NOAO Newsletter

Issue 72

December 2002

Science Highlights

Director's Office

US Gemini Program

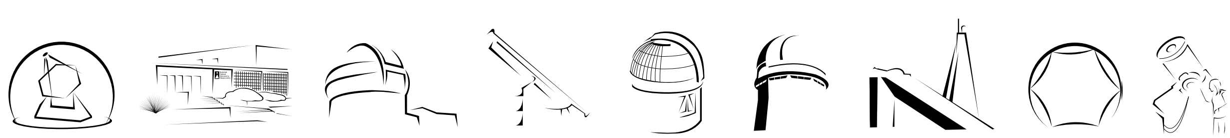
Observational Programs

Cerro Tololo Inter-American Observatory

Kitt Peak National Observatory

National Solar Observatory/GONG

Public Affairs & Education Outreach



Report Charts Falling Physical Sciences Funding

In the early fall, the President's Council of Advisors on Science and Technology (PCAST) met to discuss a draft letter to President Bush recommending substantial increases in federal research funding for physical sciences and some engineering fields. That letter still has not been released, but the analysis on which it was based is now available.

"A succinct, factual story on the federal investment in R&D" is how PCAST member Erich Bloch summarized the charge for this 120-page "project memorandum" prepared for PCAST by the RAND Science and Technology Policy Institute and the AAAS. Bloch identifies declining or stagnant human resources in science and engineering as the "paramount" issue for PCAST.

The analysis, "Federal Investment in R&D," . . . is a distillation of statistics from sources such as the National Science Foundation and AAAS. Some samples from this July 2002 analysis:

"Total federal R&D would be at an all-time high in inflation-adjusted terms in fiscal year (FY) 2003 if President Bush's proposals are approved."

". . . federal R&D as a percentage of GDP has shrunk steadily to less than 0.7 percent of GDP in 2000, bringing the federal investment down to levels not seen since the early 1950s. Although recent budget increases for federal R&D in FY 2001 and 2002 are significant, they would not materially alter these long-term trends."

"Some fields continued to experience increases in federal funding between 1993 and 2000, such as biology (up 97 percent), computer sciences (up 77 percent), and mathematics (up 31 percent). Some fields continued to have less funding in 2000 than in 1993, including physics (down 20 percent), the geological sciences (down 30 percent), chemical engineering (down 30 percent), electrical engineering (down 26 percent), and mechanical engineering (down 46 percent). In contrast . . . astronomy, which had less funding in 1999 than in 1993, had 13 percent more funding in 2000 than 1993."

"NASA is the primary supporter of research in astronomy and also funds some research in physics. NASA's funding of the physical sciences increased from the early 1980s through the early 1990s, and then leveled off through FY 1999, increasing slightly in FY 2000. Funding of the physical sciences, especially chemistry and physics, by DOD has steadily declined since FY 1983, dropping almost three-fold by FY 2000."

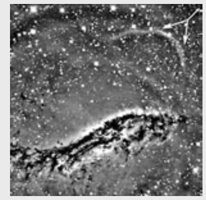
"There were fewer graduate students in the physical sciences in 2000 than in 1993—21 percent fewer in physics and 9 percent fewer in chemistry. The mathematical sciences had 19 percent fewer graduate students, and the earth, atmospheric, and ocean sciences . . . had 7 percent fewer graduate students."

The entire document is posted at *www.rand.org/publications/MR/MR1639.0/*.

--Courtesy: American Institute of Physics Bulletin of Science Policy News #121

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



The arc of blue stars in the upper right corner of the cover image of the galaxy Centaurus A (NGC 5128) from the Blanco telescope is likely the product of star birth that tracks the path of an infalling dwarf irregular galaxy, as it was ripped apart and swallowed by the larger galaxy just 200–400 million years ago. See the science highlight on page 6.

Image credit: Eric Peng (JHU), Holland Ford (JHU/STScI), Ken Freeman (ANU), Rick White (STScI), NOAO/AURA/NSF

The *NOAO-NSO Newsletter* is published quarterly by the **National Optical Astronomy Observatory**
P.O. Box 26732, Tucson, AZ 85726

Dark Visions of Finding a Cluster

Based on a contribution solicited from Tony Tyson (Lucent)

NOAO Deep Lens Survey (DLS) team members Dave Wittman, Vera Margoniner, Tony Tyson, Judy Cohen, Andy Becker, and Ian Dell'Antonio used 3-D mass tomography at high redshift, to find a cluster of galaxies at z = 0.68.

This technique starts with deep multicolor images obtained with the CTIO and KPNO 4-m Mosaic cameras. Photometric redshifts are estimated for all faint galaxies in the field. The shear of thousands of galaxies in each redshift bin is then used to reconstruct an image of the foreground mass via statistical weak gravitational lensing. More distant background galaxies are more strongly sheared by the foreground mass, yielding an estimate of the cluster redshift.

In short, the cluster was detected, weighed, mapped, and placed at its correct redshift without looking at the light from any of the cluster galaxies. This is the highest redshift cluster found by this method.

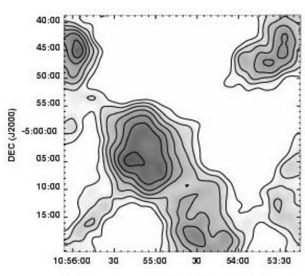


Figure 1

Wittman et al., describe this work in a recent preprint (*astro-ph/0210120*). It extends their previous low-z mass tomography of modest mass clusters to a sufficiently high redshift for testing cosmological models. First, a 2-D mass map was constructed using the shear of all galaxies behind the foreground mass search volume ($0.1 < z_{mass} < 0.8$): 21,339 source galaxies with color redshifts in the range $0.8 < z_{phot} < 1.4$. A conspicuous mass cluster (see figure 1) was found at 10h 55m 17.0s −05° 04' 43″ (J2000). Then, the mean tangential shear was measured in a series of annular bins about the center of this mass concentration, for galaxies in each of the source redshift bins. The mean shear for each source population was characterized by a single number by fitting the radial shear profile to an isothermal distribution. The resulting mean shear can then be plotted versus source redshift. For source redshifts less than the redshift of the mass cluster, the mean shear should be zero, and should grow with source redshift above the cluster redshift in a simple way.

Figure 2

The best-fit mass cluster redshift was z = 0.75. While no light from the cluster was used in any phase of this mass tomography, inspection of the color image showed evidence of a modest cluster of red galaxies (see figure 2). Keck spectroscopy of 24 candidate cluster galaxies gave a mean redshift of z = 0.68 and a velocity dispersion in agreement with the tomographic mass determination of $5.1 \pm 2.0 \times 10^{13}$ solar masses inside a projected radius of 70 kpc/h_{70}. Full-depth DLS imaging should probe to even smaller mass clusters. Far more massive

continued

Dark Visions continued

clusters at high z, found via X-ray or optical searches, are known to exist. This tomographic result demonstrates that weak lensing surveys can detect clusters lower down the mass function and in a baryon unbiased way, a capability that will be required for robust testing of cosmological models.

To date, there are two powerful tests of cosmology, each with its own parameter degeneracies: the anisotropy of the Cosmic Microwave Background (CMB) and Type-1 supernovae. The CMB observations imply that the Universe is flat geometrically: the sum of the dark matter and dark energy add up to precisely the critical value. When combined with the CMB anisotropy, the Type-1 supernovae results suggest that the Universe is roughly 70% dark energy and 30% dark matter. Weak gravitational lensing of millions of galaxies promises to be an independent and complementary precision probe of dark matter and dark energy. Since only angles and redshifts are measured, it does not depend on standard candles or standard meter sticks. Weak lens cosmic shear and counts of mass clusters as a function of redshift can internally break parameter degeneracies, measure Ω_m, and constrain the dark energy equation of state (*astro-ph/0209632*). Dark energy affects the expansion history of the Universe; a weak lens assay of mass clusters versus z is exponentially sensitive to the dark energy equation of state. It will be important to survey mass clusters over the redshift range most affected by dark energy: $0.2 < z < 0.8$.

The DLS deep imaging of seven 2 × 2 degree fields is in progress, using the Blanco and Mayall 4-m telescopes and Mosaic cameras in four bands (B, V, R, and z'). Image quality in the R filter is selected to be 0.9 arcsec FWHM or better. The new results reported here were based on one of the sixty-three 40 arcmin square subfields. That field currently has 5, 10, 15, and 8 exposures respectively in B, V, R, and z'. When the DLS imaging is complete it will have 20 deep exposures in each filter and each subfield. The DLS images are released as soon as they are complete, along with calibrated photometric catalogs and color jpegs (see *dls.bell-labs.com*). Optical transients discovered by pipeline image differencing are posted to that Web site immediately upon discovery.

The DLS is a precursor survey to the Large Synoptic Survey Telescope (LSST) project. Using the same imaging data for a number of unique probes ranging from near-Earth asteroids to optical bursts, LSST weak lens shear data for several billion source galaxies is expected to constrain the dark energy equation of state to percent-level precision.

Gemini + Phoenix = A Chemical Equation for the LMC

Based on a contribution solicited from Verne Smith (University of Texas, El Paso)

Verne Smith used the Phoenix high-resolution infrared (IR) spectrometer at the Gemini South 8-m telescope to obtain spectra of 12 red giant members of the Large Magellanic Cloud (LMC). Chemical abundances can be derived from such stellar spectra to be used as probes of chemical evolution.

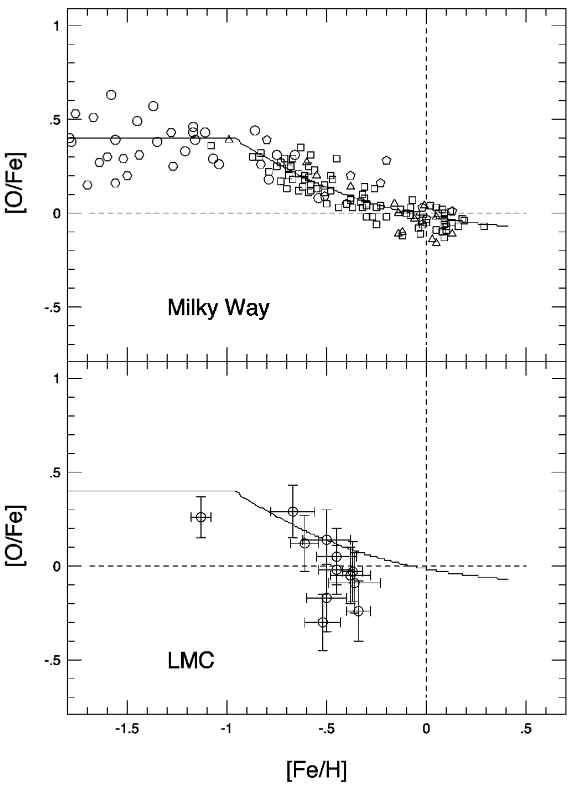
Within a given stellar population in a galaxy, chemical evolution is driven by stellar nucleosynthesis, with the dispersal of the processed material back into the galactic interstellar medium (ISM). Heavy-element enrichment over time depends on such processes as star formation history, internal stellar evolution and nucleosynthesis as a function of mass, how stars return their processed ejecta back into the ISM, and whether some of the stellar ejecta can be lost from the galaxy by galactic winds.

Use of Phoenix at Gemini to conduct high-resolution IR spectroscopy on red giant stars in nearby galaxies is opening a new window on chemical evolution, as well as stellar evolution and nucleosynthesis. Numerous spectral transitions in the IR from molecules such as CO, OH, CN, and NH are readily observable in these cool giants. The observation of carbon, nitrogen, and oxygen abundances in red giants, including their minor isotopes (such as ^{13}C or ^{17}O), is crucial for sorting out internal mixing-related abundance changes versus chemical evolution in the original gas from which the stars formed. Atomic lines are also observable in the IR, with many transitions from interesting elements such as iron, sodium, magnesium, silicon, scandium, titanium, or nickel.

Certain aspects of chemical evolution can be probed from determinations of various strategic elemental abundance ratios. One such abundance ratio is that of oxygen to iron, as this provides information on the star formation rate averaged over time. Oxygen is a primary product of massive star evolution, and it is dispersed into the ISM through core

continued

Gemini + Phoenix continued



collapse supernovae; oxygen appears quite suddenly after star formation, such that subsequent stellar generations will incorporate this freshly produced oxygen into their chemical abundance mixtures. Iron is produced in relatively small amounts by massive stars and is synthesized largely in Type-1a supernovae, which are thought to result from evolution in a binary system (with lifetimes of roughly 1 Gyr). Thus, the oxygen to iron abundance ratio will be relatively large for rapid chemical enrichment, and then will decline as Type-1a supernovae begin to add iron, after a time delay of about a Gyr. The relation of [O/Fe] versus [Fe/H] can then be used to compare rates of chemical evolution in other systems relative to the Milky Way.

Smith's results of [O/Fe] versus [Fe/H] for the 12 LMC red giants observed in this program are shown in the bottom panel of the figure. These particular abundances are based upon four OH vibration-rotation lines and three Fe I lines near a wavelength of 1.55 μm. Abundances for Milky Way stars (taken from a number of published sources) are shown in the top panel for comparison.

A simple model of chemical evolution designed to fit the Milky Way results is shown in the top panel as the solid curve. The model that produced this curve is a numerical model with a constant star formation rate and instantaneous recycling, with no infall or outflow, and oxygen and iron yields estimated from the texts by Pagel (1997) and Arnett (1996).

The model curve for the Milky Way is also plotted in the bottom panel as a comparison to the LMC results. The values of [O/Fe] in the more metal-rich LMC giants (at [Fe/H] ~ −0.5 to −0.3) fall below their corresponding Milky Way values by about 0.2–0.3 dex. This result is consistent with previous results from Hill et al. (1995) for a sample of LMC F-supergiants and Korn et al. (2002) for four main-sequence B-stars.

The evidence from a variety of stellar spectral types points consistently to a [O/Fe] versus [Fe/H] relation in the LMC that falls below the same relation for the Milky Way. Lower values of the oxygen to iron ratio in the LMC can be modeled as a result of a lower efficiency of star formation, per unit mass of gas, by about a factor of 2 or 3 in comparison to the Milky Way.

The red giant populations of several other nearby galaxies are within reach of high-resolution IR spectroscopy, with the result that CNO abundances (along with other heavier elements) can be measured in these systems. Chemical evolution in a variety of different galactic environments can be studied, resulting in an improved understanding of how heavy-element enrichment proceeds in different types of galaxies.

