

NOAO Newsletter

Issue 71

September 2002

Science Highlights

A Planely Fundamental Survey.....	3
A Wide-Field Survey for Stellar Variability.....	4
Imaging Polarimetry in the Ultraviolet.....	6
Imaging Polarimetry of Jupiter and Saturn with ZIMPOL.....	7
12- μ m Magnetometry with Visible Tip-Tilt Image Stabilization.....	8

Director's Office

The GSMT Science Working Group.....	10
The Physics of the Universe.....	10
TSIP Launched!.....	12
LSST Science Working Group.....	12
Q&A with Alan Whiting.....	14

US Gemini Program

Gemini Update and Opportunities in Semester 2003A.....	15
Changes in Gemini Partner Share.....	16
GMOS Science Operations.....	16
NIRI, a Visitor's Perspective, 2002A.....	18
Phoenix Queue Update.....	19
US Gemini Instrumentation Program Update.....	20

Observational Programs

NOAO Nighttime Proposals Due for 2003A.....	22
Community Access to the Keck 10-Meter Telescopes Begins through TSIP.....	23
Community Access Time on the MMT and HET.....	23
Two New NOAO Survey Programs Approved.....	24
Observing Request Statistics for 2002B.....	25
Instruments Available in 2003A.....	26

CTIO Operations

News from the Director.....	29
The Future of the Small Telescopes at CTIO.....	29
ISPI Approaches First Light.....	30
Hydra-CTIO Update.....	31
Other Happenings at CTIO.....	31

KPNO Operations

WIYN Tip-Tilt Module Available for General Use.....	32
Summer Upgrades.....	33
Staff Changes.....	34
High-Risk Wildfire Season.....	35

National Solar Observatory/GONG

From the NSO Director's Office.....	36
SOLIS.....	37
First Light for McMath-Pierce Adaptive Optics.....	38
Ratio of Sodium to Potassium Atoms in the Atmosphere of Mercury.....	39
GONG.....	40

Public Affairs & Educational

Outreach

Educational Outreach Update.....	43
The REU Experience.....	44
Report on the First REU Site Directors' Meeting.....	46
Undergraduates Wanted for the 2003 CTIO REU Program!.....	46
In Brief.....	47

NEWS FLASH

Observing time now available on Keck! (See page 23)



Notable Quotes

The Senate Appropriations Committee demonstrated strong support for the National Science Foundation within its allocations and report language for the FY 2003 VA, HUD, and Independent Agencies Appropriations Act, S. 2797.

The total NSF budget would increase 11.8%, or \$564.1 million, from \$4,789.2 million to \$5,353.4 million. Within the Research and Related Activities budget, the Mathematical and Physical Sciences budget would increase 14.8%, or \$136.1 million, from \$920.5 million to \$1,056.6 million.

The Major Research Equipment and Facilities budget would decline 42.9%, or \$59.5 million, from \$138.8 million to \$79.3 million.

The Committee directed NSF to “provide adequate support for preparatory work for the Giant Segmented Mirror Telescope (GSMT).”

“The Committee also encourages NASA and NSF to work together on the Large-aperture Synoptic Survey Telescope (LSST).”

A conference between House and Senate appropriators will occur in September.

--Courtesy: *American Institute of Physics Bulletin of Science Policy News #89*



“I think it’s damn lucky that we’re not in jail given the kind of progress we’ve made over the last five or ten years. We ought to be working on the technologies to get us back to the Moon and Mars.

“Whether or not you actually go to the Moon or Mars, those technologies have the ability to save us on planet Earth. Do we know when the next asteroid is going to hit? We don’t know if it’s going to hit tomorrow. We can’t predict when a super-volcano will go off. The human race is at risk and we better be working on the technologies to get us out of that risk. The technologies needed to spread people out into the solar system are the very technologies that allow us to save our species.”

--Veteran NASA astronaut John Young, speaking to *Space.com* senior writer Leonard David, following a presentation at a “Return to the Moon” symposium in Houston



“Each new image of the early universe refines our model of how it all began. Just as the Universe grows and spreads, humankind’s knowledge of our own origins continues to expand.”

--NSF Director Rita Colwell, as quoted in a May 24 article by the *Associated Press*, “Universe’s Earliest Light Detected”

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

SOAR dome from crane, Cerro Pachón, Chile.

“Happiness is a weather-tight dome.”

With the SOAR dome complete and able to stand up to the worst of the winter weather (see page 48!), the project team is now concentrating its efforts on assembly of the telescope mount, with expert on-site assistance provided by mount manufacturer Vertex RSI. We anticipate that this activity will be complete by early September, allowing work to begin on servo tuning and nighttime pointing tests with an 8-inch finder telescope borrowed from the Curtis Schmidt telescope.

Meanwhile, optics manufacturer Goodrich Electro Optical Systems continues to make steady progress on fabrication of the primary mirror, the pacing item for completion of the telescope. Currently, we expect the completed optical system to arrive in Chile in early 2003 and thus, anticipate first light during the second quarter of 2003.

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A Planely Fundamental Survey

Based on a contribution solicited from Russell J. Smith (University of Waterloo)

The NOAO Fundamental Plane Survey (NFPS), initiated in 1999, is capitalizing on the wide-field imaging and spectroscopic capabilities at the KPNO and CTIO 4-m telescopes to investigate the structure, contents, and motions of nearby galaxy clusters. The NFPS is led by Mike Hudson (University of Waterloo). Collaborators are John Lucey, Stephen Moore, Stephen Quinney, and Roger Davies (University of Durham); Gary Wegner and Jenica Nelan (Dartmouth College); Nicholas Suntzeff (CTIO); David Schade (Canadian Astronomy Data Center); and Russell Smith.

The principal goal of the NFPS is to resolve the controversial issue of large-scale bulk flows in cluster samples, using the Fundamental Plane as a distance indicator relation. With ~50 early-type members observed per cluster, this method yields distances with random errors of <3%, allowing meaningful measurements of peculiar velocities out to distances in excess of $100 \text{ h}^{-1} \text{ Mpc}$. The award of NOAO survey time has allowed the NFPS continued access to stable instrumentation over the duration of the survey, a critical advantage given the importance of data homogeneity. In addition to their use for cosmic flows, the data will provide an unprecedented wealth of information on galaxy morphology and spectroscopic parameters for nearby cluster galaxies. For example, the survey will provide a firm low-redshift reference point for studies of cluster populations at moderate redshifts conducted on larger telescopes.

The sample consists of ~100 clusters within $z < 0.06$ distributed over the whole sky, selected by X-ray luminosity. Clusters have been imaged in the B and R bands, using the 8K Mosaic cameras at the CTIO Blanco 4-m, the KPNO Mayall 4-m, and the KPNO 0.9-m telescopes, with some extra data obtained from the CFHT 12K Mosaic, under the CHF queue program. B-R color-magnitude relations are then used to select red-sequence cluster members (i.e., likely early-type galaxies) for spectroscopic follow-up. The images will also be employed to measure morphological parameters (including bulge/disk decomposition) for all bright galaxies in the field. This computationally intensive task is being undertaken using a

high-performance “beowulf” cluster ($112 \times 667 \text{ MHz}$ alpha processors; see www.sharcnet.ca).

The spectroscopic program uses the Hydra multifiber spectrographs at the WIYN 3.5-m and Blanco 4-m telescopes. In each cluster, typically 40 to 70 galaxies (with $R < 17$ and “red” relative to the cluster color—magnitude relation) are observed, over the 60 arcmin or 40 arcmin field of view of the instruments. Spectral resolution and S/N are sufficient to measure redshifts, internal velocity dispersions, and a wide range of metal and Balmer-series absorption line indices over the spectral range 4000–6000 Å.

Early results from the spectroscopic observations will include a study of the line strength versus velocity dispersion relationships, and the possibility of environmental influences on these parameters. For example, it has long been known that the Mgb index at 5177 Å increases strongly with velocity dispersion, σ . This is likely due to a steady increase of metallicity with mass, as expected in galactic wind models

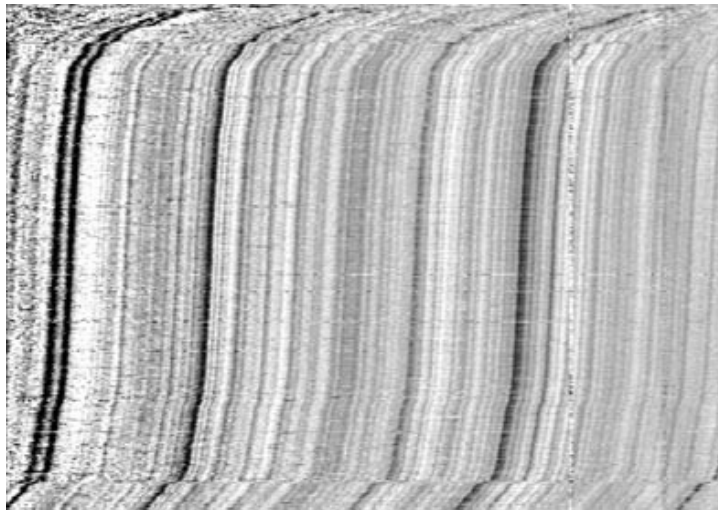


Figure 1. Galaxy spectra from a recent NFPS observing run. Each spectrum is plotted left to right from 3900 Å to 6100 Å, and stacked into the diagram in order of redshift, with the most distant (background) galaxies at the top. The strong Ca H+K doublet is seen at the left (blue), the G-band and Mgb features are prominent, while NaD is seen at the red end only for the nearest galaxies. The vertical noise feature results from sky subtraction residuals at 5577 Å. No restriction on signal-to-noise has been applied; a few spectra of poor data quality can be seen as the horizontal noise-streaks. These spectra, for ~900 galaxies, represent ~15% of the NFPS spectroscopic database.

continued



Planely Fundamental Survey continued

(although age can also influence this index). Interestingly, in some clusters *Mgb* is systematically stronger (at a given σ) for galaxies in the center of the cluster than for members further out. That is, galaxies near the cluster core may be more metal-rich, at given mass, than galaxies in the outskirts. An age interpretation (in the sense that outer members are younger) can be ruled out, due to the lack of any radial trend in residuals from the $H\gamma$ - σ relation.

This effect is found in NFPS data for a number of clusters so far (the case of Abell 3558 is shown here), and a similar effect has been noted for the Coma cluster in previous studies. However, initial indications are that such gradients are not ubiquitous in NFPS clusters. Since any existing cluster-centric gradient in metallicity (or indeed, in age) would probably be quickly erased by mixing in cluster mergers, it is possible that the presence of gradients might be correlated

with other indicators of “regularity” in clusters, such as cooling-flows, absence of substructure, etc.

As of July 2002, the survey’s imaging data are fully in hand and largely reduced, although morphological analysis is still under way. Spectroscopic data for most of the clusters has been obtained, with the more complex spectral reductions now in progress. In particular, a subset of clusters has been selected to serve as a testbed for many of the analyses foreseen, and data for these clusters is in an advanced stage. Efficient management and (useful) public release of the large quantity of data yielded by the survey present a significant challenge. An early release of image data can be found at the NFPS public Web page (astro.uwaterloo.ca/~mjhudson/nfjp). Ultimately, image data, spectra and parameter-rich catalogues will be made available via the NOAO science archive and/or via the CADC.

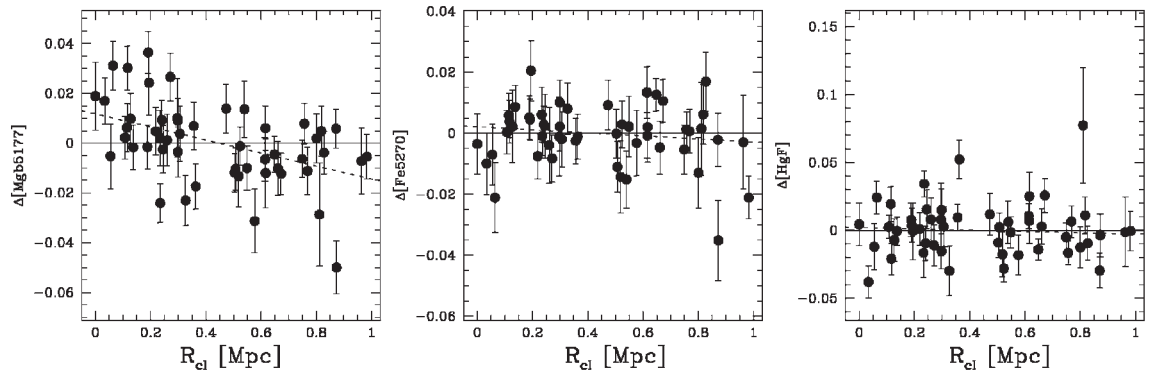


Figure 2. Residuals from the *Mgb*- σ , *Fe5270*- σ and $H\gamma$ -*Fe*, relations, plotted against cluster-centric distance R_{cl} , for galaxies in the rich cluster Abell 3558. Here the sample has been restricted to 55 galaxies with $\sigma > 160 \text{ km/s}^{-1}$, to exclude points with the largest error bars; the trends are formally unchanged if all ~ 90 galaxies are plotted. The significant $>3\sigma$ trend in the *Mgb* residuals suggests that centrally located galaxies have higher metallicity at a given mass than members further out. Note that the *Fe5270* line shows no strong trend (indeed, the four most central galaxies have lower Fe than expected for their mass). The lack of trend in $H\gamma$ Fe residuals strongly argues against an “age-gradient” interpretation.

A Wide-Field Survey for Stellar Variability

Based on a contribution solicited from Mark E. Everett & Steve B. Howell (Planetary Science Institute)

Mark Everett and Steve Howell used the Mosaic Camera at the KPNO 0.9-m as part of a high-precision variability study of Galactic field stars (PASP 113, 1428 and PASP 114, 656). Stellar variability at low amplitudes among solar type stars has not been studied extensively, yet represents a potential source of confusion for detecting extrasolar planets. The NASA Discovery mission Kepler, which aims to detect Earth-sized extrasolar planets transiting solar-type stars, will rely on the ability to

distinguish between transits and intrinsic stellar variability (at 0.1 millimagnitude levels). The Space Interferometry Mission (SIM) can expect at least some of its target stars (and possibly reference stars) to show astrometric variations due to spots and other asymmetries. Ground-based projects hoping to find transiting extrasolar planets must also distinguish between intrinsic stellar variations, grazing stellar eclipses, and true transits.

continued



Wide-Field Survey continued

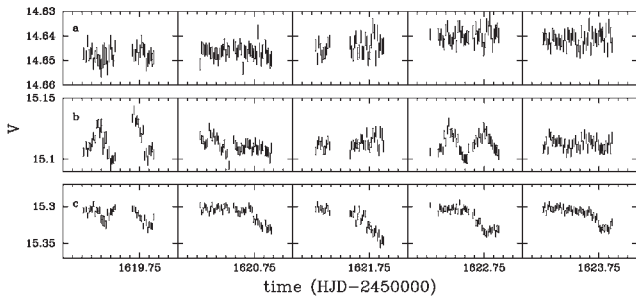


Figure 1. Light curves of three example variables. Each night of data is approximately 4.5 hours long. Panel (a) shows an unidentified class of variable. The colors and light curve suggest it may be a late-type spotted variable. Panel (b) shows a pulsating star, probably of the SX Phe class. Panel (c) shows an eclipsing variable.

The Everett and Howell study will identify signatures and frequency of intrinsic stellar variations and those spectral classes that are most variable or stable (which could serve as high-precision standards). Their survey is also useful for other stellar variability studies and should help define questions addressed by future projects like the Large Synoptic Survey Telescope (LSST), which will provide data for long-term stellar variability studies.

Time-series images were taken toward two 1-square degree fields on five consecutive nights in March 2000, sampling every 5 minutes to obtain light curves of all stars in the magnitude range $V = 14-19$. The data were reduced using automated procedures, including IRAF scripts, to produce light curves and UBVRI colors for each star in the field.

The light curves allow detection of millimagnitude amplitude variations in stars over a range of spectral types, as well as the quantification levels and frequency of variability in these populations. The data are particularly rich in G and K dwarfs. Among 12,000 stars, 221 new variables were identified, including members of eclipsing and pulsating classes (see figure 1). The fraction of stars showing variability reaches 17% at $V = 14$, the bright (high photometric precision) end of the program's magnitude range. The fraction of stars that are variable peaks at colors both bluer and redder than the Sun. These features correspond to instability strip and late-type spotted stars respectively (see figure 2).

In the future Everett and Howell plan to perform multicolor time variability surveys to sample rich star fields, various galactic positions, and open and globular clusters. Their primary objective is to search for transits by extrasolar planets, but longer-time baselines and follow-up spectroscopy of interesting sources will provide a more complete census of variable sources within and external to the Galaxy.

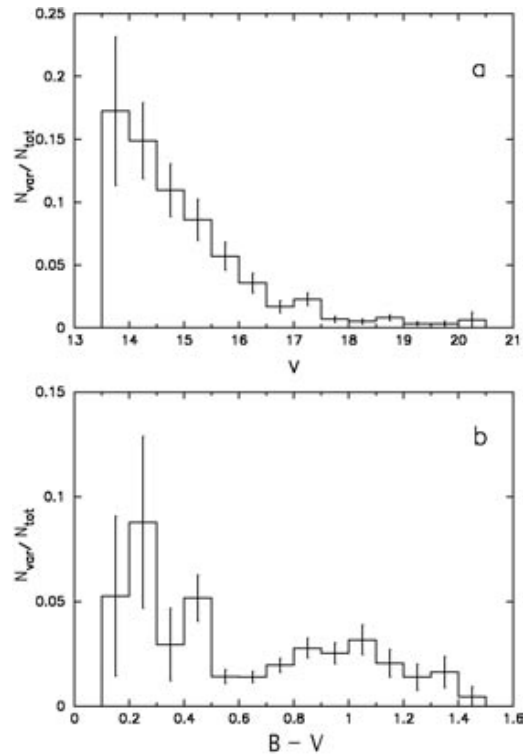


Figure 2. (a) The fraction of stars found to be variable as a function of V . The fraction is highest for the brightest stars since they are observed with the best precision. Approximately 17% of the brightest stars exhibit variations. (b) The fraction of stars found to be variable as a function of $B-V$. Pulsating stars in the instability strip account for most of the variability at blue colors ($B-V < 0.5$) while the fraction of variables among stars with Sun-like colors is relatively low. The variability fraction increases for colors redder than the Sun.



Imaging Polarimetry in the Ultraviolet

Jan Stenflo (ETH Zürich), Achim Gandorfer (ETH Zürich) & Christoph Keller (NSO)

Since 1994, a group from ETH Zürich, in collaboration with Christoph Keller, has carried out a series of observing runs at the McMath-Pierce facility with their polarimeter system ZIMPOL (Zürich Imaging Polarimeter). Since seeing and gain-table noise are eliminated with this system so that the polarimetric precision becomes limited only by photon statistics, noise levels as low as 5×10^{-6} have been achieved in combination with high spectral resolution. At this level of precision, *everything* in the solar spectrum is polarized, even in the absence of magnetic fields. In linear polarization, we see a spectrum that is as richly structured as the intensity spectrum, but which has a very different appearance, since the underlying physical processes are different. It is as if the Sun has presented us with an entirely new and unfamiliar spectrum, and we have to start all over to identify the spectral structures that we see. This new spectrum in linear polarization has therefore been called the “second solar spectrum.”

