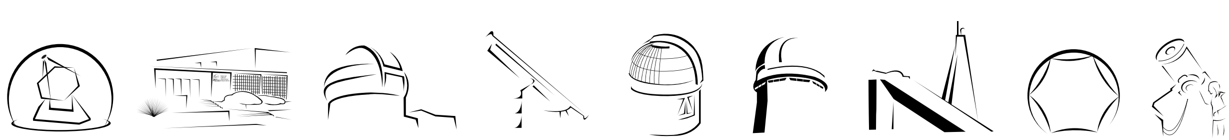
NOAO-NSO Newsletter

Issue 82

June 2005



STATE OF ARIZONA

JANET NAPOLITANO
GOVERNOR

OFFICE OF THE GOVERNOR
1700 WEST WASHINGTON STREET, PHOENIX, AZ 85007

MAIN PHONE: 602-542-4331
FACSIMILE: 602-542-7601

May 9, 2005

The Honorable Jim Weiers
Speaker of the House
Arizona House of Representatives
1700 West Washington Street
Phoenix, AZ 85007

Re: House Bill 2461: outdoor advertising; regulation

Dear Speaker Weiers:

Today I vetoed House Bill 2461, relating to outdoor advertising regulation.

This bill, which would have allowed illuminated and flashing signs along Arizona Department of Transportation rights of way, is opposed by neighborhood associations across Arizona, along with our major observatories. These opponents argue that the light from such advertising poses a threat to the dark and starry night skies that have made Arizona a world-renowned hub of astronomical research.

Such research has not only scientific, but economic value. Among other things, as the *Arizona Republic* recently reported, our dark skies have attracted more than $1 billion in astronomical investments, including $150 million recently spent by an international consortium to build state-of-the-art telescopes and an $84 million astronomy research grant awarded last year to the University of Arizona. We should be doing more to enhance this research, and reap these scientific and economic rewards.

For these and other reasons, House Bill 2461 should not become law.

Yours very truly,

Janet Napolitano
Governor

JN:TN/jm

cc: The Honorable Ken Bennett
The Honorable Pamela Gorman

—Governor Janet Napolitano issued this letter to the Arizona House of Representatives following her second veto this year of legislation that would have opened the door for further development of illuminated billboards and flashing signs across the state. The defeat of this legislation was aided significantly by a coalition of Arizona observatory directors and a stream of letters from observatory staff members, all prompted by the tireless efforts of Mark Mayer, who represents the interests of a coalition of Tucson neighborhood associations to state and local government.

Notable Quotes

"It's the best thing since two pieces of sliced bread were assembled to make a sandwich."

—Paul Ginsparg, professor of physics and information science at Cornell University, describing the capabilities of a new customized Web alert system from the NASA Astrophysics Data System called "myADS," quoted in a Harvard-Smithsonian Center for Astrophysics press release, 18 April 2005.

On the Cover

The dynamic solar chromosphere on 18 January 2005 is seen in this false color image. Daily images like this one, made with the new SOLIS vector spectromagnetograph, have been obtained with various instruments on Kitt Peak for 31 years. Shown is the strength of the He I absorption line at 1083 nanometers; dark is increasing line absorption. Unique among lines accessible from the ground, helium line strength is controlled in part by the intensity of emission from the overlying corona and also has negligible strength in the cool photosphere. This allows mapping of the bases of coronal features like holes, filament channels, and streamers. Such features are important in forecasting space weather.

Image Credit: NSO/AURA/NSF

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

Joan Najita	*Science Highlights*
Dave Bell	*Observational Programs*
Mia Hartman	*Observational Programs*
Nicole S. van der Bliek	*CTIO*
Richard Green	*KPNO*
Ken Hinkle	*NGSC*
Sally Adams	*NGSC*
John Leibacher	*NSO*
Priscilla Piano	*NSO*
Douglas Isbell	*Public Affairs & Educational Outreach*

Production Staff

Stephen Hopkins	*Managing Editor*
Mark Hanna	*Digital Processing*
Pete Marenfeld	*Design & Layout*
Kathie Coil	*Production Support*

Low-Luminosity, Compact Accretion Sources in the Galaxy

Josh Grindlay (Harvard Observatory and CfA)

Accretion onto compact stellar objects (white dwarfs, neutron stars, and black holes) from companions in close binaries is the primary beacon for study of the astrophysics of the extreme: from endpoints of stellar and binary evolution, to the physical processes in the extremes of gravity, radiation, or magnetic fields. Accretion from the interstellar medium on the presumed still larger population of isolated compact objects should, at least for relatively more massive and low-velocity stellar black holes, also be observable in certain conditions, yet never has been. Given the fundamental role that accretion plays in so many key problems of interest in current astrophysics, it is surprising that the space density and luminosity function(s) of the most common accretion-powered compact objects—white dwarfs accreting from low-mass stellar companions, or cataclysmic variables (CVs)—has not been measured to better than a factor of ~10 in the solar neighborhood, and they have even less well-known spatial distributions in the Galaxy.

Motivated by these and related questions, we set out in 2000–2001 to conduct a survey of low-luminosity accretion sources in the Galaxy with the newly-launched Chandra X-ray Observatory. We proposed the Chandra Multiwavelength Plane (ChaMPlane) Survey to constrain

- CV space density and X-ray luminosity functions (XLFs) in the disk vs. Bulge;
- Galactic Bulge source populations;
- Populations of quiescent low-mass X-ray binaries (qLMXBs) with neutron star and black hole primaries and isolated BHs;
- Be-High Mass X-ray binaries (HMXBs);
- Stellar coronal XLFs in the disk vs. Bulge.

Chandra would first detect low-luminosity (e.g., L_x ~10^{31} erg/s at ~8kpc) sources with sufficient precision (≤1 arcsec) to enable their optical counterpart candidates to be selected and then identified with follow-up spectroscopy for final classification and study. Optical identifications were essential, so we also proposed a five-year NOAO Survey Program to do deep imaging (R~24.5) with the Mosaic I and Mosaic II CCD cameras on the Kitt Peak and Cerro Tololo 4-m telescopes. To detect the faintest accretion source candidates by their (near) ubiquitous Hα emission, as well as prioritize spectroscopy, the Mosaic imaging is comparably deep in Hα and R to derive (Hα– R) colors; exposures in V and I allow color-color classification.

The survey was conceived as a serendipitous source survey using primarily archival Chandra data that would be reprocessed with a uniform set of custom tools to ensure careful treatment of astrometry for optical identifications, and derived source fluxes for a range of model spectra and absorption columns for both the source number-flux distribution, logN-logS, and X-ray spectral classification.

Initial ChaMPlane results were given for logN-logS in several Galactic fields (Grindlay et al. 2003, *AN,* 324, 57), as well as an early description of the Mosaic imaging identification survey (Zhao et al. 2003, *AN,* 324, 176). The survey has now achieved nearly its original goal of ~100 Chandra ACIS-I or ACIS-S galactic plane fields, with in fact 94 now selected (through Chandra cycle 6). These have |*b*| ≤ 12°, exposure times ≥12 ksec (most are >20–30 ksec), and are selected to avoid dense clusters or bright diffuse optical emission, and (if possible) to have a minimum hydrogen column density in order to maximize the detection and subsequent identification of faint point sources. These 94 ACIS fields are covered by 59 Mosaic fields (36 x 36 arcmin), as shown in figure 1.

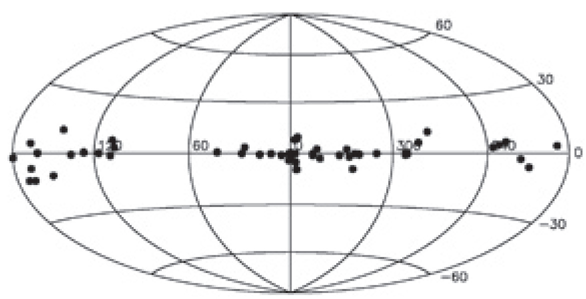


Figure 1. Distribution of 59 Mosaic fields to cover 94 distinct ChaMPlane fields (April 2005). Some 15 Mosaic fields cover the Galactic Center region, which includes some 40 Chandra ACIS fields.

In figure 2, we show a "typical" resulting color magnitude diagram and color-color diagram for a 16 x 16-arcmin field corresponding to one of the 30 short (12 ksec) Chandra ACIS-I exposures in the Galactic Center Survey (Wang et al. 2002, *Nature,* 415, 148), which contained 46 sources. All of this 2° × 1° survey centered on SgrA* was covered in five of our deep Mosaic images. One bright Hα object is detected out of the ~12,000 stars with >5σ detections in R and Hα (vs. ~23,000 in R alone), although many others are below the nominal threshold of (Hα – R) < -0.3 and are primarily dMe stars. However, our follow-up spectra in June 2004 with the Blanco 4-m and Hydra (see figure 3) showed the bright-emission (R = 18.7) object to be a CV. The small displacement off the main sequence track in the color-color diagram suggests it has a small extinction (A_v~1). Using the distance versus

continued

Low-Luminosity, Compact Accretion Sources continued

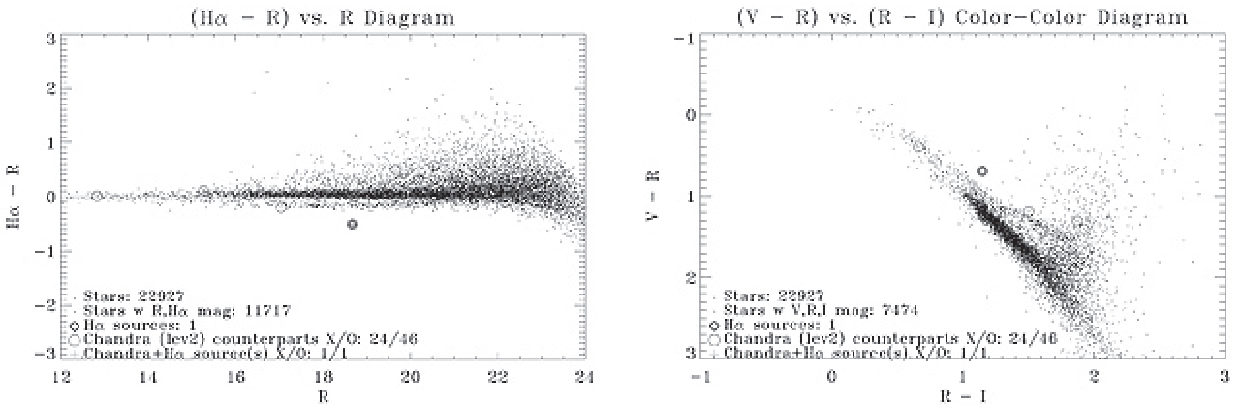


Figure 2. (Hα – R) vs. R CMD and color-color diagram for Galactic Center Survey field showing a bright-emission object confirmed as a Chandra CV and 23 other optical IDs, largely foreground stars, out of the 46 Chandra sources in the field.

A_v model of Drimmel et al. (2003, *ApJ*, 409, 205) gives a distance of ~1.2 kpc, and thus M_v = 8.0, consistent with a K7 secondary and its de-reddened colors. The Chandra flux in the 2-8 keV band is 1.0 x 10^{-13} erg cm^{-2} s^{-1}, which when de-reddened by A_v gives $\log(F_R/F_X) = +0.9$ and luminosity L_x = 3.7 x 10^{31} erg s^{-1}, both of which are typical values for a CV.

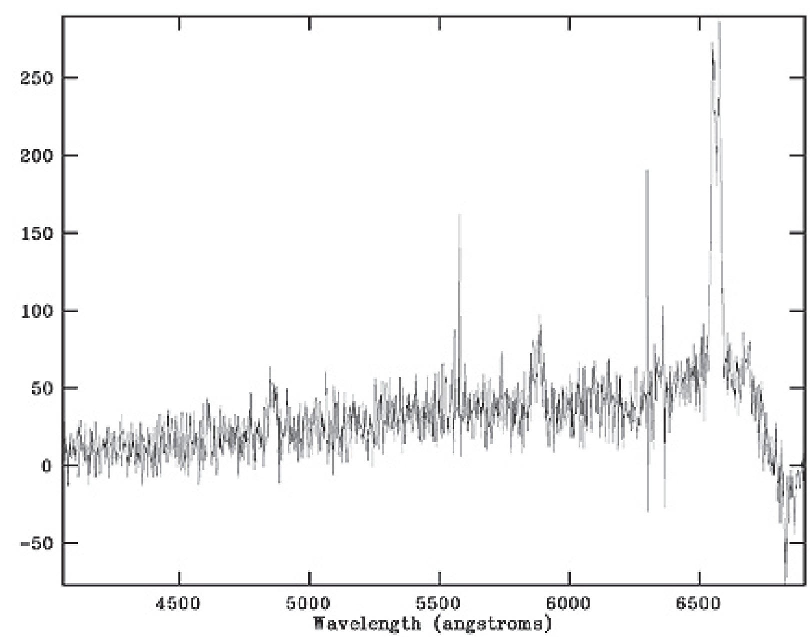


Figure 3. Hydra spectrum of the ChaMPlane Chandra CV initially identified with Mosaic.

Full results on this object, as well as other tantalizing results in the Bulge, are in preparation or have been submitted (e.g., our results from IR (JHKBrγ) imaging of a 10-arcmin field around SgrA* with Magellan/PANIC, which rules out Be-HMXBs for the SgrA* cusp sources; see Laycock et al. 2005). We have submitted three papers to the *Astrophysical Journal* describing the overview of ChaMPlane and initial constraints on the CV population from 14 fields in the Galactic Anticenter (Grindlay et al. 2005), a description of the X-ray processing and X-ray results for these Anticenter fields (Hong et al. 2005), and a detailed discussion of the optical/Mosaic survey processing and example results for one of the Anticenter fields (Zhao et al. 2005).

The deep Mosaic images of now ~21 square degrees of the Plane and photometric catalogs are being archived on the ChaMPlane Web site (*hea-www.harvard.edu/ChaMPlane*) as regions are submitted for publication. The first 14 Anticenter fields are on line, together with Web-based tools for their analysis and display. Many other projects could be conducted with these deep Hα images and photometric catalogs. We are extremely grateful for the NOAO Survey Program having made this possible.

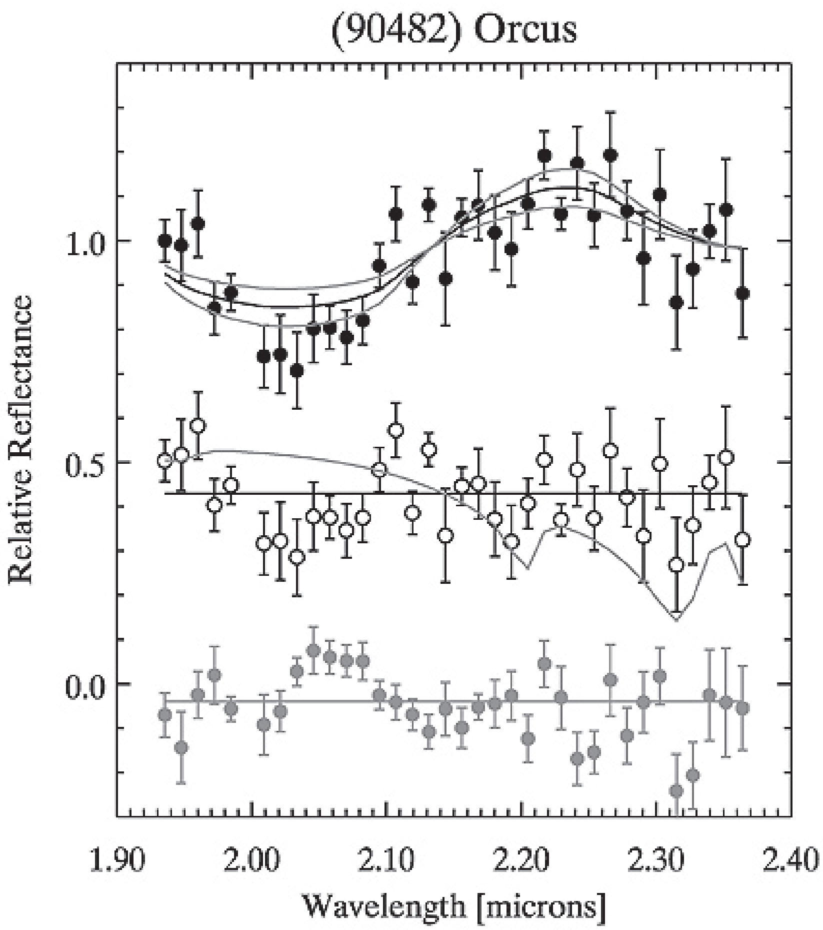
Gemini Observations of the Two Intrinsically Brightest Minor Planets

Chadwick Trujillo (Gemini Observatory), Michael Brown (Caltech), David Rabinowitz (Yale University) & Thomas Geballe (Gemini Observatory)

We have obtained first-look observations of Orcus and Sedna (provisional designations 2004 DW and 2003 VB12) in order to place constraints on their composition. These two planetary objects are unique in that they have the largest absolute magnitudes of any minor planets (this includes all asteroids, comets and Kuiper Belt objects, but not moons or planets). Orcus and Sedna were both discovered within the past two years as part of our ongoing survey of the outer solar system. Although they are brighter in an absolute sense when compared to all other minor planets, they are quite faint due to their extreme distance. Orcus is farther from the Sun than Pluto and is likely to be at least 1/3 the size of Pluto if its albedo is similar to that of other icy planets, which have albedos around 30%. Sedna is 60% farther from the Sun than any other known body bound to the solar system and is probably similar in size. The most interesting aspect of Sedna is its orbit: its perihelion of roughly 70 AU is 60% farther than any other solar system body.