Arc of Blue Stars a Lingering Sign of Shredded Dwarf Galaxy

Adapted from NOAO Press Release 02-11, released 15 October 2002
(Subsequent media coverage included CNN.com, Space.com, Astronomy.com, SpaceRef.com, and the "Astronomy Picture of the Day" Web site on October 17)

An unobtrusive arc of blue stars stretching above the iconic galaxy Centaurus A represents the lingering signature of an episode of galactic cannibalism that is surprisingly recent and, astronomically speaking, quite nearby.

Several complementary observations from the National Science Foundation's Blanco telescope provide compelling evidence that massive Centaurus A ripped apart and swallowed a dwarf irregular galaxy only 200–400 million years ago, leaving behind an arc of young stars stretching at least 2,000 light-years. This finding adds to emerging evidence that smaller galaxies may be significant contributors to the formation of galactic halos, the outer perimeters of galaxies where stellar populations are sparse. "The tidal forces of the main galaxy caused a burst of star formation within the infalling galaxy, and what we see now are these young stars spread along the remnant of the incoming orbit," explains Eric Peng, a graduate student at the Johns Hopkins University in Baltimore.

The arc had been noted as an unusual feature in earlier photographic plates of the violent maelstrom surrounding Centaurus A (also known as Cen A and NGC 5128). However, Peng and his collaborators decided to search for evidence of dwarf-sized fragments near the galaxy by using the powerful ability of modern digital imaging instruments to measure subtle differences in color. This made it possible to isolate the arc, and then to determine its youthful age and dynamic history from independent lines of evidence.

The Blanco 4-meter telescope at Cerro Tololo Inter-American Observatory (CTIO) near La Serena, Chile, has helped astronomers make several important insights into Cen A since the early 1970s, from the existence of a faint visible light jet to its complex exterior shell structure.

Peng and collaborators Holland Ford of Johns Hopkins, Ken Freeman of the Australian National University, and Rick White from the Space Telescope Science Institute used the Blanco telescope and its NOAO Mosaic II camera to study the stellar content of Cen A via optical maps in several color bands.

"It was striking how this one arc feature really stood out," Peng says, "which suggested strongly to us that it had a different origin from its surroundings."

The wide field-of-view of the Mosaic camera on the Blanco matches up extremely well with the Hydra-CTIO spectrograph, which was used to confirm that a representative star cluster in the image is associated physically with the blue arc and Cen A, rather than being a foreground cluster in the Milky Way.

The spectroscopic data yielded an age for this cluster of approximately 350 million years. Further analysis of the color maps yielded an integrated age for the stream of about 200–400 million years, consistent with a separate estimate for the disruption of the stream based on its physical dynamics.

"We propose that the stream was formed from a tidally triggered burst of star formation that occurred when the dwarf galaxy fell into Cen A about 300 million years ago, which is interesting because it adds to evidence seen in the Milky Way and M31 that galactic halos are built up from the accretion of dwarf satellites," Peng explains. "However, most of these examples involve older stellar populations in gas-poor dwarf galaxies, whereas the one we've observed in Cen A has young stars. This shows that younger, gas-rich dwarfs also fall into galaxies, which has never been seen clearly."

The stars and star clusters from this tidal stream will eventually disperse into the main body of the galaxy, suggesting that the late infall of gas-rich dwarf galaxies plays an important role in the build-up of stellar halos, Peng says. This process was likely much more common in the early universe.

"This result demonstrates how wide-field CCD cameras are breaking new ground in areas recently dominated by photographic techniques—digital processing played a critical role in this discovery," explains CTIO Staff Scientist Knut Olsen. "The arc of young stars in Cen A is the closest such feature that we are likely to see in the local universe, so it provides a natural means to study the formation of the stars and star clusters that populate galaxy halos today."

The results from Peng, et al., have been accepted for publication in the December 2002 issue of the *Astronomical Journal*. The team's image of Cen A, featured on the cover of this *Newsletter*, and a full-frame view of the entire galaxy processed in the same way, are available at *www.noao.edu/image_gallery/html/im0791.html* and *www.noao.edu/image_gallery/html/im0792.html*.

Vector Magnetic Fields in Prominences with the Advanced Stokes Polarimeter and Principal Component Analysis

Arturo López Ariste, Roberto Casini, Steven Tomczyk & Bruce Lites (HAO)

A. López Ariste and R. Casini (UCAR/HAO) recently developed an inversion code to infer the magnetic field vector in prominences using pattern recognition techniques (*ApJ*, 575, 2002). The code treats the full Stokes profiles in the He D_3 line at 5876 Å. The necessary data required a telescope capable of precise spectropolarimetry and with low scattered light. Several telescopes were tested. THEMIS in the Canary Islands was the first one to provide the required data. The National Solar Observatory (NSO) Evans coronagraph, which had already provided good Stokes profiles in the 1980s with the Stokes I and II instruments, may be used in the future. The third choice was the Advanced Stokes Polarimeter (ASP) on the Dunn Solar Telescope (DST) at Sunspot. After two initial runs in June 1997 and March 2001 that identified the instrumental constraints, a new run was scheduled for the last week of May 2002.

The ASP was set in the 30-Hz mode to ensure maximum exposure time compatible with a reliable constant speed of the rotating waveplate (something that could not be ensured in the 15-Hz mode). The requirement of simultaneously observing the Na D_1 and D_2 lines (5895 Å and 5890 Å respectively) with the He D_3 line was attained by using a shorter (f = 500 mm) camera lens, which reduced the spectral dispersion so that the detector recorded roughly 25 Å in total. The smaller focal length also reduced the separation of the two orthogonally polarized beams so that just one chipset of the ASP camera (Bert) was used to record both beams. Another consequence was the reduced spatial sampling (1 arcsec per pixel), which helped increase the signal-to-noise ratio.

From May 25 through May 30, under very good seeing conditions, we were able to scan about 20 prominences reaching up to heights of approximately 50 arcsec above the solar limb, at 1-arcsec steps. The slit was kept parallel to the limb at all times. Calibration of the instrument was done following the usual ASP procedures, with the addition of an ND filter to avoid camera saturation at disk center for such long exposure times. The recorded data proved to have a good signal-to-noise ratio in all four Stokes parameters. In some time series, time and spatial averages have resulted in profiles with noise levels down to 1×10^{-5} with absolute polarization measurement. No modification of the usual calibration procedures was necessary.

After reduction, the data were inverted with the code described by López Ariste and Casini. This code uses a line formation model for the He D_3 line, originally described by Landi Degl'Innocenti (1982), which considers the five lowest atomic terms of the triplet configuration of He I. In particular, this code provides a full quantum treatment of the Hanle and Zeeman effects, accounting also for the alignment-to-orientation transfer mechanism that is essential to achieve agreement with the observed Stokes V profiles. The code assumes optically

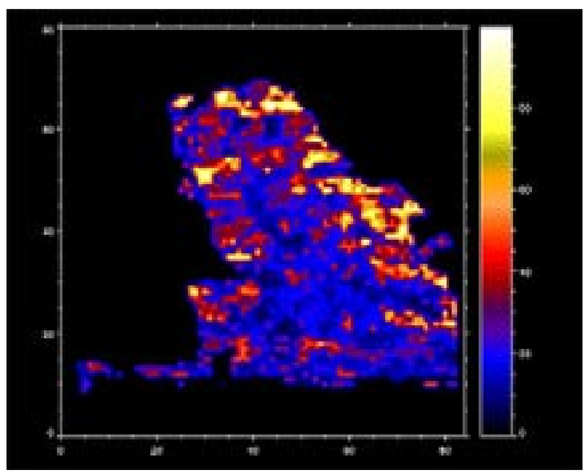


Figure 1. Field strength map of the He D_3 line of a solar prominence.

thin plasmas, with constant temperature and electron density. Otherwise, the magnetic field vector and the geometry of the scattering event in the prominence are considered free parameters of the model.

Principal Component Analysis uses a database of synthetic profiles to compute eigenprofiles for all four Stokes profiles. Those eigenprofiles are used to reconstruct any observed

continued

Vector Magnetic Fields continued

profile using just a few coefficients. The coefficients from the observed profiles are compared to those present in artificial databases created under known magnetic fields and geometries. This comparison constitutes the core of the inversion process.

The code was tested first with synthetic profiles with very good results: error levels were of the order of 2 to 3 G in field strength and a few degrees for most of the angles involved in the model. The tests also showed that Stokes V is fundamental for a correct determination of the magnetic field. The Stokes V profile of the He D_3 line in prominence conditions results from the addition of two contributions: one originating in the alignment-to-orientation transfer mechanism that creates symmetric, intensity-like profiles, the second from the longitudinal Zeeman effect that produces the better known antisymmetric profile. The Zeeman contribution is the smallest one, casting serious doubt on the past inferences of magnetic fields in prominences using Zeeman-based magnetograph techniques. The richness of the Stokes V profiles determined by the combination of these two contributions makes Stokes V the most important piece of information for the inversion, as the tests show.

Figures 1, 2, and 3 show one of the prominences observed on 25 May 2002 at 16:33 UT at PA 61.8°. This prominence was seen almost along its axis. The three maps show the peak intensity of the He D_3 line, the field strength and the field inclination (90° for a horizontal field).

In this preliminary stage of the inversion code, a few general conclusions can be drawn: the fields are mainly horizontal (in agreement with the work of Leroy and Bommier in the 1980s) including the lowest parts of the prominences and in particular their feet. The predominant field strengths are in the 20 G regime, but fields as high as 80 G appear as well. These high fields have been closely scrutinized, but their Stokes V profiles show unambiguous Zeeman signatures that exclude any possible bias of the inversion code toward high fields.

It is important to notice that previous Hanle diagnostics suffered from Hanle saturation that made it very difficult to diagnose fields above 30 or 40 G, when present. The use of Stokes V, together with Stokes Q and U, allows us to infer the correct field strengths for such high values. These results should be accepted with some caution due to the assumption of optically thin plasma and the possible presence of subpixel velocity or field structure.

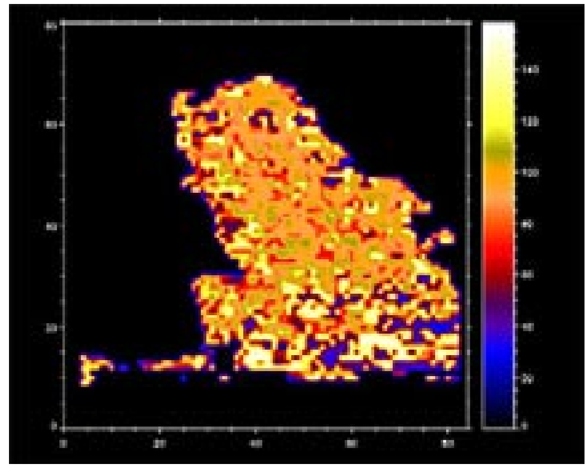


Figure 2. Field inclination map of the He D_3 line of a solar prominence.

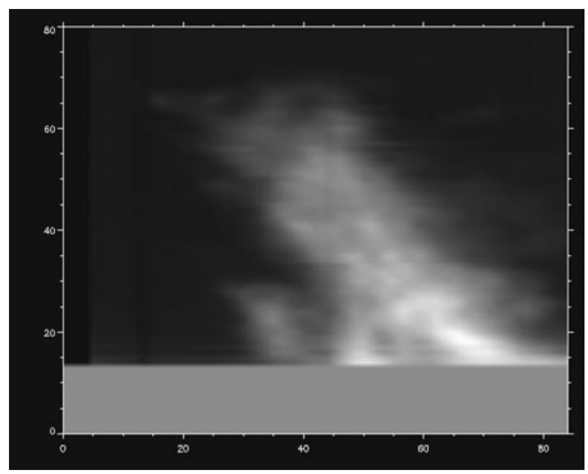


Figure 3. Field intensity map of the He D_3 line of a solar prominence.

X-Ray Radiance and Magnetic Flux

Alexei Pevtsov

For the poet, the solar corona is a faint but luminescent portion of the outer solar atmosphere. For the scientist, though, it is a hard-to-solve puzzle.

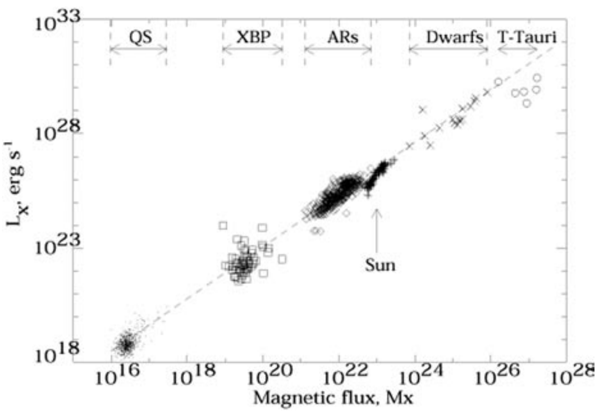
The temperature of plasma in the solar photosphere, where one sees familiar sunspots, is about 5000 K and it decreases with height. Somewhere around 2500 km above the photosphere, however, the temperature "jumps" to 1 million degrees, and it grows even higher in the outer corona. Similar hot coronae exist around many other stars. Whether the same mechanism heats the solar and stellar coronae is a significant question. The relationship between magnetic and radiative fluxes may provide some answers.

We are studying a correlation between magnetic and X-ray fluxes using observations of the Sun (quiet Sun, X-ray bright points, active regions, and integrated solar disk), and dwarf and pre-main sequence stars. For solar features, we use data from the soft X-ray telescope (SXT) on board the Yohkoh satellite, and magnetograms from three different instruments: the NSO/Kitt Peak spectromagnetograph, the Michelson Doppler Imager on board SoHO, and the University of Hawaii Stokes Polarimeter at Haleakala. The X-ray radiance and total magnetic flux of 16 dwarf stars (types G, K, and M) and six T-Tauri stars were computed using X-ray surface flux, magnetic field strength, and magnetic filling factor observed by Saar (1996), Johns-Krull and Valenti (2000), and Johns-Krull et al. (2001).

The accompanying figure shows the relationship between total unsigned magnetic flux and X-ray spectral radiance for all six data sets. With one exception (T-Tauri), all objects show statistically significant correlation between X-ray and magnetic flux. Deviation of five T-Tauri stars from the general dependence might be the result of selection effects or X-ray absorption in the stellar wind. It might also indicate the saturation of coronal heating on these stars, whose surfaces are completely covered by strong magnetic fields.

