

NOAO-NSO Newsletter

Issue 73

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“America’s space program will go on. This course of exploration and discovery is not an option we choose. It is a desire written in the human heart, where that part of creation seeks to understand all creation.”

--US President George W. Bush, speaking at a February 4 memorial service in Houston following the loss of Space Shuttle Columbia.

“In addition to confounding federal agencies and those who work with them, the stalemate over [FY2003] appropriations is a symptom of a larger breakdown in our lawmaking process. Increasing ideological rigidity and partisan gamesmanship, along with an electorate that is, paradoxically, both evenly divided and widely disengaged, have conspired to make it harder and harder to conduct the mundane but essential business of Congress. It’s hard to predict when this state of affairs is likely to improve.

“But it’s worth noting how science funding has largely stayed out of the partisan and ideological crossfire. The passage of our NSF [doubling] bill, while not guaranteeing linear growth, is a sign that both Congress and the Administration have come to understand that broadly based increases in science spending are overdue.”

--Excerpts from comments by House Science Committee Chairman Sherwood Boehlert (R-NY) during an address to the University Research Associates’ Annual Council of Presidents Meeting and Policy Forum on January 30.

For details on the NSF Fiscal 2004 budget request, see:

www.nsf.gov/od/lpa/news/03/pr0317.htm
www.nsf.gov/bfa/bud/fy2004/toc.htm

“We’re collecting the photo album of the life history of the universe for the first time: the baby pictures, the teenage pictures, the grown-up pictures.”

--Sandra Faber (University of California Santa Cruz) on current advances in galaxy formation studies, in Ron Cowan’s article “Galaxy Hunters: The Search for Cosmic Dawn,” National Geographic, February 2003.

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

Astronomers from the University of Colorado (Nathan Smith, John Bally, Jacob Thiel and Jon A. Morse) used the Blanco 4-meter telescope at CTIO to discover dozens of potential stellar cocoons [inset] within the hostile environment of the Carina Nebula. Each of these objects may harbor disks of gas and dust that could one day form planetary systems.

This is the first large population of these so-called “proplyd” objects to be found outside of the Orion Nebula, the closest region to Earth known to be forming massive stars. The newly discovered proplyds located within the Carina Nebula (NGC 3372) are five times farther from Earth than Orion.

This photo was released on 8 January 2003 in Seattle at the 201st meeting of the American Astronomical Society. (See Science Highlight on page 3.)

Image Credit: University of Colorado/NOAO/AURA/NSF

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Proplyds and Silhouette Disks in the Carina Nebula

Adapted from NOAO Press Release 03-01, which was featured jointly with results from Keck in a press conference at the January 2003 AAS meeting in Seattle (Subsequent media coverage included the Associated Press and Reuters wire services, CNN-TV Headline News and CNN.com, USA Today, Space.com and SCIENCE)

Observers using the Mosaic II imager on the Blanco 4-m have reported the discovery of what may be dozens of bright “proplyds” and dark silhouette disks within the hostile environment of the Carina Nebula.

Both proplyds and silhouette disks are generally recognized to be circumstellar matter surrounding young stars that is rendered visible by ionizing photons from nearby hot stars. As their name suggests, silhouette disks are seen in absorption against bright-background line emission from an HII region. In the case of the proplyds, the circumstellar material is itself lit up as it is ionized by photons from the hot star. Proplyds are, thus, sources of bright line emission. The name “proplyd” is derived from the likelihood that the circumstellar material harbors a protoplanetary disk.

The well-known images of proplyds in the Orion Nebula are some of the most arresting obtained with the Hubble Space Telescope (HST). They graphically illustrate how the radiation environment of young stars is responsible for sculpting and eroding (through photo-ablation) circumstellar material.

The new study of proplyds in the Carina Nebula (Smith, Bally, Thiel, and Morse, 2003; submitted to *ApJ Letters*) is the first to detect large numbers of proplyds outside Orion. The inset image on the *Newsletter* cover shows some of the detected bright proplyds (top row) and silhouette disks (middle row). The bottom row of the image shows objects with unusual shapes not seen in Orion, such as large round

heads and thin tails. Each panel in the figure is 15×15 arcsec.

“These intriguing proto-planetary systems in the Carina Nebula are located near several of the hottest and most massive stars known in the Milky Way,” says Nathan Smith of the University of Colorado. The Carina Nebula is indeed impressive—it spans several square degrees and is powered by more than 60 O stars. The Lyman continuum luminosity of the nebula is larger than that in Orion by a factor of approximately >100 . Although the central star clusters have cleared most of the remnant molecular cloud material from the core of the nebula, regions of ongoing star formation have been previously identified at the edges.

Because of the harsh radiation environment even at the edges of the nebula, proplyds are expected far from their ionizing sources, at an angular distance more than a degree away. These large angular scales could be surveyed efficiently using the large field-of-view provided by Mosaic II on the Blanco 4-m telescope.

In their H α , [SII], and [OIII] survey, Smith et al. found that despite the inhospitable environment, the proplyds they detected were large, ~ 4 to 5 arcsec in size ($\sim 10^4$ AU) and several times the physical size of the proplyds in Orion. The lack of smaller proplyds is, in part, a selection effect since the Carina Nebula is five times more distant than Orion. In addition, the survey was carried out from the ground rather than with HST.

Nevertheless, the detection of large proplyds is surprising—where are their counterparts in Orion? Smith et al. speculate that the larger Carina proplyds

may result from the evaporation of larger, more massive disks such as those expected for the progenitors of Herbig AeBe stars. These young, intermediate-mass stars are expected to be more numerous than in the Orion Nebula since the Carina Nebula is a far richer star-forming region.

“One explanation for this peculiar situation may be that the Carina proplyds have more massive protoplanetary disks than those in Orion, since the whole region of Carina tends to give birth to more massive stars,” explains John Bally (University of Colorado). An alternative explanation discussed by Smith et al. is that the larger proplyd sizes are due to higher far ultraviolet/extreme ultraviolet flux ratios in the Carina Nebula.

Further observations are required to confirm that the identified proplyds do indeed harbor young embedded stars and protoplanetary disks, as well as to answer the new questions raised by these observations.

“More intensive imaging and spectroscopy are needed with the sharper view of HST to see if these objects really are proplyds like those in Orion, since some may turn out to be starless molecular globules. HST images are also needed to look for smaller ones, comparable in size to those in Orion, to determine if they too can survive in the less hospitable environment,” Smith notes. “Thanks to the Mosaic II images from the CTIO 4-m, we now know where to point HST.”



A Warp in the Disk of the Large Magellanic Cloud?

A new study of the shape of the Large Magellanic Cloud (LMC) by CTIO Research Experiences for Undergraduates student Colette Salyk of MIT and NOAO astronomer Knut Olsen has revealed evidence for a warp in the disk of this nearby galaxy.

Salyk and Olsen observed 50 fields in the LMC with the CTIO 0.9-m (see figure 1). In each of the fields, they identified and measured the brightness of the “red clump” stars. These intermediate-age, metal-rich, core helium burning stars shine with a well-defined luminosity and color. Since red clump stars are both bright and numerous, they are a useful relative distance indicator.

Salyk and Olsen used the observed color of the clump in each field to estimate the extinction to the field, and they used the extinction-corrected brightness of the clump to determine the distance to each field. By mapping the changes in the relative brightness of the clump stars from field to field, they were able to trace out the geometry of the LMC.

The results of this study are illustrated in figure 2. The first panel (a) shows the relative positions of the fields studied, as projected on the plane of the sky, where each field is depicted as a dot. The second panel (b) shows what the LMC would look like if it was rotated along the horizontal axis (of panel a) to an angle (~90 degrees) where the LMC is seen approximately edge-on. The vertical axis in the plot shows the relative differences in the brightness of the clump stars in magnitudes. The length of the cigar-shaped points corresponds approximately to the measurement errors.

The third panel (c) shows what the LMC would look like if it were further rotated (from the configuration shown in panel b) along the vertical axis until the line of nodes is reached. This shows that the LMC is tilted by ~35 degrees out of the plane of the sky. This result agrees with that obtained previously by van der Marel and Cioni (2001) using AGB and TRGB stars, although the new result is a substantial improvement due to the higher spatial resolution of the study.

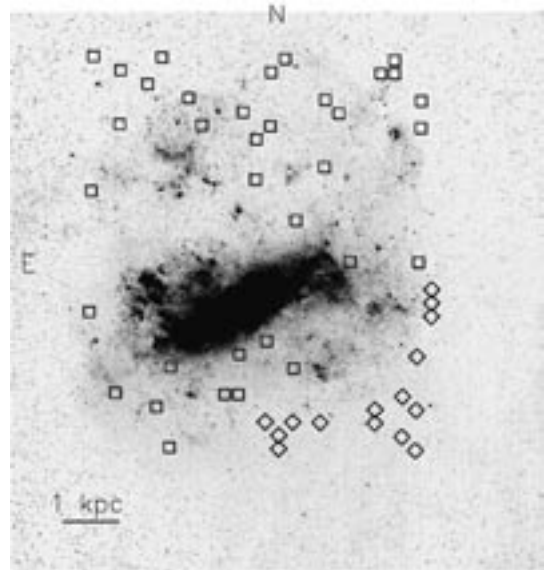


Figure 1

In a new wrinkle, however, Salyk and Olsen find that the disk of the LMC also appears to be bent. The southwest portion of the disk (the right edge in panel c) clearly deviates from the plane of the disk, with features extending 2.5 kpc out of the plane towards the Earth. “This discovery fits nicely into a picture where an interaction with the SMC or the Milky Way pulled out this material—the warp is aligned with the long axis of the LMC’s elliptical shape,” Olsen says. This interpretation is supported by the kinematics of the LMC’s carbon stars, which also show a disturbance in this region of the galaxy.

These results were reported by Salyk and Olsen at the January 2003 AAS meeting and have been published recently in the *Astronomical Journal* (Olsen and Salyk 2002, *AJ*, vol. 124, p.2045).

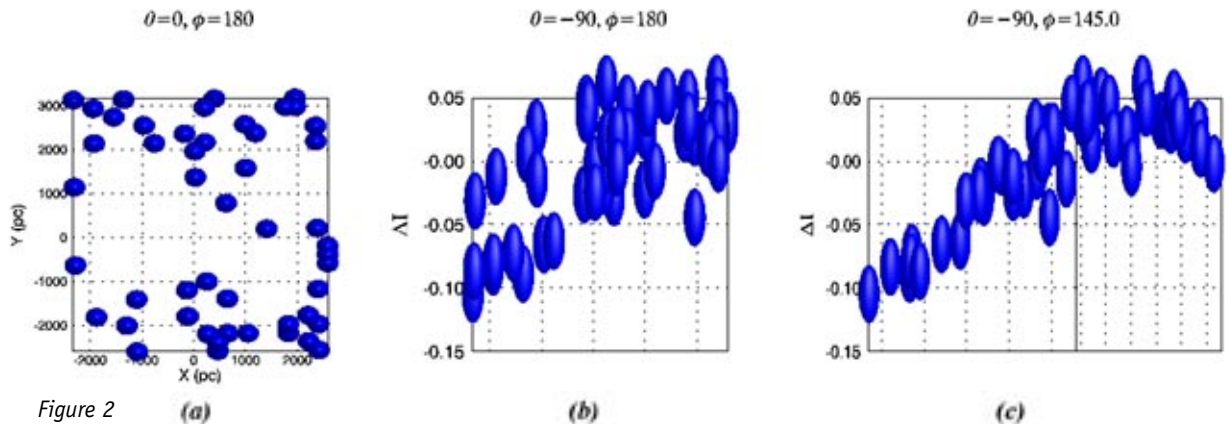


Figure 2



Clustering of Red Galaxies in the NOAO Deep Wide-Field Survey

The study of the large-scale structure of galaxies is one of the most direct methods by which we may learn about the mechanisms responsible for the origin and growth of inhomogeneities in our otherwise nearly homogeneous Universe. At the same time, galaxies clearly form and evolve in the context of large-scale structure. As a result, there is considerable interest in studying the evolution of the structure traced by different galaxy populations.

In a paper recently submitted to the *Astrophysical Journal*, NOAO astronomers Michael J.I. Brown, Arjun Dey, Buell Januzzi, Tod Lauer, and coauthors Glenn Tiede and Valerie Mikles (University of Florida), used the initial 1.2-square degree release of the NOAO Deep Wide-Field Survey (NDWFS; see www.noao.edu/noao/naodeep and www.archive.noao.edu/ndwfs) to measure the clustering evolution of the red population of galaxies out to $z \sim 1$.

Measuring the clustering evolution of individual galaxy populations requires very large galaxy sample sizes, and large-area, deep-imaging surveys such as the NDWFS are well suited to this task. NDWFS is a multiband (B_W RIJHK) survey of two 9-square degree fields of sky. The survey depth ($R \sim 26$, $K \sim 19.5$) is designed to enable studies of the evolution of galaxies and large-scale structure to $z < \sim 5$.

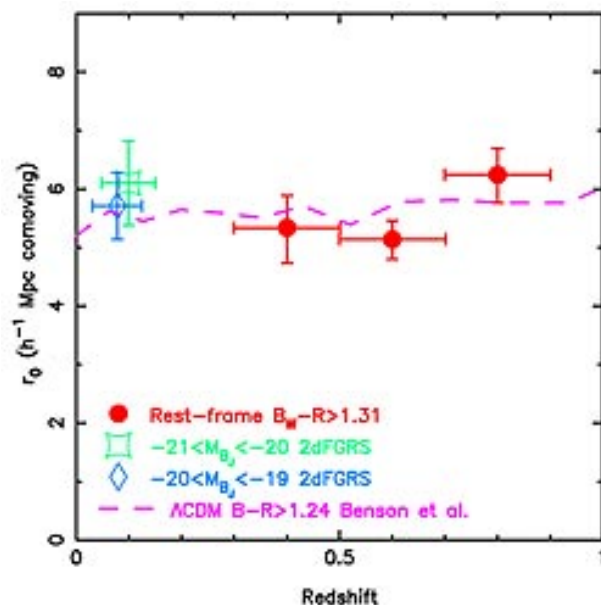
Many previous measurements of clustering at high redshift were obtained from apparent magnitude-limited samples. These samples contain a broad range of galaxy types and luminosities and consequently may average over considerable detail, since clustering may depend significantly on galaxy rest-frame color and luminosity.

For their study, Brown et al. chose to study the clustering of the red galaxy population in the redshift range $0.3 < z < 0.9$. Their focus on red galaxies is advantageous because these galaxies likely constitute a homogeneous population, and robust photometric redshifts can be derived for red galaxies.

In a departure from previous studies, Brown et al. used galaxy spectral evolution models to predict how the red galaxy population would evolve as a function of redshift in B_W RI colors. Appropriate color selection criteria were then used to identify the evolving red galaxy population in the NDWFS data. The selection criteria were matched to those used by the 2dF Galaxy Redshift Survey (2dFGRS) and the Sloan Digital Sky Survey (SDSS) to measure the clustering of low-redshift ($z < 0.15$) early-type galaxies.

Remarkably, the red galaxy population shows little clustering evolution between $z \sim 1$ and the present, in good agreement

with the recent predictions of Λ CDM models. The figure shows the evolution in the spatial correlation function parameter r_0 as a function of redshift for the NDWFS red galaxy sample (solid symbols). When compared with the results from the 2dFGRS and SDSS at low redshift, it is clear that little clustering evolution has occurred between $z \sim 1$ and the present. A similarly slow rate of evolution is predicted by the Λ CDM model of Benson et al. (2001; long dashed line).