The extreme distance of Sedna (reaching about 1,000 AU at aphelion) means that surface temperatures from solar heating never exceed 38 Kelvin (dropping to 11 Kelvin at apehelion). We do not know what to expect on such an extreme surface, because no solar system surfaces with such peculiar orbits have been studied. However, two possibilities present themselves: (1) the surface could be rich in volatile ices, which could be present based on the low temperature of the body as is the case for Pluto and Pluto's moon Charon; or (2) the surface could be devoid of any ices, as bombardment by cosmic rays and solar UV should carbonize simple

continued



Spectrum of Orcus. At the top of the plot, the relative reflectance spectrum of Orcus (black filled circles) is compared with the best-fit water ice model (black line) and 1-sigma limits on the best-fit model (gray lines). For comparison, the spectrum of the nearby sky (gray circles) is shown at the bottom of the plot. The middle spectrum shows the residual model of Orcus after subtracting the best-fit water ice model (hollow circles, offset vertically for clarity). The gray line on the middle spectrum illustrates the 3-sigma methane ice model. Any greater amount of methane is ruled out by our observations. The model shown is for 100-μm diameter particles. Spectrum error bars are computed from the reproducibility of the spectral data in each spectral point.

Gemini Observations of Two Britghtest Minor Planets continued

ices on megayear timescales if there is no other resurfacing process.

The near-IR is the preferred wavelength regime to study icy planetary surfaces. Ices such as water, methane, methanol, ammonia, carbon monoxide, and nitrogen all have broad absorptions in the K-band in particular. Using Gemini North's Near Infrared Imager (NIRI), we collected about two hours of on-source K-band spectroscopy from each of the targets within a few months of their discovery. This was enough to place crude limits on basic surface composition (with more detailed studies to follow).

Sedna's spectrum appears featureless in the data collected. However, the signal-to-noise ratio was high enough to rule out strong ice absorptions, such as those found on Pluto (whose spectrum is dominated by methane ice) and Charon (whose spectrum is dominated by water ice). Orcus, on the other hand, shows strong signatures of water ice (see the figure). This is not unexpected, since several other Kuiper Belt objects (KBOs) have been shown to have water ice. We hope that deeper studies of these two objects will reveal additional ice species.

Using the data already in hand, we can place some crude limits on the surface properties of Sedna and Orcus. Our conclusions are limited primarily because the albedos of Sedna and Orcus are unknown. Using Hapke modeling of the collected spectra, we find to 3-sigma confidence that the surface of Sedna must be covered by less than 70% water ice under most grain models and albedo combinations studied. Assuming moderate to large grain models (diameters 100 µm or larger), the surface of Sedna must be covered by less than 60% methane ice, to 3-sigma confidence. For Orcus, the best-fit models for grain diameters 25 µm and larger suggest that the water ice surface fraction is less than 50%. Additionally, unless grain diameters on Orcus are smaller than 25 µm, its surface cannot be covered by more than 30% methane ice. When the albedos of Sedna and Orcus are measured, the above results will be significantly more constrained, as only one albedo model need be considered.

These numbers aside, it is clear that the surface of Sedna is very unlike that of Pluto or Charon. Instead, it is consistent with a surface processed by cosmic rays and solar UV radiation. Orcus, on the other hand, is more typical of some KBOs, with up to 50% water ice, and so far, no other identified species. We are anxious to see what deeper spectra will reveal about these two most extreme minor planets.

This work will be published this summer in the *Astrophysical Journal* (available on line at *xxx.lanl.gov/abs/astro-ph/0504280*).

The Sun's New Neighbors

Todd Henry (Georgia State University)

The Cerro Tololo Inter-American Observatory Parallax Investigation (CTIOPI) began in August 1999 under the auspices of the NOAO Survey Program as a significant research track of the Research Consortium on Nearby Stars (RECONS). Since February 2003, CTIOPI has been continued as part of the Small and Moderate Aperture Research Telescope System (SMARTS) Consortium. CTIOPI is an international collaboration with the primary goal of revealing unrecognized neighbors of the Sun. Particular emphasis is placed on red dwarfs within 10 pc (the horizon of the RECONS sample) and white dwarfs within 25 pc. The latter distance is the horizon of the Nearby Stars Project (NStars) and Catalog of Nearby Stars (CNS) programs, which are US and German efforts to provide compendia of stars within 25 pc.

Three groups in the United States (Todd Henry, Wei-Chun Jao, and John Subasavage at Georgia State University; Phil Ianna and Jennifer Bartlett at the University of Virginia; and Dave Koerner at Northern Arizona University) and one in Chile (Edgardo Costa and Rene Mendez at Universidad de Chile) work together to discover and characterize the true stellar population of the Sun's environment. The only other substantial parallax program currently underway is that of the US Naval Observatory in Flagstaff, AZ.

CTIOPI was carried out on the CTIO 0.9-m and 1.5-m telescopes through time granted by NOAO, and the program continued on the 0.9-m as part of SMARTS. The first results from both programs have recently been published (Jao et al. 2005, *AJ,* 129, 1954, for the 0.9-m program) or are in press (Costa et al 2005, *AJ,* July issue, for the 1.5-m program). We observe promising nearby star candidates that have some combination of high proper motions, photometric, or spectroscopic information indicating a small distance from Earth. A trigonometric parallax series is typically considered finished when we have acquired at least 40 frames over a two-year period, yielding parallax errors of ~2 mas.

From the 0.9-m program, we have determined 217 parallaxes to date—20 are for new systems in the RECONS 10-pc sample, and an additional half dozen have been placed firmly within 10 pc for the first time (previous parallaxes had large errors). We have also found 110 more systems between 10 and 25 pc. For comparison, only 195 trigonometric parallaxes from ground-based efforts have been published since the definitive Yale Parallax Catalog (van Altena et al. 1995). Perhaps most importantly, the new 10 pc members constitute a 10% increase in the RECONS sample, illustrating that we have many neighbors with whom we are not familiar. In the table, we present a few of the more intriguing distance determinations. This list is not exhaustive, and these results should be considered preliminary. Definitive results are forthcoming in the *Astronomical Journal* as part of the RECONS series of papers entitled "The Solar Neighborhood." What becomes clearer with each round of parallax reductions is that the Universe is dominated by the Sun's small red dwarf cousins, which account for more than 70% of all stars.

During complementary photometric programs on the 0.9-m, we have also amassed VRI photometry for more than 400 systems. Spectral typing work carried out on the CTIO 1.5-m during SMARTS time has also allowed us to determine definitive spectral types for more than 500 systems. This allows us to evaluate the true natures of the stars we place on the CTIOPI observing list for intense observations. When combined, these astrometric, photometric, and spectroscopic efforts provide a complete portrait of our stellar neighbors. They also provide an ideal research environment in which young astronomers can learn many tools of the trade.

CTIOPI Distances for New Nearby Stars

Name	*Distance*	*SpType*
SO 0253+1652	3.82 +/- 0.06 pc	M7.0V
SCR 1845-6357	3.94 +/- 0.04 pc	M8.5V
DEN 1048-3956	4.04 +/- 0.03 pc	M8.5V
LHS 1723	5.43 +/- 0.06 pc	M4.5V
LHS 2090	6.29 +/- 0.18 pc	M4.5V
GJ 1128	6.53 +/- 0.11 pc	M4.5V
LHS 337	6.58 +/- 0.16 pc	M4.0V
GJ 1068	6.97 +/- 0.10 pc	M4.5V
SCR 1138-7721	7.96 +/- 0.52 pc	M5.5V
LHS 145	9.80 +/- 0.16 pc	white dwarf

Magnetic Field Changes during Solar Flares

Jeff Sudol & Jack Harvey (NSO)

Solar flares have been an astrophysical mystery for almost 150 years. Observations have shown that these explosions, the largest in the solar system, occur in the solar atmosphere above strong, complicated, and presumably stressed magnetic field configurations. Estimates of the energy required to power solar flares, together with their association with complicated magnetic fields, led to the conclusion that flares must be electromagnetic in origin.

In the 1950s it became possible to map the magnetic field in the photosphere and the search for magnetic field changes during solar flares ensued. From the 1950s through the 1990s, positive and negative reports of magnetic field changes appeared in the literature, leaving the situation confused. Transient magnetic field changes were often reported, but these proved to be an instrumental effect, the result of line profile changes caused by the heating of the plasma along magnetic field lines. In the past six years, however, high-quality, high-cadence observations have provided unequivocal evidence of abrupt and permanent changes in both the longitudinal and transverse magnetic field during solar flares.

Most publications have presented results for a single event. Magnetograms from the global network of GONG telescopes have afforded us a unique opportunity to assess the characteristics of magnetic field changes during solar flares for a large number of events. The GONG magnetograms, which show the line-of-sight component of the vector field across the entire solar disk, are available at a one-minute cadence. The magnetograms have a spatial resolution of 5 arcsec and an instrumental noise of about 3 G.

To characterize the magnetic field changes during solar flares, 15 X-class flares were selected for which continuous magnetograms from a single GONG site were available for at least one hour before and after the peak of the flare. Each image was remapped to an overhead view with compensation for solar rotation (see figure 1). Previous work, including observations in November 2000 with the GONG+ prototype, showed that the magnetic field changes are quite abrupt and can be modeled with a simple step function. A model of the magnetic field as a function of time, allowing for the evolution of the field and an abrupt change in the field, was fit to each pixel. Maps of the fit parameters were constructed to show the characteristics of the field changes across the active region. Based on these parameter maps, 42 sites were identified where a significant change in the magnetic field had occurred. For each site, a representative point, the point where the most abrupt and the strongest change in the field occurred, was selected for further study.

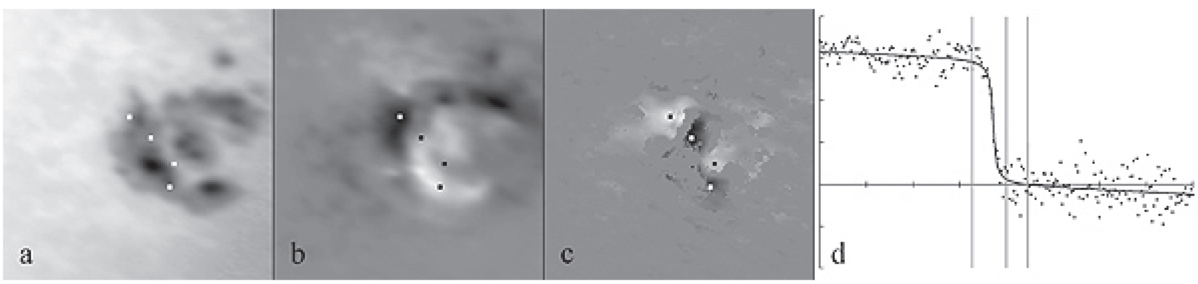


Figure 1. (a) A remapped GONG "white light" image of the flaring active region on 2 November 2003. The image is 128 pixels square. The image scale is 0.125° per pixel in heliographic coordinates. (b) A remapped GONG magnetogram of the same active region. Black indicates negative field; white indicates positive field. (c) A map of the fit parameter for the change in the magnetic field. Black indicates a decrease in the field, white indicates an increase. The black and white boxes in each image denote the positions of the representative points used in our analysis. (d) A plot of the longitudinal magnetic field as a function of time for one of the representative points. The black line represents the fit to the data. The three vertical lines denote the start, peak, and end of the flare according to GOES X-ray flux measurements. The vertical axis spans 300 G, and tick marks appear at an interval of 50 G. The horizontal axis spans 240 minutes, and tick marks appear at an interval of 30 minutes.

We have found that abrupt, significant, and permanent field changes occurred in at least one location in the flaring active region during all 15 flares. The magnitudes of the field changes range from 30 G (the detection limit) to almost 300 G. In 70% of the cases, the magnetic field change occurred on a time scale

continued

Magnetic Field Changes during Solar Flares continued

of less than ten minutes. In about two-thirds of the cases, the longitudinal magnetic field decreased, in the remaining cases, the field increased. Most field changes occurred in the penumbrae of sunspots. In six cases, the change in the magnetic field appears to have propagated across the active region. The rates of propagation range from 5 to 30 km s^{-1}.

Because the full field vector is not observed, the interpretation of these results is ambiguous. Among several possible scenarios, we favor one in which the observed change in the longitudinal field is a result of the vector field becoming more vertical as an immediate consequence of the flare. If our favorite scenario is correct, work is associated with the tilting of the field, and this work must be included in the energy budget of any theory. Because the field changes always occur after the flare start, it is likely that the observed field changes are just one of the numerous post-flare phenomena and not the event that triggers flares. Still, the observed field changes may help sort out the basic physics of the flare phenomenon. This work contradicts current theories that posit that the photospheric magnetic field does not change during a flare. Extensions to our work will cover more events by relaxing our selection criteria and including weaker events.

The Spatial Distribution of Sodium on Mercury

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

We are mapping the sodium emission from planet Mercury using the McMath-Pierce Solar Telescope, a 10-arcsec-square image slicer, and the stellar spectrograph. We obtain sodium images that are 10 arcsec square with 1-arcsec pixels. Since 1997, we have accumulated approximately a thousand of these images, covering a nearly complete range of true anomaly angles. The reason for collecting so many images is that the sodium distribution over the planetary surface is variable, sometimes from one day to the next. We expect that analysis of these variations will lead to a better understanding of the processes that govern the interaction of the space environment with planetary surfaces.

Figure 1 shows four sodium images that represent the most common kinds of sodium distribution. Figure 1a (upper left) shows limb brightening, resulting from an approximately uniform distribution of sodium vapor in the Mercury atmosphere. The long path length through sodium vapor above the planetary limb yields an image with bright sodium emission along the limb. Figure 1b (upper right) shows dawn-side enhancement of sodium. For this case, we are viewing the dawn terminator. As the sun rises, sodium that has condensed on the cold dark side of the planet is warmed, and evaporates into the atmosphere, leading to excess sodium on the dawn side. An additional dawn-side effect is the precipitation of sodium photo-ions to the surface, which some theoretical models predict should occur mostly in the dawn hemisphere (Killen et al. 2004, *Icarus,* 171, 1). Figures 1c and 1d show another sodium distribution effect, in which we see excess sodium in either the northern hemisphere (figure 1c) or the southern hemisphere (figure 1d).

The simplest quantity that we can use to characterize the distribution patterns illustrated in figure 1 is the ratio of the total sodium intensity from one hemisphere to the other. We calculated north-south and east-west ratios, using the brightest pixel in the surface reflection image as the center of the image. The north-south ratios are plotted against true anomaly angle in figure 2.

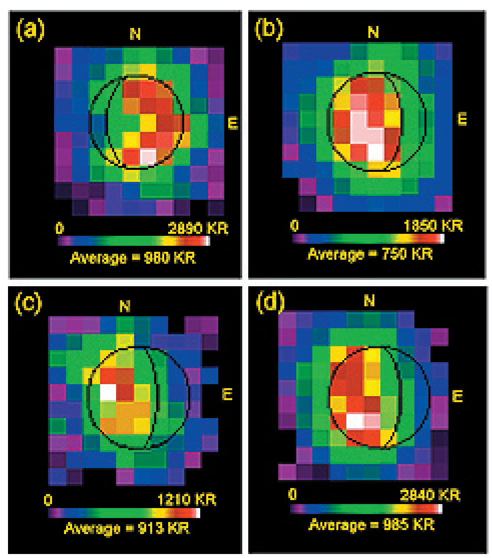


Figure 1. Sample distributions of sodium on the surface of Mercury. Figure 1a is a limb-brightened image, as expected for a uniform distribution of sodium. Figure 1b shows sodium emission extending to the dawn terminator, and figure 1c and 1d show northern and southern hemisphere excess sodium, respectively.

continued

Spatial Distribution of Sodium on Mercury continued

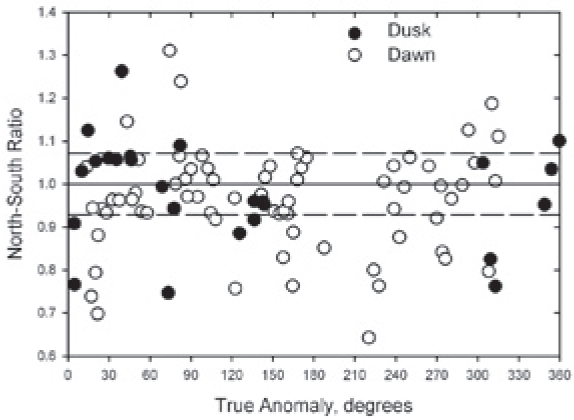


Figure 2. The variation of north-south ratio of sodium emission with true anomaly angle.

Each data point represents the average of ten or more images taken on one day, with a standard deviation of about 10%, represented by the dashed lines. For perfectly symmetric distributions, such as seen for limb brightening in figure 1a, the ratio should be unity, or very close to it. In fact, most of the ratios are near unity. However, about a third of the ratios show excess sodium either in the north or south, with southern excess predominating over northern excess by a factor of about two. We suggest that the excess sodium seen in the northern or southern hemispheres is the result of sputtering of sodium from surface rocks by direct impact of the solar wind on the surface. Sarantos et al. (2001, *Planet. Space Sci*., 49, 1629) have shown that open field lines can connect with Mercury's surface at high latitudes, and their number and hemispheric locations depend on values of the Interplanetary Magnetic Field (IMF). Equally important is the fact that heavy stripped ions in the solar wind are extraordinarily efficient sputtering agents, as shown by Shemansky (2003, *AIP Conf. Proc.,* 63, 687).

We also plotted the north-south ratio against longitude of the brightest point in the image, in the expectation that if there were some correlation of sodium emission with geological formations, we would see a clump of excess north or south sodium at that location. Results for this were inconclusive—there were no clear-cut longitudes where emission was consistently in excess in one hemisphere or the other. Better spatial resolution images are needed to resolve this question.

The east-west ratios showed some interesting features. The plot of east-west ratios against true anomaly angle for dawn-side images is shown in figure 3.

The geometry of Mercury observations is such that the dawn terminator is in view whenever Mercury is seen east of the Sun. Then the terminator is on the east side of the planet as seen in the sky, so that if there is a strong dawn enhancement, we expect that the ratio of east to west to be equal to or greater than unity. However, at true anomaly angles near zero, there should be little or no dawn enhancement from sodium evaporation, because the terminator is moving very slowly, and in fact reverses direction for a few days. Consequently, we might expect to find a ratio less than unity near zero true anomaly angles, but the observed ratios are actually slightly greater than unity. Perhaps this is the result of photo-ion precipitation on the dawn hemisphere.

