NOAO-NSO Newsletter

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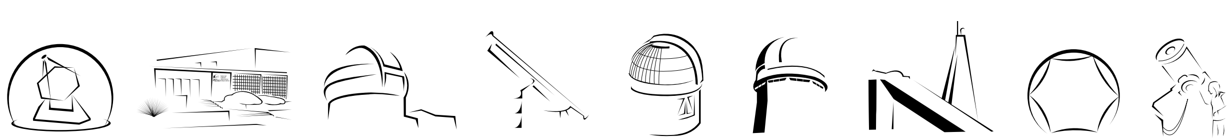

"Who or what is Sunspot?" Dave asked.

"It's the home of the National Solar Observatory. *The* premier research facility for solar phenomena in the country. I've been wanting to visit for years," Kate said.

She took a quick look at her watch, another at the mile indicator on the signpost, and calculated they could squeeze in a quick visit.

"Think they're open this late on a Sunday afternoon?"

"Not to the general public, maybe. But I've done some work with the observatory's director. If I drop his name, maybe they'll let us poke around."

…Kate felt as though they'd reached the top of the world when they arrived at the cluster of buildings that constituted Sunspot, New Mexico. There was no restaurant, no grocery store, no services of any kind, so she could only hope the pickup had enough gas to get them down the winding twists and turns.

What Sunspot did have, though, was a searingly blue New Mexico sky known for its clarity and transparency. For this reason, the U.S. Air Force had asked Harvard University to design a geophysics center on the site back in 1948 to observe solar activity. They started with a grain bin ordered from Sears Roebuck. The site had since developed into a complex that included two forty-centimeter coronographs, high-tech spectrographs to measure light wavelengths and the Richard B. Dunn Solar Telescope—an instrument that was thirty stories tall and weighed some two hundred and fifty tons.

Kate couldn't wait to see it. Being able to show Dave some of her world was an added excitement.

…Dave's travels had afforded him the opportunity to view a good number of the world's marvels, both ancient and modern. The Dunn Telescope certainly qualified as the latter. The telescope's upper portion was housed in a tall, white tower that rose some thirteen stories into the air. The lower portion lay underground. The entire instrument was suspended from the top of the tower by a mercury-float bearing. The bearing in turn hung by three bolts, each only a couple of inches in diameter. Thinking about those nine meager inches didn't make Dave feel exactly comfortable when he followed the two scientists onto the observing platform.

"The telescope is set to look at the quiet side of the Sun right now," [deputy director] Petrie said apologetically as Kate peered through its viewer. Dave took a turn and saw a dull gray ball.

"We use a monochrome camera to record the video image," Petrie explained. "This one is being taken in hydrogen alpha light, at about sixty-five hundred angstroms."

Thankfully, Kate drew the scientist's attention with a comment. "You must use an electronic CCD to record the color images captured by your spectrographs."

"We do. With the Echelle Spectrograph, we can measure two or more wavelengths simultaneously even when they're far apart on the spectrum. We can also conduct near-ultraviolet and near-infrared observations."

Like most pilots, Dave had studied enough astrophysics to follow the conversation for the first few minutes. He knew near-ultraviolet and near-infrared light were just outside the visible range. After that, the scientists left him in a cloud of dust.

…Busy studying [Kate's] profile, Dave missed the comment that drew her auburn eyes into a quick slashing frown. "How much activity?" she asked Petrie.

They were talking about sunspots, Dave realized after a moment. The real thing, not the town. Evidently the folks at the observatory had recorded a buildup of energy in the sun's magnetic field.

"There's definitely potential for eruptive phenomena."

-- Excerpt from Full Throttle *by Merline Lovelace, Book 2 in the Protect and Defend Series, 2004 Reprinted with the kind permission of the author, who is an ex-US Air Force Colonel, and publisher Silhouette Books (For more information, see www.merlinelovelace.com)*

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

On the Cover

This artist's concept shows spiral galaxy C153 being shredded by the hot gas of a galaxy cluster that C153 is falling into at a speed of 7.2 million kilometers per hour. The ram pressure that the gas in the cluster is imparting to the infalling galaxy is stripping off the spiral arms of C153, and causing it to leave a streaming tail of gas that stretches for 200,000 light-years.

This artwork was commissioned by the Space Telescope Science Institute's Office of Public Outreach to support a press briefing at the January 2004 AAS meeting in Atlanta. The press briefing described parallel observations at optical, radio and X-ray wavelengths from NOAO, Gemini, Hubble, National Radio Astronomy Observatory, and Chandra that trace how stars, gas, and dust are being tossed and torn from the fragile galaxy. (See related article on page 7 for details.)

Image credit: A. Schaller and NASA

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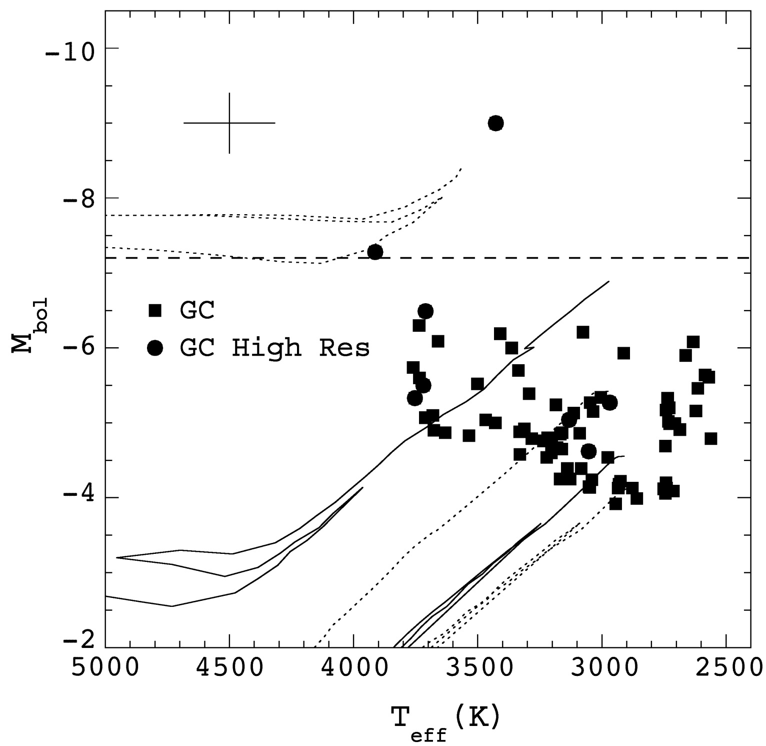
Star Formation History at the Galactic Center

Bob Blum (NOAO)

There are some really cool stars in the Galactic Center. In fact, the Galactic Center is so chock-full of interesting objects and phenomena that it sometimes seems mysterious or at least overly complicated. However, three decades of work have shed amazing light on the nucleus of the Milky Way since it was first observed in stellar light by Eric Becklin and Gary Neugebauer in 1968 (*ApJ,* 151, 145). Not long after, Bruce Balick and Robert Brown (1974, *ApJ,* 194, 265) identified the strong and compact nonthermal radio source, Sgr A*, which has been identified with the massive black hole (4×10^6 $M_\odot$) at the heart of the Galaxy. Exquisite images taken with the new generation of adaptive optics (AO) instrumentation (by groups at Keck Observatory, led by Andrea Ghez of UCLA, and at the European Southern Observatory, led by Reinhard Genzel) have at long last observed direct accretion activity at the location of Sgr A* in the near infrared. Presumably this activity is due to stellar or gas infall onto the black hole. The enclosed mass within one parsec is dominated by the black hole, but on scales larger than a few parsecs, the stars begin to take over. The present gas content of the Galactic Center is rather low, a few times 10^4 $M_\odot$ in molecular material in the circumnuclear ring, whose inner edge is located roughly at 2 parsecs.



Hertzsprung-Russell diagram for the Galactic Center stars (filled squares). Solar metallicity isochrones for ages of 10 million years, 100 million years, 1 billion years, 5 billion years, and 12 billion years are plotted as alternating dotted and solid lines. No isochrones reach the coolest stars, although the solar metallicity isochrones extend to cooler temperatures and provide a better fit than lower metallicity isochrones. All the Galactic Center stars are AGB stars, a consequence of the selection criteria. The horizontal line segment at Mbol=-7.2 in each panel indicates the approximate observed luminosity above which only supergiants lie. The Galactic Center stars analyzed at high-spectral resolution by Carr et al. (2000) and Ramirez et al. (2000) are plotted as filled circles.

Perhaps one of the most difficult questions remaining in the study of the Galactic Center is how stars form in this dense environment. The tidal forces are so extreme due to the black hole (on the smallest scales) and due to the black hole plus stellar mass on parsec scales, that the molecular density required to collapse gravitationally is thousands of times greater than presently observed. And yet, stars do form. In the 1990s, it was recognized that strong compact emission in the lines of HeI and Br gamma were due to evolved massive stars of a few million years in age (see e.g., Krabbe et al. 1991, *ApJ,* 382, L19). Recent AO imaging by the ESO group has detected perhaps lower-mass companions to this activity, and the UCLA group has identified one of the individual stars that orbits the black hole as a main sequence OB star.

Ignoring the apparent difficulties faced by stars during formation, we can take their existence for granted and step back to ask what is the history of star formation in the central few parsecs? It is the cool stellar population that dominates the integrated light at the Galactic Center at near-infrared wavelengths. The many bright asymptotic giant branch (AGB) stars and M supergiants are excellent tracers of the history of star formation there. There have been many studies of the late-type population at the Galactic Center, but our group has recently completed the first detailed calculation of the star formation history, using advances in stellar models and analysis techniques (see Blum et al. 2003, *ApJ, 597, 323*) along with H-band and K-band spectroscopy obtained with the OSIRIS near-infrared spectrometer at the CTIO Blanco 4-m telescope in Chile.

continued

Star Formation History continued

Using a sample of about 80 luminous AGB and M supergiant stars in the central 4 parsecs, we have transformed the observed brightnesses to bolometric luminosities and, along with effective temperatures derived from the spectra, have placed them in the Hertzsprung-Russell diagram (see figure). Using a maximum likelihood technique like those used successfully in deriving star formation histories from Hubble Space Telescope color-magnitude diagrams, we computed the star formation history in the Galactic Center.

The sample is relatively small, and thus the models are not unique, but several conclusions can be made. The bulk of the stellar mass in the Galactic Center is old. Approximately 75% of the total mass formed in stars in the Galactic Center over its history is more than 5 billion years old. The star formation rate is variable, being somewhat more active in the recent past than at the current time and with some evidence that an intermediate age burst (a few billion years) may have occurred at the same time as a similar age burst in the larger inner Galaxy region. This suggests possible connections between the inner Galaxy and its nucleus and events, which may funnel gas from large scales to small. In order to match the estimates of the dynamical mass, the star formation model must have a low mass cutoff in its initial mass function, which might be due to mass segregation effects or to the unique conditions of star formation in the Galactic Center mentioned above. The latter could result in a mass function weighted to more massive stars.

The chemical enrichment picture in the Galactic Center is not clear, but the star formation history analysis gives better fits to the data for models with solar metallicity, even at the oldest ages. There are simply too many stars at very cool temperatures and low luminosity that are not fit by lower metallicity isochrones. Given the limits of the sample, it is possible that an even older, metal-poor component exists but is too faint to have been included. The solar metallicity result is consistent with high-resolution abundance analyses recently completed by the Ohio State group led by Kris Sellgren (see Carr et al. 2000, *ApJ,* 530, 307 and Ramirez et al. 2000, *ApJ,* 537, 205) at least for stars with ages up to about one billion years.

The Nature of Damped Lyα Absorbers via the Clustering of Lyman Break Galaxies

Nicolas Bouché (ESO)

From recent large surveys of galaxies, we know much about the star formation history and the buildup of stellar masses of galaxies as a function of redshift. However, one important question remaining is that if cold gas is being turned into stars, at what rate is the transformation occurring? Our best tracer of cold gas at high redshift is damped Ly α absorbers (DLAs). DLAs are the largest reservoirs of neutral hydrogen at high redshift, but their detailed nature and connection to normal galaxies, as well as their role in the galaxy formation process are unclear.

Wolfe and colleagues have argued that the neutral hydrogen content and kinematics of DLAs are consistent with their origin in massive, gas-rich disks. But theoretical simulations have argued that DLAs can arise from a wider range of structures that are found in overdense regions, including massive galaxies, their satellites, and filaments.

In a recent study, we have explored the hypothesis that DLAs arise in overdense regions, using the clustering of Lyman break galaxies (LBGs) around DLAs to constrain the dark matter halo mass of DLAs. Basically, if the amplitude of the DLA-LBG cross-correlation is stronger (weaker) than the LBG-LBG auto-correlation, that means that DLA halos are more (less) massive than the halos of LBGs (~10^{12} $M_{\odot}$).

Using the MOSAIC camera on the Mayall 4-m telescope, we imaged three z~3 DLA fields in *UBV* and *I* (see figure). The images cover a wide field (0.34 sq. deg. per field) and include approximately 800 LBGs per field over the redshift range $2.75<z<3.5$. The wide field of view of the MOSAIC camera was critical. It makes our observations sensitive to clustering on large scales and provides a control sample of the background surface density of LBGs.

We selected LBGs in a redshift slice using photometric redshift techniques. Preliminary results (Bouché and Lowenthal 2003, *ApJ,* 596, 810) indicated that some DLAs reside in overdense regions: in one of our fields, we see a factor of three enhancement in the density of LBGs within 2.5–5 comoving megaparsecs of the DLA.

The more extensive results of our survey (Bouché and Lowenthal 2004, submitted) show that LBGs are correlated with the absorbers on scales of 5–10h^{-1} megaparsecs. The amplitude of the cross-correlation between DLAs and LBGs, w_{dg}, is 1.60±1.3 w_{gg} where w_{gg} is the LBG auto-correlation. This

continued

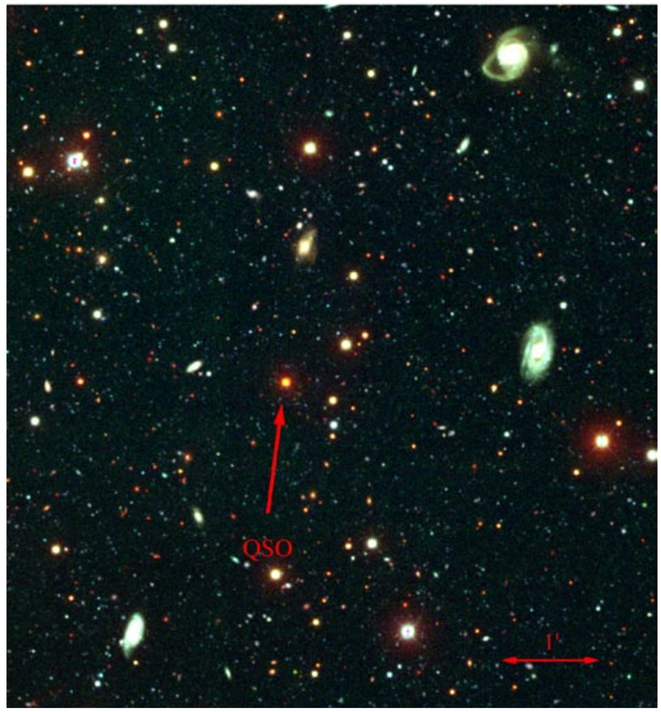
Damped Ly α Absorbers continued

corresponds to a correlation length of r_o=5±4.5h^{-1} megaparsecs.

This result is similar to that of Wolfe (1993, *ApJ,* 402, 411) who reported that Ly α emitting galaxies are clustered near DLAs at *z*~2.6. In contrast other, more recent studies did not detect significant clustering (Gawiser et al. 2001, *ApJ,* 563, 628; Adelberger et al. 2003, *ApJ,* 584, 45). Because these recent studies were limited to small angular scales <5h^{-1} megaparsecs, whereas our study probes larger angular scales (>3h^{-1} megaparsecs), their results are not inconsistent with ours.

At this point, we cannot determine with greater than 1.5-σ confidence whether w_{dg} is larger than zero, and therefore our ability to constrain the mass of DLA halos is limited. Numerical hydrodynamical simulations suggest that w_{dg}=0.7 w_{gg} (Bouché et al. 2004, in preparation) and this would imply that DLA halos have masses approximately five times smaller than LBG halos, using the bias prescription of Mo and White (2002, *MNRAS* 336, 112). Our constraint on w_{dg} is consistent with this prediction within the current observational errors.

The uncertainties on the clustering amplitude improving to the 3-σ level, and therefore, the DLA halo mass, will require sampling an additional nine DLA fields—without spectroscopic redshifts. Multi-object spectroscopy of our LBG candidates can halve the current error bars or the number of additional fields required.



The 8×8 arcmin central region of one of the DLA fields studied, toward QSO APM 08279+5255. The QSO appears red in the BVI image due to its redshift (z=3.91, see the electronic version of the NOAO/NSO Newsletter *for a color version of the figure). There are about seven LBGs with z_{phot}~z_{DLA} in the portion of the field shown. The full MOSAIC data covers more than 30×30 arcmin, or 40×40 megaparsecs, which enabled us to probe the clustering of LBGs around DLAs on scales of 5 to 10 megaparsecs.*

High-Resolution Thermal Infrared Imaging of SN 1987A

Based on a paper by Patrice Bouchet et al.

The explosion 16 years ago of supernova 1987A at a distance of only 50 kiloparsecs from Earth has given us a unique opportunity to study the evolution of a supernova up close. Recent Gemini mid-infrared (IR) observations of SN 1987A are providing new insights into the birth of supernova remnants and the extent to which dust is produced in supernova events.

Using the Thermal-Region Camera and Spectrograph (T-ReCS) on Gemini South, Patrice Bouchet and collaborators James De Buizer, Nicholas Suntzeff, John Danziger, Thomas Hayward, Charles Telesco, and Christopher Packham imaged SN 1987A on 4 October 2003 (day 6067) as part of the System Verification program for the instrument. With the high angular resolution achieved with T-ReCS on Gemini South (0.3 arcsec at 10 µm), emission from the equatorial ring was detected and easily resolved (see figure).

The emission from the ring is clumpy, with "hot spots" that are similar to, but not always spatially coincident with, clumps seen in optical emission lines and at X-ray and radio wavelengths. The T-ReCS result confirms the ISOCAM discovery by Fischera and Tuffs that the mid-IR emission is not concentrated in the debris. Bouchet and colleagues interpret the emission as arising from dust that is heated by shocks. Since it is unlikely that much dust has formed in

continued

High-Resolution Thermal Infrared Imaging continued

the outer, metal-poor region of the ejecta that is currently interacting with the ring, Bouchet and colleagues suggest that preexisting dust in the surrounding circumstellar envelope is responsible for the emission.

Also detected in the T-ReCS image is weak, spatially unresolved emission from the center of the ring at the 0.32 mJy level. This is interpreted as emission from dust in the supernova ejecta itself. The faint emission is likely to be the remnant dust emission that has been the primary cooling process for the thermalized energy produced by the radioactive nuclides synthesized in the supernova explosion.

With the gradual fading of the emission from the ejecta, SN 1987A had become increasingly difficult to study in the thermal IR. As a result, the thermal IR emission from SN 1987A has been detected only a few times in the last five years. In addition to the Gemini observations, other thermal IR measurements have been made by ISOCAM on the ISO satellite and with OSCIR at Cerro Tololo Inter-American Observatory.

The 0.32 mJy flux density of the central emission feature is consistent with an exponential decline in the 10 µm flux density with time from day 2200 to 6000. This suggests that the much brighter emission from the ring (which is approximately 20 times brighter than the central point source) is a new feature that developed around day 4000 or sometime thereafter.

Such observations of SN 1987A and other supernovae have the potential to address directly the issue of whether supernovae are a significant source of dust, for example, as compared to dust production by winds from supergiants and AGB stars. While various indirect arguments suggest that dust production in supernovae is efficient, it may be relatively difficult for dust to survive both the intense extreme ultraviolet radiation field in the supernova environment as well as the shocks that are produced as the outflowing material encounters the surrounding medium.