These results illustrate the ability of deep, wide-field surveys to begin to probe the evolution of clustering in the galaxy population. “By measuring the clustering as a function of the physical properties of galaxies rather than the observables, we have gained a significant advantage in measuring the evolution of large-scale structure,” says Michael Brown.

More definitive studies will be possible when the full NDWFS data set (more than 15 times larger) is available for analysis. The larger data set will reduce the statistical errors of similar studies, as well as enable clustering studies of a larger number of galaxy subpopulations and to larger redshifts ($z \sim 5$). “This preliminary result, obtained with just 6% of the survey area, shows the potential of the NDWFS,” Brown comments. “We are looking forward to extending this work to higher redshifts, and further constraining models of structure evolution and galaxy formation.”



Solar H α Zeeman Spectropolarimetry

K.S. Balasubramaniam, Han Uitenbroek (NSO) & Eugenia B. Christopoulou (University of Patras)

The H α spectral line at 6562.808 Å is exceptional in its sensitivity to chromospheric activity. However, inferring magnetic fields in H α (or for that matter, any chromospheric spectral line) is difficult because the spectral line is formed under a complicated set of non-LTE conditions. K.S. Balasubramaniam, E.B. Christopoulou (2001 NSO Summer Research Assistant from the University of Patras, Greece), and H. Uitenbroek are researching the Zeeman spectropolarimetric properties of H α observed in a sunspot using the HAO/NSO Advanced Stokes Polarimeter.

Comparing Stokes V profiles of photospheric lines (Fe I λ 6301.5, 6302.5 Å) with that of H α , it was found that the Stokes V profiles are easily seen in sunspots and active regions, and at the site of flares (marked by an "o" in figure 1), where the core of the Stokes intensity profile in

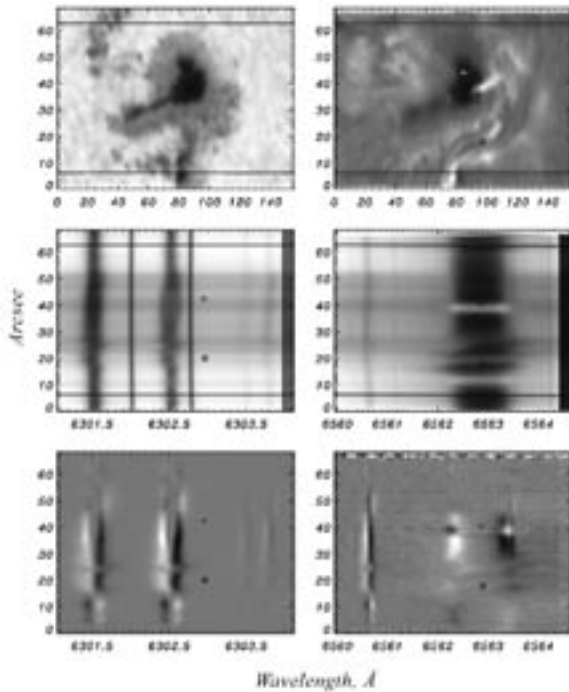


Figure 1. Comparison of Stokes I and V profiles in the 6300 Å region (left panels) and H α (right panels).

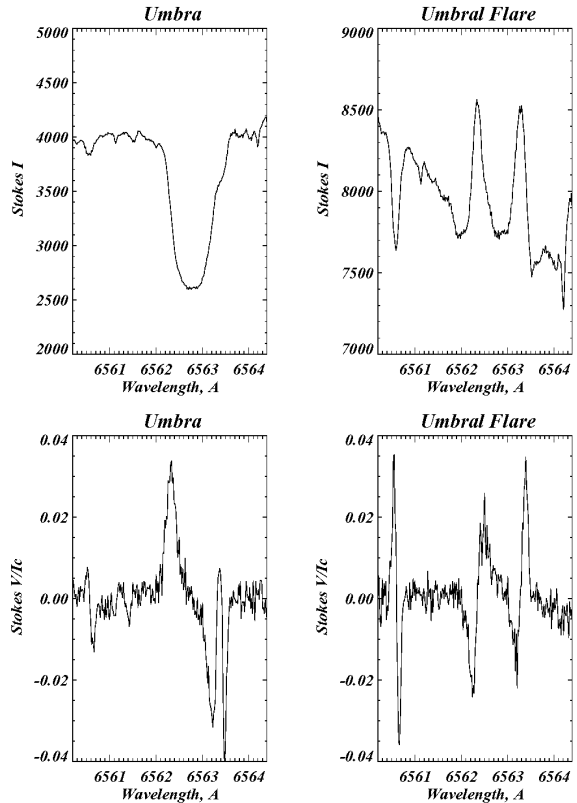


Figure 2. Plot of normal and double-reversed polarization profiles.

H α is seen to undergo a self reversal. The Stokes V profile in the core of the spectral line is formed in absorption, while in the wing of the spectral line it is formed in emission. This causes a polarization double reversal. In figure 2, this double reversal is shown as a plot, comparing it with a normal Stokes V in the umbra. If not correctly interpreted, this exceptional behavior of H α showing the normal and the inverse Zeeman effect can lead to the misinterpretation that the magnetic fields in the umbral chromosphere are reversed. The authors have reproduced the H α Zeeman self reversal using a complete radiative transfer treatment of the spectral line, including partial redistribution in a strong magnetic field, and under the influence of a model flare atmosphere.

DIRECTOR'S OFFICE

NATIONAL OPTICAL ASTRONOMY OBSERVATORY

Two New Associate Directors of NOAO

Jeremy Mould

It is a pleasure to announce the appointment of Taft Armandroff as Director of the NOAO Gemini Science Center (NGSC). Taft's energy and enthusiasm will carry the center into a future in which the national astronomy community gets to know the twin 8-meter telescopes intimately, and Gemini becomes a prolific source of astronomy discoveries.

As Taft says in the NGSC section of this *Newsletter*, there is a great deal to do. There are US instruments to deliver, new ones to plan, and data reduction tools needed that are only concepts at present. There are observers who know NOAO instruments, but don't know GMOS. In all of these areas and more, the NGSC team is at the service of our community.

This would be an overwhelming solo task for the international Gemini Observatory (which is still quite busy commissioning instruments). With the help of the national centers like NGSC, Gemini can deal with a complex partnership as if it were a simple one.

A warm welcome also to David Sprayberry, who joins us to lead the Major Instrumentation Program at NOAO. The Major Instrumentation Program combines the resources of our Engineering and Technical Services people in Tucson and in La Serena. Our objective is to take on bigger challenges in instrumentation by combining forces. It is a particular pleasure to announce David's appointment as NOAO's Associate Director for Instrumentation.

David comes to us from the W.M. Keck Observatory, where he was Associate Director for Observing Support, and responsible for new instrument integration and nighttime operations.

This program too will be very busy over the coming year. Delivery of GNIRS to Gemini is close, detailed design is underway for the NOAO Extremely Wide Field IR imager (NEWFIRM), and plans are developing for a new array data acquisition system and adaptive optics for SOAR.

These are all big projects and they require coherent management motivated by science. I congratulate David on taking up his new responsibilities, which include long-range planning for the national observatory's instrumentation, a subject on which he will want input from all of us.





TMT Consortium

Jeremy Mould

Half of the 8- to 10-meter class telescopes in existence were built by consortia of universities, and the other half by international partnerships. So it is not surprising that there is intense institutional interest in 20- to 30-meter telescopes, as befits the top-ranked ground-based optical/infrared (O/IR) priority of the Decadal Survey.

Last year, Cornell University, Indiana University, and NOAO all played their part in focusing this institutional interest by hosting a steadily growing consortium of institutions interested in 20-meter or larger O/IR telescopes. A December 2002 meeting in Tucson included representatives from the University of Arizona, University of Toronto, Indiana University, CFHT, the Harvard-Smithsonian Center for Astrophysics, Cornell University, NOAO, the Carnegie Observatories, the Herzberg Institute of Astrophysics, University of Chicago, University of Texas, University of Virginia, and

INAOE and UNAM of Mexico (Yale University was unable to attend).

The upshot of these meetings has been nucleation around two design efforts, a 20-meter telescope (TMT), following a concept by Roger Angel (SPIE session 4840, 2002), and a large scalable telescope project to be located at a site with low precipitable water vapor. The Magellan partners are pursuing the former concept, and Cornell, Chicago, Illinois, and Northwestern are collaborating toward the definition of the latter.

NOAO engineers are planning to work closely with Caltech and UC in the coming year to pursue the design and development phase outlined in the CELT Green book and the GSMT book, which describe concepts with highly segmented primary mirrors. NOAO scientists are collaborating with the three groups on coordinated site testing.

The GSMT Science Working Group (SWG), chaired by Rolf Kudritzki, expects to hear from all three groups early this year to better understand the science capabilities of each concept. The SWG's emphasis is on assembling a high-caliber public science case able to command LIGO-level funding from the National Science Foundation.

In contrast, the TMT Consortium's focus is on communication. Through the consortium, NOAO leads community participation in GSMT, as the Decadal Survey envisaged. One approach the consortium is considering is for institutions not directly involved in large telescope partnerships to be associate members of a public/private GSMT in which NOAO becomes the public partner.

I expect to chair the next meeting of the TMT Consortium soon, and meeting details will be provided by my office to representatives of any interested astronomy institution.



Presenters at the NOAO Town Meeting at the American Astronomical Society meeting on 7 January 2003 in Seattle included NOAO Gemini Science Center Director Taft Armandroff, NOAO Deputy Director Todd Boroson, NOAO Director Jeremy Mould, GSMT Science Working Group Chair Rolf Kudritzki, and LSST Science Working Group Chair Michael Strauss.

Wayne Van Citters, director of the astronomical sciences division at the National Science Foundation, added words of support for the two science working groups, saying that their pending input would receive strong consideration within the foundation.

NOAOGEMINISCIENCECENTER

TUCSON, ARIZONA • LASERENA, CHILE

Announcing the NOAO Gemini Science Center (NGSC)

Taft Armandroff

Within the structure of the Gemini Partnership, each partner agency created a national project office to spearhead its participation. The project offices form the nodes of communication between the Gemini Observatory and each partner country, providing input and advice to Gemini on partner perspectives, and communicating to the national communities the capabilities and science opportunities that Gemini presents. NOAO is the home of the US national project office, which we have reorganized into the NOAO Gemini Science Center (NGSC). Our change in name, from the construction-era designation of the US Gemini Program to the NOAO Gemini Science Center, is intended to clearly express our science emphasis and our association with NOAO.

Science is the focus of NGSC's mission in the following ways:

- NGSC informs the US community of Gemini scientific observing opportunities via numerous means, including the *NOAO-NSO Newsletter*, the NGSC Web pages, an NGSC booth at winter AAS meetings, and presentations at US astronomy departments.
- NGSC invites scientific proposals for Gemini observing, performs technical review of these proposals, and applies the NOAO Time Allocation Committee (TAC) system to the proposals. NGSC also provides user support for the approved observing programs.
- NGSC intends to organize and conduct science workshops to highlight particular areas of Gemini science and instrumentation that are both timely and productive.
- NGSC plans and oversees the development of scientific instrumentation in the United States for the Gemini telescopes.
- NGSC provides selected operations support for Gemini science observing. For example, all queue observations using the Phoenix infrared spectrograph involve NGSC staff.
- NGSC provides support to the US community for the reduction and analysis of Gemini data.
- Finally, the NGSC permanent staff and postdoctoral fellows conduct frontline scientific research using Gemini.

Gemini Observing Opportunities for Semester 2003B

Taft Armandroff

The NOAO Gemini Science Center (NGSC) invites and encourages the US community to submit proposals for Gemini observing opportunities during semester 2003B. Gemini observing proposals are submitted and evaluated via the standard NOAO proposal form and Time Allocation Committee (TAC) process. Although the Gemini Call for Proposals for 2003B 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 2003B. 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. Several important new instrumental capabilities are expected to be offered in semester 2003B, as described below.

Gemini North:

- The GMOS optical multi-object spectrograph and imager will be offered in 2003B. Multi-object spectroscopy, long-slit spectroscopy, integral-field unit (IFU) spectroscopy, and imaging modes will be available. Nod-and-shuffle mode, which greatly enhances sky subtraction, will be offered in 2003B.
- The NIRI infrared imager/spectrometer will be offered in 2003B. The $f/6$ imaging mode (over a 2-arcmin field) and $f/6$ grism spectroscopy mode are expected to be the most popular configurations. NIRI functioned well during its queue observing runs in December 2002.
- GMOS and NIRI will be offered in both queue and classical modes. It is expected that classical mode will be offered only to programs with a size of three nights or longer.
- Michelle is a mid-infrared (8- to 25-micron) imager and spectrograph for shared use between Gemini and the United Kingdom Infra-Red Telescope (UKIRT). Observing modes include direct imaging and long-slit spectroscopy with spectral resolutions of approximately

continued



Gemini Observing Opportunities continued

200, 1,000, and 30,000. Michelle was delivered to Gemini Observatory in late 2002. A period of characterization and commissioning of Michelle is presently underway, after which Michelle is expected to be available for scientific use. As of late January, we believe that some modes of Michelle may be included in the 2003B Gemini Call for Proposals.

- The Altair adaptive optics system was delivered to Gemini North in October 2002. Altair commissioning, in natural guide star mode with NIRI, has begun. During 2003B, it is expected that Altair commissioning will be completed, and system verification will be performed. Therefore, Altair will probably not be available for user proposals until semester 2004A.

Gemini South

- The Phoenix infrared high-resolution spectrograph will be offered in semester 2003B.
- The Acquisition Camera will be available for Quick Response in 2003B.
- The GMOS-South optical multi-object spectrograph and imager is expected to be offered during semester 2003B. GMOS-South was delivered to Cerro Pachón in late 2002. Integration of GMOS-South with the telescope and software systems is underway; this will be followed by commissioning and system verification. The imaging, long-slit spectroscopy, multi-object spectroscopy, and nod-and-shuffle modes of GMOS-South are expected to be offered in 2003B. Also, all GMOS-South observations are expected to be performed in queue mode.

- It is expected that the T-ReCS mid-infrared instrument may be offered in 2003B, in imaging mode. As of late January, T-ReCS has not yet passed its pre-ship acceptance test at the University of Florida. Hence, it is particularly important to check the Gemini Call for Proposals (in early March) regarding the availability of T-ReCS in 2003B.

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

We remind the community that US Gemini proposals can be submitted jointly with collaborators in another Gemini partner; a collaboration simply submits proposals in each relevant partner country, explicitly noting how much time is requested from each Gemini partner. Such multipartner proposals are encouraged because they access a larger fraction of the available Gemini time, thus encouraging 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).

Please note also that in addition to Gemini observing capabilities, proposers may request other public-access facilities in the US observing system required to carry out a science program, as part of the same proposal. For example, one can request imaging with ISPI on the CTIO 4-meter and spectroscopy with GMOS on Gemini South in the same proposal without facing double jeopardy.

Reminders about Gemini Observing Proposals

Taft Armandroff & Dave Bell

For Gemini observing proposals for semester 2003B, we wish to remind proposers about several procedural issues that will help NGSC and the Time Allocation Committee (TAC) in evaluating the proposals.