Since its first implementation, the ZIMPOL system has been continually upgraded, and new, more powerful versions have been put to use at NSO as they have become available. While the first generation (ZIMPOL I) could only image two of the four Stokes parameters simultaneously, the second generation (ZIMPOL II) had the capacity of imaging the full Stokes vector (by creating four simultaneous image planes on a single CCD detector chip). ZIMPOL I and II, however, could not be used for wavelengths below about 4500 Å. This was a serious limitation, since both the structural richness of the “second solar spectrum” and the polarization amplitudes increase greatly toward shorter wavelengths.

Therefore, during the last couple of years we have made a considerable investment to develop specially designed CCD sensors in collaboration with CCD manufacturer EEV. These sensors that have high efficiency throughout the UV, all the way down to the atmospheric cutoff near 3000 Å, while possessing an architecture that allows the fast (kHz range) ZIMPOL-type charge-shifting technology. To achieve high quantum efficiency in the UV, holes had to be etched in the polysilicon gate layer above the pixels, creating an Open Electrode Structuring (OES).

The new, UV-sensitive ZIMPOL system was used for the first time at NSO in an exploratory observing run in March 2002. The run exceeded our expectations, both in terms of system performance and in terms of the astounding richness of the polarized UV spectrum. It is like digging in a newly discovered “gold mine.” Here we can only provide a glimpse of what we observed.

Figure 1 shows the four Stokes vector images of the spectral region around the Ca I 4227 Å line, which has the strongest scattering polarization in the visible spectrum. The spectrograph slit has been placed 20 arcsec inside and parallel to the solar limb in a facular region. While the circular polarization (V/I) shows the familiar antisymmetric signatures of the longitudinal Zeeman effect, the linear polarization in the Ca I line is due to scattering polarization (while the transverse Zeeman effect shows up in many of the blend lines). The strong variations along the spectrograph

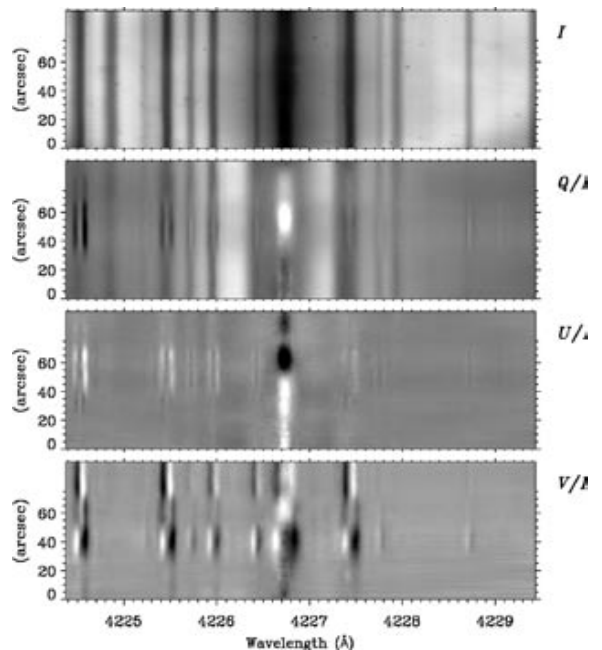


Figure 1. Stokes vector image of the spectral region around the Ca I 4227 Å line. The recording was made in a facular region 20 arcsec inside the limb.

slit of the linear (Q/I and U/I) polarization in the Ca I line core are due to the Hanle effect from the spatially structured chromospheric magnetic fields. The Hanle effect is a new tool to diagnose aspects of solar magnetic fields that cannot be seen with the Zeeman effect. The ambiguities that often occur in the interpretation of the Hanle signatures can be removed by using combinations of spectral lines with different sensitivities to the Hanle effect. Since the UV presents us with a much greater selection of such lines than other spectral regions, the UV range is of unique importance for the application of Hanle diagnostics.

continued



Imaging Polarimetry in UV continued

Figure 2 gives another example of what the UV region has to offer. The recording was made with the spectrograph slit positioned 6 arcsec inside and parallel to the solar limb at the heliographic south pole, covering the wavelength range around the Be II resonance doublet at 3130.414 and 3131.058 Å. Since the recording was made in a very quiet region, the scattering polarization did not show spatial structuring, so we could average the 2-D spectra along the spectrograph slit to produce the 1-D spectra in figure 2. At these UV wavelengths the continuum is strongly polarized, and the majority of the lines suppress (depolarize) the continuum. In contrast, the left Be II line exhibits a strong, positive (electric vector parallel to the limb) polarization peak, while the right Be II line depolarizes the continuum.

The two Be II lines are due to transitions with a quantum-number structure, including hyperfine-structure splitting, that is identical to the well-known Na I D₂ and D₁ lines at 5889.97 and 5895.94 Å, which have polarization signatures that remain enigmatic. Using the notation D₂ and D₁ in figure 2, the general quantum-mechanical expectation is that the D₂ line should be polarized, while the D₁ line should be unpolarized. Though various diagnostic applications of such observations are possible (determination of beryllium abundance, radiative transfer physics, Hanle diagnostics),

the focus of these initial, exploratory observations is to identify the multitude of phenomena in the second solar spectrum and to clarify the underlying physics.

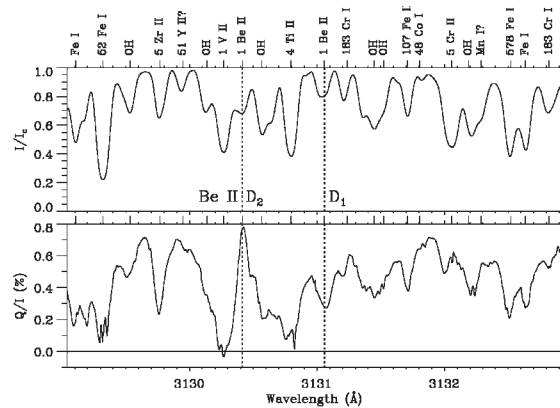


Figure 2. The spectrum in intensity (top panel) and degree of linear polarization (bottom panel) in the spectral region around the Be II D₂ (3130.414 Å) and D₁ (3131.058 Å) lines. The recording was made in a quiet region at the heliographic south pole, 6 arcsec inside the limb. The vertical dotted lines mark the resonant wavelengths of the two beryllium lines.

Imaging Polarimetry of Jupiter and Saturn with ZIMPOL

Daniel Gisler & Hans Martin Schmid (ETH, Zürich)

In March 2002, we obtained imaging polarimetry of the planets and bright stars using the Zürich Imaging Polarimeter (ZIMPOL) at the 1.5-m McMath-Pierce telescope. J. Stenflo, A. Gandorfer, and C. Keller observed the Sun with spectropolarimetry during the day (see previous article in this *Newsletter*) and we observed at night. Our aim for these test measurements was to gain experience with this type of instrument for stellar (nighttime) applications.

The ZIMPOL technique is based on a fast, electro-optical polarization modulator working in the kHz range, in combination with a special CCD camera performing on-chip demodulation of the signal. ZIMPOL has been used very successfully for polarimetric measurements of the Sun. In fact, the polarimetric accuracy was improved by about two orders of magnitude in S/N. Accordingly, we have adapted the ZIMPOL technique for nighttime astronomy in order to exploit its unprecedented measuring accuracy.

Our first tests at Kitt Peak used a ferro-electric liquid crystal (FLC) retarder plate—where the optical axis can be switched by 45°—as a polarization modulator. The FLC allows lower

modulation rates of 1 kHz, instead of the 40-kHz rates of piezo-elastic modulators. Thus, the FLC enables longer integration times of up to 40 seconds. This is because the CCD demodulation shifts are limited to about 10⁵ modulation cycles due to anomalous charge transfer effects in the CCD. The slower modulation also reduces CCD heating. In our case, the thermoelectric cooling achieved a lower temperature of -30°C, instead of the norm of -10°C. This FLC modulator was combined with “spare parts” from the solar ZIMPOL instrument for the observing run.

Our tests with the McMath-Pierce telescope are very promising. For Jupiter and Saturn, high-quality maps for the linear polarization in four narrowband filters centered at 4500 Å, 5500 Å, 6000 Å, and 7300 Å, with a width of 200 Å, were obtained. The figure shows the reflected sunlight from Jupiter and Saturn at 5500 Å. The other maps are qualitatively the same except for some small but significant color trends. Both planets have a low polarization at the disk center, because the scattering angle is close to 180° (backscattering), as is always

continued

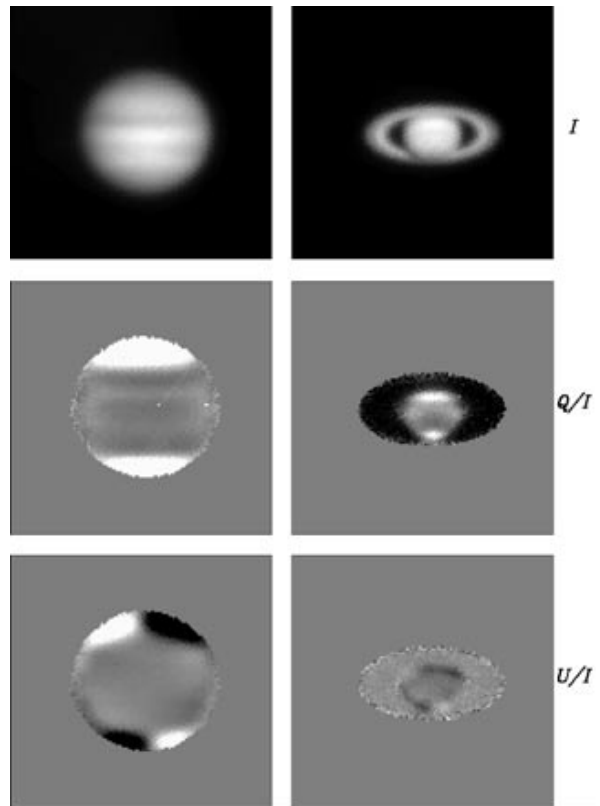


Imaging Polarimetry continued

the case for the outer planets observed from Earth. Both objects exhibit a limb polarization perpendicular to the limb that is much stronger at the poles than at the equator.

The perpendicular limb polarization is caused by a well-known second-order scattering effect. Photons reflected after one scattering in the planet atmosphere are practically nonpolarized, because the scattering angle is close to 180°. After the first scattering, photons travel predominantly parallel to the planet surface before being reflected toward us by the second scattering process. Because the polarization angle induced in a scattering is perpendicular to the propagation direction of the incoming photon, a polarization perpendicular to the limb results. The polarization at the poles is much higher because the Rayleigh scattering atmosphere is deeper, or the effective cloud level is lower than in the warmer equatorial regions. In the rings of Saturn, practically no polarization structure is seen as should be expected from a mixture of reflecting solid debris bodies.

Much has been learned from this observing run and we are confident that the ZIMPOL technique has a huge potential for astrophysical polarimetry. However, further improvements are required, such as lower CCD dark-current and read-out noise levels with an improved cooling system, or the development of an achromatic modulator system for broadband imaging polarimetry. This effort is warranted since the new 8–10-m telescopes provide sufficient light-collecting power to obtain a very high polarimetric accuracy for bright objects. For example, a spectropolarimetric accuracy of $\Delta = 10^{-4}$ with a spectral resolution of 300 can be achieved for a 9th-magnitude object with an integration time of one hour. For broadband imaging, this polarimetric accuracy is possible for a 13th-magnitude object. Such an improvement in measuring accuracy will open up many new opportunities for investigations of stellar magnetic fields, or scattering gas and dust structures near stars and active galactic nuclei.



Images of the intensity I and Stokes parameters Q/I and U/I for Jupiter and Saturn at 5500 Å. The images are not completely corrected for the telescope polarization. The polarization, however, is displayed relative to the polarization at the center of the planet disk, which is set to zero (the intrinsic polarization is very small). The gray scale in the Stokes polarization images goes from -1% (black) to +1% (white). The maximum polarization at the poles of Jupiter is greater than +5%.

12- μm Magnetometry with Visible Tip-Tilt Image Stabilization

George McCabe, Don Jennings, Drake Deming (NASA GSFC) & Christoph Keller, Claude Plymate (NSO)

In April 2002, the Celeste spectrometer was used with the McMath-Pierce tip-tilt image stabilizer, operating in the visible, to test whether this technique would improve measurements of solar magnetic fields in the thermal IR. Combined with a computer-controlled wave-plate polarization analyzer and synchronized telescope guider stages, Celeste creates high-resolution IR (12.32- μm) maps

of active regions in all four Stokes parameters. The Celeste detector array double-samples the diffraction-limited spot of the telescope, but the effective limit on the spatial resolution of spectral-image scans is set by atmospheric motion and telescope tracking errors. We were able to demonstrate that the tip-tilt system, operating in the visible, successfully eliminates the unwanted motion in the IR image.

continued



12- μm Magnetometry continued

Short integration time measurements of the solar limb recorded with and without the tip-tilt mirror activated show how image motion is removed in the IR using 1-D. Figure 1 compares limb profiles for 10 scans (each 1/10 sec). Note that the dip in the curve near the middle is the extension of the Mg I emission line beyond the solar limb. In the left frame, the spread in the data due to limb motion in the nonstabilized case is approximately 3 arcsec. Thus, without stabilization, a time average of the measurements is degraded by a significant smearing of the limb. In the right frame, the limb motion during stabilization is reduced to less than 1 arcsec.

Measurements of Stokes parameters in a sunspot were made to compare closed-loop and open-loop tip-tilt operation. Limb guiders were not used, so as to avoid any contribution of the telescope control system beyond tracking errors, which accumulate slowly on the scale of the data read times. Manual guide corrections were made between closed-loop integrations to compensate for telescope drift, and to maintain the position of the image near the center of the range of travel (20 arcsec) of the tip-tilt mirror. In figure 2, the plot of Stokes V shows the difference in appearance of the spectral profiles for the closed-loop and the open-loop cases. A larger separation of σ components is distinctly seen in the darker curve (closed-loop), as compared with the lighter curve (open-loop). Also, the line-of-sight magnitude of B is larger in the data with tip-tilt turned on. Since the average slit position on the spot is biased in the direction of telescope drift, we can't yet say for sure whether these differences are completely due to image stabilization, i.e., they may be partly due to looking at different places in the spot. However, it is clear from the data that the tip-tilt

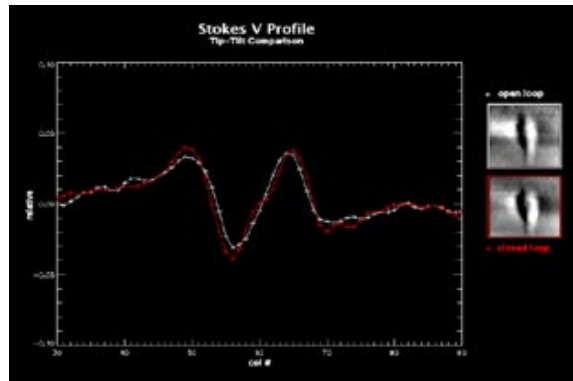


Figure 2

system is providing improved image stability at 12 μm . We anticipate that use of the tip-tilt correction will produce higher precision in magnetic field maps. The full potential of this improvement in the IR will be realized with the Advanced Technology Solar Telescope (ATST) and its planned adaptive optics facility. We anticipate developing this technique further in upcoming runs at the McMath-Pierce telescope.

The Celeste instrument system was built by the NASA Goddard Space Flight Center (G. McCabe, D. Jennings, D. Deming). Our work is supported in part by the NASA Solar Physics Program. The adaptive optics image stabilizer was developed at the National Solar Observatory by C. Keller and C. Plymate.

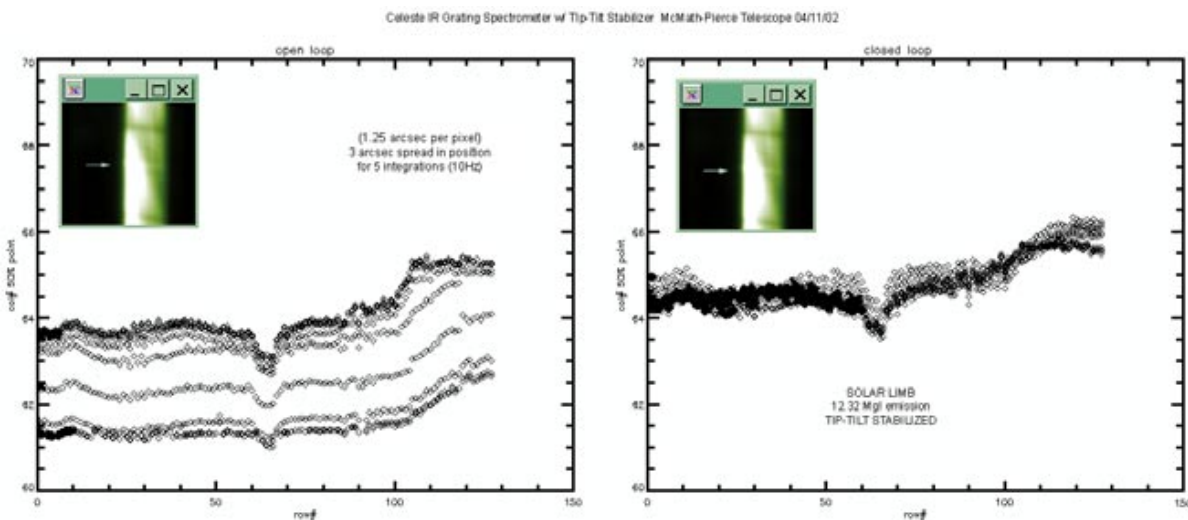


Figure 1

DIRECTOR'S OFFICE

NATIONAL OPTICAL ASTRONOMY OBSERVATORY

The GSMT Science Working Group

Jeremy Mould

The Giant Segmented Mirror Telescope (GSMT) Science Working Group (SWG), under the chairmanship of Rolf Kudritzki, held its first meeting in Tucson on July 29–30.

Members are:

Betsy Barton—University of Arizona
Rolf Kudritzki—University of Hawaii
Jill Bechtold—University of Arizona
Claire Max—Lawrence Livermore National Laboratory
Michael Bolte—University of California Santa Cruz
Francois Rigaut—Gemini
Matthew Colless—Australian National University
Chick Woodward—University of Minnesota
Terry Herter—Cornell University
Doug Simons—Gemini
Paul Ho—Center for Astrophysics
Irene Cruz-Gonzales—Instituto de Astronomia (UNAM)

Although the McKee-Taylor Decadal Survey made GSMT its top priority ground-based optical/infrared (O/IR) facility, the report leaves great freedom of interpretation regarding the design and total cost of the telescope. Indeed, the O/IR panel report is more exact about the Large Synoptic Survey Telescope (LSST) than

GSMT. Therefore, the Science Working Group has to discern the relative scientific advantages of a number of different concepts in order to recommend to NSF its optimum investment in a public/private partnership.

Proponents will present the merits of

- “classical” versus multiconjugate adaptive optics
- a seeing-limited wide-field mode
- larger and smaller primary mirrors than 30 meters
- high-dynamic-range imaging performance.

The SWG will also be examining

- scientific complementarity with NGST and ALMA
- the suite of instruments needed to accomplish the scientific goals.

A number of these matters will require detailed study, for which the GSMT SWG will rely on a NOAO support group including Steve Strom, Joan Najita, Steve Ridgway, Knut Olsen, Sam Barden, and engineers led by Larry Stepp.

The charter of the GSMT SWG was published in the June *Newsletter*. The SWG is expected to furnish a report in July 2004.