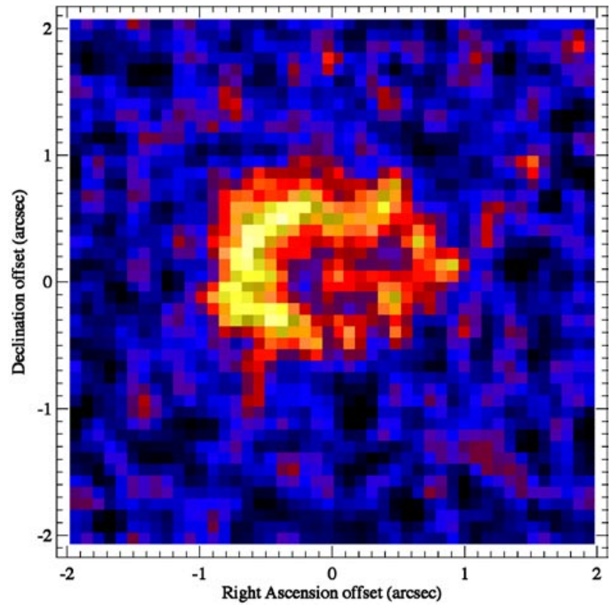


Image of SN 1987A obtained on 4 October 2003, showing the bright equatorial ring and fainter central point source. These results demonstrate the high angular resolution achieved with T-ReCS on Gemini South.

The Gemini observations demonstrate that dust condensates in the SN 1987A ejecta have survived the 16 years since the outburst. Further observations over a wider range of wavelengths are required to measure the mass of the dust that has been produced.

NOAO at the January AAS Meeting

A New Titleholder for Most Massive Star?

A 17-member team of astronomers and graduate students led by Steve Eikenberry (University of Florida) have identified a potential new record holder for the most massive star discovered to date.

In their paper, described at the January 2004 AAS meeting and recently submitted to the *Astrophysical Journal,* Eikenberry's team concluded that the luminous blue variable LBV 1806-20 is at least as luminous as the previous record holder, the "Pistol star" (5–6 million $L_\odot$), and is perhaps as luminous as 40 million $L_\odot$, making it potentially the most massive star known. Located 15 kiloparsecs away on the other side of the Galaxy, LBV 1806-20 is highly extincted and consequently best studied at infrared wavelengths.

In order to estimate the luminosity of the object, Eikenberry's team used the CTIO Blanco 4-m telescope combined with previous millimeter observations to measure the temperature, extinction, and distance to LBV 1806-20. They also carried out speckle imaging at the Palomar 200-inch telescope. The high angular resolution observations demonstrated that LBV 1806-20 is not a stellar cluster but rather a single or binary star system.

Simple Eddington luminosity arguments suggest a total (single or binary) mass of >150 $M_\odot$ for the object. If the object is a single star, it is substantially more massive than the upper mass limit of approximately 120 $M_\odot$ predicted by current theories of star formation.

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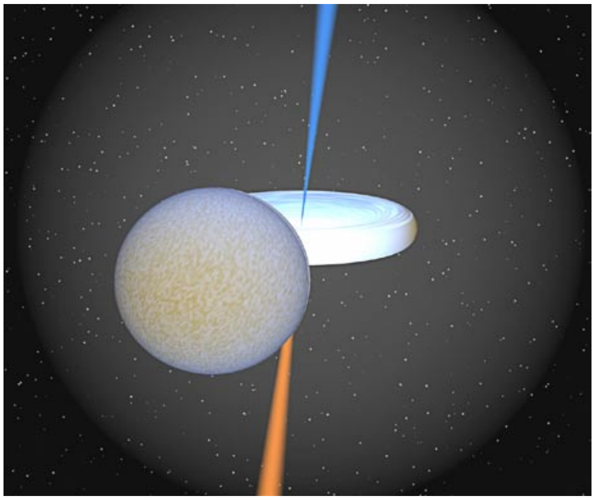
NOAO at the January AAS continued



A computer-generated image of the X-ray binary SS 433, produced using software written by Robert Hynes of the University of Texas at Austin.

The Mass Donor Star in SS 433 Revealed

Although the X-ray binary SS 433 was made famous 26 years ago when astronomers discovered that the system emits gas jets moving at about one quarter the speed of light, the mass donor component of the system has eluded direct observational study, until now.

In order to detect the donor star, a team of astronomers led by Todd Hillwig of Georgia State University waited for the most opportune moment to observe the system: when the donor star eclipses the extended disk surrounding its unseen companion and at the disk precessional phase when the star lies above the disk. This configuration occurs only twice a year.

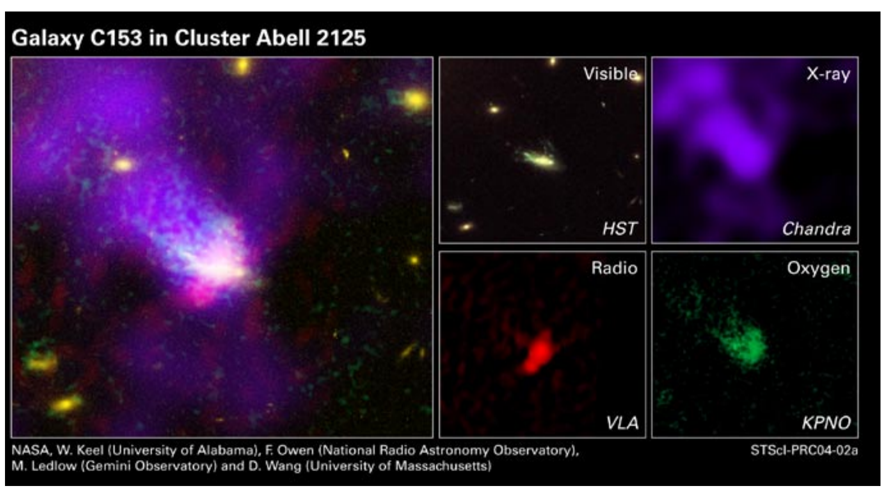
As described by the research team at the January AAS meeting, moderate-resolution spectroscopy of SS 433 carried out with the 4-m Mayall telescope on 2 October 2003 revealed the donor star to be an A supergiant. The variation in the strength and velocity shift of the A-star spectrum is consistent with this interpretation. The radial velocity variations imply a mass of ~11 $M_\odot$ for the donor star and ~3 $M_\odot$ for the unseen companion and its disk, suggesting that the companion is a low-mass stellar black hole. Hillwig and collaborators are planning follow-up Gemini observations in order to refine their estimate of the component masses.

A Galaxy Takes the Plunge *(see cover photo)*

The close encounter approximately 100 million years ago of major merging subsystems in the well-known cluster Abell 2125 is thought to have thrown cluster member C153 onto an infall trajectory into the dense cluster core. Recent observations of induced star formation and gas stripping from C153 provide insight into how cluster-level mergers may affect the evolutionary histories of galaxies.

The transformation of C153, as a consequence of its headlong plunge, was described by astronomers William Keel, Frazer Owen, Michael Ledlow, and Daniel Wang in a presentation at the January AAS meeting. Imaging with the Mosaic camera on the Mayall 4-m telescope revealed a tail of ionized gas, detected in [OII] emission, that extends more than 70 kiloparsecs toward the cluster core. The tail is coincident with a soft X-ray feature detected with the Chandra X-ray Observatory.

The optical morphology of C153, as measured with HST WFPC2, is clumpy, showing irregular dust features as well as multiple sites of star formation embedded within the envelope of the ionized gas tail. Further evidence that the gaseous component of the galaxy has been disturbed comes from optical spectroscopy obtained with Gemini North. GMOS spectroscopy shows that the gas kinematics are decoupled from the stellar kinematics and possess multiple gas velocity systems, including counter-rotating components. The optical spectroscopy also shows that the most recent burst of star formation in the galaxy occurred approximately 100 million years ago. The timing of the burst strongly suggests that the burst was triggered by the passage of C153 through the dense cluster core.



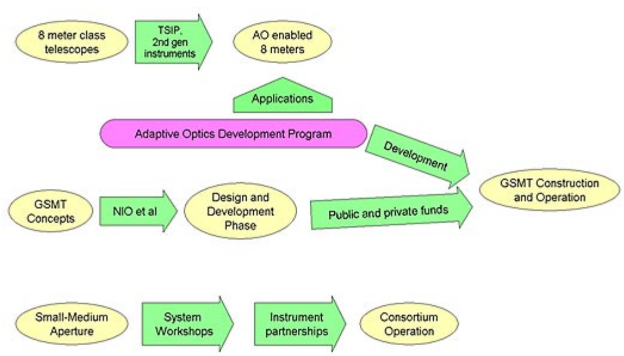
Composite image showing galaxy C153 as it travels through the cluster Abell 2125. The separate images were taken in X-ray (with Chandra), radio (by VLA), and visible (with HST) wavelengths, as well as the green light of singly-ionized oxygen at the KPNO Mayall 4-meter telescope.

Creating a Decadal Survey Roadmap

Jeremy Mould

When *Astronomy & Astrophysics in the New Millennium* was written four years ago, it described a vision for the future, complemented by some quite detailed concepts and illustrations of new facilities. However, the Decadal Survey report was careful not to be prescriptive about how its goals should be achieved, although the committee spoke strongly to the national observatory to lead the ground-based optical/infrared project of largest scale, or get out of the way.

For the Giant Segmented Mirror Telescope (GSMT) and Large Synoptic Survey Telescope (LSST), the landscape now features multiple design concepts. The National Virtual Observatory is advancing in its architecture and broadening its grid plans internationally. The Telescope System Instrumentation Program (TSIP) was really the only Decadal Survey program that came ready to implement. ("Just add water.") The National Science Foundation (NSF) added the "water," and we are now in the third cycle of TSIP. The community enjoys access to Keck and other telescopes, and a new generation of instruments in the underbudgeted 10-meter telescope generation is under construction.



With the decade advancing, it is time to think about a proper roadmap for GSMT and LSST, one that links the telescope concepts we have been developing for the last few years. As we heard at the NSF Town Meeting at the January AAS meeting in Atlanta, the GSMT roadmap needs to look out beyond end of the decade. The figure shows how the four processes of TSIP, the Adaptive Optics Development Program (see article on page 9), the NIO (see article on page 11), and SMARTS work together to prepare the road for GSMT.

Currently, both a Thirty Meter Telescope (TMT) and a Giant Magellan Telescope (GMT) are entering a design and development phase. As the GSMT Science Working Group opined last June, there is a sound case for supporting the technology development for both of these concepts in a coordinated way:

- The broad front on which adaptive optics is advancing needs multiple approaches
- Like lightning, we cannot predict where the unique US astronomy community asset—private funding—will strike next. Since university faculties yearn for telescope shares of the order of 20 percent, placing more than one design project on the roadmap maximizes our chances
- We need to establish constructive links with Europe. An ALMA-like collaboration will surely be considered by the next Decadal Survey

In merging NOAO's 30-meter telescope concept with CELT's and ACURA's last year, AURA acted to simplify the roadmap. Redundant duplication was removed. As we develop a clear roadmap, more phasing and merging will be needed. But I concur with the view expressed in a recent *New York Times* article on GSMT that "all options are open." The healthiest atmosphere is one in which both TMT and GMT support each other to realize their goals, and in which new concepts, such as an Antarctic Extremely Large Telescope, continue to come forward.

The roadmap for the Decadal Survey's revolutionary survey telescope concept looks a bit different. Thanks to the initiative of the Institute for Astronomy, we have a funded prototype telescope (PanSTARRS) capable of delivering a significant fraction of the planned survey science. Other precursor experiments are already productive, such as QUEST and ESSENCE. The funding agencies are lining up to support this science. Perhaps this should not surprise us after the success of the push on cosmology in the last decade, which, in finding elegant astronomical solutions, asked new fundamental physics questions.

Other important landmarks on an LSST roadmap are the One Degree Imager (ODI) for WIYN and the Joint Dark Energy Mission, the spacecraft formerly known as SNAP. For the LSST roadmap, the key questions to answer along the way concern the single versus multiple aperture question, and the science drivers for LSST in 2011, building on the work of precursor facilities. Work on the second question is under way with the community's LSST Science Working Group. Their soon-to-be published LSST Design Reference Mission sets a high bar for whatever large AΩ design is chosen, when a construction decision is needed (possibly as early as 2006).

continued

Creating a Decadal Survey Roadmap continued

A dimension missing from this roadmap is the challenge of interfacing the new digital sky to an astronomy community that has established concepts of the tools with which it wishes to analyze the data. Which agency will support this challenge? We should expect the NSF to play a significant role, as a pioneer in academic information technology research and developer of high-performance computing facilities for the research community.

Let's give some serious thought to roadmaps for LSST and GSMT in the context of the Science Working Groups' discussions during 2004. And we should not forget, that, as we roll out roadmaps for future years, we need to roll up the roadmap that got us to where we are. We need innovative plans to make productive use of the facilities that used to be the frontline. A good example is provided by the SMARTS Consortium, whose first year review can now be read on the CTIO Web site.

In 2004, NOAO wants to engage the community in a strategic planning process focused on our prime responsibility, optical/infrared ground-based facilities. A Second Workshop on the Ground-Based O/IR System, aimed at achieving a better understanding of the current state of the system and near-term options, is planned for May 13–14 in the Washington, DC, area; look for details on the NOAO Web site. Meeting in January at CTIO, AURA's Observatories Council backed the idea that this should be supplemented with a longer-term strategic planning activity, and we are now discussing the approach with other community advisory committees.

We need a roadmap that has wide acceptance, good options, and timely decisions, and one which ensures, in the provocative words of the Decadal Survey, that GSMT construction "starts before the end of the decade."

Adaptive Optics Development Program—First Technology Development Awards and Second Roadmap Workshop

Steve Ridgway & Steve Strom

In 2000, the Decadal Survey panel on Optical and Infrared Astronomy from the Ground recommended that an adaptive optics (AO) technology effort should be supported by funding on the order of $5 million per year throughout the decade. This work was understood to be an essential element of a larger program to develop an Extremely Large Telescope (ELT), and promised significant benefits for the scientific capability of existing large telescopes as well.

Early that same year, NOAO and the Center for Adaptive Optics sponsored a community workshop to prepare an Adaptive Optics Roadmap directed toward fulfilling this recommendation. The roadmap set out in detail the ELT and large telescope science requirements for AO and the committee's vision for a calendar of technology and facility development. With feedback from the National Science Foundation (NSF), strong community support and endorsements, and further iteration with the Roadmap Committee, additional details of technology requirements and priorities were added, and the plan was published in July 2000 (see *www.noao.edu/dir/ao*).

The NSF was able to allocate funding to the Adaptive Optics Development Program (AODP) last year, and in the June 2003 *NOAO Newsletter*, we announced the first AODP funding opportunity at an initial level of $2.9 million. Seventeen proposals were received and peer reviewed by a community-based panel. Six proposals were recommended for funding, in areas of laser technology, deformable mirrors, detectors, and algorithms. Information about the funded proposals can be found at *www.noao.edu/system/aodp*.

The AODP program will continue in 2004 and subsequent years with an expectation of increasing the funding toward levels envisioned by the Decadal Survey and the Roadmap Committee. Preparatory to the development of the 2004 Call for Proposals, the AODP will host a one-day workshop in Tucson on April 26 to review recent and ongoing developments in AO science opportunities, requirements, and technology. Participants in this workshop will include the AODP 2004 Roadmap Panel, who will benefit from input and advice from invited speakers as a current context for preparing an update of the roadmap. A program of contributed papers is not planned, but the workshop will be open to the public on a space-available basis and there will be time for open discussion. When the agenda and venue are available, they will be posted at the AODP Web site.

LSST: A Progress Report

Sidney Wolff

First light in the winter of 2011–2012—that ambitious goal for the Large Synoptic Survey Telescope (LSST) project can be achieved, provided that cash flow is not the pacing item.

Design and Development

The Design and Development (D&D) phase of the LSST project will occur over the next three years, and it will produce a fully costed proposal for the completion of the final design and construction of the 8.4-meter survey telescope. The D&D phase will culminate in preliminary design reviews for most components of the telescope and associated facilities, the camera, and the data management system.

The telescope and facility will be challenging to build, given the very fast focal ratio, tight alignment tolerances, the requirement for managing three active mirrors, and the need to maintain system stability while minimizing downtime. Even more challenging are the 2.3-gigapixel focal plane array camera and the data management system. During the D&D phase, we will evaluate both CCD and CMOS imaging devices. The data management system must process and store more than six terapixels per night, a data rate and volume unprecedented in astronomy. A sampling of high-energy physics and astronomy experiments shows that although no single past experiment has simultaneously managed the LSST data flow, analysis rate, database capability, and real-time requirements, all of the LSST requirements have been met individually within different experiments. We expect to draw heavily on the experience of these other data intensive projects, and participants in several of them are already contributing to the LSST.

The LSST project is being carried out by the LSST Corporation, under the leadership of John Schaefer (Research Corporation), President; Tony Tyson (Lucent and the University of California at Davis), Director; and Don Sweeney (Lawrence Livermore National Laboratory), Project Manager. The founding members of the corporation are Research Corporation, the University of Arizona, the University of Washington, and NOAO. We expect to add more members as the project proceeds. NOAO's representatives to the LSST Board are Jeremy Mould and Sidney Wolff.

The LSST Corporation has recently submitted a proposal to the National Science Foundation for funding that would supply approximately half the cost of the D&D phase of the project. We have pledges of support for the other half of the costs and the human effort needed from 13 different institutions.

Research Corporation and a private donor have made a major financial pledge that will allow the purchase of long-lead-time items, such as glass for the large telescope optics. Steve Kahn will head the effort to design the camera and focal plane, and contributors to this effort include the Kavli Institute of Particle Astrophysics and Cosmology, the Stanford Linear Accelerator Center, and Brookhaven National Laboratory.

Lawrence Livermore National Laboratory is contributing to several different aspects of the project, including project management and data management. Other pledges of assistance in data management have come from the National Center for Supercomputer Applications at the University of Illinois, Microsoft, and Google.

Contributions to scientific planning, oversight, and technical developments will come from Lucent, the University of California at Davis, the Universities of Washington and Illinois, and NOAO. The lead on optics fabrication, testing, and support will come from the University of Arizona. NOAO will take the lead on the telescope, enclosure, and systems engineering for the facility.

In order to maintain its aggressive schedule, the project will have to achieve several significant milestones while the proposal is under review. By October 2004:

- The optical design must be frozen
- The science requirements, functional requirements, and interface requirements documents must all be complete
- The choice of sites must be narrowed to a primary and an alternate
- Glass for the primary mirror must be ordered

The LSST Science Working Group

Major input to the science requirements will be provided by the LSST Science Working Group (SWG), chaired by Michael Strauss (Princeton University). The SWG report should be available shortly. It is already clear that two of the major science goals of a facility with the power of the LSST will be characterization of dark matter and dark energy through measurement of weak lensing over a large area of the sky, and the search for near-Earth asteroids and other small bodies in the solar system.

continued

LSST: A Progress Report continued

As part of the input for the proposal for the design and development phase, Abi Saha of NOAO developed a simulator that made it possible to assess whether the LSST could achieve the scientific goals of both programs with a single observing protocol and in a finite period of time. His simulations show that the goals of the weak lensing program can be achieved in 10 years if and only if the product of telescope aperture (A) and field of view (FOV=Ω) are approximately equal to 260. This product is achieved by the design that we are currently exploring: an 8.4-meter aperture with a field of view stretching 3 degrees in diameter.

Simulations of the asteroid discovery rate given the same observations as used for the weak lensing program, but with the cadence optimized for discovery of nearby solar system objects, indicate that we can discover approximately 80 percent of the potentially hazardous asteroids down to 140 meters in diameter in the same period of time, with even greater completeness for larger sizes. A goal of discovering asteroids as small as this size was recently recommended in a report prepared at the request of NASA's Office of Space Science.

