-time instrument controls, algorithm development, and data archive. In addition, we have recently submitted a proposal to NASA to develop a new magnetic field product that will combine GONG and SOLIS data into a synchronic map. Long-term plans will integrate GONG and SOLIS into an NSO Synoptic Program.



John Kennewell (left) and David Cole (center with Frank Hill) received the Hero of GONG (HOG) award for their outstanding service to the GONG++ Program over the last 20 years. Paul Cally (right) received the HOG award for hosting the SOHO 19/GONG 2007 meeting in Melbourne, Australia in July 2007.

NOAO and the Tohono O'odham Nation "Reach for the Stars" Together

Katy Garmany

"Reach for the stars!" This expression can mean many different things to different people. For students at Indian Oasis-Baboquivari School District on the Tohono O'odham Nation, it is the name of a program initiated by the district last summer to encourage them to do their best in school.

The schools on the Nation face many challenges. One basic issue their leaders want to address is student attendance. This year, the district decided to offer incentives to students from kindergarten through high school for good attendance, including weekly prizes, field trips, and other rewards. These incentives will culminate with grand prizes at the end of the year: a pick-up truck (donated to the high school by the local auto dealer), a laptop for the middle school, and a bike for the elementary school.

These 5th grade students wondered how astronomers measure distances to galaxies.

Kitt Peak National Observatory was asked to participate in "Reach for the Stars" as a major partner. Kitt Peak Director Buell Jannuzi and NOAO Director Todd Boroson readily agreed to help, both financially and through staff time. The school district was eager to offer a field trip to Kitt Peak for students with the best attendance so far. Thus, in October, we hosted a series of three evening visits to give students the chance to observe through the 20-inch telescope at the Visitor Center, learn how to use a planisphere, and experience the wonderfully dark skies atop Kitt Peak.

Many of the students had never been to Kitt Peak beyond the picnic grounds. A number of enthusiastic parents came along as well. Happily, all three nights were clear—the cloudy night back-up plan involved visits to various domes and hands-on activities. We were very pleased at the positive response to this program from the visiting astronomers at the major telescopes.

Students from Baboquivari Middle School enjoy sunset.

Kitt Peak Observatory later received a two-page letter from a 5th grade student, who ended by writing, "I loved the trip to Kitt Peak. I learned a lot and I would recommend that kids come to school every day and maybe they could go to Kitt Peak too." Kitt Peak's support of the program was also noted on page one of a story in The Runner newspaper, the primary source of general news on the Nation.

The school district is honoring the best students at the monthly Board of Education meeting in Sells. They requested that Kitt Peak print some posters with pictures of the eight major planets. Large posters designed and printed by NOAO public affairs now hang in the Board Room to remind everyone of the program. Among the prizes to be awarded at the board meeting will be binoculars and other items with an astronomical theme.

Fostering Optics Education Around the World

NOAO Manager of Science Education Stephen Pompea gave two invited papers in October at the International Workshop on Science Education in School in Bucharest, Romania. Pompea is the director of the Hands-On Optics project that recently completed its NSF Informal Science Education funding and is now a core outreach program at NOAO. He was also part of an international team of judges who evaluated school science fair projects on polarization, spectroscopy, and astronomy, including this project (photo) by younger students on light and shadows, which won an award. The conference and science fair were sponsored by the Center for Science Education and Training at the Romanian National Institute of Laser, Plasma, and Radiation Physics; the European "Hands-on Science" Network; and SPIE-the International Society for Optical Engineering. The trip followed upon several presentations by NOAO outreach staff members in Athens, Greece, at the Communicating Astronomy with the Public 2007 meeting, sponsored by the International Astronomical Union.

GLOBE at Night: Plans for 2008 and Look Ahead to IYA 2009

Constance E. Walker, Douglas Isbell & Stephen M. Pompea

The ongoing loss of a dark night sky as a natural resource is a serious and growing issue for much of the world's population. It impacts not only astronomical research, but also human health, ecology, safety, security, economics and energy conservation. Dark-skies education efforts aim to heighten awareness of light pollution as a global problem with a local solution.

These efforts have proven to be most effective when they get people physically involved. For example, "star hunts" or "star counts" provide people with a fun, fast and no-frills way to acquire heightened awareness about light pollution through firsthand observations of the night sky. Over the past two years, the GLOBE at Night program led by NOAO educational outreach staff has enabled thousands of citizen-scientists around the world to contribute measurements of their local sky brightness to a growing global database in two ways: simple unaided-eye observations that anyone can do and quantitative digital measurements through a handheld, well-calibrated sky-brightness meter. The dates for GLOBE at Night 2008 are February 25-March 8.