The Physics of the Universe

Jeremy Mould

The new National Research Council (NRC) study, “Connecting Quarks with the Cosmos” is required reading for astronomers (www.nap.edu/books/0309074061/html/R1.html), regardless of whether cosmology is our field or high-energy physics our avocation. The Committee on the Physics of the Universe (CPU) has chosen an interesting way to highlight the significance of research at the interface of physics and astronomy.

The CPU has seized on 11 particularly direct questions:

1. What is the dark matter?
2. What is the nature of the dark energy?
3. How did the Universe begin?
4. Did Einstein have the last word on gravity?
5. What are the masses of the neutrinos and how have they shaped the evolution of the Universe?

6. How do cosmic accelerators work and what are they accelerating?
7. Are protons unstable?
8. Are there new states of matter at exceedingly high density and temperature?
9. Are there additional spacetime dimensions?
10. How were the elements from iron to uranium made?
11. Is a new theory of matter and light needed at the highest energies?

The CPU goes on to make seven recommendations to address these questions.

continued



Physics of the Universe continued

From NOAO's perspective, it is interesting to note the extent that our research community's current lines of investigation reflect these priorities. To test this, one need only look at the publication record in the NOAO 2001 annual report.

Until recently, dark matter was the biggest challenge astronomy had served up to physics. How dark matter manifests itself, on stellar scales to the scale of the Universe, was a theme of more NOAO scientific highlights of 2001 than any other. This includes the census of white dwarfs, the MACHO project follow-up, investigation of dwarf spheroidal galaxies (where the dark matter to baryon ratio seems highest), and the inventory of baryons in galaxy clusters.

Since 1998, when *Science* dubbed the accelerating universe theory the discovery of the year, the most blatant challenge has become dark energy. Distance indicator work (past and future) at NOAO probes the nature of cosmic expansion; of particular note are the Deep Lens Survey and its successor projects.

As the late Dave Schramm was fond of reiterating, "optical spectroscopy probes the epoch of nucleosynthesis in the early Universe." Observations of the cosmic helium abundance constrain the size of the neutrino family. Measuring the power spectrum at the redshift of Lyman-break galaxies constrains the mass of the dark matter particles. Both of these areas of investigation were among NOAO's publication highlights of 2001.

There are several candidates for the cosmic accelerators that produce beams of highly energetic particles. Among those studied with NOAO telescopes were supermassive black holes and gamma ray bursters.

Stellar-mass black holes and neutron stars are the laboratories of choice for ultrahigh density and temperature. In 2001, GRO J1655-40 yielded its black hole mass (6.3 solar masses) and 3EG J2227+6122 (a young neutron star with a bow shock) was imaged at Kitt Peak.

Finally, stellar nucleosynthesis has had its Nobel laureates in physics, and continues to be a rich subject for high-resolution spectroscopy. Workhorse echelle spectrographs enabled astronomers at NOAO to find the onset of the main r -process at iron abundances one-thousandth that of the Sun; this onset is consistent with the suggestion that low-mass Type II supernovae are responsible for the r -process.

All this is not to pretend that physics is the driving force behind all research with astronomical facilities. The full picture of NOAO's research endeavor also includes such unashamed orgies of baryons as the Magellanic Clouds, young stellar associations, the WIYN open clusters, Milky Way cannibalism, stellar mass loss, damped Lyman- α galaxies, and the ecology of disk galaxies. In addition, there is no doubt that the "Origins" theme in NASA astronomy has an appeal to both the science community and the public that transcends its impact on physics.

Furthermore, a number of the 11 questions are currently untouched by optical/infrared astronomers: cosmic inflation and proton stability are two prime experimental examples, particularly since the CPU sees microwave background polarimetry as the most promising

probe of photon properties in the era of inflation when the Universe began.

However, one of the seven CPU recommendations (which has much in common with the astronomy decadal survey) is going to have a very major impact on NOAO's community:

"The Committee supports the Large Synoptic Survey Telescope (LSST) project, which has significant promise for shedding light on the dark energy.

"A ground-based wide-field telescope has its greatest power in studying the dark energy at redshifts of less than about 1. It can discover tens of thousands of supernovae out to redshifts of about $z \sim 0.8$ and follow them up (though not with the same control of systematics that can be done in space). It can carry out weak-gravitational lensing surveys over thousands of square degrees to moderate depth."

In fact, LSST will serve NOAO's community in a wide variety of ways, perhaps the greatest of which will be to open the observational time domain routinely and comprehensively. For all of these reasons, NOAO will aggressively pursue LSST design, construction, and operation. Our near-term goals are to submit a fully engineered and fully costed proposal to funding agencies by the end of 2004, and to begin work immediately on items with the longest lead-times.

Until recently, dark matter was the biggest challenge astronomy had served up to physics. How dark matter manifests itself, on stellar scales to the scale of the Universe, was a theme of more NOAO scientific highlights of 2001 than any other.



TSIP Launched!

Todd Boroson

The Telescope System Instrumentation Program (TSIP), the highest-priority moderate initiative of the McKee-Taylor Decadal Survey, has become a reality.

At the request of the astronomy division of the NSF, NOAO took on the administration of this program, and a solicitation for proposals was issued in December 2001. Proposals in this first year were limited to instruments or improvements for telescopes with six-meter apertures or greater.

The goals of TSIP are threefold. First, TSIP aims to provide new, scientifically important capabilities to the system of ground-based optical/infrared (O/IR) facilities. Second, TSIP acknowledges and rewards the huge investment made by independent observatories in building the current generation of large telescopes. Third,

TSIP strengthens the public-private partnership by broadening access to the independent observatory facilities. These three goals are jointly served by the requirement that telescope time equal in value to half of the funds awarded for new instrumental capabilities will be made available to the entire astronomical community.

In early May, a panel met to review and rank the proposals received. Alan Dressler, chair of the Decadal Survey panel on Optical and Infrared Astronomy from the Ground, chaired the review committee. Two proposals were selected for funding, resulting in total awards of \$3.89 million. The remaining funds will be carried over to supplement the FY 2003 TSIP allocation.

The two funded proposals involve OSIRIS, an integral field spectrograph for the Keck II Telescope; and

KIRMOS, a near-IR imager and multi-object spectrograph for the Keck II telescope—Phase B. The OSIRIS award is \$2,749,200 to fund the fabrication of this instrument, which is currently completing its design phase. The KIRMOS award is \$1,137,600 to fund one year of preliminary design work for this instrument.

Each night on one of the Keck telescopes is valued at \$47,400. Therefore, the two awards will provide a total of 41 nights on one of the Keck telescopes. See the article in the Observational Programs section of this *Newsletter* for the announcement of availability of the first 12 nights of this time.

Check the NOAO TSIP office Web site at www.noao.edu/system/tsip for ongoing information about the awards, the status of TSIP-funded instruments, and program news.

LSST Science Working Group

Jeremy Mould

We received a very healthy response during July to the request published in the AAS e-news for membership of a Science Working Group (SWG) for the Large Synoptic Survey Telescope (LSST). The SWG will provide advice in the areas outlined in the formal charge below. Establishing the relationship between the scientific opportunities arising from the Decadal Survey's LSST and those of other related surveys will be a key task. Another crucial product of the SWG's work will be a Design Reference Mission (DRM). The challenge with the DRM is to balance the science so that all of the objectives—cosmology, solar system exploration, and time domain astrophysics—are met. Although survey objectives tend to be synergistic, they do become competitive when one attempts to optimize a finite duration experiment.

The composition of the SWG is:

- Gary Bernstein—University of Pennsylvania
- David Morrison—NASA Astrobiology Institute
- Andy Connolly—University of Pittsburgh
- Mike Shara—American Museum of Natural History
- Kem Cook—Lawrence Livermore National Laboratory
- Alan Stern—Southwest Research Institute
- Peter Garnavich—University of Notre Dame
- Fiona Harrison—California Institute of Technology
- Alan Harris—NASA Jet Propulsion Laboratory
- Michael Strauss (Chair)—Princeton University
- Dave Jewitt—University of Hawaii
- Chris Stubbs—University of Washington
- Steve Larson—University of Arizona LPL
- Tony Tyson—Bell Labs
- Dave Monet—US Naval Observatory
- Dennis Zaritsky—Steward Observatory
- Nick Kaiser—University of Hawaii

continued



LSST SWG continued

The SWG will be supported by NOAO staff members:

Chuck Claver
 Dave De Young
 Dick Shaw
 Richard Green
 Chris Smith
 Buell Jannuzi
 Nick Suntzeff
 Abhijit Saha
 Sidney Wolff

I'm very grateful to the large number of people who offered their services to the SWG, and I'm confident there will be other roles for them in the LSST enterprise as it moves forward.

LSST SWG Charge

The NSF has authorized NOAO to establish and maintain a Science Working Group for the Large Synoptic Survey Telescope. This working group is intended to be the community-based body that will develop the science case and justification for federal investment by NSF, NASA, and other agencies in LSST. The SWG will represent the US community in assembling relevant partnerships for describing and advocating the appropriate federal role in this project. This guidance is intended to be a product of all public, private, and international groups that expect to play a role in the LSST. SWG members are expected to actively participate in technical, observational, and theoretical astrophysical studies that will be useful in defining and focusing the scientific objectives for the LSST.

Although not limited to these areas, the LSST SWG has been assigned the following specific tasks:

1. Develop the science cases and scientific priorities for an LSST, and refine the science goals outlined in earlier reports prepared by participating institutions. This includes evaluation of the likely impact that advances expected with existing and near-term studies will have on the science goals of LSST, along with consideration of the costs and benefits of alternative approaches. It also includes working with the scientific community to ensure that the goals continue to be exciting, important, and representative of the highest scientific priorities for a survey telescope.
2. Develop a "flowdown" from key science to top-level engineering goals and requirements. Develop performance metrics for the LSST telescope, instrumentation, software, operations, data management, and other aspects of the program; and, assess performance against these metrics.
3. Identify the key instrumentation capabilities for a LSST. Review the currently proposed survey camera and propose alternate designs or complementary instrumentation that would enhance scientific usefulness, improve observing efficiency, or lead to potential cost reduction.
4. Prepare a design reference program for a 10-year LSST mission. The DRM should be the optimum science program achievable with the LSST for the recommended design, cost and schedule. The DRM should be planned in sufficient detail that it is possible to specify the total data product of the telescope, the parameter space surveyed, and the predictable discovery set.
5. Establish the scientific relationship between LSST and other major facilities (SNAP, Gemini, POI, GSMT, VISTA, etc.).
6. Identify any priorities for technology development.
7. Provide scientific assessments of design concepts and implementation plans for their impact on the overall scientific performance. This includes the calibration plan and the data management plan.
8. Assemble appropriate community-wide partnerships for preparation of any proposals to NSF and NASA for funding activities related to LSST.



Director's Office



Alan B. Whiting
CTIO Postdoc

Alan Whiting arrived in La Serena in October 2001, after having spent the last four years teaching physics and astronomy at the US Naval Academy (where he also did his undergraduate studies). Before his teaching stint, Alan spent 11 years at sea and then completed the graduate program at the University of Cambridge Institute of Astronomy.

Alan's scientific focus is mainly in the dynamics of nearby galaxies; current projects include finishing a search for small, faint galaxies in the Local Group with Mike Irwin (University of Cambridge Institute of Astronomy) and George Hau (European Southern Observatory); and investigating the dynamics of the region within 10 megaparsecs of the Milky Way.



What are the roots of your interest in astronomy?

When I was about 12, I visited a cousin in Los Angeles. He had a six- or eight-inch Newtonian that, strangely, he was willing to let me play with. I pointed it at the first "star" I saw, which turned out to be Jupiter; and after that it was all over. I still look at Jupiter whenever I can.

How did your Navy career prepare you—good or bad—for the life of an astronomer? Did you have any especially memorable experiences with the night sky during your time at sea?

There really is little directly comparable between the job of a seagoing officer and that of an astronomer. On a ship you work closely with many people, within strict lines of authority and responsibility, and the job pressures are immediate. In the end, doing an outstanding job may only mean the ship got from there to here on time, and now you've got to do it over again. Being a scientist is creative, and you can actually accomplish something you can point to later. You provide your own motivation. But if you do a good job there are fewer people to share it with.

Indirectly, having been a Naval officer proved to be useful at graduate school. I had a solid base of self-confidence; setbacks didn't threaten my whole world, as they might to someone who had only been a student.

There are awesome things to be seen at sea, by day and night, and if I were a poet I would tell you about them. But the Captain (quite properly) becomes upset if he finds his watch officers looking up at the stars, rather than out at the sea where there are things to run into.

What are the main results to date from your survey work with Irwin and Hau?

We found the dwarf galaxies in Antlia and Cetus, for a start.

The Antlia dwarf had been catalogued before, and someone had suggested that it was in the Local Group based on radial velocity, but no one had followed it up. From the distance we derived that it appears to be on the border of the Group.

But what may be more important are all the dwarfs we didn't find. Popular kinds of galaxy-formation scenarios seem to require more Local Group dwarfs than are known, by an order of magnitude or so—we can now say that they aren't there. We've looked over the whole southern sky and most of the northern, so this is a full-sky effort. Thus, the result of a very local search has cosmological implications.

What are your service duties at CTIO?

I work with Nicole van der Bliik and Chris Smith in the Research Experiences for Undergraduates (REU) program. Nicole has done the most work this past year, an incredible amount; unfortunately, I found myself travelling for most of the ten-week period. Next year I should be more useful.

I've also become the staff contact for the 0.9-meter telescope, taking some of the load off Nick Suntzeff.

What are the most sharp comparisons or contrasts between life in the military and working for a civilian astronomical research organization?

As I've mentioned, in the Navy there is much more immediate pressure, and your accomplishments are, at best, temporary, but always shared in some way with the rest of the crew. Here the scientific work is done in much smaller groups and you can be (indeed, have to be) creative.

But in both I find a sort of selflessness, a willingness to work longer and harder than is strictly necessary, in order to get something worthwhile done. No one joins the Navy or becomes an astronomer to get rich or famous; to be successful in either you have to find your satisfaction in other ways.

What are your main interests away from work?

I probably spend most my money, if not time, on photography. I have two old cameras that take superb pictures (you have to pay attention, nothing is automatic on them), and there are wonderful pictures waiting to be taken where I find myself often going, such as mountaintops at sunrise and sunset.

But I've only begun to explore what there is to do and see in Chile, so anything might catch my attention. I may even succeed in establishing a local fencing club.

USGEMINI PROGRAM

THE UNITED STATES GEMINI PROGRAM

Gemini Update and Opportunities in Semester 2003A

Taft Armandroff

The US Gemini Program (USGP) strongly encourages the US community to take advantage of Gemini observing opportunities for semester 2003A. This is accomplished by applying through the standard NOAO Time Allocation Committee (TAC) process. A number of exciting new instrumental capabilities are expected to be offered, as described below. Also, more nights are planned to be used for scientific observations than in previous semesters. The US proposal deadline for 2003A is September 30. Please watch the USGP Web page (www.noao.edu/usgp) for the Call for Proposals for Gemini observing to establish the actual capabilities that one can request.

Gemini North

- The NIRI infrared imager/spectrometer will be offered in 2003A. The $f/6$ imaging mode (over a 2-arcmin field) and $f/6$ grism spectroscopy mode are expected to be the most popular configurations in 2003A (and until Altair is commissioned). NIRI underwent a major refurbishment to make the instrument more robust operationally that removed it from the telescope for most of July and August (see the following article by R. Blum).
- The GMOS optical spectrograph/imager will be offered in 2003A. Imaging, long-slit spectroscopy, multi-object spectroscopy, and integral-field unit (IFU) modes will all be available. Excellent progress has been made on commissioning the “nod-and-shuffle” mode, which greatly enhances sky subtraction, particularly at the red end of the spectrum. Consequently, it is anticipated that GMOS nod-and-shuffle mode will be offered in 2003A. It is also expected that a GMOS spectroscopy mode with the slit position angle set to the average parallactic angle for the exposure will be available in 2003A (see the following article by T. Lauer).
- Michelle is a mid-infrared (8–25 micron) imager and spectrograph for shared use between Gemini and UKIRT. Observing modes include direct imaging and long-slit spectroscopy with spectral resolutions of approximately 200, 1000, and 30,000. Michelle is in use at UKIRT and is expected to be delivered to Gemini Observatory in late 2002. After delivery, there will be a period of characterization and commissioning before Michelle will be available for scientific use. Michelle may be included in the 2003A Gemini Call for Proposals, with science availability anticipated toward the end of the semester.
- Based on Gemini Board action, the science fraction for Gemini North is expected to be between 50% and 55% in 2003A. Some of the activities for which nonscience time will be used include performing system verification for NIRI polarimetry, commissioning Michelle, commissioning and performing system verification on the Altair adaptive optics system, and commissioning new gratings and narrowband filters for GMOS.

Gemini South

- The Phoenix infrared high-resolution spectrograph will be offered in semester 2003A (see article below by K. Hinkle).
- The Acquisition Camera will be available for Quick Response in 2003A.
- It is expected that the T-ReCS mid-infrared instrument will be offered in 2003A. Although T-ReCS has both imaging and spectroscopic modes, only the imaging mode is expected to be fully commissioned and verified for this semester.
- The GMOS South optical spectrograph/imager may be offered at the end of semester 2003A. With GMOS South's arrival, optical spectroscopy with identical instrumentation will be available in both hemispheres. It is particularly important to check the Call for Proposals for up-to-date expectations of GMOS South's potential availability.
- Based on Gemini Board action, the science fraction for Gemini South is expected to be between 40% and 45% in 2003A. Some of the activities for which the nonscience time will be used include commissioning and performing system verification for GMOS South, recoating the primary mirror (M1), commissioning the T-ReCS spectroscopic mode, and commissioning the high-resolution optical spectrograph bHROS.

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

USGP was very pleased to see a strong community response to the Gemini Call for Proposals for semester 2002B. In total, 103 US proposals sought 181 nights on the two Gemini telescopes. The results of consideration of these proposals by the NOAO TACs and then the Gemini International TAC (ITAC) were announced in mid-June, with a total of 48 US programs being approved for the Gemini Queue in 2002B. A list of these programs and their PIs is available at www.us-gemini.noao.edu/sciops/schedules/schedQueue2002B.html.

continued



Gemini Update continued

The selected 2002B observers will define their observational programs in detail via the Gemini Phase II process. USGP staff will provide technical support to US PIs as they construct their Phase II programs. The Phase II process for semester 2002B is described at www.us-gemini.noao.edu/sciops/OThelp/otSpecialInstructions2002B.html.

Scientific papers based on Gemini observations continue to appear; a list of papers is available at www.us-gemini.noao.edu/science/publications/users.html. These papers demonstrate how others have exploited the capabilities of the Gemini telescopes and instruments, and are likely to be of use to potential proposers.

Changes in Gemini Partner Share

Wayne Van Citters (National Science Foundation) & Taft Armandroff (USGP)

Chile is a partner in the Gemini Observatory and has had control of 4.76% of the observing time, in addition to the time that it receives as host country for Gemini South. Chile is undergoing a change in status as a Gemini partner. In order to better fund astronomy data analysis, interpretation, and related research within the Chilean astronomical community, as well as to establish a fund to invest in the development of astronomy within the country, Chile wishes to retain only its share of Gemini telescope time that it receives as host. Chile will remain a Gemini partner.

The Gemini Board has settled on the shares of the Chilean subscription of Gemini time. The Chilean fraction will be divided as follows: US 47%, Australia 33%, Canada 15%, and Brazil/Argentina 5%. We believe that this represents an excellent outcome, firmly establishing US and Australian interest, getting Canada back to their fraction before Australia joined Gemini, and solidifying the South American position. The National Science Foundation will fund this expansion in US Gemini share from 47.62% to 49.86%. The AURA Observatory Council and the US Gemini Science Advisory Committee discussed and endorsed this increase in US Gemini share. Given the high oversubscription currently seen for the US Gemini time, these additional nights will allow additional high-priority science projects to be carried out by the US astronomical community.