The individual subsets are different in scattering and functional dependency between magnetic and X-ray fluxes. One can think of several explanations of such "individuality." In a quiet corona, the magnetic field, expanding with height, may form a bright canopy above neighboring magnetically independent areas, and thus affect the relationship between magnetic and X-ray fluxes. In solar disk averages, the relationship may be distorted by the presence of the coronal holes. The coronal holes have reduced X-ray flux, but their unsigned magnetic flux is comparable to brighter quiet-Sun areas.

Nevertheless, despite all possible complications, the combined data follow one simple dependency. Over a great diversity in spatial scales and magnetic flux densities, the



X-ray spectral radiance L_x versus total unsigned magnetic flux for solar and stellar objects: quiet Sun (QS), X-ray bright points (XBP), solar active regions (Ars), solar disk averages (Sun), G, K, and M dwarfs, and T-Tauri stars. The dashed line represents the power-law approximation $L_x \alpha \Phi^{1.15}$ of the combined data set.

X-ray output of coronal plasma is roughly proportional to the unsigned magnetic flux threading the solar or stellar photosphere. The simple, nearly linear relationship suggests a common heating mechanism, although the level of scatter about that relationship indicates that detailed morphology also plays an important role.

This work is being done in collaboration with G. H. Fisher (University of California, Berkeley); L. W. Acton, D. W. Longcope, and C. C. Kankelborg (Montana State University); C. M. Johns-Krull (Rice University); and T. R. Metcalf (Lockheed Martin).

Come to the NOAO Town Meeting

Jeremy Mould

NOAO will host a town meeting on Tuesday, January 7, in Seattle at the 201st meeting of the American Astronomical Society. This is the perfect opportunity for you to tell us directly—without the intermediary of a user's committee or observatory council—what you think of our new programs, our old programs, and the programs that you think NOAO should have but does not.

In addition, a major release of data into the NOAO Science Archive is planned at the Seattle AAS meeting. We want to know if these data meet your needs, or will grow into something that will meet your needs.

The Giant Segmented Mirror Telescope (GSMT) and Large Synoptic Survey Telescope (LSST) science working groups started work in 2002, with the aim of developing science cases for these facilities commensurate with their large demand on NSF funds. The science working group (SWG) chairs will give brief progress reports at the town meeting and will be available for your input.

External partners are playing a bigger role in the national observatory, in providing new telescopes and instruments, such as SOAR, and in keeping old telescopes going for new purposes. We'll get you up to date with these developments.

The Telescope System Instrumentation Program (TSIP) is providing funds for innovative instrumentation at independent observatories with large telescopes. In return, TSIP opens up public time on these telescopes through the NOAO time allocation process. TSIP is here for the long haul; we want to make sure that the program is understood well by the community, and test whether we are managing it in the way the community wishes.

The commissioning of the Gemini Multi-Object Spectrograph (GMOS) and other science instruments means that Gemini data has started arriving with a vengeance. NOAO provides instrument scientists to support the community both before and after observing (and, in the case of Phoenix, during observing). We will be changing the name of the US Gemini Program to the NOAO Gemini Science Center to emphasize our role in the era of operations. It's now time to get your input on the next generation of Gemini instrumentation.

There will be a lot to talk about at the NOAO Town Meeting. We hope and expect to see you there!

Notable Quotes

perinigricon (noun) — the point of closest radial approach to a black hole.

--Cited in Schodel et al., "A star in a 15.2-year orbit around the supermassive black hole at the center of the Milky Way," Nature *419, 17 October 2002.*

"GSMT Book" Update Includes Cost Estimates, Science Case for Spectrograph

Larry Stepp

The AURA New Initiatives Office (NIO) is pleased to include with this *Newsletter* a CD-ROM containing an updated html version of the "GSMT Book," initially made available on the NOAO Web site in March 2002 (*www.aura-nio.noao.edu*).

This electronic document summarizes studies initiated over the past two years by the NIO to: (1) develop quantitative science cases for a GSMT; (2) develop a representative GSMT "point design" in order to identify key technical challenges; and (3) carry out technical studies to address issues common to next-generation telescopes.

Key additions to the original version of the book include:

- A cost estimate for the point design telescope structure, prepared by the engineering firm of Simpson, Gumpertz and Heger,
- A feasibility study and cost estimate for two enclosure concepts, prepared by AMEC Dynamic Structures Ltd.,
- A cost estimate for the full GSMT Project,
- Reports describing feasibility studies on testing off-axis paraboloidal mirrors using computer-generated holograms, prepared by the University of Arizona Optical Sciences Center,
- A report describing the science case for and conceptual design of a Million Element Integral Field Unit (MEIFU) spectrograph for GSMT,
- Links to more than a dozen recent technical papers related to GSMT.

The NIO is a partnership between NOAO and Gemini formed by AURA in response to the Decadal Survey's recommendation that a 30-meter class Giant Segmented Mirror Telescope (GSMT) be completed early in the coming era of the Atacama Large Millimeter Array (ALMA) and the James Webb Space Telescope.

The NIO is working with the astronomical community to carry out engineering studies and site evaluation activities to meet this challenge, and is proactively encouraging the public-private partnership envisioned by the Decadal Survey as the most desirable path to a GSMT.

NIO staff members are also supporting the efforts of the National Science Foundation's newly constituted GSMT Science Working Group (SWG), which is charged with evaluating and prioritizing the top-level science goals for GSMT from a broad perspective. GSMT SWG activities are updated and summarized periodically at *www.nsf-gsmt-swg.noao.edu*.

NIO encourages the community to follow NIO progress on its Web site, and welcomes comments on the GSMT Book and related issues. Contact Steve Strom (*sstrom@noao.edu*) or Larry Stepp (*lstepp@gemini.edu*).

Conceptual design for GSMT.

Gemini Update

Taft Armandroff

The Gemini telescopes and their suite of instrumentation continue to advance toward a more mature state of operations and a broader range of observing capabilities. This article highlights Gemini developments that will be of interest to US Gemini users and proposers, and then discusses the strong response of the US community to the most recent opportunity to propose for Gemini observing.

Please note some recent developments that indicate progress toward new Gemini observing opportunities:

- The GMOS-South optical multi-object spectrograph and imager passed its on-site acceptance tests at the UK Astronomical Technology Center (UK/ATC) in October and was shipped from Edinburgh to Chile. The UK/ATC members of the integration and commissioning team arrived in Chile at the end of October and began on-site software installation. The Canadian contingent planned to arrive in November. If the integration goes smoothly, first light on Gemini South is possible in January. Upon completing an extensive commissioning and system verification process for its several modes during semester 2003A, we hope that GMOS-South will be available for most or all of semester 2003B. GMOS-South and GMOS-North are twin instruments that will enable identical spectroscopic observations of samples that span both hemispheres.
- Michelle is a mid-infrared (8- to 25-micron) imager and spectrograph for shared use between Gemini and the United Kingdom Infra-Red Telescope (UKIRT). Observing modes include direct imaging and long-slit spectroscopy with spectral resolutions of approximately 200, 1000, and 30,000. Michelle has been used successfully for science observations on UKIRT. A number of enhancements will be made to Michelle before it is mounted on Gemini North, including the installation of a more capable science detector, installation and testing of the Gemini fore-optics, and integration of the Gemini-specific software for Michelle. It is expected that Michelle will have first light on Gemini North in January, to be followed by commissioning and system verification. Michelle science observations are planned for the final months of semester 2003A. (See following article by S. Fisher and K. Hinkle.)
- The Altair adaptive optics system has been delivered by the Herzberg Institute of Astrophysics to Gemini North, where it has now been fully reassembled. Altair was tested in the summit lab at the end of October. After this testing, Altair, in natural guide star mode, will be commissioned on Gemini North in November, December, and March.
- The CIRPASS near-infrared integral-field-unit spectrograph was commissioned and successfully performed Demonstration Science at Gemini South. CIRPASS has been offered for science observations in semester 2003A.
- The NIRI infrared imager underwent modifications in July and August in order to install new bushings to enhance reliability and a new prism to generate 2 × 2 Shack-Hartmann spots for focus sensing. Unfortunately, NIRI suffered failures of two mechanisms during a science run in September. Subsequent analysis revealed that a failed stepper motor and an electrical short caused these problems. As of mid-October, repairs had been made, and detailed cold testing has been scheduled. NIRI is planned for use in Altair commissioning in November, and it then will resume science observations in December.
- For semester 2002B, almost all of the observing is being performed in queue mode. However, for semesters 2003A and B, classical observing mode will be offered for runs of sufficiently long duration using instrumentation that has proven high-level software. Proposers who can benefit from classical mode are encouraged to investigate this option in conjunction with USGP.
- Gemini Observatory has been successful in increasing observing efficiency by reducing overheads for field acquisition, wavefront sensor setup, primary mirror tuning, and related tasks. This will be an ongoing process and requires work on many telescope and instrument subsystems.

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

The US community responded enthusiastically to the Gemini Call for Proposals for semester 2003A. Overall, US proposers submitted 131 proposals for 2003A, which represents a 27 percent

continued

Gemini Update continued

increase over the number submitted in 2002B. On Gemini North, 148.6 nights were requested in 86 proposals. GMOS was the most popular instrument on Gemini North (84.3 nights requested in 47 proposals), followed by NIRI (50.4 nights requested in 29 proposals), and Michelle (13.9 nights requested in 12 proposals). On Gemini South, 45 proposals requested 83.6 nights. Phoenix was the most popular instrument on Gemini South (57.6 nights requested in 31 proposals), followed by CIRPASS (18.1 nights requested in 9 proposals), and AcqCam (8 nights requested in 6 proposals).

Michelle

Scott Fisher (Gemini Observatory) & Ken Hinkle (NOAO)

Michelle, the facility mid-IR (8- to 25-micron) imager and spectrometer for Gemini North, is in the process of being transferred to Gemini after its first use at the United Kingdom Infra-Red Telescope (UKIRT) on Mauna Kea. The instrument was removed from UKIRT on September 30th and will undergo a period of engineering and testing before it arrives at Gemini in late December. Staff from the Joint Astronomy Center (JAC) and the Astronomy Technology Center (ATC) will repair some mechanical parts of Michelle and will retrofit the instrument with a newly purchased detector. The new 320 × 240 Si:As blocked impurity band detector will have the same pixel scale and field of view as the old chip; however, the cosmetic quality (i.e., number of bad pixels and columns) of the new detector is significantly better.

Michelle in transport on the summit of Mauna Kea (photo courtesy of UKIRT).

Along with work on the instrument itself, there is a strong engineering effort underway at Gemini North to prepare the observatory for the arrival of its mid-IR instrument. For the first time an instrument will use the pier lab of Gemini, and work is well under way to supply the lab with power, optical fibers, compressed helium lines, and network access.

The instrument is scheduled to arrive in December, and work on the characterization of the new array will begin immediately. After the holidays, Michelle will be moved from the pier lab to the uplooking port of the telescope, where it will be integrated into the telescope hardware and software environments. First light for Michelle on Gemini is scheduled for late January. The first community science time with Michelle will be available in June and July of the 2003A semester.

USGP at the January 2003 AAS Meeting

The US Gemini Program will have a booth at the January AAS Meeting in Seattle.

Please stop and see us!

Acknowledgements in Publications

Taft Armandroff

Acknowledging in a journal paper the telescope and instrument that produced the observational data is important for a number of reasons. One fundamental reason: most observatories, including Gemini, maintain databases of published papers and the resulting scientific impact that are used in future development and funding decisions. In addition, clearly citing the source of the data enables interested readers to propose related observations.

USGP asks the US community to include the following general acknowledgment in their publications employing Gemini data: "Based on observations obtained at the Gemini Observatory, which is operated by the Association of Universities for Research in Astronomy, Inc., under a cooperative agreement with the NSF on behalf of the Gemini partnership: the National Science Foundation (United States), the Particle Physics and Astronomy Research Council (United Kingdom), the National Research Council (Canada), CONICYT (Chile), the Australian Research Council (Australia), CNPq (Brazil) and CONICET (Argentina)." A cut-and-paste version of this acknowledgement text is also available at *www.us-gemini.noao.edu/sciops/ObsProcess/defAcknowledgement.html*.

In addition to this general acknowledgement to the Gemini Observatory, the following specific text should also be included in the acknowledgement section of any paper containing Phoenix data: "This paper is based on observations obtained with the Phoenix infrared spectrograph, developed and operated by the National Optical Astronomy Observatory." A cut-and-paste version of this acknowledgement text is also available at *www.us-gemini.noao.edu/sciops/instruments/phoenix/phoenixRefs.html*.

Similarly, for papers containing any Hokupa'a/QUIRC data, the following specific acknowledgement should be included: "This paper is based on observations obtained with the Adaptive Optics System Hokupa'a/QUIRC, developed and operated by the University of Hawaii Adaptive Optics Group, with support from the National Science Foundation." A cut-and-paste version of this acknowledgement text is also available at *www.us-gemini.noao.edu/sciops/instruments/uhaos/uhaosRefs.html*.

US Members of the Gemini Board

Taft Armandroff

Under the terms of the international Gemini agreement, the Gemini Board of Directors represents all of the Gemini partners (US, UK, Canada, Chile, Argentina, Australia, and Brazil), carries out broad oversight functions, and sets budgetary and policy bounds for the Gemini Observatory. The US Board appointments are made by NSF at the level of the Assistant Director for Mathematical and Physical Sciences. The Gemini Board term of Martha Haynes ended this summer. All of us sincerely thank Professor Haynes for her valuable contributions while representing the US on the Gemini Board. Replacing Haynes is Professor Chick Woodward of the University of Minnesota. Woodward's scientific specialty is infrared observations of evolved stars and solar system objects.

The other recent appointment to the Gemini Board from the US is Professor Bruce Carney of the University of North Carolina at Chapel Hill. Carney studies the early history of the Milky Way using observations of field stars and globular clusters. Woodward and Carney join veteran US Gemini Board members Wayne Van Citters, who is the Director of the Division of Astronomical Sciences at the National Science Foundation and represents NSF as the US designated member, and Gus Oemler, who is Director of Carnegie Observatories. See *www.us-gemini.noao.edu/science/#gbod* for the full international Board membership.

US Gemini Instrumentation Program Update

Taft Armandroff & Mark Trueblood

The US Gemini Instrumentation Program continues its mission 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 late October.