As the true anomaly angle increases, accompanied by increasing terminator velocity that is moving condensed sodium into sunlight, the ratio increases as expected, rising to values as high as 1.6 near 120°. However, at larger angles, the ratio quickly drops below unity, suggesting that the dawn enhancement effect has disappeared. We speculate that the locus of sodium evaporation may move toward the limb as Mercury's surface temperature decreases with increasing distance from the Sun, which might explain this effect. Another speculation is that there might be changes in the electric field that control ion recycling, resulting in a switch from one favored hemisphere to the other.

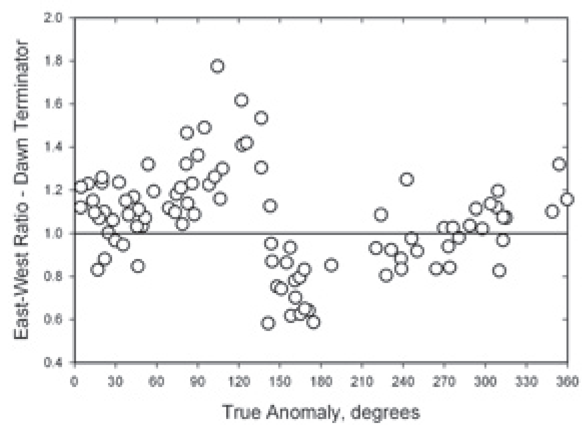


Figure 3. The variation of dawn-side east-west ratio with true anomaly angle.

We believe that our sodium distribution data support the concept that sputtering of surface rocks by the solar wind is a significant process on Mercury. Our data also support the existence of the dawn enhancement observed by Sprague et al. (1997, *Icarus*, 129, 506), but its variation with true anomaly angle presents some as-yet unexplained features.

More Details Emerge on the NSF Senior Review

Jeremy Mould

As I outlined in the March 2005 *NOAO-NSO Newsletter*, the NSF Division of Astronomical Sciences (AST) is beginning the process of a "Senior Review" of its facilities portfolio. This review, a recommendation of the most recent Decadal Survey, is motivated at this particular time by a combination of the current Federal budget outlook, the ambitions of the astronomical community as evidenced in the Decadal Survey and in other reports such as "Connecting Quarks with the Cosmos," and by the growth in the AST budget over the past five years.

This review is designed to examine the balance of our investments in the various facilities that we support. The primary goal of the review, and the adjustment of balance that will result, is to enable progress on the recommendations of the Decadal Survey, including such things as operations funds for the Atacama Large Millimeter Array (ALMA), and other priorities.

NSF has adopted the following boundary conditions for the review:

- An assumption that the AST budget will grow no faster than inflationary increases for the remainder of the decade.
- In concert with the advice of every community advisory body (and in keeping with its own evaluation of balance and need), NSF will not use resources from the unrestricted grants programs to address the challenges of facility operations or the design and development costs for new facilities of the scale of the Large Synoptic Survey Telescope (LSST), the Giant Segmented Mirror Telescope (GSMT), the Square Kilometer Array (SKA), etc.
- No facilities will be considered to be "off the table."
- The process and the adjustments in balance that may result must be realistic and realizable.
- Recommendations should be based on well-understood criteria.
- There should be ample opportunity for community input at all stages.

The specific goal of the review is to examine the impact and the gains from redistributing $30 million of annual spending from AST funds. These funds would be obtained by selective reductions in the operations of existing facilities. The review will not revisit existing community priorities and recommendations for how these funds would be used. The near-term needs for new investment has lead NSF to seek to generate the $30 million in annual redistributed funding by the end of FY 2011. Even with this, there will be challenges to be met to satisfy projected need in FY 2007–2008. NSF's target is to have the advice of the committee in hand by September of this year.

In order to treat NRAO, NOAO, NSO, Gemini, and NAIC on an equal footing and to obtain an in-depth understanding of the contributions that each of our facilities makes, component by component, NSF is adopting a "zero-base" approach. Under this approach, NOAO and our sibling observatories will consider and document:

- The case for, and priority of, each component of NOAO NSO (KPNO, CTIO, NSO, SacPeak, GONG, etc.), along with a defensible cost for each.
- The case for a forward-looking observatory operation, the highest priority components of which would exist in 2011.
- As realistic an estimate as possible of the cost and timescale that would be associated with divestiture of each component.

NSF expects that our deliberations will:

- Be based on extensive consultation with the user community.
- Involve evaluation of component facilities and capabilities using well-defined and carefully documented metrics to define productivity, cost effectiveness, and future utility.
- Take into consideration systemic issues such as complementing observations at other wavelengths, filling critical niches in the overall US system, roles in training and technical innovation, and impact on shared infrastructure.
- Explore opportunities to deliver scientific knowledge at reduced cost or increased efficiency through new operating modes.

NSF seeks to have our input by July 31. With this information in hand from all of the facilities, and with the best understanding of the needs for development and future programs, AST will then present a number of scenarios to the senior review committee for their comment and advice. These scenarios will necessarily trade progress on the various recommendations against preservation of existing capability. The challenge will be to strike an acceptable balance.

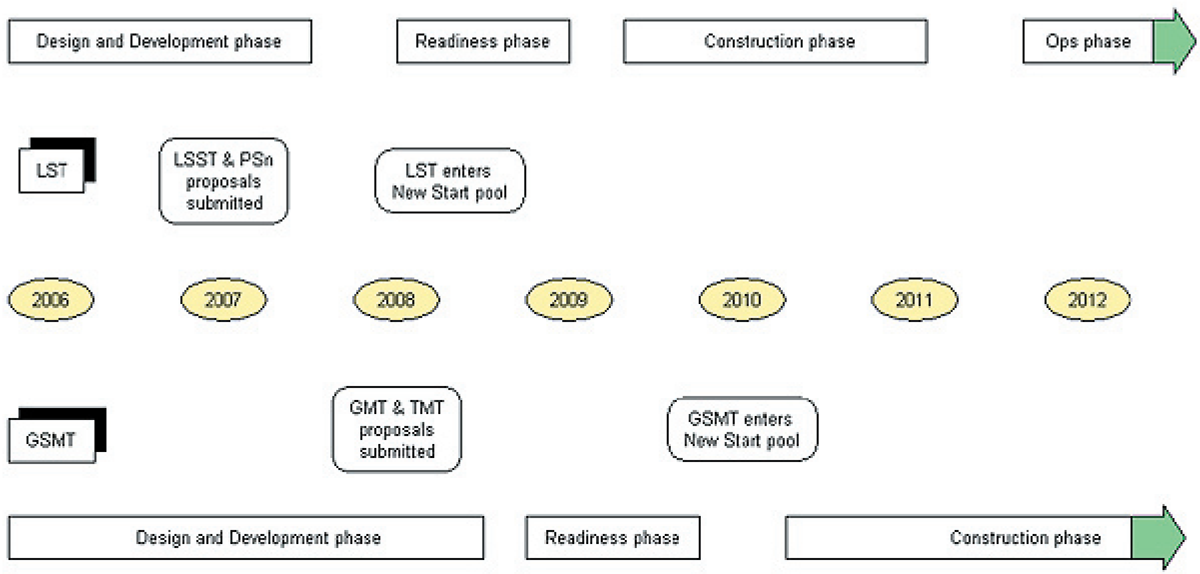
In the words of NSF AST Director Wayne Van Citters, "We recognize that this will be a difficult task and that the end result may well be that some facilities are judged to be no longer viable under the circumstances. We also recognize that the landscape of US astronomy could almost certainly change dramatically as a result of some these actions. The question for all of us is to judge whether these changes are viable and lead to a vital and sustainable future, or whether the pace and scope of change

continued

NSF Senior Review continued

necessary to realize the cumulative aspirations of the community under severely constrained budgets are too drastic."

Motivated by the desire to collect complete community input, NOAO will assemble its input to the Senior Review on an open Web page at *www.noao.edu/dir/seniorreview*. This page features a feedback icon, and I welcome and look forward to your comments and input.



An illustration of the roadmap decision points that follow the design and development phases of LSST and GSMT are articulated by the committee in detail, together with a budget profile for NSF funds.

Roadmap for Optical and Infrared Facilities
The report of the Optical/Infrared (O/IR) Long Range Planning Committee is now available, and we encourage your comments (see *www.noao.edu/dir/lrplan/lrp-committee.html*).

On behalf of all future users of the O/IR facilities proposed in the Decadal Survey *Astronomy and Astrophysics in the New Millennium*, I'd like to warmly thank Chairperson Caty Pilachowski for her strong leadership of a committee of extremely busy people.

The report plots a path through the thicket of competing notions of survey telescopes and extremely large telescope concepts, laying out the context for near- and intermediate-term decisions and actions in respect of the system of major O/IR ground-based facilities, looking forward from 2005 to as far as 2030. The plan shows how present investments realize the new initiatives, illustrates convergence paths, lays the basis for facility closures and transfers, and addresses community structural change. Logical decision points for public investment and disinvestment are highlighted. An illustration of the roadmap is reproduced below, but, of course, we recommend you read the report in full.

Decision points that follow the design and development phase of LSST and GSMT are articulated by the committee in detail, together with a budget profile for NSF funds. The report is being submitted to NSF and the Committee on Astronomy and Astrophysics, and it will be part of NOAO's submission to the Senior Review.

~

Several staff members were recipients of 2005 awards from AURA, which were given out at the recent member representatives meeting in Tucson. Joan Najita received an AURA Science Award, Ron Probst received an AURA Technology/Innovation Award, and Charles Corson of WIYN received an AURA Service Award. Well deserved by all!

New Partnership Opportunities at NOAO

The NOAO Long Range Plan envisions that by 2010, NSF-provided core funding to the National Observatory will be focused on support of major new projects, including the Thirty Meter Telescope and the Large Synoptic Survey Telescope. By that time, most of the financial support for observing facilities at Kitt Peak National Observatory (KPNO) and Cerro Tololo Inter-American Observatory (CTIO) will need to come from operating partners rather than the NOAO base budget. These new partnerships are likely to be modeled on the partnership that successfully operates the WIYN Observatory.

Various budget demands have already led us to begin the transformation of our operations. Our immediate need is to raise the funds necessary to continue the scientifically productive operation of our existing facilities. We will be offering observing time in exchange for financial support of the operations of the observatory sites. We envisage agreements of limited duration during a period of transition that would end with the establishment of more permanent partnerships on the time-scale of 2010.

KPNO

At KPNO, shares of observing time on the 2.1-meter and Mayall 4-meter telescopes will be available, and we are eager to discuss these opportunities with interested parties. We are looking to make partnership time available on the 2.1-meter as soon as possible, consistent with the stated process in the NOAO Long-Range Plan of privatizing the 2.1-meter when NEWFIRM becomes available for scientific use. The timescale for partnership observing time using the Mayall 4-meter is likely to start in Semester 2006B or later. Partners that buy into the 4-meter or 2.1-meter could negotiate how they might trade some of their time for observing on other KPNO (or perhaps CTIO) telescopes.

At this time we are seeking informal expressions of interest only. We are interested in partners who will bring cash to the support needs of the observatory, and who will use the resulting observing time for their research and educational activities. While negotiable, our current estimate of a minimum share would be 1/8th of the available time over a two-year period, on either or both the 2.1-meter or 4-meter telescopes. Institutions or individuals desiring smaller shares are encouraged to amalgamate their interests with the aim of providing a single point of contact as an operations partner.

For more information on Kitt Peak opportunities, please contact Richard Green (*rgreen@ noao.edu*) or Buell Jannuzi (*bjannuzi@noao.edu*).

CTIO

At CTIO, the SMARTS consortium operates the CTIO small telescopes (see *www.ctio.noao.edu/telescopes/smarts.html*). The SMARTS principal investigator is Charles Bailyn at Yale (*bailyn@astro.yale.edu*). We are about to put SMARTS II together, to run for three years beginning in February 2006. The typical buy-in is $50K/year, but you can put in more to get more time if you wish.

SMARTS has been very successful, and the consortium members have produced lots of good science. The telescopes are well-instrumented, with the exception of a search for an optical spectrograph for the 1-meter, so Charles is looking for people who need telescope time to do projects, and can pay for it. You'll see there is a wide variety of observing modes—classical, service, queue—depending on the telescope. Charles would be very happy to talk to you if you are interested in this opportunity.

Partnerships for up to approximately 25 percent of the CTIO Blanco 4-meter are also available. Deals using a combination of telescopes, and perhaps creative "time swaps" with other NOAO facilities, including the SOAR 4.1-meter, are possible in principle.

In addition, the Dark Energy Camera consortium for the Blanco 4-meter continues to look for partners with funding resources. This Fermilab-led consortium, with Project Director John Peoples (*peop@fnal.gov*), aims to build a very large (2-degree-diameter field) CCD imager and new corrector for the Blanco prime focus. The instrument is scheduled to start the Dark Energy Survey in 2009. See *www.ctio.noao.edu/telescopes/dec.html* for more on this "super-Sloan survey." The consortium presently consists of Fermilab, the University of Illinois, the University of Chicago, Berkeley/LBNL, UCL, and Barcelona high energy physics institutes. The latter two are waiting on funding applications. This is a $20M project, and partners will need to bring science synergy or be able to use the survey data for another purpose.

For more information on any of the CTIO opportunities, please contact Alistair Walker (*awalker@noao.edu*).

Please note that a competitive Announcement of Opportunity for Blanco and Mayall 4-meter time will be issued in the *NOAO-NSO Newsletter* at a later date. Any partnership arrangements are subject to the agreement of the NSF.

Q&A

Tom Matheson
Assistant Astronomer

Tom Matheson joined the staff of the NOAO Gemini Science Center (NGSC) in September 2004, after four years as a post-doctoral fellow at the Harvard-Smithsonian Center for Astrophysics. He received his PhD in June 2000 from the University of California at Berkeley on the topic of the spectral characteristics of stripped-envelope supernovae, where his advisor was Alexei Filippenko. Tom has published more than 65 papers in refereed journals, including nine as first author. His service duties involve helping the US astronomical community get the best possible spectrographic results from the Gemini Observatory.

Q. What are your primary scientific interests?
My main interests are supernovae, gamma-ray bursts, and the cosmological uses of supernovae. Since supernovae are so bright, you can see them very far away, and that means you can use them to probe the distant universe by calibrating the distant ones using the nearby ones. Now that we know the cosmic acceleration from dark energy is real, the game is figuring out what is causing it.

One of the ways we are doing this is through the NOAO Survey Program named ESSENCE, using the Mosaic camera on the Blanco 4-meter telescope at CTIO. My role is to coordinate the follow-up spectroscopy of all the optical targets. To do that, we use virtually every large telescope on the planet we can get our hands on—we've used just about every telescope larger than six meters! We are still in the middle of the project. Right now, we have found 91 Type-Ia supernovae with spectroscopic confirmation, and I am fully convinced we will reach our goal of 200 when we are finished.

Q. What do your early results look like?
The goal is to determine whether the acceleration is the result of the cosmological constant the way it was envisioned by Einstein, and get a handle on the equation of state. So far, everything points to the cosmological constant being the most likely answer, but it is not definite. We should have a good answer in about two years; there is still a lot of analysis to be done.

We have a paper in the May 2005 *Astronomical Journal* that has 52 Type-Ia supernovae from the first two years of the project in it, including data on eight from the Gemini Multi-Object Spectrograph (GMOS).

Q. Why did you decide to come to work for NGSC?
I had been using Gemini a fair amount, and here I can be more closely integrated with the needs of the spectra for this project. Beyond that, Gemini is an ideal tool for observing supernovae and gamma-ray bursts because of the queue scheduling. Nobody else can provide that flexibility with a large telescope. I'm still working with a lot of data from the 1.5-meter at Mount Hopkins. But if you want to do faint objects, Gemini is clearly the best way to do these transient objects.

Q. What are your primary support tasks for NGSC?
My duties are all associated with supporting GMOS. I help people design their programs if they have questions. When the proposals come in, we do the technical reviews to determine if what they say that they want to do can actually be done. Then, once they go through the Time Allocation Committee process, I am the contact for the Gemini Phase II process to help them prepare their observing programs.

I also help with the queue observing about once per semester; I am about to go on my second one. I've learned that there are a lot of things that go on behind the scenes, and how much effort is put into supporting the community by the staff here. Even more help is available if people want it.

Q. What do you see as the future scientific promise of Gemini?
It has great capabilities for doing spectroscopy in the infrared, so that means you can push to higher redshifts than at a lot

continued

Q&A continued

of other telescopes. The infrared instruments at Gemini, both current and forthcoming, are unique. Infrared is virgin territory for the supernovae and gamma-ray bursts.

I am not sure that everyone realizes how capable the observatory is right now. I know that the people who use it tend to come back, because they find out how valuable it is. The queue scheduling is not just great for supernovae and gamma-ray bursts, but also for other kinds of variable phenomena, such as eclipsing binaries in other galaxies. You would never be able to schedule such observations easily at a more traditional observatory.

In addition, having two sites in two hemispheres where the weather is not the same is very helpful. For our projects, we chose objects that are visible from both sites, so we can get a spectrum “right now.”

Q. Would the Thirty Meter Telescope have any special applications to your research areas?
With gamma-ray bursts, there are issues about being able to see things with mid-infrared instruments that would be too faint to do even with existing telescopes, such as being able to see the entire broadband spectrum from gamma-rays and X-rays down through infrared to radio. There are some interesting characteristics in the afterglow, and some tests of the synchrotron model for the afterglow. We have a program to try to do this with Spitzer, but it would be interesting to do it from the ground at different redshifts.

Q. What is your perspective on the Large Synoptic Survey Telescope (LSST)?
The hard part will be doing the spectroscopic follow-up to all the transient objects that the LSST will find. That is one of the reasons we were able to be successful in getting the ESSENCE survey approved. It illustrates the potential, and it has uncovered some of challenges of doing a program like the LSST. How do you deal with that amount of data flow and analyze it in real-time in order to be able to act upon it? How do you tailor the observing campaign to maximize the science that you get out of it? It is a real-world example of an LSST-type of experiment.