GMOS Science Operations

Tod Lauer

The Gemini Multiple Object Spectrograph (GMOS) has just completed its first full semester of science operations. While poor weather and other demands on the Gemini North telescope reduced the number of programs that could be completed, enough data have been obtained to give a good look at the instrument's performance. Overall, the instrument performance is well modeled by the GMOS exposure time calculator (see www.us-gemini.noao.edu/sciops/instruments/gmos/gmosIndex.html for complete information on GMOS), and the IRAF GMOS package works successfully to produce calibrated one-dimensional spectra from the spectroscopic multi-slit images.

with 5.5 to 11.5 hours of total exposure, are shown in figure 2. To give some feeling for the quality of sky subtraction, figure 3 shows the H β + OIII region of A851-2365 before and after sky subtraction, and figure 4 shows the Ca II H+K lines region

Figure 1 shows an example of a GMOS multi-slit image. This image and figures 2–4 show spectra of galaxies in the rich cluster A851 ($z = 0.407$) obtained by Inger Jorgensen (Gemini Observatory) as part of her program to investigate galaxy evolution out to half the age of the Universe. The image shown represents 2.5 hours of integration time; the spectra cover roughly 3000 Å, with roughly 0.46 Å/pixel. Note that the spectra extend across the three 4608 × 2048 GMOS CCDs. Final reduced spectra of four representative galaxies,

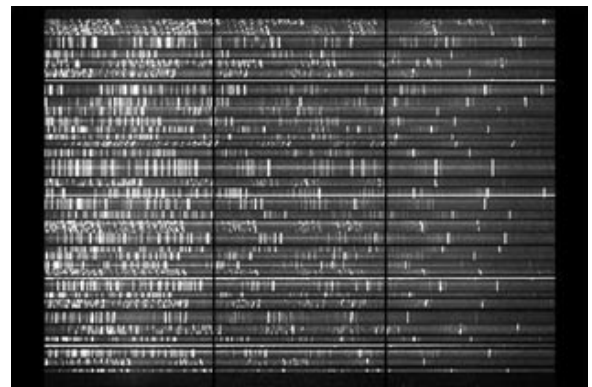


Figure 1. Sample GMOS multi-slit image of galaxies in rich cluster A851 ($z = 0.407$).

continued

GMOS Science continued

of A851-2559. Although the doublet in the latter galaxy is bisected by the strong 5577 Å [O I] night sky line, the H+K lines themselves are well observed in the reduced spectrum. For observers interested in getting a feel for GMOS observations in advance of obtaining their own data, the Gemini Observatory offers some publically available examples of GMOS data sets at www.gemini.edu/sciops/data/dataSVGmos.html.

Figures 5a, 5b, and 6 show how well GMOS performs on cosmologically distant and faint objects. Figure 5a shows an R-band image from the NOAO Deep Wide-Field Survey, while figure 5b shows the same field observed in a narrow band filter with the KPNO 4-meter telescope as part of the Large-Area Lyman-Alpha survey (PIs James E. Rhoads and Sangeeta Malhotra, STScI). The central object in figure 5b is a candidate Ly- α emitting object at roughly $z = 4.5$; its R magnitude is 26.2. Figure 6 shows a preliminary reduction of the flux-calibrated spectrum.

The Gemini Observatory is presently investigating the “nod-and-shuffle” mode of observing, to improve both the quality of the sky subtractions and the density of multi-slits. An initial attempt to use the nod-and-shuffle mode was conducted in July. Despite poor weather conditions, good progress was made. Both the instrument and the telescope are capable of performing the functions needed for this mode. Sky-subtraction uncertainties of 0.1% in the wavelength region 6000-9500 Å were obtained, even on the cloudy sky. The overheads from the telescope nodding are currently large and work is underway to improve this situation. The plan is to offer GMOS North in nod-and-shuffle mode to the community in semester 2003A, though the user should check the final Call for Proposals before planning to use this mode.

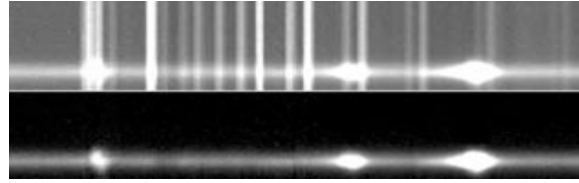


Figure 3. H β +OIII region of A851-2365 before and after sky subtraction.

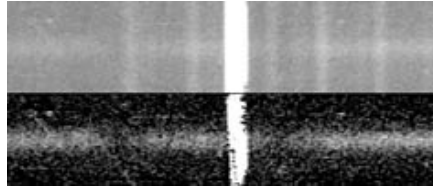


Figure 4. Ca II H+K lines region of A851-2559.

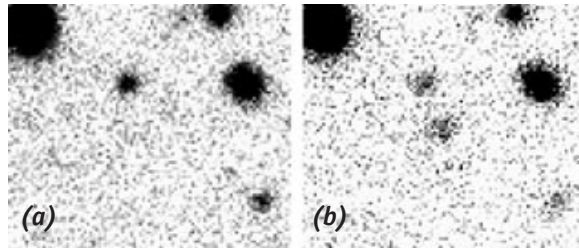


Figure 5. R-band image from NOAO Deep Wide-Field Survey (a) and same field from Large-Area Lyman-Alpha Survey (b).

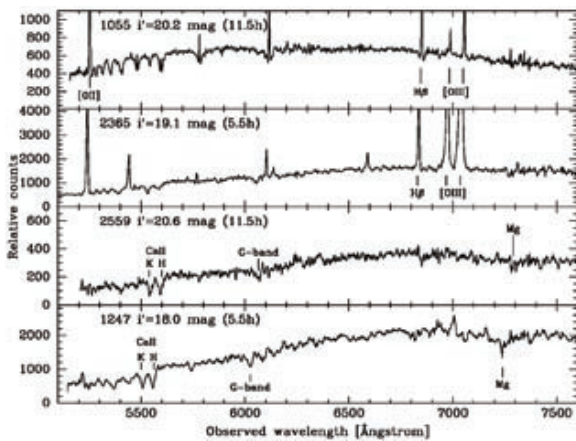


Figure 2. Final reduced spectra of four representative galaxies.

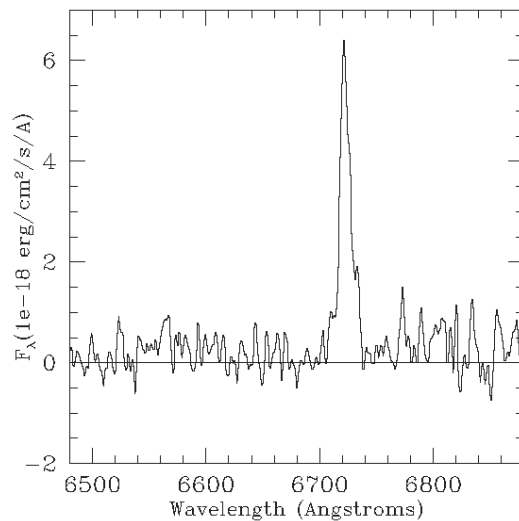


Figure 6. Preliminary reduction of flux-calibrated spectrum.

Credits: Data in Figures 1–4, courtesy of Inger Jorgensen (Gemini Observatory); Figure 5a, courtesy of the NOAO Deep Wide-Field Survey; and Figure 5b and 6, courtesy of Rhoads and Malhotra (STScI).



NIRI, a Visitor's Perspective, 2002A

Robert Blum

I had the good fortune to travel to Mauna Kea in April to see and work firsthand with the Gemini North Near-Infrared Imager (NIRI). A facility-class instrument built by the University of Hawaii, NIRI also has spectroscopic capability through the use of gratings.

The bottom line is that NIRI is now working well and should soon become very productive. Parts of all Band 1 programs were executed in 2002A, and the data for each are currently in quality assessment. More than one half of the Band 2 proposals had some data taken, and several Band 3 proposals were also observed. Currently, NIRI is off the telescope and in the lab for maintenance and for installation of a Shack-Hartmann prism in the onboard wavefront sensor (to provide focus capability).

I arrived in Hawaii on April 25 and went to the summit the next day with Tom Geballe, one of the senior astronomers at Gemini Observatory. Tom gave me the quick rundown on NIRI operations and, together with staff at the Hilo base facility, we outlined the night's queue (Q) observing plan. In practice, the bulk of the Q planning is done in advance by Gemini staff (in this case Joe Jensen) by producing a matrix of possible observations set by scientific priorities and possible observing conditions. As the next two nights unfolded, I learned more about the Q, its pitfalls, and its promise.

Designed to maximize scientific return, the Q is based on the idea that a range of programs are executed depending on the current observing conditions. This requires that the telescope and staff be able to change observing modes quickly. For Gemini and NIRI, this is no problem. The instrument can be reconfigured in a matter of minutes

and the experienced staff can adapt just as fast. The real challenge is assessing the current conditions, predicting how long they will last (or when they will improve or deteriorate), and choosing the right observing program.

Let's face it, anyone can write a proposal asking for the best observing conditions Mauna Kea has to offer. For modest amounts of time, the chances of eventually getting the perfect conditions during the semester when your object is up are good. But the more time you need, the more likely it is that part of your program won't

The sage observer, then, should always be looking for ways to accomplish her/his science with the WORST-possible "acceptable" conditions.

get observed if it requires the best conditions. The sage observer, then, should always be looking for ways to accomplish her/his science with the WORST-possible "acceptable" conditions. Do you really need photometric weather for your JHK spectra? Could you live with worse seeing and a few less targets? Of course, if you absolutely require photometric weather and 0.3-arcsec seeing for a challenging bit of science, ask for it! The whole point of the Q is giving the very best conditions to the few programs that truly need it.

A related point is that the proposer should not assume the Gemini staff will "modify" a program on the fly, even if it makes sense based on the staff's understanding of the scientific requirements. The staff make every effort to review programs before

they reach the Q, but the ultimate responsibility lies with the proposer. In the end, the observing staff is charged with giving proposers from each partner country what they request. Do not ask for better conditions than your proposal requires, or it may be indefinitely postponed due to prevailing observing conditions.

As our Q run unfolded, the weather deteriorated to the point of a spring snowstorm, but not before we had one marginal weather night and one really good one. The latter was said to be the best NIRI science night up until that time. We observed all night without a hitch in f/6 imaging and grism spectroscopy mode. Until Altair arrives, these will be the dominant modes on NIRI. The spectroscopic mode proved to be quite routine, even accounting for the extra overheads of centering objects precisely on the 0.23-arcsec slit.

Recent improvements in the Gemini observing tool (OT) interface to the instrument/TCS helped to provide rapid acquisition of $K = 13$ magnitude targets in crowded fields. The user interface is now quite manageable, to the point where most experienced infrared observers would have little difficulty using it with some initial guidance from the Gemini staff. This type of increased efficiency should eventually lead to lowering of the nominal observing overheads (at least for standard observations) charged during the proposal process. In the meantime, don't forget to add the overheads to your observation planning!

The Gemini OT is now capable of completely configuring NIRI, including different array readout modes and blocking filters for grism mode. Proposers should make sure to properly set these parameters for their

continued



NIRI continued

Phase II proposals. Remember that the OT is a powerful tool for planning all aspects of your observations. If you have questions about how to use the Phase II OT, don't hesitate to contact the USGP staff through the HelpDesk for assistance in getting the most from your planned observations.

Will Q observing come to dominate the ground-based astronomy scene? I

think the jury is still out on just how much a strong Q program can improve the total scientific throughput of an observatory. However, I do know that if the Q is going to succeed, it will need a strong interaction between the observing community and the observatory staffs that are serving them. Be careful with what you ask for, you may get it. Or, more to the point, you may NOT get it.

All the latest NIRI news can be found on the Gemini Web pages at www.us-gemini.noao.edu/sciops/instruments/niri/NIRIIndex.html. Thanks to Joe Jensen of Gemini Observatory for providing me with current NIRI status reports prior to posting them on the Web. Thanks also to Michael Merrill of NOAO for contributing to this article.

NIRI BASICS

Detector: 1024 × 1024 Aladdin array (InSb) 1–5 micron sensitivity

Cameras (3):

- f/6 0.117 arcsec/pixel, 120 × 120 arcsec FOV
- f/14 0.050 arcsec/pixel, 51 × 51 arcsec FOV
- f/32 for use with Altair

Filters: standard near-IR broadband and 13+ narrowband

Grism Spectroscopy Mode: f/6 camera, 50 arcsec slit, resolution 500 to 1700

Polarimetry: check for availability

Imaging S/N: ~5 in 1 hour at K = 22.3, H = 22.7, J = 23.6

For further details and the latest news and system availability see www.us-gemini.noao.edu/sciops/instruments/niri/NIRIIndex.html.

Phoenix Queue Update

Ken Hinkle

Phoenix had two scheduled runs in 2002A. The first, 15 nights starting in early February, was largely devoted to the DemoScience* project, although some queue observations were executed each night. The second run was 10 nights of queue in early May. An additional run of 7 nights was added in June, which is well into the winter season in Chile. This Phoenix run coincided with a major winter storm that required the evacuation of both Cerro Tololo and Cerro Pachón. Thus, few data were collected.

A summary of the 2002A semester results for Phoenix may prove insightful in what data yield to expect from your 2003A proposal. All four of the Band 1 Phoenix proposals received some data. One Band 1 proposal was completed. In Band 2, three out of four received some data. The one

Band 3 proposal received no data. For Band 4, two of the six proposals received some data. Unfinished proposals are NOT extended into the next semester.

For semester 2002B, 21 Phoenix proposals were submitted by the US community. After evaluation and merging with the proposals of other partner countries, the Time Allocation Committee (TAC) assigned two Phoenix proposals to Band 1, two to Band 2, two to Band 3, and eight to Band 4. The assigned Phoenix run dates are as follows: 5 nights in September, 15 nights in late November through early December, and 10 nights in mid-January. There are some operational differences from the 2002A semester. In particular, PIs must now undertake the Phase II planning themselves, with assistance from USGP

continued

*Phoenix Queue Update continued*

instrument scientists via the HelpDesk. Phase II planning was previously done by the Gemini South scientific staff.

As of this writing, the formal Call for Proposals has not been released for 2003A. However, it seems likely that Phoenix will be offered the entire 2003A semester. Long-term plans call for Phoenix to be shared 50/50 with SOAR, but the earliest this will start is 2003B. In preparing a Phoenix proposal, consult the Gemini Web pages for the overhead associated with changing objects and wavelengths. The RA limits given in these Web pages will be strictly enforced.

Also, please state clearly the basis of signal-to-noise (S/N) estimates (e.g., "S/N was calculated from the exposure time calculator assuming $K=12$, 0.5-arcsec seeing, and averaging over the 4-pixel-wide slit").

*The DemoScience data from "Determining the O/Fe ratio in the Large Magellanic Cloud" are now available at www.gemini.edu/sciops/data/dataSVPhoenix.html (links to Science Data and Calibration Data appear in yellow bar in middle of table).

US Gemini Instrumentation Program Update

Taft Armandroff & Mark Trueblood

The US Gemini Instrumentation Program's mission is to provide highly capable instrumentation for the Gemini telescopes in support of frontline science. This article gives an update on Gemini instrumentation being developed in the US, with status as of mid-July.

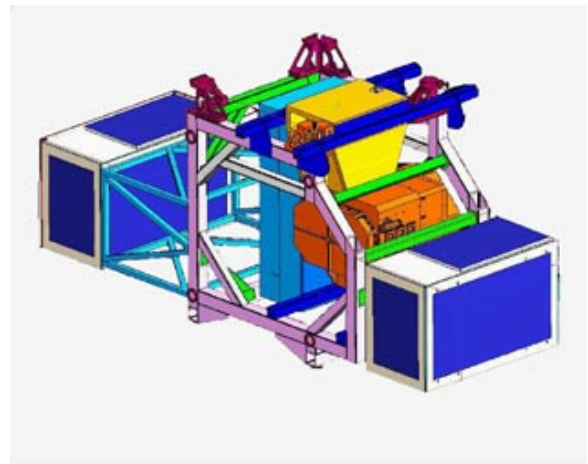
NICI

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

The NICI Critical Design Review (CDR) took place in Hilo on 24–25 June 2002. Participating in the review were CDR Committee members Chick Woodward (Chair, University of Minnesota), Ben Oppenheimer (American Museum of Natural History), Don Hicks (former CEO of Ball Aerospace), Derrick Salmon (Canada France Hawaii Telescope), Bret Goodrich (NSO), Ed Hileman (NOAO GNIRS), and Manuel Lazo (Gemini South). NICI passed its CDR; and USGP, Gemini, and MKIR received valuable guidance from the CDR Committee Report. MKIR has been authorized to proceed with the fabrication, testing, and delivery of the instrument. NICI delivery to Gemini South is planned for December 2004.

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 be based on a $4K \times 4K$ HgCdTe detector mosaic. GSAOI's imaging area will cover the well-corrected field



Rendering of the complete NICI instrument, as it will be mounted on Gemini South. The boxes at either end of the assembly are the cooled electronics cabinets. The squat box in the center is the NICI dewar, and the tall rectilinear shape to the left represents the warm adaptive optics system.

of view of the MCAO system (about 80×80 arcsec) with a pixel scale matched to diffraction-limited images. NOAO was selected as one of two teams to develop a conceptual design for GSAOI. Jay Elias and Bob Blum lead the NOAO GSAOI Team scientifically; Neil Gaughan serves as Project Manager. Technical personnel from Tucson and La Serena are participating in the GSAOI effort. The NOAO GSAOI Team has developed a robust design for GSAOI, and a management plan and cost estimate are nearing completion. The study results are being documented as a report for Gemini. The NOAO Team was scheduled to present their GSAOI results to the Gemini Source Selection Board on August 21 in Hilo.

continued

Gemini Instrumentation continued

GNIRS

The Gemini Near-InfraRed Spectrograph (GNIRS) is a long-slit 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 an integral-field unit (IFU). The project is being carried out at NOAO Tucson under the leadership of Jay Elias (Project Scientist) and Neil Gaughan (Project Manager).

Cold mechanism testing continues. Previous testing of the most demanding mechanism (the slit/IFU slide) revealed a need for enhanced bearing performance. Consequently, a program of testing new bearings was initiated; molybdenum disulfide-coated bearings were found to meet the demanding requirements; these improved bearings are being installed in the GNIRS mechanisms. An important fit check of the GNIRS optical benches into the dewar, with the radiation shields in place, was performed (see figure 1). Also, the dewar vacuum checks were successfully completed. The first cooldown of the assembled instrument was expected to take place in August. After that, two-axis flexure tests will be performed on GNIRS using the NOAO Flexure Test Facility (see figure 2). Overall, 92% of the work to GNIRS delivery has been completed. Finally, the GNIRS Team won the Grand Prize for Modeling in the 2002 SolidWorks SolidGallery Design Contest (see www.solidworks.com/swdocs/gallery/contest2002/winners.cfm).

T-ReCS

T-ReCS, the Thermal Region Camera and Spectrograph, 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.

The team continues tests and resulting adjustments of the assembled and functional instrument. Particular attention is being paid to background flux measurements (to rule out light leaks), detector noise, and other detector performance tests and enhancements to insure that T-ReCS meets its performance specifications. This will allow USGP, Gemini, and Florida to carry out the Pre-Ship Acceptance Test of T-ReCS.