Alternate Design

In parallel with LSST Corporation's work on the design of a large-aperture telescope to provide AΩ=260, the Institute for Astronomy at the University of Hawaii is building a prototype facility, called PanSTARRS, based on multiple small-aperture telescopes. A scaled-up version of this facility with approximately 22 telescopes would provide the required AΩ of 260. Parallel design studies over the next three years should allow a clean choice between the two options.

There are two major issues that will determine the choice. How important is it to optimize the discovery of very faint, rapidly moving objects and short-term transients? And, is it cheaper in the long run to build and operate a single telescope, albeit one that is unique in design and with very large optics, or to clone multiple small telescopes and provide each with a gigapixel camera? Apart from the telescope(s) and enclosure(s), the technical problems faced by the two approaches in terms of building the cameras, obtaining the focal plane arrays, and managing the data are very similar, and each project should benefit from the planning and design work of the other.

More Information

The LSST Corporation will soon have a Web site that will consolidate all of the information about the project and provide up-to-date information about progress. The new site can be found through links from NOAO or directly at *www.lsst.org.*

A Progress Report from AURA's New Initiatives Office

Steve Strom

The AURA New Initiatives Office (NIO) was formed in 2001 to respond to the Decadal Survey's highest priority ground-based initiative: designing a 30-meter-class Giant Segmented Mirror Telescope (GSMT) in this decade to ensure its availability to the US community early in the James Webb Space Telescope (JWST) era. By drawing on both NOAO and Gemini staff, the NIO has made significant progress toward advancing this ambitious goal by

- initiating studies of the scientific potential and performance requirements for a GSMT through a series of community workshops;
- organizing and supporting a community-based GSMT Science Working Group (SWG)
- developing a "point design" for a 30-meter GSMT and using it to identify key technical challenges, needed technology investments, and to develop initial assessments of cost and risk;
- exploring public-private partnerships to design and build a GSMT, and providing a channel for a strong public voice during all phases of such partnership efforts;
- preparing a proposal to the National Science Foundation (NSF) aimed at supporting technology developments (e.g., detectors, adaptive optics components, high-performance durable coatings, and site evaluation) critical to multiple Extremely Large Telescope (ELT) programs.

Developing Representative Science Cases for a GSMT

Three major workshops involving more than 80 scientists from throughout the United States and Canada examined a wide range of fundamental science problems that would be enabled by a large next-generation telescope capable of delivering diffraction-limited images at wavelengths 1 micron and beyond. Problems in three areas (development of large-scale structure; the formation and evolution of galaxies; and the formation and early evolution of stars and planetary systems) were selected for more detailed study, and were used to develop an initial suite of performance requirements for such a telescope. The results of these community-based studies and the derived telescope system requirements are captured in the "GSMT Book" (see *www.aura-nio.noao.edu*).

continued

New Initiatives Office continued

Supporting the GSMT Science Working Group

The GSMT SWG, chaired by Rolf Kudritzki, Director of the Institute for Astronomy at the University of Hawaii, was authorized by the NSF in 2002 and charged with developing a powerful science case to justify the investment needed to develop a GSMT and to provide advice regarding early investments needed to advance ELT programs. The committee membership is broadly representative of community interests (see *www.aura-nio.noao.edu/gsmt_swg/index.html*). Following a year's study and deliberation, the SWG issued its initial report in July 2003. The SWG concluded that a 20- to 30-meter-class ELT would enable fundamental advances in five key areas:

- Tomography of the Intergalactic Medium (IGM) at z>3 via high-resolution spectra of IGM absorption lines observed against the continua of background galaxies and quasars, and direct at developing a three-dimensional map of the distribution of high-redshift gas and its chemical composition
- Direct observation of the galaxy assembly process via integral field unit spectroscopy of pre-galactic fragments aimed at determining gas and stellar kinematics, and quantifying star-forming activity and chemical compositions
- Direct observation of the constituent stellar populations of galaxies via diffraction-limited imaging and spectroscopy aimed at identifying cohort populations of common ages and chemical abundances—the archaeological record of merger events
- Observations of emission arising from gaseous disks surrounding young stellar objects via high-resolution mid-infrared spectroscopy with the goal of learning where and when giant planets form and what planetary system architectures are common
- Direct observations of large numbers of extrasolar planets via coronagraphic imaging and spectroscopy, enabling characterization of their atmospheric structure and composition and a link to the epoch of formation

The SWG also evaluated the technology developments needed to advance multiple ELT programs and urged (1) immediate federal investment in key technology areas common to these programs so that preliminary designs can be completed during the next several years; (2) that federal dollars invested in ELT technology development result in community access on resulting ELTs; and (3) that the community be involved via the SWG and other mechanisms throughout all phases of ELT programs. The SWG report "Frontier Science Enabled by a Giant Segmented Mirror Telescope" was presented both to the NSF (July 2003) and to the Committee on Astronomy and Astrophysics (December 2003—see *www.aura-nio.noao.edu/gsmt_swg/SWG_Report/SWG_Report_7.2.03.pdf*).

Forging a Partnership with ACURA, Caltech, and the University of California

The Decadal Survey noted that rapid development of a 30-meter GSMT would be best accomplished via a public-private partnership that engages the skills and imaginations of scientists and engineers from private institutions and the US national observatory, and that combines funds from federal and nonfederal sources. In December 2002, AURA decided to partner with Caltech and the University of California in the Design and Development Phase for a GSMT. In June 2003, Caltech, the University of California, AURA, and its Canadian counterpart, ACURA, signed Letters of Intent aimed at advancing a Thirty Meter Telescope (TMT) to a formal, costed Preliminary Design.

The Design and Development Phase envisioned by the partners builds on more than eight years of intensive technical study of three point designs (CELT, VLOT, GSMT). Core technical teams are in place and are prepared to move forward rapidly with a goal of completing a Preliminary Design by the end of 2007.

To reach this point will require an investment of $70 million. Of these funds, $35 million are already available in the form of private funds provided by the Moore Foundation to Caltech and the University of California. ACURA has requested funds for its share to the Canadian Fund for Innovation, while AURA has submitted a proposal to the NSF.

AURA's roles are (1) to provide a strong public voice—through the GSMT SWG and through NOAO—in shaping the design of the telescope; (2) to provide funds aimed at developing or evaluating technologies that are critical not only for advancing the TMT design, but to other ELT programs; and (3) to contribute manpower to the joint Design and Development Phase activities. By agreement with the partners, federal dollars invested in TMT will result in public access in the resulting telescope.

Though partnered with TMT, AURA's NIO continues to work closely with other ELT programs by providing both direct support for site evaluation activities, and indirect

continued

New Initiatives Office continued

support through open sharing of key studies (e.g., the effects of wind buffeting on large telescopes) and design tools (e.g., integrated modeling). Our goals remain to ensure public access to one or more ELTs and to advance ELT designs rapidly so that the US community can be certain of having access to a next-generation telescope early in the JWST era.

AURA's Proposal to the National Science Foundation
AURA has submitted a proposal to the NSF aimed at technology areas identified by the GSMT SWG as essential to multiple ELT programs (detectors, gratings, and specialized AO components), and at supporting a site evaluation program aimed at providing common data for a range of sites in North and South America. We are currently working with the GSMT SWG and ACCORD to reach agreement on an implementation plan that would ensure the following outcomes in return for federal investment:

- Provide community feedback during the design phase for ELTs
- Ensure public access to a resulting ELT
- Provide open access to the results emerging from technology development programs
- Provide open competition for key technologies in order to engage the best minds from throughout the US and international community

Community Interaction with the NIO
AURA is committed to providing multiple channels for community input as the design efforts for TMT and other ELT programs proceed—via the GSMT SWG, through workshops that NOAO plans to organize over the next several years, and via direct interaction with NIO staff. Progress reports for ELT programs will be posted periodically on the GSMT SWG Web site. We very much welcome community commentary regarding the direction of ELT programs and the capabilities they plan to provide; such commentary should be addressed to me (*sstrom@noao.edu*) and to Rolf Kudritzki (*kud@ifa.hawaii.edu*), so that we can provide a forum for views that should be discussed by the SWG, and via the SWG, with ELT groups.

Scientists involved with the NIO (Steve Strom, Joan Najita, Bob Blum, Knut Olsen, and Ron Probst) are also prepared to visit institutions throughout the United States to discuss the status of TMT and other ELT programs, and to solicit input. Please contact *sstrom@noao.edu* to arrange for a presentation.

NOAO Helps Rebuild Mount Stromlo's Library

Jessica Bryant

In January 2003, Australia's Mount Stromlo Observatory suffered devastating losses due to fire. The summer bush fires that ravaged nearby Canberra also decimated most of the Observatory's facilities. Workshops, houses, a spectrograph intended for Gemini North, and all five of Mount Stromlo's telescopes were destroyed. The research library, which was housed in the fire-gutted administrative building, was among the heavy losses.

As news of the destruction spread, librarians around the world began expressing the desire to help Mount Stromlo rebuild its library. Messages peppered the listserv of the Physics, Astronomy, and Mathematics Division of the Special Library Association. By the end of January, the American Astronomical Society (AAS) had stepped in and volunteered to organize the donations of materials from the United States.

The first goal of the AAS was to assemble a master inventory list of donation offers. While Ed Anderson, a volunteer working with the AAS, took on that heady part of the project, NOAO geared up to assist. NOAO applied for and received a National Science Foundation grant to cover some of the project's inevitable shipping costs. And, after working internally to find storage space, NOAO found it could offer itself as the central receiving point. This meant that all of the donations would be sent to NOAO, where they would be stored until ready to ship to Australia in one bulk shipment. (Given that we weren't sure how much material was really at hand, this was quite a commitment!)

Kevin Marvel at the AAS worked to confirm what materials Mount Stromlo wanted and, after some delay in sorting out what would be needed (monographs) versus what would not be needed (most journals), the call came across for donors to send items to NOAO. At first, the boxes trickled in rather slowly…one or two at a time, mostly from personal donors who had found a few items to spare. Then, some of the libraries that had offered to send multiple copies of monographs in their collection started shipping multiple packages. Boxes began piling up and the process was underway!

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Mount Stromlo's Library continued

The collection process continued here for four months. Some days, the packages were overwhelming—like the day we received a 1,300-pound shipment from a private donor in Washington state (who had, we assumed, generously cleaned out his personal library). Luckily, NOAO found the space to store over 3,000 pounds of books, although it did require a bit of shuffling around (as our initial storage space filled, we found we had to expand into a sort of storage annex). In the end, NOAO shipped six large packages to Canberra, Australia. Five of the packages were sized 41×29×25 inches and the sixth stood at 55×27×60 inches. The total shipping weight was a whopping 3,271 pounds—clearly a lot of books!

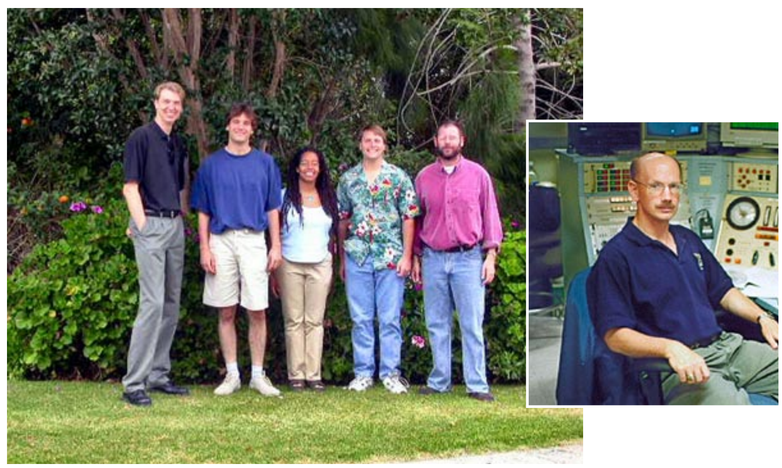
NOAO bids a fond adieu to the books as they travel to their new home, and we are happy to have played a role in helping Mount Stromlo rebuild. Thank you to all of the donors, volunteers, and, in particular, the AAS for making this worthwhile project happen. We wish Mount Stromlo all the best in their reconstruction.

Postdoc Experience at NOAO South: Rewards and Extra Challenges

Douglas Isbell

Part Two of a Two-Part Series

NOAO South postdocs seem to face many of the same challenges and rewards as their counterparts in the north, accentuated by a few geographical and cultural differences.



NOAO South postdocs, from Left to right: James de Buizer, Armin Rest, Dara Norman, Marcel Bergmann, Sean Points, and Alan Whiting.

The relatively small size of the scientific staff at NOAO South (15 people) means "it is very easy to get involved with existing projects," said Dara Norman, who received her PhD from the University of Washington. Norman is a National Science Foundation Astronomy and Astrophysics Postdoctoral Fellow (AAPF) in her third year at NOAO South working with the Deep Lens Survey Team and ISPI instrument support. "However," she added, "if you want these opportunities, like at many places, you have to seek them out."

Being a postdoc anywhere with an active science program can lead to a very busy schedule during peak times. From his previous work with the SuperMacho and ESSENCE survey teams, Armin Rest knew that the pace of the work could be demanding. "During our three-month observing run last fall, there were some days of nothing but working, eating, and sleeping, since rapid time domain follow-up observations are demanded by these surveys." Now "more routine software tools are in place," and "it should be easier" during the next observing run this fall, said Rest, who received his PhD from the University of Washington.

Postdoc Alan Whiting encourages new postdocs looking into a position at NOAO South to consider whether their research interests "can attach to something that is already being done down here [because] it can be a bit lonely if it doesn't." Though in some cases, opportunities arise in surprising places—postdoc Sean Points, who received his PhD from the University of Illinois at Urbana-Campaign and was a Posdoctoral Research Fellow for two years at Northwestern University before taking the position at NOAO South, said he was recently asked to join a collaboration with NOAO

continued

Postdoc Experience at NOAO South continued

Director Jeremy Mould, as a result of his work with Chris Smith on the Magellanic Cloud Emission-Line Survey.

The nature of the national observatory, with outside astronomers visiting often for observing runs or meetings, lends itself to meeting new colleagues, the postdocs have found. "I've been pleasantly surprised with the amount of contact with outside astronomers," said Norman.

Most of the six postdocs at NOAO South have more than two-thirds of their time to dedicate toward their own research, with the remaining fraction to be used on service duties. These duties are varied, and in some cases the postdocs have found themselves working on projects they hadn't anticipated when they started the job.

Whiting—who received his PhD from the University of Cambridge, toured with the US Navy, and taught for the US Naval Academy before coming to NOAO South—voluntarily coordinates the Research Experiences for Undergraduates program at Cerro Tololo, and serves as the science interface with the SMARTS consortium, which now operates the small telescopes at the observatory. "SMARTS has got me into things that I had not expected," such as technical discussions in Spanish with the CTIO engineering staff, said Whiting.

NOAO staff compete for telescope time in the same general pool as all US observers. This can make it challenging for NOAO postdocs to get time on "their own" telescopes for their research. Nonetheless, many of the NOAO South postdocs have been awarded time on the national telescopes, and the quality of these observing experiences seems quite high. Gemini South and the new SOAR telescope provide additional observing opportunities. NOAO Gemini Science Center postdoc Marcel Bergmann, who received his PhD from the University of Texas at Austin, said that the amount of Gemini science time available in the formal Time Allocation Committee process is growing as new instruments arrive and finish their commissioning. "I have gotten time with GMOS on Gemini, and I am very happy with the data," said Bergmann, who is using the data to study the evolution of the Fundamental Plane scaling relationship in cluster galaxies out to high redshifts.

Norman said she has benefited from the proximity of Gemini South astronomers. "I am collaborating with staff at Gemini South, which has helped me to write better proposals, one of which has been accepted for GMOS IFU science instrument verification time. These collaborations are both rewarding and a good path to obtaining new research data."

In addition, the presence of the new Gemini South headquarters building next to the NOAO South building is encouraging more interaction between Gemini and CTIO staff, the postdocs said, especially with the weekly scientific colloquium being hosted there.

The comforts of day-to-day living in La Serena have improved noticeably in recent years. "Today, if there is something you *need*, it is here," Whiting said. "If you *want* something, you may have to go to Santiago, a five-hour drive or an hour flight." Tofu has recently become available and although the value of the dollar has dropped lately, it is still not low enough to make detailed tracking of grocery store purchases a worthwhile endeavor. Chilean wine retains its world-renowned appeal and there are several nightclubs around town that feature, salsa, cumbia, and jazz music. Staff participate in weekly basketball and soccer games with local Chilean players as well as the occasional Ultimate Frisbee game on the beach.

CTIO will pay for Spanish lessons once you arrive in Chile, but going down there with some advance knowledge is very helpful. "Chileans are very patient, and they definitely appreciate it when you try" to speak the language, Rest says. The postdocs suggested that NOAO South consider a more formal program or staff coordinator for new arrivals to get past the "word of mouth" that reigns in figuring out the local environment.

However, the Chilean culture outside of NOAO remains challenging for women. "It is the case that, as a woman, some people will overlook you and talk instead to a man that you might be with, and there is the 'hooting and hollering' on the beach," Norman says. "It can be frustrating."

Overall, the cultural experience and the work involved in being a postdoc at NOAO South seems to combine to make it a rewarding personal and professional passage.

"Of course Chilean culture isn't identical to American or German culture but that's part of the great experience of living in a foreign country, as long as you stay open-minded," Rest said.

Note: NOAO South postdoc James de Buizer, who is on loan to Gemini South, was unable to participate in this interview.

Richard Joseph Elston
(1 July 1960 – 26 January 2004)

Richard J. Elston, beloved husband of Elizabeth Lada Elston and well-loved father of Joseph Lada Elston, died January 26 in Gainesville, Florida.

All of NOAO joins his family and friends in celebrating the warmth, humor, and optimism that Richard always shared so selflessly. Richard married Elizabeth in 1996. Their son Joseph, born in 1999, remembers Richard as a wonderful father who shared with him his love of life and nature. NOAO remembers him as a talented, productive, and supportive colleague as he served NOAO and the general community during his tenure as a Kitt Peak postdoctoral fellow (1988–1991), Cerro Tololo scientific staff member (1992–1996), productive user of our facilities, and member of numerous NOAO review and advisory panels.

A scientist with unusually broad interests and knowledge, Richard was well known for his development of innovative astronomical instrumentation and observational techniques. He played a leading or major role in the design, construction, and commissioning of landmark astronomical instruments that have been used by himself and hundreds of other astronomers at observatories around the world. These observatories include KPNO, CTIO, the Smithsonian Institution and University of Arizona's MMT Observatory, and Gemini South. In over 100 publications, Richard used the technological advances he had fostered to make significant contributions to the study of the formation and evolution of galaxies and the Universe.

His most recently completed instrument was the FLoridA Multi-object Imaging Near-IR Grism Observational Spectrometer (FLAMINGOS) instrument, funded by the National Science Foundation and supported by the University of Florida. Designed and constructed by Professor Elston and a talented team of coworkers at the University of Florida, FLAMINGOS serves as both a wide-field infrared imager (20 arcmin diameter field of view when used at the Kitt Peak 2.1-meter telescope) and multi-object spectrograph.

Successfully used at the MMT, Gemini South, and KPNO's 2.1-meter and Mayall 4-meter telescopes, FLAMINGOS allows scientists to perform in one night infrared spectroscopy observations that would previously have required a hundred nights. FLAMINGOS is the primary instrument for several NOAO Survey Programs that are studying topics ranging from how individual stars form to how the largest structures in the Universe evolve. New instruments using the innovations pioneered with FLAMINGOS are under construction to be used at several of the world's largest telescopes.

Astronomer Richard Elston was an expert SCUBA diver, SCUBA instructor, skier, hiker, pilot, and sailor, but he will be best remembered as a wonderful father, beloved husband, loving brother, son, uncle, friend, and inspiration to all whose lives he touched.

Gemini Observing Opportunities for Semester 2004B

Taft Armandroff

The NOAO Gemini Science Center (NGSC) invites and encourages the US community to submit proposals for Gemini observing opportunities during semester 2004B. Gemini observing proposals are submitted and evaluated via the standard NOAO proposal form and Telescope Allocation Committee (TAC) process. Although the Gemini Call for Proposals for 2004B will not be released until March 1 for the US proposal deadline of March 31, the following are our expectations of what will be offered in semester 2004B. 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 exciting new instrumental capabilities are expected to be offered in semester 2004B, as described below.