Q. How have you found the working environment of NOAO and life in Tucson?
I had been visiting here for seven or eight times a year to use the telescopes at Mount Hopkins. I have always liked coming here, and I really like living here. My wife grew up in New York, and she expected to see sand and rocks when we got off the airplane the first time to look for a house, so she has been pleasantly surprised. And my dog likes it too.

Notable Quotes

“The Vision [for Space Exploration] is Moon, Mars and beyond. I like to remind people that ‘beyond’ is a very big place.”

—NASA Goddard Space Flight Center Director Edward Weiler, telling the Baltimore Sun *that NASA Goddard should be protected from most potential job cuts at the space agency due to its active role in solar system exploration, 17 March 2005.*

NOAO**GEMINI**SCIENCE**CENTER**

TUCSON, ARIZONA • LA SERENA, CHILE

The Gemini Rapid Response Mode

Tom Matheson

There are many types of astronomical objects that change over time, often in a regular and predictable fashion. There are events, however, that can be expected (249 supernovae discovered during 2004), but not predicted (when Betelgeuse will explode, for example). For objects such as supernovae or gamma-ray bursts, the times for observation are unknown until they occur. If a gamma-ray burst is detected on October 12, and your night at the telescope was the 11th, this can be a problem. The queue mode of operation at Gemini provides a solution to this.

For several semesters, Gemini has offered a Quick Response mode for targets that are not specified in advance, but have a well-defined trigger event for activation. These are distinct from unexpected events, for which Director's Discretionary time is the mechanism for obtaining observations. During the proposal process for the expected events, a set of criteria for triggering is specified, and a template observation is designed for eventual activation.

The instruments accessible for Quick Response are the Gemini Multi-Object Spectrograph (GMOS) North and South, the Near-Infrared Imager (NIRI), and the Gemini Near-Infrared Spectrograph (GNIRS). Once a target does appear, the principal investigator (PI) can notify Gemini staff and the object will be added to the queue planning for observation within 24–48 hours, as long as the requested instrument configuration is available.

For some objects, notably gamma-ray bursts, this may not be fast enough. For example, in order to catch the still-elusive afterglow of short-duration bursts or to see signatures of the immediate stellar environment in early spectra of long-duration burst afterglows, the exposures need to begin within minutes. The recently launched Swift satellite will not only increase the number of gamma-ray bursts detected, but also provide quick and accurate localizations. The cutting-edge for gamma-ray burst follow-up observations will be those that take place as early as possible after detection. To address this need, Gemini developed a Rapid Response mode that aims to be on a target within about fifteen minutes of activation. The same set of instruments that is available for Quick Response mode can be used for Rapid Response mode.

Proposals for Rapid Response mode should be submitted through the standard proposal process and need to include a justification for the special response, as well as an explicit description of the trigger event. For approved programs, the PI will create template observation plans within the standard Gemini Phase II process. When an event occurs, there will not be a lot of time to generate observing plans, so templates for all possible contingencies should be developed.

Programs can include scheduled follow-up observations after the initial Rapid Response activation. Since these observations are not known in advance, some basic calibrations may need to be included in the template. After these templates have been reviewed by NGSC and Gemini staff, they are set to On-Hold status.

Once an event occurs, such as a gamma-ray burst detection with Swift, the PI can select from among these On-Hold templates for the one that best matches the science goals and the instrumentation available on the telescope (links describing which instruments are available, along with the current GMOS configuration, can be found at *www.gemini.edu/sciops/schedules/schedIndex.html*).

The PI will then enter the coordinates of the target, choose a guide star, and set the observation for activation after checking to make sure the object is, in fact, currently observable from the chosen telescope. This action will alert the observer at the appropriate Gemini telescope to interrupt the current program and slew immediately to the new target. The programs affected will be redone at a later date. This ability to interrupt other programs requires that the Rapid Response program achieve Band 1 in the Gemini queue.

Within the observation program, the PI should also include any relevant information for the observer, such as details for the precise timing of the start of the observation or a phone number where the PI can be reached. One of the critical items to include is the location of a finding chart, just to make sure you don't get the world's best spectrum of the star near your gamma-ray burst.

There have been many exciting developments in gamma-ray burst science in the past few years. With Swift actively detecting and localizing bursts, the Gemini Rapid Response mode is ready to provide the next breakthrough in gamma-ray burst science. We encourage all interested astronomers to consider this new method of observation.

NIRI and Altair: Report from a Successful Observing Run

Bob Blum

It was once again my pleasure to visit Gemini North to support a NIRI-Altair queue run. NIRI is the Gemini North facility near-infrared imager and Altair is the facility adaptive optics (AO) module. All National Gemini Office (NGO) staff are encouraged to visit Gemini, not only to become more familiar with the instruments they help support for their communities, but also to help with the heavy observing load at the telescope, which is now nearly completely queue scheduled.

Staff at the US national office, the NOAO Gemini Science Center (NGSC), take this responsibility seriously; our goal is to visit often enough to become efficient Gemini observers. My recent run was in the middle of March, and though the weather was difficult and we had some instrument problems, we eventually made some first-rate observations, and I was able to get an insider's view of some exciting developments at Gemini.

Before reporting some of these developments, let me remind you of some basics. Altair is a 177-actuator, Shack-Hartman wavefront sensing system that receives the 8-meter telescope *f*/16 beam and delivers the same back through the instrument support structure (the big box that holds Gemini's multiply mounted instruments at the Cassegrain focus). This capability allows Altair to feed more than one instrument with an adaptively corrected beam. NIRI imaging in the J, H, and K bands gets the largest share of Altair work, but the Gemini Multi-Object Spectrograph (GMOS) will use Altair in conjunction with its integral field unit (IFU). With NIRI's *f*/32 camera, Altair can deliver near-diffraction-limited performance with a bright natural guide star on-axis. The performance degrades fairly quickly off-axis for typical atmospheric seeing, so there is a premium on bright guide stars at or near the science target position (R-band brighter than 12 for an AO star and within about 7 arcsec are good rules of thumb).

Less than optimal performance off axis is the result of an optical design choice based on atmospheric turbulence profiles that have not panned out. It is my understanding that there is a relatively straightforward fix in the works. In the meantime, problems with finding bright on-axis guide stars should soon be a thing of the past.

While waiting for high winds and thick clouds to recede over the first few nights of the run, I got a chance to talk to my Chilean neighbor, Maxime Boccas, as he was busily preparing the new laser launch telescope (LLT) for Altair/Gemini North. Max and Dan O'Connor (along with a host of other Gemini technicians and engineers from two hemispheres) were nearly ready to install the 35-centimeter telescope behind the Gemini secondary. The LLT fires a laser beam at the wavelength of the well known Sodium (Na) transitions near 5890 angstroms in the visible portion of the spectrum in order to excite the Na atoms in a naturally occurring layer some 90 kilometers above the surface of Earth. The beam itself is produced by a solid-state laser mounted at the Nasmyth level of the telescope. The beam is transferred to the M2 position of the LLT with a completely self-enclosed and reflective set of optics.

By the time the weather cleared, the Gemini team had the LLT mounted behind M2, and owing to the importance of the task, they were given several hours on the sky to begin aligning the LLT optical axis with that of the telescope. Everything looks well placed to see first "laser" light later in semester 2005A. This truly exciting development will greatly enhance Altair's performance and will be critical to the planned science goals of the Near Infrared Integral Field Spectrometer (NIFS) to be delivered later this year.

> *This truly exciting development will greatly enhance Altair's performance and will be critical to the planned science goals of the Near Infrared Integral Field Spectrometer (NIFS)...*

Clear weather meant we could finally observe as well. While we did experience some difficulties with Altair that have since been fixed, the system worked very well for much of the night, and we were able to observe for a number of Band 1 programs aimed at finding planets or other faint companions around the nearest stars. After the wait for good weather, we were rewarded with seeing so good that we were able to observe in NIRI *f*/6 mode (i.e., without AO) allowing us to search for some of the most distant objects in very deep J-band exposures.

I would like to thank the Gemini North staff for inviting me to observe with them, and for their kind hospitality in Hilo and on the summit. Particularly helpful were Tracy Beck, who observed with me and provided Q training on the summit, and Andrew Stephens, NIRI scientist and Q manager during my stay. Chad Trujillo and François Rigaut were invaluable for their expert help with Altair.

Phoenix in Classical Mode

Verne Smith & Ken Hinkle

Since the start of the 2005A semester, Phoenix, a high-resolution (R=50,000) spectrograph for the 1- to 5-micron infrared, has been scheduled at Gemini South in classical mode. Phoenix was built by NOAO and has been on long-term loan to Gemini since late 2001. Previous use of Phoenix on Gemini has been in queue mode, with both a Gemini staff astronomer and an NOAO astronomer present at the telescope. In classical mode, the principal investigator (PI) is now present at the telescope, with an NOAO astronomer to provide the initial instrument setup, checkout, and general assistance to the PI as needed. Classical observing runs are fairly uncommon at Gemini South and we report here on our first experiences.

The first classically scheduled block of Phoenix time occurred from 24 February to 3 March 2005, with four separate classical programs supported. Both telescope and instrument performed well and data were obtained on all four programs. Another novelty was that two programs shared time over two nights, with one using the first half and the other the second half. Hand-off of the telescope/instrument occurred midway between evening and morning twilight, with no significant loss of time. Such scheduling allows more flexibility to proposers, as classical proposals must be for whole nights. Such time-sharing, however, must be coordinated via the NOAO Gemini Science Center (NGSC), with Verne Smith (*vsmith@noao.edu*) as point of contact. There is, of course, no guarantee that a suitable match will be found. Any desire to find a matching program with which to share nights should be communicated to NGSC before your proposal submission.

There are advantages to classical observing as opposed to queue. Visiting a large, advanced telescope is a useful experience. You will be able to adjust your program based on the data you see arriving at the telescope. Classical proposals are not grouped by rank into Bands 1 through 3; all Phoenix proposals granted time will now have equal access to the telescope. And of course, you can carry your data away following your run. Gemini will continue to archive Phoenix data, and a copy of your data will be sent to you following your run.

For 2005, Gemini observers are housed in the Cerro Tololo dorm as if they were CTIO observers. Every evening before sunset, the observers ride with the Gemini Systems Support Associate (SSA) to Cerro Pachón. The drive over a winding dirt road takes about 30 minutes. There are spectacular views of Cerros Tololo and Pachón along the way and frequent sightings of Chilean wildlife, including a puma on one recent occasion. The evening ride is typically much more enjoyable than the return 30-minute drive at sunrise! There is a small dining room at Cerro Pachón, but do not expect other astronomers at dinner. Until SOAR becomes operational, the Gemini crew is the only scientific team working at Cerro Pachón. The four Phoenix observing teams so far were impressed with the telescope, the Gemini staff, and the high-quality data that were obtained under the superb delivered image quality that characterizes Gemini.

Future availability of Phoenix on Gemini South could well depend on user demand and paper production. If you have potential scientific projects for Phoenix on Gemini, we encourage you to apply. For all users of Gemini, including users of Phoenix, we strongly encourage rapid publication of scientific results in refereed journals.

Following the Aspen Process: Presentations and Reviews

Taft Armandroff & Ken Hinkle

An outcome of the June 2003 Gemini Aspen Instrumentation Workshop was a list of possible new instruments for the Gemini telescopes that would enable frontier science. Following review and prioritization by the Gemini Science Committee and the Gemini Board of Directors, a call for design study and feasibility study proposals was made in December 2003. This call listed two instruments for competitive conceptual design studies and another two for noncompetitive feasibility studies. The instruments for the conceptual design studies were discussed in the September 2004 and December 2004 issues of the *NOAO-NSO Newsletter*: HRNIRS, a high-resolution, multi-object near-infrared spectrograph, and Extreme AO Coronagraph (ExAOC), a high-contrast adaptive optics system and coronagraphic instrument designed to detect planets. Feasibility studies were undertaken on WFMOS, a wide-field multi-object optical spectrograph discussed in the March 2005 *NOAO-NSO Newsletter,* and GLAO, a ground-layer adaptive optics system.

continued

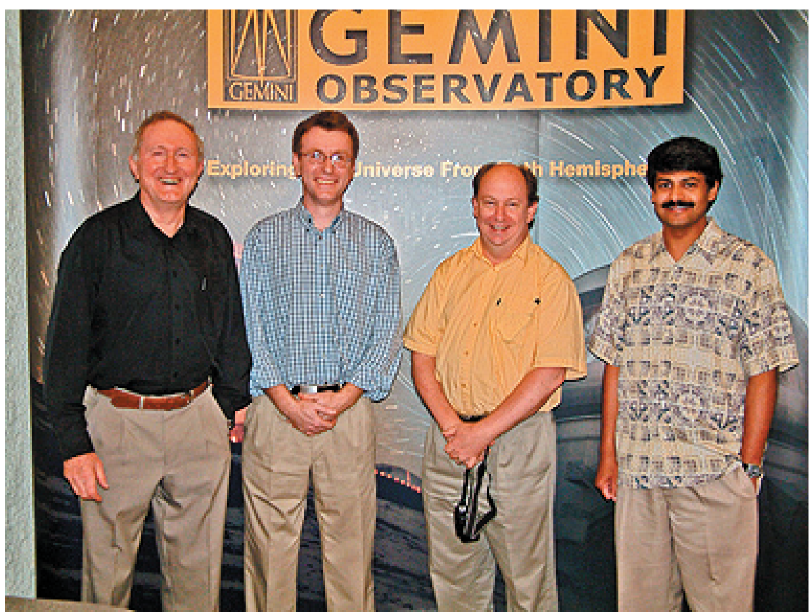
Following the Aspen Process continued

These conceptual design and feasibility studies have now been completed. HRNIRS studies were carried out by an NOAO/University of Florida team and a United Kingdom Astronomy Technology Centre/University of Hawaii team. Two teams, one led by the University of Arizona (including NOAO, the University of Hawaii, and Oxford University), and one led by the Lawrence Livermore National Laboratory, undertook ExAOC studies.

The WFMOS feasibility study was headed by the Anglo-Australian Observatory and included Johns Hopkins University, NOAO, several United Kingdom institutions, and the Canadian Astronomy Data Centre. The University of Arizona, University of Durham, and the Herzberg Institute of Astrophysics collaborated on the GLAO feasibility study. The deadlines for the design/feasibility reports were in February, with the reviews taking place in March. Each group submitted reports of multiple hundreds of pages. The reports included detailed science cases, flow-down from science to instrument requirements, systems engineering, optical design, mechanical design, electronics design, software design, management plan, schedule, and cost.

Gemini, under Associate Director for Instrumentation Doug Simons, formed committees to review the proposals. The review committees have now filed reports, and the instrument teams have responded to these. Gemini Observatory, its Board of Directors, and its other advisory committees will now take the results of these studies and the funding available to create an instrument plan that is responsive to the very exciting scientific opportunities.

The NOAO/University of Florida HRNIRS team outside the Gemini Headquarters building in Hilo, following the review of their conceptual design study.



The WFMOS team after their presentation to Gemini.

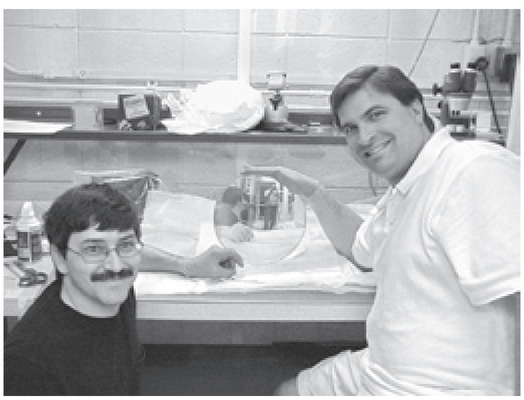
NGSC Instrumentation Program Update

Taft Armandroff & 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 in the United States, with progress since the March 2005 *NOAO-NSO Newsletter*.

FLAMINGOS-2

FLAMINGOS-2 is a near-infrared multi-object spectrograph and imager for the Gemini telescopes; it will be commissioned at Gemini North and used there for some period before being relocated to Gemini South. It 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 multiconjugate adaptive optics system. The University of Florida is building FLAMINGOS-2, under the leadership of Principal Investigator Steve Eikenberry.



The FLAMINGOS-2 calcium fluoride field lens is shown with Principal Investigator Steve Eikenberry and Instrument Scientist Nick Raines.

The FLAMINGOS-2 team is proceeding with the integration phase of the project. Additional FLAMINGOS-2 optics were received and tested. Notably, the large calcium fluoride element that serves as the FLAMINGOS-2 field lens was received and met all of its specifications. With that element, all optics for the imaging mode of FLAMINGOS-2 are in hand and meet or exceed specifications. Calculations based on the as-delivered performance of the optics indicate that the FLAMINGOS-2 throughput in imaging mode will significantly exceed the throughput that was originally predicted and adopted as a requirement. In addition, the University of Florida carried out the first cold and vacuum testing of the FLAMINGOS-2 main cryostat. During this testing, measurements of the temperature and temperature gradient were better than the instrument requirements.

As of mid-March, the University of Florida reports that 70 percent of the work to FLAMINGOS-2 final acceptance by Gemini has been completed.

NICI

The Near Infrared Coronagraphic Imager (NICI) will provide a 1- to 5-micron dual-beam coronagraphic imaging capability on the Gemini South telescope. Mauna Kea Infrared (MKIR) in Hilo is building NICI, under the leadership of Doug Toomey.

NICI is in the final assembly and testing phase of the project. Several modest changes were made to the NICI cryostat based on the results of earlier cold testing. The NICI optics were then installed in the NICI cryostat. Included in this installation were a beam splitter, a dichroic, the subset of NICI filters that are copies of those in the Near-Infrared Imager (NIRI), the pupil mask, and the spider mask. A detailed cold test of the integrated NICI system is planned for mid-May. Efforts continue to obtain a deformable mirror for NICI that meets the demanding specifications derived from the science requirements.