Figure 1. The GNIRS optical bench is lowered into the dewar shell as a fit check, with guidance from GNIRS Project Support Scientist Dick Joyce.



Figure 2. The newly installed NOAO Flexure Test Facility will be used to test GNIRS for flexure. GNIRS mechanical engineers Ed Hileman (left) and Gary Muller are shown fit testing the GNIRS ISS interface assembly.

See www.noao.edu/usgp for constantly updated information about the US Gemini Program.

OBSERVATIONAL PROGRAMS

NATIONAL OPTICAL ASTRONOMY OBSERVATORY

NOAO Nighttime Proposals Due for 2003A

Todd Boroson

Proposals for observing time for semester 2003A (February–July 2003) 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, 30 September 2002, 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 time **only** may optionally use Gemini’s tool, which runs on Solaris, RedHat Linux, and Windows platforms, and can be downloaded from www.gemini.edu/sciops/P1help/p1Index.html.

Note that proposals for Gemini time may also be submitted using the standard NOAO form. 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 to the Keck 10-Meter Telescopes Begins through TSIP

Todd Boroson

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 observing time will be allocated to the astronomical community on the two 10-meter telescopes of the W.M. Keck Observatory on Mauna Kea. These nights will be spread over five semesters under an agreement between NOAO, which is administering TSIP, and the California Association for Research in Astronomy (CARA). TSIP was the highest-ranked moderate-sized initiative of the recent Decadal Survey.

Community access will begin in the upcoming 2003A semester, during which 12 classically-scheduled nights will be available. Time will be distributed approximately evenly over lunar phases and will be divided roughly equally between the two 10-meter telescopes. 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 please see NOAO's "Gateway to Keck" Web page at www.noao.edu/gateway/keck/.

Community Access Time on the MMT and HET

Dave Bell

About 27 classically scheduled nights per year of observing time on the MMT Observatory 6.5-meter telescope are available to the astronomical community through the NOAO proposal process, under a six-year agreement with the National Science Foundation. About 12 nights will be available during the February–July 2003 period. For more information, check NOAO's MMT Web page at www.noao.edu/gateway/mmt/ and MMT's public-access instrumentation Web page at sculptor.as.arizona.edu/foltz/www/public_access.html.

About 16 equivalent clear nights of community-access queue observations per year are available on the Hobby-Eberly Telescope at McDonald Observatory. During 2003A, about 50 hours are expected to be available for integration and set-up time. For more information, please see NOAO's HET Web page at www.noao.edu/gateway/het/.



Two New NOAO Survey Programs Approved

Tod Lauer & Dave Bell

The NOAO Survey Time Allocation Committee (TAC) met on 25 April 2002 to discuss the progress of ongoing survey programs and to review and rank 15 new survey proposals, which were submitted in March. The new programs requested a total of 724 nights on the 4-meter-class telescopes and 115 nights on smaller telescopes. With 20% of science time available for surveys, these totals correspond to subscription rates of about 4.9 for the 4-meter-class telescopes and 0.8 for the smaller telescopes.

Two new programs were recommended for scheduling and approved by the NOAO Director:

- **The w Project: Measuring the Equation of State of the Universe**

PI: Nicholas Suntzeff, NOAO

Abstract: We propose to find and follow ~200 Type Ia supernovae with the Mosaic Imager on the Blanco 4-meter telescope over a five-year period. This search is designed to find supernovae distributed evenly over the redshift range (0.15, 0.75). The survey will obtain VRI photometry which we will supplement with zJ photometry and spectra using Keck, MMT, Magellan, Gemini, and the VLT. We aim to answer a simple, but very important, question: is the dark energy of the Universe consistent with a cosmological constant ($w = -1$)? If not, the dark energy must be a more general energy field such as "quintessence." This survey should determine w to ± 0.1 (one-sigma). We propose to use the other half of the 30 half-nights per year already assigned to the SuperMacho Team. We will exploit the same data reduction pipelines already developed for SuperMacho to find supernovae and to measure their light curves. By merging the two projects, we can use the same software, hardware, and people for two important investigations of matter and energy in the Universe.

- **The EXPLORE Project: A Deep Search for Transiting Extrasolar Planets**

PI: Gabriela Mallen-Ornelas, Princeton University

Abstract: We propose a search for transiting short-period extrasolar planets using the MOSAIC wide-field imagers on the KPNO and CTIO 4-meter telescopes. Our goal is to detect transiting planets and to derive statistics of planet frequency, radius, and mass for star types ranging from early G to late K. Planet transits will be detected via 1% photometric precision lightcurves with 3-minute time sampling spanning 18 nights per run. Transit searches will mark a new era in planetary discovery and characterization. Planetary radii, which provide constraints on composition, evolution, and migration history, can only be measured for transiting planets. In addition absolute planet mass can be determined with follow-up radial velocity measurements. Our 2001 search with the CTIO 4-meter telescope demonstrated our technique: we have reached a relative photometric precision of 0.2-1% on 37,000 stars. Our lightcurve database will have unprecedented time sampling and very high photometric precision for hundreds of thousands of stars, enabling new research on variable and binary stars, short microlensing events, and moving objects such as asteroids.

For information on these programs, and a list of the 13 surveys that have been previously approved, see www.noao.edu/gateway/surveys/programs.html.



Observing Request Statistics for 2002B 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								
GEM-N	74	103.16	1.39	34.89	2		34.89	2.96
GEM-S	55	78.34	1.42	17.95			17.95	4.36
CTIO								
CT-4m	92	313.7	3.41	95.5			95.5	3.28
CT-1.5m	21	110	5.24	123		11	112	0.98
YALO	6	17.45	2.91	17.45			17.45	0.34
CT-0.9m	20	134	6.7	134			134	0.91
KPNO								
KP-4m	74	252.8	3.42	90			90	2.81
WIYN	34	117	3.44	61.5	4	0.5	61	1.92
KP-2.1m	34	175.7	5.17	118		3	115	1.53
KP-0.9m	5	23	4.6	15		8	7	3.29
HET/MMT								
HET	9	15.55	1.73	6			6	2.59
MMT	13	28.5	2.19	13.5			13.5	2.11

*Nights allocated by NOAO Director



Instruments Available in 2003A

The following tables list available resources for all NOAO-coordinated facilities in the US observing system, which include KPNO, CTIO, Gemini North and South, and community-access time with HET, MMT, and Keck. For the latest updates and other information pertinent to submitting proposals for observing time, see www.noao.edu/noaoprop/help/facilities.html.

KPNO Instruments Available for 2003A

Spectroscopy	Detector	Resolution	Slit	Multi-object
Mayall 4m				
R-C CCD Spectrograph	T2KB/LB1A CCD	300-5000	5.4'	single/multi
Cryocam/MARS Spectrograph	LB CCD (1980x800)	300-1500	5.4'	single/multi
Echelle Spectrograph	T2KB CCD	18000-65000	2.0'	
FLAMINGOS ¹	HgCdTe (2048x2048, 0.9-2.5 μ m)	1000-3000	10'	single/multi
WIYN 3.5m				
Hydra + Bench Spectrograph	T2KC CCD	700-22000	NA	~100 fibers
DensePak ²	T2KC CCD	700-22000	IFU	~90 fibers
SparsePak ³	T2KC CCD	700-22000	IFU	~82 fibers
2.1m				
GoldCam CCD Spectrograph	F3KA CCD	300-4500	5.2'	
FLAMINGOS ¹	HgCdTe (2048x2048, 0.9-2.5 μ m)	1000-3000	20'	single/multi
Imaging	Detector	Spectral Range	Scale ("'/pixel)	Field
Mayall 4m				
CCD Mosaic	8Kx8K	3500-9700 \AA	0.26	35.4'
SQIID	InSb (4-512x512)	JHK + L (NB)	0.39	3.3' circular
FLAMINGOS ¹	HgCdTe (2048x2048)	JHK	0.3	10'
WIYN 3.5m				
Mini-Mosaic	4Kx4K CCD	3300-9700 \AA	0.14	9.3'
WTTM	4Kx2K CCD	3500-9700 \AA	0.11	4.6'x3.8'
2.1-m				
CCD Imager	T2KA CCD	3300-9700 \AA	0.305	10.4'
SQIID	InSb (4-512x512)	JHK +L(NB)	0.68	5.8' circular
FLAMINGOS ¹	HgCdTe (2048x2048)	JHK	0.6	20'
WIYN 0.9m				
CCD Mosaic	8Kx8K	3500-9700 \AA	0.43	59'

¹ Available February-May only

² Integrated Field Unit: 30"x45" field, 3" fibers, 4" fiber spacing

³ Shared use, 80"x80" field, 5" fibers



CTIO Instruments Available for 2003A

Spectroscopy	Detector	Resolution	Slit
4-m			
Hydra + Fiber Spectrograph	SiTe 2K CCD, 3300-11,000Å	300-2000	138 fibers, 2" aperture
R-C CCD Spectrograph	Loral 3K CCD, 3100-11,000Å	300-5000	5.5'
Echelle + Blue Air Schmidt	Loral 3K CCD, 3100-11,000Å	15,000	5.2'
Echelle + Long Cameras	SiTe 2K CCD, 3100-11,000Å	98,000	5.2'
<hr/>			
1.5-m			
Cass Spectrograph	Loral 1200x800 CCD, 3100-11,000Å	<1300	7.7'
<hr/>			
Imaging	Detector	Scale ("/pixel)	Field
4-m			
Mosaic II Imager	8Kx8K CCD Mosaic	0.27	36'
ISPI IR Imager	HgCdTe (2048 ² , 1.0-2.4µm)	0.3	11'
<hr/>			
0.9-m (or 1.0-m)			
Cass Direct Imaging	SiTe 2K CCD	0.40	13.6'
<hr/>			
1.3-m			
ANDICAM Optical/IR Camera	Loral 2K CCD	0.17	5.8'
	HgCdTe 1K IR	0.11	2.0'

NOTE

OSIRIS will not be available on the Blanco 4-m in 2003A, as it will be used for SOAR commissioning. On September 1, we will review this decision, in case the SOAR schedule slips, with any update appearing at www.noao.edu/noaoprop/help/facilities.html.

The **small telescope configuration** (see article by M. Smith and A. Walker in this issue) for 2003A will also be updated on September 1, consult the above-referenced Web page.

Gemini Instruments Possibly Available for 2003A

GEMINI NORTH	Detector	Spectral Range	Scale ("/pixel)	Field
NIRI	1024x1024 Aladdin Array	1-5µm R~500-1600	0.022, 0.050, 0.116	22.5", 51", 119"
GMOS-N	3-2048x4608 CCDs	0.36-1.10µm R~670-4400	0.072	5.5'
Michelle*	256x256 Si:As IBC	8-25µm R~200, 1000, 3000	0.10 img, 0.18 spec	~25"x25"
<hr/>				
GEMINI SOUTH	Detector	Spectral Range	Scale ("/pixel)	Field
Phoenix	512x1024 InSb	1-5µm R ≤70,000	0.1"	14" slit length
T-ReCS	320x240 Si:As IBC	8-25µm R~100,1000	0.09"	28"x21"
Acquisition Camera	1Kx1K frame-transfer CCD	BVRI	0.12"	2' x 2'
GMOS-S*	3-2048x4608 CCDs	0.36-1.10µm R~670-4400	0.072	5.5'

*Possibly available at very end of semester. Please check www.noao.edu/noaoprop/help/facilities.html after 1 September 2002.



Observational Programs

KECK Instruments Available for 2003A

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
KECK 1					
HIRESb/r (optical echelle)	Tek 2048x2048	30k-80k	0.35-1.0 μ m	0.19	70" slit
NIRC (near-IR img/spec)	256x256 InSb	60-120	1-5 μ m	0.15	38"
LWS (mid-IR img/spec)	128x128 As:Si BIB	100, 1400	3-25 μ m	0.08	10"
LRIS (img/lslit/mslit)	Tek 2048x2048	300-5000	0.31-1.0 μ m	0.22	6x7.8'
KECK 2					
ESI (optical echelle)	MIT-LL 2048x4096	1000-6000	0.39-1.1 μ m	0.15	2x8'
NIRSPEC (near-IR echelle)	1024x1024 InSb	2000, 25000	1-5 μ m	0.18 (slitcam)	46"
NIRSPA0 (near-IR AO echelle)	1024x1024 InSb	2000, 27000	1-5 μ m	0.01-0.02	1-4" slit
NIRC2 (near-IR AO img)	1024x1024 InSb	5000	1-5 μ m	0.01-0.04	10-40"
DEIMOS (img/lslit/mslit)	8192x8192 mosaic	1200-10000	0.41-1.1 μ m	0.12	16.7x5'

MMT Instruments Available for 2003A

	Detector	Spectral Range	Scale ("/pixel)	Field
Spectrograph --Blue	Loral 3072x1024 CCD	0.32-0.8 μ m	0.3	150"
--Red	Loral 1200x800 CCD	0.5-1.0 μ m	0.3	150"
MIRAC3	128x128 Si:As BIB array	2-25 μ m	0.14, 0.28	18.2, 36"
MiniCam	2-EEV 2048x4608 CCDs	UBVRI	0.05	3.7'
FSPEC (Near IR Spec)	HgCdTe array	JHK	1.2	Resolving Power \leq 3500
SPOL	Loral 1200x800 CCD	0.38-0.9 μ m	0.2	20"

HET Instruments Available for 2003A

	Detector	Resolution	Slit	Multi-object
Marcario Low-Res Spec	Ford 3072x1024 4100-10,000 \AA or 4300-7400 \AA	600 1300	1.0"-10"x4' 1.0"-10"x4'	13 slitlets, 15"x1.3", 4"x3' field
High-Res Spec	2-2Kx4K 4200-11,000 \AA	15,000-120,000	2" or 3" fiber	single

CTIO OPERATIONS

CERRO TOLOLO INTER-AMERICAN OBSERVATORY

News from the Director

Malcolm Smith

“NOAO South”

CTIO is continuing the rapid changes envisaged in NOAO's response to the latest decadal review of astronomy and astrophysics. In particular, the scientific staff have begun the process of migration to some of the new areas it emphasized. Those of you familiar with the scientific staff at CTIO will become accustomed to seeing their names mentioned in other parts of this *Newsletter* in association with a wide variety of instruments and projects besides just those of CTIO and SOAR, from the US Gemini Program (most recently supporting Phoenix on Gemini South) and GSMT (see Brooke Gregory's article in the June issue), to Major Instrumentation (bidding for the Gemini South Adaptive Optics Imager), LSST, and Data Products. Thus, about a year ago, we began to refer to ourselves as “NOAO South” in recognition that our staff is working much more closely now with our partners in Tucson and in support of US Gemini activity in Chile and on Hawaii. The work of a staff member in Chile now covers a much wider range of activities than it did a few years ago.

Webcams—Live Pictures Day and Night from Chile

The reader can now access images from a series of external cameras installed on Cerro Tololo and Cerro Pachón. Some of these are still being worked on and so looking at these sites should be treated very much the way we approach “shared risk” observing. Sometimes the cameras are down when they are taken out of service for upgrades and to fix known bugs. Nevertheless, you may enjoy just checking things out from time to time:

- www.soartlescope.edu gives an external view of the SOAR dome on Cerro Pachón. The dome is now weathertight and rotates remarkably quietly.
- Fish-eye lenses have been installed on the daytime and nighttime cameras on Cerro Tololo. Go to www.ctio.noao.edu/new, click on “Sky Conditions” and then select “Webcam” for the day view (you normally see nothing at night with this camera) or select “TASCA” (Tololo All-Sky Camera) for a variety of nighttime options. TASCA saturates in moonlight and, of course, in daytime. Remember to allow for time zone differences in selecting the camera you want to use.
- As you will see over the next months and years, the TASCA camera (www.ctio.noao.edu/sitetests/WorkShop2002/schwarz_jul02_tasca.ppt) is expected to play an important role in all kinds of monitoring experiments, from clouds to moving objects to light pollution. Surf around for more details, and enjoy.

Other exciting news from CTIO is that the integration of the Infrared Side Port Imager (ISPI) for the Blanco 4-meter telescope is approaching readiness for commissioning at the telescope in late September (see the Probst et al., article on page 30 in this *Newsletter*).

The Future of the Small Telescopes at CTIO

Malcolm Smith & Alistair Walker

There are six small telescopes at CTIO: the 1.5-meter, 1.3-meter (ex-2MASS), 1.0-meter (Yale), 0.9-meter, 0.6/0.9-meter Schmidt (Michigan), and the 0.6-meter (Lowell). The Schmidt and the Lowell telescopes are now operated only by their owners. The Yale 1.0-meter telescope is operated in queue-scheduled mode by the YALO consortium, of which NOAO is a member, while the 2MASS 1.3-meter telescope, without instrument, has been handed over to CTIO.

Earlier discussions about the future of these telescopes involved moving CCD imaging to the 1.3-meter telescope and moving the YALO operation from the 1.0-meter to the 1.5-meter in 2003. Since then we became rather more ambitious, and decided to seek a consortium to run several of the small telescopes. Such a consortium would be made up of institutions with both a strong scientific interest in the telescopes and the ability to pursue this interest instrumentally and operationally. Under NSF rules,

such a change has to be competed, so an Announcement of Opportunity for Operating the CTIO Small Telescopes was issued earlier this year. Two groups indicated an intention to propose to operate the telescopes. One was the SMARTS (Small and Medium Aperture Research Telescope System) group led by Charles Bailyn at Yale University, the other was a national consortium from Brazil. Shortly before the 30 June 2002 deadline for receipt

continued



Small Telescopes at CTIO continued

of the actual proposals, the groups decided to merge and submit a single proposal.

This proposal dealt with the operation of four telescopes (1.5-meter, 1.3-meter, 1.0-meter, and 0.9-meter), building on the experiences of the YALO consortium in operating the 1.0-meter (see the recent article on page 20 of the December 2001 *Newsletter*). The proposal includes provision of new instrumentation and some telescope upgrades (e.g., replacement of the 0.9-meter TCS). There is no doubt that the strong scientific benefits inherent in such an approach would give new life to these facilities.

The announcement of opportunity stipulated that NOAO will participate at the ~25% level, retaining access for NOAO users to at least CCD imaging over moderate fields, and access to some to-be-determined share of other instruments provided by the operating consortium. It's very likely that some telescopes will be scheduled for large projects more than others, so this will be an average figure for the system. Some members of the new SMARTS consortium (which now includes

Brazil) already use much of the small telescope time for large projects, and we believe that by retaining or enhancing the core capabilities of small-telescope imaging at a ~25% level, NOAO users will be well served.

A small committee was set up (external to NOAO) to review the proposal against a series of specific criteria mentioned in the announcement of opportunity. The committee strongly endorsed the scientific vision contained in the proposal, but was concerned about the financial viability of the project. The proposed management structure and lack of an educational and public outreach component were also criticized. Given the last-minute amalgamation of the two proposals, the committee recommended that the deficiencies be remedied and the proposal be resubmitted. The consortium accepted these recommendations and intends to resubmit, perhaps as soon as August 2002.

At the time of writing however, the detailed implementation of consortium operation of the small telescopes is still being discussed, and thus, telescope

and instrument combinations available for NOAO users in 2003A are not yet finalized. Prospective users should consult www.noao.edu/naoaprop/help/facilities.html before submitting a proposal. This site will be updated approximately one month before proposal deadline.