- Include the proper overhead time for your observing program. Overhead should be included in both the total time request, and in the “observation times” of each target. The rules for calculating overheads are given in the “Performance and Use” sections of Gemini’s instrument Web pages.
- Gemini proposals require specification of the observing conditions for cloud cover, image quality, sky brightness, and water vapor. Think carefully about what observing-condition bands should be specified in your proposal. Specifying the conditions too tightly reduces the probability that your program will be approved and executed. Our advice is to specify the worst conditions under which your program can be successful. Also, please explain your choice of observing-condition bands in your technical description.

continued



Reminders about Proposals continued

- For GMOS multi-object spectroscopy, pre-imaging with GMOS is required currently for mask fabrication. Please be sure to clearly include the observing time needed for this pre-imaging.
- If your observing program is being proposed jointly with another partner country, be sure to enter both the total time requested from all partners and that requested from the US TAC. Also, please specify who is the overall contact for the multipartner program. New fields are available on the NOAO Web proposal form for supplying this information.
- If you plan to use Gemini's Phase I Tool (PIT), be sure to read and follow the guidelines available at www.noao.edu/naoaprop/help/pit.html.
- If you plan to download a LaTeX template to be filled in and submitted by e-mail, be sure all target and instrument information is completed on-line (including guide stars, filters, etc.). Changing such information in the LaTeX file will often produce proposals that are incomplete or invalid.

NGSC Support of Gemini Phase II Submissions

Taft Armandroff

All principal investigators (PIs) with approved Gemini observing proposals are required to undertake a Phase II program submission. Successful proposers use the Gemini Observing Tool (OT) to define their programs in detail. A new version of the OT is released by Gemini each semester in order to support newly released instruments and any other changes in instruments or observing procedures. The OT for 2003A ("river") was released in early January (see www.us-gemini.noao.edu/sciops/OThelp/otInstallation.html).

New for 2003A, NGSC staff will be the point of contact for Phase II submissions for US projects utilizing GMOS, NIRI, and Phoenix. NGSC (and the other national Gemini offices) will assume the role previously held by Gemini for

Phase II submission checking and the resulting interactions with astronomers regarding submissions issues. These three instruments represent the vast majority of US Gemini observing programs.

Phase II for the following developmental or more specialized instruments will continue to be handled by Gemini: Michelle, CIRPASS, and the Acquisition Camera. Hence, for GMOS, NIRI, and Phoenix, US proposers should interact with NGSC staff about Phase II and submit their Phase II proposals (xml files) to the NGSC staff contact. A list of staff contacts for each 2003A Gemini observing program can be found at www.us-gemini.noao.edu/sciops/schedules/schedSupport2003A.html.

Phoenix News

Ken Hinkle & Steve Ridgway

In December 2002 and January 2003, there were two Phoenix queue blocks and one classically scheduled Phoenix block at Cerro Pachón. The classically scheduled block had two observing teams, both including one observer with previous experience observing with Phoenix at Kitt Peak. Both teams obtained excellent data and were very pleased with their observing experience. Observers who are interested in classical scheduling should note this in their observing proposal. While the national office can make recommendations, the assignment of classical versus queue nights is ultimately handled by Gemini Observatory and not by the national Gemini offices.

continued



Phoenix News continued

For the Phoenix queue blocks, the NGSC must supply a staff member to be the Phoenix observer. Gemini South staff runs the queue. Ken Hinkle was the December queue observer; Bob Blum and Steve Ridgway were the January observers. Steve says that after he was given a solid briefing and update on the operation, Bob handed him the keys and he was able to man the Phoenix console solo for the last week of the run. Steve reports:

“Bernadette Rogers, and later Phil Puxley, were the Gemini queue scientists who set out the observing program hour by hour based on the conditions and the program requirements and priorities. This was a very impressive run. There were eight consecutive clear, calm nights. The seeing was usually quite stable from the very beginning of the night to the end. Most of the time the delivered image quality was 0.5 arcsec at K or better, and two full nights had image quality of better than 0.3 arcsec at H. A variety of observations were carried out in the H, K, and M bands. Highlights included observing prominent CO fundamental emission lines from young sources, obtaining spatially resolved spectra of H₂ emission from a protoplanetary nebula and from an HH object, and recording high-resolution spectra of the newly discovered, very nearby T Dwarf eps Ind B in the last few minutes that it was available this season. There were no instrument problems, and the few telescope issues were inevitably resolved within a few minutes. The entire queue process ran like a well-oiled machine. It is really a delight to see Phoenix utilized so effectively and extensively on a wide variety of programs.”

NGSC Booth at the AAS Meeting in Seattle



The NOAO Gemini Science Center booth at the January 2003 AAS meeting was a busy place. From left to right, top: Larry Ramsey (Penn State University), Taft Armandroff (NGSC), Catherine Pilachowski (Indiana University), Bruce Hrivnak (Valparaiso University), Ken Hinkle (NGSC), Bernadette Rodgers (Gemini Observatory); bottom: Matt Mountain (Gemini Observatory), Dave Bell (NOAO) explaining the Gemini Observing Tool to Peter Joachim and Julianne Dalcanton (University of Washington), and Wayne Van Citters (NSF).



US Gemini Instrumentation Program Update

Taft Armandroff & Mark Trueblood

The US Gemini Instrumentation Program continues its efforts to provide highly capable instrumentation for the Gemini telescopes in support of frontline science programs. This article gives an update on Gemini instrumentation being developed in the United States, with status as of late January.

GNIRS

The Gemini Near-Infrared Spectrograph (GNIRS) is an infrared spectrograph for the Gemini South telescope that will operate from 1 to 5 microns and will offer two plate scales, a range of dispersions, and both long-slit and integral-field modes. The project is being carried out at NOAO in Tucson under the leadership of Neil Gaughan (Project Manager), Jay Elias (Project Scientist), and Dick Joyce (Co-Project Scientist).



GNIRS on the NOAO Flexure Test Facility in December 2002.

In December, the GNIRS Team carried out their second cycle of GNIRS cold testing. The cold cycle was performed with an engineering-grade array installed in GNIRS. During the cold test, the instrument reached the desired operating temperature, all motors and mechanisms performed as designed (including the on-instrument

wavefront sensor provided by the University of Hawaii's Institute for Astronomy), spectra were obtained with the detector, and the instrument was controlled by the complete GNIRS software suite. In addition, initial flexure testing was carried out using the NOAO Flexure Test Facility. The team is currently making adjustments and enhancements to GNIRS based on a "punch list" from the cold test. Overall, 95 percent of the work to GNIRS delivery has been completed.

NICI

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



The NICI dewar being fabricated at the machine shop.

The NICI cryostat components are undergoing fabrication, as are the optical elements. In addition, development of the array controller for the two NICI ALADDIN arrays is progressing well. Overall 46 percent of the work to NICI final acceptance by Gemini, planned for December 2004, has been completed.

continued



Program Update continued

T-ReCS

The Thermal Region Camera and Spectrograph (T-ReCS), is a mid-infrared imager and spectrograph for the Gemini South telescope, under construction at the University of Florida by Charlie Telesco and his team.

In late November, Gemini and NGSC personnel traveled to Gainesville, FL, and tested whether T-ReCS meets its optical performance requirements. The image quality achieved was outstanding, and T-ReCS passed all of the acceptance requirements related to optical performance. The electronic, mechanical, and software acceptance tests still remain. The T-ReCS team is devoting particular attention to detector performance tests and enhancements to ensure that T-ReCS meets those performance specifications. This will allow NGSC, Gemini, and Florida to complete the pre-shipment acceptance test of T-ReCS.

GSAOI

The Gemini South Adaptive Optics Imager (GSAOI) will be used with the multi-conjugate adaptive optics (MCAO) system being built for the Gemini South telescope. The imager will cover wavelengths between 1 and 2.5 microns, and will employ a $4K \times 4K$ HgCdTe detector mosaic.

NOAO and the Australian National University (ANU) were both selected to develop independent conceptual designs for GSAOI. The NOAO GSAOI Team produced a well-developed instrument concept, and the results were documented as a report for Gemini. Both NOAO and ANU presented their instrument concepts to the Gemini Design Review Committee in late August in Hilo, and revised proposals (in October) following significant changes to the requirements requested by Gemini. After what Gemini called an extremely close competition, in which the external review committee concluded that either team could build an excellent imager for the MCAO system, the decision was made to award the fabrication contract to ANU.

Gemini Next-Generation Instrumentation Planning

Taft Armandroff

Gemini Observatory will hold an international planning meeting for next-generation Gemini instrumentation on 27–28 June 2003. The goal of this meeting is to identify new science opportunities for Gemini in the 2004–2010 window, and to define the instrumentation that will enable these science opportunities.

With the assistance of NGSC, Gemini arranged to hold this meeting in Aspen, CO. This location facilitates participation by members of the US astronomical community. Gemini envisions approximately 40 participants, selected by the international organizing committee (chaired by Doug Simons, Gemini Associate Director for Instrumentation). The Aspen meeting will be organized around four science-themed breakout groups:

- Stars, the Solar System, and Extrasolar Planets
- Star Formation Processes and the Interstellar Medium
- Structure and Evolution of the Milky Way and Nearby Galaxies
- Formation and Evolution of Distant Galaxies and the High-Redshift Universe

The most recent Gemini instrumentation meeting was held in Abingdon, UK, in January 1997.

NGSC will organize a preparatory workshop “Future Instrumentation for the Gemini 8-m Telescopes: US Perspective in 2003” for the US community. The US meeting will follow the structure of the international meeting. The goal of the US workshop is to encourage discussion about how this Gemini planning process relates to the scientific goals of the US community, and to develop compelling science cases and instrumentation plans for input to the “Aspen” planning process. All the US delegates to the Gemini Aspen instrumentation meeting, the US Gemini Board representatives, and members of the US Gemini Science Advisory Committee are expected to participate. The US workshop is planned to occur in April or May in the Scottsdale, AZ, vicinity. For more information about the US planning processes for Gemini next-generation instrumentation, please contact Taft Armandroff, Director of NGSC (armand@noao.edu).

OBSERVATIONAL PROGRAMS

NATIONAL OPTICAL ASTRONOMY OBSERVATORY

NOAO 2003B Proposals Due 31 March 2003

Todd Boroson

Proposals for observing time for semester 2003B (August 2003–January 2004) with the Gemini North and South telescopes, the Cerro Tololo Inter-American Observatory, the Kitt Peak National Observatory, and community access time at the Hobby-Eberly Telescope, the Keck I and II telescopes, and the MMT Observatory telescope are **due by Monday evening, 31 March 2003, midnight MST**.

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 **only** may optionally use Gemini’s tool, which runs on Solaris, RedHat Linux, and Windows platforms, and can be downloaded from their Web site.

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

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

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



Community Access Time at the Keck, MMT, and HET Observatories

Todd Boroson & Dave Bell

As a result of two awards made in the first proposal cycle of the National Science Foundation's Telescope System Instrumentation Program (TSIP), a total of 41 nights of classical observing time are being allocated to the astronomical community on the two 10-meter telescopes of the W.M. Keck Observatory on Mauna Kea. These 41 nights are being allocated over five semesters, with 12 nights to be scheduled in 2003B. The nights will be divided equally between the two telescopes and distributed evenly over lunar phases. All current facility-class instruments and modes (which excludes interferometry) are available. Any scientist may propose without regard to nationality or preferred access through other channels. For additional information, see www.noao.edu/gateway/keck/.

About 27 classically-scheduled nights of community-access observing time per year are available on the MMT Observatory 6.5-meter telescope, under a six-year agreement with the National Science Foundation. About 12 nights will be available during the August 2003-January

2004 period. Proposals that can take advantage of MMT's bright-time capabilities are particularly encouraged, as public-access programs in previous semesters have somewhat disproportionately used the community's share of dark time. For more information, check NOAO's MMT Web page at www.noao.edu/gateway/mmt/ and MMT's public-access instrumentation page at www.mmt.org/public_access/.

About 16 equivalent clear nights of community-access queue observations per year are available on the Hobby-Eberly Telescope (HET) at McDonald Observatory, under a six-year agreement with the National Science Foundation. During 2003B, about 50 hours are expected to be available for integration and set-up time. Beginning this semester, community-access investigators may submit proposals for the new Medium Resolution Spectrograph (see the following article) in addition to the High- and Low-Resolution Spectrographs. For additional information, see www.noao.edu/gateway/het/.

The Hobby-Eberly Telescope Medium-Resolution Spectrograph

Larry Ramsey (Penn State)

The Hobby-Eberly Telescope (HET) Medium-Resolution Spectrograph (MRS) is currently in commissioning, and the most basic single-object mode has been tested. That and the "long-slit" modes, which we anticipate testing in the March-June period, will be available to the general community through NOAO starting in August 2003.

The MRS is a complex fiber-feed instrument with single-object, fiber long slit, and multi-object capability

in the resolution range $5,000 < \lambda/\Delta\lambda < 20,000$ in the visible and $5,000 < \lambda/\Delta\lambda < 10,000$ in the 1- to 1.35-micron range. The complete capabilities of the MRS are described in Ramsey et al. 2002 (available at www.noao.edu/gateway/het/) and are summarized in the table below, taken from that paper.

The available modes are called the direct-feed mode and the long-slit mode. The direct-feed mode utilizes the MOS 0 probe and has an object/sky pair of blue-optimized (Polymicro

Technologies PT FVP300330370500) and red-optimized (PT FIP 300330370500) fibers that project to 1.5 arcsec on the sky, yielding a fixed resolution of about 7,000. The object and sky fibers are separated by about 10 arcsec. There are also single 2-arcsec red or blue optimized fibers that yield a resolution of about 5,300. These modes have all been tested with cross-disperser #1. Next to be tested will be the synthetic fiber long slits. The 1.5-arcsec long slit is an array of 15 fibers in a linear array and the 2 arcsec long slit is a linear

continued



Hobby-Eberly continued

array of 9 fibers. At the spectrograph end, the fibers are reimaged via an all-reflecting optical system to an intermediate slit mask that can enable resolutions from 5,300 to 20,000 and select four different slit “heights.” A number of configurations are possible

with different cross dispersers and these are discussed in the “MRS Fiber and Slit Arrangements” document. This document, and other information useful to 2003B proposal writers, can be found at www.noao.edu/gateway/het/.

Currently, only the visible beam of the MRS is available. We anticipate that the near-infrared beam, which has had one test run, will be available this fall. The MOS mode should be available to the community for 2004A.