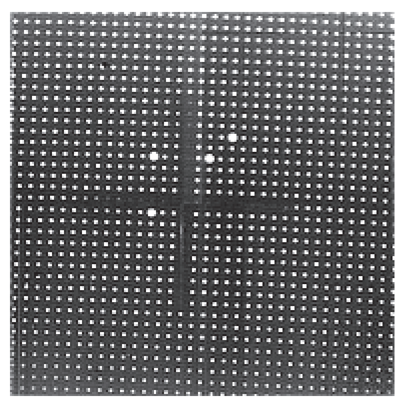


Image of a grid projected in the focal plane of one channel of NICI, with a MUX performing the imaging.

At the end of February, MKIR reported that 96 percent of the work to NICI final acceptance by Gemini had been completed. NICI is expected to be deployed on Gemini South in 2005B.

2005B Proposal Process Update

Dave Bell

NOAO received 415 observing proposals for telescope time during the 2005B observing semester. These included 168 proposals for Gemini, 132 for KPNO, 125 for CTIO, 10 for Magellan, 8 for MMT, and 7 for HET. Twenty-one of the Cerro Tololo proposals were processed on behalf of the Chilean National Time Allocation Committee (TAC), and 9 of the Kitt Peak proposals were processed on behalf of the University of Maryland TAC. Thesis projects accounted for 24 percent of those received, 18 proposals requested long-term status, and 14 were submitted for the NOAO Survey Program. Time-request statistics by telescope and instrument appear in the tables below. Subscription rate statistics will be published in the September 2005 issue of *NOAO-NSO Newsletter*.

As of this writing, proposals are being reviewed by members of the NOAO TAC (see the following listing). We expect all telescope schedules to be completed by 10 June 2005, and plan to notify principal investigators of the status of their requests at that time. Mailed information packets will follow the e-mail notifications by a few weeks.

Looking ahead to 2006A, Web information and forms will be available on line around 1 September 2005. The September 2005 *NOAO-NSO Newsletter* will contain updated instrument and proposal information.

2005B Instrument Request Statistics by Telescope

KPNO

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
4-m		**54**	**63**	**226.5**	**51.1**	**23**	**3.6**
	ECH	10	12	50	0	0	4.2
	FLMN	13	13	56	0	0	4.3
	MOSA	19	25	72.9	45.5	62	2.9
	RCSP	9	9	30.6	5.6	18	3.4
	SQIID	2	2	10	0	0	5
	VIS	2	2	7	0	0	3.5
WIYN 3.5-m		**35**	**40**	**122.4**	**60**	**49**	**3.1**
	DSPK	1	1	3	0	0	3
	HYDR	12	12	34.2	2	6	2.9
	MIMO	16	21	64.1	47	73	3.1
	SPSPK	2	2	8	5	63	4
	VIS	2	2	9	2	22	4.5
	WTTM	2	2	4	4	100	2
2.1-m		**24**	**30**	**156.2**	**20**	**13**	**5.2**
	CFIM	7	9	44	7	16	4.9
	FLMN	3	4	17	7	41	4.2
	GCAM	10	11	59	6	10	5.4
	SQIID	4	4	18.2	0	0	4.5
	VIS	1	2	18	0	0	9
WIYN 0.9-m		**9**	**10**	**49**	**22**	**45**	**4.9**
	MOSA	9	10	49	22	45	4.9

CTIO

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
4-m		**65**	**74**	**257.5**	**103.8**	**40**	**3.5**
	HYDRA	10	11	35	12	34	3.2
	ISPI	13	13	38.5	0	0	3
	MOSAIC	29	31	121.2	66	54	3.9
	RCSP	18	19	62.8	25.8	41	3.3
SOAR		**10**	**10**	**24.5**	**5**	**20**	**2.5**
	Goodman	5	5	15.5	3	15	3.0
	OSIRIS	2	2	3.5	0	0	1.8
	SOI	3	3	5.5	2	36	1.8
1.5-m		**6**	**7**	**29**	**0**	**0**	**4.1**
	CSPEC	6	7	29	0	0	4.1
1.3-m		**16**	**16**	**57.8**	**1.9**	**3**	**3.6**
	ANDI	16	16	57.8	1.9	3	3.6
1.0-m		**6**	**7**	**48**	**36**	**75**	**6.9**
	CFIM	6	7	48	36	75	6.9
0.9-m		**12**	**17**	**117.5**	**43**	**37**	**6.9**
	CFIM	12	17	117.5	43	37	6.9

GEMINI

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Gemini North		**97**	**121**	**156.8**	**51.1**	**33**	**1.3**
	GMOSN	50	56	77.3	48.5	63	1.4
	HIRES_Keck	7	8	13.6	0	0	1.7
	Michelle	14	16	17.3	2.7	15	1.1
	NIRI	34	41	48.7	0	0	1.2

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Gemini South		**90**	**107**	**183.6**	**59.6**	**32**	**1.7**
	GMOSS	40	47	81.3	56.9	70	1.7
	GNIRS	28	31	47.7	2	4	1.5
	Phoenix	15	16	41.6	0	0	2.6
	TReCS	12	13	13	0.8	6	1

COMMUNITY ACCESS

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
HET		**7**	**8**	**13.2**	**0**	**0**	**1.6**
	HRS	6	7	12.7	0	0	1.8
	LRS	1	1	0.5	0	0	0.5
Magellan-I		**3**	**3**	**8**	**8**	**100**	**2.7**
	IMACS	3	3	8	8	100	2.7
Magellan-II		**7**	**8**	**15**	**1**	**7**	**1.9**
	MIKE	7	8	15	1	7	1.9

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
MMT		**8**	**9**	**19**	**5**	**26**	**2.1**
	BCHAN	3	3	6	1	17	2
	Hectochelle	2	3	6	0	0	2
	Hectospec	2	2	5	2	40	2.5
	MegaCam	1	1	2	2	100	2

2005B TAC Members

Galactic (2–3 May 2005)
Letizia Stanghellini, Chair, NOAO
Steve Strom, Chair, NOAO
Sidney Wolff, Chair, NOAO

Lori Allen, SAO
Adam Burgasser, American Museum of Natural History
Ed Guinan, Villanova University
Tom Harrison, New Mexico State University
Ray Jayawardhana, University of Toronto
Jeremy King, Clemson University
Davy Kirkpatrick, Caltech/IPAC
Greg Laughlin, University of California, Santa Cruz
John Monnier, University of Michigan
Caty Pilachowski, Indiana University
Bart Pritzl, Macalester College
Verne Smith, NOAO
Nicole van der Bliek, CTIO
Eva Villaver, STScI
Lisa Young, New Mexico Tech

Solar System (4 May 2005)
Caitlin Griffith, Chair, University of Arizona, LPL

Debra Fischer, San Francisco State University
Matthew Holman, Harvard-Smithsonian CfA
Robert Millis, Lowell Observatory
David Trilling, University of Arizona, Steward

Extragalactic (5–6 May 2005)
Dave De Young, Chair, NOAO
Tod Lauer, Chair, NOAO
John Mulchaey, Chair, Carnegie Observatories

Lee Armus, Spitzer Science Center
Stefi Baum, Rochester Institute of Technology
Romeel Davé, University of Arizona, Steward
Megan Donohue, University of Pennsylvania
Harry Ferguson, STScI
Mauro Giavalisco, STScI
Brad Holden, Lick Observatory
Robert Knop, Vanderbilt University
Henry Lee, University of Minnesota
Crystal Martin, University of California, Santa Barbara
Bahram Mobasher, STScI
Alice Shapley, University of California, Berkeley
Malcolm Smith, CTIO
Adam Stanford, Lawrence Livermore National Laboratory
Donna Weistrop, University of Nevada, Las Vegas

Survey (19–20 April 2005)
Tod Lauer, Chair, NOAO

Jill Bechtold, University of Arizona, Steward
Jim Leibert, University of Arizona, Steward
Tom Matheson, NOAO
Marc Postman, STScI
Jeff Valenti, STScI
Rachel Bean, Princeton University

SOAR Update

Steve Heathcote

The SOAR Telescope is now capable of producing high-quality images, as illustrated by the accompanying image of M83. Wavefront residuals measured immediately after adjusting the mirror figure for a given target meet specifications and the optics remain well tuned for periods of up to an hour. Consequently, the telescope regularly delivers seeing-limited images including during occasional periods of sub-half arcsec seeing. This is achieved despite the problem with the lateral support system for the Primary Mirror reported in the December 2004 issue of the *NOAO-NSO Newsletter*. Although SOAR will not achieve its full design performance until that problem has been solved, the impact is primarily on efficiency rather than delivered image quality (the mirror must be retuned for each new object, and at intervals while tracking, a process that takes 5–10 minutes).

Composite image of M83, the Southern Pinwheel Galaxy, obtained with the SOAR Optical Imager using B-, V-, and R-band filters. The field covered is approximately 5×5 arcmin, and the images have 0.7 arcsec FWHM, comparable to the prevailing site seeing at the time.

As a result, the focus of work is now being trained on other key components of the 4.1-meter telescope including tuning of the servo control system for the tip-tilt tertiary, and optimization of the parameters of the Environmental Control System, which provides daytime cooling and nighttime ventilation of the enclosure to minimize dome seeing. Steady progress is also being made on the test and characterization of the three instruments now on site, the Optical Imager, the Ohio State Infrared Imager/Spectrometer (OSIRIS), and the Goodman Spectrograph. With the telescope now regularly delivering seeing-limited images, we are also beginning to execute the "Early Science" program, utilizing sample data collected with the Optical Imager for a number of programs. In particular, SOAR joined with the PROMPT telescopes on Cerro Tololo, as well as the 0.9-meter SARA and 3.5-meter ARC telescopes, to obtain near-simultaneous data on the Gamma Ray Burst GRB 050408, spanning the range from U to K.

Meanwhile considerable progress has been made toward a definitive solution to the problem with the primary mirror support system. A conceptual design for actuators that can be installed in place of the current passive links has been completed, and the SOAR consortium has secured the additional funding required to proceed to detailed design and fabrication. It is currently anticipated that installation and test of this new lateral support system will begin in the last quarter of 2005. At the same time, the guide cameras at each focus are being modified so that they can be used as low-order wavefront sensors, allowing the active optics system to be operated in closed-loop mode. It is hoped that these measures will allow the telescope to come into full operation, meeting its original stringent performance requirements during the first half of 2006.

Virtual Observing

Christopher Miller

The US National Virtual Observatory (NVO) is transitioning from a framework to a working facility. The goal of this transition is to provide a sustainable and usable facility that provides a true research environment to the astronomical community. The US NVO was initially funded through an NSF Information Technology Research (ITR) program grant in 2001 to build the infrastructure for a virtual observatory. The latest NVO Advisory Committee met in January 2005 and was impressed by the continued progress of the NVO team. The next phase of the NVO will be geared toward the operational phase next.

Throughout the last four years, NVO development has focused on three key areas: standards, grid computing, and prototypes. An example of a Virtual Observatory standard is VOTable, a way to represent astronomical data in XML. There are other Virtual Observatory standards that utilize VOTable formats on a regular basis. For instance, data providers can offer ConeSearch services or Simple Image Access Protocol services that take a sky position and search radius as input and return astronomical data or metadata (which describe data) in VOTable format. NVO prototyping has appeared through an ever-increasing list of Virtual Observatory tools that are available for community use. Finally, the NVO was recently awarded 257,000 service units (akin to computing hours) on the NSF TeraGrid project (see *www.teragrid.ord*). This computing time will be used to help solve seven data-intensive science projects in a Virtual Observatory framework.

The NOAO Data Products Program (DPP) is actively participating in the continued development of the NVO and the NVO Project Scientist, Dave De Young, is a member of DPP. Additionally, the NOAO Science Archive (NSA; described in the June 2002 *NOAO-NSO Newsletter)* has created a Simple Image Access service, which is also a cutout service. This NSA image cutout service meets the standards of the International Virtual Observatory Alliance (IVOA) and is accessible at *archive.noao.edu/nvo/sim*.

The NOAO DPP has also provided access to the galaxy catalog of the NOAO Deep Wide-Field Survey (NDWFS; highlighted in the September 2004 *NOAO-NSO Newsletter*). Access to the NDWFS catalog is through a Virtual Observatory prototype called Open SkyQuery, which conducts dynamic cross-matching of over 20 astronomical catalogs. You can look for the NDWFS node at the Open SkyQuery Web page *www.openskyquery.net*.

The NOAO, along with the Large Synoptic Survey Telescope (LSST), hosted the Spring 2005 NVO Team Meeting on April 25 and 26. These Team Meetings provide a forum to discuss the latest Virtual Observatory developments and future prospects. The agenda included discussions of a VOStore and VOSpace, as well as VOEvent, which is bringing time-domain data to the Virtual Observatory. The attendance at the spring meeting was nearly 50 people, exemplifying the broad interest in NVO issues.

So with this continuing success and development of the US NVO, researchers tend to ask a simple question: "How can I use the NVO in my own daily research?" To address this question, the NVO officially released its first set of software tools and applications at the January 2005 AAS meeting that make it easy to locate, retrieve, and analyze astronomical data. You can find an overview document and tutorials at the NVO Web site (*www.us-vo.org*), but the following is a brief description of each tool and/or service.

The first highlighted service is a Registry Portal at Space Telescope Science Institute (STScI). VO Registries are distributed databases of astronomical "resource information." "Resources" can be anything from a data-providing organization, to a service such as the NSA Simple Image Access Cutout Service, to a catalog or image archive. The Registry at STScI allows users to browse, query, and publish resource information in the Virtual Observatory. As an example of how an astronomer might use this Registry, one can type "NDWFS" within the Keyword Search box and click "GO!" The next page then shows the NOAO Deep Wide-Field Survey Open SkyQuery Resource, in which you can view a description, contact e-mail, publisher, reference URL, etc. This basic information not only describes what the resource is, but also where to find it and who to contact if you have questions.

The second tool is the NVO DataScope, which allows users to input a coordinate on the sky and specify a search radius (or an object name that is resolved in NED and SIMBAD). DataScope then searches all registered data providers (over 300) and returns content descriptions on a summary page, which also has links to the necessary Registry information. Individual data products (e.g., images and catalogs) can be accessed through a resource display page. Users can then select images and catalogs for download or analysis via the OASIS or Aladdin data viewers.

continued

Virtual Observing continued

A third highlighted service is Open SkyQuery (OSQ). OSQ allows users to access catalog data from over 20 different sources (SDSS, 2dF, NDWFS, GOODS, the Deep Lens Survey, etc). Additionally, OSQ will cross-match sources for you. For example, a researcher may only want NDWFS data that also have GALEX UV data as well. If you have your own catalog, you can upload it to OSQ and cross-match against it. While OSQ uses an extension of the SQL query language, you don't need to know SQL to use the OSQ, since the developers have created a great point-and-click SQL-command generator.

The NVO also contains a significant amount of spectral information that can be searched, downloaded, viewed, and manipulated using the NVO Spectrum Services. Spectrum Services provide access to the SDSS and 2dFGRS spectra via multiple methods: ConeSearch (which is Virtual Observatory Standard), Formed-based queries, and also SQL-based queries. In return, you can view GIFs of the spectra, see their photometric sources, and send them to a remote server or your own desktop as a VOTable. There is also a Filter Profile Service, where users can download or upload any number of instrument filter curves.

The final highlighted Virtual Observatory tool is the Web Enabled Source Identification and Xmatching (WESIX) program. WESIX combines many of the above Virtual Observatory standards, tools, and services into one package. Using WESIX, one can upload an astronomical image (with a valid WCS in the header) and specify which catalog in the Open SkyQuery you want to match against. WESIX then runs a source extraction algorithm (SExtractor written by E. Bertin) on the image. The sources are then uploaded to the OSQ and cross-matched against the catalog specified by the user. All of the catalogs are returned in VOTable format. Additionally, users can view the catalog data overlaid on their image using Aladdin or compare source measurements using VOPlot (another Virtual Observatory tool for catalog data).

Using the five tools and services discussed above, astronomical researchers can discover, access, understand, and even analyze astronomical data across the world at the click of a mouse-button. We urge you to go to *www.us-vo.org* and give them a try. These tools are not in their final form, so please send comments and suggestions.

As part of transitioning into a working facility, the NVO has initiated a Summer School sponsored by the NSF and NASA. The first Summer School was one week long and held in Aspen, Colorado, in late-summer 2004. Attendees came from a variety of backgrounds and had an even wider range of Virtual Observatory experience. The Virtual Observatory faculty taught the students about the Virtual Observatory standards, how to use the Virtual Observatory tools and services, and how to build new tools and services. At the end of the week, students formed small teams to produce a VO-enabled product that was then presented to the rest of the school. Many of these projects were presented in a Special Session (130) at the 205th meeting of the American Astronomical Society in January 2005. The Proceedings from the NVO Summer School 2004 are on line at *www.us-vo.org*.

If you are interested in learning more about how to use the Virtual Observatory, build services for the Virtual Observatory, or become a data provider within the Virtual Observatory, you might be interested in attending the Second NVO Summer School scheduled for 6–15 September 2005. Similar to the first summer school, it will provide hands-on experience and training in using Virtual Observatory tools and services, culminating with a major team-based Virtual Observatory project. The school will accept 40 students and the application deadline is 15 June 2005. There is a registration fee and some financial assistance may be available to those who qualify. For more information, see the NVO Web page.

Notable Quotes

"Does your head just *ache* all the time?"

—CBS-TV talk show host David Letterman, struggling to understand the concept of string theory, during an interview with astrophysicist and author Brian Greene on "The Late Show," 22 March 2005.

Other Happenings at CTIO

New Internet-2 Service Quadruples Access

On April 30, our 10-megabyte Internet-2 service with the local carrier Entel terminated. The new Internet-2, 45-megabyte connection at CTIO is provided by Reuna in Chile, and Florida International University to Miami and on to the Atlanta POP. We will also be provided with an additional 15 megabytes on the Chilean NREN backbone to provide closer links with universities in Chile and Latin America. This will be an enormous advantage to Data Products Program-South in providing archive services to the southern Americas and the Brazilian partners of SOAR.

These circuits are currently shared on a 50/50 basis with Gemini, but Carnegie-Las Campanas will shortly be joining us as a member and it is foreseen that the 45-megabyte capacity will satisfy all our needs into the next 3- to 5-year period.