As guidance, at minimum the 1.5-meter with Cassegrain spectrograph and an imaging capability will be offered; the latter will be either (a) the 0.9-meter and CFCCD with the usual SITE 2K CCD, or (b) a new 4K imager on the 1.0-meter with 0.3 arcsec pixels.

The consortium is also planning to offer Andicam on the 1.3-meter. Although in consortium operation the nominal overall participation of NOAO is 25%, the amount of time available on any given telescope may be more or less.

In the above scenario, we anticipate that substantial amounts of 1.5-meter telescope time would be available for NOAO users in 2003A.

ISPI Approaches First Light

Ron Probst, Nicole van der Blik, Andres Montane, Ramon Galvez, Michael Warner, & Roberto Tighe

The laboratory integration of the Infrared Side Port Imager (ISPI) for the Blanco 4-meter telescope is well under way. On-telescope commissioning is scheduled for September.

The figure shows the optical subassemblies undergoing a warm bench alignment check. An artificial star in the telescope focal plane (right) is being reimaged through the collimator and camera assemblies onto a 2K x 2K bare infrared multiplexer at the detector focus (left). Our build-to-print design philosophy has proven out; system alignment is within specifications with no adjustments necessary. In addition to the focus-to-focus image quality check shown, geometrical alignment and wavefront quality

have been verified using a laser, a point source and shear-plate interferometer, and a commercial Shack-Hartmann test system (Wavescope™). At the time of this writing we have installed the optics and an engineering-grade array in the dewar for the initial system cold checks.

We have received our science-grade Hawaii 2 array from Rockwell Scientific and have performed initial warm and cold tests. These benefited from our prior extensive exploration of array operating parameters with an engineering-grade array. The well depth (of the order of 100,000) and dark current (0.6 electrons per second at 83K) at 1-volt bias are very good for the imaging application of ISPI. However, there is a fairly large number of hot pixels

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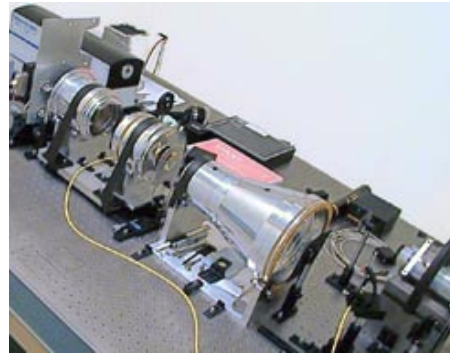


ISPI First Light continued

that vary with bias. The optimal trade between hot-pixel cosmetics and well depth remains to be defined.

For updates on ISPI, please check the ISPI Web pages at www.ctio.noao.edu/instruments/ir_instruments/ispi.

Proposals for scientific use of ISPI are being solicited for the February–July 2003 observing semester. Instrument contacts are probst@noao.edu and nvdbliek@ctio.noao.edu.



Optical subassemblies of ISPI undergoing a warm bench alignment check.

Hydra-CTIO Update

Knut Olsen

Thanks to continued maintenance and repair work, the overall performance of the Hydra-CTIO multi-object spectrograph remains high (see the March issue of the *Newsletter*). We are concerned, however, by uncertain data suggesting a spatial distortion across the Hydra field with an amplitude of a few tenths of arcseconds. Monitoring of astrometric fields and the comparison of fluxes measured in Hydra spectra to fluxes obtained from CCD photometry both suggest distortion, but no systematic patterns are obvious. If present, the distortion could significantly affect faint-object spectroscopy. Users who have available CCD photometry and fluxes measured from Hydra spectra are encouraged to get in touch with Knut Olsen (kolsen@ctio.noao.edu) and Nick Suntzeff (nsuntzeff@ctio.noao.edu).

Other Happenings at CTIO

Anil Seth, a second-year graduate student of the Astronomy Department at the University of Washington, recently concluded a month-long stay at CTIO and looks forward to returning soon. Seth, Bryan Miller (Gemini South), and Knut Olsen (CTIO) are studying the properties of star clusters in low-mass dwarf galaxies, with the aim of measuring and understanding the galaxies' star formation modes. Seth's stay in Chile, which was made possible by NOAO, was both invaluable to the progress of the project and an enriching experience for all involved. US graduate students interested in collaborative research with CTIO scientific staff are welcome to peruse the observatory's Web pages, particularly the listings of scientific staff research interests at www.ctio.noao.edu/pers/staff.html.

The CTIO Director's Office sent the President of Chile a photograph of himself and his delegation on Cerro Tololo beside the presidential helicopter on the occasion of the dedication of Gemini South. President Lagos took the trouble to write back to say thanks and to acknowledge the importance of this project for Chile. See www.ctio.noao.edu/diroff/lagos.html for a copy of his letter (in Spanish) and the photograph of the group taken by Elaine Mac-Auliffe.

Stellar Candles For the Extragalactic Distance Scale

An international workshop will be held at the Universidad de Concepcion, Chile, on 9–11 December 2002 to explore the current viability of a variety of stellar standard candles used to set up the distance scale, including Cepheids, RR Lyraes, blue supergiants, supernovae Ia, novae, planetary nebulae, and globular clusters. There will be 16 invited review talks, and astronomers are encouraged to present contributed papers and poster papers at the meeting.

For more information, please check the conference Web site at cluster.cfm.udec.cl.

KPNO OPERATIONS

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

WIYN Tip-Tilt Module Available for General Use

Chuck Claver & Abi Saha

Beginning in semester 2003A, investigators will have access to “tip-tilt” wavefront correction for imaging at the WIYN 3.5-meter telescope. The WIYN Tip-Tilt Module (WTTM) has successfully completed an extensive phase of testing and commissioning from its first light run in February 2002, through June 2002. The WTTM is an addition to the WIYN Instrument Adapter System (IAS), providing a second image port alongside the existing MiniMosaic imager (MIMO).

Figure 1 shows the newly reconfigured IAS with the MiniMosaic dewar (left) and the WTTM dewar (right). The WTTM is accessed via a movable pickoff mirror in the IAS. Observers will be able to choose between using the 9.6-arcmin-square field of MIMO or a tip-tilt-corrected field nearly 4 arcmin on a side imaged via a CCD on the WTTM. It will also be possible to go back and forth from one instrument to the other by moving a feed mirror in the instrument adapter. The configuration change takes only a few minutes.

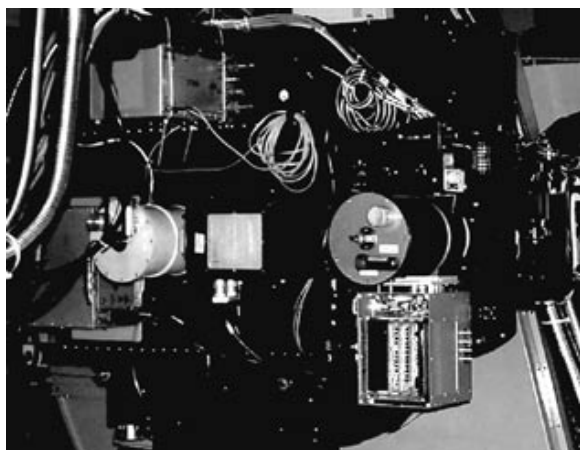


Figure 1

The WTTM not only provides tip-tilt correction of the wavefront with update rates as fast as 1000 hertz, but it also senses drifts in focus and sends corrective signals to the telescope secondary-mirror control. The exact update rates depend on the guide star brightness, where 500 hertz can be achieved with a $V = 15.5$ magnitude star. Early commissioning results for the WTTM were presented in the June 2002 *Newsletter*, where we reported seeing impressive gains in image quality. Since then, in the best conditions we have had during testing, R and I band images with FWHM as small as 0.25 arcsec have been obtained on exposures that are several minutes in duration.

In the control room, the additional workstation, Navajo, provides control to the HARCON CCD system. This data acquisition system is very similar to the one used on Sand for the MiniMosaic. Thus, users of MiniMosaic will be familiar with the control and command syntax for the WTTM CCD. Currently the instrument is being run with an EEV-80 CCD with 2430×2048 13.5-micron square pixels that project to 0.11 arcsec on the sky, providing an approximately 4.6×3.8 arcmin field. Our measured performance shows that the EEV-80 has readout noise of 4.5 electrons at a gain of 1.33 electrons per data number. The measured quantum efficiency of this device is shown in figure 2. The full well of this device is 84,000 electrons at $<0.1\%$ nonlinearity.

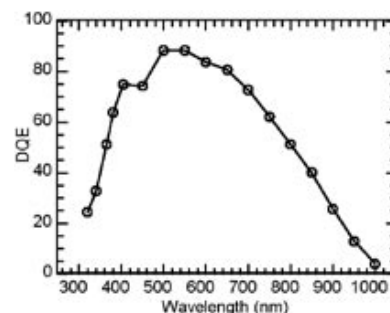


Figure 2

We have verified that aperture photometry can be done to better than 1% accuracy with this setup while imaging through the WTTM. Due to the five extra reflections in the light path and the losses from the beam splitter that sends a portion of the light to the wavefront sensors, it is expected that the WTTM imager will have a lower overall throughput than the MIMO. At present WTTM loses 0.26 magnitude in V, 0.56 magnitude in I, and 0.40 magnitude in B and R in comparison compared to MIMO.

A substantial part of this inefficiency is due to the WTTM's lossy beam splitter, which passes approximately 20% of the light to the error sensor and 60% to the science CCD, while 20% is lost in the metallic coating. We are in the process of acquiring a set of beam splitters and a notch filter that are optimized for a host of applications. We also plan to upgrade to a Lincoln Labs CCD that will have an imaging area of 2048×2048 with 15-micron pixels (0.125 arcsec). The Lincoln Labs device uses high-resistivity silicon, which has an enhanced red response that is 2 to 5 times better than the EEV device between 850 and 1000 nanometers. This will dramatically improve I and z band performance.

During the recent commissioning period, we have been characterizing the image improvement in different observing conditions. In the best conditions so far (“native” seeing of 0.5 arcsec), WTTM has

continued



WIYN Tip-Tilt continued

delivered images with FWHM as good as 0.25 arcsec. Even in less than average seeing (1 to 1.2 arcsec), WTTM produces better images, varying from only marginally better to a very noticeable 0.7 arcsec. Figure 3 shows what can be achieved with the WTTM in moderately good conditions. These histograms of FWHM are from 45 image pairs taken by alternating 10-second exposures between closed-loop and open-loop control.

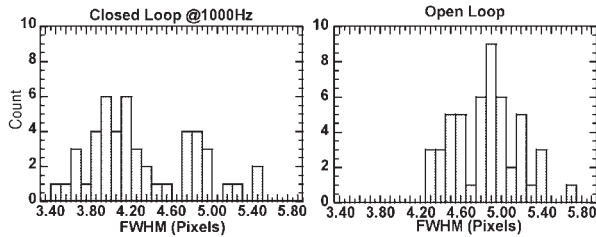


Figure 3

Due to coherence length limitations, tip-tilt correction is best very near the star that is used for deriving the wavefront correction, and the improvement diminishes as one moves away—if sufficiently far away, the wavefront corrections become uncorrelated and actually start to degrade the image. Thus far, we have seen only improvement within the 4 arcmin field of view of the WTTM, and never any degradation. The rate at which the degree of improvement falls off with distance from the reference star varies from night to night. Presumably when it changes slowly, the disturbing region in the atmosphere is relatively low, and when it changes quickly, the disturbances are farther aloft.

In most instances, this variation in PSF is subtle and can only be detected under the best of conditions (see figure 4).

An observing manual is being compiled and written. Substantial contribution to this effort is coming from Dipankar Maitra (a graduate student at Yale, one of the WIYN partner institutions), who is already using WTTM on a shared-risk basis. While the operation of this instrument is not trivial, it should be well within one’s grasp after a careful reading of the manual. We shall be posting progressively improved versions of the manual at www.noao.edu/wiyn/wttm_usr_man.html.

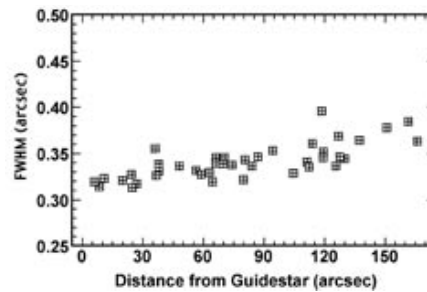


Figure 4

We hope that you will help make the effort of developing and deploying this instrument worthwhile by proposing to use it in semester 2003A. There is a huge gap between the 0.7- to 1-arcsec images typical of good ground-based telescopes and the 0.1-arcsec images from HST. We think that WTTM will fill this niche.

Summer Upgrades

Richard Green

One visible aspect of the new operating mode for Kitt Peak is a reduced scope of activities during summer shutdown. Nevertheless, both WIYN and the 4-meter received significant attention during the summer monsoon.

The major activity at WIYN was realuminizing the primary and tertiary mirrors. This project marked the first use of the new aluminizing arrangement in the 4-meter building. The chamber is now located in a partial enclosure on the opposite (west) side of the large ground-floor area. That location is away from the giant truck-loading door and should offer considerable advantages for cleanliness, particularly during the critical stage from washing to sealing the chamber. The facility improvement was made possible in part through the

revenues provided by the other observatories that make use of the KPNO aluminizing capability. The realignment of the WIYN primary in its cell and to the telescope requires a concerted effort, along with the generation of new lookup tables for the pointing and active optics systems. Minor repairs to the primary mirror support system led to the best active optics system performance yet recorded. Some facility work was planned for this two-week interval as well, particularly improvements to the computer room hardware configuration.

In the subsequent two weeks, attention turned to the 4-meter. The two major efforts there were a brake job for the 4-meter declination drive, and installation of the wavefront camera in the guider-rotator. The telescope was officially shut down

continued



Summer Upgrades continued

only when it was not usable, which was a five-day interval while the declination brake work was completed and the wavefront camera was physically installed. The next work week was planned for wiring and testing of operability for the wavefront camera assembly. The successful completion of that project will allow for tuning of the 4-meter active optics system without mounting a direct camera at the Cassegrain focus. That capability was designed into WIYN, and has proven very effective for nightly zero-pointing of the active optics settings.

The 2.1-meter was not slated for any major maintenance this summer, but was instead scheduled for special observing programs and instrument testing. Teachers with the NOAO Teacher Leaders in Research Based Science Education (TLRBSE) program used it for three nights in mid-July, and the Research Experiences for Undergraduates (REU) students enjoyed two weeks of scheduled time with SQUIID and then Goldcam. Two weeks in early August were given to Jian Ge and his team from Penn State for Test and Engineering time. They produced a novel fiber-fed bench spectrograph, which includes a Michelson interferometer and iodine reference cell. The goal is to achieve radial velocity measurement stability of better than 10 meters per second, and to offer that capability to users.

Rob Seaman, Mike Fitzpatrick, and colleagues led the charge for a mountainwide upgrade of IRAF and ICE. Bob Marshall



WIYN 3.5-meter mirror being inspected prior to stripping and washing in the upgraded aluminizing area. Note the new location for the vacuum chamber.

upgraded the data acquisition computers for Mosaic, while the IRAF group worked on integrating a new fast LINUX box for data reduction.

As a KPNO user myself, I appreciate an occasional reminder of the amount of effort required from a highly skilled staff to maintain the competitive level of performance of our telescopes. My thanks to all those involved.

Staff Changes

Richard Green

Since the release of the last issue of the *Newsletter*, we have bid farewell to several KPNO staff members and welcomed back an old friend.

John Hoey left KPNO after 32 years with the observatory. It was clear from the discussions over cake and punch at his farewell party in the Drafting Room that John is widely respected for his skills in mechanical design, his experience, and for passing the most stringent test of all: designs that have seen long and trouble-free service at the telescope. We wish him all the best in retirement.

Andrew Allday ended his service as WIYN Observing Assistant to return to Hawaii. Andrew's warm cheerfulness and observatory experience were qualities we greatly valued during his time at Kitt Peak.

Mike Brotherton completed his term as Postdoctoral Research Associate to take up a tenure-track faculty position at the University of Wyoming. Mike worked with me on analysis of FUSE spectra of Active Galactic Nuclei (AGN) to study energetic outflows and the mechanism of far-ultraviolet continuum emission. He is looking forward to joining a department

that is in the midst of a renewed commitment to astronomy, as well as continuing a vigorous research program on AGN.

George Will returned to the mountain in July as an Observing Assistant (OA). George was a telescope operator for KPNO from 1980-1991, preceded by a stint as an operator at Steward Observatory. We're delighted to add an experienced, top-tier OA to the group, and look forward to gaining the benefit of his experience in the telecommunications industry to assist with the challenges of our pending mountain telephone switch and its support of the impending data flood.



High-Risk Wildfire Season

Richard Green

From the headlines all summer, it was easy to tell that the Western United States was in grave danger from wildfires. Southern Arizona and Kitt Peak were no exceptions. By the end of May, the measured moisture content of plants was significantly below the lowest value ever recorded, and there had been essentially no winter rain. A small fire in two-foot-high grass on the reservation below Kitt Peak produced eight-foot-high flames. On Mt. Lemmon, a huge national crew of firefighters worked for more than a week to contain the massive Bullock fire. The concern for Kitt Peak was the possibility of an extended period of dry lightning preceding any significant monsoon rains. In unfavorable circumstances, the brush-filled canyons on the mountainside could act as chimneys to transporting a wildfire to the summit within a half-hour of ignition.

KPNO therefore took a number of precautions to reduce the risk of fire damage to the observatory. We had meetings on the mountain and excellent support from Guy Acuña, the Division Chief of the Wildlands Fire Division of the Tohono O’odham Department of Public Safety. His crews worked with the observatory facilities crew and our summer interns from the Nation to clear brush from critical areas. Two high-priority places were the steeply wooded slopes below the WIYN telescope and below the power station and water pumps in the maintenance area. Mike Hawes and his facilities team enabled the power foaming unit, which has the potential to protect all the structures of the observatory for at least 12 hours. The mountain evacuation plan was updated and distributed. The picnic grounds were closed and afternoon public visiting hours were curtailed during the period of highest thunderstorm risk. In addition, tenant observatories reduced the brush in their areas. With these precautions in place, scheduled observing was not curtailed.

Fortunately, the monsoon season commenced with little lightning and immediate soaking rains. Although the rains were not anticipated to make up the deficit of the drought condition, they were sufficient for sharply reducing the immediate fire risk. The picnic grounds were reopened and normal visiting hours restored on August 1.

This was one year where July observers’ disappointment in getting rained out was more than matched by the staff’s relief in seeing storm clouds roll in and let loose.



KPNO staff and summer students Steve Preciado, Cooney Lejero, Steve Fredericks, and Juan White (working for Mountain Facilities) help clear away brush and cut trees.



KPNO facilities crew tests foaming pump for fire protection.

WIYN Strategic Planning Needs You!

There will be a planning meeting of all partners on September 13–14 to discuss and decide strategic directions for the WIYN Consortium, including upgrades and new instrumentation on the WIYN 3.5-meter telescope. See www.noao.edu/wiyn for information on the current state of WIYN.

Your thoughts and suggestions for strategic planning are valuable. Please assist us by passing on your views to Abi Saha at saha@noao.edu, or by phone at (520) 318-8288.

From the NSO Director's Office

Steve Keil

The National Solar Observatory (NSO) remained very dynamic this past quarter with continued growth of new capabilities and a very busy summer of educational outreach. The ongoing collection of high-resolution data by GONG, the implementation of adaptive optics for the thermal infrared (IR) at the McMath-Pierce telescope (see the article by Keller and Plymate on page 38), an active summer of Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET) outreach activities, near-completion of the instrument for the Improved Solar Observing Optical Network (ISOON) by the Air Force group at Sunspot, and progress in developing international partnerships for the Advanced Technology Solar Telescope (ATST) are just a few recent highlights.



