

NOAO-NSO Newsletter

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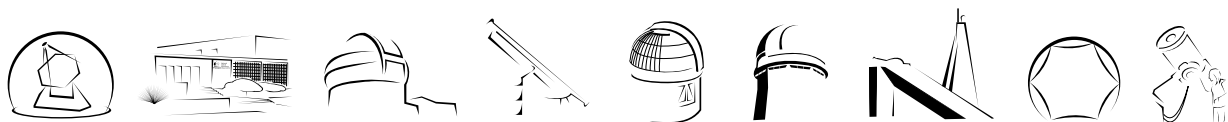
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“The Universe is expanding. That should help ease the traffic.”

—Comedian Steven Wright, quoted in the *Washington Post*, 21 June 2004



UNC Receives Grants for New Telescopes in Chile; Remote Access Will Benefit State Schools, Students

The University of North Carolina at Chapel Hill has received two National Science Foundation grants totaling \$912,000 to build six telescopes in Chile that will study the most distant objects in the Universe. The six Panchromatic Robotic Optical Monitoring and Polarimetry Telescopes (PROMPT) will be built at the Cerro Tololo Inter-American Observatory in the Andes and are designed to study powerful but distant explosions called gamma-ray bursts.

The new 0.4-meter telescopes in Chile also will open fields of study for undergraduate and high school education statewide, thanks to a consortium of 11 state colleges and universities, and remote operating technology available online and at UNC-Chapel Hill's Morehead Observatory.

UNC-Chapel Hill is the lead partner in the PROMPT project, with research collaborators at Appalachian State University, Elon University, Fayetteville State University, Guilford Technical Community College, NC Agricultural and Technical State University, UNC-Asheville, UNC-Charlotte, UNC-Greensboro, UNC-Pembroke, and Western Carolina University, as well as Hampden-Sydney College in Virginia.

Each partner will have about 420 hours of annual observing time among the PROMPT telescopes. Students and faculty researchers will be able to observe the Southern Hemisphere skies over Chile using PROMPT through special remote technology.

PROMPT is being built in two phases. Construction for the first phase, which is supported by a \$130,000 pledge from UNC-Chapel Hill's department of physics and astronomy and a \$100,000 gift from alumnus Leonard Goodman of New York City, is scheduled to begin this month.

In September, 15 UNC-Chapel Hill undergraduate students will travel to the PROMPT and SOAR sites in Chile with astronomers Gerald Cecil and Wayne Christiansen and graduate student Jane Moran. The group will assemble PROMPT as part of a semester-long study-abroad program. Students also will conduct research using the SOAR telescope.

The first phase is scheduled for completion this year, and the second phase, which supports a major equipment upgrade, is scheduled for completion in mid-2005.

Each PROMPT telescope will have a unique capability, said Reichart, such as observation of violet light, blue light, red light and very red light. One will observe infrared light, which the human eye cannot see, and another will measure the polarization, or orientation, of incoming light waves, which should yield valuable information about the role of magnetic fields in the creation of gamma-ray bursts.

For more, see www.physics.unc.edu/~reichart/prompt.html.

—From a press release issued 5 August 2004 by the University of North Carolina

On the Cover

This image from the NOAO Deep Wide-Field Survey (with added “blow-ups” of interesting objects in the field) is among the many images from the survey that will be released via the NOAO Science Archive on 22 October 2004. The survey is led by Arjun Dey and Buell Jannuzi of the NOAO scientific staff.

The color image of this 35-arcmin by 35-arcmin subfield, NDWFS J1431+3531, in the constellation Boötes was made from B_w, R, and I-band images obtained with the Kitt Peak Mayall 4-meter telescope using the Mosaic I imager.

Interesting new science results from the NDWFS are reported in two articles in the Science Highlights section of this *Newsletter* (see pages 4–7).

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High-Resolution Near-Infrared Spectroscopy of FU Ori Objects

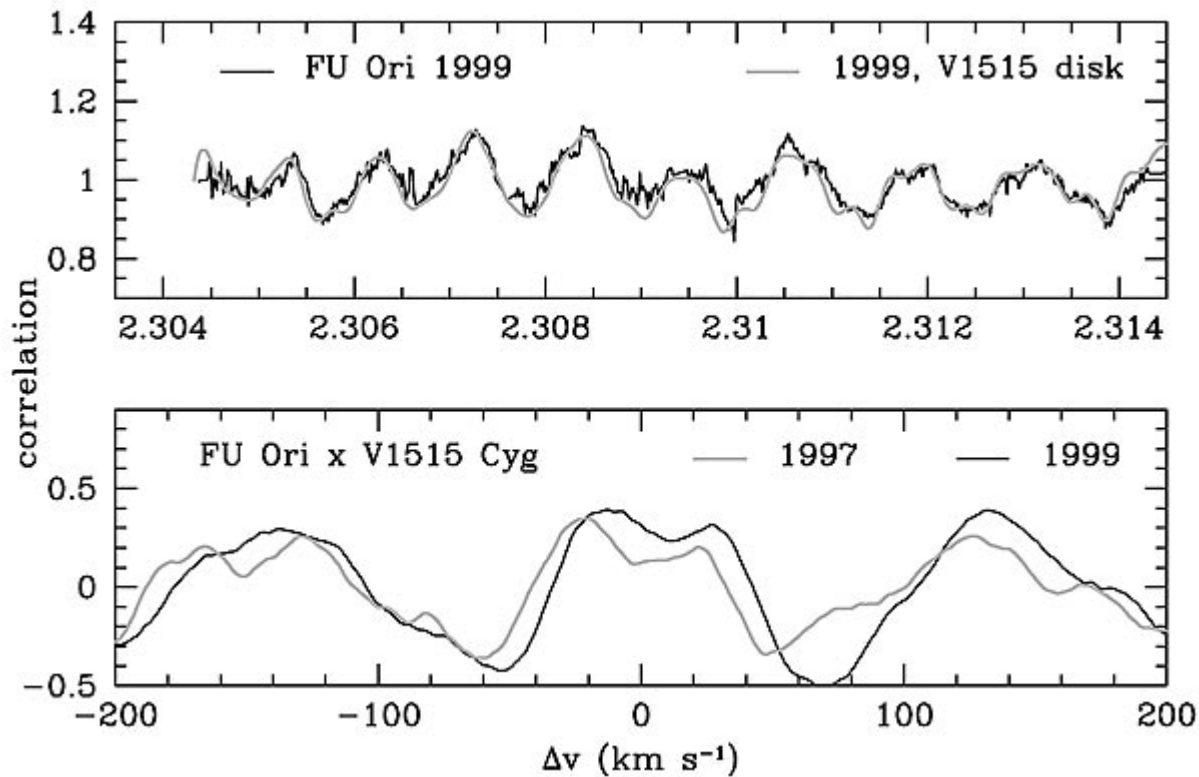
Lee Hartmann (Harvard-Smithsonian, CfA)

FU Orionis objects are a remarkable class of eruptive pre-main sequence systems whose unusual properties may arise from the presence of a rapidly accreting ($10^{-4} M_{\odot}/\text{yr}$) circumstellar disk (Hartmann & Kenyon 1996). The accretion disk model explains the broad spectral energy distributions of these objects, as well as why near-infrared spectra of these objects show later spectral types and slower rotational velocities than spectra taken at optical wavelengths: the longer wavelength spectra probe the outer, cooler, more slowly rotating regions of the disk. Finally, the disk model predicts “doubled” line profiles, which are often (though not always) detected. A significant amount of mass can be accreted during an FU Orionis outburst: FU Ori itself has been in a high state since the 1930s, and therefore we infer that it has accreted approximately $0.01 M_{\odot}$, or

approximately a minimum-mass solar nebula, during that time. More generally, rapid disk accretion in FU Orionis outbursts may be a part of the evolutionary history of all low-mass stars. As a result, there is considerable interest in verifying the disk paradigm for FU Ori objects.

Recently Herbig et al. (2003) raised questions about the disk model based on optical and near-infrared spectra of FU Ori and a similar system, V1057 Cyg. To address some of these questions, we analyzed (Hartmann, Hinkle, & Calvet 2004) high-resolution spectra in the region of the first-overtone CO bands obtained with the Phoenix spectrometer (Hinkle et al. 1998, 2003) on the Kitt Peak 2.1-m telescope and the Gemini South 8-m telescope.

continued



Upper panel: Comparison of Phoenix spectrum of FU Ori (black line) with a synthetic disk spectrum (gray line). Lower panel: Cross-correlations of FU Ori spectra with a narrow-lined template spectrum (V1515 Cyg). The broad cross-correlation is double-peaked, as predicted for a rapidly-rotating disk; the same structure is seen in both epochs, with a possible radial velocity shift.



High-Resolution Near-Infrared Spectroscopy continued

Herbig et al. had called attention to the appearance of narrow optical emission lines of low-excitation species in V1057 Cyg starting in 1997. They interpreted these emission features as resulting from a chromosphere that, in a weaker state, produced the line doubling seen at earlier epochs. We found that the 1997 Phoenix spectrum of V1057 Cyg showed very strong “shell” absorption in the first-overtone CO lines, blueshifted by about 50 km/s from the system velocity. The physical properties of this shell are uncertain, but we estimated an excitation temperature of $\sim 600\text{K}$ and a total column density possibly as large as 10^{23} cm^{-2} . We suggested that V1057 Cyg ejected cold, dense, massive shells, which at least qualitatively account for the CO absorption, the optical decline (probably due to dust obscuration; Ibrahimov 1999), and the low-temperature optical lines seen in both emission and absorption by Herbig et al.

We also analyzed the CO line profiles of FU Ori in some detail. The figure shows Phoenix spectra of FU Ori compared with a predicted disk spectrum calculated by convolving the rotational line profile with the Phoenix spectrum of V1515 Cyg, a slowly-rotating (pole-on) FU Ori object. The comparison is reasonably good, suggesting that the line broadening predicted for a rotating disk is consistent with the observations. This can be tested without

using a model by cross-correlating the V1515 Cyg spectra with FU Ori; the resulting cross-correlation peaks reflect the average line profile in the rapidly rotating object. As shown in the bottom panel of the figure, the cross-correlations show a double-peaked structure, as expected for a rotating disk, and this structure is repeatable between the 1997 and 1999 spectra. Moreover, the rotational velocity broadening in the near-infrared remains considerably smaller than that observed in the optical, consistent with the predictions of a differentially rotating disk.

These observations indicate the potential of continued optical and near-infrared monitoring at high spectral resolution for increasing our understanding of pre-main sequence disk accretion. It is likely that mass ejection is continuously variable, with occasional large eruptions, and multiwavelength monitoring could yield new insights into the physics of the outflows. Our detailed models suggest the need for sonic or even slightly supersonic turbulent broadening in the disk atmosphere, which may be a necessary by-product of the magnetorotational instability (Miller & Stone 2000). It is not clear whether the small velocity shift seen between the two epochs in the figure is significant, but it might be an indication of a companion object (Clarke & Armitage 2003). The FU Ori objects have not yet yielded all of their secrets.

Special Session on the NOAO Deep Wide-Field Survey at the June AAS Meeting

Arjun Dey (NOAO)

The NOAO Deep Wide-Field Survey (NDWFS; see cover image) was recently the focus of a well-attended Topical Session at the June 2004 AAS meeting in Denver. The survey (PIs Arjun Dey and Buell Jannuzi) consists of two 9 square degree fields, one in Boötes and one in Cetus, which have been mapped to approximately $0.1\ \mu\text{Jy}$ depth at optical wavelengths and approximately $10\ \mu\text{Jy}$ depth in the near-infrared. The two survey fields provide the unprecedented ability to investigate the clustering and evolution of galaxies over large scales

and over a wide range in redshift. As a result of this large ground-based campaign, successfully mounted by NOAO staff members, the Boötes field of the NDWFS is now being studied by a large number of observing programs, spanning X-ray to radio wavelengths and using facilities in space and on the ground.

As vivified by the session talks (archived at www.noao.edu/noao/noaodeep/AAS2004/), the Boötes field is fast becoming one of the best-studied regions of the sky: it has

now been mapped in its entirety at X-ray wavelengths by Chandra (AAS presentation by Steve Murray, CfA), at UV wavelengths by GALEX (presentation by Charles Hoopes, Johns Hopkins University), at 3.6, 4.5, 5.8, 8, 24, 70, and $160\ \mu\text{m}$ by Spitzer (presentations by Tom Soifer, Caltech; and Peter Eisenhardt, JPL; see following article), and at radio wavelengths by the VLA at 20 and 90 cm and Westerbork at 20 cm (presentations by Jim Higdun, Cornell University; and Steve Croft, LLNL).

continued



NOAO Deep Wide-Field Survey at AAS continued

Additional surveys carried out with NOAO facilities have targeted smaller regions within the Boötes field. One of the NOAO Survey programs, the FLAMINGOS Extragalactic Survey (FLAMEX; presentation by Anthony Gonzalez, University of Florida), which was completed this spring, has carried out deep J K_s imaging over a ~ 5 square degree region. Narrowband imaging of a portion of the Boötes field has been carried out by the Large Area Lyman Alpha (LALA) survey for line-emitting galaxies at $z=4.5$, 5.7, and 6.5 (presentation by James Rhoads, STScI).

At the AAS session, Steve Murray (CfA) also presented early results from the AGES survey (PIs Chris Kochanek, Ohio State University; and Daniel Eisenstein, University of Arizona) which is obtaining MMT/Hectospec spectra for a complete, magnitude-limited sample of galaxies and AGN in the Boötes. The wide coverage and depth of all of these multiwavelength surveys render themselves invaluable to detailed studies of galaxy and AGN evolution. The NDWFS is also becoming a focus of future space missions: Daniel Stern (JPL) described plans for a future hard-X-ray survey of the field by the MIDEX satellite NuSTAR. The depths of all of these current and future surveys are summarized in figure 1.

The presentations at the session focused on a wide range of topics related to galaxy evolution, ranging from studies of AGN evolution at $z < 1$ (Kate Brand, NOAO) to searches for clusters at $z > 1$ (Peter Eisenhardt, JPL; and Anthony Gonzalez, University of Florida; see figure 2); from extended X-ray emission from nearby star-forming galaxies (Casey Watson, Ohio State University) to Ly α emission from star-forming galaxies at $z \sim 6$ (James Rhoads, STScI;

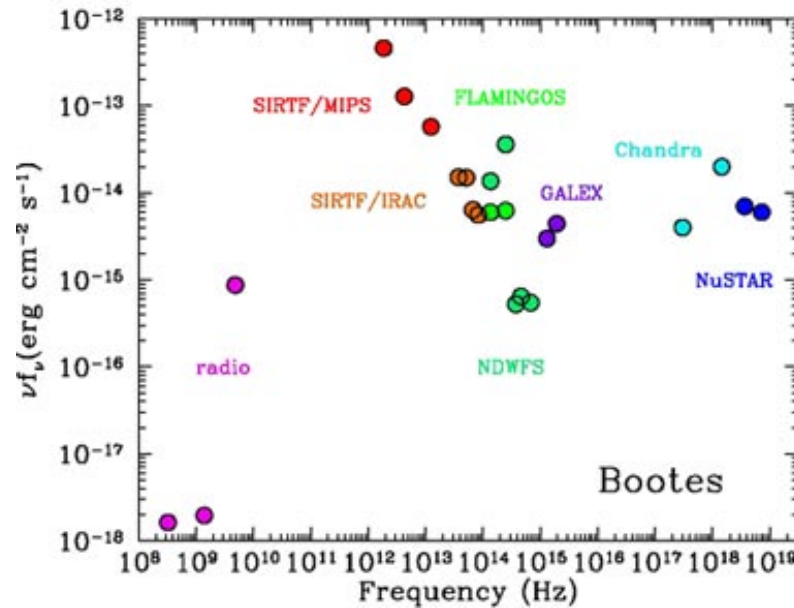


Figure 1: Depths of current and future studies of the Boötes field as a function of wavelength (figure courtesy of Daniel Stern, JPL).

see the June 2004 *Newsletter*); and from optically invisible radio sources (Jim Higdon, Cornell University; and Steve Croft, LLNL) to optically invisible 24- μ m sources (Tom Soifer, Caltech).

Steve Dawson (University of California at Berkeley) presented results from the LALA survey for the redshift range $z \sim 4.5$. This survey has yielded the largest sample (~ 80) of narrow-lined emitters thus far at this redshift. About a quarter of the sample shows large Ly α equivalent widths, suggesting that these galaxies are young, star-forming systems. However, the stacked spectra show no evidence for HeII, suggesting that the gas in these galaxies is unlikely to be primordial. The lack of detectable CIV or X-ray emission from this population suggests that the AGN fraction in these galaxies is small (Junxian Wang, Hefei, China).

Michael Brown (NOAO & Princeton) presented studies of the spatial clustering of the red galaxy population (see the March 2003 *Newsletter*) and extremely red objects. Richard Green (NOAO) presented recent results on a survey of K -band selected QSOs.

The diversity and number of presentations at the meeting illustrated the growing community interest and involvement in the NDWFS. We invite our readers to browse the meeting presentations at www.noao.edu/noao/noaodeep/AAS2004/.

One square degree of the ground-based optical survey data are currently available through the NOAO Science Archive (archive.noao.edu/nsa/). All of the NDWFS optical and near-IR data in the Boötes field will be available through this archive on 22 October 2004.

continued



NOAO Deep Wide-Field Survey at AAS continued

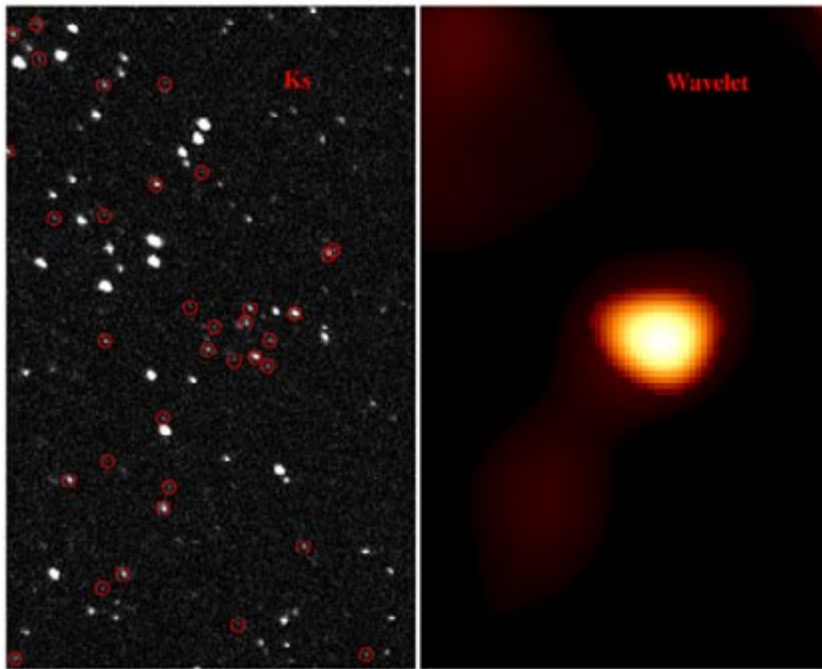


Figure 2: The first spectroscopically confirmed galaxy cluster from the FLAMINGOS Extragalactic Survey, an NOAO Survey Program that uses FLAMINGOS on the KPNO 2.1-m. The left and center panels show the K_s - and J-band imaging with red circles overlaid to mark objects with $J-K_s > 1.75$. As a preliminary means of identifying clusters, galaxies redder than this threshold (which should lie at $z > \sim 1$) are used as input for a wavelet analysis that identifies structures on scales of ~ 30 – 100 arcsec (right panel). The galaxy cluster shown is spectroscopically confirmed with Keck to lie at $z = 1.05$ (figure courtesy of Anthony Gonzalez and Richard Elston, University of Florida, and the FLAMINGOS Extragalactic Survey team).