GNIRS

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

The GNIRS project achieved a major milestone in late September / early October. GNIRS was integrated, vacuum tested, and then cooled to cryogenic temperature, where it came very close to its desired operating temperature. While the instrument was cold, the GNIRS Team verified the cryogenic performance of the GNIRS mechanisms, the on-instrument wavefront sensor, and the temperature control. As expected, some areas need work; however the tests have revealed excellent performance in most cases. The second GNIRS cooldown will feature an engineering-grade detector and imaging tests using it. Overall, 94 percent of the work to deliver GNIRS has been completed.

GNIRS Team members Paul Schmitt and Ron George "button up" the instrument in preparation for the cold tests in late September.

NICI

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

NICI passed its Critical Design Review (CDR) in June and is in the fabrication phase. Currently, a great deal of procurement activity is underway for the NICI optical, mechanical, and electronic components. Delivery of NICI 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 × 4K HgCdTe detector mosaic. GSAOI's imaging area will cover the well-corrected field 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. Bob Blum leads the NOAO GSAOI Team scientifically with assistance from Jay Elias and Dick Joyce; Neil Gaughan serves as the Project Manager. Technical personnel from Tucson and La Serena are participating in the GSAOI effort.

The NOAO GSAOI design study results were documented as a report for Gemini, and the NOAO Team presented their results to the Gemini Design Review Committee on August 21 in Hilo. After some significant changes in requirements from Gemini, NOAO submitted a revised GSAOI proposal, as did the other design team, from the Australian National University.

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 detector readout speed 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.

Changes to the NOAO Survey Program—No New Surveys to Start in 2003

Todd Boroson

The NOAO Survey Program has completed four proposal cycles and three full years of observations. In supporting projects specifically identified as surveys, we have tried to be flexible because we expect more of these projects. It has been our intent that these projects produce uniform, coherent data sets that are quickly made available to the community. It has also been our intent that a large fraction of the total telescope time remains available for traditional, non-survey projects. In order to satisfy these two desires, we announce here two changes to the NOAO Survey Program: (1) a mechanism for survey projects to replace time lost to weather or technical malfunctions, and (2) a one-year hiatus in new survey starts to accommodate the needs of ongoing surveys without further decreasing the time available to non-survey observations.

All observing projects are subject to loss of time for weather and instrument or telescope problems. It has always been NOAO policy that we do not grant time with the expectation that some fraction will be lost, and for regular, one-semester projects, this is appropriate. A statistical adjustment for a three-night observing run doesn't make sense. Surveys are different for two reasons. First, over several years and several tens of nights, one can expect that lost time will be inevitable. Second, the success of these projects depends on providing large (and in many cases, complete) data sets. Therefore, we will allow all survey projects to request an adjustment to their allocation at one point in their lifetime. These requests and their justifications will be reviewed by our survey time allocation panel approximately one year before the end of observations for any given survey. Since we have not offered this opportunity in the past, we expect most of the ongoing surveys (many of which are near completion) to take advantage of this change soon.

The current allocation for survey projects on the larger telescopes is near the 20 percent limit that we have imposed for the next few semesters. In addition, most of the survey time uses particular instruments (CCD Mosaic Imager, FLAMINGOS) that are the most highly oversubscribed. In order to prevent the survey program from blocking the access of excellent non-survey proposals to the telescopes, we have decided not to issue our call for new survey proposals for the semester 2003B deadline. The next call for new surveys will have a deadline of 15 March 2004.

Joint HST-NOAO Observing Proposals

Jeremy Mould

NOAO is again collaborating with the Space Telescope Science Institute to award observing time on NOAO facilities for highly ranked Cycle 12 Hubble Space Telescope (HST) proposals that request time on both HST and NOAO telescopes. The award of time on NOAO facilities will be subject to approval by the NOAO Director, after nominal review by the NOAO Time Allocation Committee (TAC) to avoid duplication of programs. The important additional criterion for the award of NOAO time is that both the HST and the ground-based data are required to meet the science goals of the project.

Up to 5 percent of NOAO's available observing time may be allocated to proposals meeting the stated criteria. NOAO observing time will be scheduled during the two semesters from August 2003 through July 2004. Time is available at KPNO, CTIO, HET, and MMT, but not Gemini or Keck. In addition, time on the heavily-subscribed Mosaic cameras may be limited by the NOAO Director. Detailed information on available facilities is given on the NOAO/NASA Collaboration Web page (*www.noao.edu/gateway/nasa/*).

2003A Proposal Process Update

Dave Bell

NOAO received 392 observing proposals for telescope time during the 2003A semester, plus an additional 12 proposals on behalf of the Chilean National Time Allocation Committee (TAC) for time at CTIO. Of those sent to the NOAO TAC, 146 proposals requested time at KPNO, 131 with the Gemini telescopes, 104 at CTIO, 31 at Keck, and 7 each at MMT and HET. Thesis projects accounted for 20 percent (77 proposals) of those received, and 19 proposals requested long-term status. Time-request statistics by telescope and instrument appear in the following tables. Subscription rate statistics will be published in the March 2003 issue of the *Newsletter.*

As of this writing, the proposals are being reviewed by members of the NOAO TAC (see the following listing). After their deliberations, the KPNO and CTIO schedules will be completed by early December, and e-mail notifications will be sent promptly to principal investigators. Investigators who have submitted community-access requests for time at HET, MMT, or Keck will also be notified at this time. Investigators who have requested time at Gemini will be notified by December 19, after the meeting of the Gemini International TAC and final approval by the Gemini Director. Mailed information packets will follow the e-mail notifications by about two weeks.

Looking ahead to 2003B, on-line Web information and forms will be available by late February 2003. The March issue of the *Newsletter* will contain updated instrument and proposal information. The deadline for submitting 2003B proposals will be Monday, 31 March 2003.

2003A Request Statistics by Telescope and Instrument

Gemini

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
GEM-N		**86**	**95**	**148.6**	**56.7**	**38**	**1.6**
	GMOSN	47	53	84.3	56.7	67	1.6
	Michelle	12	12	13.9	0	0	1.2
	NIRI	29	30	50.4	0	0	1.7
GEM-S		**45**	**59**	**83.6**	**3.6**	**4**	**1.4**
	AcqCam	6	7	8	1.5	19	1.1
	CIRPASS	9	9	18.1	2.1	11	2
	Phoenix	31	43	57.6	0	0	1.3

CTIO

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/ Run
CT-4m		**80**	**88**	**272**	**84**	**31**	**3.1**
	ECH	9	9	28	0	0	3.1
	HYDRA	16	16	51	23	45	3.2
	ISPI	13	13	39.2	0	0	3
	MOSAIC	26	29	86.3	44	51	3
	OSIRIS	7	9	26.5	0	0	2.9
	RCSP	12	12	41	17	41	3.4
CT-1.5m		**11**	**12**	**69**	**19**	**28**	**5.8**
	CSPEC	11	12	69	19	28	5.8
CT-1.3m		**8**	**8**	**24**	**4**	**17**	**3**
	ANDI	8	8	24	4	17	3
CT-0.9m		**13**	**15**	**100**	**13**	**13**	**6.7**
	CFIM	13	15	100	13	13	6.7

KPNO

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
KP-4m		**84**	**97**	**315.8**	**145**	**46**	**3.3**
	ECH	6	6	17	3	18	2.8
	FLMN	16	17	65	2	3	3.8
	MARS	10	10	29	15	52	2.9
	MOSA	27	29	91	69	76	3.1
	RCSP	25	30	99	56	57	3.3
	SQIID	5	5	14.8	0	0	3
WIYN		**36**	**40**	**112.2**	**74.8**	**67**	**2.8**
	DSPK	1	1	1	0	0	1
	HYDR	17	17	53.8	28.2	53	3.2
	MIMO	7	10	25	23	92	2.5
	SPSPK	2	2	7	3	43	3.5
	WTTM	10	10	25.5	20.5	80	2.5
KP-2.1m		**35**	**39**	**183.2**	**79**	**43**	**4.7**
	CFIM	13	14	65	54	83	4.6
	FLMN	3	4	22	0	0	5.5
	GCAM	16	16	75	25	33	4.7
	SQIID	5	5	21.2	0	0	4.2
W-0.9m		**6**	**7**	**21**	**17**	**81**	**3**
	MOSA	6	7	21	17	81	3

Community Access

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Keck-I		**14**	**14**	**18.5**	**4**	**22**	**1.3**
	HIRES	8	8	10	2	20	1.2
	LRIS	1	1	2	2	100	2
	LWS	5	5	6.5	0	0	1.3
Keck-II		**17**	**19**	**28**	**7**	**25**	**1.5**
	DEIMOS	6	6	7	6	86	1.2
	ESI	2	2	3	1	33	1.5
	NIRC2	3	5	7	0	0	1.4
	NIRSPEC	6	6	11	0	0	1.8
HET		**7**	**8**	**8.2**	**4**	**49**	**1**
	HRS	5	6	5.9	2	34	1
	LRS	2	2	2.3	2	87	1.1
MMT		**7**	**7**	**16**	**10**	**63**	**2.3**
	BCHAN	5	5	12	8	67	2.4
	RCHAN	2	2	4	2	50	2

2003A TAC Members

Extragalactic (31 October–1 November 2002)
Dave DeYoung, NOAO (C)
Tod Lauer, NOAO (C)
Patrick McCarthy, Carnegie Observatories (C)

Lee Armus, SIRTF Science Center
Julianne Dalcanton, University of Washington
Roelof De Jong, STScI
Arjun Dey, NOAO
Erica Ellingson, University of Colorado
Brian McNamara, Ohio University
Philip Pinto, University of Arizona
Marc Postman, STScI
Lisa Storrie-Lombardi, SIRTF Science Center
Nick Suntzeff, CTIO
Rogier Windhorst, Arizona State University
Rosemary Wyse, Johns Hopkins University
Howard Yee, University of Toronto
Ann Zabludoff, University of Arizona
Dennis Zaritsky, University of Arizona

Galactic (4–5 November 2002)
Caty Pilachowski, Indiana University (C)
Abi Saha, NOAO (C)
Chris Sneden, University of Texas, Austin (C)

Lori Allen, SAO
Michael Briley, University of Wisconsin
Margaret Hanson, University of Cincinnati
Jeremy King, University of Nevada, Las Vegas
Davy Kirkpatrick, CalTech, IPAC
Julie Lutz, University of Washington
Ken Mighell, NOAO
Knut Olsen, CTIO
Randy Phelps, California State University, Sacramento
Marc Pinsonneault, Ohio State University
Steve Ridgway, NOAO
Jeff Valenti, STScI
Stefanie Wachter, SIRTF Science Center
Rene Walterbos, New Mexico State University
Jonathan Williams, University of Hawaii

Solar System (30 October 2002)
Dave DeYoung, NOAO (C)

William Hubbard, University of Arizona
Robert Millis, Lowell Observatory
Susan Wyckoff, Arizona State University

ISPI Sees First Light on Blanco 4-Meter

Ron Probst & Nicole van der Bliek

The Infrared Side Port Imager (ISPI) had a very successful "first light" engineering run on the Blanco 4-meter telescope during the nights of September 24 and 25. The first astronomical target for ISPI was the galactic cluster Blanco 1, overhead at 0 hours, -30 degrees. The instrument produced excellent, uniform image quality in J, H, and Ks over its 11 × 11 arcmin field of view: 0.6 to 0.7 arcsec FWHM in short exposures at the zenith. Throughput was similar to its optical twin FLAMINGOS. There were no major installation or performance problems. This validated the project's "build to print" philosophy for design and fabrication, supported by extensive subsystem testing prior to final instrument integration. The "can-do" cooperative spirit shown by all members of the La Serena engineering team was vital for this approach.

A second engineering run is scheduled for November 20 and 21. We will explore external illumination effects with the telescope-plus-instrument, such as scattered-light dependence on angular distance from the Moon. We will also inaugurate the user GUI, which has a great deal of commonality with SOAR instrument GUIs. The first science observations are scheduled for January 2003.

This single-frame image of 47 Tucanae, taken during a 3-second exposure, illustrates the combination of area coverage and depth provided by ISPI on the Blanco 4-meter telescope.

SOAR Achieves "First Glimmer"

Steve Heathcote

The Southern Astrophysical Research Telescope (SOAR) achieved a significant milestone, nicknamed "First Glimmer," in late October with the acquisition of the first image of a star using an auxiliary telescope attached to the SOAR mount. This event marks the successful culmination of nearly a year's gruelling effort by the project team led by Tom Sebring, during which first the dome, and then the mount, and their control systems, were assembled on the SOAR site. The mount was then painstakingly aligned (the residual tilt of the azimuth bearing is only 13 arcsec) and put through a series of tests, which matched or bettered the excellent performance seen in the manufacturer's acceptance test prior to shipping. The ease with which the first star

continued

SOAR continued

was found—it took only ten minutes from the moment the dome was opened and fell within half a degree of the field center—demonstrates the success of these efforts. This and the excellent out-of-the-box tracking performance—0.6 arcsec RMS dominated by seeing—attests to the quality of the conceptual design and fabrication work performed by the mount contractor Vertex RSI of Richardson, TX.

During the remainder of this year, the SOAR team will work to fully integrate all the observatory systems with the telescope control system, and optimize the pointing and tracking performance of the mount, as well as clean up the remaining loose ends. Integration and testing of the commissioning instrument, the SOAR Optical Imager, and the Nasmyth instrument selector/guider boxes, both being built at CTIO, will begin early next year. The goal is to have the telescope and its first instruments fully functional before the optics are delivered in mid-2003.

Figure 1. SOAR Project Engineer Victor Krabbendam perches on one of the Bent Cass mass simulators in order to acquire the first star through a finder mounted on the auxilary telescope, a Meade LX200. The finder was needed only once. Having established the initial zero point, blind pointing was good enough, even before determining a pointing model to place targets near the center of the field of the S-BIG CCD (controlled by Steve Heathcote) mounted on a second finder, and thus centered in the main telescope.

Figure 2. SOAR's first star Achernar (Alpha Eridanus V = 0.45), as imaged with an S-BIG CCD camera mounted on the 10-inch Meade telescope.

SuperMacho Returns to CTIO

Christopher Stubbs (University of Washington)

The SuperMacho microlensing survey of the Large Magellanic Cloud (LMC) is using the Blanco 4-meter and the MOSAIC camera to obtain its second season of observations this year. The objective of the survey is to ascertain the location of the excess LMC lensing population seen in the MACHO survey. Observations are scheduled for alternate second-half nights, except during October, November, and December bright time.