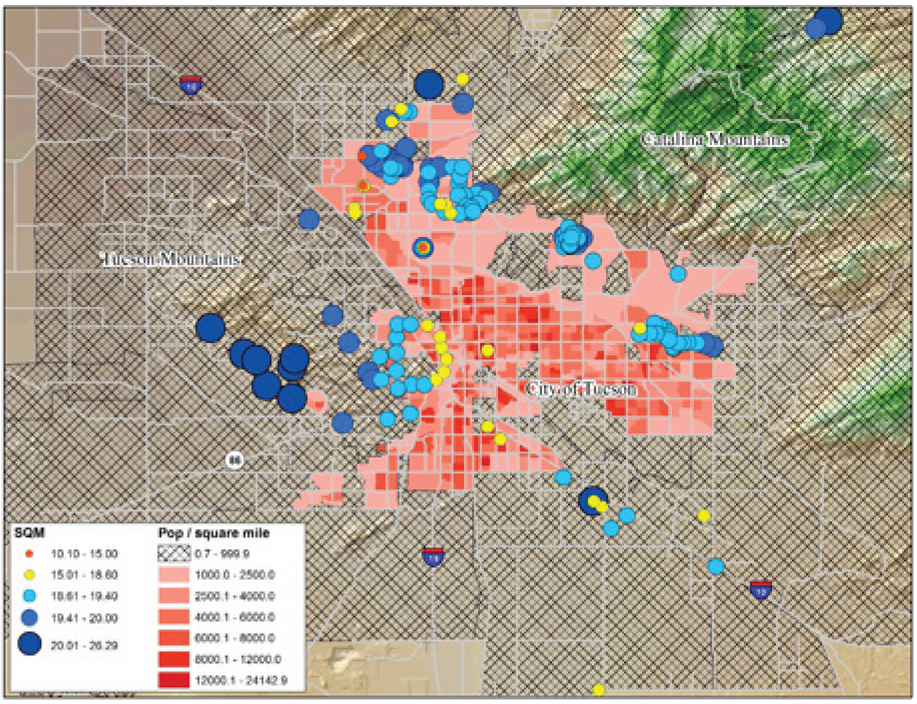


Figure 1: GLOBE at Night 2007 data from Tucson compared to a population density map.

continued

GLOBE at Night continued

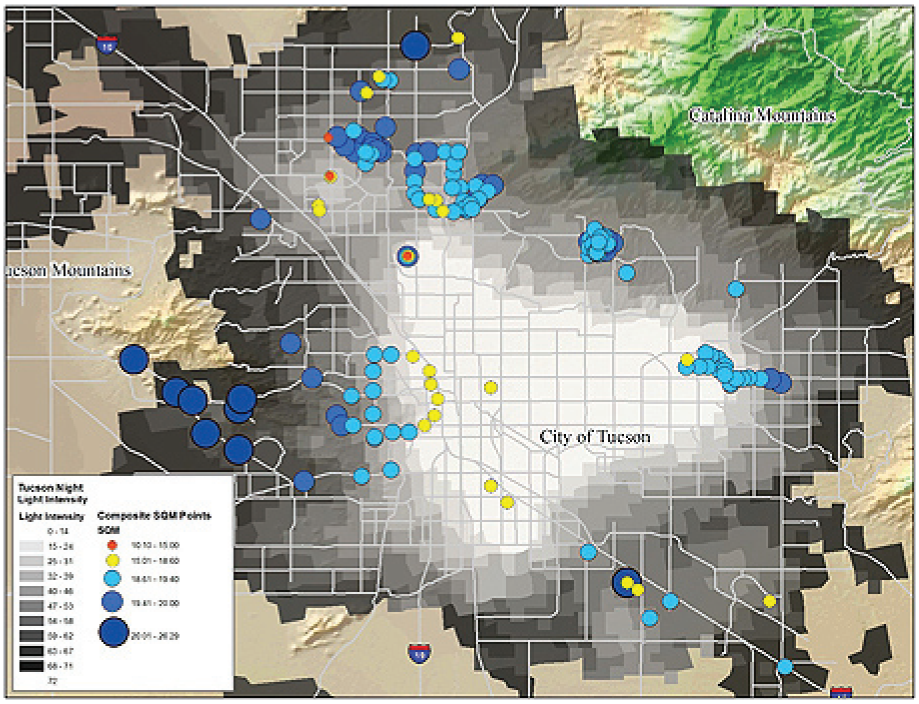


Figure 2: GLOBE at Night 2007 data from Tucson compared to the intensity of local nighttime lighting using satellite imagery.

The success of GLOBE at Night and related public outreach efforts has prompted dark-skies awareness to be named one of the cornerstone projects of the International Year of Astronomy (IYA) 2009, which is being planned now by the International Astronomical Union (IAU) and a network of nearly 100 individual country contacts. Connie Walker of the NOAO educational outreach group is leading both the international dark-skies task group and the related US IYA 2009 working group. Malcolm Smith of the CTIO scientific staff (and director of the related IAU commission) is an active contributor.

Past star-count programs have originated in Greece, Austria, Canada, the International Dark-Sky Association and a pilot program between NOAO North in Tucson and NOAO South in La Serena, Chile, among others. GLOBE at Night benefited greatly from the experience gained by these efforts, and has built upon them by adding digital data to the mix.

More than 18,000 people contributed 4,600 observations from 96 countries in the first GLOBE at Night campaign in March 2006. Citizen-scientists recorded the brightness of the night sky by matching its appearance toward the constellation Orion with one of seven stellar maps of different limiting magnitude. They submitted the measurements to a Web site developed by a team that included the GLOBE program, Windows to the Universe, ESRI, and NOAO. Participation increased to 8,500 observations from 60 countries during GLOBE at Night 2007. This expanded the success of the inaugural campaign in 2006 by adding an effort to obtain precise measurements of the brightness of urban dark skies toward zenith using digital sky-quality meters (SQMs).