Surveying the NOAO Deep Wide-Field Survey with IRAC

Peter Eisenhardt, Daniel Stern & Mark Brodwin (Jet Propulsion Laboratory)

The millionfold lower background seen at infrared (IR) wavelengths in space means that even brief exposures with a modest aperture telescope like the Spitzer Space Telescope probe vastly larger volumes than are possible from the ground. For objects distributed uniformly in Euclidean space, the number of sources detected is maximized by observing a given field only long enough to become background limited, and to reduce repositioning overheads to one-third of the observing time. Such considerations motivated a survey with the Spitzer Infrared Array Camera (IRAC) of the Boötes region of the NOAO Deep Wide-Field Survey

(NDWFS; see previous article). Much as the Hubble and Chandra Deep Fields have become the fields of choice for ultradeep pencil-beam surveys across the electromagnetic spectrum, Boötes has become the wide-area, deep survey field of choice. The resulting IRAC shallow survey (Eisenhardt et al.) covers 8.5 square degrees of the Boötes field with 90-second exposures per position. The survey detects approximately 370,000, 280,000, 38,000, and 34,000 sources brighter than the 5σ limits of 6.4, 8.8, 51, and 50 μJy at 3.6, 4.5, 5.8, and 8 μm respectively.

A major scientific driver for the IRAC shallow survey is the detection of galaxy

clusters at $z > 1$ via the redshifted 1.6- μm peak in galaxy spectral energy distributions. Extending the evolution observed in the K-band in clusters to $z \sim 1$, we expect to detect cluster galaxies fainter than L' at $z = 2$ at 3.6 and 4.5 μm . The survey should also be an extremely powerful tool for studying the evolution of large-scale structure out to $z \sim 2$. Additionally, the shallow survey team plans to address many other astrophysical objectives using these data sets, ranging from identifications and size estimates for high ecliptic latitude asteroids from 8 μm thermal emission, to identification of T-type and cooler field brown dwarfs based on methane



Surveying the NOAO Deep Wide-Field Survey with IRAC continued

absorption that produces extremely red 3.6 to 4.5 μm colors, to studying and identifying obscured AGN across cosmic history, to foreground subtraction for the detection of fluctuations in the 1 to 3 μm cosmic background due to Ly α emission from Population-III objects at $z \sim 15$ (e.g., Cooray et al. 2004).

Finally, the IRAC shallow survey, by virtue of pushing several orders of magnitude into area-depth discovery space, is expected to identify new, rare objects. As an example, we have thus far identified a handful of sources with extreme optical-to-mid-IR colors in a 1.2 square degree region of the NDWFS (see figures 1 and 2). The 8 μm to 0.8 μm flux ratio of the objects is >500 , which corresponds to a spectral index of >2.7 . These unusual optical-to-mid-IR colors could be caused by moderate-redshift, extremely-dusty starbursts where PAH emission augments the mid-IR emission. Extremely dusty, moderate-redshift AGN could also produce such extreme colors. Finally, an intriguing, but less likely possibility is a population of quasars at $z > 6$ for which the Ly α forest suppresses light below 1 μm . Comparison of template spectral energy distributions with the observed colors show that none of these scenarios are completely satisfying; follow-up observations with Spitzer's Infrared Spectrograph are likely to reveal which of these possibilities is correct, or whether these objects represent a new phenomenon. Given the large volume probed by the IRAC shallow survey, many more objects with unusual colors may await discovery.

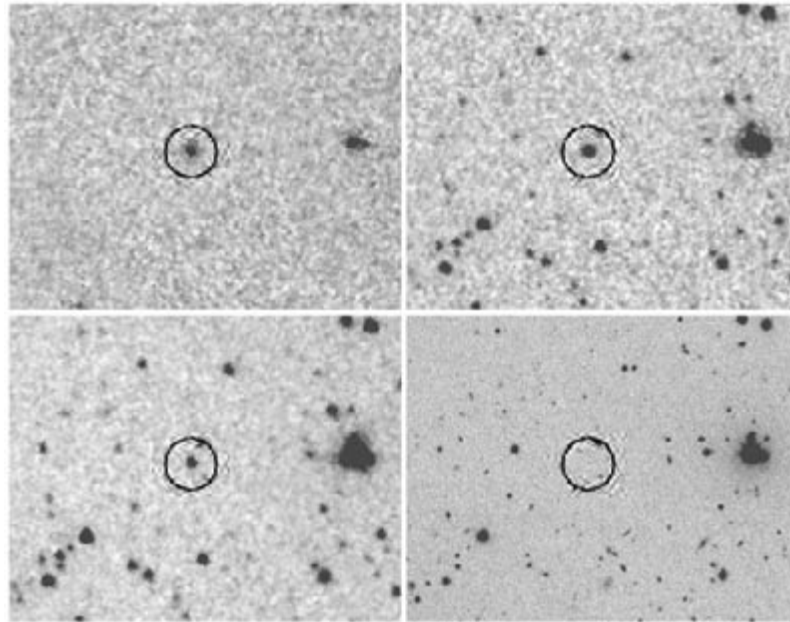


Figure 1. One of the extreme 8 μm to I flux ratio objects detected in the IRAC shallow survey, IRAC J142939.1+353557. Images are approximately 1.5 arcmin on a side. Clockwise from top left, images are through 8 μm , 4.5 μm , I-band, and 3.6 μm filters. This source is bright in the mid-infrared, with an 8 μm flux >0.2 mJy. At optical wavelengths, the source has $I_{AB} > 24.5$, making followup ground-based spectroscopy challenging, if not impossible.

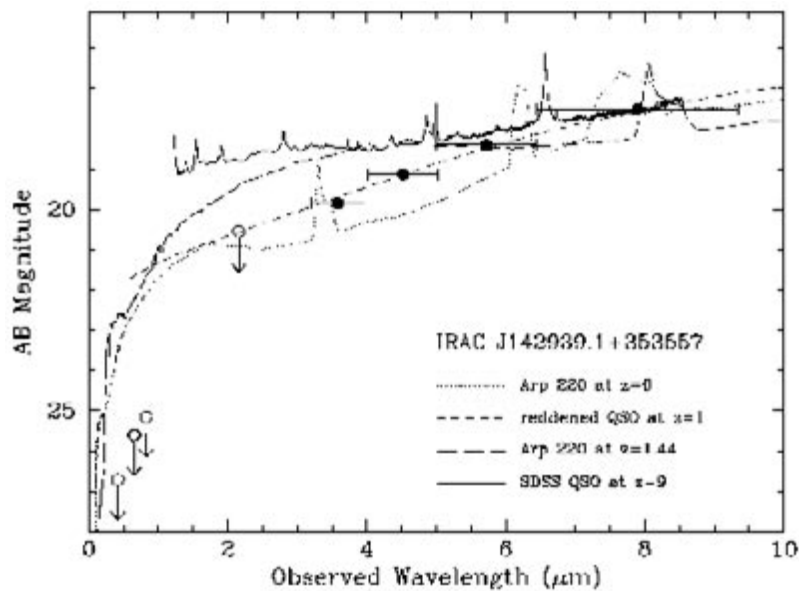


Figure 2. Spectral energy distribution of IRAC J142939.1+353557 compared with several models that have been proposed to explain the unusual colors.



Observational Evidence for Magnetic Flux Submergence

Alexei A. Pevtsov (NSO)

It is widely believed that the magnetic field on the Sun is generated by a dynamo operating at the base of the convection zone, although recent studies suggest that there may be a second dynamo operating at or near the visible solar surface, the photosphere. In 1984, Eugene Parker concluded that only a small fraction of magnetic flux threading the solar surface can escape. He also pointed out an inconsistency between the upper limit of magnetic flux stored at the base of the convection zone and the rate of flux emergence in a long-lived complex of activity. To resolve this “dynamo dilemma,” Parker suggested that magnetic flux retracts below the surface and is recycled several times. So far, however, this flux submergence has proven to be illusive.

Magnetic flux concentrations in the photosphere often disappear via flux cancellation when opposite poles collide with each other and vanish. Figure 1 (upper panel) shows the expected topology of the magnetic field at a flux cancellation site. Two independent magnetic elements with opposite polarity approach each other and reconnect. The reconnection forms two loop-like structures: concave-up and concave-down. The magnetic tension would try to “shorten” newly formed “loops,” and thus, at the place of maximum curvature (apex/valley), one loop would show rising motions, and the other would show descending motions. The observer would see only one loop crossing the photosphere whenever the reconnection took place below or above the photosphere.

Using high-resolution vector magnetograms of active region NOAA 10043, observed on 26 July 2002 with the Advanced Stokes Polarimeter and low-order adaptive optics system at the Dunn Solar Telescope at Sacramento Peak, we studied the magnetic field topology and line-of-sight velocities at two flux cancellation sites. Figure 1 (lower panel) shows the magnetic field (B) and line-of-sight velocities (V) associated with one canceling feature. Near the cancellation site, the longitudinal magnetic field (B_{\parallel}) vanishes (grayscale), but the transverse field (B_{\perp}) reaches its maximum (white areas). This implies that the magnetic field is mostly horizontal there, in agreement with Figure 1b and c scenarios. However, the velocity map (V from I) shows significant downflows (white half-tone areas) where the magnetic field is horizontal, suggesting that the magnetic field is moving downward. Figure 2 shows Stokes profiles at the flux cancellation site that support our description of plasma motions and the magnetic field topology. These rare observations provide the first observational evidence for the submergence of magnetic flux on the Sun.

This work was done in collaboration with Jongchul Chae (Seoul National University and Big Bear Solar Observatory), and Yong-Jae Moon (Korea Astronomy Observatory and Big Bear Solar Observatory).

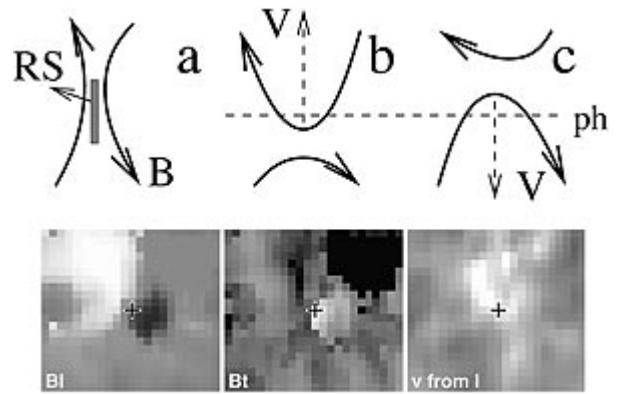


Figure 1. Upper panel: Schematic representation of the magnetic topology at a flux cancellation (reconnection) site (RS) prior to reconnection (a) and after reconnection below (b) and above (c) the photosphere (ph, horizontal dashed line). Solid lines with arrows represent the magnetic field B , and vertical dashed arrows show the direction of motion of newly formed loops. Lower panel: Observations of a flux cancellation site; longitudinal field B_{\parallel} (white/black corresponds to positive/negative polarity), transverse field B_{\perp} , and Doppler velocity V (white half-tone corresponds to downward motions). The flux cancellation site is marked by a “+”.

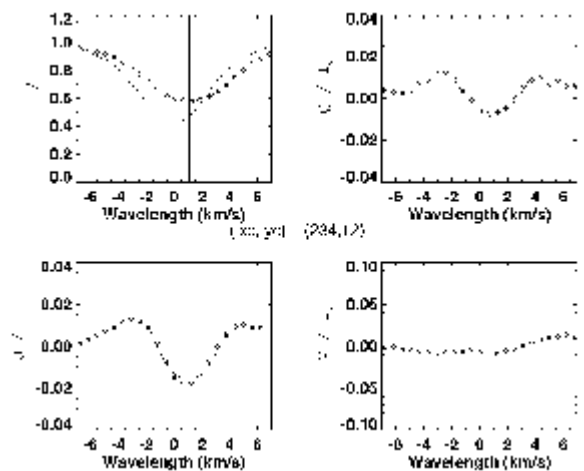


Figure 2. Stokes profiles at the flux cancellation site shown in figure 1. The wavelengths for all profiles are expressed in units of velocity relative to the nearby quiet Sun. Negative velocity corresponds to blueshift, or upward (with respect to image plane) motions. The dotted curve in the top left panel shows the Stokes I profile from the quiet Sun area. The vertical solid line represents the center of the Stokes profile.

DIRECTOR'S OFFICE

NATIONAL OPTICAL ASTRONOMY OBSERVATORY

Building the System from the Ground Up— The Second Community Workshop on the O/IR System

Todd Boroson

The first Workshop on the Ground-Based O/IR System was held in October 2000, following the release of the McKee-Taylor decadal survey by the Astronomy and Astrophysics Survey Committee (AASC). This AASC report argued for a new paradigm for establishing strategic priorities in ground-based optical/infrared (O/IR) astronomy, one that would take an inclusive perspective, creating a virtual “system” from the combination of public and private facilities. Integral to this new approach was a community-based forum to explore the concept of the system, develop priorities in the context of science goals, identify needed capabilities, and create mechanisms by which they might be developed. The first workshop report detailing these goals can be found at www.noao.edu/gateway/oir_workshop.

Since that first workshop, a number of new programs, based on recommendations from the AASC report, have enhanced the viability and the visibility of the system perspective for ground-based O/IR facilities. Initial work has begun on the two large joint-public/private telescope projects, the Giant Segmented Mirror Telescope (GSMT) and the Large Synoptic Survey Telescope (LSST). The Telescope System Instrumentation Program (TSIP), seen from the outset as a driving force that would provide incentive to participate in the system, has gone through three successful annual cycles. The Adaptive Optics Development Program (AODP), a TSIP-like grants program also advocated by the AASC report, has completed its first year. And the National Science Foundation (NSF) has recently announced PREST, a program similar to TSIP but for smaller telescopes, which, based on the large number of initial inquiries, will be extremely popular.

The motivation for a second system workshop, “Building the System from the Ground Up,” came partly from these programs, which require continuing guidance in the form of updated priorities, and partly from a desire to extend the system idea in new directions. The workshop was held in Alexandria, Virginia, on 13–14 May 2004. The workshop was attended by 63 people from 38 different institutions, including staff from the NSF astronomy division and AURA.

Workshop recommendations include the following:

- TSIP has succeeded very well in developing a system perspective around the large telescopes, and now PREST is poised to invigorate the small telescopes. TSIP rules should continue to evolve to ensure the best benefit to all users and providers within the system.
 - Specifically, eligibility as an “instrumentation proposal” should be extended to any instrument or facility improvement that results in an added or improved scientific capability or in improved efficiency.
 - Also, the category of proposal known as “improvement” should be simplified to provide a path for an observatory to sell telescope time.
- The inclusion of medium-sized (2.5- to 5-meter) telescopes in the system is essential. The TSIP program rules should be modified to be more attractive to these facilities, and institutions with telescopes of this size should be given assistance to arrange consortia and time swaps.
- Data reduction pipelines, data archives, and good community data access and support are becoming increasingly important to the system at all levels (and for all telescope sizes).
 - Data reduction pipelines and archives should be considered desirable elements of TSIP proposals—either for new or existing instruments.
 - Data and archive centers must be established to ingest, distribute, and enhance the scientific value of ground-based O/IR data. These centers will ensure compliance with VO standards and protocols.
- NOAO (by broad consensus) should become involved in providing services in developing data reduction pipelines, stewardship of public archived data, facilitating instrumentation collaborations, and enabling institutions to form telescope operating consortia.

A full report of the workshop and the recommendations of the organizing committee can be found at www.noao.edu/meetings/system2.



The NOAO Data Products Program

Todd Boroson

NOAO has recently established a new program aimed at helping the community take advantage of opportunities to use public, archived data to do forefront research. New survey databases (such as SDSS and 2MASS), new tools (such as Mirage and SkyServer), and the newly developed ability to interact with multiple archives, pioneered by the National Virtual Observatory (NVO) project, together have made possible new kinds of investigations. Ground-based optical/infrared (O/IR) facilities have lagged behind the space-based facilities and radio observatories in archiving data, but NOAO's Data Products Program (DPP) is trying to make up some of this ground in time to fully participate in the next generation of large survey programs, like the Large Synoptic Survey Telescope (LSST), which ultimately will dominate astronomical data archives.

The DPP is an outgrowth of the Image Reduction and Analysis Facility (IRAF) group, which now includes 12 software developers and eight scientists, divided between Tucson and La Serena. While this group continues to support IRAF, and to build new data reduction tools for new instruments, including those at Gemini (see the March 2004 *Newsletter*), its principal focus is now on archives, automatic data reduction pipelines, new tools for "VO" research, and infrastructure to enable the flow of data from NOAO facilities.

The NOAO Science Archive was launched in April 2002 as a repository for the data sets that were produced by the projects that make up the NOAO Survey Program. The next release, due in late 2005, will see a dramatic shift in emphasis to serving data from all NOAO telescopes. This will initially be raw data, available to everyone after the 18-month proprietary period—or less, if proposers choose that option—but with links to all necessary metadata and

calibration information. This new arrangement will also replace Save-the-Bits, the tape-based backup system that allows observers to recover lost data. Future developments will include a "virtual workspace," where archive users can process or analyze data without downloading it, and tools to work on catalogs, images, time series, and spectra in an integrated manner.

The most obvious evolution for expertise in data reduction algorithms is to incorporate them into automatic data reduction pipelines. Instruments are becoming more complex and focal plane formats are becoming larger. New instruments, such as the wide-field IR imager NEWFIRM, will come with data reduction pipelines as integral parts of their data flow, but even the first generation CCD mosaic imagers will benefit from the development of pipelines. Thus, the pipeline group within DPP is working on these two projects, with the intent of providing pipeline-reduced data to observers and the public through the archive.

Other parts of DPP are engaged in other pieces of this system, including the management of data transport, archive and pipeline operations, and support for the LSST and NVO projects. If all of these activities suggest that this group is spread pretty thin, it is important to note that a critical factor in our approach is to develop partnerships that will help us to accomplish more. One of these is with the National Center for Supercomputing Applications (NCSA) in Illinois, with whom we are working to develop a method for providing interface and support services to a remote data repository. It is an exciting time in this field, and we look forward to being an integral part of the development effort that will allow new kinds of astronomical research.