Abhijit Saha's Sabbatical

Abi has spent five months, from January through May, working at the La Serena office of NOAO. While there he worked on some projects that are of common interest to both NOAO North and South, specifically, on such LSST-related activities as first attempts to set up an absolute flux calibration experiment on the Blanco 4-meter telescope, and on setting up a photometric all sky monitor with the Tololo All-Sky Camera (TASCA) as a way of measuring site performance. (He also subjected some of the NOAO South staff to extracurricular gastronomical experiments.)

Tohono O'odham Dispute Process of VERITAS Site Selection on Kitt Peak

Richard Green & Douglas Isbell

The Tohono O'odham Nation has filed suit in US District Court in Tucson seeking a declaratory judgment that the VERITAS project did not follow proper procedures in assessing the Horseshoe Canyon Site on Kitt Peak. The VERITAS project had commissioned an environmental assessment to comply with the terms of the National Environmental Protection Act (NEPA), but the Nation claims that opportunities for comment were not provided in strict accordance with NEPA procedures. In addition, the Nation asserts that because the entire summit area of Kitt Peak is considered sacred to them, it is subject to the terms of the National Historic Preservation Act, which were not explicitly followed in the site assessment process. That assertion is a matter of dispute.

The NSF has ordered work on the VERITAS project site to be stopped and has reopened the cultural assessment process. Court filings are due near the end of May. Efforts at mediation are also proceeding.

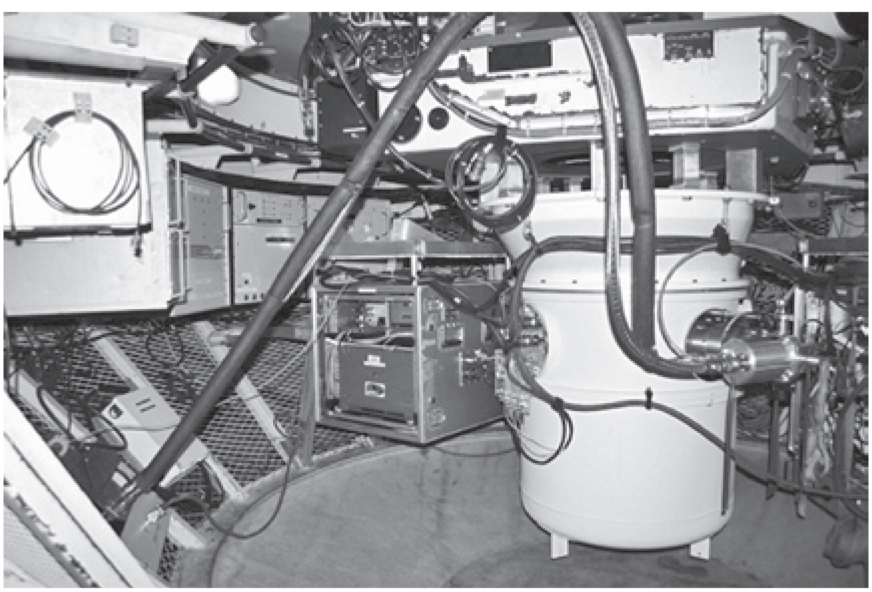
The newspaper circulated within the Tohono O'odham Nation, *The Runner,* reported about the Nation's lawsuit with the NSF, stating that "[T]he Tohono O'odham Nation…contends the agency has breached the lease by not complying with federal laws and regulations" and that "the Nation wants the Bureau of Indian Affairs to cancel NSF's lease to Kitt Peak."

KPNO management is working with the other parties involved to accomplish four objectives:

- Reestablish an effective dialogue with the Tohono O'odham leadership in order to address their underlying concerns.
- Avoid costly and divisive litigation when possible.
- Expedite the completion of the VERITAS array on the Horseshoe Canyon site near the Kitt Peak summit.
- Emerge with a viable agreement for the use and future development of the observatory leasehold on the mountain.

KPNO has been privileged to operate for 47 years on that mountain summit, a special place to both astronomers and the Tohono O'odham. We share a mutually productive relationship on a wide range of issues, from public safety to economic opportunities, and we anticipate a mutually respectful settlement of our differences on VERITAS in the near future.

~



Good Progress on IRMOS

This photo shows the Infrared Multi-Object Spectrograph (IRMOS) instrument mounted in the Cassegrain cage of the Mayall 4-meter telescope. Good progress on verifying its scientific performance and operations has given co-Principal Investigators John MacKenty of the Space Telescope Science Institute and Matt Greenwood of NASA Goddard Space Flight Center added confidence in their plan to offer the instrument for shared-risk observing in Semester 2006A.

Community Time Offered on Calypso 1.2-Meter Telescope

Edgar Smith & Richard Green

The Calypso Telescope is a 1.2-meter Ritchey Crétien telescope designed specifically for high-quality imaging. Operational on Kitt Peak since 2002, the telescope optics have extremely smooth, high-quality surfaces. The combined rms wavefront error for the primary, secondary, and tertiary mirrors is better than $1/17^{th}$ wave. To eliminate the effects of dome seeing, the enclosure retracts completely from the telescope, leaving the telescope exposed to the laminar airflow at the edge of the southwest ridge.

The telescope has two imaging cameras: the wide-field camera has a 10-arcmin-square field and the high-resolution camera has an 80-arcsec-square field and is equipped with a tip/tip adaptive guider. The wide-field camera incorporates a thinned, backside-illuminated 4K × 4K CCD imager from Fairchild, and its median image quality is better than 1 arcsec. The high-resolution camera incorporates a 2K × 2K thinned, backside-illuminated Loral CCD imager. Its median seeing is better than 0.7 arcsec when using rapid tip-tilt, and has been as good as 0.3 arcsec on better nights. Each camera can accommodate up to six filters in a cassette-style filter changer. Standard Cousins U, B, V, R, and I filters, as well as H-alpha, [O III], [N II], [S II], and He II filters, are available. For further details on the camera specifications, see *www.calypso.org*.

Observing time on Calypso is being offered to the community for runs of arbitrary length. Observers will be charged $450/night for every night scheduled for their programs. The Calypso staff will maintain the telescope and instrument, and provide observer support, while KPNO will handle observer arrangements.

If you wish to request time, please submit an informal proposal at any time to the KPNO Director at *rgreen@noao.edu*. The proposal should contain about a half page of scientific description, your choice of cameras and filters, and first and second choice of observing dates. When observing dates are assigned, we will request that you submit an ORP form for Calypso through the regular KPNO process. Members of your observing group can be accommodated in the KPNO dorms if the capacity of the Calypso facilities would be exceeded. NOAO Central Administrative Services will handle your billing.

It is our hope that this arrangement will provide for productive scientific use of this modern telescope facility.

The Calypso 1.2-meter Telescope Facility (Photo © Adeline Caulet).

A Time of Transitions

Steve Keil

As budgets become more restricted, bringing new facilities into operation becomes more challenging. In order to provide a funding wedge for new instrument development, the NSF Division of Astronomical Sciences is planning a Senior Review of its national facilities, with the intent of phasing out those that are less productive. The National Solar Observatory (NSO) Long-Range Plan calls for the phased reallocation of existing facilities support to our new capabilities as they become available. Thus, we have discontinued synoptic programs at the Evans and Hilltop facilities at Sacramento Peak, and at the Vacuum Telescope on Kitt Peak, over the past few years as SOLIS and ISOON, respectively, have commenced operations.

The NSO Long-Range Plan clearly shows a phasing out of operations at both the Dunn Solar Telescope (DST) and the McMath-Pierce Solar Telescope when the Advanced Technology Solar Telescope (ATST) is completed and operational. This will generate a funding wedge for the support of ATST operations. In anticipation of the continuing scientific productivity of our current facilities, and in view of the significant cost of permanently closing a major telescope complex when the ATST comes online, the NSO will attempt to find organizations that will support the operation of the older NSO facilities for ongoing programs in research and educational outreach. In this regard, I encourage any organizations that may be interested in the future utilization and support of our flagship telescopes to contact me.

During the Senior Review process, it will be important for the solar community to provide the NSF with comments on the usefulness and near-term (~5 years) potential of our current facilities and synoptic data sets in their research. Please feel free to contact me (*skeil@nso.edu* or 505-434-7039) if you would like further information on the review or if you would like to provide input to the review of NSO facilities and programs. While NSO can provide the review with statistics on use and productivity, it will be the voice of the users that determines the ultimate outcome.

We continue to make good progress in the execution of our Long-Range Plan, in partnership with the solar community, to provide state-of-the-art synoptic facilities through SOLIS and the GONG++ network, and to provide unrivaled high-resolution and coronal observing capabilities with the ATST. Calibration of SOLIS full-disk vector magnetograms is nearing completion and they should become available via the Web through the NSO Digital Library and the Virtual Solar Observatory (VSO) in the next month or two. Cross calibration between the older Sun-as-a-star spectral line surveys and the SOLIS Integrated Sunlight Spectrograph (ISS) will be performed over the next several months, allowing for the integration of the old and new data. This will yield a continuous record of cycle variations in the Sun seen as a star. GONG near-real-time data links and data pipeline are near completion, and the preliminary data are available at the GONG Web site or via the NSO Digital Library and the VSO.

ATST continues its progress toward submission to the Major Research Equipment and Facilities Construction (MREFC) program. Costs developed in the ATST construction proposal were reviewed for the NSF by an independent panel as a prelude to submitting the ATST proposal to the National Science Board (NSB) for its consideration as a new construction start. While revealing a few underestimated areas, the review showed that the costs have been thoroughly examined. The independent cost review concluded that the ATST is ready to enter the construction phase. It is not yet certain when the NSB will review the ATST proposal for an MREFC new start. Meanwhile, the ATST project has begun geotechnical testing on Haleakala, as well as environmental assessment and impact studies. NSO is working closely with the University of Hawaii in this process.

Given the potential delay in the start of ATST construction until 2007 or later, first light probably will not occur until 2012 or later. In the interim, NSO is taking steps to ensure the robust support of users requiring high-resolution visible and infrared (IR) observations. Currently, there are two adaptive optics (AO) systems installed at the Dunn Solar Telescope capable of feeding the primary instrument ports. One port has been dedicated to the Diffraction-Limited Stokes Polarimeter with accompanying imaging cameras (G-band, K-line, H-alpha, and continuum) all fed by AO. This set up will remain fixed and will be available for rapid response to targets of opportunity and ideal seeing conditions. The other AO system feeds the horizontal spectrograph, which is used for the Advanced Stokes Polarimeter and its upgrade, SPINOR (Spectro-Polarimeter for Infrared and Optical Regions). SPINOR is a joint High Altitude Observatory (HAO)-NSO project led by HAO. The AO system at this port can also feed the Interferometric BI-dimensional Spectrometer (IBIS) developed at Arcetri Observatory and now installed at the DST, as well as other filters and cameras in a fairly flexible configuration.

The data collection camera system at the DST was upgraded and is now much more robust and flexible. At the McMath-Pierce, an AO system optimized for the IR is operational and a new IR, large-format camera will become available soon. As a result, programs requiring ultrahigh-precision polarimetric observations at the diffraction limit of the 1.52-meter McMath-Pierce in the IR will be feasible. The FTS was recently refurbished and is operating well. We have planned upgrades of the DST and McMath-Pierce telescope control systems (TCS) that we will implement this year. These TCS upgrades are essential for the continued operation of the DST and

continued

A Time of Transitions continued

McMath-Pierce until the advent of the ATST. These upgrades, together with the new instrumentation, will ensure that NSO can continue to provide the user community with access to forefront capabilities for ground-based, O/IR investigations of the Sun during the course of the ATST construction project.

✷

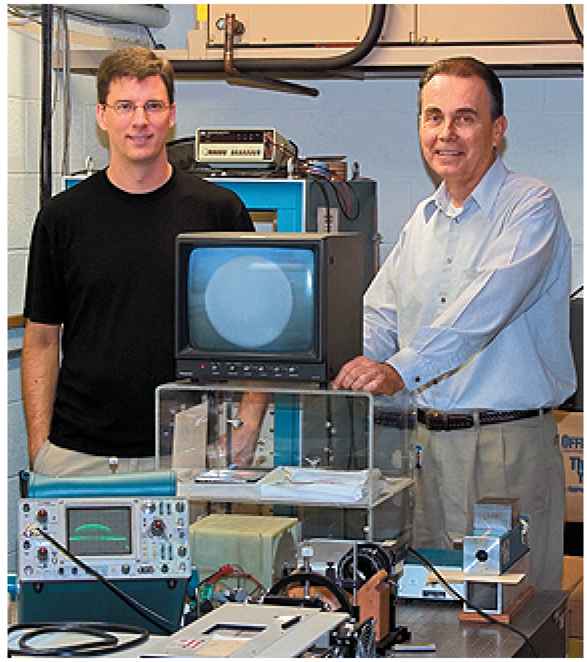
In addition to the new NSO team members introduced in the articles that follow, we welcome Electronics Technician Robert Radcliffe to the Sac Peak staff. Bob's primary responsibilities will be Dunn Solar Telescope maintenance, repairs and upgrades. He comes to us from Honeywell Technical Services at White Sands Missile Range after a 23-year career at the US Forest Service's Engineering Laboratory in Houghton, Michigan.

✷

Pat Eliason being presented with the AURA Service Award.

Recent awards recognized outstanding personal achievements by NSO staff. The AURA Science Achievement Award for 2004 was presented to Jeff Sudol and Jack Harvey for their use of the new high-cadence GONG magnetograms to convincingly demonstrate that all large solar flares are accompanied by significant, long-term magnetic field changes (see their article in the Science Highlights section). Congratulations to Jeff and Jack for their pioneering work in the scientific exploitation of the GONG magnetograms and for demonstrating a long-sought-for physical basis for solar flares.

Pat Eliason was presented with the 2004 AURA Service Award for her role in the highly successful completion of the GONG+ camera system upgrade, the GONG++ local helioseismology data analysis pipeline and replacement of the data processing "sneakernet" projects, her leadership of the GONG Data Management and Analysis Center, and her role in the transformation of GONG from a project to an ongoing program.



AURA Science Achievement Award recipients Jeff Sudol (left) and Jack Harvey.

The AURA Technology and Innovation Award went to the ATST Site Survey Team for conducting one of the most thorough surveys of potential solar sites ever made, implementing innovative instrumentation and data processing techniques, and carrying the survey through to a definitive conclusion in the limited time available. Current and past NSO staff, as well as staff from ATST partner institutions, comprised the 35-member site survey team. NSO also acknowledged the efforts of the Venus and Mercury Transit Team—Jean Goodrich, Ruth Kneale, Chirag Shroff, and Cliff Toner—for developing the real-time data acquisition, processing and display capabilities to support the worldwide viewing of the transits of Mercury and Venus by GONG.

✷

Finally, it is with deep sadness that the NSO mourns the passing of Keith Pierce. We will always remember Keith as a warm and supportive colleague, dedicated researcher, and skilled experimentalist. He will be greatly missed.

Austin Keith Pierce

1918–2005

Keith's parents encouraged and shared his passion for scientific discovery, beginning with the telescopes Keith built with his father, a professor of mathematics at the University of Nebraska. In addition to raising five children, his mother earned a degree in mathematics from the University of California, Berkeley. Their home was a gathering place for astronomers and other scientists.

Keith earned his PhD at Berkeley, where he took classes from Robert Oppenheimer. During the war, Keith worked on the Manhattan Project at the Lawrence Radiation Lab in Berkeley and at Oak Ridge, Tennessee. Later, Keith was offered a job working for Robert McMath in Michigan at the McMath-Hulbert Observatory. McMath, who knew his way around Washington and government funding, had the dream of building a large solar telescope at a western site. Essentially, he groomed Keith to lead this project.

Keith is remembered for his leading role in the conception and development of the solar telescope and of Kitt Peak National Observatory. He advanced our knowledge of the solar spectrum, built the world's largest solar telescope, made it available to researchers, and served in many advisory roles, including the Editorial Board of *Solar Physics.* For 16 years, Keith directed the solar division of KPNO with a light but supportive hand. His scientific publications spanned 1946 through 2000. Keith's proudest achievement was the solar telescope at Kitt Peak. At the 30th anniversary of the telescope in 1992, the McMath Solar Telescope was renamed the McMath-Pierce Solar Telescope to honor Keith's contributions.

Keith's insatiable interest not only in science but also in the world around him finds expression in one of his favorite quotations from the 19th century explorer Sir Richard Burton, who said, "If geography itself has significance, it is that we are made to lift our eyes from our small provincial selves to the whole complex and magnificent world."

Keith was preceded in death by a son, and is survived by a daughter and a son, and his wife Trudy Griffin-Pierce, an anthropologist at the University of Arizona. A celebration of Keith's life was held on April 29 at the Tucson Botanical Gardens. Obituaries will appear in *Solar Physics* and *Physics Today* in the next few months.

ATST Project Developments

Bret Goodrich, Rob Hubbard, Thomas Rimmele, Jeremy Wagner, Mark Warner & the ATST Team

The AURA Board met in early January and endorsed the selection of Haleakala, Hawaii as the best site for building the Advanced Technology Solar Telescope (ATST). Working closely with the University of Hawaii, the project has begun geotechnical testing and environmental impact studies (EIS) on Haleakala. The NSF held a cost review of the construction proposal in late March, so the proposal continues to move through the review process. We also continue to make good progress developing the design, as described below.

Software

The ATST software team enjoyed a busy March with the successful completion of the Common Services and Telescope Control System (TCS) preliminary designs. Both systems have been on a fast-track design and development schedule because of their importance to other ATST software systems. Common Services provides the communication and control structures required to operate in a widely distributed software environment, while the TCS defines the operational behavior of the telescope subsystems, such as the mount, enclosure, and primary mirror.