Properties of the MRS

	Visible Beam	NIR Beam
Fiber-fed MOS (max. # objects)	9	5
Wavelength range (nm)	430–880	1000–1300
Typical	380	900
Blue limit	900	1350
Red limit		
Resolution-slit product (Rφ arcsec)	10400	10400
Max. resolution	~20000	10400
Camera	Dioptric f/1.6	Dioptric f/1.6
Detectors	Two 2K×4K Marconi 15μm pixels	1K×1K HgCdTe Hawaii 18μm pixels
Echelle	79 or 110g/mm, R2	31.6g/mm, R2
Cross dispersers (g/mm & wavelength of max. efficiency)	#1: 220g/mm, 590nm #2: 600g/mm, 650nm #3: 900g/mm, 515nm #4: 1200g/mm, 560nm	#1: 400g/mm, 1200nm #2 TBD
Max. wavelength range/frame	450nm	300nm



Observing Request Statistics for 2003A Standard Proposals

	No. of Requests	Nights Requested	Average Request	Nights Allocated	DD Nights (*)	Nights Previously Allocated	Nights Scheduled for New Programs	Over-subscription for New Programs
GEMINI								
Gemini North	95	148.62	1.56	41.64	2	0	41.64	3.57
Gemini South	59	83.58	1.42	32.2	0	0	32.20	2.60
CTIO								
CTIO 4-m	88	272	3.09	103	5	0	103	2.64
CTIO 1.5-m	12	69	5.75	74	0	7	67	1.03
CTIO 1.3-m	9	24	2.67	23.3	0	0	23.30	1.03
CTIO 0.9-m	15	100	6.67	62.5	0	0	62.5	1.60
KPNO								
KPNO 4-m	94	307.8	3.27	111.50	5	0	111.5	2.76
WIYN 3.5-m	40	112.25	2.81	55.75	0	8.5	47.25	2.38
KPNO 2.1-m	39	183.2	4.7	115	0	0	115	1.59
WIYN 0.9-m	7	21	3	21	0	8	13	1.62
Keck/HET/MMT								
Keck I	14	18.5	1.32	6	0	0	6	3.08
Keck II	19	28	1.47	6	0	0	6	4.67
HET	8	6.8	0.85	4.3	0	0	4.3	1.58
MMT	7	16	2.29	11	0	0	11	1.45

*Nights allocated by NOAO Director



KPNO Instruments Available for 2003B

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



Observational Programs

CTIO Instruments Available for 2003B

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'
1.3-m			
ANDICAM Optical/IR Camera	Fairchild 2K CCD	0.17	5.8'
	HgCdTe 1K IR	0.11	2.0'
0.9-m			
Cass Direct Imaging	SiTe 2K CCD	0.40	13.6'

Gemini Instruments Possibly Available for 2003B

GEMINI NORTH	Detector	Spectral Range	Scale (" / pixel)	Field
NIRI	1024×1024 Aladdin Array	1–5μm R~500–1600	0.022, 0.050, 0.116	22.5", 51", 119"
GMOS-N	3 - 2048×4608 CCDs	0.36–1.10μm 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"
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	0.36–1.10μm R~670–4400	0.072	5.5'



Keck Instruments Available for 2003B

	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	0.31–1.0μm	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"
NIRSPA0 (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 2003B

	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	0.5–1.0μm	0.3	150"
MIRAC3 (mid-IR img, PI)	128×128 Si:As BIB array	2–25μm	0.14, 0.28	18.2, 36"
MiniCam (optical imager)	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 2003B

	Detector	Resolution	Slit	Multi-object
LRS (Marcario low-res spec)	Ford 3072×1024 4100–10000Å or 4300–7400Å	600 1300	1.0"–10"×4' 1.0"–10"×4'	13 slitlets, 15"×1.3" in 4'×3' field
MRS (med-res spec)	2 - 2K×4K, visible 1K×1K HgCdTe, near-IR	5000–20000 5000–10000	1.5" or 2" fibers (synth long-slit)	9 objects (no MOS in 2003B)
HRS (high-res spec)	2 - 2K×4K 4200–11000Å	15000–120000	2" or 3" fiber	single

Big Telescopes and Little Children

Malcolm G. Smith

We are making rapid progress in realigning our activities with the directions set out in NOAO's Long-Range Plan. Scientific staff in Chile have transferred significant portions of their efforts (3.4 FTE service work so far) onto the new programs, including support of Gemini through the NOAO Gemini Science Center (NGSC). This shift of scientific staff from the CTIO Program to other parts of NOAO South has been combined with more effective sharing of common services with other AURA programs in Chile through AURA's Observatory Support Services (AOSS) Group. When combined with a similar shift of resources in the engineering and technical services area, the net result is that the former CTIO "Program" has been able to withstand a cut in excess of US\$1M, and pay for significant staff effort from Tucson in support of SOAR and instrumentation at the Blanco 4-meter without local layoffs.

The SOAR telescope is expecting first light on or about November 1 of this year. The Infrared Side Port Imager (ISPI) has been successfully commissioned on the Blanco 4-meter telescope (see www.ctio.noao.edu/instruments/ir_instruments/ispi/first_light.html). In addition, the small telescopes on Cerro Tololo will enjoy a new lease of life and instrumentation under the new SMARTS consortium (see the article, "Small Telescopes Update").

Of course, the drawbacks are that more than 70 percent of the time on the smaller telescopes is no longer available to the general user community, and the 12 scientific staff members, who spend part of their time doing service work, have not been doing enough research. The Telescopes Operations Division on Cerro Tololo will have to run telescopes on two mountains now with little or no increase in staff. Furthermore, we need to develop a strong follow-on to ISPI with an imaginative and competitive plan for instrumenting the Blanco 4-meter telescope. This will have to be done in a world in which the leading instrumentation groups (including the group at NOAO North and South) are busy designing and constructing instruments for 8- to 10-meter class telescopes.

In its final site visit last December, AURA's NOAO Observatory Visiting Committee generally shared these perceptions. So, what are we doing about this?

I have asked the scientific staff to prioritize their service time so that we can compare more accurately the excess time being spent

on the lower-priority projects. These projects will be dropped to make more room for research time—unless more resources are provided to NOAO South. This list of threatened projects will be provided to the next CTIO director, who takes over early in November, so that she/he can start to set the new directions for NOAO South in conjunction with the community and the Director and staff of NOAO.

OK, so what about the little children? Public outreach and education in Chile is an essential component of our long-term "Sites" program. Alistair Walker is leading the effort here to locate and characterize sites for future US telescopes. The outreach effort at NOAO South supports the protection of existing and potential sites, mainly from the effects of light pollution but also, in the case of the ALMA site, from radio-frequency interference.

The primary components of AURA's outreach program in Chile are:

- (a) **The Mamalluca Municipal Observatory** — See *Sky and Telescope*, February 2002, p91; and www.angelfire.com/wy/obsermamalluca. The NSF supplied their first telescope via funding to CTIO six years ago. This public observatory is now famous in the world of amateur astronomers, receiving three times the visitors (who have to pay) than all the international observatories in Chile combined (where visitors do not have to pay). As a result, they have constructed a number of their own telescopes and provide an essential component of the overall public astronomy support system in Chile. They now have the leading national center for astronomical tourism in South America.
- (b) **The Office for the Protection of the Skies of Northern Chile** (OPCC) — See www.opcc.cl. The OPCC's major achievement has been following up successfully on the implementation of the light-pollution control law DS696/98, which sets clear guidelines for artificial lighting in the astronomically sensitive 2nd (ESO Paranal), 3rd (Las Campanas), and 4th (ESO La Silla and AURA-Pachón-Tololo) Regions. Behind the scenes, work is being done involving the lighting of mines in the neighborhood of Paranal and Las Campanas, well before such artificial light sources become a problem. Potential sites for future large US telescopes will also be areas of priority once the exact locations of such planned telescopes are known. This work is being carried out in close collaboration with AURA, ESO and Las Campanas and with the International Astronomical Union (www.ctio.noao.edu/light-pollution/iau50). The director of the OPCC is employed by AURA

continued



Big Telescopes continued

and funded through a consortium of the major observatories and the EPA equivalent (Comision Nacional del Medio Ambiente, CONAMA) of Chile. In the 3rd Region, the city of Copiapó has converted 7,000 of its lights to near full cutoff. Ovalle (to the southwest of the AURA property) has done much the same thing. Following recent visits to see quality lighting in Tucson, the mayor of La Serena indicated that she is studying a project to change all 13,000 municipal "points of light" to comply with DS696/98.

- (c) **The RedLaSer schools network** — See www.ctio.noao.edu/AURA/redlaser. The La Serena "Red" (network), was started by NOAO staff members Ron Probst and Hugo Ochoa, who worked together with local teachers and the University of La Serena to set up an initial network of seven schools. The network now has grown to 70 schools, mostly in the area near Pachón/Tololo. The presentation of a STARLAB portable planetarium (www.ctio.noao.edu/AURA/planetario) by the Gemini Observatory has enabled the RedLaSer to reach out (in a joint program with NOAO) to more than 65,000

Chilean children in four years. The teachers of these children propose how the planetarium can be used within the context of the science programs in their school. RedLaser teachers are participating in NOAO's ASTRO-Chile remote-learning program. Dara Norman, who holds an NSF Postdoctoral Fellowship at CTIO, has led the involvement of NOAO South in this and other Project ASTRO initiatives in the United States.

- (d) **StarTeachers** — See www.gemini.edu/project/announcements/press/2003-1.html. Three teachers from RedLaSer are funded by Gemini this year to travel to La Serena's sister "city," the island and county of Hawaii. Prior to that trip, three teachers from the Big Island will spend two weeks in La Serena in March.

Plans for 2003 include establishing the RedLaSer network at a national (Chilean) level. The hope is that in 2004, the network can be expanded to an international level. The NSF (via NOAO's ASTRO-Chile initiative) and the Chilean CONICYT (via its EXPLORA program) have both begun to provide specific support for this overall outreach activity.

First ISPI Run with Visiting Astronomers

Nicole van der Blik, Ron Probst & Dara Norman

After a successful commissioning of the Infrared Side Port Imager (ISPI) at the Blanco 4-meter in September last year (see the December issue of the *Newsletter*), and another set of engineering nights in November, we are right now accommodating the first visiting astronomers. The instrument is stable and allowing the observers to obtain data at a rate of about 10 gigabytes per night.

As the run proceeds, a list of suggestions for improvements, mainly GUI related, is being generated, with some improvements already implemented. We expect that before the next ISPI block, in May, the growing pains will have subsided and that we will be able to offer an even more user-friendly instrument that never crashes.

Results of preliminary throughput measurements are shown in the following table. A set of narrowband filters has been ordered and will hopefully arrive in time to be installed before the May ISPI run. This set includes filters centered at 2.03 microns (continuum), 2.06 microns (He I), 2.08 microns (C IV), 2.12 microns (H₂), 2.14 microns (continuum), 2.16 microns (Br gamma), 2.19 microns (He II) and 2.25 microns (continuum and H₂). Please keep an eye on the ISPI Web pages (www.ctio.noao.edu/instruments/ir_instruments/ispi) for further information and updates.

continued



First ISPI Run continued

ISPI Performance on the Blanco 4-Meter

Band	Background flux per pixel (electrons/sec)	Integrated flux from m = 15 star (electrons/sec)	5 sigma source detection limit in 60 sec
J	330	4000	19.6
H	1560	5000	18.9
K'	2160	3300	18.3



This image of 30 Doradus (the Tarantula Nebula) is a combination of three ISPI images taken using J, H, and Ks broadband filters, each with an exposure time of 4.5 minutes. The object's faint nebulosity is clearly visible, while the stretch of the inset image of the bright core has been modified to demonstrate the instrument's dynamic range.



33,490 Mosaic II Exposures

Tim Abbott

As a normal part of its operation, the Save The Bits data archiving tool records the primary FITS headers of all images and spectra obtained at the Blanco 4-meter telescope. This disk record provides an invaluable tool for studying the demographics of actual instrument use.

With minor variations, the Mosaic II imager has operated in a stable configuration for some time. It is used in the classical mode and the visiting observer is assisted by a telescope operator (TO). It is possible to script sequences of images of a given field and to slew from field to field semiautomatically with minimal dependence on reaction time of the observer or TO, but guide stars are normally acquired manually.

Figure 1 provides an indication of the typical efficiency of use of the Mosaic II camera in the calendar years 2001 and 2002. The fraction of each night expended as integration time in object exposures is plotted against the number of such exposures collected in that night. The procedure followed by an observer to initiate exposures on program targets is such that we can be reasonably certain that an exposure with FITS keyword OBSTYPE = "object" is indeed of a scientifically interesting target or standard and not, for example, a focus frame, flat field, or other calibration.

This analysis only includes exposures initiated from midway between sunset and evening astronomical twilight through midway between morning astronomical twilight and sunrise. The night length is also defined by this interval, approximately reflecting the useful night for the instrument.

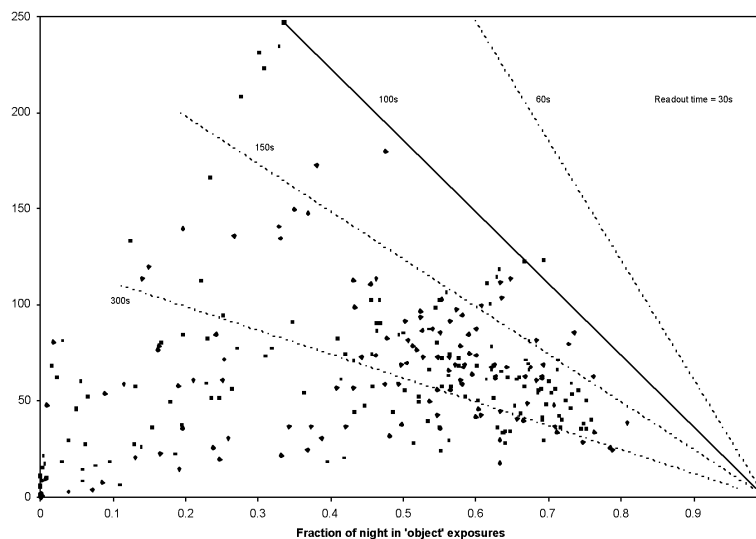


Figure 1. Nightly observing efficiency with the Mosaic II imager on the Blanco 4-meter telescope. Squares indicate nights in 2001, diamonds in 2002.

Because the assessment of time lost to bad weather or technical failures tends to be highly subjective, and sometimes not even reported, no attempt has been made to correct for this in figure 1. Thus, partially and completely lost nights will appear as the scattering of points toward and at the origin, respectively.

The maximum possible number of exposures for the stated interexposure dead time, with the fraction of night used to obtain them, are also plotted. The solid line indicates this limit for the actual Mosaic II readout time (~100 seconds) and a few particularly efficient observers manage to approach it (i.e., by following a single field all night). However, more typically, nights tend to cluster between the dashed lines, indicating nightly average interexposure intervals of 150 seconds to 300 seconds. Thus, on a clear, trouble-free night, other overheads normally account for 0.5 to 2 times the readout time (slewing

during readout is encouraged when feasible with this instrument). Most nights achieve greater than 40 percent efficiency but never more than about 80 percent, with a median around 65 percent.

Clearly, there is room for improvement. The 100-second readout time is long for modern CCDs, and is limited both by the transfer time of the SITe devices and by the controller itself. The dynamic range of these detectors is less than might be expected, and will therefore discourage long exposure times (in the two years studied, not a single 1,800-second object exposure was acquired). For long-standing but addressable technical reasons, the telescope slews more slowly than it should. Basic observation queuing software is already in place, but the facility can be expanded and rendered more attractive to the visiting observer. For example, guide star acquisition could be automated.

continued



33,490 Mosaic II Exposures continued

Figure 2 shows the distribution of total object integration time with the filter used. The overlying quantum efficiency (QE) curve indicates the average QE of the mosaic at the central wavelength of each filter. Recent developments in detector manufacture could improve response throughout the optical spectrum, but most dramatically at the red and blue ends. It should be noted that the U and SDSS u filters are significantly affected by a steep cutoff in the transmission of the prime focus corrector at these wavelengths.

These data and their implications are under active consideration at the observatory as we continue to seek ways to improve efficiency and productivity.

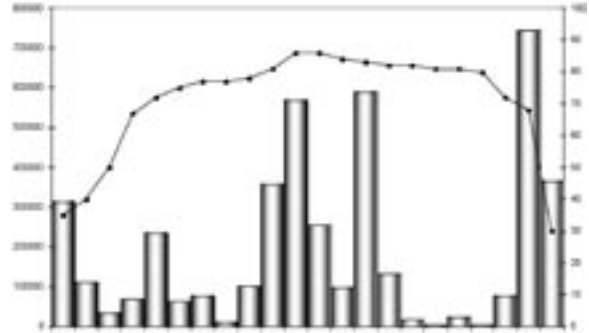


Figure 2. Total Mosaic II object exposure time in the years 2001–2002, as a function of filter used. The filters are ordered from blue to red by central wavelength. The overlying curve shows the QE of the Mosaic CCDs at the central wavelength of each filter used.

Site Testing/Surveying in the Atacama Region of Northern Chile

Robert Blum



Figure 1. Edison Bustos of CTIO downloads meteorological data from the weather station on Cerro Honar (5,400 meters).