During the June AAS/SPD meeting in Albuquerque, NSO organized a topical session on the ATST. The goal of the session was to highlight current knowledge as well as the challenges of understanding solar magnetism, and to discuss the role of the ATST in advancing this understanding. The current status of ATST development was also discussed.

The keynote talk by Eugene Parker (University of Chicago) clearly stated many of the unanswered questions about solar magnetism and its terrestrial influence that ATST observations will address. While the solar magnetic field is often defined by the many large magnetic features on the solar surface, their evolution is largely determined by the unresolved small-scale fibril structure. Some of the questions that the ATST will address are centered on the structure of the 1500-gauss fibrils: their

size distributions, emergence, evolution and condensations to larger structures, their propensity to form flux bundles, the clustering of these bundles into sunspots, their interaction with turbulence in granules and supergranules, and the role this plays in the solar dynamo. The ATST will also address the fine structure and cause of solar flares and prominences.

A presentation by Alan Title (Lockheed) highlighted what we have learned about sunspots, both above and below the solar surface, using a variety of observing assets. Title pointed out that sunspot structure is the key to how magnetic flux is released into the solar atmosphere. Sunspot observations have revealed a wealth of fine structure that the combined efforts of space missions, such as Solar-B and the Solar Dynamics Observatory (SDO), and a telescope with the capabilities of the ATST, will be required to fully understand.

While observations of solar structure and processes have led theory for many decades, theory is now predicting and modeling phenomena on the Sun that we cannot resolve. As Parker pointed out, it is easy to have a theory for everything that is not resolved in the telescope. The ATST should put many of these theories and models to critical observational tests. Neal Hurlburt (Lockheed) gave a nice review of current theoretical and numerical models of solar magnetoconvection. These models indicate that much of the essential physics involved escapes detection with current observational capabilities. While the physics of the fine-scale magnetoconvection may be invisible, however, its consequences for atmospheric heating, structuring of coronal activity (and hence solar activity), and irradiance variations can be far reaching.

Talks by Haosheng Lin (University of Hawaii), Don Jennings (NASA/GSFC) and Phil Judge (High Altitude Observatory) examined how the planned IR capabilities of ATST can be used to make precise measurements of solar magnetic fields from the photosphere to the corona by exploiting both the near- and thermal-IR.

ATST project scientist Thomas Rimmele concluded the session by summarizing plans for the ATST, its science drivers, and the technical challenges of building the telescope. The talk included very impressive images and movies taken at the diffraction limit of the Dunn Solar Telescope (0.15 arcsec) using the solar adaptive optics system that he developed. One sequence showed what is perhaps the first observations of emerging magnetic flux collapsing into a ~1500-gauss flux tube. The ATST will provide the capability of observing the full-vector magnetic fields associated with this process.

Progress is also being made in the ATST site survey. The instrument at Panguitch Lake, Utah, has been installed and a preliminary glimpse of the data from this site suggests that it provides excellent seeing. Regular operations at Panguitch Lake will commence in early September. Other site survey developments include the installation of new software at Big Bear, which corrects/eliminates the sensitivity of the S-DIMM to wind shake; reinstallation in early August of the instrument at Haleakala that was damaged by moisture; and shipment and installation of the test stand for La Palma.

The ATST project office is in full swing and hiring of the core project team is essentially complete with the recent addition of Rob Hubbard as optical systems engineer and

continued



NSO Director's Office continued

Ron Price as lead opto-mechanical engineer. Both are familiar faces at NSO and NOAO and we're delighted to have them back with us. Prior to spending the past five years at the Breault Research Organization in Tucson, Rob was on the KPNO and NSO staff from 1977–1997 and worked on the GONG project from 1986–1997. Ron Price comes to us from Arete Associates in Tucson. He worked on the Gemini project from 1991–1997.

The next major ATST milestones will be development of international partnerships and a conceptual design review planned for spring 2003. To this end, Thomas Rimmele and I visited institutions and observatories in France, Spain, Italy, and Germany during July. We were joined at the Instituto de Astrofísica de Canarias on Tenerife by ATST project manager Jim Oschmann, and in Göttingen by Rob Hubbard for discussions with several groups in Spain and Germany, respectively. The meetings included solar astronomers and technical people from several other countries in addition to those visited. An ATST design workshop and Science Working Group meeting will be held in October in Tucson. Visit the ATST Web site

at atst.nso.edu for more information about the project.



The Air Force Research Laboratory (AFRL) group at Sunspot is now obtaining very good images with the telescope that was intended for the upgrade of the Solar Optical Observing Network (SOON). Unfortunately, due to budgetary constraints, the Air Force will probably not go forward with the planned upgrades. The good news, however, is that the AFRL may be able to retain the telescope and associated equipment for its operation at Sunspot. This would provide an excellent set of synoptic solar activity data and be highly complementary to the SOLIS program. We will provide additional information as things develop over the next few months.



We had a very busy summer with educational outreach activities. Eight REU students and five graduate students worked with NSO and its partner staffs in Sunspot and Tucson. Four middle school teachers also participated in the NSO RET program,

and NSO hosted a four-day workshop at Sac Peak in July as part of the Teacher Leaders in Research Based Science Education (TLRBSE) program with NOAO. Articles related to these activities are featured in Public Affairs and Educational Outreach section of this *Newsletter*.



In addition to Rob Hubbard and Ron Price, NSO welcomes administrative assistant Jackie Diehl, who comes to us from the New Mexico Museum of Space History, where she gained experience in educational outreach and administration. Jackie's responsibilities include support of the Director's office, scientific staff, and educational outreach activities. Diane Craig has transferred from her position as senior engineer on the USAF's ISOON project to become an NSO telescope engineer. She will spend much of her time working with the staff of the Dunn Solar Telescope and Evans Solar Facility to assist in maintaining and upgrading those facilities. She will also assist Steve Hegwer in overseeing the design and fabrication of instrumentation projects at Sac Peak.

SOLIS

Jack Harvey

SOLIS continues toward first light. The SOLIS mounting was exercised by pointing to a large number of stars and measuring offsets between commanded and actual pointings. This information showed that the polar axis was displaced about 2 arcmin from the correct position, which is remarkably small for a first placement of the 16-ton assembly. The error was corrected using an adjustment procedure. This exercise indicates that the mounting can be aligned quickly and accurately when it is moved to Kitt Peak later this year. Work also continued to ensure that safety interlocks and overspeed detectors operate as designed. These are intended to prevent personnel injury and damage to the instruments.

Optics are being loaded into the vector spectromagnetograph (VSM). The VSM should be fully assembled by early September. Optics alignment procedures were developed before the optics were completed. These procedures required some changes when they were actually implemented. The VSM consists of a telescope section and a spectrograph section. If access to both sections is available, alignment is relatively easy. In the future, we expect to have to service the telescope section without opening the spectrograph section, and we required an alignment procedure for the telescope that can be done from just the one side. Such a procedure was developed and verified. Preliminary indications are that the image quality delivered by the telescope is excellent.

continued

*SOLIS continued*

The VSM camera/data acquisition system loses a tiny fraction of the image data when operated at full speed. This problem seems to be associated with conversion to and from fiberoptic data transmission. Otherwise, the camera system has delivered good images for measuring dark signals, system noise, uniformity of response, etc.

Laboratory tests of the Integrated Sunlight Spectrometer (ISS) are continuing. The emphasis has been on stability measurements that involve recording spectra from a uranium emission lamp every few minutes for days at a time. Earlier tests had shown that the spectra move more than was acceptable in response to room temperature changes. A new part was fabricated from invar that reduced the temperature effects by a large amount. The present stability is about one pixel over periods of up to a couple of days. Work is in progress to identify remaining sources of drift.

The Full Disk Patrol (FDP) housing is nearing completion and when that is done, its optics will be loaded. One of the two narrowband filters built for the FDP (for the 1083 nanometer He I line), was used for several days in support of a community high-cadence imaging campaign. Images of active regions were recorded at 30 frames per second by using a simple television camera feeding a digital video camcorder. A few small flares were observed. Surprisingly, all of the flares were seen only as emission features, whereas earlier observations of flares with this spectrum line showed a lot of absorption, with emission confined only to small kernels. Assembly of the tunable filter (range 380 to 660 nanometers) has been slowed by higher-priority work demands. Accordingly, an old H- α filter will be installed temporarily in the FDP until the tunable filter can be finished.



Gary Poczulp installs the secondary mirror of the SOLIS Vector Spectromagnetograph Ritchey-Chretien telescope. The mirror is mounted on a piezoelectric tip-tilt mechanism that allows correction of image motion up to ± 55 arcsec. The spider that holds the mechanism is inverted here.

Work on the Observation Control System (OCS) and Data Handling System (DHS) software has been completed for the laboratory setup and is awaiting actual data from the instruments. The final DHS hardware is arriving and being checked. Responses to an RFQ for the final digital archive hardware are arriving and being evaluated. Software work continues on the instrument data control systems associated with the VSM cameras.

First Light for McMath-Pierce Adaptive Optics

Christoph Keller & Claude Plymate

Development continues on an adaptive optics system for the 1.5-meter McMath-Pierce solar telescope. Off-the-shelf components are used to minimize cost (less than \$25K total hardware costs). The system is designed to provide diffraction-limited images in the thermal infrared under most seeing conditions. Previous *Newsletter* articles focused on tests of subsystems and successful science operation of the Universal Tracker, which corrects for image motion on the solar disk or at the limb. In the meantime, the full system, including the deformable mirror, has seen first light at the McMath-Pierce West Auxiliary Telescope.

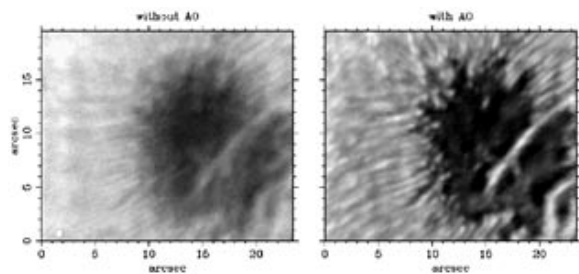
The first serious attempt at closing the loop on a solar feature was attempted on 2 July 2002. The system exhibited a remarkable improvement in image quality. The wavefront sensor was operated at 830 nanometers while a video camera recorded the image at 990 nanometers. A short, unprocessed video showing the performance with and without adaptive optics can be found at www.noao.edu/noao/staff/keller/irao. Two slightly processed images extracted from this movie are shown here.

The system resides on a breadboard optical table under the McMath-Pierce 0.9-meter West Auxiliary Telescope, which

continued



McMath-Pierce AO continued



16-millisecond exposures of a sunspot at 990 nanometers, without (left) and with (right) adaptive optics. Both images were filtered with an unsharp mask to compress the large intensity range, and both are displayed at identical contrast. The image to the left was among the sharpest images recorded without adaptive optics.

has been stopped down to an aperture of 50 centimeters. It contains the tip-tilt mirror from the Universal Tracker, a 37-actuator electrostatic deformable mirror from Okotech, and a Shack-Hartmann wavefront sensor. The sensor provides between 100 and 250 subapertures depending on the chosen geometry. This number of subapertures, which is substantially larger than for any other adaptive

optics system in solar physics, is required by the moderate seeing at the McMath-Pierce and the 1.5-meter aperture of the main telescope, where the system will eventually reside. Analyses of the wavefront sensor images and the control of the deformable and tip-tilt mirrors are performed on a single 1-gigahertz Intel Pentium III processor running Linux RedHat 7.1. Currently, the deformable mirror shape is updated at 250 hertz. It is expected that software optimization will allow for 500-hertz performance within a few months, and eventually 1 kilohertz will be reached with the current hardware. The wavefront sensor geometry being used works well on sunspots, and will soon work on the solar limb. Future implementations will also be able to work with granulation.

Though significant improvements have been made to the breadboard system, various issues such as optimum wavefront sensor geometry for various targets, wavefront reconstruction algorithms, and calibration strategies will need to be studied before a user instrument can be built during FY 2003. However, we do expect the breadboard to be available for user observations on a limited, shared-risk basis starting in early 2003.

Ratio of Sodium to Potassium Atoms in the Atmosphere of Mercury

Andrew Potter

Both sodium and potassium atoms can be observed in the atmosphere of Mercury with the McMath-Pierce main telescope and the stellar spectrograph. We have found that the ratio of sodium to potassium in the atmosphere is highly variable, and averages about 100. This is considerably larger than the ratio observed in the atmosphere of the Moon and the Galilean satellites, where the ratios range from about 7 to 20. We believe that the reason for this high ratio is that potassium is lost more rapidly than sodium from the Mercury atmosphere.

The main loss processes for sodium and potassium are the sweeping of hot atoms off the planet by solar radiation pressure, and the capture of photoionized metal atoms by the solar

wind. Radiation pressure losses were not sufficiently different for sodium and potassium to explain the high ratio. This pointed to different loss rates of metal ions to the solar wind as the major difference between sodium and potassium.

There are differences between sodium and potassium that could affect their relative loss rates. First, the scale height of potassium is smaller than that of sodium by a factor of 1.7. Consequently, potassium ions will be generated by photoionization closer to the planetary surface than sodium ions. More of them will experience an outward-directed electric field near the surface, leading to loss to the magnetopause. Second, the gyroradius of the potassium ion is

1.3 times larger than the sodium, and this may lead to greater losses or fewer impacts on the surface for recycling of the atoms.

In any case, we expect the ion loss efficiencies to depend on the configuration of the magnetosphere, which in turn is dependent on solar wind parameters in the vicinity of Mercury. In support of that, we found that the Na/K ratio increased with solar activity, suggesting a more rapid loss of potassium with increasing solar activity. Without knowledge of the Mercury magnetosphere and the surface electric fields, however, it is not possible to quantify the importance of these loss processes. Data from future planned spacecraft missions to Mercury should allow us to do so.

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 very successful GONG+ upgrade has sparked an increased interest in GONG data. Fourteen posters and presentations that focused on GONG+ results were given at this year's Spring SPD/AAS Meeting, and during the last quarter, 340 gigabytes of data have been distributed in response to 41 requests. Katrina Gressett's AAS poster demonstrated that the GONG+ data will easily support global p-mode analysis at ℓ 's (out to 1200) that are much, much higher than the current $\ell < 150$! Cliff Toner, Thierry Corbard, Frank Hill, Deborah Haber (University of Colorado at Boulder), and Rick Bogart (Stanford University) showed a very reassuring comparison of inversions of subsurface flows from SoHO/MDI and GONG (see figure 1), and Doug Braun and Charlie Lindsey showed similar excellent agreement with their farside imaging.

In order to support the new data format and the sheer amount of it, we will complete the GONG++ hardware system to produce local helioseismology and high- ℓ global helioseismology products for the community within the next several months. Significant progress has already been made on the software side with Thierry Corbard's implementation of the GONG++ local helioseismology area extraction package, Deborah Haber's ring-fitting package, Charlie Lindsey's farside imaging application, and various GONG+/MDI comparisons. A programmer will soon be joining the project to work on the GONG++ data handling system and the implementation of the continuous, full-Sun, local helioseismology pipeline.

Don't forget that this year's annual meeting, GONG+ 2002/SOHO 12—"Local and Global Helioseismology: The Present and Future"—is being organized by the Big Bear Solar Observatory and will be held at Big Bear Lake, California, October 27 to November 1. Full information is available at www.bbso.njit.edu/gong02.

Network Operations

The first scheduled preventive maintenance visits since the completion of the GONG+ network installation occurred during the second quarter of 2002, at CTIO and El Teide. Mauna Loa and Big Bear have experienced DLT-drive failures, but thanks to site staff, the tape drives were swapped and no data were lost.

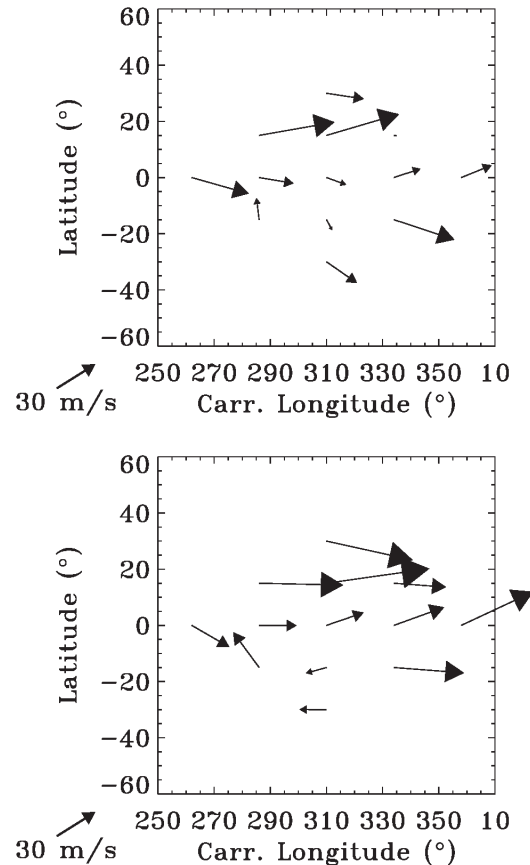


Figure 1. Deborah Haber and Rick Bogart have produced the first comparison of the direction and magnitude of subsurface flows at selected depths inferred from ring diagram analysis of 11 hours of data from MDI (top) and the GONG+ Big Bear instrument (bottom). Independent analyses were performed for a set of thirteen 15° regions centered at the Carrington coordinates of the bases of the arrows representing the flows. These results are from 1-dimension RLS inversions at a depth of 7.1 Mm. The results have shown excellent agreement in the flow maps at depths below 2 Mm, but discrepancies near the surface. These variations are currently thought to arise from the differing optical distortions in the two instruments, which mostly affect the high- ℓ modes that sample just below the surface.

continued



GONG continued

In late May, the Learmonth instrument began to show signs that the waveplate rotator system was experiencing anomalies. However, attention soon focused on the turret as the primary origin of the problem. The same symptoms had been seen at Mauna Loa at the end of last year and were eventually traced back to a leaky turret, which in turn caused electronics components inside the shelter to fail. The Learmonth staff determined that water had indeed entered the turret, and extensive electrical tests and component inspections further revealed the extent of the failure. The turret from the Tucson engineering station was removed and rushed “down under” with a repair team to bring the system back on-line early in July. A great deal of gratitude and thanks are extended to the Learmonth staff who spent many hours to help verify the nature and extent of the problem. Because of the recent damage at Mauna Loa and Learmonth due to leaky turrets, we decided to shut down and cover the Udaipur turret until the heavy monsoon rains have passed.

Data Management and Analysis

During the past quarter, the DMAC produced month-long (36-day) velocity, time series, and power spectra for GONG+ months 66, 67, and 68 (ending 17 January 2002) with fill factors of 0.68, 0.86, and 0.83, respectively. These fill factors are approaching the average fill factors obtained during the GONG Classic program and reflect the completion of the GONG Classic to GONG+ transition. The DSIDS distributed 340 gigabytes in response to 41 data requests as opposed to 5 gigabytes in response to 19 requests in the same quarter of the previous year, which reflects both the larger image size and the increased interest in GONG data as a result of the GONG+ upgrade.

The GONG Classic month 62 images and the GONG+ month 62 images were processed separately producing month-long time series and ℓ - v spectra. They were then used to produce a GONG Classic/+ blended version of these time series. A similar procedure was applied to months 61 and 63 to improve the fill factors of all three months. These results (in particular, the mode frequencies from the three-month-long time series assembled from these months) produced better fill factors and improved mode frequencies. The archived mode frequency products for these months are from the blended time series (the three-month-long time series centered on months 61, 62, 63, and 64). The various versions of the one-month-long time series (Classic, +, and blended) will be archived in the near future.