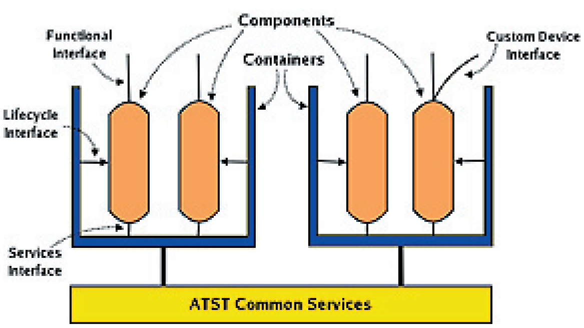


Figure 1. The deployment of containers and their components in ATST systems.

Early in the conceptual design process, the ATST project undertook a survey of observatory software control systems to determine the best approach for software design and implementation. One result of the survey was the conclusion that large, distributed software projects can reduce their overall development, integration, and maintenance costs by basing as much software as possible on a standard infrastructure. The ATST Common Services develops this infrastructure; it provides the benefits of standardized interfaces, separation of technical and application architectures, uniform implementation across all systems, and easy management in a distributed environment.

With the envisioned application of Common Services across all ATST software systems, it is critical that Common Services is deployed early in the project, before systems that rely upon it for control and communications. Along with the preliminary design of the Common Services, the ATST project has also delivered the second alpha release candidate of the operational software. This release provides a Java implementation of all technical architecture functionality, from the communications middleware through the container/component infrastructure to the connection and event services. Future releases will provide the application architecture, expanded services, and a C++ implementation. The goal of these releases is the deployment of a fully operational beta release at the beginning of ATST contruction.

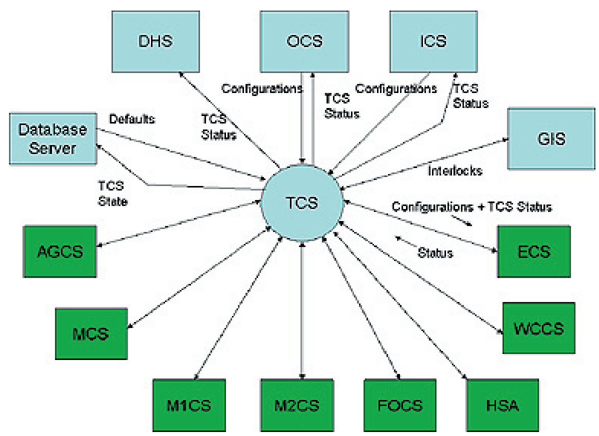


Figure 2. Telescope control interfaces.

In June 2004, the ATST TCS design contract was awarded to Observatory Sciences, Ltd., of Cambridge, United Kingdom. Following the Common Services review in March, Chris Mayer of Observatory Sciences and David Terrett of Rutherford-Appleton Laboratories, Oxford, United Kingdom, presented the TCS preliminary design. The design is based upon the Common Services infrastructure, giving the TCS a seamless interface with the other ATST principal systems. The TCS is also the first application designed with the Common Services in mind; accordingly, the preliminary design provided a very good proof-of-concept for the Common Services.

The TCS controls the various telescope hardware systems, the mount, enclosure, primary and secondary mirrors, feed optics, wavefront correction, and acquisition camera. In addition, the TCS provides ephemeris, pointing and tracking, and time base support for the ATST. By implementing a

continued

ATST Project Developments continued

number of virtual telescopes, the TCS can determine the position of the requested target on one or more observing focal planes. The addition of a world coordinate system and transformations between various solar coordinate systems allows users to work in many reference frames. The TCS supports heliographic, helioprojective, heliocentric, sidereal, geocentric, and topocentric coordinate systems.

The interfaces between the TCS and telescope subsystems are critical to the integration and operation of the ATST. The TCS preliminary design delivers the first version of these software interfaces. Based upon the ATST configuration model, the interfaces identify the attributes needed for each subsystem to perform its role in delivering images to the instruments. For instance, the mount receives attributes that define its mode, for example, whether it should initialize, stop, move to a position, or follow a stream of coordinates. The implementation and sequencing of the attributes is the responsibility of the mount. Similar interface mechanisms are also in place for the other telescope subsystems.

Enclosure

In early March, LeEllen Phelps joined the ATST project to take responsibility for the enclosure development effort. LeEllen is a degreed engineer with a strong thermal and industrial engineering background that is well suited to the challenges of the enclosure design.

Also in March, the final report on the enclosure thermal system design was delivered from M3 Engineering. Reducing the overall cost of the system continues to be a challenge, but it is being pursued aggressively on a number of fronts. These include review of the site and seeing statistics, exploring lower-cost thermal subsystem components, and incorporating computational fluid dynamics (CFD) modeling of the site topography and predominant wind directions and speeds. Additional thermal modeling of the enclosure and surrounding terrain is also underway.

Support and Operations Building

The design of the support and operations (S&O) building is evolving concurrently with the enclosure. The environmental impact statement effort requires ATST to define a maximum exterior envelope of the observatory at a specific location on the site. The current preliminary S&O building design incorporates the recently resolved height of the telescope as well as the relationship of ATST to existing site structures. To support initial foundation design, exploratory soil borings have been done and lab testing is in progress.

Optical Design

The project was delighted to bring Eric Hansen to the team in April 2005. Eric joined the team as our Lead Optics Systems Engineer, and we look forward to putting his extensive knowledge and experience from the Gemini Observatory to good use on ATST.

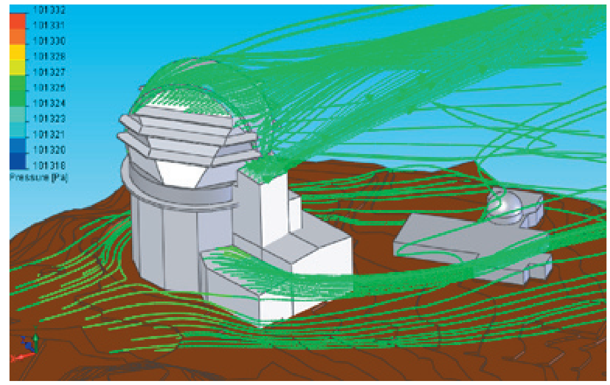


Figure 3. Flow trajectories off the enclosure and the support and operations building.

Key elements of the ATST optical design are now frozen. At the top end of the optical train we have frozen the size, location, and optical prescription of the first six mirrors. These include the off-axis primary and secondary mirrors (M1 and M2), a flat fold mirror (M3), an off-axis aspheric transfer mirror (M4), the nominally flat deformable mirror (M5), and the fast tip-tilt flat (M6). These six mirrors combine to form a horizontal relay image located just below the telescope along the azimuth axis.

We have also frozen the optical prescription for three alternative Nasmyth mirrors: M3N is a flat that is substituted for M3 during Nasmyth operations. M4N and M5N are off-axis aspheres that combine to transfer the *f*/13 Gregorian image to the Nasmyth focal plane, also operating at *f*/13.

Some significant work remains. We have been searching for a more cost-effective way to form the final image in the coudé room. Two additional powered folding mirrors in the baseline plan (M7 and M8) are located at suitable positions for a future multiconjugate adaptive optics (MCAO) upgrade, followed by a final flat pupil-steering mirror (M9) that renders our beam collimated and horizontal in the coudé room. Our baseline optical design calls for the two MCAO conjugate mirrors to be off-axis aspheres. Currently, we are investigating alternatives that allow these mirrors to be spherical while preserving diffraction-limited performance with a low-order programmable deformable mirror. Options include using the M5, the main high-order deformable mirror, or one of the spheres (likely M8) to accomplish the necessary correction.

continued

ATST Project Developments continued

We also are developing a detailed strategy for maintaining quasi-static alignment of the telescope. A recent funded study performed by Optical Research Associates in Tucson and Pasadena demonstrated that misalignment of optical components (due primarily to the slow flexure of the optical support structure holding M1 and M2 as the gravity vector changes) can be corrected by shifting M2 on its hexapod mount while maintaining optical bore-site alignment with the M3 and M6 flats. Three sensors sampling the wavefront at off-axis field points, working in conjunction with the active optics (aO) or AO wavefront sensors sampling on axis, give sufficient information to move these mirrors to optimum positions during operations. The update rates will be similar to, or slower than, those required for the M1 aO system.

Upcoming Milestones

Our efforts are focused on supporting the start of the EIS efforts while furthering the designs in preparation for the Systems Design Review. We also are scheduling fall 2005 subsystem Preliminary Design Reviews for Wavefront Correction (AO and aO) and for the instruments. We continue to update our Web site and encourage anyone interested to visit it periodically for the latest information.

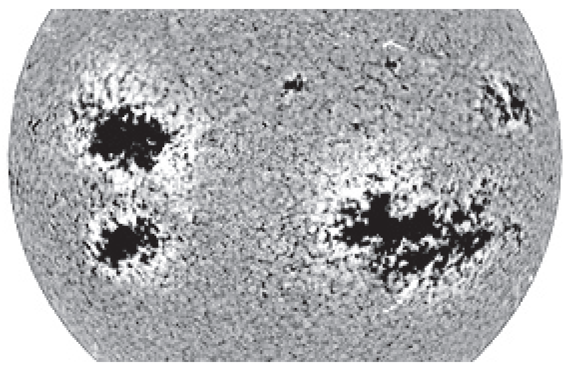
SOLIS

Jack Harvey & the SOLIS Team

Highlights of the past quarter included achieving first sunlight for the Integrated Sunlight Spectrometer (ISS) after its move to Kitt Peak, replacement of some optics in the Vector Spectromagnetograph (VSM), progress on the guider for the VSM, and resumption of construction work on the full-disk patrol (FDP). The SOLIS team welcomes postdoc Nour-Eddine Raouafi to work on exploiting the vector magnetograms obtained with the VSM. He was previously at the Max-Planck Institute for Solar-System Research in Lindau, Germany, and is supported by a NASA "Living with a Star" grant.

The ISS was moved to Kitt Peak in 2004 and the fiber-optic light feed to it was installed in February 2005. About the same time, the CCD camera of the ISS suffered a failure that was not repaired by the vendor until March. By early April, the ISS was complete and healthy, and first sunlight was obtained. Currently, various adjustments are being made to optimize throughput and spectral quality in preparation for starting regular observations. We expect data to become publicly available this summer.

The VSM housing was opened in February to investigate why one of the polarization modulators required to make vector magnetograms had stopped operating. Cables were examined without locating a problem. However, after the instrument was closed up, the modulator was working again. A few weeks later, the entrance slit of the VSM was replaced. The replacement is a laser-cut slit, 17.5 microns wide, 38 millimeters long, with a 250-millimeter radius in a 4-micron-thick foil of nickel. The original slit was narrower, half the thickness, and had warped under the intense *f*/6 sunlight. This distortion was thought to be due to the melting method used to cut the slit, which resulted in a change of material property at the slit's edge. The vendor used a new ablation method to make a new slit that should



Calcium circumfacules are the light-toned ellipses around the dark solar active regions in this SOLIS VSM negative image of the depth of the chromospheric 854.2 nm Ca II line. This large-scale phenomenon was discovered 102 years ago by G. E. Hale and F. Ellerman using the 40-inch Yerkes refractor but is mentioned in only three research papers during the subsequent century. As the image illustrates, the phenomenon is not subtle in SOLIS data and the ability of the VSM to provide polarized spectra at every point of the solar image has revealed new information about its physical nature. In brief, it is one of several signatures of a chromosphere whose dynamics, structure and radiative properties are different than the quiet Sun, active regions, sunspots or filaments. This newly recognized type of chromosphere deserves more study.

continued

SOLIS continued

not warp. So far, results are good. At the same time the slit was replaced, we also replaced some of the calibration polarizers; in particular, the circular polarizer used to calibrate 854-nanometer magnetograms and a linear polarizer used to calibrate 630-nanometer observations. Both of the original polarizers had degraded in the intense solar beam and are now replaced with a new type of polarizer that resists heat up to 400°C.

We are not satisfied with the performance of the vector modulator of the VSM. For unknown reasons, it has gradually lost efficiency since its original installation. An alternate technology has recently become available, and we are investigating the possibility of replacing the present modulators. We also investigated the possibility of replacing the VSM interim cameras with superior units recently available from another vendor. Unfortunately, the effort of converting the data handling system to accommodate the new cameras was estimated to be far beyond available labor resources.

Calibration of vector magnetograms under Christoph Keller's leadership received high priority. A full-disk observation was calibrated and inverted. An important issue that faces all vector magnetogram observations is how to resolve an inherent 180° ambiguity as to which way the magnetic field component transverse to the line-of-sight is pointing. Nour-Eddine Raouafi is testing numerous algorithms that have been proposed to resolve this ambiguity. A community workshop on disambiguation organized by the High Altitude Observatory was to be held in mid-April but fell victim to a spring snowstorm in Colorado. SOLIS continues to provide daily magnetograms and 1083-nanometer observations to the community via the SOLIS Web site.

The FDP is not finished because it was given low priority compared to the demands of getting the VSM and ISS up and running. The FDP is also being used as a test bed for work on the common VSM and FDP guider. As the pressure of other SOLIS aspects has lessened and progress on the guider continues, work has resumed on a tunable, visible light filter for the FDP. This was greatly assisted by recent commercial availability of suitable achromatic waveplates that we had planned to build in-house.

Instrumentation for Nighttime Use at the McMath-Pierce Solar Telescope

Jeffrey Morgenthaler, Walter Harris (University of Washington, Seattle), Ronald Oliversen (NASA/GSFC), Jason Corliss & Edwin Mierkiewicz (University of Wisconsin, Madison)

Since the early 1970s, a team with its origins at the University of Wisconsin has maintained an active program of scientific observations and instrument development for nighttime use at the McMath-Pierce Solar Telescope. Typical scientific targets have been emission lines from diffuse solar system objects such as the Io plasma torus and comets. The instrumentation under development has been based on the interferometric spectroscopic techniques of Fabry-Pérot (FP) and, since the late 1990s, spatial heterodyne spectroscopy (SHS). A related program of observations of [OI]6300 angstroms from Io's atmosphere has been conducted with the McMath-Pierce stellar spectrograph by Scherb and Smyth (1993, *J. Geophys. Res.,* 98, 18729) and Oliversen et al. (2001, *J. Geophys. Res.,* 106, 26183). A discussion of McMath-Pierce FP observations of the Io plasma torus can be found in Woodward et al. (1994, *Icarus,* 111, 45). A variety of comet observations also have been conducted, which are described below.

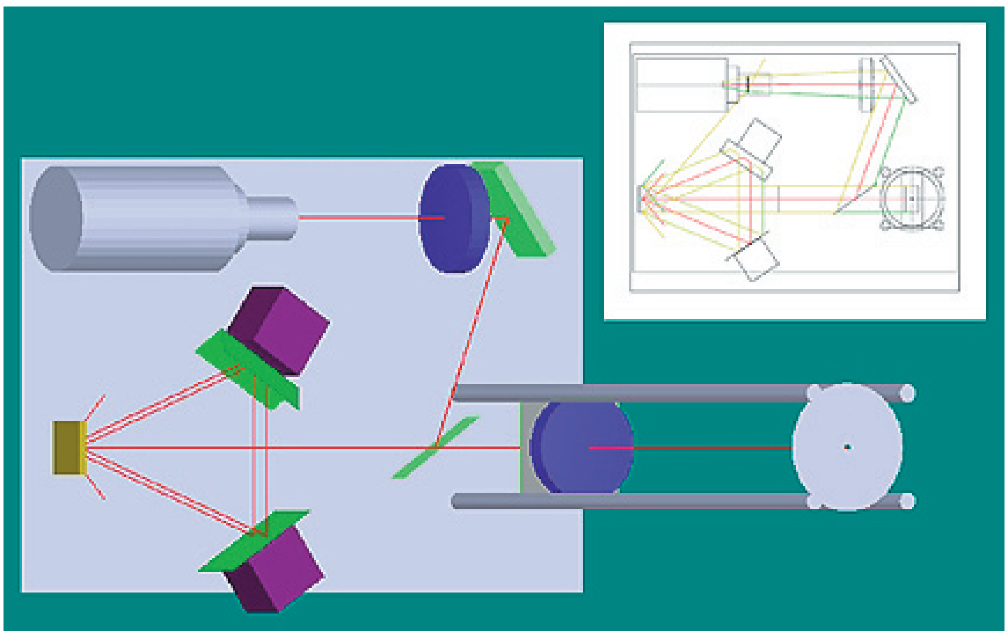
FP spectroscopy relies on the constructive interference of light between two plane-parallel plates of glass. A change in the separation between the plates results in a change in the wavelengths of peak transmission. Order separation is accomplished with conventional narrowband filters. By arranging more than one FP system (etalon) in parallel, each with different plate spacing, the spectroscopic resolving power of the system and the free spectral range can be increased simultaneously. A typical FP system has a much broader field of view (FOV) than a conventional grating-based spectrometer, making the FP technique ideally suited for the study of diffuse emission sources. Pioneering work on the use of FP spectrometers for both imaging and spectroscopic studies of comets has been done by the University of Wisconsin team at the McMath-Pierce (see Huppler et al., 1975, *Astrophys. J.,* 202, 276; Magee-Sauer et al., 1988, *Icarus*, 76, 89; Scherb et al., 1990, *Icarus,* 86, 172; Schultz et al., 1992, *Icarus,* 96, 190; Oliversen et al., 2002, *Astrophys. J.,* 581, 770).

continued

Nighttime Use at the McMath-Pierce continued

The SHS technique was first formalized by researchers at the University of Wisconsin (Roesler and Harlander, 1990, *Proc. SPIE,* 1318, 234). An SHS is a compact Fourier transform interferometer similar to a Michelson in design, but with fixed gratings replacing the movable mirrors. This technique permits sampling of the full resolving power of a grating and FOVs that are large compared to conventional high-resolution spectrographs. Thus, SHS is ideally suited for studies of faint, extended sources like comets. SHS development continues at the University of Wisconsin and has spread to several other institutions (St. Cloud State University, University of Washington, NRL, NASA Goddard Space Flight Center, and Boston University). The University of Wisconsin team has used the McMath-Pierce, particularly the North Port and West Auxiliary, as a test bed for demonstrating the feasibility of the SHS technique.