NOAO and the AURA New Initiatives Office (NIO) are entering their third year of active site testing/surveying in the Atacama region of northern Chile. This activity forms (in part) the basis from which future telescope sites may be chosen for projects like the Giant Segmented Mirror Telescope (GSMT), the private–public partnership Twenty Meter Telescope (TMT), and the Large Synoptic Survey Telescope (LSST). In addition, NOAO/NIO are engaged with other groups, such as the University of Tokyo, CELT, and ESO, in sharing information and sites analysis data for developing possible future telescope sites in Chile and elsewhere.

Through its group based at CTIO, NOAO has been characterizing mountain tops in the Atacama region of northern Chile. The group has maintained a weather station near the Atacama Large Millimeter Array (ALMA) project site for more than two years and now has agreed to take over the maintenance of another weather station operated by Cornell University as part of the site survey for the Atacama Telescope Project (astrosun.tn.cornell.edu/atacama). For more information on the site survey project in general, see www.ctio.noao.edu/sitetests. The entire area around the ALMA site (in the 2nd Region of Chile near the border with Bolivia and Argentina) is sometimes referred to as Chajnantor, and a large section of it is officially reserved for science activities by the Chilean government.

continued



Testing/Surveying in Atacama continued

In January 2003, Edison Bustos and Bob Blum of CTIO met Chuck Henderson and Luke Keller of Cornell University in San Pedro de Atacama to assess the status of Cornell's two weather stations on Cerros Toco (5,500 meters) and Negro (5,025 meters), with the purpose of taking over maintenance and data-download responsibilities for these towers. These are rugged, high peaks, and it is difficult sometimes to keep equipment running. In addition to the activities involving the Cornell towers, a routine visit was made to the NOAO/NIO station at Cerro Honar (5,400 meters). Ascending such high peaks with little time to acclimatize is also difficult. However, other than being tired, the group is happy to have left the Honar and Negro stations busily taking data. The Toco station was removed for repairs.

This on-site activity is producing valuable long-term statistics that will aid in the process of site selection for the large, next-generation ground-based telescopes. In particular, any future telescope whose science drivers point to the need for an excellent "high and dry" site might be well placed in the Chilean Andes on one of these peaks overlooking the new ALMA radio telescope.

On a personal note, the CTIO staff have very much enjoyed the enthusiasm, hard work, and professionalism of the Cornell group. The January trip signaled a break in their visits to Chajnantor, but we hope it will not be a long one. The Cornell group has been a driving force behind the site activities on Chajnantor, and AURA/NIO are indebted to them.



Figure 2. Luke Keller of Cornell University is happy that the weather station on Cerro Negro (5,025 meters) has survived more than one year without human intervention while taking data every few minutes.



Site Activities on Tololo and Pachón

Hugo E. Schwarz

The weather tower on El Peñón, a promising rocky outcrop on Cerro Pachón near Gemini South, has been re-erected after collapsing last winter from ice and snow load. This Chilean summer we will install a weather station there that will send its data to Tololo via a radio modem. This will be a test for more remote weather stations we may put up on mountains in northern Chile. The data will be accessed through the CTIO Web site. We are also planning a road to El Peñón so that we can set up seeing monitors and other instruments without the need for climbing with heavy equipment. The site is also a potential location for the Large Synoptic Survey Telescope (LSST).

A campaign with a DIMM and MASS observing the same star from the ground near the SOAR telescope has been begun. The small instruments have screens to protect against wind buffeting and are operated from the SOAR control room. The DIMM measures the seeing, including ground effect, while the MASS gives the result for the free atmosphere from about 500 meters above the site. The difference in these readings gives us an idea of the ground effect at Pachón.

The Tololo All-Sky Camera (TASCA) is now running in the full four-filter mode. The latest addition to the software is subtraction of the dark-current images from the median filtered light-

pollution (Na and Hg) images. This has improved the quality of the images significantly (see www.ctio.noao.edu/~david/tasca.htm).

We have taken nighttime photos of the light-pollution sources from Tololo, and the same will be done from Pachón. To be able to monitor the details of polluting sources, we will repeat this approximately every six months. The Tololo images were shown to a group of visitors from EMEC (the electricity utility) and the SEC (the government organization that monitors energy use and installations in Chile), who visited in mid-January to learn about light-pollution issues.

Small Telescopes Update

Alistair Walker & Alan Whiting

At time of writing, the Small and Medium Aperture Research Telescope System (SMARTS) Consortium is two weeks away from starting operations of the CTIO 0.9-meter, 1.3-meter, and 1.5-meter telescopes.

CTIO has built an adaptor for Andicam on the 1.3-meter telescope, and has installed and tested a new CCD TV guide camera. A few weeks ago, similar new cameras were installed at the 1.5-meter and 0.9-meter. Last week, Bruce Atwood (Ohio State University) installed a new Fairchild 2K CCD in Andicam, replacing the dead Loral 2K. In a few days, a team led by Darren DePoy (Ohio State University) arrives to move the instrument from the 1.0-meter to the 1.3-meter. In the meantime, the 1.3-meter queue observers have been gaining familiarity with the telescope, and also have been helping with a few changes needed elsewhere, such as altering arrangements in the 1.5-meter control room to suit single-person operation.

The telescopes have been scheduled by the Yale support team led by SMARTS Principal Scientist Charles Bailyn. For semesters 2003A and 2003B, NOAO users are entitled to one third of the telescope time, the rest goes to Chile (10 percent) and the consortium members: AMNH, STScI, OSU, SUNY-SB, Georgia State, and Yale.

NOAO users applying for time on the small telescopes for 2003B should be aware that the 0.9-meter was heavily oversubscribed in 2003A, so a good proposal is necessary! Again, all 0.9-meter proposals should be for seven nights and, since every second week is Service Observing, please state on your proposal whether having your observations done by a service observer would be acceptable. A decision on which programs will be done by the service observer will be made at scheduling time. Also, although all day-to-day operations of the telescopes will be directed by Charles Bailyn and the Yale operations team, visiting observers will see the familiar faces of Arturo Gomez or Edgardo Cosgrove doing their usual efficient job of making the small telescopes operate smoothly. Alan Whiting (awhiting@ctio.noao.edu) is the CTIO astronomer responsible for the interests of NOAO users observing on the small telescopes. Please contact him if the need arises.

Finally, the SMARTS consortium is looking for one or two more partners. If you have a large project that could use observing time on these telescopes, and you can support the project at a level of \$50K to \$100K per year, please contact Charles Bailyn at bailyn@astro.yale.edu.



New Faces in ETS

Brooke Gregory

It's been a long while since we updated our community about changes in staffing in the Engineering and Technical Resources (ETS) group in La Serena. We have always prided ourselves on the stability and depth of experience that the low turnover among our Chilean staff has implied, but we are going to have to change our tune! With the advent of Gemini and SOAR, one began to hear talk of the "loud sucking noise" coming from across the Quebrada San Carlos. But we now prefer another metaphor, that of a refreshing breeze. The winds have settled down a bit now and, though we miss our former colleagues, it is exciting to have so many new ones. It is worth taking this opportunity to note the many additions to our staff—some permanent, some on contract or other temporary postings—who have arrived since January 1999. In the notes accompanying each name, we include a few words describing the background and, where appropriate, the principal project activities of the new staff members.

Mechanical Engineering

Patricio Schurter Mechanical engineer; U. Técnica Federico Santa María (UTFSM); lead engineer on SOAR Imager
 Andrés Olivares Mechanical engineer; U. de La Serena; SOAR Imager
 Juan Gallardo Mechanical engineer; U. de La Serena; instrument support boxes for SOAR

Instrument Shop

(all graduates of La Serena's Colegio Salesiano San Ramón)
 Cristian Díaz
 Víctor Pinto
 Víctor Robledo
 Cristian Robledo
 Mario Santander

Electronic Engineering

Gustavo Rahmer Electronics engineer; U. of Chile; prior experience working with detector controllers at ESO; Monsoon hardware development
 Michael Warner Electronics engineer; U. Católica de Chile, U. of Arizona, 20 years of experience at Hughes (now Raytheon) in Tucson; ISPI, commissioning of SOAR
 Rodrigo Alvarez Electronics technician; INACAP; electronic technician for the La Serena electronics group

Computer Technician

Samuel Flores Electronics technician; IADE, Stgo.; computer technician for ETS

Software Engineering

Rafael Hiriart Software engineer; electronic engineering degree from U. de Chile, prior experience at several Chilean firms; data pipeline for Super-Macho and Quintessence projects
 Francisco Delgado Software engineer; electronic engineering degree from the UTFSM, 4 years experience with ESO; software for new detector controllers
 David Walker Software; U. Francisco de Aguirre, La Serena; TASCA

Optical Engineering

Roberto Tighe Physicist; UTFSM, U. Católica de Chile, 14 years experience at La Silla; ISPI and SOAR Imager commissioning, SOAR integration
 Sandrine Thomas Optics engineer from the École Supérieure D'Optique, Paris, now a doctoral student in astronomy at the U. de Nice; adaptive optics for SOAR
 Joselino Vasquez Site characterization measurements

continued



New Faces in ETS continued

SOAR Project

Tom Sebring	Optical engineer; Rochester Institute of Technology; project manager for Hobby-Eberly Telescope (former), SOAR (current), Discovery Telescope of the Lowell Observatory in Flagstaff (1 March 2003)
Victor Krabbendam	Mechanical engineer; U. Massachusetts; previously with the Hobby-Eberly Telescope, project engineer for SOAR
Oliver Wiecha	Electronic engineer; Warsaw Technical University, former experience with several Brazilian technical firms; Electrical Engineering Manager for SOAR
Mike Ashe	Scientific programmer; U. Connecticut, Director of Engineering at Imaginatics, Inc.; SOAR telescope control system and ArcView detector controller software
Omar Estay	Software engineer; degree in electronic engineering from the U. Católica de Valparaiso; working on LabView software for SOAR

Other Happenings at CTIO

Cerro Tololo Summer Students Begin Their Research

The 2003 CTIO summer student program began on January 12, bringing five US undergraduates together with two Chilean counterparts for ten weeks of firsthand astronomy. Flying south immediately following the winter AAS meeting (where the 2002 students presented their research), the Research Experiences for Undergraduates (REU) students found themselves in high summer alongside their Prácticas de Investigación en Astronomía (PIA) companions. Together they will attend a series of seminars given by CTIO, Gemini, and SOAR staff astronomers; observe with the CTIO 0.9-meter telescope, gathering data for four different investigations; and each complete a personal research project under the direction of an experienced mentor.

As the students explore Chile, astronomy and the CTIO environment, they will post their results on their Web pages, which together with other information on the program may be found at www.ctio.noao.edu/REU/ctioreu_2003/REU2003.html.



Publication of Workshop and Conference Proceedings

The proceedings of the International Astronomical Observatories in Chile (IAOC) workshop on “Galactic Star Formation Across the Stellar Mass Spectrum,” held in March 2002 in La Serena, are being published as volume 287 of the ASP Conference Series, edited by James M. De Buizer and Nicole S. van der Bliek.

The proceedings of the “Conferencia Internacional sobre Contaminación Lumínica,” a conference initiated by IAU Commission 50’s Working Group on Controlling Light Pollution held in March 2002 in La Serena, will be published by Kluwer in their ASSL Series: Light Pollution a Global View, edited by H. E. Schwarz.

A New Doppler Radial Velocity Machine at Kitt Peak for Extrasolar Planet Searches

*Jian Ge, Suvrath Mahadevan, Julian van Eyken, Curtis DeWitt (Pennsylvania State University)
& Stuart Shaklan (Jet Propulsion Laboratory)*

In August 2002, a new, compact, efficient, and low-cost interferometric instrument for high-precision Doppler radial velocity measurements was successfully demonstrated at the KPNO 2.1-meter telescope. It has confirmed the existence of a planetary companion around 51 Pegasus. This first-discovered nearby extrasolar planet was originally detected by Dr. Mayor's group in 1995, using a state-of-the-art echelle instrument. The new interferometric instrument, built by a Penn State team led by Prof. Jian Ge, is called the Exoplanet Tracker (ET). Team members include Penn State graduate students Suvrath Mahadevan and Julian van Eyken, undergraduate student Curtis DeWitt, and Jet Propulsion Laboratory collaborator Dr. Stuart Shaklan.

The instrument consists of a Michelson-type interferometer with fixed optical path difference and a moderate-resolution spectrograph, and is similar to the wide-angle Michelson interferometer being used in the Global Oscillation Network Group (GONG) project for high-precision Doppler radial velocity monitoring of the solar disk. The Doppler measurements are conducted by monitoring phase shifts of the interference fringes of stellar absorption lines, rather than tracking line centroid shifts as is done by current planet search echelle instruments. Instead of using a narrowband filter to monitor a single stellar line as in the GONG instrument, ET employs a moderate-resolution spectrograph to cover a broader band of wavelengths, thereby increasing sensitivity to faint stellar sources. The ability to use a moderate-resolution spectrograph opens up exciting possibilities, including multi-object capability, high throughput, and high sensitivity, all in a compact architecture that enables the development of low-cost radial velocity instruments with high thermal and mechanical stability. The first-light results of the prototype instrument are reported here.

First light of the Prototype Instrument at the KPNO 2.1-Meter
Penn State's ET is a Michelson-type interferometer with a 7-millimeter optical delay in one arm coupled with a $f/7.5$ medium-resolution spectrograph of $R = 6000$, operating in the first diffraction order. The interferometer consists of a commercial 50/50 cube beam splitter made of BK7 glass, two flat mirrors, and one BK7 parallel glass plate with 4-millimeter thickness. The glass plate is used to create a fixed optical path difference between the two interferometer arms. The interferometer output

is fed into the spectrograph with an adjustable entrance slit. The spectrograph is a simple Czerny-Turner design, with two parabolas and a first-order reflecting grating from Richardson Grating Inc. The dispersed stellar fringing spectrum is recorded on the KPNO F3KB $1K \times 3K$ back-illuminated CCD camera. The instrument is operated in the visible spectrum with a wavelength coverage of about 270 angstroms. During the first light, the instrument was setup on a vibration-isolated optical bench in the Coudé room of the telescope (see figure 1). An iodine calibration cell was placed in the path of the starlight to provide a calibration spectrum that could resolve instrument drifts from the real stellar drifts.



Figure 1: ET setup at the KPNO 2.1-meter telescope in August 2002, with Penn State student Curtis DeWitt in the background.

The interferometer path difference is maintained to $\lambda/1500$ by active control of a mirror backed by a piezoelectric transducer (PZT). The cavity drifts are monitored by a stabilized HeNe laser sent through the beam splitter off-axis and collected by a video camera. A LabView GUI compensates for the drifts by engaging the PZT and can also dial to other user-specified phases. The entire instrument was enclosed in an insulated box and heated from the top of the enclosure by an actively controlled heating blanket. This created stable stratification of the environment, with the optical

continued



Extrasolar Planet Searches continued

plane heated to $24.0 \pm 1.5^\circ\text{C}$. A photomultiplier is mounted at the slit to monitor the fiber coupling and to monitor the stellar flux in order to be able to better correct for Earth's motion.

The instrument was coupled to the telescope using a 200-micron optical fiber at $f/6$. The efficient coupling of the fiber to the 2.1-meter telescope was achieved with the excellent Penn State fiber feed built in the 1980s by Larry Ramsey. Though the 200-micron fiber was not exactly matched to our instrument slit size, it was chosen as a compromise to prevent losing too much starlight from seeing variations. The need to measure the interferometer fringes in the nondispersion direction makes it necessary to spread the light out, so the starlight was spread over 300 pixels in the nondispersion direction by inserting a cylindrical lens in the beam before the interferometer. This had the additional advantage of being able to collect photons from bright stars without saturating the CCD.