A careful analysis of last year's data has verified that the survey likely has the statistical power to discriminate between various lensing scenarios (for example, LMC-LMC lensing versus lensing by a foreground screen of stars). Variable stars in the SuperMacho fields were identified from last year's images, and this year the goal is to put the analysis on a real-time footing.

continued

SuperMacho Returns continued

An important milestone this year was the installation of a high-end computing cluster and associated disk storage at CTIO. Ten dual-processor computing nodes (1.2-gigahertz CPUs with a gigabyte of RAM each) and a total of 3 terabytes of RAID disk were shipped to Chile and have been installed in the computer room on the La Serena compound. After an initial round of hardware "features" (almost certainly due to Coriolis force mismatches between the Northern and Southern Hemispheres!) the system is now in stable operation. A frame subtraction pipeline and SQL-compatible database are installed on the system, and a night's worth of MOSAIC data can be processed essentially in real time. The transfer of images from the mountaintop to La Serena is accomplished automatically, using the "postproc" capability of the data acquisition system. Jobs on the cluster machine are managed using (appropriately enough) the Condor task management system.

The pipeline reduction hardware and database schema are common to both the SuperMacho survey and the ESSENCE project, which intends to detect and monitor hundreds of Type 1a supernovae in the coming years. The two teams are working closely together, with a particular focus on treating the joint endeavor as a precursor project for the Large Synoptic Survey Telescope (LSST).

An important and interesting development this year has been the capability to carry out observing from the computer room in La Serena, using a video link to the telescope operator on Cerro Tololo. This has eased the logistical burden of carrying out observing on alternate nights, and has allowed the SuperMacho team the benefits of staying together in one location. Full Mosaic images can be transferred down to La Serena in a matter of few seconds, so that there is no appreciable difference between being in La Serena and being on the mountain, even for tasks like focusing the telescope.

The SuperMacho team comprises scientists from the University of Washington, CTIO, Lawrence Livermore National Laboratory, Universidad Católica, Lucent/Bell Labs, and McMaster University. Armin Rest, one of the SuperMacho team members, has recently moved to CTIO as a postdoc where, along with pursuing other interests, he will continue his work on the microlensing survey.

Blanco 4-Meter Shutdown October 2002

Tim Abbott

At the time of writing, the Blanco 4-meter telescope shutdown is nearing completion. The first priority for this shutdown was to repair broken radial supports. Two dozen of these edge-mounted, mechanical assemblies reduce sagging of the primary mirror under gravity by distributing the load; they push from below and pull from above when the mirror is tilted, with the force vectors passing through its center of gravity.

The supports are attached to the Cervit primary via epoxied Invar pads. In some cases, the epoxy has failed. The supports are nearly impossible to access without dismantling the telescope and it is difficult to detect precisely when they detach from the mirror, and therefore under what circumstances. On average, only one or two of these supports break during a period of roughly two years, but this time a total of four supports had given way in the two years since the last re-aluminization of the primary. The risk of further breakage and possible disabling of the telescope forced our hand, even though we had hoped to wait another two years before re-aluminizing, and thus gaining access to the supports. As it is, we are now cleaning the mirror with both water and CO_2 snow.

Given that the repairs require dismantling the telescope, and thus closing it for a minimum of ten days, we decided to extend the downtime to two weeks and take the opportunity to re-aluminize the primary as well. A number of other tasks were also scheduled and completed:

- New mirror cover actuators have been installed—the new mirror cover stretches the capability of the old actuators, requiring that the telescope be brought to north station to open and close; the new actuators are considerably more powerful.
- A new Cassegrain guide camera has been installed—permitting region-of-interest and therefore faster guiding.
- Telescope grounding paths were improved, perished compressed-air lines were replaced, and cables were rerouted to bypass an ancient and failing cable run.

continued

Blanco Shutdown continued

- Microswitches and self-illuminating cameras have been installed on each support pad to provide instant notification of broken pads and the ability to inspect their condition remotely.

Considerable thought was put into identifying plausible causes for the support breaks, and as many of these as possible were addressed. Old epoxy was stripped and the surfaces carefully prepared to create a good bond. Previously, joints were repaired after re-aluminization of the primary. Then the epoxy cure was accelerated by heating with lamps, and the supports were neither disassembled prior to reinstallation nor lubricated—both of which might have relieved differential thermal expansion stresses. Cervit and Invar have very low thermal expansion, but Invar's is greater than Cervit's and considerable forces can still develop. This time, repairs were done before re-aluminization, the joints were cured at ambient temperatures for a full week, the supports were removed after the repair, and lubrication was applied to critical bolted surfaces.

Figure 1. One of the infamous edge supports, mounted on the mirror cell at bottom and still attached to the mirror at top.

No evidence was found of binding in the supports from corrosion (as a result of either condensation or possible leaks in the wet-wash seal). All repairs survived strain tests 50 percent greater than the nominal specification before the telescope was reinstalled.

Suspecting that mechanical misalignment might be a contributory cause, we carefully measured the relative positions of the mirror, its cell, and the supports. A full analysis is pending, but we discovered that the mirror was mounted in the cell at 2.3 millimeters below its nominal position. There is no obvious reason for this but it may be the accumulated result of repeated recollimations and other adjustments experienced by the telescope. Since such a displacement would generate a torque in the tilted mirror via the edge supports and produce lateral forces in the epoxy joints, we corrected the error. A gratifying sanity check was provided on reassembling the telescope: the run of below-mirror hard point loading with telescope altitude is now a clean sinusoid whereas previously it had been lopsided, exactly as would be expected.

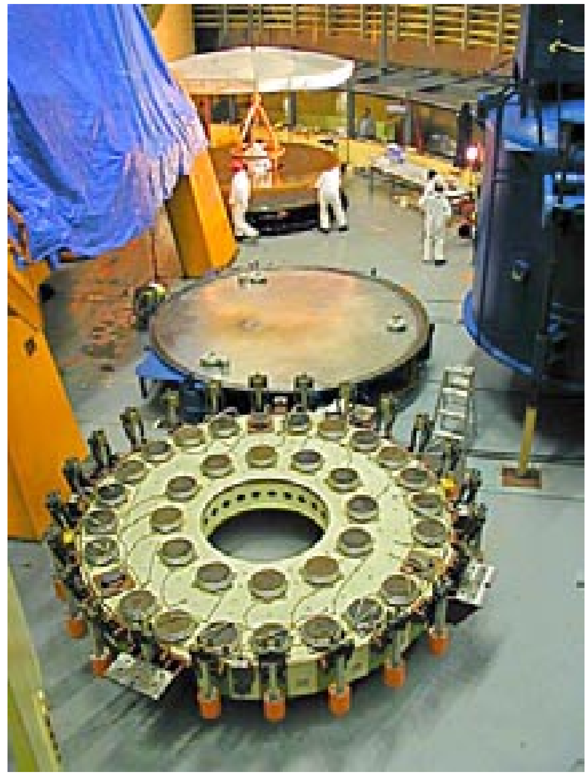


Figure 2. The dismantled Blanco telescope. In the foreground is the mirror cell, the edge supports around the edge and two circles of active optics supports within. At the rear, the primary mirror, freshly stripped of its aluminum coating, is prepared for lifting onto the bottom of the re-aluminization chamber in the middle of the picture.

Despite these efforts and to our considerable distress, one of the repaired edge supports failed almost immediately after we started moving the telescope. The proximate cause of the break may have been the result of a procedural error, but it seems clear that the supports should be able

continued

Blanco Shutdown continued

to take considerably more strain than they are suffering if everything is per design. Nevertheless, we have considerably improved our knowledge of the telescope through this shutdown, and the new capability to monitor the condition of the supports will hopefully provide us with unambiguous information in the event of additional breaks and perhaps lead us to a permanent cure.

The final tasks of the shutdown involve confirming that the telescope is operating correctly and tweaking the optical alignment as necessary. Thus far, all seems well.

It is impossible to mention everyone who has made a crucial contribution to this work, but Oscar Saá, Roberto Tighe, Gale Brehmer, Andrés Montané, Eduardo Huanchicay, Ricardo Schmidt, and their teams have all played central roles at one point or another. In particular, the frequently unsung mechanics have been a pleasure to watch; their deft handling of tens of tons and metal and glass made graceful choreography of dangerous work.

Figure 3. The US Ambassador to Chile paid us a visit during the shutdown. Back row: Gale Brehmer, Manuel Martinez, Javier Rojas, Tim Abbott, and Oscar Saá. Middle row: Eduardo Huanchicay, Andrés Montané, Ambassador William R. Brownfield, Malcolm Smith, and Wilson Muñoz. Front row: Eduardo Aguirre and Jorge Briones.

Small Telescopes at CTIO: An Update

Alistair Walker

In the September *Newsletter,* Malcolm Smith and I discussed the future of the small telescopes at CTIO, and we described how at that time we were in the midst of evaluating a proposal from the SMARTS consortium (comprising NOAO and six other institutions) to operate the CTIO small telescopes for three years, starting at the beginning of semester 2003A. Since then, at the recommendation of the review committee, SMARTS submitted a revised operations plan and budget. On the basis of this revised plan, NOAO Director Jeremy Mould recommended to the National Science Foundation that the proposal be accepted. At the moment we are working on a SMARTS-AURA Memorandum of Understanding, with a view to having all the bureaucratic details completed by year-end.

As a reminder, the initial telescope-instrument complement consists of the 1.5-meter telescope with Cassegrain spectrograph; the 1.3-meter telescope with Andicam, operated in queue mode; and the 0.9-meter telescope with a 2K CCD imager. The consortium plans both to provide new instrumentation and to bring the Yale 1.0-meter telescope back on-line during 2003-2004. In the first year of operations, NOAO users receive one third of the time, integrated over all the telescopes. A good number of proposals have been submitted for 2003A. These will be evaluated shortly via the usual NOAO Time Allocation Committee (TAC) process, and then scheduled along with projects from other SMARTS members and Chile. Scheduling and day-to-day running of the small telescope operations will be directed by the SMARTS Principal Scientist, Charles Bailyn (Yale University). CTIO astronomer Alan Whiting (*awhiting@ctio.noao.edu*) will be looking out for the interests of NOAO users, and coordinating the move of the dual IR-CCD imager Andicam from the 1.0-meter to the 1.3-meter by a team from Ohio State University.

New Staff

Malcolm Smith

Armin Rest arrived in La Serena on October 25 to take up a two-year Postdoctoral Research Associate appointment at NOAO South. He comes from the University of Washington, where he has just defended his PhD thesis. We expect to benefit greatly from Armin's expertise in database development, gained during his work on the SuperMacho project, a precursor to the Large Synoptic Survey Telescope (LSST). He will further improve the robustness and flexibility of the pipeline he developed, which should provide a useful model for a similar pipeline that must be employed in order to maximize the scientific output of both the LSST and the Giant Segmented Mirror Telescope (GSMT).

On December 4, Marcel Bergmann is scheduled to arrive from the University of Texas, after completing his PhD thesis. Bergmann will hold the first US Gemini Postdoctoral Fellowship. His primary duty within USGP will be to support US users of the Gemini Multi-Object Spectrograph (GMOS). He plans an active science program focused on the dynamics and stellar populations of elliptical galaxies.

Other Happenings at CTIO

Amber Young, a student at Middlebury College in Vermont, came to La Serena for a year-long study-abroad experience during the 2001–2002 academic year. During her year abroad, Amber lived with a Chilean host family, taking classes at the University of La Serena, and interning at CTIO. As a physics major at Middlebury, Amber was anxious to take advantage of her proximity to the CTIO offices to explore the field of astronomy. She began by joining the REU/PIA program from January to March 2002, working with Bob Blum and Nicole van der Bliek on an investigation of near-infrared spectroscopy of AGB stars in the Galactic center. After the conclusion of the REU program, Amber started work with Chris Smith and the MCELS group in order to explore another facet of astronomy research. The new project has led to her senior thesis work at Middlebury, under the supervision of Frank Winkler, where she has begun her hunt for planetary nebulae in the Small Magellanic Cloud.

Hektor Monteiro arrived in La Serena in April 2002 to work with Steve Heathcote and Hugo Schwarz for PhD work on the structure of planetary nebulae (PNe). Hektor's work at Brazil's Universidade de Sao Paulo was mainly theoretical, using three-dimensional photoionization codes to study the gas distribution in PNe, and the collaboration with Heathcote and Schwarz was intended to complement this work with high-quality observational data. In two separate 2002A runs (one night in April with the 0.9-meter and five nights in June with the 1.5-meter) they used standard long-slit spectroscopy and a variation of a technique that allows mapping entire nebulae to observe a number of interesting and complex objects. This work led to two posters on one of the mapped PNe, NGC 6369, at the "Winds, Bubbles & Explosions" conference in Mexico, September 9–13. Hektor will be finishing his PhD with Ruth Gruenwald, and will also be reducing some new polarization data from the 4.2-meter WHT and the ESO 3.6-meter telescopes.

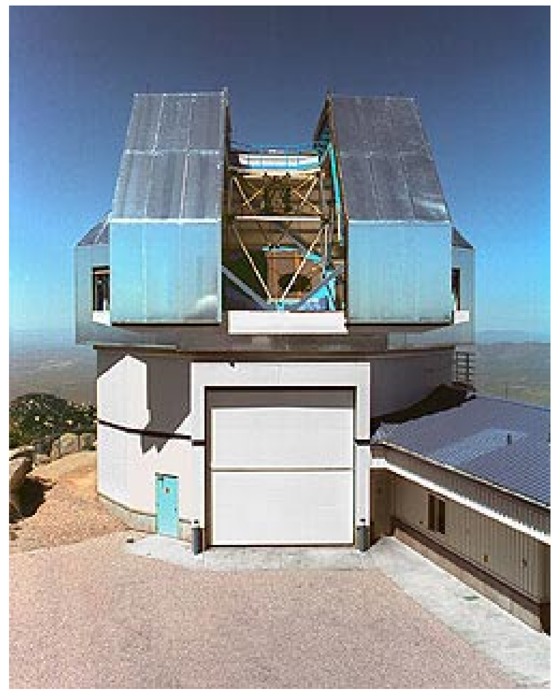
WIYN Strategic Planning

Richard Green

The draft outline of the next strategic plan for the WIYN Consortium and WIYN Observatory, below, represents results from the recent meeting of WIYN Consortium members held in Chicago on September 13–14. Participants were charged to create a strategic plan to take the consortium and observatory to the end of the decade. The assembled group came very close to forging a definitive form for that vision. This draft document serves now as the focus of ongoing discussions within the partner institutions and among the WIYN Board and Science Advisory Committee members, in anticipation of a second consortium meeting to prioritize goals and to develop specific actions.