SHS observations of interstellar [O II] at 3727 angstroms were conducted at the North Port in 2001 (Mierkiewicz et al., 2004, Proc. SPIE, 5492, 751). Subsequent runs have been conducted to observe comet Q4/NEAT at OH 3080 angstroms (2004) and comet Machholz at OH 3080 angstroms and Hα 6563 angstroms (2005). SHS Observations of comet Tempel 1 in support of Deep Impact on 4 July 2005 are planned.



The optical path of the all-reflective SHS deployed during our Machholz run. After passing through a field lens in the vertical telescope beam (not shown), light enters the system from above via a tower that holds an aperture stop and collimating lens. A fold mirror below the collimating lens reflects the light to a horizontal plane, directing it toward the grating (far left). Dispersed light from the symmetric grating is directed toward two mirrors, a flat and a roof mirror. Interfering light, recombined on a lower plane at the grating, is directed though a narrowband filter into a CCD camera (upper left).

GONG

John Leibacher & the GONG Team

GONG highlights this quarter include the first meeting of the Magnetogram Users' Group (MUG), an on-site meeting of the Data Users' Committee (DUC), the first movie of merged continuous full-resolution GONG magnetograms, the release of the long-awaited first one thousand days of local helioseismology science products, and the arrival of some important new talent.

The GONG instruments routinely obtain magnetograms every minute and the high temporal resolution and moderate spatial resolution of these observations offer a unique resource for the solar physics community. Originally developed to identify areas of possible contamination of the helioseismic signal, the magnetograms are proving exceedingly useful in their own right because of their high cadence, continuity, and sensitivity. GONG's newly formed MUG met in March to help define the future processing goals of the program (see figure 1). We are currently developing new polarization modulator electronics to reduce the systematic GONG magnetogram instrumental zero point error to 0.3 gauss over time (at least one day) to make them useful for potential field extrapolations and studies of large-scale field changes. Once in place, a routine processing pipeline will be implemented to produce new magnetogram data products. A preliminary list of products and the recommendations from the group can be found on our Web site.

Figure 1. Members of the Magnetogram Users' Group (MUG) are (from left) Giuliana de Toma (HAO, chair), Gordon Petrie (HAO), Carl Henney (ex officio for SOLIS), Dave Hathaway (NASA/MSFC), Todd Hoeksema (Stanford University), Yan Li (University of California, Berkeley), and Nick Arge (Air Force Research Laboratory).

GONG's DUC met in Tucson May 5 and 6 to review the overall helioseismic data processing, and to "cross the t's and dot the i's" on the new Automatic (Bad) Image Rejection (AIR) package and to evaluate the new site-merging geometry algorithm, which uses frequent noon drift-scans from the sites to compute the angles. The group also assessed the progress of the local helioseismology pipelines. As shown in the composite image, we now have over one thousand days of local helioseismology science products (see figure 2). The day-to-day variation in the distribution of horizontal velocities below the surface yields the divergence of the flows. Thirty-seven solar rotations are shown stacked one above another.

GONG's science team was awarded a three-year NASA Guest Investigator grant to investigate the dynamics of the convection zone using SoHO/MDI and GONG data and local helioseismology techniques. In particular, the focus will be on the shear layers at the top and bottom boundaries. The expected scientific impact of this work will include: 1) testing the validity of models of the convection zone, 2) constraining models of the solar dynamo mechanism, 3) determining the properties of the deep meridional circulation, 4) investigating longitudinal structure in the tachocline (the transition zone between rigid and differential rotation), and 5) searching for subsurface precursors of solar activity. All work will be done in collaboration with the MDI science team.

By addressing the specified scientific objectives, we should significantly increase our understanding of the physical processes controlling the solar cycle, as well as contribute to a number of broader areas, including astrophysical fluid dynamics (testing the validity of numerical models of the convection zone), the generation of astrophysical magnetic fields (constraining models of stellar dynamos), and space weather predictive capabilities (searching for subsurface precursors of solar activity). The proposed research will also provide new tools for analysis of current SoHO/MDI and provide new research paths for SDO.

The Solar Physics Division of the American Astronomical Society has undertaken the organization of a series of summer schools to cover various aspects of solar physics. The first in the series, scheduled for summer 2005, will focus on helioseismology. The school is being hosted at the High Altitude Observatory in Boulder, Colorado, and is sponsored jointly by the NSF and NASA/ILWS. Visit the SPD Web site (*spd.aas.org*) for more information. The applications significantly exceeded our resources.

The program welcomes the newest GONGster, Tim Purdy, as the team's real-time programmer in charge of the remote instrument and data computers control systems. After the four-month vacancy

continued

GONG continued

in that position, there's a lot to keep him occupied. We were fortunate to get Chirag Shroff back for two days to help Tim through the intricacies that lurk below the surface. We also welcome Kirin Jain who will be working with us as a long-term visitor comparing MOTH data with GONG, and extend a welcome to Harry Jones who is coming out of his one-month retirement to work with us on developing methods to improve the merging of the magnetograms.

Network Operations

During the first quarter of 2005 two preventative maintenance (PM) trips took place. The first was to Mauna Loa in February where only routine tasks were anticipated, however, upon inspecting the optics, a flaw in the filter/interferometer was discovered. It appeared that the grease between optical elements had failed, allowing air to creep into the grease and causing the solar image to be obscured. An on-site fix was attempted but resulted in only partial success and it was necessary for Jeff Sudol to bring a replacement assembly from Tucson to correct the problem while the PM was underway.

The other PM trip was to Learmonth during the end of March into April. Anticipating the possibility of a problem with the filter/interferometer assembly there too, a spare was taken along and indeed, a similar problem was found and the spare was employed. A camera and modified camera power supplies were scheduled to be changed out, but acceptable camera temperature control using the new supplies could not be achieved and the old power supplies remain installed. Other PM tasks included replacing the turret with a refurbished one that has the more robust weather seals, and considerable maintenance and repair was completed on the instrument shelter.

At Big Bear, a turret mirror heater became operational. The purpose of this device is to prevent condensation on the mirrors, which occurs overnight when the temperature is low and the humidity high, and could result in several hours of data loss the following morning under beautiful skies. The heaters are on only when the turret is stowed and the temperature falls below 18°C. The Tucson site seems to be the only other site with this problem.

An occurrence of the wrong year on the Big Bear data computer CPU caused several days of data to be compromised. If the incorrect year were restricted to only the data computer, then only the image file name would be affected. However, because the instrument computer's date is corrected to match the data computer, the ephemeris parameters calculated by the instrument computer were incorrect as well. There have been other events where the instrument falls into an inappropriate state, such as when a window cleaning is done while the instrument is taking its calibration. These, along with other unexplained events, are under investigation.

During the last half of March, the Mauna Loa system began to lock up, both during operation and at boot up. Initial brainstorming led down the path of the camera power supply, the DAS boards, and then the CPU board. Swaps were made, but the problem remained intermittent and suspicion turned to the communication between the camera and data computer. After further troubleshooting, the problem was identified at the camera end, and a team was sent to Mauna Loa with a replacement camera.

Data Processing and Analysis

As previously mentioned, we have now completed ring diagram analysis for the period 22 July 2001 to 24 April 2004, which covers 27 consecutive GONG months or 37 consecutive Carrington rotations and provides an unprecedented history of the subsurface flows. Divergence and helicity maps are being produced, along with a movie.

Mode frequencies for GONG months 91 through 93 (ending 5 July 2004) are now available. Month 93 enjoyed a 93 percent fill factor. We had a bit of a glitch processing this month as the Venus transit gave rise to all sorts of little problems! The Data Storage and Distribution System (DSDS) distributed 274 gigabytes in response to nine data requests, in addition to many FTP downloads of a variety of data products.

The data reduction team is maintaining the cumulative backlog for calibrated data products at around 100 days (600 site days). The testing of the automated image rejection module has been delayed after the discovery that the values of the angular orientation of the images were substantially different when compared with the original values. This has been traced to the incorrect handling of a PM trip by the original labor-intensive QA method. We are thus repeating the test on

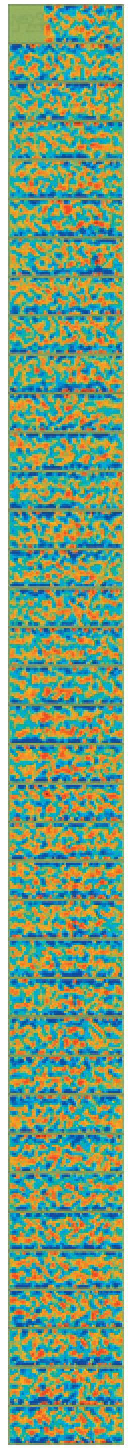


Figure 2. 1000 Days of Local Helioseismology Science Products: The divergence of the horizontal velocity over the surface of the Sun for 37 consecutive solar rotations. Each image shows a map over 360 degrees of longitude horizontally and ±60 in latitude.

continued

GONG continued

a different, more recent time period, which also includes numerous noon drift-scans.

By the time you read this, the new version of our angular registration program will be complete. It has undergone extensive testing, and we have verified that noon drift-scans alone are an acceptable substitute for the use of MDI data as a reference. We are working toward a new release of the GONG Reduction and Analysis Software Package (GRASP), which will include both the new angular registration code and the automated image rejection modules.

The GONG scientific staff has been working on several projects. These include testing the sensitivity of global inversions to modern dynamo models, investigating the relationship between subsurface kinetic helicity and flare characteristics, time-distance measurements of the solar radius and the deep meridional flows, determination of the near-surface meridional flow from uninterrupted rotations, and comparisons of frequencies derived from rings obtained in intensity and velocity as a function of disk position. In addition, we now have some 30-second cadence data that we will use to investigate high-frequency oscillations, and we are starting a comparison of flow fields derived from GONG and Stuart Jefferies' MOTH South Pole experiment.

As mentioned, the new Magnetogram Users' Group (MUG) held its first formal meeting in Tucson on March 2-3. It was a very productive meeting, resulting in a detailed list of specifications and actions for GONG magnetic field data processing and products. We are now in the process of planning the development of the magnetogram-processing pipeline, while we continue to work on reducing the zero-point uncertainty. We have produced a nice movie of 36 days of six-site merged GONG magnetograms, which even with the zero-point fluctuations is an exciting new scientific capability for the non-helioseismic community.

Notable Quotes

"They say there are two ways to get famous [in astronomy]. One is to make a very big discovery. The other is to break a very big mirror."

—Freelance photographer Joe McNally, speaking about the challenge of doing a helicopter photo shoot over Kitt Peak National Observatory; the resulting panoramic image and accompanying guide to all of Kitt Peak's telescopes was published in Discover *magazine's May 2005 issue, with the cover headline "Kitt Peak: Telescope Heaven."*

Astrobiology Weekend at the McMath-Pierce Solar Telescope

Mark Giampapa, Claude Plymate, Frank Hill, Matt Penn & Connie Walker

Members of the NSO staff participated in the LAPLACE-University of Washington (UW) Exchange on March 19–21, which involved a visit to Kitt Peak by 14 graduate students from the UW astrobiology program along with members of the Life and Planets Astrobiology Center (LAPLACE) of the University of Arizona. The graduate students represented a broad range of disciplines in the life and physical sciences, and engineering.

During their three days on the mountain, the students participated in demonstration observing exercises in order to gain an understanding of how astronomical data relevant to goals in astrobiology are obtained, reduced and analyzed. At the McMath-Pierce Solar Telescope, the graduate students obtained infrared spectra of sunspots and measured umbral field strengths based on the observed Zeeman splitting of a magnetically sensitive Fe I line at 1.56 microns. In addition, they saw Ca II H and K spectra acquired for active regions in the vicinity of the spot, similar to the kind of spectra obtained at the nighttime telescopes for active solar-type stars. Frank Hill and Mark Giampapa interspersed the solar observations with presentations on solar-terrestrial interactions, solar-stellar activity, and helioseismology. As one student remarked, "I really learned a great deal about the Sun."

Astrobiology weekend participants from the University of Washington, Seattle, and the University of Arizona.

2005 CTIO REU/PIA PROGRAM

Alan Whiting

With an afternoon of presentations on March 24, the 2005 CTIO summer student intern programs drew to an end (for the moment). Six students from colleges all over the United States joined with two Chileans to show astronomers from CTIO, Gemini, and SOAR (plus some visitors) what their past ten weeks of work had generated. The projects covered several types of stars (new, old, varying in several ways), planetary nebulae, star formation in the Large Magellanic Cloud, and a search for quasars in new infrared data. Of particular note this year were several projects that started or continued ongoing efforts: long-term photometry of the enigmatic star Eta Carinae, and of Cerro Tololo sky brightness; and part of a complicated scheme to determine accurate distances to planetary nebulae.

The previous ten weeks had seen the six Research Experiences for Undergraduates (REU) students and the two Práctica de Investigación en Astronomía (PIA) students conducting a week-long observing run on the CTIO 0.9-meter telescope, attending talks on various aspects of astronomy from specialists in the fields, and learning all the pitfalls and elation of their own research. They were directed by mentors from CTIO, SOAR, and Gemini South (with one co-mentor again this year from ESO). Some of the students had the opportunity to observe with other telescopes, including the 4-meter Blanco, the 8-meter Gemini South, and the 3.5-meter NTT at La Silla. And the US students learned a great deal about living in a foreign country (with the help of the Chileans).

While the students have now dispersed, they will join up again at next January's AAS meeting in Washington, DC, where they will present posters on their research. In the meantime, details of their science and life in La Serena can be found at *www.ctio.noao.edu/REU/ctioreu_2005/REU2005.html*.

continued

2005 CTIO REU/PIA Program continued

Sonia Aggarwal, Betsy Mills, and Omar Valdivia observing with the CTIO 0.9-meter telescope.

Ben Brandvig and Claire Bendersky coordinating observations with the CTIO 0.9-meter telescope.

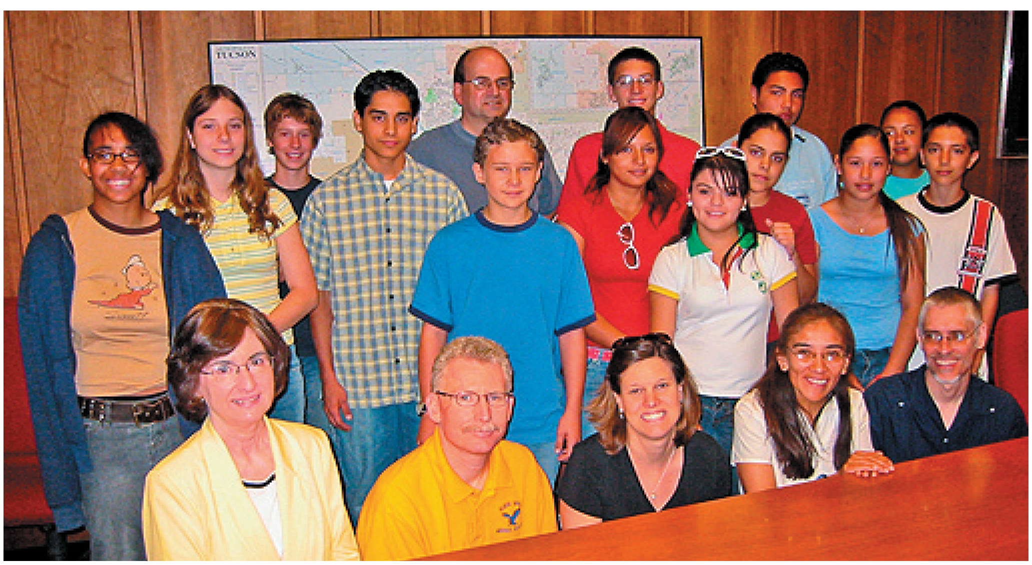
The 2005 students ready to take over in the Gemini South control room (from left to right): AJ Carver, Omar Valdivia, Sonia Aggarwal, Dylan Semler, Betsy Mills, Claire Bendersky, Ben Brandvig, and Laura Perez.

The Sky is the Limit—Student Light Pollution Surveys in Both Hemispheres

More than a dozen students and teachers on each side of the equator participated in the latest NOAO ASTRO-Chile videoconference between Tucson and La Serena, held on 16 April 2005 in honor of Astronomy Day. Middle and high school students at both sites gave presentations on the results of light pollution observations made by hundreds of participants in the two locations over the previous several weeks. Two of the three Tucson presentations were conducted in Spanish. The findings were presented via PowerPoint slides, maps, posters, and written reports.

Tucson Unified School District participants in the videoconference hailed from Tucson High School, Gridley Middle School, and Vail Middle School. The La Serena attendees included many of the students and teachers that have participated in the most recent training workshops conducted by the local RedLaSer educational outreach group, which is funded in part by Gemini South and Cerro Tololo Inter-American Observatory, with support from the University of La Serena.

Some of the La Serena students and their teacher (right) with RedLaSer director David Orellana (left) and AURA Observatories Director Malcolm Smith.



The Tucson participants in the April 2005 ASTRO-Chile videoconference with NOAO Director Jeremy Mould.

FunFest 2005

NOAO educational outreach and public outreach staff again cohosted a booth at the 3rd Annual Math Science and Technology "FunFest" at the Tucson Convention Center from 16–18 March 2005. Held in conjunction with the yearly Southern Arizona Regional Science and Engineering Fair (SARSEF), FunFest brought together scientists and students from elementary school through high school to share in the wonders and excitement of science. The event attracted more than 5,800 students and 1,200 adults over the three days. Assisted by the crucial participation of 18 volunteers, the very popular NOAO booth featured seven hands-on activities in astronomy, near-continuous shows in a portable planetarium, and live solar observing.

Hands-on activities at the NOAO FunFest booth.

"World Year of Physics" Celebrated at Kitt Peak

The Kitt Peak Visitor Center hosted a festive "Einstein Day" on Saturday, March 12, in honor of the 2005 World Year of Physics and the March 14 birthday of Albert Einstein. More than 75 people participated in the successful public event, which included special tours of the WIYN 3.5-meter and McMath-Pierce telescopes, sunspot observing on the sunny spring day with solar telescopes on the Visitor Center patio, engaging lectures from Kitt Peak director Richard Green and University of Arizona cosmologist Daniel Eisenstein, and a (quickly consumed!) birthday cake.

Sunspot Observations on the Visitor Center patio.