Guest Column

Politics and Science in a Complex World

If the last 12 months presage the future, we can certainly expect interesting times ahead. When President George W. Bush first announced his new vision for NASA last winter, most professional astronomers held their breath. NASA's resources are limited, and the relatively small proportion that funds astronomy research could easily be lost in a major redirection of the agency. The President

directed NASA to shift its focus from a human presence in low-Earth orbit to the exploration of the Moon, Mars, and beyond, using both crewed and robotic spacecraft. Shortly thereafter, NASA Administrator Sean O'Keefe announced his decision to terminate Hubble Space Telescope (HST) Servicing Mission 4 (SM4).

continued



Politics and Science in a Complex World continued

These two announcements, occurring so close in time, left the astronomical community in shock. The last decade has been, without doubt, a "golden age" for astronomy. The discoveries and new paradigms from the past 10 years are well known to all of us, and the coming decades are ripe with promise for fundamental new discoveries. The President's and Administrator's decisions, motivated not from scientific priorities but from other rationales, could have a profound impact on the progress of science.

We began to breathe again when Administrator O'Keefe made it clear that science would continue to play a major role in NASA's future. In his thoughtful and personal remarks at the June AAS meeting in Denver, Mr. O'Keefe made several important points. He assured us that NASA would continue to conduct world-class astronomy from space, with multiple, enormously capable instruments, on a sustained basis. He assured us he would do his best to keep the HST among those capabilities. Finally he assured us that NASA's space astronomy activities beyond the solar system are integral to the President's vision of exploration. The full text of Mr. O'Keefe's remarks is available at www.nasa.gov/audience/formedia/speeches/ok_astronomical_060104.html.

Mr. O'Keefe reviewed his reasons for terminating SM4, including both the need for diligence about mission safety, and the dangerous schedule pressure that could arise from the need to fly SM4 before HST ceases to function, but before safety requirements could be met.

Instead, he asked us to consider the possibility of telerobotic servicing of HST, and described to us the progress in recent months as NASA engineers, with industry and academia, have evaluated the feasibility of robotic servicing. The results are so promising that Mr. O'Keefe announced the release of a call for proposals for a robotic servicing capability, with a mission before the end of 2007. He also stressed the central benefit of the development of robotic technology, in combination with a human presence in space, to open the way for the assembly and servicing of future large space instruments.

Just a couple of weeks earlier, I had visited NASA's Goddard Space Flight Center and taken the opportunity to view firsthand the progress being made toward robotic servicing of HST. I came away with great enthusiasm for this approach, both because I was convinced that teleoperated robots could indeed install new instruments as well as new batteries and gyroscopes, and because of the creativity and dedication to success I found in the engineering team.

The events of early 2004, as dramatic as they were, are part of a much broader process that shapes the priorities and progress of astronomy. Among the scientific disciplines, astronomy

is unusual in undertaking each decade a broad review of the state of the field, an evaluation of opportunities for the future, and a determination of priorities for new directions and initiatives. The familiar process of the decadal survey has led us to think we operate in an orderly world where scientific priorities are set based on science goals determined by a consensus of scientists, operating only under the constraints of funding. But the world we live in is not so simple, and we must learn to participate in a more complex process that incorporates the broader goals and needs of our society, our nation, and our world. We must actively engage in a wider debate about the value of astronomical exploration and discovery.

All of us have a role to play in sustaining the high priority of research in astronomy and astrophysics at the national level. It is a fine line we must walk, between asking Congress to take sides in our own debates on the priorities of astronomy missions, projects, and research, and making sure a bigger message about why the priorities we set through our community processes are important to the nation is delivered successfully. While it seems a simple task, writing our Members of Congress about the importance of what we do is a powerful tool, and one we need to use more effectively.

Catherine A. Pilachowski
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(Cathy Pilachowski holds the Kirkwood Chair in Astronomy at Indiana University in Bloomington, and she is the past president of the American Astronomical Society (AAS). Previously, she served as a member of the NOAO scientific staff for more than 20 years.)



Director's Office



Mark Dickinson
Associate Astronomer

One of the newest members of the NOAO scientific staff, Mark Dickinson is the principal investigator for the Great Observatories Origins Deep Survey (GOODS) Spitzer Legacy Science Program, a major multiwavelength, multi-observatory survey of the Hubble Deep Field-North and the Chandra Deep Field-South fields using the Hubble Space Telescope, Spitzer Space Telescope and both NOAO 4-meter telescopes, among others.

Dickinson earned his undergraduate degree at Princeton University, working with Richard Gott, and his doctorate from the University of California at Berkeley, working with Hiram Spinrad on the clustering evolution of radio galaxies. He then went to the Space Telescope Science Institute (STScI) as an AURA fellow, and returned there after a subsequent fellowship at Johns Hopkins University.

Dickinson, 41, and his spouse, Letizia Stanghellini, moved from STScI to join the NOAO scientific staff in April 2004.



Q: Why did you decide to come to NOAO?

NOAO is a place that I've known and loved for my whole astronomical career. I've been observing here since I was a young graduate student, and I've been a regular visitor and user of NOAO observing time. I've also had many friends and collaborators here on the scientific staff. It is one of the institutions that I feel I

know best in astronomy, and that I feel most comfortable with. It was a very natural decision and an excellent match with the research that I do.

Q: How would you describe the current view of NOAO in the general astronomical community?

I would say that when I started looking recently at new opportunities, I had every impression of NOAO as an organization and an observatory on the upswing, with a growing science staff, several exciting projects on the horizon, and a lot of current activity in research that appealed to me.

Q. What are the roots of the GOODS Survey? How did such a large, multi-observatory project get approved?

GOODS has its roots in the Hubble Deep Field (HDF). I was very fortunate to arrive at STScI just after the first Hubble servicing mission. In that first year, I did the deepest observation with Hubble to date, looking at a galaxy cluster (3C-324) that I had discovered at Kitt Peak. This got people

excited about a very deep field program, which was initiated by then-STScI director Bob Williams.

The great things about the HDF were that it was a public data set, and it became a magnet for other work in the same observing field—nearly everybody with a telescope trained their facilities on it, and most of that data was then made public. It really showed us the potential of combining multiwavelength observations and spectroscopy on a common area to understand galaxy evolution and much more.

But the HDF had its limitations—it was a very small field, in only one hemisphere, and it had some wavelength gaps, particularly in the near- and far-infrared.

GOODS was planned to be multiwavelength in two fields (the HDF-North and the Chandra Deep Field-South) from the very beginning, with the wavelength gap filled by the new capabilities of Spitzer. The opportunity arose from the Spitzer Science Center's decision to have data from the first year of Spitzer operations go to Legacy projects, and we proposed successfully.

There are many scientific motivations, but the ones that drive me are the formation and mass assembly history of galaxies through most of cosmic time. GOODS is uniquely powerful for redshifts from one to six.

Q. What is the status of GOODS?

Because of the Spitzer launch delay, we completed all of the Hubble observations first, and those data are fully released to the community. We are now exactly in the middle of the Spitzer observations—they started in February 2004 and run through November.

continued



Q&A continued

We issued some initial results at the June AAS meeting in Denver, and are working on more. We are also building up ground-based observations in the near-infrared, and conducting a large campaign of spectroscopy with the Very Large Telescope (VLT).

The quality of the Spitzer data is totally remarkable. By and large, the IRAC instrument observations have exceeded our expectations—it is amazing how deep and how fast you can go with an 85-centimeter infrared telescope in space, it is really staggering.

We are seeing mid-infrared light from ordinary galaxies out to a redshift of six, and we think we are seeing a substantial population of evolved galaxies out to a redshift of three that we don't see even in the Hubble Ultra-Deep Field. We may even have some examples of extremely high redshift objects, which we need to confirm.

The first public release of Spitzer GOODS data will be later this year, in time for the Spitzer General Observer Cycle 2 call for proposals.

Q. What have you learned about organizing and leading big observing projects?

For better or worse, the boundaries of GOODS are not that well-defined. The original proposal had 41 coinvestigators, which is already huge. It has now become more of an anthology than a tightly defined program. The people involved have not always been the same, and they change over time, and that is just fine. These are data for the community, and people can do very different things with it. For example, a group at the Keck Observatory carried out a large redshift survey of the GOODS-North field, published on their own, and made their data public.

Because of the size and heterogeneous nature of GOODS, it would be very hard to rule with an "iron fist." I'm fortunate to have worked with people who work well together and have great enthusiasm. My role has been more coordination; it's really been quite spontaneous and productive. But I do think that I will swear off telecons for at least two years when GOODS is finished.

Q. What next? Could Gemini play a role in future observations?

The follow-up observations, such as targeted infrared spectroscopy, will continue for a while. Then there will be a period of time when the data is in the public domain, where we and others will explore them, perhaps at a more leisurely pace.

GNIRS and FLAMINGOS-2 on Gemini South will really open things up in the near-infrared. I expect that we will be proposing to use Gemini more. Several other groups have been awarded significant amounts of Gemini South observing time for GMOS follow-up in the GOODS-South field. Again, those efforts were essentially independent of the GOODS team.

There are lots of these large sky surveys going on, including many supported by NOAO, but there has not been much work done to synthesize what we have learned from all of them. I'm looking forward to some time to systematically explore them. This is one reason I was excited to come to NOAO, to collaborate with groups like the NOAO Deep Wide-Field Survey. That is really essential to build a complete picture, which should eventually represent a real maturation of what we can learn from observational cosmology.

Q. How do you find life in Tucson? Was it difficult for you and Letizia to find a single place to meet both of your professional and personal goals?

I've been coming to Tucson for more than 15 years, so it is a familiar place. We are living in town and are very happy with that. I can bike to work and walk to movie theaters and stores, but can go up on our deck to enjoy the visual spectacle of the sky, clouds, and mountains. I loved living in Baltimore, but the sky was not something you paid a lot of attention to! And I have been pleasantly surprised that the summer heat has not been as unbearable as expected. We haven't had any poisonous animals in our backyard...yet.

Letizia was part of the European Space Agency employment system at STScI, and we wanted to be part of one system. NOAO presented a great opportunity. It is large enough that we could both find positions where we can work productively on our science—she studies planetary nebulae—and contribute to the observatory in its role as a national facility.

My service duties will involve working for the NOAO Data Products Program on the pipeline for data from the NEWFIRM instrument, which is a natural fit with my experience and scientific interests.

We have both found NOAO to be a very welcoming place, and we are very glad to be here.

Gemini Observing Opportunities for Semester 2005A

Taft Armandroff

The NOAO Gemini Science Center (NGSC) invites and encourages the US community to submit proposals for Gemini observing opportunities during semester 2005A. Gemini observing proposals are submitted and evaluated via the standard NOAO proposal form and Time Allocation Committee (TAC) process. The following are our expectations of what will be offered in semester 2005A in the Gemini Call for Proposals, with a US proposal deadline of September 30. Please watch the NGSC Web page (www.noao.edu/usgp) for the Call for Proposals for Gemini observing; this will unambiguously establish the capabilities that one can request.

NGSC is pleased to report that a suite of scientifically vital instrumental capabilities will be offered in semester 2005A.

Gemini North

- The GMOS-North optical multi-object spectrograph and imager will be offered in 2005A. Multi-object spectroscopy and long-slit spectroscopy (both optionally with nod-and-shuffle mode), integral-field unit (IFU) spectroscopy, and imaging modes will be available.
- The NIRI infrared imager/spectrograph will be offered in 2005A. Both imaging mode and grism spectroscopy mode will be available.
- The Altair adaptive optics (AO) system will be offered in natural-guide-star mode in 2005A. The following capabilities of Altair are expected to be offered in 2005A: AO-enhanced infrared imaging and spectroscopy using NIRI.
- Michelle is a mid-infrared (8–25 micron) imager and spectrograph. Michelle is expected to be offered for imaging and for spectroscopy (resolutions of R=200 and R=3000, and possibly echelle spectroscopy at R=30,000 pending commissioning).
- Classical observing will only be offered to programs with a length of three nights or longer. All instruments and modes are available for classical observing, except for Michelle spectroscopy.

Gemini South

- The GMOS-South optical multi-object spectrograph and imager will be offered during semester 2005A. Multi-object spectroscopy, long-slit spectroscopy, IFU spectroscopy (all optionally with nod-and-shuffle mode), and imaging modes will be available.
- The T-ReCS mid-infrared imager and spectrograph will be available in semester 2005A. Both the imaging and spectroscopic modes of T-ReCS will be available in 2005A.

- The GNIRS facility infrared spectrograph will be offered in semester 2005A. Four GNIRS observing modes are expected to be available in 2005A: long-slit spectroscopy with resolutions R=2000 and R=6000; cross-dispersed spectroscopy at R=2000 (with continuous coverage from 1 to 2.5 microns) and R=6000 (noncontinuous coverage); higher-resolution mode with R=18,000; and IFU spectroscopy (pending commissioning report).
- The Phoenix infrared high-resolution spectrograph will be offered in semester 2005A. Phoenix will be offered only for classical observing with an integer-night run length (1, 2, 3...).
- The Acquisition Camera will be available for time-series photometry in 2005A.
- A new visitor instrument, Hokupa'a-85, may be available in semester 2005A. Hokupa'a-85 is an 85-element, curvature-sensing adaptive optics system. It was developed by the University of Hawaii, under the leadership of Mark Chun and Christ Ftaclas. Hokupa'a-85 would be offered for high-resolution infrared imaging, coupled to NOAO's ABU infrared imager. Please check the 2005A Call for Proposals.
- Classical observing will only be offered to programs with a length of three nights or longer, except for Phoenix as described above.

Detailed information on all of the above instrumental capabilities is available at www.us-gemini.noao.edu/sciops/instruments/instrumentIndex.html.

The percentage of time devoted to observations for science programs in semester 2005A is planned to be 70 percent at Gemini North and 75 percent at Gemini South. The primary use of the remainder of the time will be instrument commissioning (and system verification, if required) of NIFS and the Laser Guide Star System at Gemini North, and NICI and bHROS at Gemini South.

We remind the community that US Gemini proposals can be submitted jointly with collaborators in another Gemini partner. An observing team requests time from each relevant partner country. Such multipartner proposals are encouraged because they access a larger fraction of the available Gemini time, thus enabling larger programs that are likely to have substantial scientific impact. In order to facilitate multipartner proposals, the NGSC accepts Gemini proposals through both the standard NOAO proposal form and the Gemini Phase I Tool (PIT).



GNIRS Key Science Opportunity in Semester 2005A

Taft Armandroff, Jeremy Mould & Steve Strom

The Gemini Near-Infrared Spectrograph (GNIRS) has been commissioned in its primary modes and will be used for community science programs starting in semester 2004B. NOAO is eager to see the powerful capabilities of GNIRS exploited for major scientific initiatives.

As announced in the December 2003 and March 2004 issues of the *NOAO/NSO Newsletter*, NOAO is conducting a program to enable observations with high scientific potential that require significant blocks of time with GNIRS on Gemini South (15 to 20 nights over the next two to three years). Proposers must agree to make all Gemini data and ancillary information available publicly following a minimal proprietary period (less than six months). Please submit such proposals using the normal NOAO Time Allocation Committee (TAC) process, but indicate in the Abstract that your proposal is to be considered for the "GNIRS Key Science Opportunity." The TAC will evaluate the scientific merit of these proposals. In addition, because discretionary time from the NOAO Director will be used for this program, the Director will employ the following criteria in evaluating proposals:

- Intrinsic scientific merit as evaluated by the TAC
- Breadth and quality of the scientific team and its demonstrated track record
- Enhancement of undergraduate education through involvement in research
- Potential value of the archival database to other users
- Plans to manage data reduction and archiving, and deliver data products, in a timely fashion.

We recommend that you address the last three bullets explicitly in your proposal.

During the proposal review process for semester 2004B, NOAO selected the first program for GNIRS Key Science: "A *Near-Infrared Kinematic Survey of Nearby Galaxies: Black Holes, Bulges, and the Fundamental Plane*" by Karl Gebhardt (University of Texas) and colleagues. We wish this team every success in their pioneering work with GNIRS, and we look forward to other ambitious GNIRS Key Science submissions for semester 2005A.

Following the Aspen Process: A High-Resolution Near-Infrared Spectrograph

Ken Hinkle

As reported in the March 2004 *NOAO/NSO Newsletter*, the June 2003 Aspen workshop produced a report on the research ambitions of Gemini (www.us-gemini.noao.edu/project/announcements/press/aspen_report/aspen_report.pdf). A derivative of this report was a draft list of instrumental capabilities required to pursue those ambitions. Vetting by the Gemini Science Committee and the Gemini Board resulted in four announcements of opportunity for either design or feasibility studies.

One of the instruments for which Gemini has now contracted a design study is a high-resolution near-infrared spectrograph, HRNIRS. In May, Gemini funded two groups to produce concepts for HRNIRS. While Gemini cannot formally disclose the teams until contracts have been finalized, the size of the effort has required that both groups be partnerships between major instrument building teams. The process is competitive and Gemini will review the proposals in early 2005.

One group that is preparing a concept is a team made up of the University of Florida (UF) and NOAO, with Steve Eikenberry at UF as the overall principal investigator and Ken Hinkle at NOAO as the project scientist. Additional scientific staff with major commitments are Jian Ge at UF and Dick Joyce at NOAO. The engineering groups at both UF and NOAO are engaged. The NOAO-UF team brings considerable experience with Gemini instrumentation and high-resolution spectroscopy, gained from the construction and use of Phoenix, T-ReCS, and GNIRS at Gemini.

The basic instrument concept requested by Gemini features two modes, both of which operate over the 1–5 micron range. One mode is an R=70,000 spectrograph capable of observing either the entire J-H-K region or the entire L-M region in a single integration. The R=70,000 mode would be fed by the standard *f*/16 Gemini tip-tilt secondary. The

continued



Following the Aspen Process continued

second mode of the instrument is an R=30,000 spectrograph with multi-object input fed by the Gemini multiple conjugate adaptive optics system. With 15 to 30 multiple object probes, the spectrograph would cover at least about one third of either the J, H, or K band. In both modes, significant sensitivity improvements are expected over existing high-resolution infrared spectrographs.

The scientific case for HRNIRS extends from solar system to extragalactic topics. For instance, the capability to record comet spectra over a very broad wavelength interval will allow detailed analysis of numerous molecular species, including symmetric molecules and light organic molecules critical in the chemistry of the young solar nebula. Broad spectral coverage will allow the masses and luminosities of protoplanets to be estimated from a single observation with high spectral resolution, allowing line profile analysis to track angular momentum evolution. Many interesting objects, including massive stars that are highly reddened, for example, in the Galactic Center, can be studied only in the infrared. Large wavelength coverage will permit a single exposure to determine temperature, gravity, and abundances. Routine determination of CO/H₂/H₃⁺ ratios along a line of sight

in the interstellar medium will be possible with a single exposure. Spectroscopy of sets of individual giant stars in the Local Group galaxies, including cluster giants, will be possible in a single exposure, allowing CNO group and metal abundances to be determined quickly for a large number of targets.