Gemini North

- The GMOS-North optical multi-object spectrograph and imager will be offered in 2004B. Multi-object spectroscopy (optionally with nod-and-shuffle mode), long-slit spectroscopy, integral field unit (IFU) spectroscopy, and imaging modes will be available.
- The NIRI infrared imager/spectrometer will be offered in 2004B. Both imaging mode and grism spectroscopy mode will be available.
- GMOS-North and NIRI will be offered in both Queue and Classical modes. It is expected that Classical will only be offered to programs with a size of three nights or longer (see the 2004B Call for Proposals).
- The Altair adaptive optics (AO) system will be offered for scientific observations in 2004B. The following modes of Altair are expected to be offered in 2004B: 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 for all of semester 2004B and for spectroscopy (resolutions of R=200 and R=3000) late in the semester. Michelle would be offered only in Queue mode. Note that after three months at UKIRT (United Kingdom Infra-Red Telescope) during semester 2004A, Michelle will return to Gemini for the longer term. Gemini plans to reintegrate and recommission Michelle during June and July. Michelle spectroscopy requires additional commissioning and system verification, which explains the likelihood of offering spectroscopy for only the second half of the semester.

Gemini South

- The GMOS-South optical multi-object spectrograph and imager will be offered during semester 2004B. The imaging, long-slit spectroscopy, multi-object spectroscopy, and nod-and-shuffle modes of GMOS-South are expected to be offered in 2004B. The GMOS-South IFU is undergoing System Verification during semester 2004A, and thus it is likely to be available to proposers during semester 2004B.
- The T-ReCS mid-infrared imager and spectrometer will be available in semester 2004B. Both the imaging and spectroscopic modes of T-ReCS are expected to be offered in 2004B.
- GMOS-South and T-ReCS will be offered in both Queue and Classical modes. It is expected that Classical will only be offered to programs with a size of three nights or longer (see the 2004B Call for Proposals).
- The Phoenix infrared high-resolution spectrograph will be offered in semester 2004B.
- The Acquisition Camera will be available for time-series photometry in 2004B.
- The GNIRS facility infrared spectrograph will probably be offered in semester 2004B. This is not yet certain because, as of late January, GNIRS is in the on-telescope commissioning process (see subsequent article "GNIRS Commissioning"). GNIRS has several observing modes. It is likely that only GNIRS's basic modes (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) will be available in 2004B. Please check the 2004B Gemini Call for Proposals for additional GNIRS information. GNIRS would be offered only in Queue mode.

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 is planned to be 70 percent for semester 2004B, at both Gemini North and Gemini South.

We remind the community that US Gemini proposals can be submitted jointly with collaborators in another Gemini partner. An observing team submits proposals in each relevant partner country, explicitly noting how much time is requested from

continued

Gemini Observing Opportunities continued

each Gemini partner. 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 United States accepts Gemini proposals both with the standard NOAO proposal form and with the Gemini Phase I Tool (PIT).

Queue programs assigned by the International TAC (ITAC) into queue Science Ranking Band 1 (the highest priority band) will be eligible for rollover into the next semester. A program without a complete set of ITAC-approved observations will be rolled over for no more than two consecutive semesters, in order to increase the likelihood of program completion. Eligibility for rollover will be decided at the 2004B ITAC meeting, and proposers will be notified of rollover status in their ITAC feedback. Rollover will apply to Band-1 queue programs only.

It is likely that a special opportunity for Gemini follow-up of Spitzer Space Telescope programs will be announced in the 2004B Call for Proposals.

GNIRS Key Science Opportunity

Taft Armandroff, Steve Strom & Jeremy Mould

As discussed elsewhere in this newsletter, the Gemini Near-Infrared Spectrograph (GNIRS) is undergoing commissioning and is nearing availability for observing to the Gemini communities. NOAO is keen to see the powerful capabilities of GNIRS exploited for major scientific initiatives. These could include:

- Spectroscopic follow-up for the Spitzer Space Telescope
- Moderate-resolution near-infrared spectroscopy of individual stars and substellar objects
- Studies of the dynamics and excitation of pre-main-sequence star disks and jets
- Dynamical and abundance investigations of stellar populations in galaxies, such as the inner bulge of our galaxy, and the late-type giants in M32
- Investigation of the dynamics, excitation, and abundances of gas in nearby active galactic nuclei
- Dynamical, excitation, and abundance studies of starburst galaxies and ultraluminous IRAS galaxies
- Study of stellar and gaseous dynamics and excitation in radio galaxy hosts, and the origin of radio jet/host galaxy alignment

As announced in the December 2003 *NOAO/NSO Newsletter*, NOAO is conducting a pilot 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

To help inform the community, NGSC has created a Web site on the GNIRS Key Science Opportunity (see *www.noao.edu/usgp/gnirs_key_sci_op*). The site has links to GNIRS information and features a form to allow individuals or groups to register their interest to persons forming science teams.

In addition, NGSC will hold a Webcast on the GNIRS Key Science Opportunity on March 16 at 10:00 a.m. MST. We will briefly review the opportunity, discuss GNIRS commissioning status, and then take questions from the community. In order to connect to the Webcast, or to download the necessary software, visit *www.noao.edu/usgp*. You are encouraged to send your questions on the GNIRS Key Science Opportunity, before or during the Webcast, to *usgemini@noao.edu*, or phone them in to 520-318-8421.

As discussed above, NGSC expects the following modes of GNIRS to be offered in semester 2004B: long-slit spectroscopy with resolutions R=2000 and R=6000, and cross-dispersed spectroscopy at R=2000 with continuous coverage from 1 to 2.5 microns.

GNIRS Commissioning

Jay Elias

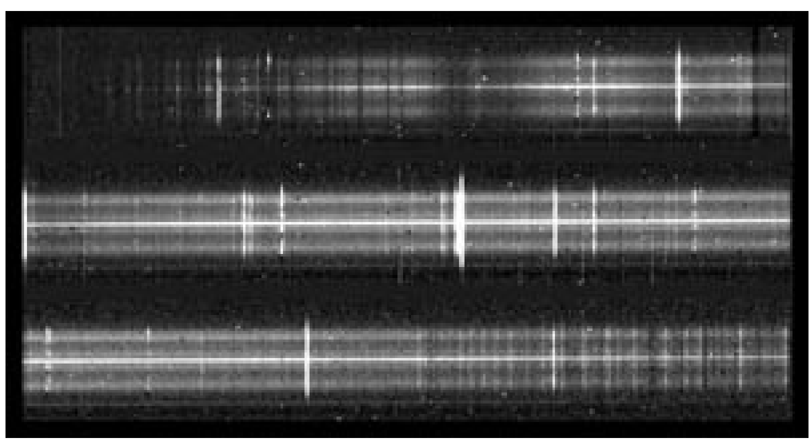
The Gemini Near-Infrared Spectrograph (GNIRS) final acceptance tests and initial stages of commissioning took place during the nights of 7–17 January 2004. GNIRS is a medium-resolution, 1- to 5-micron spectrograph with long-slit, cross-dispersed, and integral-field capabilities. Overall, GNIRS performed well during the acceptance tests. Problems were encountered interfacing the on-instrument wavefront sensor (OIWFS) software with the Gemini South Acquisition and Guiding system. These problems had not been completely solved at the end of the run, so all observations were carried out using the peripheral wavefront sensors. The OIWFS is expected to be working by the end of commissioning. The first phase of GNIRS system verification will occur in semester 2004A, with the first observations planned for early March.

GNIRS mounted on the side port of the Gemini South telescope, 12 December 2003.

It seems likely that GNIRS will be offered in semester 2004B in an initial configuration supporting the highest priority modes. The supported modes probably will include: 1) long-slit spectroscopy with resolutions R=2000 and R=6000 over the full wavelength range; and 2) cross-dispersed spectroscopy at R=2000 with continuous coverage from 1 to 2.5 microns. These are the modes for which system verification is occurring during the first half of semester 2004A. The polarization analysis mode will not be available in 2004B.

Our pleasure at the successful commissioning of GNIRS is mixed with sadness at the passing of Richard Elston. Richard was a key member of the team that put together the original proposal to Gemini that led to the GNIRS contract with NOAO; the performance and capabilities outlined above are largely those of the concept he helped put together nearly 10 years ago. Richard undoubtedly would have been one of the more productive users of an instrument he helped to bring about.

GNIRS currently does not include the integral field unit (IFU). Completion of the IFU, which is being built by the University of Durham, was delayed by a missing optical component. This component has been received, and the IFU is completing final integration and testing. Previous testing over half the field showed good results. The IFU is currently scheduled to be integrated into the instrument in late March after the first system verification run, with initial commissioning on the telescope planned for early April.



GNIRS spectrum of the planetary nebula NGC 2867 at a spectral resolution of 6000. The figure is a mosaic of three grating settings, covering 1.9–2.4 microns, and shows numerous nebular emission lines, primarily H I, He I, He II, and H_2. The observations were obtained by C. Winge (Gemini), J. Elias (NOAO), and A. Ardila (Laboratório Nacional de Astrofísica, Brazil) during the January commissioning run.

Considerable information on the instrument is now available on the Gemini Web pages, and it is being supplemented on an almost daily basis (see *www.us-gemini.noao.edu/sciops/instruments/nirs/nirsIndex.html*).

Gemini Next-Generation Instrumentation: Progress and Opportunities

Taft Armandroff

The Gemini Partnership began a process in early 2002 to identify the major science opportunities for Gemini in the period 2008–2012 and the required instrumentation to enable Gemini to capitalize on these opportunities. This process included community-based workshops in the Gemini partner countries. The NOAO Gemini Science Center (NGSC) organized a workshop for the US community, "Future Instrumentation for the Gemini 8-m Telescopes: US Perspective in 2003," on 30–31 May 2003 in Tempe, Arizona (report available at *www.noao.edu/usgp/Tempe_Report_7-8.pdf*). Gemini then conducted an international science and instrumentation planning meeting in Aspen, Colorado, on 27–28 June 2003.

The diverse participants in this planning process developed a broadly supported set of major science questions for Gemini's future:

- How do galaxies form?
- What is the nature of dark matter on galactic scales?
- What is the relationship between super-massive black holes and galaxies?
- What is dark energy?
- How did the cosmic "dark age" end?
- How common are extrasolar planets, including Earth-like planets?
- How do star and planetary systems form?
- How do stars process elements into the chemical building blocks of life?

A detailed report that enunciates these questions and explains how Gemini can play a major role in answering them, "*Scientific Horizons at the Gemini Observatory: Exploring A Universe of Matter, Energy, and Life*," is circulating in draft form and will be released shortly.

With this draft report, including the instrumentation requirements and estimates of their cost (developed by Gemini, NGSC, and the other national Gemini offices), the Gemini Science Committee (GSC) discussed the Gemini future instrumentation program at its October 2003 meeting. The GSC endorsed the draft "Aspen" report and recommended a core set of future Gemini instruments that it felt enabled the strongest "Aspen" scientific opportunities. The Gemini Board, meeting in November 2003, endorsed the GSC recommendations and worked with Gemini Observatory to define the scope and mechanics of the future Gemini instrumentation program.

As a result of these Gemini Board actions, Gemini Observatory released opportunities for community participation in the Gemini future instrumentation program in December 2003. These opportunities include funded design studies for two groundbreaking instruments and funded feasibility studies for two other frontier instruments. NGSC broadcasted these opportunities to its list of interested instrument builders in the United States, and advertised the opportunities on the NGSC Web page.

The design studies are requested for:

- Extreme Adaptive Optics Coronagraph (wavelength range of 0.9–2.5 microns; the use of either an integral field unit or direct multiband imaging will be among the design options considered; a contrast ratio of ~10^7 within a 0.1–1.5 arcsec radius of the central target is needed to meet this instrument's science objectives)
- High-Resolution Near-Infrared Spectrograph (wavelength range of 1.1–5.0 microns; single-slit cross-dispersed seeing-limited spectrometer with R~70,000 spectral resolution and providing simultaneous wavelength coverage of as much of the J+H+K or L+M windows as possible; also multi-object MCAO-fed cross-dispersed spectrometer sampling targets across a 2 arcmin field with ~3 arcsec long slits, R~30,000 spectral resolution, and limited wavelength coverage)

The feasibility studies are requested for:

- Wide-Field Fiber-Fed Optical Multi-Object Spectrometer (wavelength range of 0.39–1.0 microns; field of view of ~1.5 degree; spectral resolution of R~1000 to R~30,000; 4000–5000 simultaneous targets)
- Ground-Layer Adaptive Optics System (field of view of ~10 arcmin diameter; desired PSF FWHM of ~0.2 arcsec in the J band for 0.5 arcsec seeing in the V band; seek high level of point spread function uniformity over the field of view)

The intent of the design studies is to develop the instrument concepts to the point that fixed-price contracts to fabricate them can be pursued. The intent of the feasibility studies is to establish the technical feasibility of the instruments, develop telescope impact assessments, refine cost estimates, and verify the science case for these instruments. Please see *www.gemini.edu/science/aspen/general-announce.html* for more information about these study opportunities.

continued

Gemini Next-Generation Instrumentation continued

In this Gemini procurement, proposals are submitted directly to the Gemini Observatory. The contacts for these opportunities are Doug Simons, Gemini Associate Director for Instrumentation, and Andy Flach, Gemini Contracts Manager. Proposals for design and feasibility studies are due on 31 March 2004. NGSC is aware of significant interest in and expects a very strong response from the US community.

In closing, I would like to acknowledge and thank the numerous members of the US astronomical community (well over 100 people in total) who have contributed to the success of this important planning process by contributing science ideas, participating in the workshops, and helping to define the requirements and cost of the proposed instrumentation.

The Gemini/IRAF Project

Mike Fitzpatrick for the Gemini/IRAF Team

NOAO and the Gemini Observatory are now several months into a collaborative project with the (appropriately) twin goals of improving and enhancing both the GEMINI reduction software and the underlying IRAF system it uses. The key to success in this case is that the partners are not only dedicating new resources to the project, but also the expertise and institutional commitment required to meet its goals—a combined 70 years of IRAF development experience from NOAO, detailed knowledge of the instruments and reduction requirements from Gemini staff, and shared responsibility for development and scientific oversight of the project. The results will benefit not only Gemini users, but will extend to the wider IRAF user community as well.

The core programming group is made up of two full-time equivalents from each institution (three new hires plus existing staff) based in Hilo, Tucson, and La Serena. Inger Jørgensen (Gemini) serves as the Project Scientist, Mike Fitzpatrick (NOAO) serves as Project Engineer, and scientific staff from Gemini and its partner countries will compose a Science Working Group charged with supplying the scientific and functional requirements and oversight for the software. Application development will come largely from Gemini staff responsible for a particular science instrument, teamed with a programmer responsible for the proper implementation of its data reduction package. Experience gained by both sides should lead to more efficient implementation of the data reduction tasks for current and future Gemini instruments.

In general terms, over the course of two years the collaboration will deliver the following items (in roughly this order):

- Enhancements to the core IRAF system, including error handling and improved scripting capabilities in the CL
- 24-bit display support for XImtool
- Improved automatic wavelength calibration capabilities for optical, near-infrared and mid-infrared spectra
- A low-level MEF (Multi-Extension FITS) I/O interface, optimized for Gemini data formats but general enough for all MEF data
- Numerous utility tasks and general application enhancements in both the GEMINI package and core IRAF system
- Compiled-task packages for the reduction of MOS and IFU instrument data, possibly a package for near/mid-infrared imaging
- High-level, script-based packages for instrument-specific reductions

The strategy is to focus initially on providing the core IRAF system and base tools needed to simplify higher-level, instrument-specific application script development in the long term. Simultaneously however, the Gemini/IRAF programmers will be working on new tasks using existing tools to meet the short-term needs of Gemini as new instruments are commissioned.

We expect most of the system infrastructure work to be completed by this summer, when the focus will shift largely to new science applications development. The existing package will undergo a continual evolution throughout the project to make use of new system features as well as to improve the script's efficiency, maintainability, and applicability to new instruments and observing modes. New software will be made available through more frequent IRAF and GEMINI package releases, with the releases being driven both by the data analysis needs of the Gemini community and by the completion of major enhancements to the software.

The Gemini/IRAF programmers visited Tucson this past July for two weeks of intensive IRAF training, and

continued

The Gemini/IRAF Project continued

NOAO programmers will remain active in the design and implementation of GEMINI tasks as well as serve as a resource for programmer and scientist alike in getting the most out of the IRAF system. The interactions thus far have been very productive, resulting in the GEMINI V1.5 and IRAF V2.12.2 releases in January, and the identification of several new utility tasks that will further simplify and streamline the development process. Work is already underway on these new tasks, the core IRAF enhancements, improvements to the spectroscopy tasks required by GMOS, and the next version of the GEMINI package itself.

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

The members of the Gemini/IRAF Team are Craig Allen, Andrew Cooke, Mike Fitzpatrick, Inger Jørgensen, Kathleen Labrie, Rob Seaman, Frank Valdes, and Nelson Zarate. Questions may be directed to the Gemini HelpDesk or *gemprog@noao.edu*.

Gemini Science 2004 Meeting

The NOAO Gemini Science Center invites and encourages US community members to participate in "Gemini Science 2004," the first conference on Gemini science results, on 23–26 May 2004 in Vancouver, British Columbia, Canada.

The purposes of the conference are to:

- Highlight the first four years of Gemini Science
- Promote the unique capabilities of Gemini telescopes and instruments
- Enhance scientific collaboration
- Define new science avenues
- Increase mutual acquaintance among Gemini users

Both verbal and poster presentations will be included. The Scientific Organizing Committee consists of Tim Bedding, Malcolm Bremmer, Stephanie Cote, Katia Cunha, Tom Geballe, Karl Glazebrook, Phil Puxley, Jean-Rene Roy, and Taft Armandroff. US community members should feel free to contact Taft Armandroff (*armand@noao.edu*) about how to participate in this meeting. Please see *www.gemini.edu/science/gem_conf/gem_conf.html* for more information about Gemini Science 2004.

NGSC Instrumentation Program Update

Taft Armandroff & Mark Trueblood

NICI

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

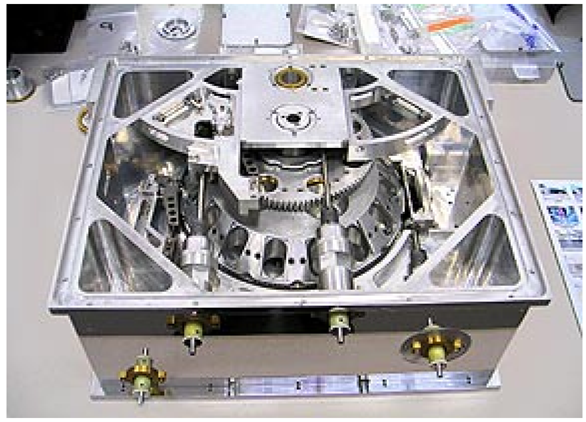
NICI is in the integration phase of the project. The dewar and mechanisms have been cleaned and assembled for a "test fit," then sent to a vendor for painting. As of late January, vacuum and cold tests of the dewar and cold mechanisms are imminent. Overall, two thirds of the work to NICI final acceptance by Gemini, which is planned for December 2004, has been completed.

continued

NGSC Instrumentation Program Update continued

FLAMINGOS-2

FLAMINGOS-2 is a near-infrared multi-object spectrograph and imager for the Gemini South telescope. 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 Project Scientist Richard Elston, Co-Project Scientist Steve Eikenberry, and Project Manager Roger Julian.



The assembled filter/dichroic wheel subassembly for NICI.

FLAMINGOS-2 is in the procurement and fabrication phase of the project. Essentially all of the FLAMINGOS-2 optics have been ordered. Mechanical fabrication is underway in the University of Florida shops and at a few key subcontractors. In addition, fabrication of the detector control and motor control electronics is underway at Florida. Overall, 31 percent of the work to FLAMINGOS-2 final acceptance by Gemini has been completed.