This expansive vision for WIYN reflects an underlying confidence that the consortium can provide a long-term vehicle to realize many of the scientific aspirations of the partners. It was recognized by participants that an important next step in the process is the prioritization of the major specific goals. The vision provides strong motivation for continuing to expand the resources available for reinvestment. The priorities will allow the board, director, and staff to optimize resource allocation and achieve near-term goals that are matched to the actual resource envelope.

As a proposer for and user of the WIYN facility, you are a key part of the NOAO scientific constituency of the telescope. In order to represent NOAO aspirations properly in the consortium, we need your opinion on which priorities will make WIYN the most effective for your science. Please send your comments to me (*rgreen@noao.edu*) or to Abi Saha (*asaha@noao.edu*) about both the broad (bulleted) directions and the more specific supporting goals.



The WIYN 3.5-meter facility.

Draft Outline: WIYN Strategic Plan — September 2002

1. Mission Statement

The plan is based on a WIYN Mission Statement updated from that given in the 1998 Strategic Plan:

WIYN is a consortium of public and private educational institutions that seek to:

- **Learn about the Universe through forefront research programs in observational astronomy.**
- **Operate, maintain, and enhance the WIYN Observatory, including the development of innovative operational modes and instruments to support the research and educational needs of the WIYN users.**
- **Communicate the excitement of scientific research and the exploration of the Universe to wider communities.**
- **Develop new capabilities for astronomical research.**

2. Strategic Directions

- **Focus on core capabilities.** The goal is to complete two major new capabilities, including the One-Degree Imager (ODI) and, for example, enhanced wide-field spectroscopy, and to prioritize resources for their effective exploitation.
    a. Proceed with funding, development, and deployment of the ODI as the highest consortium priority for major instrumentation.
    b. Identify, explore, and implement the next major capability representing the best combination of consortium scientific interests and opportunities, niche for WIYN telescope performance, and complementarity to ODI (e.g., bright time usage).
    c. Identify, explore, and implement operational consequences of core capability choices.

continued

WIYN Strategic Planning continued

- **Maintain and develop the facility.** The intention is to keep the WIYN telescope delivering top-quality images with high reliability. This category is usually not a strategic one, but the priority of investment for maintaining state-of-the-art performance is to be emphasized.
    a. Maintain the performance of telescope core systems at state-of-the-art levels.
    b. Identify potential catastrophic failure modes, develop an emergency response plan, and prioritize investment to mitigate failure risks.
    c. Design, implement, and commission a bent Cassegrain port for PI instruments.
- **Enhance the impact and visibility of WIYN science.** This direction includes enabling key projects, demonstrating advanced technology, promoting outreach, and strengthening collaborative efforts within the consortium.
    a. Enable high-impact key projects.
    b. Demonstrate advanced technology.
    c. Improve WIYN visibility through public outreach.
    d. Adopt and exploit unique observing modes.
    e. Raise the interaction cross section of external scientists with WIYN.
    f. Promote internal collaborations.
    g. Connect with other disciplines.
- **Enhance and deepen the instrumentation and technical capabilities of the partnership.** A broader distribution of technical and software development among the WIYN partners strengthens the observatory. Included within this goal will be continued support of PI instrument projects.
    a. Develop leadership in key technologies that strengthen WIYN.
    b. Provide assistance and incentive to members to educate, train, and support instrumentalists.
- **Explore gaining WIYN access to larger telescope facilities, both existing and planned.** Concepts to be explored include WIYN acting as the nucleus of a broader partnership to become a member of a consortium to build a 20- to 30-meter telescope and WIYN partnering to develop major instrumentation for existing 8- to 10-meter telescopes in exchange for telescope time.
    a. WIYN Consortium scientists all recognize that guaranteed access to 8-meter class facilities now, and 20-meter class facilities in the next decade, is a valuable component to competitive advantage in optical observational astronomy.
    b. The goal is to develop an understanding of options and resource requirements in sufficient detail to inform the renewal process of the partnership agreement.
    c. Consortium astronomers will take the lead, providing specific WIYN representation at exploratory planning meetings for new facilities or new instrumentation options.

New Responsibilities

Richard Green

Two scientific staff members will be leaving us temporarily, and many of their responsibilities will be passed on to others, who will be the new contacts for your questions and comments. Buell Jannuzi is looking forward to a research sabbatical, starting January 1. Heidi Schweiker, the WIYN 0.9-meter site manager (and former KPNO observing assistant) will be taking on the responsibility for assuring the reliability and performance of the CCD Mosaic imager. She will have the continued backing of the Tucson-based Mosaic team, including electronics support from KPNO and NOAO engineering, and software expertise from Mountain Programming and the Data Products Program. She will get additional help with expert-level questions from Chris Smith and Knut Olsen, the support team for Mosaic II. You can direct your questions to *heidis@noao.edu*.

Nigel Sharp has accepted the rotator position for the extragalactic grants program in the NSF Astronomy Division, effective early December. We'll miss Nigel's deep knowledge of the telescope system, but we wish him and his family every success in this new challenge.

From the NSO Director's Office

Steve Keil

National Solar Observatory (NSO) involvement in several major projects continues to dominate life in both Sunspot and Tucson. These projects include the final stages of assembly and debugging of the SOLIS instruments, development of high-order adaptive optics (AO), development of the diffraction-limited spectral polarimeter, and design of the Advanced Technology Solar Telescope (ATST). In addition, the payoff of image improvement and AO at the flagship facilities is creating excitement and observing pressure. Some of the interesting science resulting from these efforts are presented in this *Newsletter*. Particularly exciting is the measurement of prominence magnetic fields at the Dunn Solar Telescope by the High Altitude Observatory group. Conducting all of these projects, while maintaining telescope operations in an essentially level-funded environment, places a lot of pressure on NSO personnel.

✷

The dominance of instrument programs at NSO was reflected in our strong presence at the August SPIE meeting on astronomical telescope instrumentation in Hawaii. Two of the conferences (on innovative solar telescopes and instrumentation, and on large ground-based telescopes), as well as a number of sessions within the conferences, were chaired by NSO personnel. Twenty-one presentations were given by NSO staff, with talks ranging from adaptive optics to software control of telescopes. Several presentations discussed progress and plans for the ATST and SOLIS.

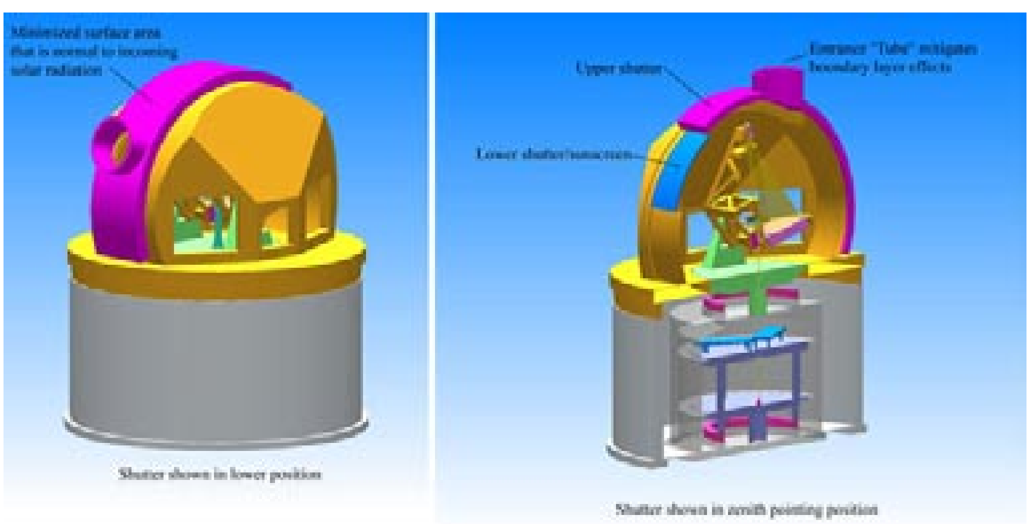
✷

In October, the ATST project held a 2½-day design workshop, with wide community participation, to discuss the current design effort, straw man concepts, expected costing, and schedule. The workshop, which had 42 attendees, served to focus the community on trade-off issues, associated risks, the need for some up-front decisions, and the necessity of getting started on such long-lead items as the primary mirror.

Constructive discussions were held on a number of important issues. Three major trade areas related to design, and two others related to schedule impacts, were presented. The design areas discussed were on-axis versus off-axis trades, alt-az versus equatorial mount configurations, and enclosure considerations. The workshop consensus was to pursue only the off-axis concept. The ATST Web site presents a summary of the reasons for this, and information on our efforts (primarily through the start of four fabrication-study contracts) to address the difficulties of the off-axis approach.

For the mount configuration, the majority of participants favored the alt-az option, so that greater effort could be concentrated on more detailed design and on performance issues relating to enclosure design, balanced seeing, wind buffeting, dust, and maintenance. Again, see the ATST Web site for additional information, including rationale.

continued



Hybrid enclosure concept being considered after feedback from the October 2002 ATST design workshop. This design represents options taken from the CLEAR concept and open or collapsible dome concepts. Much work is still to be done on evaluating performance impacts and trades.

NSO Director's Office continued

On the enclosure concepts, there was a wide range of opinions and concerns, and it was suggested that this topic, and thermal control in general, be a major area of emphasis in our work toward the Conceptual Design Review (CoDR) scheduled for summer 2003.

In other schedule-related concerns, a strong preference was expressed for attempting to raise the money needed for, and obtaining permission to proceed with, early purchase of a primary mirror blank as a long-lead item. This has the potential of shaving about two years from the project schedule. Ideally, we would initiate purchase of this blank mirror immediately after the CoDR, once the details of the fabrication studies are in and first-order choices of blank parameters, such as thickness, are finalized. A project schedule with a completed telescope in 2012 would result if we cannot proceed with purchasing the blank during the D&D phase. Based upon initial feedback from suppliers and other preliminary assumptions, it appears that early purchase of the blank and one or two smaller actions would allow this schedule to be advanced by over two years.

Early purchase of the mirror blank would put considerable pressure on other action items, such as final design of the enclosure and support facilities, as well as the permitting process and site selection date. Though the time frame for site permitting is a very rough estimate, we are concerned it could easily take more than a year. The long-lead schedule calls for site selection by the end of 2003. Concern was expressed that this is a rather short time period for collecting site survey data. It was strongly suggested that the site survey data be complemented with existing data from the test sites (e.g., nighttime seeing, scintillation, weather statistics) and input from atmospheric models.

The major points summarized above on trade areas and schedule impacts were the most important conclusions of the workshop. We are very pleased with the level of input and discussion. Immediately after the design workshop, the ATST Science Working Group met to refine and agree on the science requirements document, site survey output, and site selection criteria.

✷

With GONG++ now operating its new high-resolution cameras with continuous magnetograms, and the high-resolution data-processing pipeline taking shape, the GONG Science Advisory Committee (SAC) met in October to discuss the new GONG++ science operations plan. In addition to its ongoing study of time-varying solar internal structure and dynamics, based on global helioseismology, GONG++ will begin routine generation of local helioseismology data products, as well as value-added science products such as subsurface flow maps.

✷

Dave Dooling has joined NSO as the ATST project outreach and education officer. Dave has extensive background and experience in science writing, and comes to us from Huntsville, AL, where he worked on many outreach projects, including management of outreach and education for the NASA Microgravity Research Program, and writing for NASA Marshall Space Flight Center's *Science@NASA* Web site. Dave is in residence at NSO/Sunspot and can be reached at *dooling@nso.edu*.

✷

Maud Langlois, an expert in multi-conjugate adaptive optics (MCAO), has joined our adaptive optics team. Prior to NSO, she worked on MCAO laboratory experiments at the University of Durham, England, and on adaptive optics at the University of Arizona/Steward Observatory. Gilberto Moretto was also hired by NSO as an optical scientist and is spending part of his time supporting the solar AO effort. We also welcome scientific programmer John Bolding and administrative assistant Norma Aguilar to GONG, Scott Long to the Sac Peak shop as a craftsperson, and Scott Sales, a student assistant working with Frank Hill on reducing ATST site survey data.

NSO Proposal Submission Deadline for Spring (April–June) 2003 Quarter:
15 February 2003
Observing Time Request Forms are available at *www.nso.edu*

ATST Site Survey Status

Frank Hill

The site survey effort for the Advanced Technology Solar Telescope (ATST) is rapidly nearing completion of the initial deployment phase. As of this writing, we have five sites operating and returning data: Big Bear, Haleakala, and Sacramento Peak were joined by Panguitch Lake, Utah, in early September and La Palma, Canary Islands, in early October (see accompanying tower photos). The last site to be deployed is San Pedro Martir, Mexico. There, the footings have been poured, a static crane has been built, and we are waiting for the test stand to clear customs in San Diego. By the time this is published, we expect that this last instrument will have been installed.

The ATST site survey test stand at Panguitch Lake, Utah.

The nagging wind shake problem has been solved. This proved to be a software problem: while the SDIMM application was reading the video memory buffer, the frame grabber was, on occasion, beginning to write the subsequent image. This corrupted the data and also resulted in an overcount of the number of points being averaged during a sample, which artificially lowered the estimated seeing. The problem was corrected by forcing the frame grabber to write a single image at a time. This lowered the number of samples per second from 30 to 15, which is still sufficient for a reliable measurement of the seeing.

The ATST site survey stand at La Palma, Canary Islands, Spain.

Work is finishing up on the Sky Brightness Monitor in Hawaii. A prototype is operating at Haleakala, and software to point the mount is under development. These instruments should be delivered in the next 4 to 6 weeks.

Considerable progress has been made on the data reduction package. We now have an analysis package to estimate the turbulence and seeing as a function of height above the test stand. Scott Sales, a University of Arizona student, will perform the routine data reduction and quality checks. Once all of the sites have been producing data for a while, the summary results will be put on the Web without site identification.