A keystone of the Gemini scientific case for several of the planned instruments is the detection of extrasolar planets. Spectroscopy of a broad range of cool dwarfs will be possible with HRNIRS. The design of the spectrograph is intended to facilitate radial velocity precision to a few meters per second. This will allow the detection of low-mass planets around low-mass stars using the Doppler shift technique.

The NOAO-UF team welcomes input from the potential users. A small scientific team has been formed to evaluate key science issues. Ultimately, a very strong and broad scientific case must be made as a basis for funding this promising instrument. Interested and motivated spectroscopists are encouraged to contact Steve Eikenberry at eikenberry@astro.ufl.edu.

Gemini/IRAF Project Update

Mike Fitzpatrick for the Gemini/IRAF Team

NOAO and the Gemini Observatory are engaged in a collaborative project with the twin goals of improving and enhancing both the GEMINI reduction software and the underlying IRAF system it uses.

The Gemini/IRAF Project Team celebrated the first anniversary of the collaboration with a June meeting in Hilo to begin planning the second year and to review progress. The already busy agenda for the week was complemented by presentations to the Gemini scientific staff giving an overview and status of the project goals, discussion of GNIRS package development led by Andrew Cooke, and a tutorial on best-practices for CL scripting by Rob Seaman, which was received with great interest. The trip also included a visit to the Mauna Kea summit to see GMOS queue observing in action, providing the visiting programmers with a better understanding of how the GEMINI package is integrated in the observing environment and initiating several new ideas for enhancements to existing products.

One outcome of the Hilo meeting is that the Gemini/IRAF Team is holding biweekly videoconferences between the Hilo/Tucson/Chile sites that include both software experts and instrument scientists. The coordination of work being done at the three sites produced some recent accomplishments, which are outlined below.

An IRAF V2.12.2a patch release was made public in mid-July ahead of the recent GEMINI V1.7 release. V2.12.2a contained a number of system bug fixes needed for the newly released GNIRS package, as well as several new tasks that came out of discussions in Hilo. These include changes to the LONGSLIT package to support bad pixel masks and a new LSCOMBINE task for combining longslit images. Additionally, there is a new ODCOMBINE task in the ONEDSPEC package for combining spectra with masks and supporting features previously only found in IMCOMBINE. The AUTOIDENTIFY task changes made earlier this year have greatly improved the automatic

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Gemini/IRAF Project Update continued

wavelength calibration processing of data; however, fine tuning of the algorithms and instrument parameter defaults continues.

The V1.7 release of the GEMINI package should be available in early September, and is the third major release of the package under this collaboration. Highlights of V1.7 include:

- First release of the GNIRS reduction package
 - Supports NIRI as well as GNIRS data
 - Handles long-slit, cross-dispersed and (preliminary support for) IFU data
 - Includes steps toward support of T-ReCS/ Michelle spectra with same package
- Initial round of task modifications to use a new, generalized task logging facility
- Release of new GEMARITH/GEMEXPR tasks for doing arithmetic on MEF image extensions automatically

Additionally, several tasks that had previously lived in other external packages have been incorporated under GEMTOOLS to provide needed features and simplify the dependencies for installing the package. Future versions of the package will see the addition of more new tasks as well as another round of task changes to implement scripting improvements and new reduction capabilities.

New releases of software will be announced on the Gemini and IRAF homepages as they become available. For more information and progress reports, see iraf.noao.edu and www.gemini.edu/sciops/data/dataSoftwareReleases.html.



The Gemini/IRAF team in front of the Gemini North dome at Mauna Kea. From left to right: Andrew Cooke, Frank Valdes, Kathleen Labrie, Craig Allen, Nelson Zarate, Inger Jørgensen, Mike Fitzpatrick, and Rob Seaman.

Gemini Science 2004 Meeting

Taft Armandroff

The first conference on Gemini science results, “Gemini Science 2004,” took place on May 23–25 in Vancouver. This conference highlighted the first four years of Gemini science. Gemini Observatory and the National Gemini Offices, including the NOAO Gemini Science Center (NGSC), organized the conference. A total of 128 participants from the Gemini partner countries and Gemini Observatory attended.

Thirty-nine US community members registered for Gemini Science 2004. There were 26 US oral presentations and four US poster presentations. In addition, NGSC displayed posters on “GNIRS Update” and “How to Apply for US Time on Gemini.”

The following are representative examples of the results presented at Gemini Science 2004:

- Karl Glazebrook and Sandra Savaglio (Johns Hopkins University) presented results from the Gemini Deep-Deep Survey (GDDS), an infrared-selected ultra-deep spectroscopic program to investigate galaxies in the redshift interval $1 < z < 2$. This interval, known as the “redshift desert” for lack of previous discoveries, is particularly interesting because it is when the Universe experienced its peak star formation activity. Using GMOS at the Gemini North telescope, with its nod-and-shuffle mode, the

continued



Gemini Science 2004 Meeting continued

GDDS Team detected 150 galaxies at $0.8 < z < 2$ and derived properties, including metallicities, ages, morphologies, and masses. Glazebrook described GDDS finding a great abundance of massive, old galaxies at z significantly above 1. In contrast to the paradigm of standard hierarchical formation models, a large fraction of the stellar mass in large galaxies was assembled at high redshifts rather than recently.

- Chad Trujillo (Gemini Observatory) discussed the discovery of the minor planet Sedna (officially called 2003 VB12), the most distant object ever seen in our solar system. Pre-discovery images allowed refinement of the orbit sufficiently to conclude that Sedna has a highly eccentric orbit, permanently residing well beyond the Kuiper belt with a semimajor axis of 509 astronomical units. Such an orbit is unexpected in our current understanding of the solar system. Sedna is one of the reddest objects in the solar system, almost as red as Mars. Spectroscopy of Sedna with NIRI at Gemini North revealed that Sedna's surface composition is very different from that of both Pluto and Charon.
- Chris Smith (NOAO), Chris Pritchett (University of Victoria), and Isobel Hook (Oxford University) each discussed the use of Gemini for supernova cosmology. Two major observational programs seek to constrain the characteristics of the dark energy that is driving the accelerated expansion of the Universe. Gemini GMOS spectroscopy is used to determine the redshifts and types of the supernova candidates. The nod-and-shuffle capability of GMOS on Gemini, combined with queue scheduling, makes Gemini critical to the success of these two groups, which also have access to Keck and ESO's Very Large Telescope. In fact, both groups use Gemini for their most challenging targets.
- Charlie Telesco (University of Florida) presented observations from T-ReCS at Gemini South of the circumstellar

environments of pre-main-sequence and younger main-sequence stars. He showed extensive new multiband mid-infrared images of the Beta Pictoris circumstellar disk and discussed marked trends in the disk structure with wavelength. Based on modeling, Telesco hypothesized that the orbits of protoplanets cause the observed structure in the disk.

- Karl Gebhardt (University of Texas) spoke about using Gemini to study central black holes in the most massive galaxies to constrain the high-mass end of the black hole correlations. However, such black holes are difficult to detect due to the low surface brightness of their galaxy hosts. The Gemini GMOS Integral Field Unit (IFU) is the ideal instrument to measure the central kinematics. Gebhardt et al. targeted eight cD and central galaxies in clusters. In particular, they measured the black hole mass in NGC 4472, accurate to 15 percent. Gebhardt emphasized that Gemini's new instrumentation is poised to play a unique role in understanding the relation of central black hole formation to the formation and evolution of galaxies. With the advent of GNIRS, and its IFU, followed by the NIFS IFU spectrograph coupled to the Altair adaptive optics system, Gebhardt predicted that Gemini would inherit Hubble Space Telescope's renown for studying black holes in the centers of galaxies.

continued



Presentations at Gemini Science 2004 meeting (clockwise from upper left): Wayne Van Citters (NSF), Keivan Stassun (Vanderbilt University), Julianne Dalcanton (University of Washington), Charlie Telesco (University of Florida), Sandra Savaglio (Johns Hopkins University), Craig Kulesa (University of Arizona), and Karl Gebhardt (University of Texas). Photos courtesy of Gemini Observatory.



Gemini Science 2004 Meeting continued

- In a previous observational program, Julianne Dalcanton (University of Washington) and colleagues found that late-type disk galaxies all host a substantial thick-disk component. As part of an extensive follow-up campaign to constrain the origin of the thick-disk population, Dalcanton et al. have been using Gemini and GMOS to measure the kinematics of thick disks in external galaxies. Their preliminary results indicate kinematics that

are comparable to those of the Milky Way's thick disk. However, the degree to which the rotation of the thick disk lags that of the thin disk has been found to vary from galaxy to galaxy. Dalcanton argued that her Gemini data favor an accretion scenario for the formation of thick disks.

For the final program of the Gemini Science 2004 meeting, see www.us-gemini.noao.edu/science/gem_conf/sched.html.

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 June 2004 *NOAO/NSO Newsletter*.

NICI

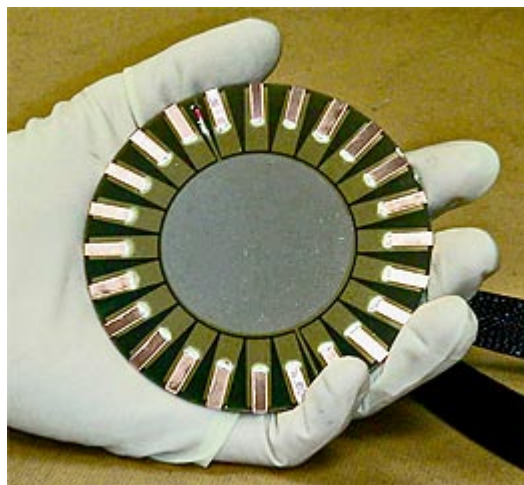
The Near Infrared Coronagraphic Imager (NICI) will provide a 1- to 5-micron dual-beam coronagraphic imaging capability on the Gemini South telescope. Mauna Kea Infrared (MKIR) in Hilo is building NICI, under the leadership of Doug Toomey.

Work continues on the integration and testing of the NICI dewar and its contents. Following the first NICI cold test in March, the NICI cryogenic optics have been integrated into the dewar in preparation for a second cold test (planned for August). All electronics boards and components have been integrated into the array controller cabinet, which has passed subsystem testing.

In addition, work on the components of the NICI adaptive optics (AO) system has advanced. The University of Hawaii Institute for Astronomy, which is providing the components for the AO system, has produced a batch of 85-element deformable mirrors that meet the stringent NICI requirements. The AO electronics for NICI have been integrated and tested.

MKIR reports that 81 percent of the work to NICI final acceptance by Gemini has been completed. NICI is expected to be deployed on Gemini South in 2005.

continued



Progress on the NICI adaptive optics system is shown via images of a deformable mirror (top), the enclosure containing the avalanche photodiodes (APDs) for the NICI AO system (lower left), and the populated enclosure for the other NICI AO electronics (lower right).



NGSC Instrumentation Program Update continued

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.

FLAMINGOS-2 is in the late fabrication phase of the project. Recent achievements include the completed fabrication of major dewar components. Both the main camera dewar and the smaller (MOS) dewar that contains the masks for multi-object spectroscopy have been fabricated, test fitted, and vacuum tested. The FLAMINGOS-2 lenses are undergoing fabrication. Wiring of major electronics subassemblies is underway, and the first software Beta release occurred in July.

As of 7 July 2004, 45 percent of the work to FLAMINGOS-2 final acceptance by Gemini had been completed.



View of the FLAMINGOS-2 camera workbench (top), G-10 spacer, and dewar spacer ring, alongside FLAMINGOS-2 mechanical engineer Jeff Julian.

OBSERVATIONAL PROGRAMS

NATIONAL OPTICAL ASTRONOMY OBSERVATORY

NOAO 2005A Proposals Due 30 September 2004

Todd Boroson

Proposals for NOAO-coordinated observing time for semester 2005A (February–July 2005) are **due by Thursday evening, 30 September 2004, midnight MST**. The facilities available this semester include the Gemini North and South telescopes, the Cerro Tololo Inter-American Observatory (now including SOAR), the Kitt Peak National Observatory, and community-access time with the Keck I and II telescopes, the Hobby-Eberly Telescope, Magellan-I, and MMT.

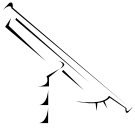
Proposal materials and information are available on our Web page (www.noao.edu/noaoprop/). There are three options for submission:

- **Web submissions**—The Web form may be used to complete and submit all proposals. The information provided on the Web form is formatted and submitted as a LaTeX file, including figures that are “attached” to the Web proposal as encapsulated PostScript files.
- **E-mail submissions**—As in previous semesters, a customized LaTeX file may be downloaded from the Web proposal form, after certain required fields have been completed. “Essay” sections can then be edited locally and the proposal submitted by e-mail. Please carefully follow the instructions in the LaTeX template for submitting proposals and figures.
- **Gemini’s Phase-I Tool (PIT)**—Investigators proposing for Gemini time **only** may optionally use Gemini’s tool, which runs on Solaris, RedHat Linux, and Windows platforms, and can be downloaded from www.gemini.edu/sciops/P1help/p1Index.html.

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

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

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



Community Access Time Available in 2005A with Keck, HET, Magellan-I, and MMT

Todd Boroson & Dave Bell

As a result of awards made through the National Science Foundation's Telescope System Instrumentation Program (TSIP) and a similar earlier program, telescope time is available to the general astronomical community at the following facilities in 2005A:

- **W.M. Keck Observatory**—A total of at least four nights will be available for classically scheduled observing programs with the 10-meter Keck I and II telescopes on Mauna Kea. At press time, there remains the possibility of a few additional nights being offered in 2005A. For the latest details on Keck community-access time, see www.noao.edu/gateway/keck/.
- **Hobby-Eberly Telescope**—About 16 clear nights of community-access queue observations per fully scheduled year are available with the 9.2-meter-effective-aperture Hobby-Eberly Telescope (HET) at McDonald Observatory. During 2005A, about 76 hours are expected to be available for integration and set-up time. Available instruments include the High-, Medium-, and Low-Resolution Spectrographs. Please see the following article for additional details, and for the latest information on HET instrumentation and instructions for writing observing proposals, see www.noao.edu/gateway/het/.
- **Magellan-I Telescope**—Three bright nights will be available for classically scheduled observing programs with the 6.5-meter Baade telescope at Las Campanas Observatory. The Clay telescope will not be available for new community access programs in 2005A due to a previous allocation that will be held over. For updated information on available instrumentation and proposal instructions, see www.noao.edu/gateway/magellan/.
- **MMT Observatory**—Twelve nights of classically scheduled observing time will be available with the 6.5-meter telescope of the MMT Observatory in 2005A. Four new instruments are being offered: MegaCam, Hectospec, Hectochelle, and ARIES. For further information, see www.noao.edu/gateway/mmt/.

A list of instruments we expect to be offered in 2005A can be found at the end of this section. As always, investigators are encouraged to check the NOAO Web site for any last-minute changes before starting a proposal.

Current Status of the Hobby-Eberly Telescope

Matthew Shetrone (McDonald Observatory/HET)

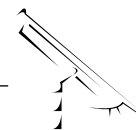
The Hobby-Eberly Telescope (HET), a fixed altitude 9-meter class optical telescope, has shown significant improvements in performance over the past six months. The addition of louvers to the HET enclosure and modifications to the open-loop model used to control the motion of the prime focus corrector have improved the delivered image quality to within half an arcsec of the site seeing (determined by DIMM measurements).

The HET instrument suite includes: 1) the Marcario Low-Resolution Spectrograph with long slit or multislit capabilities at resolutions ranging from 300 to 1800; 2) the High-Resolution Spectrograph with a single object fiber feed with resolution of 15,000–120,000; and 3) a Medium-

Resolution Spectrograph with a single object fiber feed with resolutions of 6800 or 9200. The direct single object feeds to the Medium Resolution Spectrograph are newly commissioned and taking regular science observations. Additional observing modes for the Medium Resolution Spectrograph are being commissioned at the present time.

The queue-scheduled nature of the HET allows rapid response to changing conditions. This fast turnaround combined with recent improvements in our synoptic planning capabilities makes the HET a powerful tool for spectroscopic temporal surveys. An example of this capability is the recently published "The First HET Planet: A Companion to HD 37605" by Cochran et al. 2004, astro-ph/0407146. The

continued



Current Status of the Hobby-Eberly Telescope continued

parameters for this planet were found in a single orbital cycle owing to quick data reduction by the PI and active feedback to the HET queue.

For the last six months the HET has been conducting science operations 94 percent of available observing time (the remaining 6 percent has been used for continued engineering efforts to improve image quality and instrument commissioning), with less than 6 percent of science operations time lost due to problems. This is approximately twice the efficiency of previous years. The astronomical community has time on the HET that is administered through NOAO.

The NOAO community can now expect 76 hours of clear HET nights each period to be spread roughly evenly over bright and dark time and also over the sky.

The most successful programs are those that capitalize on the strengths of the HET: slightly flexible temporal surveys (given weather constraints), all-sky surveys, near-full moon programs (given 33 percent of the NOAO time is for the near-full moon time) and an active customer service oriented queue. We look forward to seeing your programs and papers.

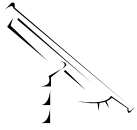
KPNO Instruments Available for 2005A

Spectroscopy	Detector	Resolution	Slit	Multi-object
Mayall 4-m				
R-C CCD Spectrograph	T2KB/LB1A CCD	300–5000	5.4'	single/multi
Cryocam/MARS Spectrograph	LB CCD (1980×800)	300–1500	5.4'	single/multi
Echelle Spectrograph	T2KB CCD	18000–65000	2.0'	
FLAMINGOS	HgCdTe (2048×2048, 0.9–2.5μm)	1000–3000	10'	single/multi
WIYN 3.5-m				
Hydra + Bench Spectrograph	T2KC CCD	700–22000	NA	~100 fibers
DensePak ¹	T2KC CCD	700–22000	IFU	~90 fibers
SparsePak ²	T2KC CCD	700–22000	IFU	~82 fibers
2.1-m				
GoldCam CCD Spectrograph	F3KA CCD	300–4500	5.2'	
FLAMINGOS	HgCdTe (2048×2048, 0.9–2.5μm)	1000–3000	20'	

Imaging	Detector	Spectral Range	Scale ("'/pixel)	Field
Mayall 4-m				
CCD Mosaic	8K×8K	3500–9700Å	0.26	35.4'
SQIID	InSb (4-512×512)	JHK + L (NB)	0.39	3.3' circular
FLAMINGOS	HgCdTe (2048×2048)	JHK	0.3	10'
WIYN 3.5-m				
Mini-Mosaic/OPTIC	4K×4K CCD	3300–9700Å	0.14	9.3'
WTTM	4K×2K CCD	3700–9700Å	0.11	4.6'×3.8'
2.1-m				
CCD Imager	T2KA CCD	3300–9700Å	0.305	10.4'
SQIID	InSb (4-512×512)	JHK + L (NB)	0.68	5.8' circular
FLAMINGOS	HgCdTe (2048×2048)	JHK	0.6	20'
WIYN 0.9-m				
CCD Mosaic	8K×8K	3500–9700Å	0.43	59'

¹ Integral Field Unit: 30"×45" field, 3" fibers, 4" fiber spacing @ f/6.5; also available at Cass at f/13.