NGSC Booth at the AAS Meeting in Atlanta

The NOAO Gemini Science Center (NGSC) booth at the January 2004 AAS meeting was the site of much activity. NGSC staff answered questions about how to apply for time on the Gemini telescopes and provided tutorials on the Phase II process. Brochures on the Gemini instruments were available, as was a flyer on the upcoming Gemini Science Conference in Vancouver. From left to right, top: Ken Hinkle (NGSC), Bruce Hrivnak (Valparaiso University), Alan Whiting (NOAO South), Kimberly Ennico (NASA-Ames); center: David Yong (University of Texas at Austin), Taft Armandroff (NGSC), Marcel Bergmann (NGSC), Dara Norman (NOAO South); bottom: Patrick McCarthy (Carnegie Observatories), Roberto Abraham (University of Toronto), Brian Siana (University of California at San Diego), Marcel Bergmann (NGSC).

NOAO 2004B Proposals Due 31 March 2004

Todd Boroson

Proposals for NOAO-coordinated observing time for semester 2004B (August 2004 – January 2005) are **due by Wednesday evening, 31 March 2004, midnight MST.** The facilities available this semester include the Gemini North and South telescopes, the Cerro Tololo Inter-American Observatory, the Kitt Peak National Observatory, and community-access time with the Keck I and II telescopes, the Hobby-Eberly Telescope, and the 6.5-meter telescopes of the Magellan and MMT Observatories.

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 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 2004B with Keck, HET, Magellan, 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 2004B:

- **W.M. Keck Observatory**
  A total of 11 nights will be available for classically scheduled observing programs with the 10-meter Keck I and II telescopes on Mauna Kea. All facility-class instruments and modes are available to the community. The interferometer is in shared-risk mode in 2004B and thus not offered, but it might be available in a future semester. For further 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 2004B, about 43 hours are expected to be available for integration and set-up time. Available instruments include the High-, Medium-, and Low-Resolution Spectrographs. For the latest information on HET instrumentation and instructions for writing observing proposals, see *www.noao.edu/gateway/het/*.
- **Magellan Telescopes**
  A total of six nights will be available for classically scheduled observing programs with the 6.5-meter Baade and Clay telescopes at Las Campanas Observatory. 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 2004B. For further information, see *www.noao.edu/gateway/mmt/*.

A list of instruments we expect to be offered in 2004B 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.

Observing Request Statistics for 2004A 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	90	171.71	1.91	74.525	2.3	0	74.525	2.30
Gemini South	65	129.36	1.99	53.655	0	0	53.655	2.41
CTIO								
CTIO 4-m	99	298.25	3.01	121.55	5	2	119.55	2.49
CTIO 1.5-m	9	38.5	4.28	25	0	0	25	1.54
CTIO 1.3-m	16	64.22	4.01	32	0	0.55	31.45	2.04
CTIO 1.0-m	6	33	5.5	44	0	0	44	0.75
CTIO 0.9-m	16	93	5.81	50	0	0	50	1.86
KPNO								
KPNO 4-m	66	227.8	3.45	109	0	4.5	104.5	2.18
WIYN 3.5-m	42	144.25	3.43	51.25	0	2	49.25	2.93
KPNO 2.1-m	34	169.2	4.98	112.5	0	0	112.5	1.50
WIYN 0.9-m	4	25	6.25	22.5	0	0	22.5	1.11
Keck/HET								
Keck I	13	21	1.62	7	0	0	7	3.00
Keck II	25	39.5	1.58	6	0	0	6	6.58
HET	4	7.5	1.88	6	0	0	6	1.25

*Nights allocated by NOAO Director.

KPNO Instruments Available for 2004B

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	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.

CTIO Instruments Available for 2004B*

Spectroscopy	Detector	Resolution	Slit
4-m			
Hydra + Fiber Spectrograph	SITe 2K CCD, 3300–11000Å	300–2000	138 fibers, 2" aperture
R-C CCD Spectrograph	Loral 3K CCD, 3100–11000Å	300–5000	5.5'
Echelle + Long Cameras	SITe 2K CCD, 3100–11000Å	60000	5.2'
1.5-m			
Cass Spectrograph	Loral 1200×800 CCD, 3100–11000Å	<1300	7.7'

Imaging	Detector	Scale ("/pixel)	Field
4-m			
Mosaic II Imager	8K×8K CCD Mosaic	0.27	36'
ISPI IR Imager	HgCdTe (2048×2048, 1.0–2.4μm)	0.3	11'
1.5-m			
CPAPIR	Hawaii II 2K IR	0.88	30'
1.3-m			
ANDICAM Optical/IR Camera	Fairchild 2K CCD	0.17	5.8'
	HgCdTe 1K IR	0.11	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 March 2004 for confirmation of available instruments.

Gemini Instruments Possibly Available for 2004B*

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
Phoenix	512×1024 InSb	1–5μm R≤70000	0.1	14" slit length
T-ReCS	320×240 Si:As IBC	8–25μm R~100, 1000	0.09	28"×21"
Acquisition Camera	1K×1K frame-transfer CCD	BVRI	0.12	2'×2'
GMOS-S	3-2048×4608 CCDs	0.36–1.1μm R~670–4400	0.072	5.5'
GNIRS[1]	1K×1K Aladdin Array	1–5.5μm R~1700, 6000, 18000	0.05, 0.15	3"–99" slit length

* Please refer to the NOAO Proposal Web pages in September 2004 for confirmation of available instruments.
[1] Not all configurations will be offered in 2004B.

Keck Instruments Available for 2004B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
Keck I					
HIRESb/r (optical echelle)	Tek 2048×2048	30k–80k	0.35–1.0μm	0.19	70" slit
NIRC (near-IR img/spec)	256×256 InSb	60–120	1–5μm	0.15	38"
LWS (mid-IR img/spec)	128×128 As:Si BIB	100, 1400	3–25μm	0.08	10"
LRIS (img/lslit/mslit)	Tek 2048×2048	300–5000	0.31–1μm	0.22	6×7.8'
Keck II					
ESI (optical echelle)	MIT-LL 2048×4096	1000–6000	0.39–1.1μm	0.15	2×8'
NIRSPEC (near-IR echelle)	1024×1024 InSb	2000, 25000	1–5μm	0.18 (slitcam)	46"
NIRSPAO (NIRSPEC w/AO)	1024×1024 InSb	2000, 25000	1–5μm	0.18 (slitcam)	46"
NIRC2 (near-IR AO img)	1024×1024 InSb	5000	1–5μm	0.01–0.04	10–40"
DEIMOS (img/lslit/mslit)	8192×8192 mosaic	1200–10000	0.41–1.1μm	0.12	16.7×5'

MMT Instruments Available for 2004B

	Detector	Spectral Range	Scale ("/pixel)	Field
BCHAN (spec, blue-channel)	Loral 3072×1024 CCD	0.32–0.8μm	0.3	150"
RCHAN (spec, red-channel)	Loral 1200×800 CCD	0.5–1μm	0.3	150"
MIRAC3 (mid-IR img, PI inst)	128×128 Si:As BIB array	2–25μm	0.14, 0.28	18.2, 36"
MiniCam (optical img)	2-EEV 2048×4608 CCDs	UBVRI	0.05	3.7'
SPOL (img/spec polarimeter, PI)	Loral 1200×800 CCD	0.38–0.9μm	0.2	20"

HET Instruments Available for 2004B

	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
	or 4300–7400Å	1300	1"–10"×4'	
MRS (med-res spec)	2-2K×4K, visible	5000–20000	1.5" or 2" fibers	9 objects (not offered in 2004B)
	1K×1K HgCdTe, near-IR	5000–10000	(synth long-slit)	
HRS (high-res spec)	2-2K×4K 4200–11000Å	15000–120000	2" or 3" fiber	single

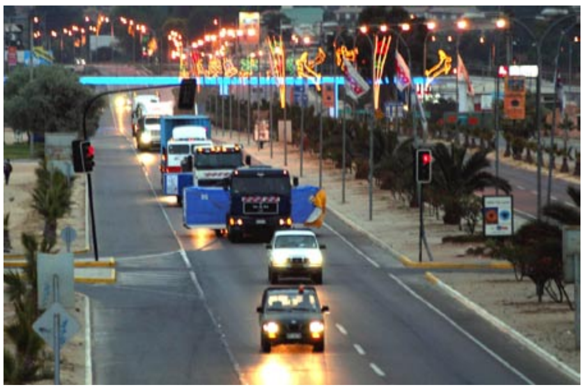
Magellan Instruments Available for 2004B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
Magellan I (Baade)					
PANIC (IR img)	1024×1024 Hawaii		1–2.5μm	0.125	2'
IMACS (img/lslit/mslit)	8192×8192 CCD	R~2100–28000	0.34–1.1μm	0.11, 0.2	15.5', 27.2'
Magellan II (Clay)					
MagIC (optical img)	2048×2048 CCD		BVRI, u'g'r'i'z'	0.07	2.36'
BCSpec (lslit)	2048×515 CCD	R~1000–6000	0.31–1μm	0.25	72" slit
LDSS2 (mslit spec/img)	2048×2048 CCD	R~200–1000	0.4–0.8μm	0.38	6.4'
MIKE (echelle/multi spec)	2K×4K CCD	R~19000–65000	0.32–1μm	0.14	30' (~200 fibers)

SOAR Mirror Delivered to Cerro Pachón

Steve Heathcote & Victor Krabbendam

To the great happiness of all concerned, the SOAR Active Optical System (AOS), including the 4.1-meter clear-aperture primary mirror, was safely delivered to the SOAR site on 9 January 2004.



The convoy carrying the SOAR AOS passes through the city of Coquimbo, just south of La Serena, during the early hours of January 9. The first wide load is the primary mirror cell, the second is the mirror itself, while the container holds the control electronics, smaller optics, and ancillary systems.

The AOS began its 10,000-kilometer odyssey on December 10, when it was trucked from the Danbury, Connecticut, plant of contractor Goodrich Aerospace to the port of New York. There it was loaded onto a freighter, SS Sea Tiger, which carried it via the Panama Canal to the Port of San Antonio, Chile, arriving on the evening of January 5. The shipment was quickly disembarked, cleared through customs, and carried by truck on the final 560-kilometer leg of its journey to Cerro Pachón.

The SOAR team is currently hard at work integrating the AOS with the telescope and its control system, with the help of expert on-site support provided by Goodrich staff. The SOAR primary mirror was successfully aluminized in the Gemini South coating plant on January 28. Following months of preparation, the coating process itself took only 40 minutes. Subsequent measurements confirm that a good-quality coating was achieved with reflectivity at 470 nanometers, in excess of 91 percent over the majority of the clear aperture. At the same time, the 120-actuator support system for the primary mirror, the active mount for the secondary mirror, and the tip-tilt tertiary assembly are being put through their paces in the laboratory prior to installation on the telescope. Integration will be followed by an intensive period of optomechanical alignment, calibration, and testing, culminating in first light, which we anticipate will occur in late March. This will be just in time for the SOAR dedication ceremony symbolically scheduled for 17 April 2004, six years to the day after the groundbreaking ceremony!

The convoy winds its way up Cerro Pachón toward SOAR and Gemini South.

At long last, the SOAR primary mirror arrives on the summit of Cerro Pachón.

The primary mirror is carefully washed in preparation for aluminization in the Gemini South coating plant.

SOAR Telescope Time–Coming Soon!

Steve Heathcote & Alistair Walker

Through NOAO, the US community has access to 30 percent of the time on the SOAR telescope (Brazil receives 30.8 percent, the University of North Carolina at Chapel Hill 16.7 percent, Michigan State University 12.5 percent, and Chile 10 percent). With first light now only a few months away, it is time to begin thinking seriously about proposals to use SOAR. It is currently expected that time will first become available through the regular NOAO Time Allocation Committee (TAC) process in the 2005A semester. However, it is likely that some time will be available in the 2004B semester. We expect that both the SOAR Optical Imager and OSIRIS will be available during the second part of that semester, and both the Goodman High Throughput Spectrograph and Spartan infrared camera may come on line during this period. Be on the lookout for a special call for proposals shortly after first light.

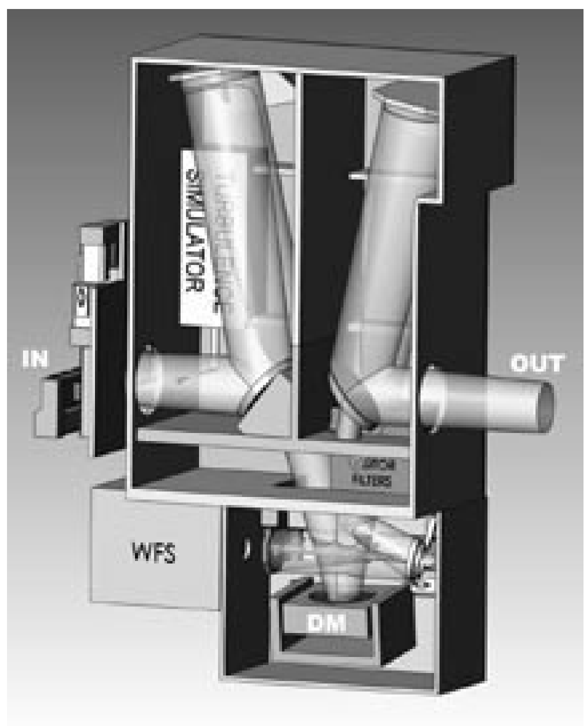
See *www.soartelescope.org* for more information about SOAR and its instruments.

SOAR-AO Passes Delta CoDR and Receives a Name

David Sprayberry & the CTIO AO Team

NOAO's Major Instrumentation Program is designing a ground-layer adaptive optics (AO) system for the SOAR telescope to provide enhanced image quality over a field of view of several arcmin at visible and near-infrared wavelengths. The project had its original Conceptual Design Review (CoDR) in April 2003, but the design has changed somewhat since then. The changes were needed for three reasons: a) the SOAR telescope optics were completed but at a slightly different primary mirror size from the original design; b) the new electrostatic deformable mirror technology proved not suitable for the needs of the project after extensive testing; and c) meeting the primary science goal (partial correction over a wide field) without compromise for the secondary goal (full correction over a narrow field) allowed for a much simpler and more robust design.

The design changes were presented to a reconvened review panel on January 26, and the review panel strongly supported all the changes. The project team is working hard toward preparing a more detailed design, along with a realistic budget and schedule, all to be presented at a Preliminary Design Review in a few months. In addition, the team came up with a final name for the project: SAM, the SOAR Adaptive Module. Congratulations, SAM.



Beam path inside the SOAR Adaptive Module. The optical design is essentially an OAP 1:1, with folds preserving the optical axes.

New Instruments to See the "Seeing"

Andrei Tokovinin

Ground-based astronomy is seriously affected by "seeing," that is, image degradation in the terrestrial atmosphere. Recognizing this, major observatories are equipped with seeing monitors (Differential Image Motion Monitors or DIMMs). Site surveys for new telescopes (e.g., the Thirty Meter Telescope) consider seeing to be one of the major selection criteria. Still, knowing just the seeing is not enough. We have to know where it comes from as well. In other words, we have to measure the vertical distribution of turbulence in the atmosphere and its speed. This information is vital for designing adaptive optics systems and for understanding the mechanisms of the seeing itself.

That is where the Multi-Aperture Scintillation Sensor (MASS) comes in. MASS is a small instrument that measures the vertical turbulence profile. Unlike previous techniques, it is simple, inexpensive, and designed to work continuously as a turbulence monitor at existing and new sites. It is based on a statistical analysis of stellar scintillations in four concentric-ring apertures. This novel approach was proposed in 1998 and tested the same year at Mt. Maidanak in Uzbekistan. The first MASS instrument came into operation in 2002 at Cerro Tololo (see figure 1). It was built by a team at the Sternberg Astronomical Institute (Moscow) led by Victor Kornilov under an AURA contract. The control software provides on-line data reduction, so one can watch the turbulence evolution on a computer screen in real time.

What do we learn from MASS?
MASS subdivides the whole atmosphere into six thick "slabs," and measures the turbulence intensity in each layer. The vertical resolution of MASS is low, only about half of the slab's altitude. Yet, this information is a significant addition to plain seeing data and it provides new insights.

During even the first year of MASS operation at Cerro Tololo we learned a few new things about seeing. It is true that, typically, the first kilometer above the summit suffers most from turbulence. However, the turbulence in this layer cannot be very strong. When the seeing is really bad (say, above 1.5 arcsec), it is caused by turbulence in higher layers as one would suspect, and hence seeing is equally bad on all neighboring mountains. On the other hand, there are periods when the whole upper atmosphere is very calm with a seeing of only 0.2 to 0.3 arcsec. During these (fairly common) periods, the seeing is entirely dominated by ground-layer turbulence. Hence, subtle differences between mountains, locations on the same mountain, and even the height of the telescope dome become very important. When all layers are calm, images as small as 0.3 arcsec (in the visible) can be obtained, as has been demonstrated at Magellan and the Very Large Telescope (VLT).

Good seeing is rare and fragile because it only occurs by a coincidence of several independent conditions. However, we can make it more frequent by compensating the ground-layer turbulence with a special kind of adaptive optics. Such an instrument is being designed for the SOAR telescope: the SOAR Adaptive Module. Data obtained with MASS at Cerro Pachón in 2003 were very useful for statistical prediction of the gain in resolution

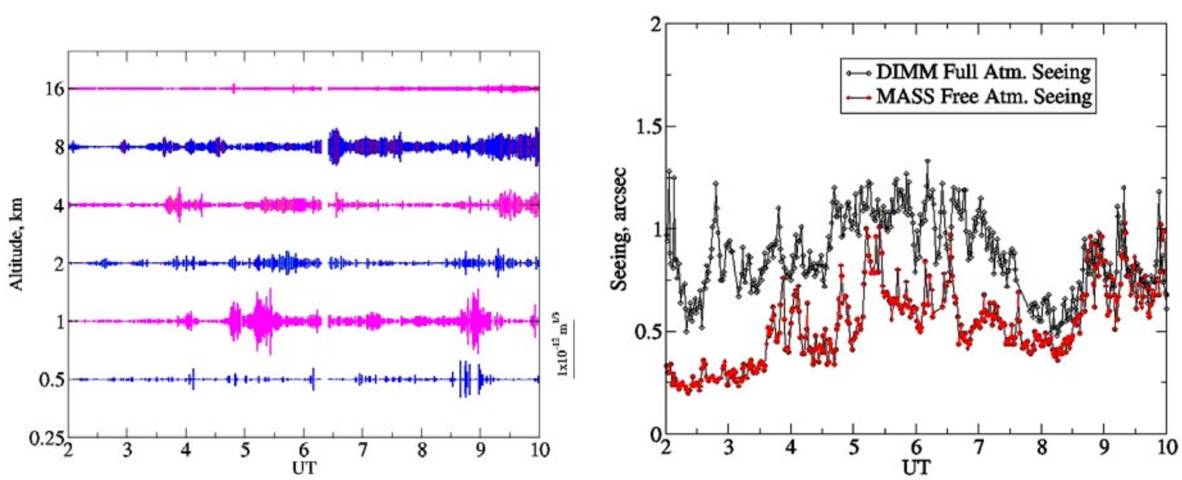


Figure 1. Evolution of seeing (left) and turbulence profile (right) on the night of 14–15 July 2002 at Cerro Tololo.

continued

New Instruments to See continued

expected from this instrument. It turns out that the gain is indeed significant (of the order of two) most of the time.

Combining MASS with DIMM

As ground-layer turbulence does not produce any scintillation, it is not sensed by MASS. On the other hand, DIMM senses the whole atmosphere. Thus, the intensity of the turbulence in the ground layer can be measured by combining MASS and DIMM data; indeed, the two instruments should always work together!

Yet another reason for this "marriage" is that DIMM is wasteful, using only two portions of its telescope mirror and throwing away the rest. Happily, the same telescope can (and should) feed both instruments. Facing this challenge, we developed a combined MASS-DIMM instrument. In its interior, an image of the telescope pupil is formed and segmented: two apertures are sent to the DIMM channel, whereas four concentric apertures are cut out to feed the MASS detectors.