The development and implementation of the GONG++ ring-diagram application is proceeding rapidly. Cliff Toner now has an image-merge code that restores velocity images before averaging them together, and it is fast enough to allow its use in the GONG++ pipeline. The restored merged images have been run through Thierry Corbard’s dense-pack ring-diagram code, and then through Deborah Haber’s ring-fitting code, which is now installed and running in Tucson. Joy Chavez, a GONG Research Experiences for Undergraduates (REU) student from the University of Houston, is pushing a substantial amount of data through the entire pipeline all the way to flow maps. So far, there are no indications of any problems in the processing. We will be performing comparisons with SoHO/MDI to further validate the processing.

Charlie Lindsey is working with REU student Anna Malanushenko on implementing farside imaging on the GONG++ system. Along with Jean Goodrich’s plan for near-real-time processing at the sites, this could ensure the continued availability of this valuable Space Weather product.

A fit of the mode frequencies to orthogonal polynomials as defined by Ritzwoller and Lavelly has been added to the suite of mode frequency data products for GONG months 2–67.

Rachel Howe has developed code to use the leakage matrix in the low-degree regime with a bootstrap approach that includes the effects of m - and n -leaks (see figure 2). Simon Kras has taken on the job of running the GONG Classic data through the procedure, which will provide greatly improved estimates of low-degree mode parameters that should improve inversions of the deep solar interior.

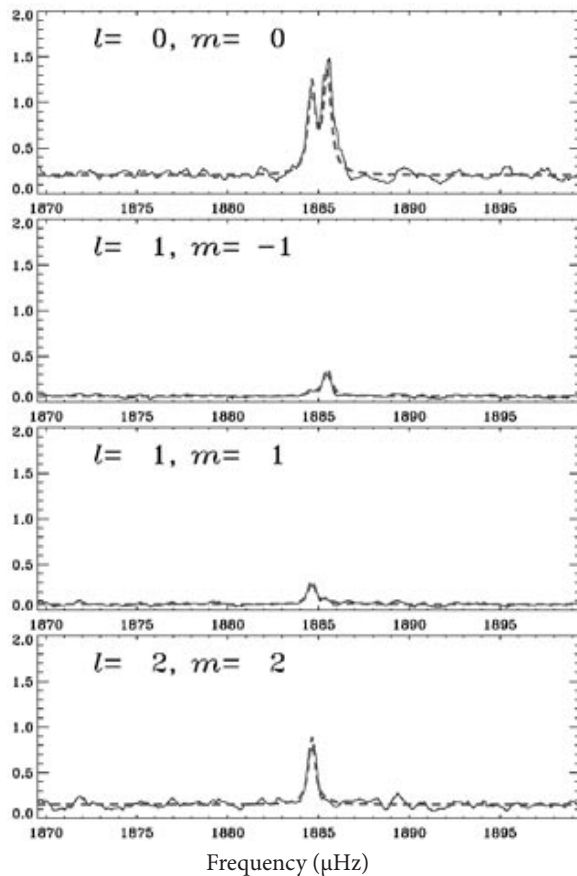
Rudi Komm has been working with Bernard Durney on estimates of the angular momentum in the solar convection zone. While this is a difficult measurement, there are hints that the angular momentum in the tachocline may be varying over the solar cycle. If so, this could be an indication that the tachocline is indeed the location of a dynamo. However, it would be nice to have more than a 0.5 cycle to examine.

Caroline Barban has succeeded in implementing the V-I multispectral fitting method and has fitted a number of m -averaged peaks around $n = 16$. There are already

continued



GONG continued



indications of a frequency dependence of the various noise background components, which will provide new insights into the excitation of the modes. The next steps are to extend the analysis to cope with leaks, install more accurate statistical models, and fit modes as a function of m .

Finally, Richard Clark and Jack Harvey have been working on the correction of the GONG+ magnetogram zero point. We hope to have this working shortly and to be able to turn on the magnetogram pipeline.

Figure 2. This plot illustrates a simultaneous fit of a GONG low-degree mode and its m -leaks using several spectra and the leakage matrix. For the example here, we show the target mode at $l = 1, m = 1, n = 13$, its m -leak at $l = 1, m = -1$, and their appearance in the $l = 0, m = 0$ and $l = 2, m = 2$ spectra. The solid lines are the data, and the dashed lines are the fit. The simultaneous fit uses much more information than a fit in a single spectrum, and the leakage matrix provides a constraint on the relative amplitudes of the peaks across the spectra. The net result is a greatly improved estimate of the mode parameters for the low-degree modes.

EDUCATIONAL OUTREACH

PUBLIC AFFAIRS AND EDUCATIONAL OUTREACH

Educational Outreach Update

Dr. Steven Croft joined the PAEO staff in early July as a Senior Science Education Specialist, with primary responsibilities in the Teacher Leaders in Research Based Science Education (TLRBSE) Program. He worked in the NASA planetary program for over 15 years as a planetary geologist/geophysicist and worked on the Voyager 2 Imaging Team for the Uranus and Neptune encounters. While working at the University of Arizona Lunar and Planetary Lab, he helped found the Image Processing for Teaching Project and the Center for Image Processing in Education. Dr. Croft came to NOAO from the NASA Classroom of the Future in West Virginia, where he worked as a senior scientist developing inquiry and problem-based science education materials and led teacher professional development workshops. Dr. Croft has a master's degree in astronomy and master's and doctorate degrees in geophysics and space science from UCLA. He has also received many awards for outstanding teaching. We are delighted to have him in the department.



Stephen Pompea and Connie Walker represented NOAO at several recent education and public outreach conferences. In mid-June, NASA's Office of Space Science Education and Public Outreach held a specialized conference in Chicago to bring together scientists and educators with an interest in space science education and outreach. Three posters were presented on Project ASTRO, TLRBSE, and Teaching about Spectroscopy in a Children's Museum setting. In addition to this and other education/public outreach conferences, PAEO staff displayed the NOAO exhibit at the 200th Meeting of the American Astronomical Society, hosted by the University of New Mexico in Albuquerque on June 2-6.



On May 29, Stephen Pompea, Connie Walker, and John Keller (Steward Observatory) gave two three-hour workshops on spectroscopy and the nature of light and color to 50 TUSD teachers at the Inquiry Institute. The Inquiry Institute is a three-day institute held at the University of Arizona each year with the purpose of deepening understanding of inquiry-based instruction among K-12 teachers. At the spectroscopy workshop, teachers learned by guided inquiry how a spectrometer works by building it and then using it to explore the color of room lights to determine the elements present in these lights, using their characteristic optical "fingerprints."



Doug Isbell and Stephen Pompea attended a National Virtual Observatory Outreach workshop at Johns Hopkins on July 11 and 12, presenting a talk on "Lessons Learned from Data-Rich Science Education Projects." Planning efforts are underway to identify the tools of greatest educational utility for use with large data sets.



Efforts to jumpstart a Project ASTRO-like program in Chile are progressing well. Toward the end of May, NOAO Educational Outreach Staff, NOAO Spanish-speaking astronomers, and local Spanish-speaking teachers conducted a successful teleconference with their

counterparts at CTIO. Several copies of the Spanish version of an astronomy activity and resource book, the Astronomical Society of the Pacific's *Universe at Your Fingertips (UYAF)*, as well as Learning Technologies spectrometers were sent to CTIO for Chilean teachers. Efforts have begun in Chile to provide feedback on the Spanish translation of *UYAF*.

At the end of June, NOAO Tucson was selected as a Family ASTRO site for 2002-2004. Family ASTRO is a new program (supported by the National Science Foundation) to bring hands-on astronomy activities and astronomy events to families of all backgrounds. There are three diverse communities in the Tucson area that will be participating in the Family ASTRO program: the families of students in the Indian Oasis/Baboquivari Unified School District of the Tohono O'odham Indian Nation, the Hispanic community associated with the Sunnyside Unified School District, and families affiliated with the Sahuaro Girl Scout Council. The program will start at the end of October with training for Site Leader Connie Walker and Site Coordinator Robert Wilson.



In May, the TLRBSE program successfully wrapped up its first on-line distance learning course on astronomy content, pedagogy, and leadership skills for teachers. This was a 15-week course with intensive instructor-participant interaction. The on-line course was preparation for a two-week research experience in July. The 19 TLRBSE teacher leaders converged on Tucson from all over the US, bringing with them

continued



Public Affairs

Outreach Update continued

a variety of backgrounds and impressive credentials. At the workshop, they received specialized training on mentoring and leadership, as well as science education content and pedagogy in order to work more effectively with their learning colleagues.

The teachers were divided into two groups. One group conducted research at Kitt Peak National Observatory and the other at the National Solar Observatory's Sacramento Peak facility. Both groups received instruction on leadership, instrumentation, data analysis, and image processing. Each teacher was part of a research team pursuing an authentic research topic using observational data. The task before them now is to bring the research, and their renewed excitement for it, into the classroom. In addition each of the teacher leaders are to mentor three teachers new to the field, in an effort to retain them in the teaching ranks.

The workshop and distance learning course were very successful experiences, thanks to the efforts of the in-house NOAO TLRBSE team, as well as Jeff Lockwood (TERC), Don McCarthy (Steward), Steve Howell (Planetary Science Institute), Travis Rector (NRAO), Randy Accetta (Magellan University), Kathy Stiles (WestEd), and Jean Young (M.J. Young & Associates). Particular thanks goes to three NSO scientists who worked extensively with the TLRBSE Team to develop the solar research experience and who served as

mentors for the teachers during their stay at Sac Peak: K.S. Balasubramaniam, Han Uitenbroek, and Alexie Pevtsov. Their outstanding work with the teachers and many months of labor leading to the workshop contributed greatly to its ultimate success.



Mary Bishop, a high school science teacher from New York, carefully sketches all sunspots visible on a projected solar image during the July 2002 TLRBSE workshop. Such sketches are done each sunny day in the Hilltop Dome at Sacramento Peak Observatory as part of the dawn "Flare Patrol." Mary and her fellow teachers made solar sketches using the patrol telescope as part of their research experience in Sunspot, NM.

The REU Experience

Allison Heinrichs (Ohio State University)

As my plane glided into the Tucson International Airport, I craned my neck toward the tiny window to try to see the twinkling lights of the sprawling city below. Having never been to the West before, I didn't know what to expect, but I pictured a sandy desert littered with cow skulls and crawling with snakes and scorpions. The sudden thud of the plane making contact with the runway jolted me from my thoughts, and the excited butterflies in the pit of my stomach returned. I could hardly wait to start my summer Research Experiences for Undergraduates (REU) program with Kitt Peak National Observatory.

It's been several weeks now since I arrived in Tucson and, although my impression of the desert has been refined, my excitement has not waned. The research done here is fascinating, and the REU program provides me with many opportunities to learn about it.

Weekly colloquia, casual discussions with various research scientists, and even just wandering the halls has given me an

incredible appreciation for the vast amount of research done in astronomy. The best part is that the astronomers here have a contagious enthusiasm for their research, and all it takes is an expression of interest to launch any one of them into discussions covering everything from the detection of distant quasars and the formation of planets around other stars, to the workings of CCD cameras and seismic vibrations on the Sun.

Over the 4th of July holiday, I went on the annual REU group trip to Sunspot, NM. After a day filled with games, food, and fun in this small community, and a beautiful clear night spent gazing up at the Milky Way, we were treated to an in-depth tour of the National Solar Observatory high atop Sacramento Peak. Our day started with a lecture on solar astronomy, the different methods used to observe the Sun, and the future of solar observing, from both the ground and space. We were then given a tour of the solar telescopes and watched as the solar astronomers took afternoon observations. We ended

continued



REU Experience continued

the tour at the Hilltop Dome, where we were personally able to observe the Sun and see some sunspots and solar flares.



KPNO REU students (from left to right): Jeffrey Fogel (Harvard University), Kwayera Davis (College of Charleston), Allison Heinrichs (Ohio State University), Bryan Henderson (University of Washington), Ely Duenas (Hunter College), and Gisela Telis (Columbia University). Ely Duenas was part of NASA's URPA program.

On our way back to Tucson, we made a side trip to Socorro, NM, to see the Very Large Array (VLA). Upon our arrival we donned hard hats and, much to my delight, were allowed to walk around inside the dish of radio telescope #27 (which had been taken out of the formation for service). The adventurous few who climbed to the edge of the dish received a breathtaking view of the remaining bright white telescopes gazing up into an electric-blue desert sky. After exiting the dish, we wandered through various control rooms, heard the whirl of machines processing data, and watched as the telescope operators kept a wary eye on the status of each dish. As we left the VLA for the long trek back to Tucson, everyone in the van watched as the massive telescopes became tiny dots strewn across the horizon.

True to the word "Experiences" in its name, the REU program does not merely involve a series of lectures and fascinating field trips; it also includes hands-on research in various areas of astronomy. The applications of potential REU students are reviewed and selected by their future advisors based on the students' stated fields of interest. We are then given the opportunity to make a contribution to these topics by designing programs, reducing data, and going on observing runs.

Since reading a captivating article about the eventual collision of comet Shoemaker-Levy 9 with Jupiter a year before it occurred, I've found comets to be incredibly interesting. Moreover, the act of collecting article upon article regarding the collision sparked a love for science writing in me as well. These interests play directly into the focus of my REU responsibilities. My research project involves data reduction on a periodic comet, Neujmin 1, in order to determine and

confirm characteristic properties, such as the comet's period of rotation and diameter. This information, though only a small drop in the bucket of knowledge, will contribute to our understanding of some of the most pristine bodies in our solar system.

My REU advisors, Beatrice Mueller and Nalin Samarasinha, are just as enthusiastic about their research as the rest of the scientists at NOAO, and they are more than willing to take time out of their day to indulge my questions and hypotheses regarding everything from the composition of asteroids to the best way to do photometry using IRAF. Beatrice and Nalin are also very supportive of my interest in science writing, and have provided me with several opportunities to gain more experience in this pursuit.



NSO REU students (from left to right): Marjorie Frankel (Wellesley College), Erika Roesler (Northern Arizona University), Adam Kraus (University of Kansas), Joy Chavez (University of Houston), William Plick (Connecticut College), Mary Melton (Texas A&M University), and Carol Thornton (Virginia Polytechnic Institute). Missing from photo is Adria Updike (Smith College).

Perhaps even more valuable than learning about the research currently being done in astronomy has been meeting the other REU students, the people who may someday take the lead in this research, and help shape and refine the world's understanding of our mysterious universe.

Two days after I landed in Tucson, my roommate and I threw a small party for the other REU students on our patio, and their different personalities began to emerge. Some have definitely established themselves as the comedians of the group, while others are a bit more reserved and reflective. The one trait that seems to be common among all the students, however, is a bright optimism regarding their futures.

I'm sure that I will leave Tucson with lasting memories, not just of beautiful mountains and breathtaking night skies, but of valuable friendships and a wealth of knowledge.



Report on the First REU Site Directors' Meeting

Alan B. Whiting

Site directors of the Research Experiences for Undergraduates (REU) programs in Astronomy met at the University of Indiana on July 10–11 to review their progress and discuss improvements. NOAO was represented by Ken Mighell from Tucson and I represented CTIO.

REU programs generally take place over the summer (the southern summer in CTIO's case), with the general goal of allowing undergraduate students a chance to learn about and take part in astronomical research. This year there are 125 students at 14 sites funded by the National Science Foundation (NSF). Three more sites are to be added next year. Small colleges and consortia, large universities, and national observatories are all represented. The variety of situations makes for a wide variation in the details of how the programs are conducted,

a fact made evident from the short presentation each site director gave at the opening of the meeting. However, all programs have students conducting astronomical research under the direction of professional astronomers.

The directors quickly agreed on measures to coordinate things like offer and reply dates, and to work for rough equality of student stipends. Many details of how to run an REU program were brought out and exchanged. Some sites, for example, have all students apply on a Web-based form; and the software to handle this has been made available to all.

An important issue is more effective recruitment of students, especially of minorities who have been historically underrepresented in astronomy. Based on a tour he made to several Historically Black Colleges

and Universities (HBCU), Ken Mighell emphasized that personal relationships with professors are vital. The NSF REU office is investigating ways of developing such relationships, including the coordination of visits by several site directors on behalf of all the REU programs.

Perhaps most important was the exchange of ideas among the directors. Each program seemed to have some insight or method of doing something that another program picked up as a good approach to try.

Overall it was a very worthwhile meeting. There is enough follow-up work for everyone to do that no one has mentioned another meeting as of yet, but certainly the REU site directors will get together again.

Undergraduates Wanted for the 2003 CTIO REU Program!

Nicole van der Bliek, Alan Whiting & Chris Smith

The year 2002 saw another successful NSF-funded Research Experiences for Undergraduates (REU) program at CTIO. Four students participated in our REU program and all four will attend the January 2003 AAS meeting in Washington D.C. to present a poster on their work. We are looking forward to another outstanding program for 2003, when we anticipate offering five undergraduate Research Assistant positions for a ten-week program starting in January.

CTIO hosts the only NSF-funded REU program that takes place during the US academic year, which is the Chilean summer (January through March). This schedule provides an alternative for students who can take advantage of a quarter or semester away from their home campuses, and who are interested in participating in an "overseas" program. The CTIO REU program offers students the unique opportunity to gain observational experience studying objects in the rich Southern Hemisphere sky (e.g., the Magellanic Clouds and the Galactic Center), while also providing them with a chance to work alongside Chilean astronomy and engineering students who come to CTIO to participate in the "Prácticas de Investigación en Astronomía" (PIA) program of summer engineering internships.

The application deadline for the 2003 CTIO REU program is 1 October 2002. The program is open to US citizens or permanent residents who will be enrolled as full-time undergraduate students through January 2003. Please check the CTIO REU Web page (www.ctio.noao.edu/REU/reu.html) for application materials and the latest news about our 2003 program, as well as for more information about the CTIO REU program, projects, and participants from previous years.



In Brief

A spectacular **wide-field color image of the Eagle Nebula (M16)**, taken by Travis Rector at the WIYN 0.9-meter telescope, was promoted to the media at the June AAS meeting. Its subsequent release by the Reuters news service and related coverage on Yahoo.com led to widespread international popularity, with inquiries for media publication or public use spanning the globe from Scotland to South Korea.

A typical comment from the public: “It is by far the most beautiful creation I have seen in my 63 years!”



A **new color poster of the Eagle Nebula image** was prepared simultaneously for release by NOAO Public Outreach, along with new posters of M33 and AE Aurigae, “The Flaming Star.” We were therefore able to refer dozens of queries by interested members of the public to the Kitt Peak Visitor Center for a phone order purchase of the poster-sized image. The new poster of M33 is unique in its combination of data from Kitt Peak and several radio telescopes, including NRAO facilities.



New lighting for the **Kitt Peak Visitor Center** was contracted and installed in June (see photo), lending a much more relaxed “atmosphere” to the interior, and giving greater flexibility to the placement of exhibits. A new spectroscopy exhibit purchased from the Exploratorium has been delivered and put on display. A solar-powered audio kiosk describing the tile mural on the exterior wall of the Kitt Peak Visitor Center has been installed on the outdoor patio.



Snow Day Down South



This striking photograph shows the SOAR telescope dome on snow-covered Cerro Pachón in late July, only a month after the cover photo of this Newsletter.

(Photo Credit: Sergio Franco)