² Integral Field Unit, 80"×80" field, 5" fibers, graduated spacing.

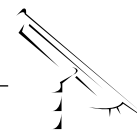


Observational Programs

CTIO Instruments Available for 2005A*

Spectroscopy	Detector	Resolution	Slit
4-m Blanco Hydra + Fiber Spectrograph R-C CCD Spectrograph	SITe 2K CCD, 3300–11000Å Loral 3K CCD, 3100–11000Å	300–2000 300–5000	138 fibers, 2" aperture 5.5'
4-m SOAR Goodman Spectrograph OSIRIS IR Imaging Spectrograph	Lincoln 4K×4K Mosaic, 3100–11000Å HgCdTe 1K, JHK Windows	1400–6000 1200–3000	5" 1.3', 3.3'
1.5-m Cass Spectrograph	Loral 1200×800 CCD, 3100–11000Å	<1300	7.7'
Imaging	Detector	Scale ("/pixel)	Field
4-m Blanco Mosaic II Imager ISPI IR Imager	8K×8K CCD Mosaic HgCdTe (2048×2048, 1.0–2.4μm)	0.27 0.3	36' 11'
4-m SOAR Optical Imager OSIRIS IR Imaging Spectrograph	E2V 4K×4K Mosaic HgCdTe 1K	0.08 0.014, 0.35	5.5" 1.3', 3.3'
1.5-m CPAPIR	Hawaii II 2K IR	0.88	30'
1.3-m ANDICAM Optical/IR Camera	Fairchild 2K CCD HgCdTe 1K IR	0.17 0.11	5.8" 2'
1-m Direct Imaging	4K CCD	0.29	20'
0.9-m Cass Direct Imaging	SITe 2K CCD	0.4	13.6'

* Please refer to the NOAO Proposal Web pages in September 2004 for confirmation of available instruments.



Gemini Instruments Possibly Available for 2005A*

GEMINI NORTH	Detector	Spectral Range	Scale ("/pixel)	Field
NIRI	1024×1024 Aladdin Array	1–5μm R~500–1600	0.022, 0.05, 0.116	22.5", 51", 119"
GMOS-N	3-2048×4608 CCDs	0.36–1.1μm R~670–4400	0.072	5.5'
Michelle	256×256 Si:As IBC	8–25μm R~200, 1000, 3000	0.10 img, 0.18 spec	~25"×25"
Altair (feed to NIRI)	1024×1024 Aladdin Array	1–2.5μm R~500–1600	0.022	22.5"

GEMINI SOUTH	Detector	Spectral Range	Scale ("/pixel)	Field
GNIRS	1K×1K Aladdin Array	1–5.5μm R~1700, 6000, 18000	0.05, 0.15	3"–99" slit length
GMOS-S	3-2048×4608 CCDs	0.36–1.1μm R~670–4400	0.072	5.5'
T-ReCS	320×240 Si:As IBC	8–25μm R~100, 1000	0.09	28"×21"
Phoenix	512×1024 InSb	1–5μm R≤70000	0.1	14" slit length
Acquisition Camera	1K×1K frame-transfer CCD	BVRI	0.12	2'×2'
Hokupa'a-85	1024×1024 Aladdin Array	1–5μm	0.022	22"

* Please refer to the NOAO Proposal Web pages in September 2004 for confirmation of available instruments.



Observational Programs

Keck Instruments Available for 2005A

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
Keck I					
HIRESb/r (optical echelle)	4096×6144	30K–90K	0.31–1 μ m	0.12	60×45" slit
NIRC (near-IR img/spec)	256×256 InSb	60–120	1–5 μ m	0.15	38"
LWS (mid-IR img/spec)	128×128 As:Si BIB	100, 1400	3–25 μ m	0.08	10"
LRIS (img/lslit/mslit)	Tek 2048×2048	300–5000	0.31–1 μ m	0.22	6×7.8'
Keck II					
ESI (optical echelle)	MIT-LL 2048×4096	1000–6000	0.39–1.1 μ m	0.15	2×8'
NIRSPEC (near-IR echelle)	1024×1024 InSb	2000, 25000	1–5 μ m	0.18	46"
NIRSPA0 (NIRSPEC w/AO)	1024×1024 InSb	2000, 25000	1–2.5 μ m	0.018	4.6"
NIRC2 (near-IR AO img)	1024×1024 InSb	5000	1–5 μ m	0.01–0.04	10–40"
DEIMOS (img/lslit/mslit)	8192×8192 mosaic	1200–10000	0.41–1.1 μ m	0.12	16.7×5'

MMT Instruments Available for 2005A

	Detector	Spectral Range	Scale ("/pixel)	Field
BCHAN (spec, blue-channel)	Loral 3072×1024 CCD	0.32–0.8 μ m	0.3	150"
RCHAN (spec, red-channel)	Loral 1200×800 CCD	0.5–1 μ m	0.3	150"
MegaCam (optical img)	(36) 2048×4608 CCDs	0.32–1 μ m	0.08	24'
Hectospec (300-fiber MOS)	(2) 2048×4608 CCDs	0.38–1.1 μ m	R~1K	60'
Hectochelle (240-fiber MOS)	(2) 2048×4608 CCDs	0.38–1.1 μ m	R~32K	60'
MIRAC3 (mid-IR img, PI inst)	128×128 Si:As BIB array	2–25 μ m	0.14, 0.28	18.2, 36"
SPOL (img/spec polarimeter, PI)	Loral 1200×800 CCD	0.38–0.9 μ m	0.2	20"
ARIES (near-IR img, PI)	1024×1024 HgCdTe	1.1–2.5 μ m	1.1, 2.1	20, 40"

HET Instruments Available for 2005A

	Detector	Resolution	Slit	Multi-object
LRS (Marcario low-res spec)	Ford 3072×1024			
	4100–10000Å	600	1"–10"×4'	13 slitlets, 15"×1.3" in 4'×3' field
	4300–7400Å	1300	1"–10"×4'	13 slitlets, 15"×1.3" in 4'×3' field
	6250–9100Å	1900	1"–10"×4'	13 slitlets, 15"×1.3" in 4'×3' field
MRS (med-res spec)	(2) 2K×4K, visible	5000–20000	1.5" or 2" fibers	single
HRS (high-res spec)	(2) 2K×4K 4200–11000Å	15000–120000	2" or 3" fiber	single

Magellan Instruments Available for 2005A

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
Magellan I (Baade)					
PANIC (IR img)	1024×1024 Hawaii		1–2.5 μ m	0.125	2'
IMACS (img/lslit/mslit)	8192×8192 CCD	R~2100–28000	0.34–1.1 μ m	0.11, 0.2	15.5', 27.2'



Observing Request Statistics for 2004B Standard Proposals

	No. of Requests	Nights Requested	Average Request	Nights Allocated	DD Nights (*)	Nights Previously Allocated	Nights Scheduled for New Programs	Over-subscription for New Programs
GEMINI								
Gemini North	95	150.68	1.59	50.74	0	0	50.74	2.97
Gemini South	101	215.19	2.13	50.28	10.665	0	50.28	4.28
CTIO								
CTIO 4-m	77	214.7	2.79	112.5	0	5	107.5	2
CTIO 1.5-m	10	42	4.2	38	0	0	38	1.11
CTIO 1.3-m	18	60.10	3.34	21.7	0	0	21.7	2.77
CTIO 1.0-m	5	23	4.6	20.83	0	0	20.83	1.1
CTIO 0.9-m	13	96.7	7.44	63.6	0	0	63.6	1.52
KPNO								
KPNO 4-m	62	178.8	2.88	104	0	0	104	1.72
WIYN 3.5-m	34	99.8	2.94	38	2	7	31	3.22
KPNO 2.1-m	27	123.2	4.56	105	0	0	105	1.17
WIYN 0.9-m	9	48	5.33	18	0	0	18	2.67
Keck/HET/MMT/ Magellan								
Keck I	14	22	1.57	6	0	0	6	3.67
Keck II	14	29	2.07	6	0	1	5	5.8
HET	5	10.5	2.1	5.5	0	0	5.5	1.91
Magellan-I	4	11	2.75	3	0	0	3	3.67
Magellan-II	4	10	2.5	3	0	0	3	3.33
MMT	10	19.5	1.95	12.5	0	0	12.5	1.56

CTIO/CERRO TOLOLO

INTER - AMERICAN OBSERVATORY

Tololo Key Pathfinder for Thirty Meter Telescope Site Testing

Bob Blum

In March of this year, the Thirty Meter Telescope (TMT) sites group began a campaign on Cerro Tololo to test and further develop the complete suite of in-situ testing equipment and methods to be deployed on the TMT candidate sites. The sites group is a collaboration between TMT personnel based at Caltech and the AURA New Initiatives Office (NIO) personnel based in Tucson and Chile. The latter group has participation from both Gemini and NOAO.

Both Matthias Schöck, the TMT sites group leader, and Warren Skidmore have spent many weeks on Cerro Tololo this fall and winter setting up, debugging, and running the sites equipment. The CTIO sites group, as part of the AURA-NIO team, has been helping them at each stage. Engineers Edison Bustos and Juan Sequel, computer specialist David Walker, and sites technician Joselino Vasquez have worked many long nights on Tololo alongside Matthias and Warren.

Many visitors to Tololo in this time will fondly recall many interesting stories (everything from near-death scuba diving exploits to “running into” President Bill Clinton on the Royal Saint Andrews golf course) heard at the dining table from that “British guy.” In addition, they may recall seeing that “crazy German” running between Cerros Tololo and Pachón for a bit of exercise during the long campaign (a feat, I believe, only matched by Todd Henry of Georgia State some years ago). Thanks to the dedication of this eclectic group, the perception of the noise emitted by the Sound Detection and Ranging (SODAR) equipment evolved from a harsh distraction to a reassuring soft “ping.”

Aside from demonstrating that work on Tololo can be interesting and fun, the sites campaign is a key element in the site selection process for the TMT. The campaign consists of a comprehensive plan to test the atmosphere above a select number of candidate sites in the United States, Mexico, and Chile. Considerable effort is going into probing the ground layer (0–30 meters), low levels (0–500 meters), and most of the free atmosphere

(0.5–20 kilometers). Side by side tests of similar and different DIMMs (differential image motion monitors) are being carried out to fully verify that the integrated seeing measured by such instruments is the same.

Early in the testing, a sounding balloon campaign was made to obtain the necessary input conditions to computational fluid dynamics (CFD) models. This was executed by a team from the Large Synoptic Survey Telescope (LSST) project including Gary Poczulp and Jacques Sebag, along with key support from the TMT group. The balloons are standard meteorological equipment

that carry a few hundred grams payload (a “radiosonde”) consisting of a GPS tracker and temperature, humidity, and pressure sensors. The data are relayed in real time by radio transmitter to a ground tracking station. Figure 1 shows a balloon being filled with Helium just before launch. The balloon and simultaneous ground data are being analyzed by Konstantinos Vogiatzis, whose CFD models are intended to provide predictive power in modeling the atmosphere above remote sites.



Figure 1. Joselino Vasquez and Gary Poczulp prepare a balloon for launch. The payload consists of sensors and a transmitter/receiver and is carried on a 60-meter tether. The balloons ascend to an altitude of 20–25 kilometers before bursting (with a diameter of ~10 meters).

A detailed set of safety procedures, including real-time communication between the launch team and the Chilean civil air authorities, was put in place before the launches started, which worked very well throughout the campaign. Thus, possible tragedy was averted early on when a launch of balloons was delayed at the last minute that would have occupied the airspace of the Chilean national soccer team returning from a triumphant match in Bolivia.

The balloon launches were only the beginning of the campaign effort. Simultaneous measurements were made with the CTIO MASS-DIMM instrument, two SODARs, and a set of microthermal probes developed at the University of Nice in France. The ongoing campaign seeks to further verify and develop all these sensors.

The Nice microthermal probes are based on a resistive circuit design, but are quite fragile (the key element is a 5-micron wire). The TMT group is testing three other sets of thermal probes to

continued



Tololo Key Pathfinder for TMT Site Testing continued

judge their ability to accurately characterize the component of atmospheric turbulence in the first 30 meters from the ground. Thirty meters is a compromise between the likely elevation of the TMT primary and a freestanding tower that can be reliably deployed in remote locations. The thermal probes are located at various altitudes on the tower. Along with thin wire probes like the Nice model (which are also fragile), the TMT group is developing sonic anemometers. These probes measure the sound speed at high frequency and, from this, microthermal variations in a small volume of air. The microthermal variations (as for all the thermal probes) are converted into index of refraction variations, and then “seeing” over the 30-meter column.

Ascending beyond 30 meters, the atmospheric column is probed by the SODAR and Multi-Aperture Scintillation Sensor (MASS) units. SODAR is an acoustic profiler that transmits strong and directional sonic pulses upward. The pulses are backscattered from the interfaces between turbulent cells with different temperatures. The duration between transmitted and received signals and the strength of the backscattered signal allows a vertical profile to be reconstructed. The TMT group is testing two units that reach altitudes of about 200 meters and 800 meters, respectively.

The MASS is a profiler that resolves the free atmosphere seeing (0.5–20 kilometers) into contributions arising from six layers. While the vertical resolution is low, the MASS provides valuable information about the main contributing layers of turbulence above a site and is intrinsically insensitive to the ground layer turbulence, which produces no scintillation. It is compact and can be deployed in an integrated unit with a DIMM on a small telescope. (The MASS-DIMM implementation is described in Andrei Tokovinin’s March 2004 *NOAO/NSO Newsletter*.) During the CTIO TMT campaign, two independent MASS-DIMM units have been deployed and found to be in excellent agreement. A third, MASS-only instrument was briefly run and also agrees with the other two. The MASS-DIMM is one of the primary TMT tools, and one unit is already operating at a remote site.

The TMT MASS-DIMM has been operating on Tololo since mid-April and has already become a familiar site to visiting astronomers. The telescope is fully robotic, opening, observing, and closing each night through a set of software programs distributed over three computers in a local area network and managed by UNIX cron jobs. The operation still requires daily “care and feeding,” but this is typically routine and involves only quick checking through a Web interface that the operation has begun normally, that the

dome is closed in the morning, and that all data have been backed up on remote computers. The software programs check current weather conditions and close the telescope during the night if conditions warrant it. Operation begins again when the weather improves. Web cams allow visual confirmation that the dome is closed during the day as well as providing additional information on daytime conditions.



Figure 2. The 30-meter microthermal tower rising above the USNO and Columbia domes on Cerro Tololo. As many as 50+ probes were simultaneously mounted at 10 altitudes on the tower to measure microthermal variations (and hence seeing). The 6.5-meter tower to the right of the 30-meter is the ATST DIMM tower. The tubular tower next to the USNO dome contains the CTIO MASS-DIMM telescope.

The TMT MASS-DIMM telescopes will use a tower developed for the Advanced Technology Solar Telescope (ATST). The Tololo equipment is currently running on such a tower (see figures 2 and 3). This 6.5-meter tower is meant to place the DIMM above the first few meters of ground turbulence. The 6.5-meter height is as high as possible while still allowing the DIMM to operate without excessive windshake. Since the DIMM measures the total seeing, the combination MASS-DIMM can be used to infer the ground-layer contribution (in this case everything below the MASS lower layer of about 500 meters). Of great interest to the TMT group will be the eventual cross-calibration of the various instruments working at overlapping layers.

Another novel aspect of the TMT DIMM is its drift scan mode of taking the usual dual spot images used in measuring image motion. In the TMT implementation, the CCD is read out in drift scan mode, compressing one dimension into a row of pixels. The spot centroids are thus measured only in one direction. This readout mode is very fast and allows for many more samples to be taken in a shorter time than with traditional DIMMs. While the traditional method provides

continued



Tololo Key Pathfinder for TMT Site Testing continued



Figure 3. The TMT Halfmann telescope. The 35-centimeter telescope can just be seen through the bottom of the enclosure. The black object to the left on the same tower is a portable Meade telescope/DIMM. The tower to the left is the ATST tower on which the TMT MASS-DIMM telescope will be deployed on remote sites. The final major component of the TMT site testing suite is, of course, the DIMM (deployed as a MASS-DIMM).

two independent measures of the differential image motion variance (and hence seeing), the TMT method has been shown to give the same results. A series of tests were run on sets of Tololo DIMM images, compressing the data and piping it through the TMT software. The seeing computed from the Tololo DIMM and TMT algorithm were in excellent agreement.

Throughout the campaign, the TMT and Tololo DIMMs have been taking data on as many clear nights as possible.

The resulting database of information forms one of the most detailed data sets to test standard DIMM theory and operation ever taken. A third DIMM has been run alternately next to (on the same tower; see figure 3) the TMT DIMM and the Tololo DIMM (mounted in the same tower; see figure 2). The preliminary comparison among the three is very encouraging. A “quick” look at the data through early May suggests agreement to better than 0.1 arcsec between the TMT and Tololo DIMMs, and less than 0.05 arcsec for the portable and TMT DIMMs when run on the same tower. It is believed that a more careful analysis, including effects of the logged focus behavior of the Tololo DIMM and derived ground layer, will improve the comparison and point to methods and procedures that will be helpful in taking similar data with other DIMMs.

The TMT site selection is on a fast track and one MASS-DIMM unit has already been deployed in Northern Chile. The equipment on Tololo will soon be deployed on a second Chilean peak as the Tololo campaign winds down. A final push is under way to test two Halfmann MASS-DIMMs side by side and to finalize the testing of the microthermal probes. The hard work of assessing the data obtained over the last months on Tololo from three DIMMs, two MASS units, two SODARs, four flavors of thermal probes, and the balloon launches has begun. A complete technical description of the equipment described in this article and preliminary results from the Tololo campaign is given by Skidmore et al. (to appear shortly in the proceedings of the 2004 SPIE meeting, Glasgow, Scotland).

Besides the TMT sites group team members deservedly mentioned in this article, there are many others who have made essential contributions to the early success of this project. On Cerro Tololo, the entire Telops team has been a great help and, in particular, Gale Brehmer has been a constant source of assistance and advice during the campaign. Paul Gillett is in charge of all the sites logistics and infrastructure and has made key contributions to the deployments, both remote and on Tololo. The AURA Observatory Support Services (AOSS) group provided invaluable help with the balloon launches and communications with the Chilean civil air authorities.