MASS-DIMM is designed to work with small portable telescopes, such as the Meade LX-200 (see figure 2). Hence, the instrument itself is very compact and weights only 1.2 kilograms. The optics are also tiny: the diameters of the four MASS mirrors range from 1 to 5.5 millimeters. In addition, the instrument is meant to work in harsh environments. It is sealed from dust, and there are no moving parts inside (apart from the manually activated viewer mirror). The MASS electronics are a real masterpiece: four miniature Hamamatsu photomultipliers are packaged together with high-voltage supply, photon counters, and microprocessors in a single modular unit. A four-wire RS-485 cable connects to a PC computer and only 12 volts are needed to make it all work. Despite this small size, the electronics designed by Kornilov does not compromise performance. The dead time of the photon counters is among the fastest in the world at only 12 nanoseconds.

Nine MASS-DIMM instruments were fabricated in October 2003. The electronics, optics, and software were prepared by Kornilov's team in Moscow, while mechanical fabrication, integration, and testing were done in La Serena.

Are we ready to get data?

The MASS-DIMMs are intended to replace the regular DIMMs as site monitors at Cerro Tololo, Cerro Pachón and Las Campanas. Other units will be used in the TMT site testing campaign: the first one is already installed in Chile, others will go to potentially interesting sites like Mauna Kea or San Pedro Martir in Mexico. Finally, one unit was sent to an Antarctic site, Dome C, in collaboration with a team from the New South Wales University in Sydney.

Operating multiple instruments in robotic mode is a new challenge. To complicate things, at least three different telescope systems are being used with MASS-DIMMs, with three different versions of the control software. Furthermore, the DIMM CCD detectors are operated under Windows OS, whereas other components, including MASS, are Linux-driven. Consequently, the effort of setting up and operating MASS-DIMMs is split between different teams, with CTIO being responsible only for the Meade-based version.

continued

Figure 2. MASS-DIMM installed on a Meade LX200 telescope (left) and its electronics module (right) containing four tiny photomultipliers (one shown apart), photon-counting circuits, and microprocessors.

New Instruments to See continued

With MASS-DIMM instruments coming into operation one by one, managing the data flow becomes a task in itself. As a first step, the MASS data from 2002 have been made accessible on the Web at *mass.ctio.noao*. Going forward, we have to develop a full-fledged database that will facilitate the control of data quality and will make the data available for both immediate use and in-depth analysis.

For more information visit the MASS Web site at *www.ctio.noao.edu/atokovin/profiler* or *www.ctio.noao.edu/sitetests* for AURA site-testing.

The Hexapod Telescope

Hugo E. Schwarz

As approved during the Council of Directors meeting on August 13 last year, the Hexapod telescope will definitely be coming to Cerro Tololo. All that remains to set the move into motion is the impending signing of the memorandum of understanding.

The Hexapod telescope is a super-lightweight, 1.5-meter telescope built as a showcase for German industry at a cost of about $5 million. The telescope is 7 meters tall, and mounts on a base ring of 3 meters in diameter. It ships in two standard 40-foot containers, and can be assembled in one day. It weighs only 2.2 tons, which is about 1.2 tons per square meter (as compared to the 5 tons per square meter typical for alt-az telescopes), has a hexapod mount, carbon-fiber construction (including the mirror cell), Zeiss active optics that put 80 percent energy into 0.3 arcsec, a hexapod-controlled M2, Ritchie-Chretien, and an *f*/8 Cass single focus. The active optics has 36 actuators, of the push-pull type, controlled by a Shack-Hartmann wavefront sensor with closed loop, and a CCD guider. The pointing limit is 30 degrees altitude, and there is no singularity at zenith. Finally, the telescope comes with a lightweight building, "the pyramid." The two halves open fully so that the Hexapod telescope operates in free air, avoiding deterioration of the local site seeing.

The Hexapod telescope has been tested in Bochum, Germany, and was a project at the European EXPO2000, but it has yet to be used on any mountaintop with good seeing. To accomplish this, the telescope will be installed on a site near the 2-MASS telescope. During 2004, a service building will be constructed next to and downwind from the pyramid.

Possible instruments are a fiber-fed spectrograph in the style of FEROS (see *www.ls.eso.org/lasilla/sciops/feros*) or an infrared camera.

The Hexapod telescope is fully funded from the University of Bochum, which plans to operate it about six months per year. The use of the remaining observing time and a detailed operations model are still to be decided. The SMARTS consortium has expressed interest in the Hexapod telescope.

For details and pictures of the Hexapod telescope see *www.astro.ruhr-uni-bochum.de/astro/hpt*. For local info contact *hschwarz@ctio.noao.edu*.

Changes in Computing Staffing and Structure at CTIO

Chris Smith

We welcome two new staff members to the computer-related staff in La Serena—Petri Garagorri and Nelson Saavedra. Petri, a recent graduate of the Universidad Técnica Santa María, will be working in computer systems support, concentrating in the area of databases and Web support. Nelson is actually an old CTIO hand, coming back after working several years at Gemini South. He will be leading infrastructure development and operations for the Data Products program in La Serena.

These new additions have been accompanied by a reorganization in the computer staff in La Serena, breaking the groups up into three focused areas: instrument and telescope programming (the "Computer Applications Group," or "CAG"), computer and network support (the "Computer Infrastructure Support Services," or "CISS"), and support for the NOAO Data Products Program in Chile (DPP). Ron Lambert has been named to lead the CISS group in its new role of supporting not only CTIO observatory functions, but all of NOAO's wider activities in Chile, including collaborations with and support of observatories and consortia (Gemini, SOAR, and SMARTS).

WTTM Completes Commissioning

Steve Howell, Charles Corson & Chuck Claver

The WIYN Tip-Tilt Module (WTTM) is an optical and near-infrared reimaging system that utilizes fast tip-tilt, or image motion, compensation. It performs rapid sampling (typically 100 hertz or more) of a reference star and, by rapidly steering the mirror at the same rate, produces corrected images that are generally 15 percent or more improved over natural seeing at WIYN.

WTTM commissioning was completed this fall. "In dome" and on-sky calibration and testing were performed and we highlight some results below. A "quick start" guide is provided with a simple to follow, easy procedure to use WTTM and obtain 90 percent or more of its potential benefit without being an experienced user.

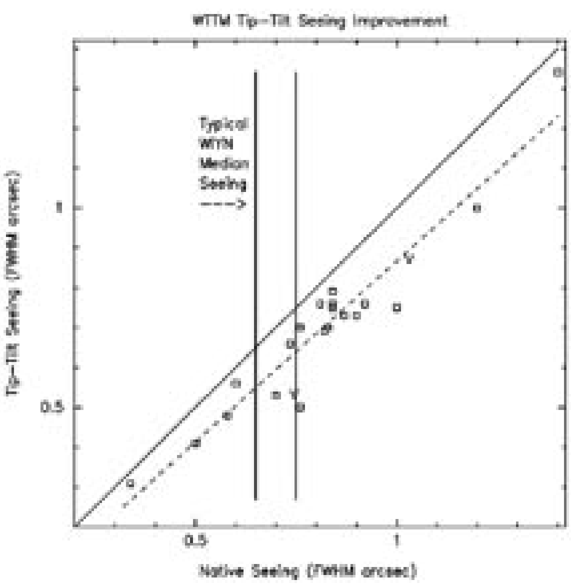


Figure 1. Performance gains when using WTTM tip-tilt correction.

WTTM has a 4-arcmin circular field of view within which the object of interest and a reference (guide) star (R=8–14) must be located. The reference star may be located anywhere within the 4-arcmin field of view and may be the same as the object of interest. The 4-arcmin field of view is optically split by a beam splitter, allowing a small fraction of the light to be passed to an error sensor mounted on an x/y stage for acquisition. Currently, two beam splitters are available, one (the 85/15 beam splitter) that passes approximately 90 percent of the light to the science detector and approximately 10 percent to the error sensor, and another (the 95/5 beam splitter) that passes about 95 percent of the light to the science detector.

WTTM uses a standard NOAO dewar and a 2K×4K CCD as the imager. A variety of 2-inch broadband filters that are matched specifically to WTTM are available. Other 2-inch filters are also available from the KPNO filter list, but these may not be optimal for WTTM.

Figure 1 shows a performance plot for WTTM. The plot shows the general 15 percent improvement to seeing, typically obtained in R band with a few "V" points shown as well. Median natural delivered image quality (DIQ) at WIYN is 0.65–0.75 arcsec and we have never experienced DIQ (natural or tip-tilt corrected) better than 0.29 arcsec for sustained (60 seconds or more) time periods.

A specific FWHM improvement is not guaranteed however. We have experienced nights and even a few hour periods within a night for which tip-tilt corrections provide zero improvement over standard imaging. It is likely these are times when upper atmosphere effects dominate the seeing and/or the seeing is simply too bad to be recovered. Ultimately though, WTTM offers users the best opportunity to maximize delivered image quality at WIYN.

Figure 2 shows a typical WTTM tip-tilt corrected image versus a natural seeing image. The figure allows a qualitative comparison of the improved image quality and encircled energy present within the tip-tilt corrected point source. Figure 3 illustrates the improvement obtainable with WTTM for an extended object.

continued

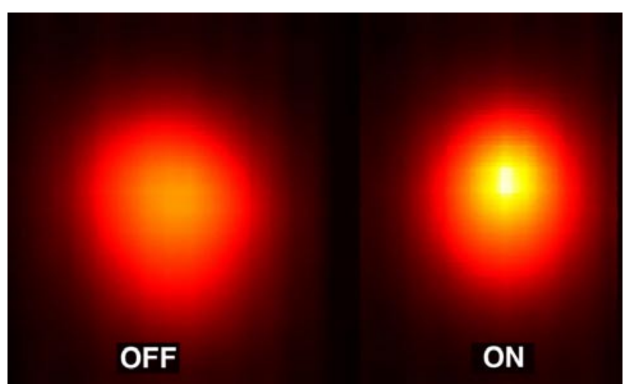
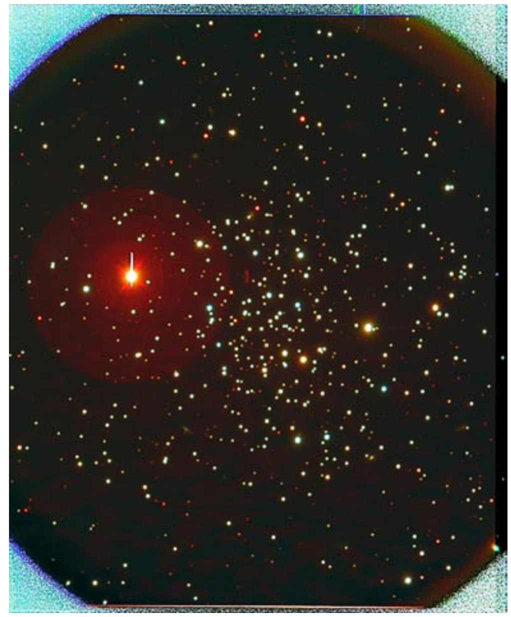


Figure 2. Two R-band images comparing the gain obtained with fast tip-tilt correction on and off: natural DIQ 0.57 arcsec, tip-tilt DIQ 0.42 arcsec, peak intensity improved by 45 percent.

WTTM Completes Commissioning continued

(3)



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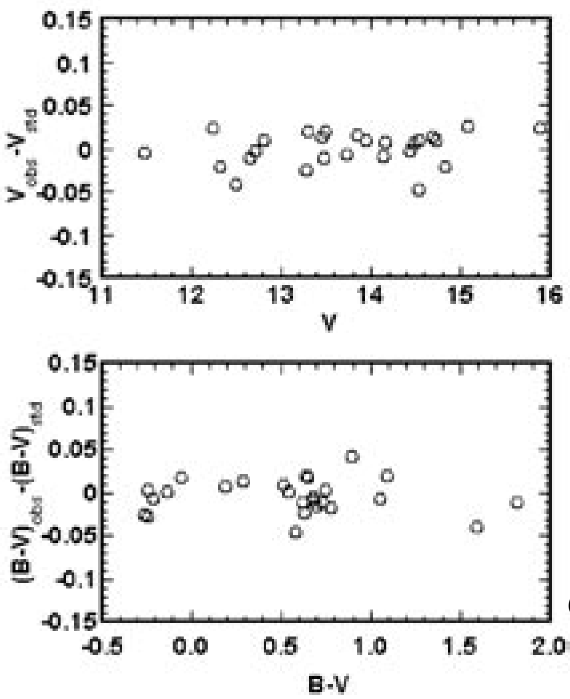

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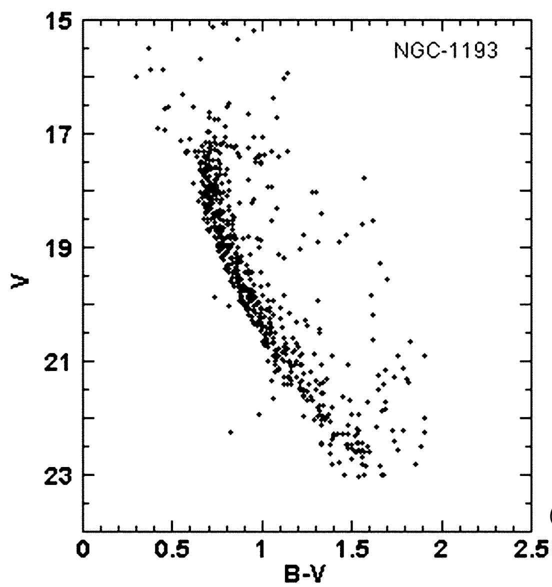


(6)

Figure 3. (Top left) Composite color image of the Ring Nebula made with WTTM. Two 3-minute exposures taken through H-α (the light of ionized hydrogen and nitrogen) and OIII narrowband filters were used to produce the color image. The tip-tilt corrected FWHM of the central star in this image is about 0.3 arcsec.

Figure 4. (Top right) Composite color image of the old open cluster NGC 1193 obtained with WTTM. This image was produced using B, V, and I band images of integration times 4×450, 4×300, and 9×180 seconds. The mean FWHM of the images is 0.5 arcsec.

Figure 5. (Bottom left) Photometric fits for V and B-V observations. The fits end near V=16 as these are the faintest Landolt standards available. Formal RMS residuals to the fits (1σ) are 0.018 (B) and 0.02 (V).

Figure 6. (Bottom right) Color magnitude diagram for NGC 1193 derived from the WTTM images used to produce figure 4. Note the main sequence turn-off and giant branch.

continued

WTTM Completes Commissioning continued

For those of you familiar with MiniMosaic at WIYN, the throughput of WTTM is about 30 percent less across the optical, but this factor is generally compensated for by improved DIQ if signal-to-noise (i.e., encircled energy) is your major concern. Thus, the choice to use WTTM for your science program (instead of MiniMosaic) will be almost exclusively based on the need for high-resolution imaging.

As an example of science that can be performed with WTTM, we illustrate some recent results obtained by Chuck Claver in December 2003. Figure 4 shows a WTTM image of the old open cluster NGC 1193. This cluster is 7–8 billion years old and lies at a distance of 4300 parsecs. NGC 1193 has [Fe/H]=-0.29 and E(B-V)=0.12. The color image was produced from Harris *B, V,* and *I* images and the observations used the 85/15 WTTM beam splitter.

Figure 5 shows the results of photometric fits based on Landolt standard star fields observed before and after NGC 1193. One result from these observations is the production of a new color-magnitude diagram (see figure 6) that extends over three magnitudes deeper than previously available. The color magnitude diagram shows the main sequence turn-off and giant branches as well as a few apparent blue stragglers.

The new WTTM user manual is available at *www.noao.edu/kpno/manuals/WTTM/WTTM.html*, and WTTM can be proposed for as an NOAO facility instrument in semester 2004B (proposals due 31 March 2004). Any scientific or technical questions related to WTTM can be directed to the WIYN instrument scientist at *howell@noao.edu*.

Proposing for an Upgraded Hydra on WIYN

Pat Knezek

WIYN Observatory is working with NOAO to upgrade Hydra, the multifiber spectrograph on WIYN's 3.5-meter telescope. The main goal of this upgrade is to ensure that Hydra remains competitive for the next ten years, and it primarily involves replacing aging parts and upgrading the software. An additional goal of the upgrade is to decrease the fiber configuration time by about a factor of two, allowing a full configuration to take approximately 10 minutes.

Linux versions of the setup and simulator software have already been released, and can be downloaded from *ftp://noao.edu/kpno/hydra/linux* via anonymous ftp. The upgrade installation on the telescope will take place in August 2004. As a result of this and other shutdown activities, the WIYN 3.5-meter will not be available for science for the entire month of August. Furthermore, Hydra will be unavailable for September 2004, while instrument commissioning is completed. We will be scheduling Hydra in October 2004 in a shared-risk mode. Proposers who are awarded early Hydra time in the fall of 2004 are encouraged to prepare a back-up observing plan using one of the imagers or integral field spectrographs, and include that as a part of their Observing Run Preparation (ORP).

Multi-Object Spectroscopy with FLAMINGOS

During the 2003B semester, we successfully supported two multi-object spectroscopy runs from the visitor community on the University of Florida instrument FLAMINGOS. The masks were designed in-house from astrometric coordinates provided by the investigators, and were fabricated by the same local vendor who provides the masks for RCSP and MARS multi-object spectroscopy. This article is a reminder that KPNO will support community proposals for MOS with FLAMINGOS, but only on the Mayall 4-meter telescope.

Those who wish to propose for this mode should familiarize themselves with the instrument performance and MOS field (roughly 3×9.5 arcmin) by referring to the FLAMINGOS manuals, available at *flamingos.astro.ufl.edu/Manuals*.

There are a couple of points to keep in mind. First, we are able to generate masks only from astrometric coordinates; we do not have the ability to support the FLAMINGOS mosplate generation pipeline, which utilizes FLAMINGOS images of the target field. The 4-meter rotator can position the long axis of the mask at any position angle, but we do not have a program for optimizing the mask layout; this must be carried out manually by the proposer. Secondly, to properly align the mask at the telescope, each mosplate field must have at least two, and preferably three, moderately bright stars (K<14) well-distributed along the long axis of the mask. The alignment star holes are typically 8 arcsec square, and this real estate is naturally unavailable for target slits.

Anyone considering a MOS proposal with FLAMINGOS should feel free to consult with Dick Joyce (*rjoyce@noao.edu*) or Ron Probst (*rprobst@noao.edu*).

From the NSO Director's Office

Steve Keil

The proposal for construction of the Advanced Technology Solar Telescope (ATST) was submitted to the National Science Foundation (NSF) in early January, and the review process has begun. On behalf of the ATST project team and the NSO, I extend my thanks for the strong support we received from the many members of the community who provided input and helped refine the proposal. The project team is now focusing its efforts on refining the ATST design in preparation for the systems-level preliminary design review in fall 2004.

At its November meeting, the ATST Science Working Group, chaired by Thomas Rimmele, was presented with a report on the data obtained to date for the six candidate sites. The report from the Site Survey Working Group, chaired by Jacques Beckers, was used to down-select the three sites that will undergo additional testing. The three sites are Big Bear Solar Observatory at Big Bear Lake, California; Haleakala on Maui, Hawaii; and Observatorio del Roque de los Muchachos on the island of La Palma in the Canary Islands, Spain. For detailed information about the ATST candidate sites, see *www.nso.edu/press/ATST_CandidateSites.html.*

✸

NSO will be hosting a number of meetings and workshops in 2004. The Local Helioseismology Comparisons Group held a workshop in Tucson on February 10–11 to advance the validation of methods to carry out seismic probing of the Sun with various instruments and procedures. On 20–22 April at Sunspot, NSO will host the NASA-sponsored US Planning Workshop for the 2007 International Heliophysical Year (IHY). The workshop program will comprise a description of the current concept for implementation of the IHY, reviews of current unresolved issues, and detailed planning of the US contribution to the success of the IHY. There are plans for working group discussions on Climate and Earth Atmosphere, Geospace, Heliosphere and Solar Wind, and Solar Drivers. For more information about this workshop, contact K. S. Balasubramaniam (*bala@nso.edu*), who is in charge of the local organizing team.