During the first-light engineering run, a set of RV stable stars as well as stars with known planetary companions were observed. The observed stars include eta Cas, 31 Aql, tau Ceti, HD209458, 51 Pegasus, upsilon Andromedae and Arcturus. Although more than 30 percent of the photons were lost at the spectrograph entrance, the net detection efficiency from above the atmosphere to the detector was about 4 percent with the iodine cell in the beam, and about 6.5 percent without. The measured total instrument throughput with wide slit (from the telescope fiber output to the detector) was 19 percent. Thus, the efficiency of this prototype is already comparable to current, state-of-the-art echelle instruments.

First Results from the KPNO 2.1-Meter

After spending a few days installing and aligning the instrument, a large amount of engineering data were collected to calibrate and perform initial instrument tests. As is always the case when setting up an instrument for the first time at a new telescope, there were various unanticipated problems to overcome. Nonetheless, some exciting results were obtained with ET, and a great deal was learned about the environment in which it is to work.

The reduced data from the Kitt Peak run represents the first-ever planet detection using this totally independent Doppler technique. Figure 2 shows the radial velocity data obtained over several nights. Overplotted is the expected curve extrapolated from previous measurements of 51 Peg by Marcy's group. Although the scatter about the curve is still larger than anticipated, a good match was found between the ET data and previous echelle results, with a $1-\sigma$ in the residuals of about 23 meters per second. Figure 3

demonstrates short-term stability, looking at eta Cas (an RV stable star) over a period of about one hour. The standard deviation in these short-term measurements is only 2 to 3 meters per second. This is the most stable results from Ge's group so far, indicating that this new small, and low-cost interferometric instrument also has the potential to provide Doppler precision similar to that of the state-of-the-art, large and expensive echelle instruments.

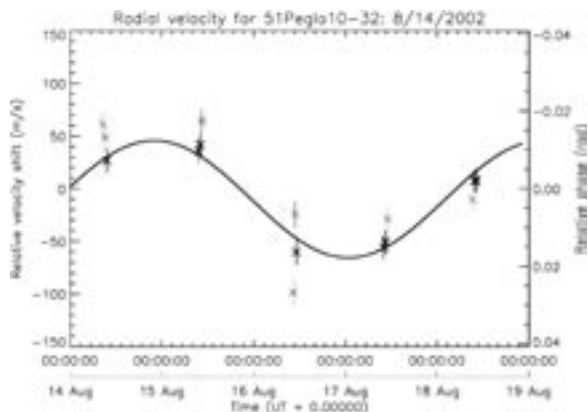


Figure 2. RV data obtained for 51 Peg, corrected for Earth's motion, along with the curve predicted from previous measurements by Marcy's group. The standard deviation in the residuals is ~ 23 meters per second (reduced $\chi^2 \sim 2.56$, implying that there are still systematic errors that need to be tracked down).

The results shown are preliminary, and the data reduction software is still under major development. Among the particular problems encountered was significant detector drift. As the liquid nitrogen in the CCD dewar evaporated over time, the moment of the dewar slowly changed and caused a drift of the image on the detector. The larger pixel size of the CCD detector used in previous lab tests at Penn State had prohibited this problem from occurring in any obvious way before. The combination of the small pixel size of the new detector, the moment change, and the inevitable disturbance caused by refilling the dewar every half day led to an image drift of several pixels over the period of a day. Simulations show that this can easily create systematic errors of the order of hundreds of meters per second, and so the software has been modified to compensate for this effect, though this still needs some perfecting. The drift is suspected to be one of the major causes of the large scatter seen in current results, over and above the error bars, which represent the internal errors from the fringe phase and visibility measurements. This problem is a particular focus of the software development at the moment, especially since image drifts will be inevitable over the long term.

continued



Extrasolar Planet Searches continued

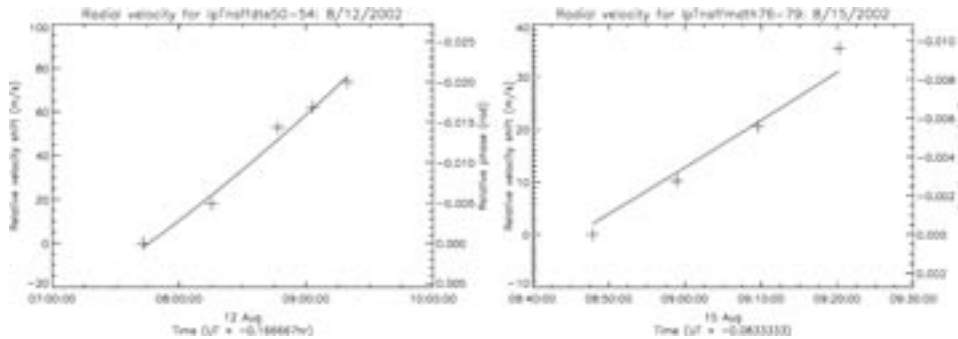


Figure 3. Short-term data obtained for eta Cas, an RV stable star. The solid line shows the expected curve due to the diurnal motion of Earth. 1σ residuals are ~ 3.7 meters per second and 2.9 meters per second respectively.

The data also suffered from aberration of various forms in the raw data images, in large part due simply to having a limited time frame for aligning the instrument properly. In order to reduce errors due to aberration, the data shown here is taken from approximately only the central third of the raw image frames obtained (in the slit direction). In principle, it should be possible to reduce the other sections independently and average the results together to further improve results.

Future Prospects

The team is still learning about the idiosyncrasies of ET and about the environment in which it will be working, and there is still considerable work to be done. They anticipate significant reductions in the systematic errors, and a dramatic increase in the throughput by about four times via instrument modifications (including replacing the grating with a Volume Phase Holographic Grating and utilizing both output beams from the interferometer).

Once ET is working robustly, we plan to install an instrument permanently at the Kitt Peak 2.1-meter and begin a small-scale survey for planets around stars that are too faint to have been investigated before. It will eventually

be opened for public use, giving astronomers access to a powerful and highly competitive tool for high-precision radial velocity measurements of faint objects. The potential applications of such a tool go beyond simple planet hunting: it will be extremely useful in the field of asteroseismology, and could even be used in cosmological applications.

More excitingly, once the 2.1-meter setup is fully operational, they intend to build a multi-object version of ET, utilizing the fact that its single-order operation allows the fitting of multiple spectra onto a single detector. Combining this with HYDRA on the WIYN telescope, they will have an instrument ideally suited toward rapid deep sky surveys for extrasolar planets, in a manner impossible until now. The potential increase in the sample of known planetary companions could open a whole new window on the field of extrasolar planet studies.

The Penn State team would especially like to thank KPNO Director Richard Green, KPNO staff Skip Andree, Daryl Willmarth, Bob Marshall, John Gaspey, Jim Hutchinson, and many others for their excellent support and practical assistance during our time at the Kitt Peak 2.1-meter telescope.

Observing Opportunity on Himalayan Telescope

Our colleagues at the Indian Institute of Astrophysics have asked us to share an announcement of opportunity for observing with the 2-meter Himalayan Chandra Telescope. Time will be offered on their faint-object spectrograph and camera, HFOSC. Observers must be present at the remote operations center near Bangalore. **Proposals are due 15 March 2003.** For information, see www.iiap.ernet.in/iao/cycle1.html.

NATIONAL SOLAR OBSERVATORY

TUCSON, ARIZONA • SAC PEAK, NEW MEXICO

From the NSO Director's Office

Steve Keil

The past quarter has brought several changes and new developments at the National Solar Observatory (NSO). For a complete review of NSO science and projects during fiscal year 2002, we refer you to the NSO Annual Report in the March 2003 volume (35) of *BAAS*, or visit our Web site at www.nso.edu.

✱

One of the most exciting developments this past quarter was a first-light demonstration of the new, high-order adaptive optics (AO) system. This system increases the number of degrees of freedom over the initial low-order AO system by nearly a factor of five, and will deliver diffraction-limited images in more challenging seeing conditions. Development of the high-order system is part of the joint New Jersey Institute of Technology/NSO Major Research Instrumentation program funded by the National Science Foundation (NSF) and led by Thomas Rimmele. The system is now being refined to become an integral part of the operating system at the Dunn Solar Telescope (DST), and should be completed by the end of the calendar year. The high-order AO system for the Big Bear Solar Observatory 65-centimeter telescope will follow several months later.

✱

SOLIS is nearing the final testing and debugging phase. The new Rockwell cameras have been tested and some anomalies are being resolved in cooperation with Rockwell. We expect the three SOLIS instruments to be acquiring sunlight by late March or early April.

✱

Following the October 2002 ATST workshop, the ATST Project has concentrated on investigations of enclosure designs and systems error budgeting. The hybrid concept presented in the last *Newsletter* and other efforts can be viewed at atst.nso.edu. Considerable effort has been devoted to understanding dome seeing. ATST personnel met with NSF Division of Astronomical Sciences management, NASA, and AFOSR representatives to discuss project schedule and progress, including the need to begin procurement of some long-lead items to maintain the schedule in the ATST proposal and Decadal Survey. The schedule calls for completion of the ATST by the end of the decade. The principal long-lead item is the primary mirror. Because it takes about a year to procure, and twenty or more months to prepare a blank for polishing, waiting to order the mirror until the start of construction will extend the project by approximately two years. The meetings did not identify an immediate solution for obtaining long-lead items, but several options were revealed and the project is currently exploring these. The final site survey tower and instruments are now installed, so all six sites are up and operating. By the time this is published, the sky brightness and dust monitors should have been tested and installed.

✱

Recent and pending changes in the operations of the Evans Solar and Hilltop Facilities at Sacramento Peak will have some user impact. Due to continued level funding from the NSF for operations and reductions in Air Force support, we have reduced the hours of operation and available support at the Evans Solar Facility. This facility houses what is still one of the largest and most versatile coronagraphs in the United States. We will now operate the synoptic coronal emission line program three times per week and the Ca II K-line program twice a week. There will be no observing support for other programs; however, proposals from scientists who wish to, and can, operate the facility themselves (after some instruction) will be considered. Now that the Air Force ISOON facility at Sacramento Peak is delivering high-quality H α and white-light images, we intend to phase out the Hilltop Facility's H α flare patrol and white-light imaging (both of which still use film), as well as the daily sunspot drawings. Issues regarding the archiving of ISOON data will be addressed first. Sunspot numbers will be generated from ISOON images. We will continue the video H α program, which provides a live image for target selection, and is available on the Web. Once ISOON is in regular operation, the plan is to supplement these images with high-quality ISOON images.

✱

We are delighted to have two long-term visiting scientists join us this year. Dr. John A. (Jack) Eddy will be in Tucson, working on a strategic plan for addressing the Sun-weather-climate (S-W-C) segment of the NASA Living with a Star Program. This effort includes chairing a series of working group meetings of a select group of scientists from appropriate disciplines to address the S-W-C question in the framework of interdisciplinary systems science. Dr. Alessandro Cacciani of the University "La Sapienza" of Rome, Italy began his 12-month tenure in January as a National Research Council Senior Associate at Sac Peak. While here, he will design and construct a magneto-optical filter system and telescope, which measures velocities and magnetic fields in the solar atmosphere.

✱

We also welcome Electronics Engineer Tony Spence and Senior Electronics Technician Dylan Sexton to the technical staff at NSO/Sac Peak, where they are supporting the electronics efforts at the DST. They bring a range of experience and training that is already paying off for our users and projects. Tony comes to us from the Physical Science Laboratory at New Mexico State University. He has a strong background in hardware modifications and maintenance, with an interest in instrumentation, sensors, and measurements. Dylan's background in electronics began in the US Coast Guard and most recently involved radio frequency work in the Dallas area and at Los Alamos National Laboratory.



ATST Design Progress

Nathan Dalrymple, Mark Warner, Rob Hubbard & Jim Oschmann

Since holding the Advanced Technology Solar Telescope (ATST) Design Workshop last October, the ATST team has been working to implement several suggestions, and working toward the Conceptual Design Review (CoDR) to be held this summer. As recommended at the workshop, the primary area of concentration is on design, analysis, and testing to support the enclosure trades, to be completed by the next review. Here, we highlight a few key aspects of recent and ongoing engineering efforts in systems, mechanical, and thermal engineering.

Thermal Design

Thermal aspects of our design are major concerns for the ATST, since roughly one kilowatt per square meter of solar radiation strikes the primary mirror and enclosure during daytime observing. One area of emphasis is on the thermal control of the enclosure skin (or floor, in the case of a retractable enclosure). Left uncontrolled, dome skin (or floor) temperature will rise some tens of degrees above the ambient air temperature, producing plumes of hot air over the enclosure that blur the optical beam. One simple solution is to circulate ambient air on the bottom side of the enclosure skin. The Gemini domes possess skin-flushing systems, but the capability has never been tested. A collaborative experiment is planned for February 2003 in which the Gemini dome skin temperature will be monitored at several locations throughout the day with the skin flushing system both on and off. The measured skin temperatures and airflow rates will help validate thermal models of the enclosure (see figure 1).

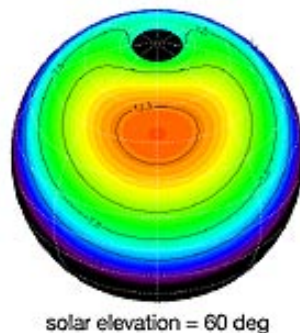


Figure 1. Enclosure skin surface temperature ($^{\circ}\text{C}$) predicted by a preliminary thermal model. Assumptions: approximately spherical enclosure; dual skin cooled by active flushing of ambient air; low-emissivity surface (for comparison with Gemini test results); 5 m/s wind; 60° solar elevation.

The validated model will then be applied to predict thermal and seeing performance of several ATST enclosure concepts. Design efforts for other thermal subsystems are proceeding along similar lines: analytical and numerical models are being developed to be validated by comparison to measurements, and then applied to concepts to assist the design selection process.

Mechanical Engineering

Recent mechanical design work has focused on updating and refining the 3D SolidWorks model of the telescope mount, optics support structure, pier, and coudé lab (see figure 2). Using this model as a baseline, a series of finite element analyses (FEA) also have been started. This initial FEA effort will serve two basic purposes leading up to CoDR: 1) validate the conceptual structural layout of the

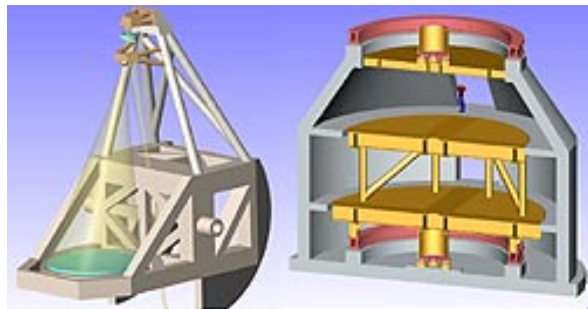


Figure 2. Telescope and coudé area 3D model being prepared for finite element analysis.

telescope assembly; and 2) determine the first-order effects of wind-induced vibration on the assembly. The issue of wind on the structure is particularly important in helping to determine the viability of the various enclosure concepts currently under consideration.

A first-order design and FEA of representative floor loading in the coudé area is shown in figure 3. It was done to size and orient major support aspects of the floor, assuming four major instrument stations per level of rotating coudé lab space.

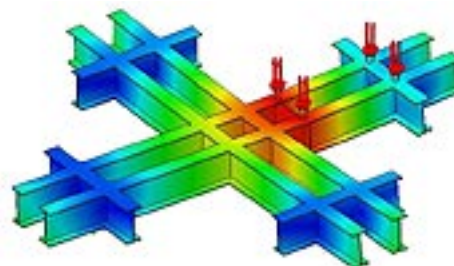


Figure 3. Coudé lab floor loading FEA analysis.