SOLIS

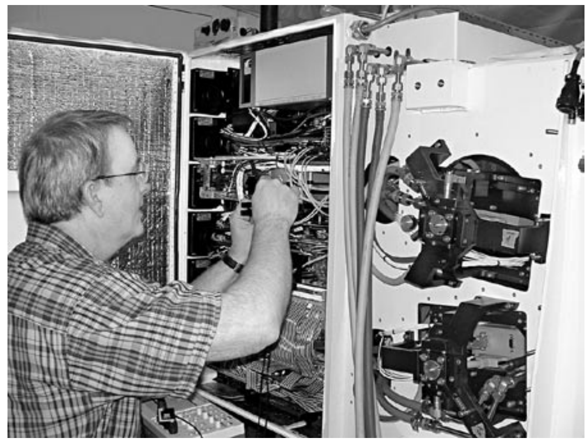
Jack Harvey

SOLIS continues toward first light. Detailed plans have been prepared for the move of SOLIS equipment to the GONG site a few kilometers north of the Tucson office. Detailed plans are also under development for a subsequent move to Kitt Peak. The first move will allow testing of the instruments without long daily trips to Kitt Peak. This period will be used to make simultaneous observations with SOLIS and the Kitt Peak Vacuum Telescope (KPVT). These observations are required to connect the new SOLIS data with the 28-year database of existing observations, before the old equipment is shut down forever. Upon completion of the period of cross-calibration, we had planned to move SOLIS to Kitt Peak for temporary storage during the final preparations of the KPVT building to receive SOLIS. However, an alternate plan, which has many advantages, is to delay the move to Kitt Peak until the building is ready. During this time, a limited synoptic observing program would be done by SOLIS at the GONG site.

Optical alignment of the Vector Spectromagnetograph (VSM) was completed, and the imaging quality of the spectrograph proved to be excellent. During this process, however, we discovered that the high-reflectivity silver coatings on some of the optics had degraded. The affected pieces were the telescope primary mirror and the spectrograph Offner relay optics. In the case of the primary, reflectivity had dropped from 96 percent to 83 percent, and scattered light had increased by a large factor. The failure mechanism is suspected to be excessive porosity of the dielectric coatings that protect the silver. The primary mirror has been recoated, this time using ion-assisted deposition of an even higher reflectivity coating that should essentially eliminate porosity. Similarly, we plan to recoat the Offner optics with highly stable protected gold. Compared to enhanced silver, protected gold decreases throughput and increases polarization cross talk by small amounts. The compensating benefit of not having to dismantle the spectrograph to reach the Offner optics in case of a silver coating failure was deemed worth the small performance degradations.

The VSM cameras have been installed and are being tested. Calibration polarizers and waveplates have been aligned and installed in the VSM. The major remaining task required to complete the VSM is to install covers over all of the ports and to test for, and seal, helium leaks.

Laboratory tests of the Integrated Sunlight Spectrometer (ISS) are continuing. Until the VSM is moved to the GONG site, it is not possible to feed sunlight into the ISS. The stability of the ISS has been improved to the point that barometric pressure variations are the major source of spectra wavelength shifts.



Lonnie Cole tests two Rockwell Scientific cameras installed in the SOLIS Vector Spectromagnetograph. The cameras are mounted inside the dark cavities to the right. Lonnie is working in the normally sealed electronics compartment. Note many fiber optic signal cables and also hoses carrying chilled glycol fluid and helium gas required for temperature and internal seeing control, respectively.

The Full Disk Patrol (FDP) housing is finished and is ready for optics to be loaded and aligned. A temporary clean room consisting of a plastic film "bubble" fed by HEPA-filtered air was set up around the FDP. One of two birefringent narrowband filters has not been completed and in its place, an old H-α filter was refurbished and will be used until time is available to finish the planned filter. The H-α filter delivers excellent images and, during testing, real-time television of several solar flares was enjoyed by many staff members in the Tucson office.

All of the final data handling system hardware has been purchased, assembled and tested. The system now contains 14 data processing computers and 1 terabyte of data storage. All of the software that controls data processing is completed and development of the data-processing algorithms continues. The VSM components are now all under software control as the VSM is being assembled and aligned. There are 13 different mechanisms that may be operated and accurately positioned. The FDP instrumentation software is completed for the cameras and most of the components. Work remains to be completed on the FDP shutters and modulators.

New Imaging Spectropolarimetry at 2231 Nanometers

Matt Penn, Bill Livingston (NSO) & Wenda Cao (NJIT)

The Ti I absorption line at 2231 nanometers has been reexamined recently with imaging spectropolarimetry, as well as single-point bolometric measurements. Early measurements at the Kitt Peak McMath-Pierce telescope have shown that this line is prominent in sunspot umbra and visible in the penumbra of spots, but the line disappears in the solar photosphere where the temperature rises to 6000 K and higher. Recent observations by Ruedi, Solanki, and Keller had made spatial cuts across sunspots to show the variations of the line splitting and polarization. New observations made under good seeing conditions with the Cal State University Northridge (CSUN)/NSO infrared camera and polarimeter system have provided the first full imaging spectroscopy and spectropolarimetry of this line in sunspots.

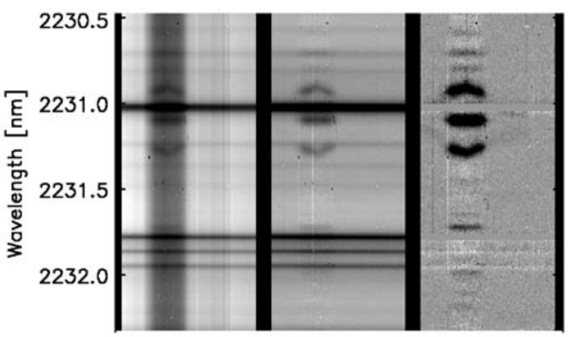


Figure 1. Time-processed spectra.

As shown in the spectral frames of figure 1, the Ti I line shows large Zeeman splitting in the sunspot NOAA 10008, observed on 29 June 2002. A telluric absorption line often interferes with the central component of the multiplet, but as the spot was observed on the west solar limb, solar rotation has Doppler shifted the Ti line so that the telluric spectra can be removed. Computing the equivalent width of the line, and comparing it with the plasma temperature, shows excellent agreement with predictions of the line formation and with bolometer spectra obtained in NOAA 9973 on 4 June 2002 (see figure 2). Maps of the continuum, Ti I line strength, and Stokes V signal showing the line-of-sight magnetic component are presented in figure 3; the Ti line strength seems anomalously enhanced on the limb-side penumbra, but the Stokes V signal shows a magnetic component on both sides of the sunspot umbra, with the usual inversion of the sign of the line-of-sight component seen in sunspots near the solar limb.

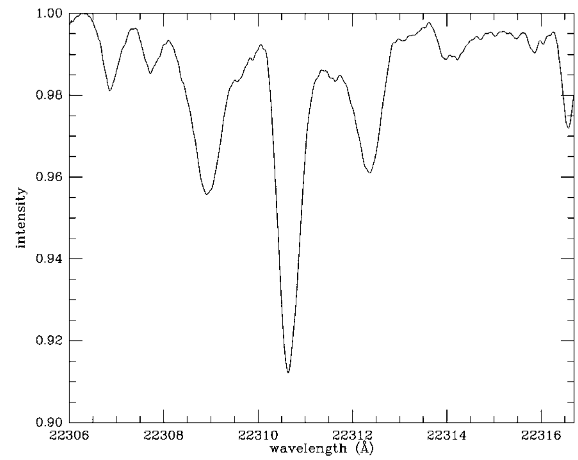


Figure 2. Ti sunspot intensity spectrum.

Because the Zeeman-shifted components are completely separated from the central component in strong solar magnetic fields, the Ti I 2231-nanometer line joins a list of very useful infrared magnetic lines that are fully resolved. Perhaps the most well-known line is the Fe I 1565-nanometer absorption line; but the Ti line has

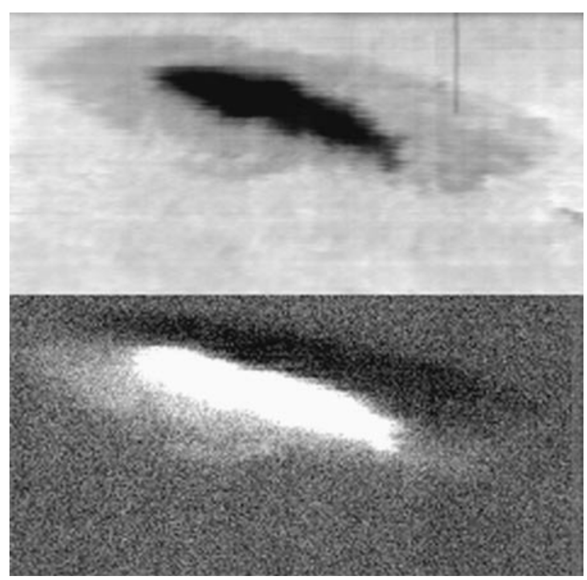


Figure 3. Ti temperature map (top) and Stokes V map (bottom).

continued

New Imaging Spectropolarimetry continued

a 20 percent greater splitting than the Fe I line, and may ultimately be a better probe of sunspot magnetic fields. Direct measurement of the total magnetic field strength is possible by simply measuring the wavelength split of the Zeeman components. With the calibrated continuum maps, we can plot the behavior of the total magnetic field with plasma temperature for the Ti I for the first time (see figure 4). Since this line is formed at a slightly different altitude in the solar atmosphere than the 1565-nanometer or the 630-nanometer Fe I lines for which this analysis has been done in the past, the Ti I line has the potential to reveal new information about sunspot magnetic fields.

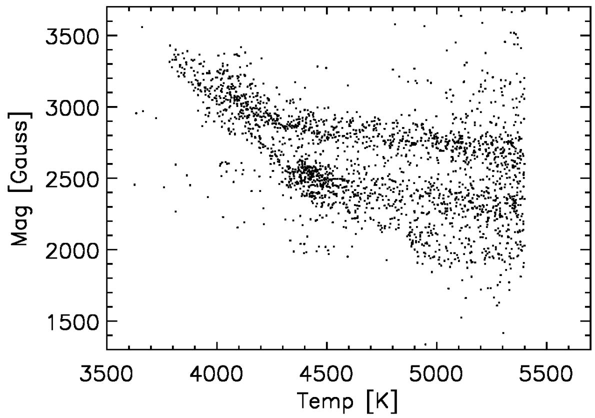
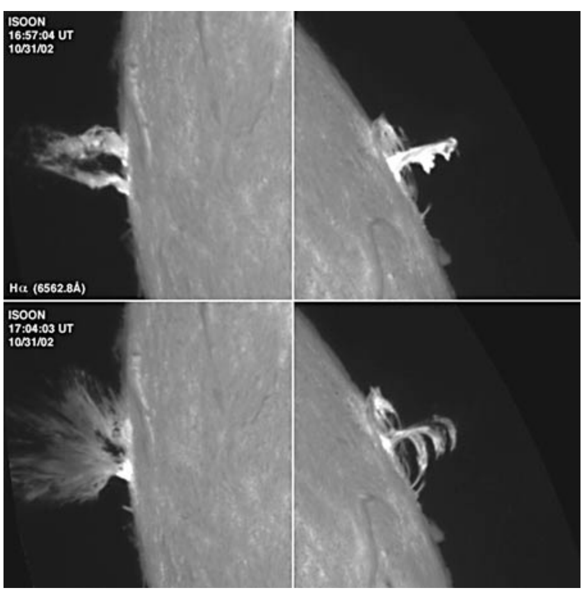


Figure 4. Ti magnetic vs. temperature relation.



These H-α images show a pair of solar flares that erupted within seconds of each other on opposite sides of the Sun on 31 October 2002. The images were taken by the prototype unit of the Improved Solar Observing Optical Network (ISOON) at Sac Peak. Known as a sympathetic flare event, such a confluence can occur "when two active regions on the sun are energized and were on the verge of erupting anyway," said Dr. Donald Neidig, ISOON project manager.

"If they are connected by magnetic flux tubes, the eruption of one can trigger the other within seconds. Or, a third, less powerful event, can trigger two more powerful active regions to go off at the same time," Neidig added. "This is unique in that the two flares are on almost opposite sides of the solar disk, about 2.2 million kilometers apart. The two appeared at almost the same instant, which could indicate that something triggered the two."

For more information, see www.nso.edu/press/flare/.

Credit: US Air Force Research Laboratory and National Solar Observatory/Sacramento Peak

GONG

John Leibacher

The Global Oscillation Network Group (GONG) is a community-based program to operate a six-site helioseismic-observing network, to do the basic data reduction and provide the data and software tools to the community, and to coordinate analysis of the resulting rich data set. Information about GONG, and access to the data, are available at *gong.nso.edu*.

The summer of 2002 marked the completion of the transition from "GONG Classic" (nominally a 256 × 256-pixel image) to "GONG+" (nominally a 1024 × 1024-pixel image with continuous magnetograms) through the data processing pipeline. The various versions of the GONG Classic, GONG+, and combined one-month-long time series have been produced and archived. The blended time series show significantly reduced 1/day sidelobes, and they will be adopted as the standard data product. Teething problems of the new instrumentation are being addressed, and the network fill factor is approaching the average fill factors obtained during the Classic program. The most exciting news is the response from the community—over 1.2 terabytes in data requests since January 2002!

We have completed the acquisition of the computing hardware necessary to support the new, high-spatial-resolution science, "GONG++," as well as the "upstream" GONG Classic processing, which had previously been based on a "sneaker net" of workstations with data being passed between them via an exabyte tape archive. The implementation of a more efficient and automated processing environment will start with the GONG++ data handling system supporting the continuous, full-Sun, local helioseismology pipeline, and then be applied to the GONG Classic processing (the first GONG++ results are highlighted in figure 1).

This year's five-day annual meeting, entitled "Local and Global Helioseismology: The Present and Future," was hosted by the New Jersey Institute of Technology's Big Bear Solar Observatory at the end of October, and was held jointly with the SoHO helioseismology experiments (see figure 2).