In conjunction with the AAS Solar Physics Division meeting in Denver on 30 May–3 June 2004, NSO is planning to host a public session on the ATST. As soon as a venue has been identified, the information will be made available via *SolarNews* and the NSO Web site. The 22nd NSO/Sacramento Peak Workshop on "Large-Scale Structures and Their Role in Solar Activity" will be held on 18–22 October 2004. Contact K. Sankarasubramanian (*sankara@nso.edu*) if you have questions about the workshop or would like to participate.

An NSO "institution" retired at the end of 2003. Raoul Reyero began working at NSO in 1979 and over the years has had a number of jobs, including shipping and receiving, local purchasing, and logistical support for observatory visitors at Sacramento Peak. Those of you who have observed at Sac Peak are familiar with Raoul, as he is well known for his transport of visitors to and from Sunspot. By the time visitors arrived on the mountain with Raoul, they were always very well informed on all details of life at the peak. Raoul went out of his way to make sure visitors had what they needed for a comfortable and productive stay. Thank you, Raoul, for your many years of service with NSO.

Best wishes, Raoul!

✸

NSO is pleased to welcome two new staff members. Libby Petrick is the new GONG administrative assistant. She comes to us from Bombadier Aerospace, where she has had many years of administrative experience. Sean Williams has joined the staff at Sac Peak as the new shipping/receiving clerk, replacing Raoul Reyero. Sean has moved back to the mountains from Alamogordo, where he delivered oxygen for a home care company and sold auto parts. He brings hazardous material transportation experience and excellent customer service skills to the position.

Hubert C. Cope
1922–2004

It is with deep sadness that the National Solar Observatory reports the passing of Hubert C. Cope, who was a long-time member of the NSO staff. Hubert was a Civil Service employee in the late 1950s as an Instrument Maker/Machinist at the Sacramento Peak Observatory, then he transferred to AURA and NSO in 1976 as a Senior Instrument Maker. He formally retired from NSO in 1987 but continued to work on a part-time basis on several projects with Dick Dunn. Hubert Cope passed away on 27 January 2004 and is survived by Rebecca Cope Coleman, Robert Cope, five grandchildren, and eight great-grandchildren.

ATST Getting Back to Design

Jim Oschmann & the ATST Team

Much to the great satisfaction of everyone involved, the ATST construction phase proposal was submitted to the National Science Foundation (NSF) on 8 January 2004. In addition to project staff efforts to organize and write the proposal, we received very constructive input and advice from a wide range of people including NSO staff, Co-PIs, the AURA Solar Observatory Council, and an external red team of scientists, engineers, and managers from a number of day- and nighttime community sources. Funded vendor-based design evaluation contracts were also completed in time to provide very useful input and independent cost estimates. Thank you to all who helped in this process.

Now that the proposal is in the hands of the NSF, we are turning our attention back to design activities that continue to follow from recommendations of the CoDR (see our Web site for the report and responses). Current areas of work include a simplified coudé lab, related beam-transfer optics to feed instrumentation, telescope-to-coudé area thermal considerations, Gregorian area modifications to include mechanical derotation, and enclosure modifications for improved airflow and thermal control.

Coudé Lab

In an effort to simplify the interface to coudé instruments, we have come up with a new optical arrangement that will feed the instruments from the center of the rotating lab (rather than the outer edge). This is accomplished via a simplified optical relay held in a tower in the center of the lab. The new arrangement (figure 1) has only one level, but with the same equivalent lab area as provided by the old two-level lab. The diameter of the lab has increased from approximately 12 meters to over 16.3 meters. This new wide-diameter pier results in better stability for the telescope. The increased cost for this pier is offset by the simpler single-level lab arrangement. Other benefits include longer paths for instruments, which minimize beam folding, and easier switching between instruments.

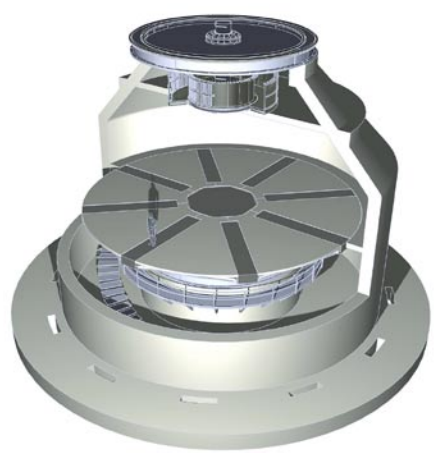


Figure 1. New single-level coudé lab.

Optical Beam Feed to Instruments

The optical concept that accompanies the new single-level coudé lab involves three mirrors at very small angles of incidence. These mirrors are held in a tower mounted to the center of the rotating lab. The resulting layout (figure 2) produces a 100- to 120-millimeter collimated pupil at the last mirror, which is steerable to direct the beam to any part of the lab, thereby feeding individual or groups of instruments. Though the number of mirrors is identical to the concept shown at the CoDR, the new optical arrangement places

continued

ATST Getting Back to Design continued

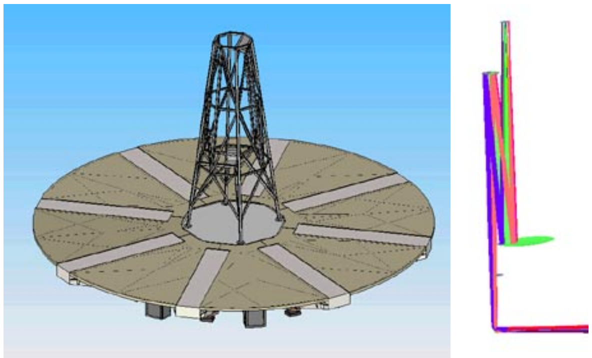


Figure 2. Central tower holding the central three-mirror beam feed to ATST instruments. The optical layout is shown on the right.

the transfer mirrors at useful conjugate locations for future multiconjugate adaptive optics upgrades without requiring any additional reflections. The CoDR concept required two additional reflections and left a highly asymmetrical feed to the lab. With the central grouping of these new beam relay optics, beam conditioning can be accomplished in less space. To make this work, the elevation axis relay optics required a change to one powered mirror. This concept still has the pupil conjugate deformable mirror on the elevation axis. Near-term work will focus on investigating methods of thermally controlling the environment to better match the lab below. This will help avoid some potential problems of deformable mirror performance that were brought up during the CoDR.

Telescope/Coudé Lab Interface

One of the major issues discussed at the CoDR was the need to control the interface between the typically colder ambient air of the telescope with that of the controlled air in the laboratory environment at the coudé level. Our baseline plan has a series of changeable windows, but we would like to eliminate these from the design if possible. One concept under consideration is to enclose, insulate, and control the air around the deformable mirror in a plenum extending down through the telescope mount to the coudé lab. Controlled air flow through this plenum, coupled with a horizontally-facing aperture where the telescope light enters the plenum will provide minimal seeing. We are currently setting up lab experiments involving air knives, laminar flow systems, and heated "boxes" to simulate this interface. A high-resolution interferometer will then be used to evaluate the various options.

Gregorian Rotator

One of the more difficult tasks that came from the CoDR is the requirement to supply a mechanical image rotator to the Gregorian area. Simply adding a mechanical bearing to hold Gregorian instruments at the current location will result in an unacceptably small allowable instrument package. We are looking at several options that relay the Gregorian focus to an area that would allow a reasonably sized package. These options include a two-mirror relay to a Nasmyth area, and a three- or four-mirror relay that would offset the instrument to one side of the current Gregorian position by approximately 1 meter. It is too soon to know how this will turn out, as there are many subtle pros and cons involved with each option, including polarization effects, variable gravity vectors acting on the instruments, and required *f*-ratios of the beam. This part of our design efforts will evolve over the next few months, so keep an eye on our Web site for updates.

Instrumentation

We are working with our partners to update and detail instrument concepts as we work toward the system preliminary design review. The new coudé lab arrangement should simplify the instrument designs, allowing for significant progress to be made in defining our initial instrument suite layout. In contrast, the Gregorian rotator concept must be finalized as soon as possible to complete the development of its related instrumentation.

Systems Engineering, Software, and Controls

We are working on many other design areas, including updates to the system error budget using the latest site data, tolerance studies of the optics train, software communications work, and the start of more detailed electronic and controls design.

Upcoming Milestones

The project's upcoming major design activities revolve around preparation for the preliminary design review later this year. In addition, we are preparing for construction proposal review activities that may be required through the June time frame, and are extending our efforts to firm up potential funding partner activities.

SOLIS

Jack Harvey & the SOLIS Team

The major SOLIS instrument, the 50-centimeter aperture vector spectromagnetograph (VSM), continues to collect regular synoptic data at its temporary site on the GONG reservation at the Campus Agricultural Center of the University of Arizona. In addition, testing, calibration, and bug fixing have been underway. A 30-year record low temperature in Tucson proved to be no problem for the VSM. Meanwhile, the old Vacuum Telescope building on Kitt Peak continued to undergo modifications in preparation to receive the SOLIS system in early 2004, and it is now dubbed the Kitt Peak SOLIS Tower. Progress on completion of the other SOLIS instruments has been slow.

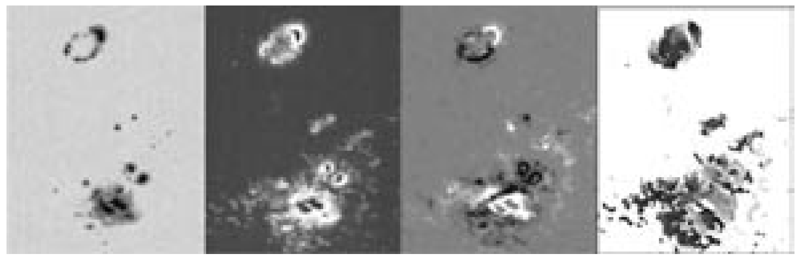


Figure 1. The super-active regions NOAA 10486 and 10488 on 27 October 2003 observed with the VSM. This is a very rough reduction of one of many VSM observations of these regions. From left to right: Continuum intensity; circular polarization (roughly proportional to the line-of-sight component of the magnetic field); square root of linear polarization (roughly proportional to the transverse component of the magnetic field); azimuth of the linear polarization represented as shades of gray. In these quick-look images, the darkest parts of the sunspots were not analyzed, and only the wings of one of two available spectrum lines were used.

Around Halloween, the Sun put on a show of extraordinary activity including the largest sunspot seen since 1990 and the most energetic X-ray flare observed since continuous monitoring started in 1975. Auroras caused by this activity were seen as far south as Arizona, Texas, and Florida. The VSM captured some of this activity in the form of vector magnetograms (see figure). A restriction of the maximum data recording capacity to about 100 gigabytes per day at the temporary site reduced the amount of data that we would have liked to collect. First results from SOLIS were presented at the fall AGU meeting.

As is obvious in the figure, we need better ways to visualize complex, high-resolution vector data, especially when distributed over the Internet and displayed with common browsers. To that end, we are experimenting with viewing the data using Virtual Reality Modeling Language (VRML), Java3d, and Scalable Vector Graphics (SVG). Most users of SOLIS data will use the Internet for data access. Thus, we are also exploring ways in which they may browse the data set without having to download the huge image files that SOLIS produces. Some promising approaches are JPEG2000, which enables downloads of region-of-interest data with progressively improving resolution, and methods using JavaScript or the IDL Virtual Machine on the client and serving just the data needed from the database. For detailed research work, the individual components of the magnetic field, and other derived quantities not shown here, will always be available in FITS format.

The major challenges now facing the SOLIS project are completing and commissioning the remaining instruments—the Full-Disk Patrol (FDP) and the Integrated Sunlight Spectrometer (ISS)—moving the system to Kitt Peak, operating SOLIS, providing data to the community of users, and most importantly, ensuring that excellent science results from the SOLIS investment. Work on all of these areas is underway, but limited staffing is a common impediment. Completion of the FDP and ISS has been slowed by the need to repair some failed key components. Our plan is to have the move to Kitt Peak completed by the time this report is published.

The operations budget for SOLIS in fiscal year 2004 is significantly less than originally proposed, and less than required to realize the operational and scientific potentials of SOLIS. Consequently, SOLIS is operating on a short-day schedule that provides a minimum program of synoptic observations. If proposals submitted to NASA and the Office of Naval Research are funded, we will be able to increase the amount and frequency of observations. Some SOLIS data are already available to the community, but release of other products depends on completing some reduction and calibration activities. Almost every new SOLIS observation shows tantalizing new phenomena that excite scientific inquiry. After years of their efforts, it is difficult for members of the SOLIS team to concentrate on mundane but critical issues of reduction and calibration when the desire to start doing research with the data is so strong.

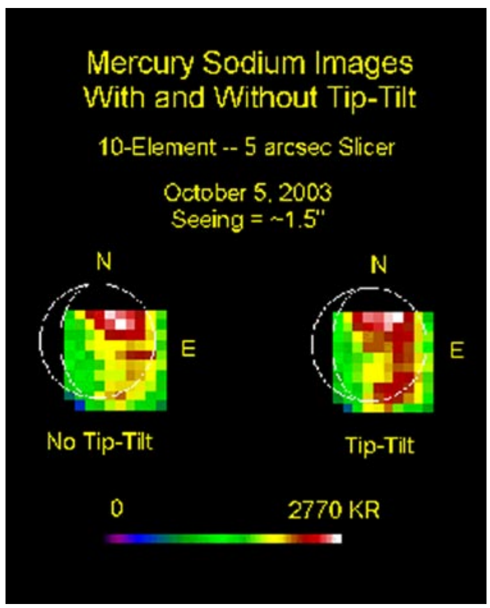
Tip-Tilt Observations of Mercury's Sodium Exosphere

Andrew Potter & Claude Plymate

Mercury has a thin atmosphere, with a composition that includes hydrogen, helium, oxygen, sodium, potassium and calcium. Gas-phase collisions are negligible, but interactions with the surface are frequent. The Mercury atmosphere is an example of a class of solar system atmospheres defined as surface-bounded exospheres. The atmospheres of most of the planetary satellites in the solar system are in this group. Sodium in the Mercury exosphere can be observed with ground-based telescopes and provides a means for studying the behavior of this class of atmospheres.

Sodium on Mercury is produced from the surface by three processes: meteoroid and cosmic dust impact, photo-sputtering, and particle sputtering. The relative importance of these is not well understood. However, the locations of maximum sodium production from these sources differ from one another. Meteoroid and cosmic dust impacts produce sodium by thermal vaporization of surface material and vaporization of the incoming material. Sodium produced from this source might be expected to be distributed uniformly over the planetary surface. Photo-sputtering, or photo-stimulated desorption, results from the interaction of solar ultraviolet photons with sodium combined in the surface rocks. Sodium produced from this source would be greatest around the subsolar point on the planet—at local noon. Sputtering of sodium from the surface by solar wind protons is expected to be confined to high latitudes, where the polar cusps can open to allow direct access of the solar wind to the surface of the planet. Thus, by mapping the distribution of sodium over the planet, we can better understand the relative importance of these sources. Of course, it is also possible that there exist regions of the surface that are especially rich in sodium, and these would produce permanent regions of high sodium density.

Mapping the sodium distribution is not easy. Mercury is small (5–7 arcsec) and is best observed in daytime or very near the horizon after sunset or before sunrise. Daytime or near-horizon atmospheric seeing is seldom better than 1.5 arcsec, meaning that resolution of sodium areas on the planetary surface is generally unsatisfactory. We have observed Mercury for several years using the McMath-Pierce telescope stellar spectrograph with a 10×10-arcsec image slicer that yields images with 1-arcsec pixels. On occasion, we observe changes in the sodium exosphere and its distribution over the surface with this slicer, but only large changes can be identified with confidence. Better spatial resolution is needed to answer the questions about the sources of sodium.



Performance of tip-tilt image stabilization for sodium mapping.

At the McMath-Pierce telescope, an image stabilizer system designed around a piezoelectric controlled tip-tilt mirror has recently been put into operation for solar observations. The image stabilizer is optimized for observing low-contrast extended sources like sunspots. This system corrects for large-scale motions of the object at frequencies up to several hundred hertz. Mercury is similar to a sunspot, in that it presents a low-contrast extended object against the bright daytime sky, so we hoped that we would be able to implement the image stabilizer for Mercury observations.

For this, we temporarily mounted the image stabilizer optical bench ahead of the stellar spectrograph and brought Mercury into the field of view. We then experimented with different filter and beam splitter combinations to get sufficient energy to the bench's control camera. We found it was possible to close the tip-tilt control loop using a dichroic mirror to send yellow light to the spectrograph and blue light to the control camera. We tested the performance of the system for imaging sodium on Mercury (see figure). The two images, one with and the other without tip-tilt correction, were taken within a few seconds of one another.

The sodium distribution is weaker and more blurred in the "No Tip-Tilt" image than in the "Tip-Tilt" image. The difference is not large, but it is appreciable. These images were taken

continued

Tip-Tilt Observations of Mercury continued

using a 5-arcsec aperture slicer resulting in 0.5-arcsec square pixels. Since the tip-tilt system gives us absolute control over the location of Mercury, we were able to move the Mercury image over the slicer aperture to take several overlapping images that could be merged into a mosaic covering the entire planet with 0.5-arcsec pixels. We are confident that observations with this system will greatly improve the quality and resolution of our sodium images.

We plan to continue to develop the image stabilizer for improved Mercury observations. An image intensifier has been purchased to increase the control camera's sensitivity and will be tested soon. We are currently studying the feasibility of developing a true adaptive optics system using a deformable mirror to further enhance our Mercury observations.

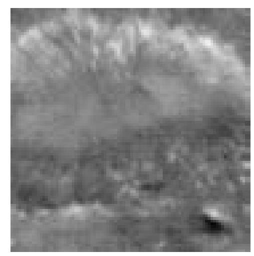
High-Resolution IR Evershed Flow Maps Using AO at the McMath-Pierce Solar Telescope

T. Alan Clark (University of Calgary), Claude Plymate (NSO), Marcel Bergman (Alberta) & Christoph Keller (NSO)

A recent observing run with the McMath-Pierce Solar Telescope, vertical spectrograph, venerable 256×256 Amber infrared (IR) array camera, and the prototype IR adaptive optics (AO) system produced excellent Dopplergrams of Evershed flow in CO lines of different strengths from the 4.7-micron wavelength range. These images show detail at or close to the 0.8-arcsec diffraction limit of this telescope, attesting to the performance of the prototype AO system, even when locking onto less than ideal targets. In the present case, the target region was a fine bridge structure across one area of the sunspot umbra, where the detail in this bridge was sufficient for the servo-control of the AO to operate effectively. The quality of these images demonstrates the potential of this technique for the investigation of the dependence of molecular gas flow upon depth in sunspot penumbrae.

Active region 0507 (McIntosh class Ekc) appeared around the eastern limb of the Sun during this run and was at μ=0.64 on the morning of 20 November 2003. The 2143 cm^{-1} IR continuum image (figure 1) was taken during this scan. Seeing at this time was good to excellent. Area scanning was achieved by moving the beam splitter that divides the optical AO beam from the IR beam to the spectrograph in 0.5-arcsec steps under control of the data acquisition computer. In this run, a 46-arcsec slit, aligned E-W and sampled at 0.18-arcsec intervals by the array, was scanned in a perpendicular direction across the N-S-aligned sunspot in 90 steps of 0.5 arcsec in 16 minutes.


(1)


(2)


(3)


(4)

Figure 1. AR0507 continuum image, 4.7 microns, 46×45 (vertical × horizontal) arcsec.

Figure 2. Weak ^{13}CO line Dopplergram.

Figure 3. Medium-strength CO Dopplergram.

Figure 4. Strong CO line Dopplergram.