The analysis gives floor deflection due to gravity, measured in microns. The maximum deflection is 20 microns. This is representative of the level of detail contained in the three-dimensional models being prepared for more extensive wind and vibration analysis.

continued



ATST Design Progress continued

Systems Error Budgets

As with any modern telescope project, a well-founded systems approach is essential to the ultimate success of the effort. A fundamental element of the ATST systems engineering effort is the development and aggressive tracking of a set of performance error budgets. Starting with the science requirements, we have identified several critical error budgets that include telescope polarization, throughput,

scattered light behavior, and various aspects of image quality. For example, one of the highest-priority (and most challenging) performance requirements placed on ATST designers is for diffraction-limited visible-light images. The science requirement, in this case, is for Strehl ratios greater than 0.6 under good seeing conditions. Overall performance will be degraded by telescope limitations (like optical imperfections in the primary and secondary mirrors), instrumental limitations, and ultimately, by the performance of the adaptive optics system.

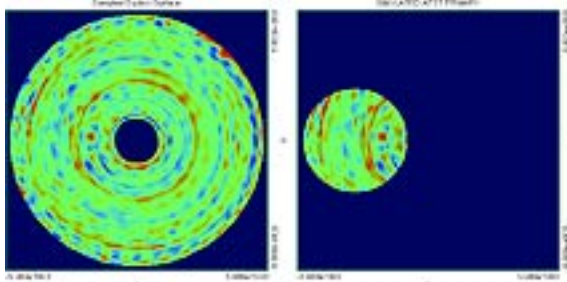


Figure 4. Gemini South 8-meter mirror figure errors after removing 20 low-order Zernike terms (left). This is a good starting point for estimating the performance of the ATST mirror with only low-order correction applied. The section on the right will have additional higher-order terms removed to simulate the effects of our 1000-degree-of-freedom adaptive optics system. This will yield an estimate of residual primary mirror error to be folded into the image-quality error budget.

The error budgeting process begins like a financial budget. The available error is divided (“budgeted”) among the various telescope components (“departments”) in the system. Then the various budgets are refined using existing data from similar projects, engineering data, manufacturer’s input, and computer models. An example appears in figure 4, where we are using manufacturer’s data from the finished Gemini primary mirror to better estimate the performance of our own off-axis 4-meter telescope. The project is also evaluating statistical tools to refine and bound error estimates, using some simple commercial packages now available.

For further details about the ATST Project, visit atst.nso.edu.

SOLIS

Jack Harvey (NSO)

The last few months exposed some technical problems that set back the SOLIS project. Two problems seriously affected the Vector Spectromagnetograph (VSM). As noted in the last SOLIS report, the high-reflectivity coatings failed on all of the VSM reflective optics. The cause of this failure has not been discovered, in spite of thorough investigations, including electron microscopy and electron beam probing of the failed coatings. We have eliminated the VSM housing as the source of the problem. To get back on track, all of the spectrograph optics, except the grating and an easily accessible fold mirror, have been coated with protected gold. The disadvantage

is a few percent loss in overall system efficiency, and higher polarization retardation at the shortest wavelength we use. The retardation issue is minor since the design of the optical system uses canceling reflections to null retardation effects. The advantage is highly stable coatings on optics that are hard to reach inside the instrument. As of this writing, the spectrograph optics have been remounted in the VSM housing and are being aligned.

The primary and secondary telescope mirrors were recoated with improved, high-reflectivity coatings. Thermal control requires use of broadband, high-reflectivity coatings in the telescope.

Since a few days after they were recoated, these recoated mirrors have been kept in a sealed environment flushed with either helium or nitrogen gas. Inspection shows no indication of deterioration. Once the spectrograph optics are realigned, the telescope mirrors will be installed and kept in an inert atmosphere as much as possible.

The second major VSM problem involves two cameras that image the split final focal plane of the instrument. These cameras, from Rockwell, have hybrid focal plane arrays consisting of a silicon-sensing layer bound to a CMOS readout multiplexer. The sensors are cooled thermoelectrically to -17°C

continued



SOLIS continued

within vacuum dewers. The format is 1024×1024 pixels, but we only illuminate the central 1024×256 portion and skip over the unused regions. The arrays are divided into four quadrants that are read out simultaneously at a frame rate of 92 per second.

We have observed strong cross talk between quadrants that are adjacent in the row direction. There is also a smearing of about 100 pixels along rows. Curiously, these effects nearly vanish if the array is operated at room temperature rather than being cooled. Experts at Rockwell are working closely with us

to correct this anomalous behavior. If a good solution is not found, we will simply operate the arrays at a higher temperature and compensate for higher noise by using longer integration times.

Some fail-safe circuitry was added to shut down the cameras in case either our system-wide glycol cooling system fails or the thermoelectric cooling of the arrays acts improperly.

Laboratory tests of the Integrated Sunlight Spectrometer (ISS) are continuing. Until the VSM is moved to the GONG site, it is not possible to feed sunlight into

the ISS. The emphasis of the lab tests is on perfecting the flat-field method. Construction is underway on a small ISS ancillary system called the extinction monitor. This consists of a camera that simultaneously produces five small images of the Sun at five widely separated wavelengths. These images will be recorded and used to understand the extinction produced by Earth's atmosphere at times when ISS spectra are taken. This will allow the uniformity of integration of the solar disk to be assessed for all spectra.

Infrared Heterodyne Observations at the McMath-Pierce West Auxiliary Telescope

Guido Sonnabend & Daniel Wirtz (University of Cologne)

During the last two weeks of November, the Cologne Tunable Heterodyne Infrared Spectrometer (THIS) was successfully operated at the McMath-Pierce West Auxiliary Telescope. Our heterodyne instrument consists of an optical receiver and common back-end electronics, including an Acousto-Optical Spectrometer (AOS). Inside the receiver, the monofrequency emission of a local oscillator (LO) is mixed with the infrared (IR) radiation coming from the telescope, and is detected on a fast Mercury-Cadmium-Telluride (MCT) detector. In this way, the spectral information is shifted from the mid-IR to the radio range, allowing amplification, filtering, and frequency analysis of the signal using a standard back-end. A photo of the setup at Kitt Peak is shown in figure 1, and a simplified schematic of the receiver appears in figure 2.

Currently, the receiver employs tunable Quantum-Cascade Lasers (QCL) as local oscillators that allow frequency tuning between 8- and 17-microns. These devices significantly expand the frequency region accessible with gas-laser systems (e.g., CO₂ lasers). At present, a frequency resolution of 3×10^7 can be provided, which corresponds to 1 megahertz at a wavelength of 10 microns. The bandwidth is currently limited to 1.4 gigahertz and will be expanded to twice that value soon. The sensitivity of our instrument is comparable to common CO₂ laser systems.

continued



Figure 1: THIS at the McMath-Pierce West Auxiliary Telescope. The cubic aluminium structure on the left is the optical receiver; the 19-inch rack on the right holds the AOS and back-end electronics.



Infrared Heterodyne Observations continued

The engineering run at Kitt Peak explored the sensitivity and frequency stability of the instrument, with a variety of different measurements. First, stratospheric ozone absorption lines were detected against the Moon as a background source. One has to take into account that the

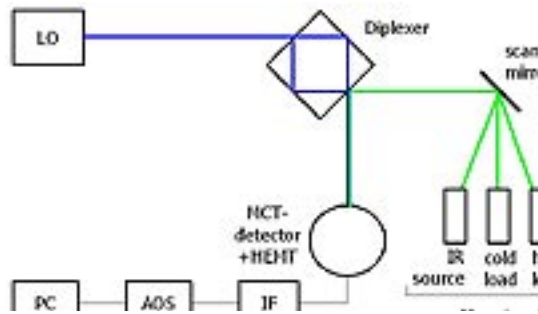


Figure 2: Set-up schematic of the receiver: laser (LO) and signal (switchable between telescope and two loads for calibration) are combined and focused on the detector. After filtering and amplification, the frequency analysis is done using an AOS.

Moon's brightness temperature at 10 microns is already down to 20 K. Figure 3 shows 1,600 seconds of integration of an ozone line with a resolution of 1 MHz. The plot shows the detected brightness temperature versus the intermediate frequency, i.e., the observed frequency from the LO position. Due to the transmission at an observing angle of about

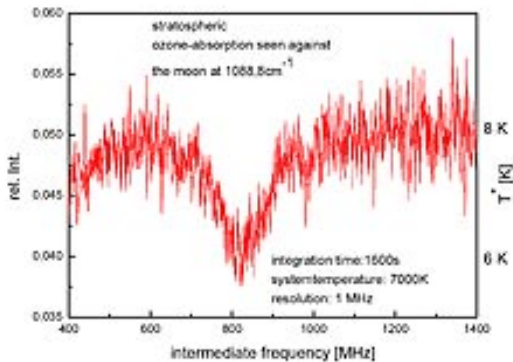


Figure 3: Stratospheric ozone absorption seen against the Moon at a frequency of 1088.8 cm⁻¹.

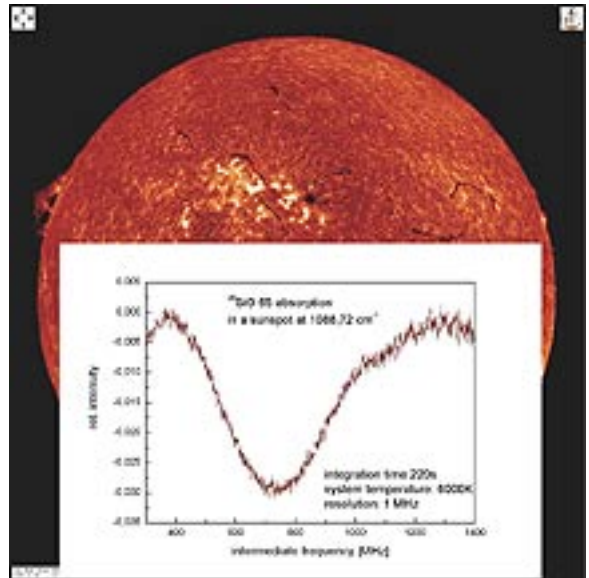


Figure 4: Ha picture of the Sun on 20 November 2002, and the 6-5 P(50) transition of ²⁶Si¹⁶O.

35 degrees and losses caused by the coupling of the instrument to the telescope, a background temperature of about 8 K results.

SiO and H₂O absorption lines were also measured in sunspots. Both were detected in the November 20 sunspot shown in figure 4. One can see the rather odd line shape of this SiO absorption feature, which is caused by contributions of different velocity components.

We observed Venus to demonstrate the system sensitivity, especially with regard to future astronomical observations. Since the 1970s, it has been known that natural non-LTE CO₂ emission is present at the illuminated arc. We were able to detect an emission signal of the R(36) transition of CO₂ with a resolution of 20 megahertz (see figure 5). One can see the emission peak sitting on a broad CO₂ absorption that stems from lower altitudes of the Venus atmosphere. It appears that the emission originates at around 80 to 120 kilometers above the surface. There still has to be a proper calibration carried out for this measurement. In particular, a comparison to a calculated atmospheric

continued



Infrared Heterodyne Observations continued

model of Venus has to be done. Keeping this in mind, the temperature of roughly 200 mK for the emission might be wrong by a factor of two.

Having been able to detect a nonterrestrial signal for the first time with THIS, we are looking forward to further observing runs in 2003. Possible targets include ozone observations on Mars that are of great interest for understanding the Martian atmosphere. Furthermore, CO₂ observations and monitoring in Earth's atmosphere and on Mars and Venus are very interesting for the same reasons. The long-term goal is the operation of THIS on the stratospheric observatory SOFIA from roughly 2007 onward. The main goal here will be the detection of cold interstellar H₂ against moderately hot IR sources at wavelengths around 17 microns.

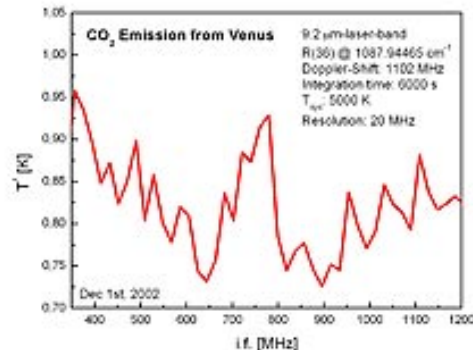


Figure 5: Non-LTE R(36) transition of CO₂ from the illuminated arc of Venus. The emission is located in the middle of the broad CO₂ absorption peak.

Infrared Observations with McMath-Pierce Adaptive Optics

Christoph Keller & Claude Plymate

The prototype adaptive optics system at the 1.5-meter McMath-Pierce Solar Telescope achieved two “firsts” on 22 January 2003. For the first time, solar images in the thermal infrared at 4.8 microns were corrected with adaptive optics. An image of a sunspot close to the solar limb is shown in figure 1. Note the substantial improvement in spatial resolution when using the deformable mirror. On the same day, the system successfully corrected images of the solar limb. This has never been done before with any solar adaptive optics system.

The 37-actuator system was operating with 109 subapertures on the wavefront sensor at an update rate of 955 hertz. More details about the system can be found at www.nsoa.edu/noao/staff/keller/irao.

By the time that this article appears, the prototype system will be available for user observations on a limited, shared-risk basis.

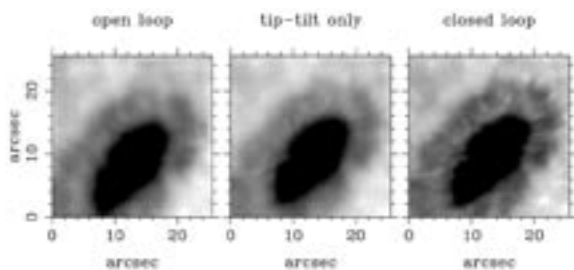


Figure 1: Average of 20 short-exposure images of a sunspot close to the solar limb, observed through a broadband interference filter at 4.8 microns with the McMath-Pierce adaptive optics system. The image on the left was recorded with the adaptive optics system off, the center image was recorded with tip-tilt correction only, and the image on the right was recorded with full adaptive optics correction. All three images are displayed at identical contrast.

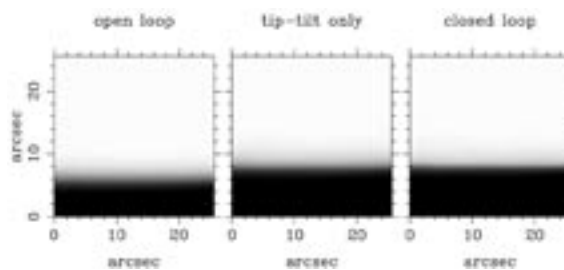


Figure 2: The solar limb at 4.8 microns. With no correction (left), tip-tilt (center), and full adaptive optics correction (right).