Goodman Spectrograph Arrives in Chile

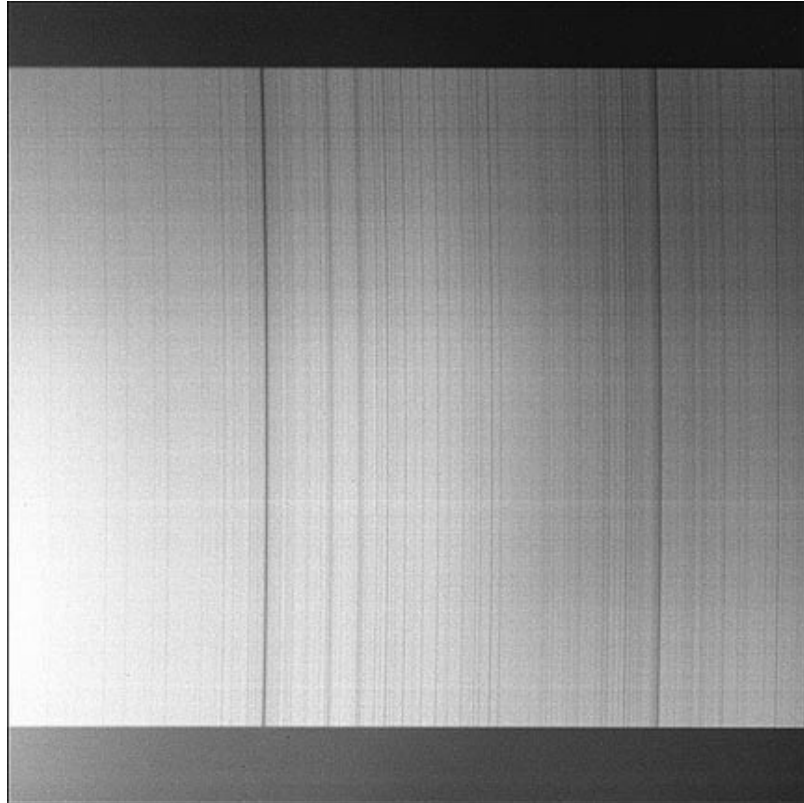
Chris Clemens (University of North Carolina)

The Goodman Spectrograph was shipped from Chapel Hill, North Carolina, to La Serena in June. As the instrument principle investigator, I was in Chile with University of North Carolina (UNC) students Adam Crain and Matt Bayliss through August for testing and integration.

The Goodman Spectrograph is the first major instrument produced by the UNC Goodman Laboratory. It is an all-refracting imaging spectrograph that incorporates transmission volume phase holographic gratings. The instrument is designed to be used on the 4.1-meter SOAR telescope.

All of the optical, mechanical, and electronic systems delivered are functioning as expected thus far, and the spectrograph has taken spectra of ambient sunlight in the Gemini instrument laboratory. Tests of the instrument flexure show that it is repeatable and within the range of the active compensation system built into the spectrograph. Remaining work includes final integration of the dewar and Lincoln Lab CCDs in the CTIO workshops. Meanwhile, the instrument is operational using a modified 2Kx2K pixel Apogee camera.

A more detailed description of the instrument, and software tools for potential observers, are available at the Goodman Laboratory Web site (www.physics.unc.edu/~clemens).



First Engineering Image from the Goodman Spectrograph. When installed on the SOAR telescope later this year, the spectrograph will provide very high throughput imaging and spectroscopy from 320 to 850 nanometers, with $R \sim 1000-10,000$.



The Goodman Spectrograph and SOAR Nasmyth cage in the Gemini South instrument laboratory.

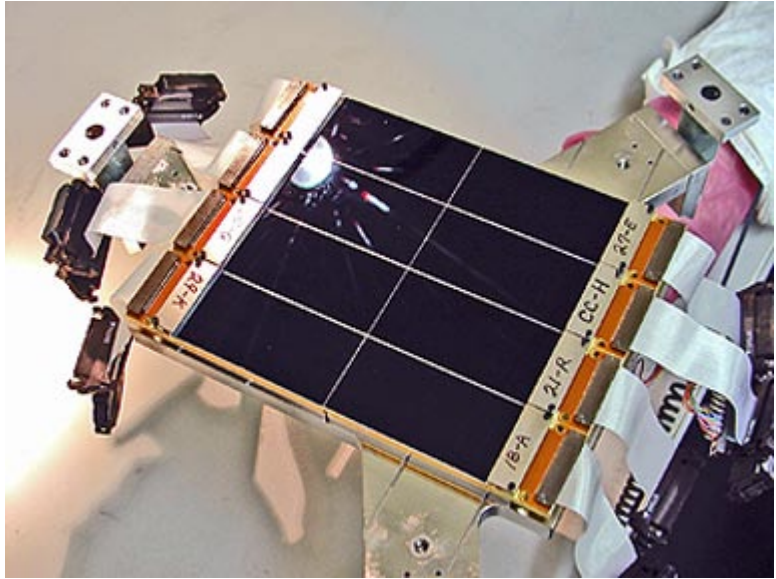


Mosaic II Detector Replacement

Tim Abbott

The Mosaic II imager suffered a failure September 2003 that resulted in the production of serious amplifier glow in one of its CCDs (CCD#3). Despite valiant efforts by CTIO staff, it proved impossible to resolve this problem and we were forced to disable this CCD entirely to avoid compromising the imaging quality of the rest of the array.

For several months, observers could only observe with this 7/8ths mosaic while we sought and acquired a replacement detector. Though the SITe 2Kx4K CCDs employed in the NOAO mosaics are no longer in production and supply is very limited, we were able to obtain a replacement through Chris Clemens at the University of North Carolina's Goodman Laboratory. Moreover, this replacement had two functioning amplifiers (perhaps the last such device!), which meant that performance of the Mosaic II camera would not be compromised after all.



The reassembled Mosaic II focal plane array with the replacement detector identified by "CC-H".

A collaborative effort by NOAO North and South—primarily Ramon Gálvez, Ricardo Schmidt, and Tom Wolfe—saw

the replacement safely installed in the cryostat in April 2004, and observations with Mosaic II resumed

in May. The new detector performs, if anything, slightly better than the original.

Blanco Telescope Shutdown 2004

Tim Abbott

When its dome shutter failed in February 2003 (see the June 2003 *NOAO/NSO Newsletter*), the Blanco 4-meter telescope fell victim to a freak hailstorm. While no lasting damage was done, the primary mirror did get wet and degraded sufficiently that we decided to accelerate the aluminizing schedule. We therefore shut down observing operations for two weeks in June and July of this year and removed the primary mirror for adjustment and recoating. In preparation for this, we had upgraded our aluminizing chamber to match the changes already made to the chamber at the Mayall telescope on Kitt Peak.

While the first coating failed as the result of a minor misunderstanding, the second was gratifyingly successful, resulting in a significantly more uniform coating than before. We also took the opportunity to repair the two radial supports that had broken since the last shutdown (see the December 2002 *NOAO/NSO Newsletter*) and made significant progress in tuning this complex and delicate system. Finally, the telescope's hydrostatic bearing oil was completely drained and replaced for, we think, the first time since the telescope was commissioned!



Other Happenings @ CTIO

Alistair Walker

I am very happy to announce that the CTIO scientific staff has been augmented by two new appointments. Rachel Mason, NOAO Postdoctoral Fellow working for the NOAO Gemini Science center (NGSC), arrived in La Serena on June 15, after having spent the first several months of her appointment in Tucson. Apart from supporting Gemini infrared (IR) instrumentation via NGSC, she expects to continue her research on interstellar dust using GNIRS and T-ReCs. In early August, Chris Miller from Carnegie Mellon University took up an Assistant Astronomer position. His recent work has involved using the Sloan Digital Sky Survey for a number of extragalactic studies, and his expertise with large databases will be put to good service by his participation in the NOAO Data Products program (DPP).

In early September we bid farewell to Jim de Buizer, who has been at CTIO as a Postdoctoral Fellow for three years, plus a year “loaned” to Gemini South where he helped in the TReCs commissioning. Jim is not moving very far though, having accepted a position as a Gemini Science Fellow at Gemini South. Jim is an expert on star formation and mid-IR instrumentation, and the facilities and opportunities at Gemini should be a perfect match to his talents. We all wish him well in his new job!

In response to an announcement of opportunity for proposals to partner in building a major new facility instrument for the Blanco telescope, a proposal was received on July 15 from a Fermilab-led consortium to construct a new prime focus CCD imager and corrector with 2.2-degree diameter field. The consortium plans to deliver the instrument in 2009, and then use 30 percent of the Blanco time over five years to undertake the Dark Energy Survey. The survey data products will be made available for public use, while the instrument itself will provide an order-of-magnitude increase in capability over Mosaic II. The proposal was reviewed by the Blanco Instrumentation Partnership Panel in August 2004.

See the Observational Programs section of this *Newsletter* for a list of telescope-instrument combinations at CTIO available for NOAO users in 2005A. For the first time, SOAR instruments appear on this list. Details will appear on the proposal Web page at the start of September, after a review of telescope and instrumentation readiness.

Notable Quotes

“There are so many surprises in store for us that we can’t even anticipate yet, and that is the glory and magic of exploration, of discovering the unknown.

The heavens above us, the stars that light the night sky, we look up and marvel and we don’t know much about it. It is a mystery and has been to humanity throughout the centuries.”

—*Legendary space artist Robert McCall, quoted in an Arizona Republic story on early Cassini spacecraft images of Saturn’s rings, written by Judd Slivka and Amanda J. Crawford, 2 July 2004*

KPNO/KITTPeAK

N A T I O N A L O B S E R V A T O R Y

In Remembrance of Jim DeVeny

(14 April 1943 – 30 May 2004)

Jim DeVeny died suddenly in Silverton, Colorado, of a long-term heart condition more serious than previously diagnosed. Jim played a major role in the development and success of Kitt Peak for over 30 years. Most visiting astronomers would know Jim for his work supporting their use of instruments and for his management of the Kitt Peak Instrument Support group. Kitt Peak staff also knew the joy of working with and for Jim as he strove to maximize the scientific utility of our facilities with his quiet, competent, professional, humble, and joyful manner.

Jim first came to Kitt Peak on 30 October 1967 to work with Roger Lynds. In these early years of Kitt Peak, Jim worked with Roger and others to implement the use of spectrographs using image intensifiers and to use these instruments in observations of quasars. Among the many “firsts” in this work were the first blind off-setting of a Kitt Peak telescope to a faint object and deployment of an automatic guider. Jim was involved in development of multislit spectroscopy at the 4-meter, and continued to support observers using this mode throughout the rest of his career. Jim’s competency at the telescope is legendary. As all of the Kitt Peak spectrograph instrument scientists of the past can attest, Jim was the true guardian of the performance of our spectrographs throughout his tenure. As leader of the Kitt Peak Instrument Support group, Jim left a legacy of competence that has been essential to the observatory to the present day.

In addition to Jim’s achievements at Kitt Peak, his love of the outdoors and the natural world touched many lives. He was often the leader on epic adventures that took him and his many friends (including colleagues from Kitt Peak) river running, hiking, backpacking, skiing, mountaineering, orienteering, caving, and bicycling.

Jim was active in the Sierra Club and led national backpacking trips into the Grand Canyon and in the slickrock country that surrounds Rainbow Bridge in southern Utah. In 1974, he bought a river dory and began a long series of river trips: the

Salmon River of Idaho, the San Juan River of Utah, several canyons on the Green River of Utah, Cataract Canyon on the Colorado River, and four runs of the Colorado River in the Grand Canyon. Piloting rubber rafts down the Colorado is common today, but only a very few experienced boatmen dare to row wooden boats through the rapids of the Grand Canyon. Jim was one of them. For their most recent trip, in 2001, Jim orchestrated a perfect 18-day run—

no flips, no wrecks, no bungsles of any kind. In both his hobbies and his work, Jim loved to help his team be at the forefront, well prepared, and successful.

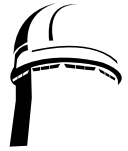
Jim is survived by his wife Maureen. They split their time between Tucson and a Silverton, Colorado, home since Jim’s retirement from full-time work at Kitt Peak in 1999. Memorial services took place in Silverton, where Jim’s ashes will be buried in the Silverton cemetery, a place special to Jim and Maureen, who volunteered many hours clearing and documenting the site. A memorial service is planned for Saturday, October 30, at 5:30 P.M. in the Tucson Botanical Gardens. We encourage friends to send their thoughts and memories of Jim to jimd@noao.edu.

These messages will be forwarded to Maureen and possibly included in the Tucson service. Individuals wishing to send private condolences to Maureen may do so at this address: Maureen DeVeny, Box 351, Silverton, CO 81433.

The family requests that any desired donations in Jim’s memory be made to one of the following charities: Hillside Cemetery Fund, PO Box 115, Silverton, CO 81433; San Juan County Ambulance & EMT Fund, PO Box 493, Silverton, CO 81433.

A permanent memorial to Jim on Kitt Peak is also being planned, for which donations may be sent to the Kitt Peak Director’s Office.





Imaging at WIYN

Richard Green & Steve Howell

Your successful proposal for WIYN imaging may get you time on one of two imagers in Semester 2004B. Some of the imager nights will be scheduled with Mini-Mosaic as they have been in the past. In the coming semester, the WIYN Observatory will be hosting extended visits of John Tonry's OPTIC camera from the University of Hawaii. That camera is mounted at the WIYN imaging port, and instrument block scheduling will generate imaging runs dedicated to OPTIC.

The OPTIC format is nearly identical to that of Mini-Mosaic. The performance advantages include enhanced red sensitivity with little fringing and rapid read-out time. In particular, OPTIC contains two MIT Lincoln Labs CCID-28 CCD chips with 2K×4K format, mounted side by side in the dewar. The 15-micron pixels give a scale of 0.14 arcsec; the format of the mounting gives a gap equivalent to 104 pixels, or 14 arcsec. The read noise is 4 to 5 electrons. The readout time is 25 seconds full format, or 8 seconds binned 2×2. The amplifiers are configured such that the image is assembled from the equivalent of four 2K×2K images. The quantum efficiency of the detectors is

42 percent at 3600 angstroms, 90 percent at 7500 angstroms, and 44 percent at 9500 angstroms. Further details can be found in a very complete manual, linked to the WIYN information page (www.noao.edu/wiyn). Click on *documentation*, then *instrument manuals* from the pop-up menu, making sure that you have that menu box starting high on your browser page to see all the entries. We do not yet support general use for OPTIC's orthogonal transfer mode for rapid guiding; WTTM is still recommended for that purpose.

OPTIC's major disadvantage is that one of the CCDs has a number of cosmetic defects. Its shutter action also requires a minimum exposure time of four seconds for accurate relative photometry on short exposures. If your program would strongly benefit from the use of Mini-Mosaic (for example, for continuity with a long-term program), please specify that need on your observing proposal form. We will otherwise assume that we can schedule your run with either Mini-Mosaic or OPTIC. We also encourage your feedback on the relative scientific performance of the two cameras in "straight" imaging mode.

KPNO Telescope Scheduling Constraints

Richard Green

The current instrument suite shows no preplanned retirements because we have tried to maintain instrument availability in response to proposal pressure. However, as our operational model becomes more constrained, we must observe more stringently the nominal minimum run lengths, and particularly, minimum instrument blocks on the telescope. Note that in general a minimum run is four nights on the 4-meter and seven nights on the 2.1-meter, unless the scientific program is better served by a different distribution (for example, if variability monitoring or an extremely limited program is demanded).

One consequence of approximately two-week minimum instrument blocks is the potential for meritorious proposals not to be scheduled. The Time Allocation Committee may recommend highly a single proposal's use of an instrument, but there may be no further proposals for that instrument judged deserving of any time award (or none submitted). In that case, it is quite unlikely that the good proposal will get scheduled. Our advice is to offer an alternative: for example, if you can use FLAMINGOS on the 4-meter instead of SQUIID as an acceptable option for your multicolor program, please include this in the proposal technical section. Our goal is to get the best science on the telescope. Given our tightening constraints, the more options you give us, the better your odds will be of receiving telescope time.

NATIONAL SOLAR OBSERVATORY

TUCSON, ARIZONA • SAC PEAK, NEW MEXICO

From the NSO Director's Office

Steve Keil

Once again, we offer an opportunity for the community to help set the strategy and roles for the future of the National Solar Observatory. AURA has requested that NSO do some strategic planning to determine its course for the next 10 to 20 years. NSO's annual Program Plan covers the current and upcoming fiscal years, while its Long-Range Plan (LRP) addresses a five-year period, but contains a road map for the next 10 years. Both plans are available at our Web site, www.nso.edu/general/docs.

Key elements of the current LRP include development of the Advanced Technology Solar Telescope (ATST), with completion scheduled for 2013; completion of SOLIS over the next several months, its operation over two or more solar cycles, and its expansion into a three-station network through the development of international partnerships; operation of the newly enhanced GONG network for one or more solar cycles; and operation of current major facilities until ATST is commissioned.

Strategic planning requires us to think about the long-term role of the NSO, what its mission should be in the changing climate of astrophysics and space sciences, what economic and political factors will help shape that role, what services and facilities open to everyone on a competitive level should be operated as a national center, where NSO should strengthen its program to support solar research, and what it should not be doing. We will be discussing our planning and soliciting inputs through the various NSO advisory committees and at AAS Solar Physics Division (SPD) and other meetings, but we would also like to hear directly about your ideas for NSO's evolution and how we can better serve the solar research community. Please feel free to contact me at skeil@nso.edu or 505-434-7039.

★

The ATST project is continuing to push toward construction readiness. During June, several talks on the status of various hardware and software designs were presented at the AAS/SPD meeting in Denver, at IAU 223 in St. Petersburg, and at the SPIE meeting in Glasgow. These provided the opportunity for the science and engineering communities to comment on the current design concepts. NSO will be issuing requests for proposals for fleshing out various subsystem designs in the next several months.

ATST has been fortunate to have Jim Oschmann as its project manager for the last few years. He quickly took the science requirements and basic telescope ideas to a fully developed concept that could be accurately costed, resulting in a comprehensive construction proposal to the National Science Foundation. Jim accepted a position with Ball Aerospace in Boulder and left the

project in July. He will continue to provide support as needed to ensure his considerable knowledge is passed along. Jeremy Wagner has agreed to serve as interim project manager, and NSO is now recruiting to fill the position. If you know of strong candidates for the position, please inform them of this opportunity. Information can be found at www.nso.edu/jobs.html.

★

The SOLIS mount and the vector spectromagnetograph (VSM) are now installed on Kitt Peak, and the other instruments will soon be ready to join the VSM on the mountain. As SOLIS gears up for operations, NSO is looking for postdoctoral candidates interested in participating in this exciting project. New data products and other information are available at solis.nso.edu.

★

AURA's management oversight committee for the NSO, the Solar Observatory Council (SOC), has undergone a few changes this past year. Paula Szkody (University of Washington) is rotating off the SOC to serve on the NOAO Observatories Council. We would like to thank Paula for her very useful help and advice these last few years. Peter Gilman (HAO), who has been an SOC member since its inception, is also rotating off the Council but could be back under a revision of the SOC charter. Peter has provided invaluable insight and help as the NSO has established its independent program and embarked on the ATST project. He remains active on the AURA Board and we hope to continue working with him on the SOC in the near future. We welcome two newly elected SOC members, Jeff Kuhn (University of Hawaii) and Steve Kawaler (Iowa State University). Their term began July 1, and we look forward to working with them over the next several years. The SOC currently consists of five elected and two invited members. Under a proposed revision, currently being voted on by the AURA Board, the Council would have seven elected and two invited members.