The sunspot shows a main umbral region crossed by several narrow light bridges. Within the surrounding penumbra, fibril structures in the continuum image appear to be aligned in a radial direction around the umbra. Below the main spot (toward the limb) are two peripheral umbral regions. The larger of these, to the lower left-hand (NE) side, is surrounded by its own smaller penumbra, which overlaps that of the main spot at about 10 arcsec from the bottom of the image. Another small umbra about 1-arcsec in diameter also has a small, symmetrical penumbra.

High-Resolution IR Evershed Flow Maps continued

Dopplergrams have been produced in two different ways. A simple difference of two images equidistant in wave number from line center produces a descriptive Dopplergram but cannot identify regions where abnormal lineshapes, formed for example by blends of lines where strength may vary, produce an apparent line shift. Full-image line fitting techniques are being developed to produce true maps of CO Doppler line shift.

Three simple Dopplergrams from weak, intermediate, and strong CO lines are shown here, from a weak ^{13}CO line (figure 2), a medium-strength line (figure 3) and a strong line (figure 4), with ATMOS line depths of 4.6, 10.7, and 22.9, respectively. They are arranged in increasing line strength and, hence, increasing source height in the solar atmosphere. In these Dopplergrams, brighter intensity indicates motion toward the observer. Spectral measurements of the overall velocity of this motion indicates that weak and intermediate lines show CO moving at roughly a few kilometers per second, while the images from the strong lines show significantly lower velocity. Careful calibration of these Dopplergrams will be carried out to quantify these speeds.

The main results from this preliminary analysis are as follows: (a) Dopplergrams show remarkable detail in CO velocity at the diffraction limit of the McMath-Pierce telescope for all line strengths; (b) there appears to be more structure in Dopplergrams from the stronger lines that originate higher in the solar atmosphere; (c) the alignment of high-speed channels appears to be approximately radial for weak-line Dopplegrams, while intermediate-strength and strong-line Dopplergrams appear to follow a spiral pattern outward from the umbra, at least on the limbward side of the penumbra; (d) regions of high line-of-sight speeds are seen at the penumbra-photosphere boundary for all line strengths; (e) there is tentative evidence of coincidence of high-speed regions with dark fibrils in the continuum image, though this is not conclusive and requires closer examination; and (f) there is also tentative evidence in the strong-line Dopplergram of inverse Evershed flow on the outer regions of the penumbra.

The present run also included observations of lines from OH that show weak, but measurable, penumbral Evershed flow, and metal lines with strong Zeeman splitting. The combination of results from these high-resolution IR images with CO Dopplergrams promises to be a fruitful line of investigation in the future, especially with the new 1024×1024 Aladdin IR array camera due later this year, further improvements to the McMath-Pierce telescope IR AO, and, further in the future, a larger solar telescope with higher spatial resolution at these wavelengths.

GONG

John Leibacher

GONG continues to make excellent progress in its transition from a limited-lifetime project to a continuously running program. Near-term milestones include 1) attaining steady state operations of the recently modified high-resolution network instruments, 2) completing the local helioseismology data processing pipeline, 3) obtaining well-calibrated magnetograms, 4) replacing the old "sneaker net" of separate-workstation-based processing of the global helioseismology data with an automated pipeline, 5) developing a replacement instrument, and 6) establishing near-real-time data return from the network.

We are enjoying a respite from failures of the light feed turrets in the field, and are in the process of reengineering the seals as well as designing a weather protection system for them. The local helioseismology pipeline has started production of the "ring diagram" flow maps. While we are exploring a replacement magnetograph modulator, modifications to the driver electronics are being undertaken that should improve the current, as well as any future, modulator's polarization state switching. The first month's comparison of automatic image selection has just been completed and it looks like we are close to its routine use, and the *p*-mode frequency backlog is at an all time low. A design review for the replacement shelter should take place this quarter, and John Kennewell's visit from Learmonth in January highlighted the urgency of getting this done before the salt air there rusts the floor supports completely away!

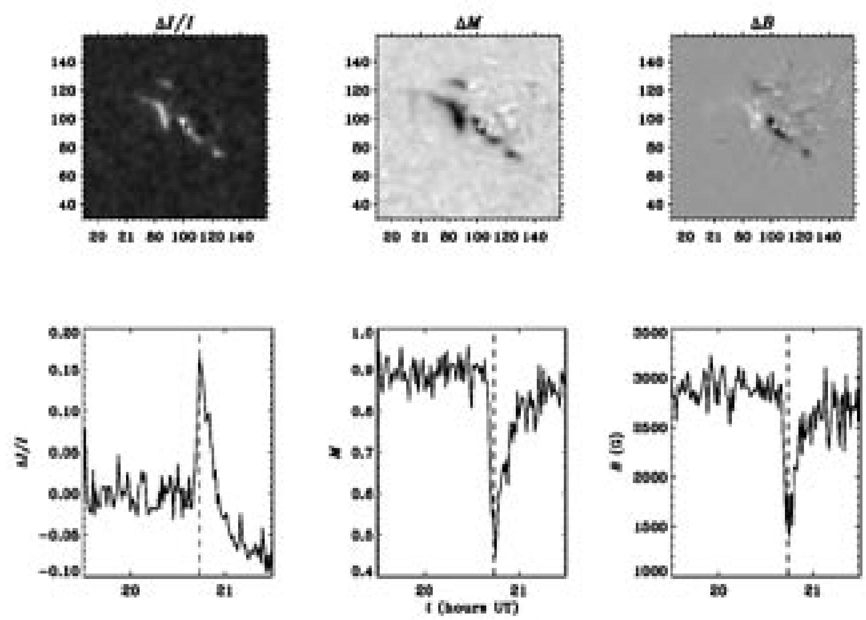


Figure 2. The 28 October 2003 X10 flare in AR10486. Top: Intensity (I), modulation (M), and magnetic field (B) at flare maximum compared to preflare over an area of approximately 4 arcmin on a side (128 pixels). Bottom: Evolution of each quantity over two hours at the pixel marked with a cross in the upper panels; the vertical dashed line indicates the time of the maps above.

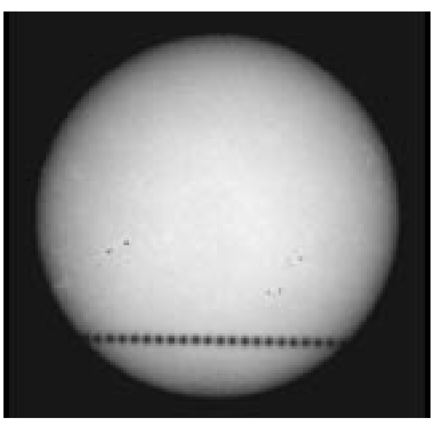


Figure 1. The anticipated path of Venus as it will transit the solar disk on June 8; north is up and east to the left. The images of Venus are spaced 15 minutes apart. The transit will last from 0520 to 1125 UT—in the middle of the night in North America—but should be viewable on the GONG Web site in near-real time from Learmonth, Western Australia; Udaipur, India; and Tenerife, Spain.

Last year's transit of Mercury gave us our first taste of real-time data acquisition, processing, and distribution, and we are looking forward to this year's transit of Venus (see figure 1) and very shortly having farside images of the Sun on line in near-real time. In addition to the global and local helioseismology that is the principal mission of GONG, we are starting to get all sorts of new and interesting science from the high-cadence, high-resolution intensity and magnetograms from the new GONG, for example "white light" imaging from the spectacular series of active regions in October and November 2003 (see figure 2).

Here in Tucson, we've started the modifications of the Data Management and Analysis Center (DMAC), which will result in six new offices on the north side of the building. Phase II, which addresses changes

continued

GONG continued

on the south end of the building, won't begin until the end of the summer at the earliest. The new offices will house current DMAC staff, a new GONG scientist, and two NASA-funded postdocs.

There are several meetings this quarter to support the GONG community. The GONG's Data Users' Committee (DUC) met in Tucson in February to evaluate progress on all fronts and set objectives for the future. The Local Helioseismology Comparisons (LoHCo) group will also convene in Tucson for a workshop with all of the newly compiled data sets. And, this year's annual meeting—GONG 2004/SoHO 14—is being organized by Yale University and will be held 12–16 July 2004 in New Haven, Connecticut (see figure 3). For more information visit *www.astro.yale.edu/sogo04*.

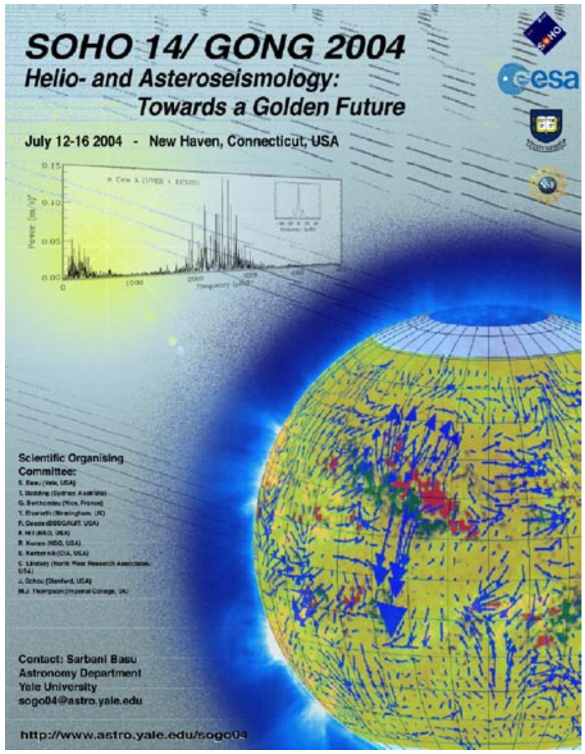


Figure 3. GONG 2004/SOHO 14, organized by Yale University, will be held 12–16 July 2004 in New Haven, Connecticut.

Site and Instrument Operations

A preventive maintenance trip took place at Udaipur in October. The Lyot Filter/Michelson Interferometer Assembly, which had proven to be susceptible to damage from humidity, and the camera, which over the last months showed intermittent variability of the signals from one of its channels, were replaced. The previsit plan also included replacing the telescope turret, however, because of concerns raised by water penetrating the seals of two other recently overhauled turrets, and because physical inspection and electrical checks found no measurable deterioration of the turret at the site, a decision was made to forgo the replacement during that visit. The light feed assembly has since been returned to Tucson and will be the next in line to undergo the newest modifications.

Regarding the light feeds, significant effort in the last quarter focused on how to prevent water leakage into the turrets, and a much improved weather seal was found. However, implementing the new seals into the turret will require some nontrivial modifications. The design and drafting work were completed and a turret was undergoing remachining before the end of the year. The current timeline has modifications complete in January, testing in February, and shipping for installation at Mauna Loa in early March. The remaining turrets will be modified around the network.

Improvements on several other fronts have also been realized. A safety system for securing the optical table during earthquakes was developed and installed at the Tucson site. This supplements the already installed equipment that secures the electronics rack and UPS cabinets, and is ready for installation at the field sites prone to this sort of excitement. Electronic-filtering circuitry that reduces noise generated by the motor driver power supplies has proven beneficial at the Tucson site and is also ready for implementation around the network. Power supply units for the SMD cameras have also been rebuilt with supplies capable of sustaining greater loads. Additional modifications for monitoring supply voltages are underway, and the units may be ready for installation during the next round of preventive maintenance visits. We have been overhauling the currently unused cameras and have produced a set of deployable spares, as well as rebuilt filter/interferometer assemblies. The components are now undergoing tests in preparation for use in the field. New UPS units for all the network sites have been ordered and are expected to be installed during 2004.

A major forest fire approached Big Bear at the end of October, requiring all local residents to evacuate and shutting down the instrument there for about a week. Fortunately, the fire avoided the area, and site operations were restored soon after everyone's return. Also at Big Bear, a disk drive used in the real-time data caching system began to fail. The backup disks, which were designed to prevent any loss of data, kicked in and the site staff installed a replacement. The event was notable

continued

GONG continued

as it was the first such disk drive failure in the more than two years of GONG+ operation.

Data Processing, Analysis, and Management
The occasional apparent spinning of the Sun seen in the ring-diagram flow maps—the so-called "washing machine effect" reported in the December 2003 *Newsletter*—has been wrung out of the GONG data, thanks to Cliff Toner, Irene Gonzalez-Hernandez, and John Bolding. Cliff implemented a method to determine the angular orientation of the images that uses the MDI legacy data as a fiducial "seventh GONG site." Irene did most of the algorithm evaluation, John fed the data through the pipeline, and Rudi Komm and Rachel Howe performed flow inversions and frequency measurements as added evaluation components. The elimination of the problem means that we can finally proceed with routine production of synoptic flow maps corresponding to Carrington Rotations (CRs). We currently have four completed CRs: 1979, 1987, 1988, and 1989 from August 2002, and March through May 2003.

The end of the spin cycle also means that a substantial amount of new data is available to the LoHCo group. Rudi Komm organized a meeting of the LoHCo group in Tucson February 10 and 11, at which researchers from Yale, Colorado, Stanford, and Colorado Research Associates participated. Materials from a 2 December 2003 conference call are on the Web at *gong.nso.edu/lohco/.*

Jack Harvey, Jeff Sudol, and Rachel Howe have been using the GONG data for some decidedly nonhelioseismic science, by studying the October-November 2003 series of monster flares that rocked our world. It turns out that the flares are very prominent in the GONG intensity, velocity, and in particular, the magnetic field data, where the large change in the magnetic field configuration is highly visible.

Shukur Kholikov has continued to work on developing his time-distance (T-D) code, which was highlighted in the December 2003 *Newsletter.* The program enjoyed an extended visit from Paul Rajaguru who worked with Shukur to install and test his and Mike Thompson's T-D code from Imperial College (London) into the local pipeline system. Shukur is also maintaining the near- and farside holography packages, and Jean Goodrich is working on aspects of the near-real-time processing at the sites that will feed the farside pipeline. GONG was awarded a NASA Living with a Star TR&T grant to develop near-real-time compression and transmission of the images needed for farside imaging from the six GONG instruments, and to produce and distribute farside proxy images on a regular and timely basis. We are working with the sites regarding bandwidth issues, but anticipate the farside pipeline will be in production mode by the end of fiscal year 2004. A postdoc is being sought to calibrate the farside "bounce" signal in terms of the real physical changes of the Sun.

Richard Clark continues to work on the automated rejection of bad images and is currently running his method in parallel with the visual inspection done by Gregg Ladd. Richard will soon have three GONG months of data processed through to global inversions, which will be compared with the traditional handcrafted method. Katrina Gressett is working on producing a three-day-long power spectrum up to degree 1200. This data will be provided to the community for use in developing ridge-fitting techniques.

During the past quarter, month-long (36-day) velocity time series for GONG months 77 and 78 (ending 12 January 2003), with fill factors of 0.87 and 0.86, respectively, were logged into the DSDS, and 698 gigabytes were distributed in response to 24 data requests. The data reduction team has worked hard to pare down the cumulative backlog for GONG+ data products, which is currently down to 194 days. Time series for months 80–84 have been produced but have not yet been entered into the archive. "Peakfind" results up to GONG month 83 (ending 11 July 2003) have been submitted as well. These should make their way to the archive by the end of the month.

Caroline Barban was back for a short visit from her new position in Leuven, Belgium. She says that the cheese and chocolate is much better in Belgium, but the weather is best in Tucson!

Atlanta AAS Meeting Bears Fruit for NOAO and Gemini News

Douglas Isbell

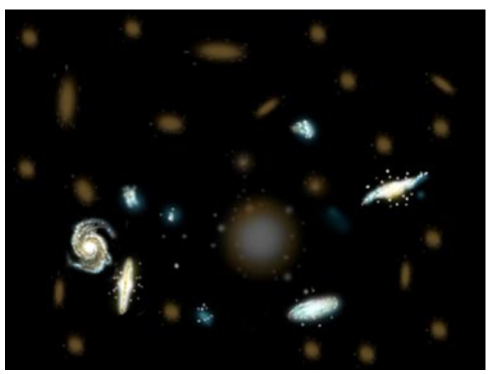
Each of the first three days of the American Astronomical Society (AAS) meeting in Atlanta from 5–7 January 2004 featured at least one press briefing with major connections to NOAO. These briefings produced strong print media and Web coverage, despite stiff competition from simultaneous robotic Mars landings and comet flybys.

The opening Monday press conference of the meeting marked the first AAS press event completely focused on a result from the Gemini Observatory. Canadian and US coprincipal investigators from the Gemini Deep-Deep Survey presented a series of initial findings on galaxy formation in the early universe in the so-called "Redshift Desert" (1<z<2), enabled by the capabilities of the GMOS instrument and the first large-scale application of the nod-and-shuffle observing technique. Nod-and-shuffle significantly reduces interference from the background natural sky-glow, which allowed very deep spectra of this window in the early universe to be obtained for the first time.

Galaxies in this "region of maximum ignorance," as it was termed by Roberto Abraham (University of Toronto), appear to be much more mature and massive than general cosmological theory suggests. "Galaxies are already old and well-formed" by this era, having reached an age of 2.5–3.5 billion years by the time the Universe itself was just 4 billion years old, explained Pat McCarthy (Carnegie Institution). This is a "significant problem" for current mainstream models of galaxy evolution, McCarthy added, which implies that gradual, hierarchical accumulation does not work for a large fraction of massive galaxies. Panel members predicted that the Spitzer Space Telescope will find large numbers of galaxies at z=2–4, and that Spitzer and the James Webb Space Telescope will see massive starburst galaxies at very early times (z=4–10).

The Gemini Deep-Deep Survey news was reported the next day on page A9 of *USA TODAY*, and in a January 8 story on page A19 of the *New York Times,* as well as in a widely used wire story by the Associated Press, and other stories in the *Australian* newspaper, *Space.com*, the January 23 issue of *SCIENCE*, and the front page of every major Hawaiian newspaper.

The Tuesday morning press conference (dubbed "Where did all the Spiral Galaxies go?") featured a cohesive story about the first clear evidence for a spiral galaxy being stripped bare of its gas by ram pressure from a violent collision with the ambient gas in a galaxy cluster. William Keel (University of Alabama) presented Mosaic imaging data from the Mayall telescope showing an extended oxygen-rich tail of gas dragged outward from the infalling galaxy that stretches for more than 200,000 light-years. Keel then discussed Gemini North spectroscopic data that pins down recent star birth at the leading edge of galaxy, where the constituent gas and dust builds up densely from this "perfect storm." Daniel Wang (University of Massachusetts) completed the multiwavelength tale of "tragedy on a galactic scale" with observations from the Chandra X-ray Observatory. (For more details, see the Science Highlight section and the cover art of this *Newsletter.*)


Credit Gemini Observatory and Jon Lomberg

This story was reported by Reuters and Associated Press wire services in stories that ran across the United States, from the *San Francisco Chronicle* to the *Cleveland Plain-Dealer*, and on numerous Web sites including *Space.com*, *Astronomy.com* and *SkyandTelescope.com*.

The Wednesday morning AAS briefing was based on observations at the Cerro Tololo Blanco 4-meter telescope and the Anglo-Australian Telescope that revealed the outline of an enormous string of galaxies 300 million light-years long at a redshift of z=2.38, only 2.8 billion years after the Big Bang. "The Universe is growing up faster than we thought," said lead panel presenter Povilas Palunas (University of Texas), summarizing one of the obvious themes of media activity at the meeting.

Given that this massive unnamed string of 37 galaxies and a quasar is located in the southern constellation Grus (the Crane), wags in the press briefing audience suggested the name "the Crane's Neck" for the structure, which was blessed with good humor by the panel. This science result was cited in the January 8 *New York Times* story on the meeting, and several space news Web sites.

Meanwhile, the NOAO exhibit booth at the Atlanta AAS meeting received the prime location of the entire exhibitor area. It drew steady attention with new display posters on the formal debut of the NOAO Spanish Language Astronomy Materials Education Center on the Web (see *www.astronomyinspanish.org*), and a striking new pink-purple-blue color image of the Veil Nebula by Travis Rector (University of Alaska Anchorage) that will soon become a poster for sale at the Kitt Peak Visitor Center (see *www.noao.edu/image_gallery/html/im0852.html*).