The digital GLOBE at Night program was made possible by a small grant from the NSF, which funded the purchase and distribution of 135 low-cost, handheld, well-calibrated SQMs manufactured by Unihedron. The SQMs and supporting light pollution teaching kits developed by NOAO were distributed to citizen-scientists in 21 US states plus Washington, DC, and in five countries, including Chile.

About 1,000 measurements were reported. Initial results from 2007 show very good consistency, with obvious gradients in brightness from city center to known dark areas. Lots of creativity was demonstrated in the way measurements were made, such as via an automobile Moon roof augmented by the GPS unit in the car. The citizen-scientists taking the data included teachers, their students, astronomers at local and national observatories, International Dark-Sky Association (IDA) members, staff from 19 science centers, members of advocacy groups and guide staff at the national parks.

As a sample illustration of the results, the SQM data for Tucson is plotted against population density in figure 1 and against the intensity of nighttime lights in figure 2. There is high correlation between the values of the SQM measurements and those for population density and the intensity of nighttime lights. The higher the population density or intensity of nighttime lights, the brighter the SQM reading.

We will continue to build on the existing infrastructure of local coordinators and participants in GLOBE at Night to create a similar, but extended, US-based classic and digital program in 2008. The program will include greater collaboration with the IDA (*www.darksky.org*) and a local SQM-related citizen-science program called Night Vision (*www.nightwise.org/nightvision.htm*). Participants will be offered the opportunity to continue SQM measurements year-round.

NOAO and the GLOBE Program in Boulder, Colorado, are developing plans for more extensive SQM-related Web pages linked to the main GLOBE at Night site that will allow one to compare classic observations and digital measurements (discussing the importance of both) and show how to make an SQM measurement with the template provided. It will also provide a selection of different types of SQM measurement programs, such as grid surveys of your town on one night (repeatable every month), seasonal surveys, hourly surveys over a night at one or more locations, or surveys of eight cardinal directions along the horizon (concurrent with regular SQM measurements).

Analysis of the maps will include a comparison with other data sets such as last year's SQM data set, the limiting-magnitude unaided-eye observations, population density, regional environmental concerns (e.g., sea turtles in Florida), and satellite data on nighttime lights (a top-view looking down versus the bottom-up view from Earth via GLOBE at Night).

continued

GLOBE at Night continued

The outcome of the 2008 campaign will provide the basis for a quantitative global effort in 2009 as one of the major IYA 2009 cornerstone programs. We also plan to connect with the many "lights out" events that are emerging around the world, including the one being planned for the United States on March 29, 2008 (see *www.lightsoutamerica.org*).

The US IYA dark-skies working group has come up with several related ideas that may extend to the global cornerstone project. The ideas include establishing dark-sky teaching sites, astronomy nights in national parks, news articles and podcasts, public service announcements, art contests, a "world series" competition for adults and kids to identify objects in the sky (the darker the sky, the more objects), and the many sidewalk astronomy events and cultural storytelling activities being planned.

For more information, see *www.globe.gov/globeatnight/* and *www.astronomy2009.us* or contact Connie Walker at *cwalker@noao.edu*.

Students Needed for the 2008 REU Program at Kitt Peak

Kenneth Mighell

Each summer, a group of talented college students comes to Tucson to participate in astronomical research at Kitt Peak National Observatory (KPNO) under the sponsorship of the National Science Foundation's Research Experiences for Undergraduates (REU) program. Like the parallel program at Cerro Tololo, the KPNO REU program provides an exceptional opportunity for undergraduates considering a career in science to engage in substantive research activities with scientists working in the forefront of contemporary astrophysics.

Each REU student is hired as a full-time research assistant to work with one or more staff members on specific aspects of major ongoing research projects at NOAO. These undergraduates gain observational experience with KPNO telescopes, and develop expertise in astronomical data reduction and analysis as part of their research activities. They also take part in a weekly lecture series and a field trip to New Mexico to visit the National Solar Observatory at Sacramento Peak and the Very Large Array in Socorro.

At the end of the summer, the students share their results with the Tucson astronomical community in oral presentations. As part of their internship experience, all six of our 2007 REU participants will present posters describing their astronomical research projects at the January 2008 American Astronomical Society meeting in Austin, Texas.

We anticipate being able to support six REU positions during the summer of 2008. Student participants must be citizens or permanent residents of the United States to meet NSF requirements.

The KPNO REU positions are full-time for 10-12 weeks between June and September, with a preferred starting date of early June. The salary is $600 per week, with additional funds provided to cover travel to and from Tucson. Further information about the KPNO REU 2008 program, including the online application form, can be found at *www.noao.edu/kpno/reu*. Completed applications (including official transcripts, and at least two letters of recommendation) must be submitted to KPNO no later than Wednesday, 30 January 2008.

Kitt Peak National Observatory 2007 REU students.