★

We're pleased to welcome new and returning staff members. Software engineer Lorraine Callahan has joined the SOLIS group, replacing Janet Tvedt, who transferred to the ATST project to develop common services software. Instrument maker Lou Lederer has returned to work with GONG, and Jim Mason, who worked on the ATST site survey, is now part of the GONG engineering development group. ATST Fellow Brian Robinson, from the Center for Applied Optics, University of Alabama in Huntsville, is now part of the ATST instrumentation team that is developing the tunable imaging filter system. Brian is working with Allen Gary (NASA) and K. S. Balasubramaniam on various aspects of the tunable filter optical design.



ATST

Thomas Rimmele, Jeremy Wagner & the ATST Team

The project continues to address the various design aspects of the telescope and supporting systems as we move toward a preliminary design. By the time this *Newsletter* is distributed, the project will have received preliminary input from a face-to-face review of the construction proposal held at the National Science Foundation in late August. All the while, progress has continued in several key design areas, including the software and controls, coudé lab, the thermal interface between the telescope and lab environment, the M1 thermal control, and instrumentation development.

Software

Common Services Design and Status

The “ATST Common Services” are a set of communications libraries and protocols used to send messages between the various ATST computer systems. These services also provide system developers with the necessary resources to interact with the ATST systems without the need to understand how the communications middleware really works. Figure 1 illustrates two software systems that use the ATST common services to communicate.

After a successful conceptual design last fall, it became clear that the common services package was the most important piece of ATST software and on the critical path for design and construction. Since the common services provide all of the components required for ATST software to communicate and interact, it is crucial that this system be in operation before other software systems. To support this need, the ATST software group is both designing and building the common services package. An alpha software release is expected in early 2005, with a beta release available

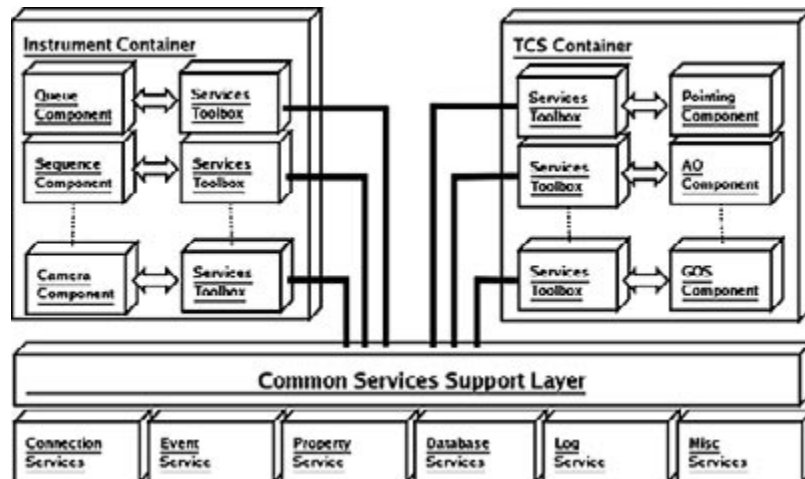


Figure 1. An illustration of two software systems that use the ATST common services to communicate.

to contractors scheduled for the following year.

Currently, the common services has a preliminary design for both the communications middleware and the communications protocols. The middleware provides the necessary software for passing messages between computers. ATST has selected Internet Communications Engine (ICE), a freely available package from ZeroC, as our middleware, and has designed interfaces using the ICEL interface design language. Tests performed on ICE’s capabilities have shown performance of almost 20,000 transactions per second of typical ATST event data.

As for the ATST communications protocols, the set of commands, events, and services available to developers has been defined and described in a set of specification documents. The common services define naming, event, log, and database servers for developers to use in the ATST environment.

Additional services provide generic software components and life-cycle management. The completed preliminary design effort should completely specify all of these services by the end of this year.

Contract for Control System Design

The first software-related design contract has been issued to Observatory Sciences, Ltd. of Cambridge, United Kingdom, for the ATST Telescope Control System (TCS). The TCS is one of the four principal software systems and is responsible for operation of the telescope and its many parts. Observatory Sciences is well-known in the nighttime astronomy and particle physics worlds for their real-time control expertise. Along with Observatory Sciences, Patrick Wallace and David Terrett of the Rutherford Appleton Laboratory in Oxford, United Kingdom have joined the design contract to provide their telescope pointing kernel and associated algorithmic experience.

continued



ATST continued

The TCS design will produce a highly accurate solar pointing model, algorithms for telescope positioning, tracking, and guiding, and interfaces to the telescope subsystems. Observatory Sciences will be working on the TCS contract for the next two years, allowing the ATST project to produce a final TCS design for the start of ATST construction.

Site Survey

The site survey efforts are currently focused on verification experiments that extend the successful cross-calibration measurements performed at the 300-meter-tall Atmospheric Technology Division (ATD) tower near Erie, Colorado (see www.atd.ucar.edu/rtf/projects/dash04/report.shtml). In situ measurements of C_n^2 as a function of height were compared to the C_n^2 measurements derived in a more indirect way with the SHABAR instrument, which is a vital component of the ATST site survey instrumentation. Similar experiments are now being performed at the Big Bear Solar Observatory and Haleakela sites. In situ measurements of $C_n^2(h)$ are obtained using sonic anemometers mounted on a mobile crane at 7.3 meters, 13 meters, and 23 meters above ground.

The goal is to further validate, in particular at a lake site, the performance of the SHABAR and its ability to measure the Fried parameter r_0 as a function of height over the range where the aperture of the telescope will be placed.

The Site Survey Working Group (SSWG), chaired by Tim Brown from the High Altitude Observatory (HAO), continues to be very active. Members of the group are participating in the data analysis and during frequent meetings the SSWG is monitoring the analysis of site survey data and the progress of the site survey effort. The SSWG will deliver its report on 30 September 2004. An ATST Science Working Group (SWG) meeting to review the

report has been scheduled for October 13–15. The SWG will forward its site recommendation to the Project Director shortly after the October meeting.

Instrumentation

The ATST project has recently completed an optical design for a Nasmyth instrument station. We have proposed this to our instrument partners as an alternative location for coronal and UV instrumentation. This station has packaging advantages over a Gregorian

platform previously studied, and the feed optics that produce the Nasmyth image introduce less instrumental polarization. The $f/13$ image at this station is formed with a total of four reflections, and is nearly diffraction limited.

In late May, the HAO hosted an ATST instrument conceptual design review/workshop at their facility in Boulder, Colorado. The emphasis at this meeting was on the system-level polarimetry components, and

continued



Figure 2. Comparison test of in situ and ATST measurements of seeing as a function of height underway at Big Bear.



ATST continued

the infrared (IR) and visible-light spectropolarimeters that are among the planned first-generation ATST instruments. The designs for these two instruments are being developed by our partners at the University of Hawaii Institute for Astronomy (IfA), and HAO/NCAR. There were 20 participants in all from NSO, HAO, and IfA. Good progress was made on polarimetric calibration issues, camera requirements, and specifications for the so-called Gregorian Optical Station, which houses the polarization modulators and calibration optics. The group also confirmed that the $f/13$ Nasmyth platform described above is now the baseline location for the coronal module of the near-IR spectropolarimeter.

Finite Element Analyses

Since the conceptual design review (CoDR) in August 2003, there have been a number of significant changes to the telescope structural design, most notably the new one-level, larger diameter coude rotator; the correspondingly larger telescope pier; and the change from a Gregorian instrument rotator to one at Nasmyth. As a result, some of the finite element analyses that were presented at CoDR are being rerun. Myung Cho and Joon Lee of the New Initiatives Office in Tucson are remodeling the telescope mount, coude lab, and pier, and expect to have preliminary results by this fall. The work they are doing will focus on static structural deflections, dynamic wind-shake effects, and modal analyses.

M1 Thermal Control Progress

The baseline for the ATST primary mirror (M1) is a 100-millimeter-thick ULE or Zerodur meniscus substrate

coated with aluminum. Two competing performance issues with such a design are optical surface deformations due to gravity and wind loading, and thermally-produced image degradation, or seeing. Mirror seeing is produced when the coated side of the substrate is hotter or cooler than the surrounding air. A mirror that is hotter than the ambient temperature is particularly troublesome, since it produces rising plumes of buoyant hot air. Thus, the mirror surface temperature must be controlled to match the ambient air

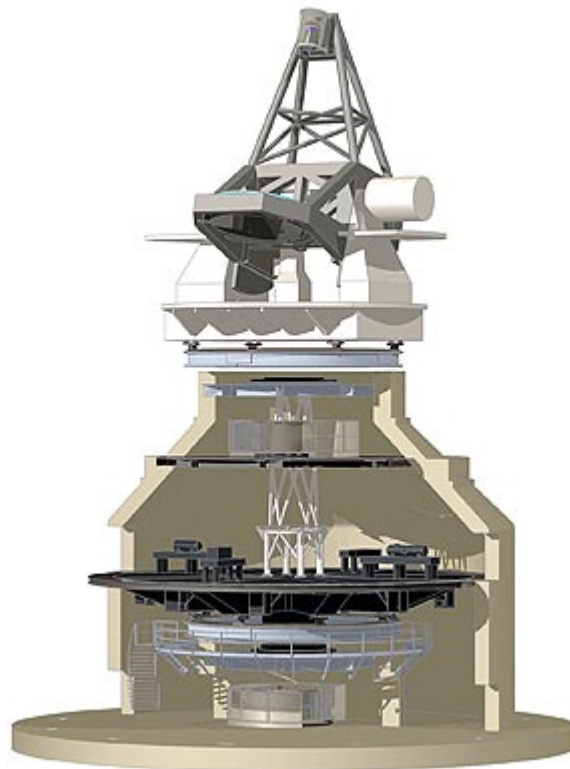


Figure 3. ATST telescope assembly.

temperature, and since the optical beam covers the front of the mirror, the surface temperature must be controlled from the back of the substrate.

The low thermal conductivity of ULE or Zerodur results in a time lag of hours between cooling events occurring on the mirror backside and the frontside

thermal response. Since the characteristic time lag scales with the square of the substrate thickness, it is quite beneficial to use a thinner mirror. For example, a 50-millimeter-thick mirror will respond about four times faster than one 100-millimeters thick. The ATST design team is currently weighing the trade-off between the baseline 100-millimeter-thick mirror and a thinner mirror that responds to thermal changes more quickly. A thinner mirror requires an increase in the number of axial supports to maintain the current level of support print-thru, but the overall weight of the M1 assembly is significantly reduced by the thinner/lighter mirror. The final choice of thickness will be a balance of optical and thermal performance, cost, and risk.

Upcoming Milestones

The project's principal activities are focused on developing the designs to mitigate identified risk areas, preparing for design review, and the development of integrated communications designs and requirements for vendor design contracts. We are prepared to respond to input received from the August peer review of the construction proposal, and we plan to announce the final site selection by November. We are continuing our efforts to firm up potential funding partners. As reported in the last *Newsletter*, our European colleagues submitted a proposal to the European Union for adding to the current Design and Development phase in many areas and they are, at this writing, receiving responses to the various sections of that proposal. 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

After a month of diligent installation work, the SOLIS vector spectromagnetograph (VSM) resumed operation on 18 May 2004 at the Kitt Peak SOLIS Tower (KPST). We thank all of those who participated in this complex installation, and in particular John Dunlop and the mountain crew. Figure 1 shows the VSM (the rectangular housing with exposed entrance window) on the SOLIS mount.

Progress toward daily observations with the VSM has been constrained by various move-in activities. Site improvements and upgrades, along with personnel shortages and an unwanted motion of the grating, have limited observational possibilities. After the addition of an extension to the SOLIS mount at a local vendor, the mount required extra shims beyond its built-in adjustments to complete the alignment with the polar axis.

Additionally, clouds associated with summer monsoon airflow have been somewhat more frequent than average. The environmental conditions of the KPST require that the focus algorithm for the VSM be adjusted until the guider is installed. As a result, the frequency and quality of observations have been notably diminished during this period of transition. The requisite observations needed

to update the focus algorithm are being collected. The guider for the VSM is still under development and some replacements of components inside the VSM are planned. The latter includes a new spectrograph entrance slit and most of the polarization calibration optics.

Several VSM data reduction algorithms were developed or improved this quarter. One new algorithm detects and corrects a varying dark bias signal from the cameras. This is presumably caused by a problem with the temperature stabilization of the detectors. Another reduction algorithm developed is a method to correct interquadrant cross talk between the four quadrants of the detectors of each camera. In addition, early observations of the chromospheric 854.2-nanometer Ca II line showed that the reduction algorithm we had been using did not adequately account for dramatic spatial variations in the core of the line profile, and a new method was devised and tested.

The magnetogram in figure 2 emphasizes features that are only manifest in the chromosphere. This figure was prepared by differencing chromospheric and photospheric magnetograms taken at different times using the old algorithm. The new reduction method produces both signals simultaneously from the core and wings of the



Figure 1. The vector spectromagnetograph mounted on top of the Kitt Peak SOLIS Tower, formerly the vacuum telescope tower. The pole that flanks the tower in the image on the left is part of a lightning protection system. (Photos by Kevin Schramm)



SOLIS continued

854.2-nanometer line. A flat-field algorithm for 854.2-nanometer observations was also developed. A similar effort for 1083-nanometer observations is still underway and is complicated by significant fringing within the detector at this wavelength.

The Integrated Sunlight Spectrometer (ISS) will be moved to Kitt Peak by the time this *Newsletter* is distributed. During this quarter, the CCD camera of the ISS was out of service for repairs for several weeks. The camera is suspected of being vulnerable to power cycling. Work on the Full Disk Patrol was suspended during the quarter due to failures of both of its CCD cameras and a nonresponsive vendor.

The hardware for the SOLIS data acquisition and handling system was moved to Kitt Peak in mid-July. Observations can now be processed without a bottleneck of having to record data to tape. The SOLIS data archive remains in Tucson and the two systems are connected by a 45 megabyte per second data link. A small data processing system that resembles the large system on Kitt Peak is being set up in Tucson to allow software testing and the processing of accumulated data files of old observations.

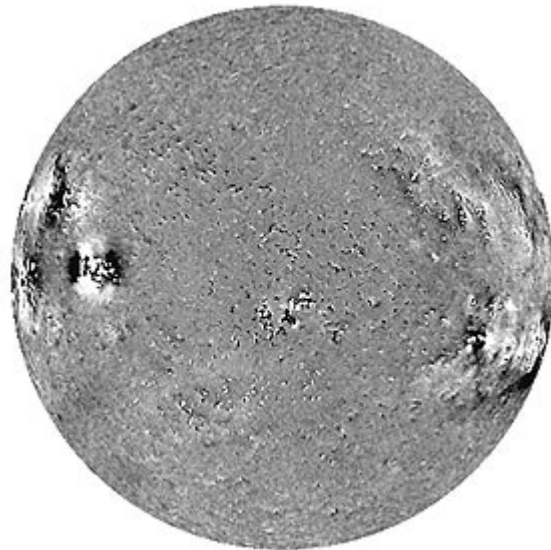


Figure 2. The line-of-sight component of the solar magnetic field processed to emphasize the chromosphere. Dark features indicate a field directed away from the observer and light features toward the observer. Note the large-scale diffuse areas near the limb, showing extended regions of horizontally oriented magnetic fields in the chromospheric component. A new reduction algorithm will show these fields more clearly.

GLOBAL OSCILLATION NETWORK GROUP

EL TEIDE • UDAIPUR • LEARMONTH • MAUNA LOA • BIG BEAR • CERRO TOLOLO

GONG

John Leibacher & the GONG Team

The 2004 biennial five-day helioseismology extravaganza (SoHO 14—GONG 2004) hosted by Sarbani Basu and Yale University has just concluded, and it was one of the best ever, with lots of exciting new results on global and local helioseismology as well as asteroseismology. The proceedings should be available very soon on CD, courtesy of ESA. Congratulations and many thanks to Sarbani for a very successful meeting, with 130+ participants. With such attendance, a host of splinter meetings were also held: a Site Representatives meeting, a Scientific Advisory Committee (SAC) meeting, a meeting of the Local Helioseismology Comparison (LoHCo) team, as well as one for the Data Users' Committee (DUC).



GONG 2004 participants.

GONG site representatives Eric Yasukawa (HAO/Mauna Loa Solar Observatory), Alex Liu (Learmonth Solar Observatory), John Varsik (NJIT/Big Bear Solar Observatory), Ashok Ambastha (Udaipur Solar Observatory), and Sebastien Jimenez-Reyes and Peré Pallé (Instituto de Astrofísica de Canarias) were in attendance. In addition to participating in the scientific meeting, we were able to have an in-depth discussion of ongoing activities as well as the many changes associated with the transition of GONG to an ongoing program. Among other things, we discussed the construction of a replacement instrument and the many new science products coming, such as continuous magnetograms, near-real-time farside images, and near-real-time recovery of the entire data stream and generation of science products.

GONG SAC members Sarbani Basu, Peter Gilman, Phil Scherrer, Mike Thompson, and Juri Toomre met and discussed the current status and plans GONG-wide. A high priority from the SAC was near-real-time science, which will allow space weather data products, such as subsurface flow maps, to be produced within a few days on a routine

basis. In order to get the ball rolling for the next big biennial meeting, the SAC accepted an invitation from Mike Thompson and the University of Sheffield to serve as host in 2006.

Over 40 participants came back after the Wednesday afternoon break to discuss future LoHCo team activities! Follow-up meetings over the next few months were scheduled to do the real work, possibly including a workshop in Tucson in January.

Finally, at the end of an exhausting week, the DUC (Sarbani Basu, Sylvain Korzenik, Ed Rhodes, and Jesper Schou, with Charlie Lindsey sitting in for Doug Braun) met to discuss the overall data processing activity with particular attention to the five-year hardware plan, high- l mode analysis, local helioseismology products, and approval of the automatic image rejection. The next DUC meeting has been tentatively scheduled to take place in Tucson next January.

The Tucson GONG team had 19 presentations at the meeting, and we have an updated CD available upon request with these and lots of other goodies. You can check it out, or simply

download it, at gong.nso.edu/CD_2004. In the spirit of taking coal to Newcastle, one of the posters reported work done by Frances Edelman, a Yale undergraduate who worked with NSO as an REU student this summer.

There have been a bunch of new faces appearing, or about to appear, in the GONG team. Jim Mason, who had worked with the ATST site survey, has joined the engineering development group part time to look at modifications required to maintain and improve the instruments' reliability, for example a turret cover. Lou Lederer has returned to work on bringing the mechanical drawings up to snuff for the long haul, and in anticipation of the development of a replacement instrument. We are delighted to have Dee Stover back with us for a bit to bring the electronics schematics along to the same level. Two undergraduates are working with GONG this summer. Anna Malanushenko is back with us from St. Petersburg, bringing the farside imaging software online for routine operations, and working on establishing the degree of correlation of the holographic signal with indicators of solar activity.

continued



GONG continued

Frances Edelman, from Yale, is working on models of the GONG instrument's response to variations in the Nickel line caused by magnetic fields, flares, and other goings on. Sushant Tripathy arrived from Udaipur in mid-August, as part of the NASA-funded SoHO/MDI guest investigator program, to pursue issues related to the transition from globally resonant to local/running waves ("glocal seismology"), and Sasha Serebryanskiy will be joining us from Tashkent, thanks to the NSF/NATO postdoctoral program to work on time-distance helioseismology. Finally, we are interviewing for the open positions for an assistant instrument scientist, and a NASA-funded postdoc to "calibrate" the farside holographic signal in terms of the observed structural changes.