The Improved Solar Observing Optical Network (ISOON)

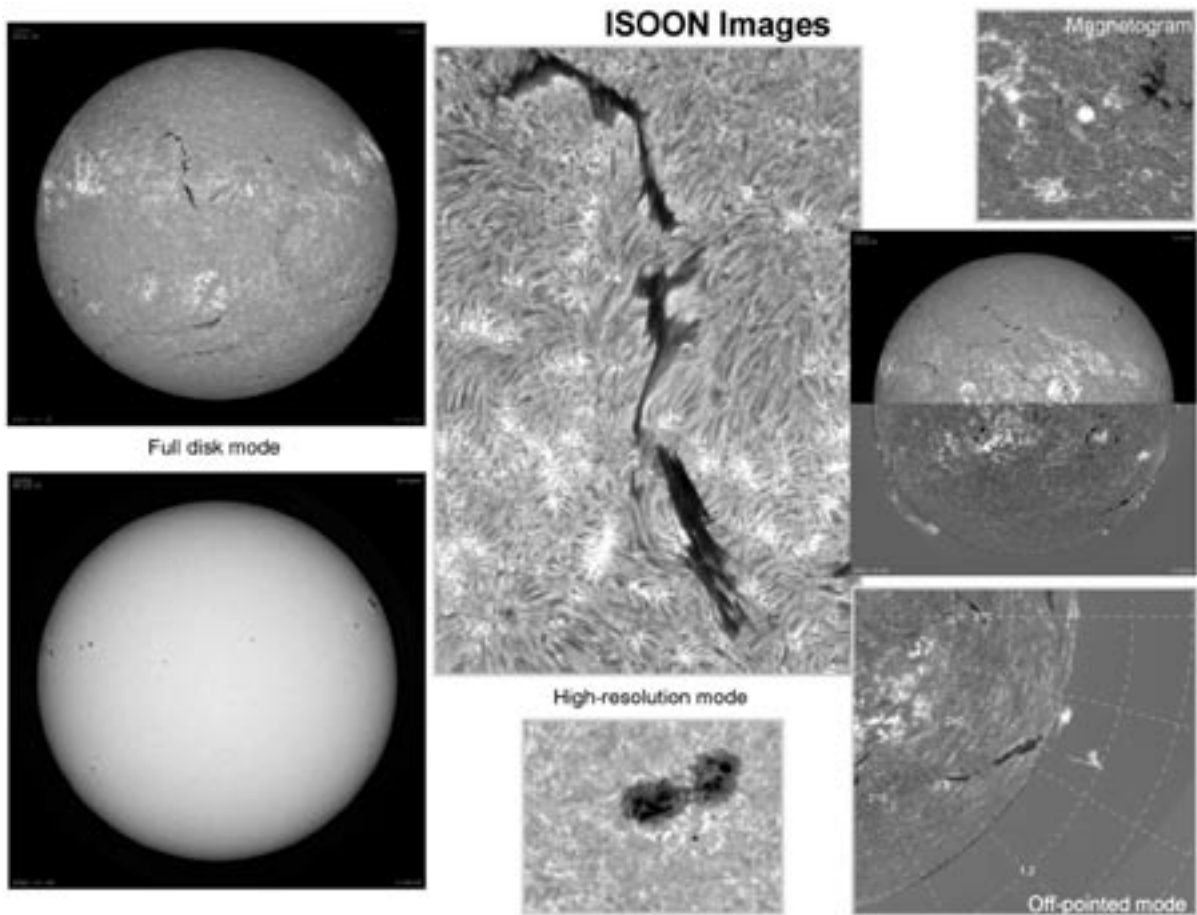
Donald Neidig (Air Force Research Lab/NSO)

The Improved Solar Observing Optical Network (ISOON) was completed during FY 2002 through prototype demonstration, although the US Air Force subsequently canceled its deployment as an operational system at three sites worldwide. Ownership of the functioning ISOON prototype system has been transferred to the Air Force Research Laboratory at NSO/Sacramento Peak, where it will be used for research and limited support to Space Weather forecasting. ISOON represents a class of instrumentation intermediate between patrol telescopes and major solar telescope facilities, and can be dedicated to interests of a synoptic nature, especially those involving transient activity such as flares, prominence eruptions, Moreton waves, and active region evolution.

of-sight magnetic fields. It features high-precision 12-bit photometry, registered images with constant magnification and orientation, and a tunable filter system. Both full-disk and high-resolution formats are available. Helium 10830 images will be available in the near future. The ISOON analysis software operates on a remote computer and includes a library of functions including still images and movies, coordinate overlays, radial average subtractions, automatic flare patrol, automatic sunspot areas, locations, counts, point and click for zoom, 30-day database, intensity measurement tools, and others.

Additional information on ISOON as well as real-time images and movies are available at www.nso.edu/sunspot/isoon/descript.html.

ISOON is a semiautonomous, remotely commandable system that provides imaging in H α , continuum, and line-



GLOBAL OSCILLATION NETWORK GROUP

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

GONG

John Leibacher

The Global Oscillation Network Group (GONG) Project is a community-based activity to operate a six-site helioseismic-observing network, to do the basic data reduction and provide the data and related software tools to the community, and to coordinate analysis of the resulting rich data set. Information on the status of the project, the scientific investigations, as well as access to the data, is available at gong.nso.edu.

The fourth quarter of 2002 marked the beginning of a new era for GONG. With the broad appreciation of the significance of the changing dynamics of the solar interior and helioseismology's efficacy in charting its evolution, GONG is now slated for long-term operations and has become one of NSO's three flagships. The past several years of building the GONG+ high-resolution cameras and the GONG++ high-capacity computer system are finally over, and we can now settle in to routine network operations and maintenance and accelerated data processing, producing much more science.

But things never really "settle down" it seems. We are finding that "routine" operations are not routine at all, and that keeping the sites up and running will be a continuing challenge. We have experienced failures with three of our turrets (the Learmonth light-feed twice!); we're running short on spares, some of which cannot be simply replaced off-the-shelf; mechanical parts are wearing out; and we have experienced a failure in one of the optical assemblies. The Tucson engineering instrument was always foreseen as a source of "hot spares," and we've really needed it the last few months!

On the downstream side of data operations, the situation is quite different. We are bringing an operating and automated pipeline for ring-diagram analysis on-line, which begins with calibrated images from the sites and ends with flow maps. Soon other local helioseismology applications will be implemented into the GONG++ pipeline scheme as well.

There have been two significant departures from the GONG data group. First, Thierry Corbard has left to return to France and take a position at the Observatoire de la Côte d'Azur. Thierry accomplished a significant amount during his brief stay with us, implementing and methodically testing the ring-diagram pipeline. We look forward to his use of the pipeline to get exciting science out of this wonderful new tool.

The other *extremely* significant departure is the retirement of Jim Pintar after 15 years as the GONG DMAC manager. Jim's contributions were fundamental to the development of the original Classic GONG pipeline. The entire scientific community in helioseismology extends an enormous "Thank You!" to him.

Operations

Soon after we powered on the Udaipur instrument at the conclusion of the monsoon shutdown, it became apparent that something was amiss. The instrument was frequently unable to acquire and track the Sun, and then the transmission began to fall. Initially, it was thought that because the image brightness at Udaipur was somewhat less than at the other sites, adjusting software parameters would help to restore normal operation. But as days passed and adjustments were made, the images became dimmer and dimmer. With a steady stream of diagnostic procedures from the Tucson operations team and constant help from the site staff, it was determined that the problem was in the 1-angstrom Lyot filter. A replacement filter was prepared in Tucson and taken to India. After the necessary alignment checks and other more general optical maintenance, the instrument was again fully operational in mid-December. Once the old filter arrived in Tucson, inspection revealed that the ADP elements in the filter assembly had reacted with moisture in the air, bonded to the neighboring calcite elements, and turned cloudy at the interface. Consequently, the filters from the remaining sites will be rebuilt and replaced to prevent any further occurrences.



continued



GONG continued

In October, the Big Bear site underwent some routine maintenance, focused mainly on the optical system. This visit was scheduled in conjunction with the GONG/SoHO meeting in Big Bear to allow operations staff to meet with the visiting site representatives who were able to attend the meeting. In November, a maintenance team visited Mauna Loa, where a new set of UPS batteries was waiting to be installed. There was also a failure of the UPS batteries at El Teide, where new ones were purchased locally and installed by the observatory staff. In late December, the Learmonth site went down with a failure in the wave-place rotator circuit. The motor amplifier was damaged, which was reminiscent of the consequences of the turret failure that occurred there only six months earlier. The Tucson operations team and the on-site staff have done considerable troubleshooting, but the exact source of the trouble is still not clear. At the time of writing, a maintenance team is on its way to Learmonth to diagnose and fix the problem.

Our sincere gratitude goes to the site staff who have spent *considerable* time and effort trouble-shooting the systems.

Data Management and Analysis

During the past quarter, the DMAC produced month-long (36-day) velocity time series and power spectra for GONG+ months, 71 and 72 (ending 24 June 2002), with fill factors of 0.82 and 0.75, respectively. The Data Storage and Distribution System (DSDS) distributed 333 gigabytes in response to 47 data requests. During the preceding two quarters, the DSDS distributed 500 gigabytes and 360 gigabytes.

The DSDS has added a new data access facility. External users can now download mode-coefficient time series (for ℓ 's less than or equal to 10) and the various mode frequency products directly from the project's Web page without submitting a data request. Since introduction, 350 low- ℓ time-series files and over 10,000 sets of mode coefficients have been downloaded. This self-serve data distribution channel will be extended to additional data products in the future.

The quest for more and better mode frequency products has expanded to include the fitting of the f -modes and the introduction of asymmetric profiles into the standard PEAKFIND procedure. In addition, a subtle, systematic difference between the results from low- ℓ fitting using a leakage matrix correction and those from the standard PEAKFIND procedure are being investigated.

Good progress has been made on the construction of the GONG++ pipeline. Thanks to the efforts of Thierry Corbard, John Bolding, Cliff Toner, Deborah Haber, and Rick Bogart, we now have an operating and automated pipeline that begins with calibrated images from the sites and goes all the way to flow maps. Along the way, the images are merged, subbrasters are remapped and tracked, ring diagrams are created and fitted, and inversions of the fitted parameters are performed.

Only one more step is needed to complete the pipeline—the construction of a synoptic flow map over a Carrington rotation. This will be done shortly, and we will then be in a position to regularly produce maps of the horizontal flows beneath the surface.

The next step in the GONG++ pipeline-plumbing job is the installation of a high-degree global analysis branch, at least to the production of the time series. However, the full scientific utilization of these products must wait for the development of a useful ridge-fitting algorithm. John Bolding will soon begin integration of the near-line hierarchical storage system into the pipeline.

As mentioned in the last *Newsletter* and elsewhere in this issue, Simon Kras and Rachel Howe found a small, unexpected discrepancy of about $\frac{1}{4}$ -frequency resolution bins between the frequencies derived with and without leaks. We initially suspected a bug in the fitting code that applies the leakage matrix at low degree, particularly in the specification of the frequency range of the fit. However, a test in which this range was enlarged showed that there was no effect on the discrepancy. In addition, Rachel took our standard frequencies, did an *ad hoc* correction of $\frac{1}{4}$ -frequency bins to the negative m frequencies, refitted the splitting coefficients, and repeated the rotation inversions with the altered coefficients. She found that this substantially improved the agreement between MDI and GONG for the inferred rotation rate below the convection zone, so it would be “nice” if there really *were* a discrepancy of $\frac{1}{4}$ bin! On the other hand, it also slightly degraded the agreement near the surface. For these reasons, now we are questioning whether there is some subtle problem in our standard peak finding code, specifically in the algorithm that selects the frequency range for the fit. We are very actively investigating this anomaly.

Rudi Komm, Cliff Toner, and John Bolding have placed 30 days of merged GONG+ images on an anonymous ftp area for use in local helioseismology comparisons. We are planning to have a workshop in the near future on this topic.

Caroline Barban has found that the velocity-intensity multispectral fitting method is apparently sensitive to the frequency range of the fit, and is experimenting with different methods of specifying the range. Frequency range fitting problems seem to be a common theme right now!

Richard Clark continues to work with Jack Harvey on the correction of the GONG+ magnetogram zero point. The current approach is to use the magnetogram calibration images at a single site to first produce the “best” magnetogram of the day. This image is then used to correct the rest of the data at that site. This works reasonably well, except for one thing—the “best” magnetogram also displays temporal variations in the large spatial scale pattern. We are working on a strategy to deal with this.

EDUCATIONAL OUTREACH

PUBLIC AFFAIRS AND EDUCATIONAL OUTREACH



Recruiting for the 2003 cadre of TLRBSE participants was completed in early December. We received nearly 140 applications, due to vigorous recruitment efforts at meetings, positive word of mouth, and especially, via Internet postings and list-serves. The selection process was a challenge, as many of the applicants were outstanding, with extensive experience in teaching astronomy, physics, general science, computers, and use of the Internet. Many applicants also had experience in using image processing software in an educational context.

Our final group of 20 teachers is geographically diverse, hailing from Alaska to California to New Hampshire. In all, the teachers come from thirteen states and Puerto Rico. Their schools are

likewise diverse, including urban and rural, public and private, and culturally mixed schools. Two of our schools serve primarily Native American and Hispanic student populations. The group includes 10 women and 10 men. Seventeen of the educators teach at the high school level, with three others at the middle school level.

The teachers are participating in a graduate-level Distance Learning course, for college credit, that runs from late January to early May. The course will prepare them for the two-week summer workshop in Tucson, which includes a week of observing on Kitt Peak. The teachers will be studying novae, active galactic nuclei, and solar phenomena, as well as learning astronomical imaging and spectroscopy skills. After completing the course and workshop, the teachers will return to their schools prepared to conduct astronomy research in their classrooms, and to mentor three other early-career science teachers through the sometimes difficult early teaching years.



Project ASTRO-Tucson is the foundation of NOAO's successful regional outreach program. The project's core element is the partnering of professional and amateur astronomers with K-12 teachers and other community educators who want to enrich their astronomy and science

teaching. In an effort to extend the partnerships, a follow-up workshop for Project ASTRO-Tucson partners was held at David Levy's home-based observatory in Vail, AZ, on February 8. Led by Connie Walker and Robbie Jones, workshop highlights included sunspot observing, tracking where the Sun sets on the horizon, and observations using a wide variety of telescopes. David also spoke to the group on "Starry Nights: Getting Kids to Love the Sky." Many Tucson Amateur Astronomy Association members and Project ASTRO-Tucson astronomer partners volunteered their time and telescopes for this successful workshop, and we are grateful for their enthusiasm and participation.

Family ASTRO-Tucson is reaching a variety of underserved groups in the Tucson area including the Tohono O'odham Indian Nation, the Hispanic community of the Sunnyside School District, and the Girl Scouts of America. Families involved with these three groups are invited to evening or weekend events where they can have fun doing astronomy activities together. The program helps parents and caregivers get more involved in their children's science education, and it offers a way for them to spend more time together in active experimentation, observation, and discussion. At the events, families work and play at activity stations as well as participate in a number of facilitated activities. At the end of the

event, the families receive a kit to take home. The evening events are facilitated by event leaders trained last fall by Connie Walker and Robert Wilson of NOAO. Evenings involving one of the three thematic family kits—"Night Sky Adventures," "Moon Mission," or "Race to the Planets"—took place on January 23 and February 7, 11, 13, and 28. Two more are scheduled for March 12 and 19. Sponsored by the National Science Foundation and developed by the Astronomical Society of the Pacific, Family ASTRO is off to a vigorous start in the Tucson area.

ASTRO-Chile

Even with participants half a world apart and speaking two languages, the most effective ways to teach concepts in astronomy is a lively topic for discussion. The second in a series of ASTRO-Chile videoconference workshops for teachers in Tucson and La Serena took place on February 12. The teachers exchanged methods and ideas about how to explain and demonstrate concepts of spectroscopy. The entire workshop was held in Spanish, facilitated by four bilingual science teachers from the Tucson Unified School District, representing the elementary, middle school, and high school grades. Teachers Julie Frieberg, Thea Cañizo, Aida Castillo Flores, and Glenn Fournier worked with NOAO's Connie Walker, Dara Norman, and Steve Pompea to make the event a productive interchange. These first two workshops are envisioned as the beginning of a larger collaboration meant to take maximum advantage of proven educational outreach programs in the United States, such as Project ASTRO, and very successful educational efforts in Chile. Merging the strategies and techniques from each group has led to an exciting cross-cultural dialogue on astronomy education in the schools and public outreach to the community.