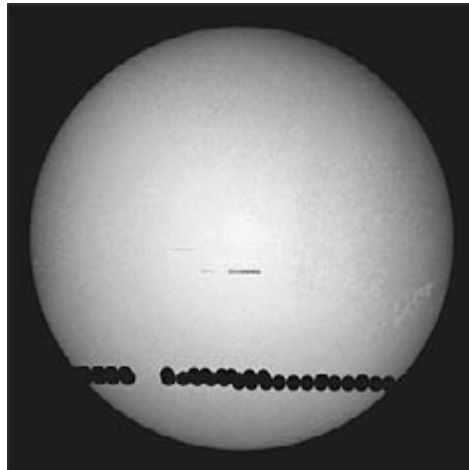
Following the meeting in New Haven, we had the pleasure of welcoming Ashok Ambastha from Udaipur, Olga Burtseva from Tashkent, Caroline Barban from Leuven, and Frederic Baudin from Orsay to Tucson for visits. Hannah Schunker, from Monash University in Melbourne, Australia, also visited for a month to work on her thesis on magnetic fields and the holographic signal.

Sites, Instruments, and Engineering

The second quarter of 2004 was very busy for the operations team, with preventive maintenance visits to Cerro Tololo, Learmonth, and Big Bear. In addition to the routine maintenance performed during these visits, a variety of upgrades took place. Earthquake protection for the optical table was installed at Cerro Tololo and Big Bear and rebuilt camera power supplies were installed at Big Bear and Learmonth. All three sites received reworked filter/interferometer assemblies and motor amplifier chassis with new noise suppression circuitry. The Big Bear turret was replaced with

one employing the newly modified seals that were designed to prevent water intrusion. This turret also includes heater elements to eliminate condensation on the mirrors, which prevents observing under unfavorable temperature and humidity conditions at the Big Bear site.

A great deal of effort was spent in rebuilding, reworking and testing the



The 8 June 2004 transit of Venus was recorded by three of the GONG instruments: Learmonth, Australia; Udaipur, India; and El Teide, Spain. The GONG Web server saw over 100,000 hits per hour during the event!

newly installed components before sending them to the sites. Work on inventory, documentation, and planning future enhancements required a significant effort from all of the operations personnel. Fortunately, the network sites performed well with no unplanned downtime.

The inability of the El Teide camera to stabilize the CCD temperature has been a cause of concern. There was some evidence that the data was being compromised. However, further investigation showed that there was no clear correlation with the CCD temperature, but instead could have been due to the failure of the clean air system. We now feel that the variable

temperature is not causing problems, nonetheless, the camera was exchanged during a scheduled August preventative maintenance trip, and will be thoroughly investigated in Tucson.

A problem in the Udaipur instrument caused the displayed year to change to 2024, but the error was found and promptly corrected. Once the year field of the image headers was corrected, the data were usable. Other anomalies involved two instances of air-conditioning malfunction, which were likewise quickly resolved.

GONG's engineering team has been juggling several projects. A breadboard for the redesign of the modulator circuitry has been implemented at the Tucson site and initial results show a factor of ten decrease in the uncertainty of the magnetogram zero point, but more testing is required before a prototype will be developed.

We are making good progress in developing the capability of making farside images of the Sun available in near real time. We should have this capability by the end of October. The bandwidth at four of the sites is adequate for real-time data transfer of the 200x200 images, and the other two sites (Learmonth and Udaipur) should be able to meet the 24-hour cadence requirement. Although not coupled with the farside project, bandwidth options at all the sites for the near-real-time (NRT) recovery of the *entire* (15 gigabytes per site per day) data stream are being investigated as well. A review of the NRT Plan will occur during the fall.

In order to protect against prolonged outages from natural disasters or other eventualities, the program is taking a serious look at building a complete replacement shelter. We have started gearing up for this by getting the as-built drawings and schematics up to

continued



GONG continued

date—which we need just for long-term maintenance—and completing a thorough inventory of replacement parts. A team review on July 30 was followed by an in-house review in August. A go-no-go decision is expected before the end of the fiscal year.

Data Processing and Analysis

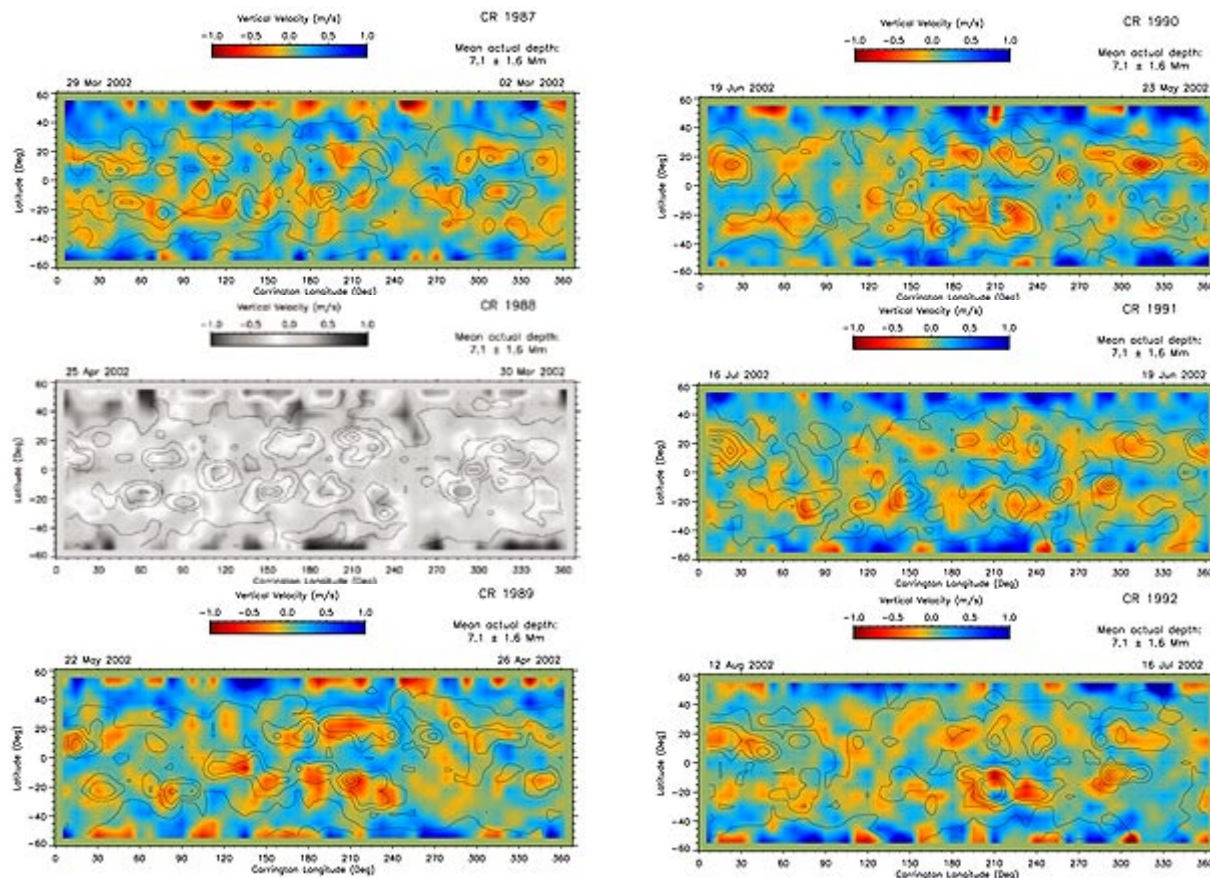
We have now completed processing the data for a ring diagram analysis covering ten solar rotations, including six consecutive ones. This is the longest unbroken series of subsurface flows maps generated thus far and it allows us to start investigating temporal variations without aliasing concerns. We should have a set of 30 consecutive rotations by the next *Newsletter!*

The analysis of the Halloween 2003 flare areas revealed a kinetic helicity signal that rapidly grew in strength immediately before the event, vanished during the flare, and was not evident in areas away from the flare. This is an intriguing result, and we will be looking for similar events associated with other flares to evaluate the predictive capability of this signal.

We have been developing a computing hardware plan to address GONG's expanded science and service requirements. The main thrust of the plan is a shift from Sun systems to Linux-based PCs, where we will benefit from a better price-to-performance ratio. Detailed timing tests of current in-house and alternative hardware options were performed, and reality-

based estimates of the resources required to adopt an alternative option were investigated. The outcome is a five-year plan for purchases that addresses both data pipeline and scientific development needs.

During the past quarter, month-long (36-day) velocity time series for GONG months 87 through 88 (ending 7 January 2004), with an average fill factor of 0.91, were archived into the DSDS. "Peakfind" results for the same time period have also been archived. The DSDS distributed 330 gigabytes in response to 22 data requests. The data reduction team continues to reduce the cumulative backlog for GONG+ data products, which is currently down to 135 days.



Six rotations of flow maps.

EDUCATIONAL OUTREACH

PUBLIC AFFAIRS AND EDUCATIONAL OUTREACH

2004 TLRBSE Summer Workshop Reaches New Heights

Steven Croft & Stephen Pompea

Twenty middle school and high school science teachers spent two weeks at NOAO in mid-June as part of their training in the Teacher Leaders in Research Based Science Education (TLRBSE) program, sponsored by the National Science Foundation. This is the third full year of this flagship Teacher Retention and Renewal program at NOAO, and both staff members and external evaluators agree this year's group was the best-prepared one yet. This advance preparation—aided by some especially good observing conditions on Kitt Peak during the intensive summer workshop—was reflected in the impressive quality of the initial research project results presented by the four teacher groups in the workshop's second week.

Designed to bolster secondary school science teaching across the nation, TLRBSE helps renew the enthusiasm and research pedagogical skills of experienced science teachers by giving them new techniques for instruction and immersing them in hands-on astronomical research. The program also helps retain science teachers by training these experienced attendees to serve as mentors to newer teachers in their area.

The experienced teachers (who must have completed more than five years in the science classroom) participate in the program as "Teacher Leaders." They are competitively selected, and come from all across the nation, from Alaska to Hawaii to Puerto Rico. They participate in a 15-week distance learning course in which they are given training in astronomy content, research pedagogy in the classroom, leadership, and effective mentoring techniques. They are also trained in one of four astronomical research projects. The projects supply them with a real research experience that they can share with their students. In order to make their research experience concrete, they come to Tucson and spend five days working with TLRBSE staff astronomers collecting data on three of Kitt Peak's major nighttime telescopes and the world's largest solar telescope.

During the summer workshop, the Teacher Leaders are provided with continued training in leadership and mentoring skills. After they leave the workshop, they are expected to take the



Figure 1. TLRBSE 2004 summer workshop participants and staff on Kitt Peak.

research techniques and astronomy research projects back to their classrooms. They are also expected to find at least three teacher "newbies" (less than five years in the classroom) in their home school or district and mentor them for at least two years to help them through the frequent rough spots encountered by those new to teaching—roughly half of all new teachers quit within the first five years.

The summer experience of this year's extremely well-qualified cadre was aided by five mostly clear days and nights on Kitt Peak that enabled them to collect significant new data for their research projects: searching for novae in the Andromeda Galaxy; recording and interpreting spectra of Active Galactic Nuclei; obtaining and interpreting spectra and light curves of giant and supergiant irregular variable stars to determine the basic nature of these stars; and, using Zeeman Splitting of infrared solar lines to investigate magnetic fields in sunspots.

Three successful alumni of the TLRBSE program returned to the workshop to provide this year's group of Teacher Leaders with the savor of real classroom experience in applying the objectives

continued



Public Affairs

2004 TLRBSE Summer Workshop continued

of TLRBSE. Babs Sepulveda, a high school teacher from California (TLRBSE Cadre of 2002), Velvet Dowdy, a high school teacher from Kentucky (TLRBSE Cadre of 2002), and Andy Miller, a middle school teacher from Texas (TLRBSE Cadre of 2001), presented discussions of their experiences with using research in the classroom and in mentoring new teachers. The 2004 teachers agreed that these presentations were an invaluable part of the workshop.

In addition to mentoring less-experienced colleagues in their home areas, the community-building aspect of the 2004 cadre will be strengthened by assembling them and their "mentees" together at the April 2005 meeting of the National Science Teachers Association in Dallas. There they will share their experiences with the TLRBSE staff and each other.

The TLRBSE program makes the new 2004 data available to all past participants of the program, so that they may continue using the TLRBSE research projects in their classrooms. In addition, TLRBSE publishes a peer-reviewed journal with science results from student/teacher research groups.

TLRBSE will continue to expand with a new class of teachers in early 2005, for which recruiting will begin in September. See www.noao.edu/outreach/tlrkse for further information. We encourage you to find teachers in your area who might be interested in applying for the program.

We thank the many NOAO staff, and NSO staff members Frank Hill, Claude Plymate, and Carl Henney, who all contributed their time and expertise to the preparation and performance of the workshop.



Some TLRBSE 2004 Teacher Comments

"A fantastic experience! The hands-on aspect of collecting data was the best part."

"It is a great validation for participants to feel as though their ideas are respected and their interests appreciated. It is also great validation to be expected to perform at a high level. Kitt Peak astronomers were tremendous at this!"

"We were treated like real astronomers. The accommodations were superb and the willingness of the staff to give up five days of their own observing opportunities is something that many of us appreciated."

"This was the experience of a lifetime. I feel privileged and fortunate to have had the opportunity. Everyone made us feel a part of the community. I really didn't want to leave."

"The night sky over Kitt Peak is magical—just an incredible experience."

"The opportunity to engage in observations at each telescope was invaluable in helping us to understand the data sets from each group. Coupled with the pre-Kitt Peak talks from each faculty member, I now have an understanding of the data limitations, etc."

"I can say that this ranks at the top of my experiences in education training. Thank you, thank you, thank you!"



First Hands-On Optics Kits Debut to Positive Reviews

Stephen Pompea & Douglas Isbell

The NOAO Hands-On Optics (HOO) team recently completed a number of milestones in the development and alpha testing of fun and instructional optical engineering activities for after-school science programs.

HOO is a collaborative program supported by the National Science Foundation's informal science education program that is designed to get underrepresented middle school students excited about science by actively engaging them in creative optics activities. NOAO is teamed with the Optical Society of America, SPIE, and MESA of California in the development, testing, and dissemination process of six inquiry-oriented optics modules aimed at the seventh grade level.

The first three modules under development deal with reflection and refraction of light. The NOAO Tucson HOO team consists of Stephen Pompea (Project Co-Principal Investigator, spompea@noao.edu), Connie Walker (professional development lead, cwalker@noao.edu), University of Arizona Optical Sciences Center graduate students Brian Kinder and Ken Cardell, and University of Arizona undergraduate astronomy major Carolyn Peruta.

Primary testing for the first three HOO modules has been held in Tucson at Wakefield Middle School and the Jewish Community Center. Further testing was conducted at a three-day workshop in mid-July led by Walker and Pompea at the University of Southern California (USC).

The USC workshop trained 28 MESA teachers and optics industry "resource agents" from California and Washington on prototype HOO activities, such as constructing a kaleidoscope, and hitting a target with a laser-pointer beam reflected off a progressively larger number of mirrors. Imbedded within these challenges are memorable lessons about magnification, how to determine the focal length of a lens, the unusual qualities of multiple mirror systems, the Law of Reflection, and the nature of common misconceptions about light.

"We use lasers because they are everywhere—in CD players, scanners, security systems, surgical devices, and military systems," explains Jason Briggs, education program manager at the Optical Society of America. "The physics and technology of lasers are ideas every student should be learning, but you've got to get the teachers on board with the ideas first."

"The sixth, seventh, and eighth grades are the perfect time to catch kids and teach them about science and technology," says NOAO's Walker, "because by high school, many of them have shied away from it, thinking it's not 'cool' enough."

The workshop was judged by the project's independent evaluator to be an outstanding success for both the teachers and volunteers. Informal comments from the teacher attendees support this positive early review.

"The kids are going to love this," said Darren Hayes, a science teacher at Willard Intermediate School in

continued



NOAO Senior Education Specialist Connie Walker helps Darren Hayes, a Compton teacher, left, and Richard Farnsworth, right, of Lawrence Livermore National Observatory, design a five-pointed laser star using mirrors and a single beam of light.



Public Affairs

First Hands-On Optics Kits Debut continued

Santa Ana, California, after learning how to build the HOO kaleidoscope kit.

Work at NOAO continues on producing and assembling extensive optics kits for the USC workshop teachers, and on the development of the second set of HOO modules. The project's advisory board will meet in October at the Optical Society of America meeting in Rochester to review the project's progress. Articles are being written about HOO for the Optical Society's *OPN* magazine and *Physics Today*, which should appear this winter.

Thanks to the USC Viterbi School of Engineering News for some of the material quoted in this article.



Michelle Hauer, a USC electrical engineering graduate student, aims laser beams at a mirror, being held by a teacher, to demonstrate the Law of Reflection.

KPNO and NSO 2004 REU Attendees



KPNO 2004 Research Experiences for Undergraduates (REU) participants. Left to right: Ian Roederer (Indiana Univ.), Lucas Laursen (Harvard Univ.), Elizabeth Schmidt (Carthage College), Laura Kushner (Univ. of Washington), Cassandra VanOutryve (Univ. of California at Berkeley), and Miranda Nordhaus (Rensselaer Polytechnic Institute).



NSO 2004 REU, Research Experiences for Teachers (RET), and Summer Research Assistantship (SRA) Program participants. From left: Creighton Wilson (RET, Lovelady High School), Michelle McMillan (REU, Northern Arizona Univ.), Drew Medlin (Grad SRA, New Mexico Tech), Leah Simon (Grad SRA, Macalester College), Maria Kazachenko (Undergrad SRA, St. Petersburg Univ., Russia), Michael Sinclair (RET, Kalamazoo Math and Science Center), Brian Robinson (ATST Fellow, Univ. of Alabama-Huntsville), Stuart Robbins (REU, Case Western Reserve Univ.), Brian Harker-Lundberg (Grad SRA, Utah State Univ.), Frances Edelman (REU, Yale), Stacia Luszcz (in front of Frances—REU, Cornell), Joel Lamb (REU, Univ. of Iowa), Mark Calhoun (RET, Sabino High School), Heidi Gerhardt (in front—Towson Univ.). Missing from photo are Matt Dawson (RET, Brockton High School), Cheryl-Annette Kincaid (Undergrad SRA, Univ. of North Texas), Kimberly Moody (Undergrad SRA, Univ. of Arizona), Anna Malanushenko (Undergrad SRA, St. Petersburg Univ., Russia).