Network Operations
The quarter began with a maintenance team at the Learmonth site completing the turret replacement

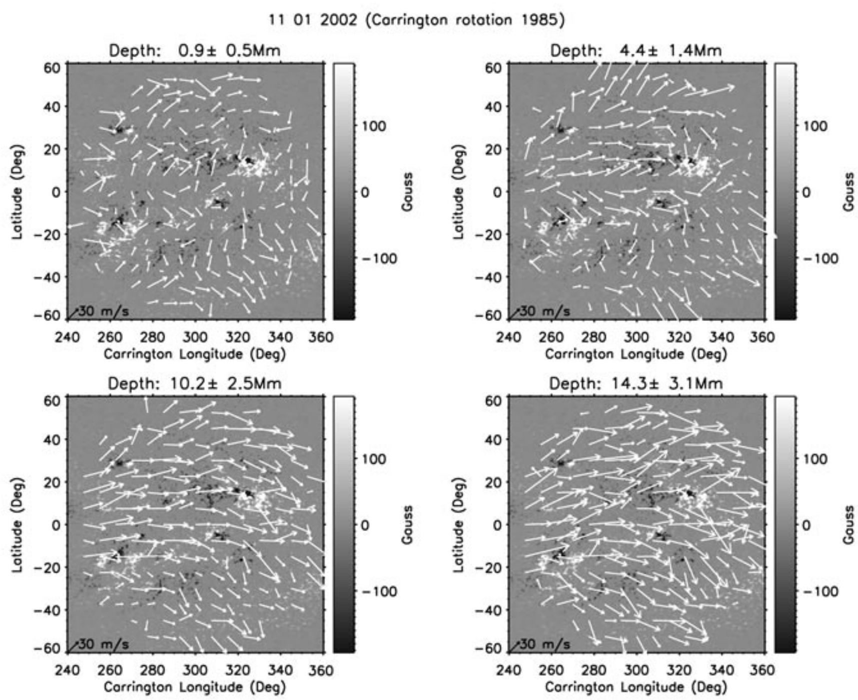


Figure 1. These "solar subsurface weather maps" show subsurface flow at four different depths inside the Sun. They provide unique tools to address the question of the origin of solar activity, which can adversely affect telecommunications and power grids on Earth. The maps are also essential for understanding astrophysical fluid dynamics, such as meridional circulation and the flows around and under sunspots. The maps were constructed from GONG+ data obtained on 11 January 2002. The images from the six different GONG sites were merged, and then analyzed with a method known as ring diagram analysis. This method follows approximately 200 regions on the Sun for a little over a day, removes the curvature of the solar surface, and measures the local distortion of the wave field caused by the flows in the 15,000 kilometers immediately below the surface. These distortions are then used to create the flow maps. The background of each map shows the GONG+ magnetogram for that day. All the computations were performed with the new GONG++ pipeline that is currently being developed using the OPUS software developed at STScI.

continued

GONG continued

and performing routine preventive maintenance tasks. The instrument resumed operations early in July, but the data is not completely nominal. It appears that the camera rotator is generating noise that is somehow being picked up by the optics thermal stabilization system and causing temperature variations of the Lyot filter and Michelson interferometer. The interference is resulting in an hour-long, very low amplitude, quasi-periodic velocity signal, which, fortunately, appears to have little to no effect on the *p*-mode results over most of the temporal frequency range of interest. To date, the investigation, analyses, and hardware replacements have not remedied the problem. The search for a solution is ongoing.

During August, anomalous noise was noticed in the Mauna Loa optics thermal stabilization system, but this time the problem was easily remedied by replacing a faulty power-supply board. A preventive maintenance trip to Big Bear also took place in August, and with the exception of the optical maintenance tasks, which were completed in late October, everything was accomplished. The team took this opportunity to evaluate the condition of the turret, and although the measurements show some degree of degradation, there does not seem to be an urgent need to replace it.

A team visited Udaipur during the last two weeks of September to restart the instrument after an extended shutdown during the annual monsoon. The Udaipur turret is also starting to show signs of its age, which could make it the next candidate for refurbishment. We should have refurbished turrets by the end of the year, and, in the meantime, the Tucson prototype instrument is available as a "hot spare." Finally, a delay in the start of solar tracking at the beginning of the day is being fixed with a software upgrade.

Data Management and Analysis

During the past three months, the DMAC produced month-long (36-day) velocity, time series, and power spectra for GONG+ months 69 and 70 (ending 30 March 2002), with fill factors of 0.88 and 0.78, respectively. The allure of the higher resolution GONG+ data has definitely sparked an interest in the community. During this past quarter, the Data Storage and Distribution System (DSDS) distributed half a terabtye in response to 74 data requests, and during the preceding two quarters, 340 and 360 gigabytes were distributed. The GONG Classic and GONG+ month 62 images were processed separately, producing month-long time series. Because the fill factor of each set of images was low, the time series were combined to produce a GONG Classic/GONG+ blended version with a fill factor of 0.77. A similar procedure was applied to months 61 and 63, where the fill factor for month 61 improved from 0.66 to 0.79, and from 0.58 to 0.76 for month 63. The blended results from the overlapping three-month-long time series produced substantially improved mode frequencies. These blended results will be the standard data products, although the pure Classic and + frequencies have been archived. The completion of these tasks marks the end of the GONG Classic to GONG+ transition.

John Bolding has joined GONG to implement the GONG++ pipeline processing system, which will incorporate our newly upgraded *gongxx* system (now with 12 new 900-megahertz processors, 3 terabytes of disk space and an 18-terabyte tape library), *OPUS* pipeline software, *Veritas* to control the tape library, and our scientific processing modules, e.g., ring-diagram analysis, time-distance, or helioholography. John has already constructed an operating pipeline to go from merged images to flow maps via a ring-diagram analysis implemented by Thierry Corbard using code from Deborah Haber and Brad Hindman (University of Colorado, Boulder). The next step will be incorporating Cliff Toner's image-merging pipeline software.

Simon Kras has been running Rachel Howe's low-ℓ fitting code incorporating the leakage matrix. We now have $\ell = 1$ splittings that suggest the core rotates at about the same rate as the surface.

Rudi Komm is heading up an effort to inter-compare local helioseismic analyses with a common data set while we ponder the production of simulated data. This comparison will be done with both GONG+ and MDI/SOI data, using ring diagrams, time distance, holographic, and global methods.

Caroline Barban has extended the velocity-intensity multi-spectral fitting method to deal with leaks and has fitted a number of *m*-averaged peaks above $\ell = 20$, but there is evidence that the spectral model may need revision modifications at higher degrees. Caroline will be leaving us next fall to join the group in Leuven, Belgium.

Richard Clark has been working on the GONG+ magnetogram zero-point correction, and thanks to Jack Harvey, we now understand the instrumental source of the

continued

GONG continued

problem—a weak linear polarization component is leaking into the GONG signal from the turret mirrors and the sky background. It should be possible to reduce this effect by using the daily calibration data set. Tests are underway to confirm this.

Jeff Sudol is investigating anomalies that appear in the velocity scale, which is derived from the Earth-observer motion. The current hypothesis is that the Earth-observer motion is contaminating our calibration procedure. We are investigating possibilities to bring back a subset of the data in near real time to implement the farside imaging developed by Charlie Lindsey and Doug Braun, as well as make full resolution magnetograms available to the community. A new server, *tarat*, has been acquired for use by the DMAC. This hardware consists of a Sun V880 with four 900-megahertz CPUs, 1-terabyte of disk space and the 20-DLT cartridge library that has been moved over from *gongxx*. This system will facilitate large-scale reprocessing and staging of the GONG+ data.

Figure 2. The GONG 2002 Meeting and the 12th SoHO Workshop were held jointly and hosted by the New Jersey Institute of Technology and Big Bear Solar Observatory October 27–November 1. The meeting focused on the results from the GONG+ and GONG++ operations and the various helioseismic experiments onboard SoHO (MDI, GOLF, VIRGO/SPM), but also included other ground-based, multisite projects such as BiSON and ECHO.

Topics ranged from global helioseismology and the ongoing study of time-varying solar internal rotation and dynamics, to local helioseismology and the many new techniques that have that are being developed (ring diagrams, time distance, holography, and farside imaging), to stellar seismology and the hunt for extrasolar planets. Prospects for the future GONG++, the Solar Dynamics Observatory (SDO), and NASA's Living with a Star initiative present opportunities and challenges for the future. The European Space Agency will be publishing the proceedings. The get-together provided the opportunity for meetings of the GONG sites representatives, the Data Management and Analysis Center Users' Committee, and the GONG Scientific Advisory Committee as well.

New Space Weather Exhibit and Second Public Telescope Draw Special Visitors

Doug Isbell

The violent beauty of solar storms and the wonders of the night sky were the featured attractions at a unique event at the Kitt Peak Visitor Center on October 8. An early evening reception marked the official opening night of a special traveling exhibit on Space Weather, and the debut of a second telescope for nightly public programs.

Tucson Mayor Robert Walkup, several middle school students from the Tohono O'odham Nation, and four dozen members of the Tucson tourist bureau and hotel communities were among the special guests that night for a ribbon-cutting ceremony and stargazing session.

The Space Weather Center exhibit's hands-on activities and colorful video displays are designed to bring the awesome power of solar flares and huge eruptions called Coronal Mass Ejections down to a scale that can be appreciated by all ages. The exhibit will occupy the Kitt Peak Visitor Center through early January 2003, with special admissions prices of $4.00 for adults and $2.50 for children, with free admission for kids under age 5.

The exhibit was developed by the Space Science Institute, Boulder, CO, in partnership with NASA's Goddard Space Flight Center, Greenbelt, MD. Major funding was provided by NASA and the National Science Foundation.

Ongoing public interest in the 20-person Nightly Observing Program on Kitt Peak spurred the creation of a second site for this popular three-hour program, which had previously been hosted only at the small dome attached to the Visitor Center. The new expansion of this nightly paid program is housed in one of the earliest domes built on Kitt Peak. Located next to the WIYN 3.5-meter telescope, it began operations in 1963 with a 16-inch telescope optimized for photometry.

The Tohono O'odham students who attended the event were selected on the basis of written essays on the best stellar targets for the new public program observatory to observe on its first official night. Each evening, the refurbished dome will accommodate 14 guests using the existing 16-inch telescope moved from the Visitor Center Observatory. A new 25-inch telescope supplied by RC Optical, Flagstaff, AZ, is expected to be installed in the Visitor Center Observatory by the end of November.

"Exhibits like the Space Weather Center help draw new visitors, while giving the local community a reason to visit again," says

The Space Weather Center exhibit at the Kitt Peak Visitor Center served as the focal point for the opening day of a teacher professional development workshop sponsored by Tucson's Coronado Instruments titled "Hands On the Sun." The workshop's Friday session at Kitt Peak was featured in an education-oriented television news report by Tucson's KVOA NBC-TV. Note the live image of the Sun on the screen at the back left, projected by the Visitor Center's newly refurbished coelostat!

Space Weather Exhibit continued

NOAO Public Outreach Manager Rich Fedele. "Adding the second public telescope will expand our revenues from that program by nearly 75 percent, which will help fund the next generation of improvements to the Visitor Center.

"We've had great cooperation from the staff of Kitt Peak and WIYN, which is crucial, since we will be transporting visitors to the telescope about 50 feet from where world-class research is being conducted," Fedele adds. "Keeping the site dark and safe is our first duty."

A color photo of one of the students looking through the 16-inch public telescope was featured in a page A1 cover story in the *Arizona Daily Star* newspaper. The expanded public program, and its potential to excite "hobby astronomers or young couples seeking a romantic evening under the stars" drew a mention on ABC Radio's Paul Harvey Show.

For more information on the exhibit, see *www.spacescience.org/SWOP/1.html*. More information about the Kitt Peak Nightly Observing Program is available at *www.noao.edu/outreach/nop/*.

Tucson Mayor Robert Walkup and three Tohono O'odham Nation students cut a ribbon to formally open the temporary Space Weather Center exhibit at the Kitt Peak Visitor Center.

First North-South Educational Outreach Video Workshop Shows Promise

Dara Norman & Doug Isbell

What is color? What is light? How can we use a spectrometer to help students understand and retain the answers to these questions? These ideas are a lively topic for discussion, even for people half a world apart, of different languages and cultures.

On October 23, NOAO North and South jointly sponsored a "proof-of-concept" videoconference workshop for teachers in Tucson and La Serena. The teachers exchanged methods and ideas about how to explain and demonstrate the nature of light and color to students of various ages. The entire workshop was held in Spanish with three bilingual teachers from the Tucson area.

The workshop included a mix of discussions and demonstrations that culminated in the construction and calibration of spectroscopes by attendees in Chile. The teachers will use these spectroscopes to examine a number of light sources around town, and will present their findings at a subsequent workshop.

An important goal of the first video workshop was to start a dialogue between the two groups of teachers that will be mutually beneficial in terms of creative ways of teaching science and, in particular, astronomy, to Spanish-speaking audiences.

The idea to hold an initial workshop on light and color was the result of several video meetings between NOAO Educational Outreach staff in Tucson and a group of interested people in La Serena, including CTIO Director Malcolm Smith. The workshop is envisioned as the beginning of an even larger collaboration, currently dubbed ASTRO-Chile. This effort is meant to take advantage of successful efforts in the United States, such as Project ASTRO, and efforts in Chile, like REDLASER, by merging the strategies and techniques from each into a cross-cultural exchange.

The number of institutions represented by the attendees demonstrates the broad support for this effort in both

continued

Video Workshop continued

the northern and southern communities. Hugo Ochoa (CTIO) and Ron Probst (NOAO), who began an observing project that eventually turned into the REDLASER program (see note below), were in attendance in the south and north, respectively.

Also present was the director of the Planetarium Movil, David Orellana, whose work has brought this traveling planetarium to numerous local schools. This planetarium project is supported in part by AURA, CTIO, and Gemini. Connie Walker (NOAO) and Dara Norman (CTIO) planned the workshop, which was presented entirely by the teachers: Julie Friberg, Glenn Furnier, and Thea Cañizo in Tucson; and Padre Juan Bautista Piccieti, Herman Rojas, Elias Espinoza, Daniel Munizaga, and Carlos Corco in La Serena.

Tucson teachers (from left) Julie Friberg, Glenn Furnier, and Thea Cañizo participate in the first international ASTRO video workshop with a group of educators in La Serena, Chile (below).

Enthusiasm was high at both sites for continuing with additional workshops. "It was a really strong first attempt at doing something that is very new for me, and probably for all of us. I enjoyed the chance to interact with teachers from another country in that format," said Cañizo, the Middle School Science Coordinator for Tucson Unified School District. "Next we need to get specific feedback from our Chilean participants to better clarify how such workshops can be a positive influence in their unique classroom situations, and perhaps expand upon the functions of the spectroscope."

Antonieta Garcia, outreach assistant for Gemini South, also participated in the workshop's activities, along with Stephen Pompea (NOAO), Doug Isbell (NOAO), and Hugo Schwarz (CTIO/SOAR).

NOTE: The name REDLASER is a play on words, with "Red" being the Spanish word for Network, and LaSer being shorthand for La Serena. More information about the program, and the Planetario Movil, are available in the education and public outreach section of the CTIO Web site.

The Project ASTRO-Tucson Fall 2002 workshop was held in mid-October. Highlights included an inspiring kick-off lecture from noted comet hunter and author David Levy, and another excellent presentation on the following day from science education specialist Dr. Ed Prather (University of Arizona) about student misconceptions in astronomy.

The astronomical inspiration continued with a group trip to Kitt Peak, where the participants enjoyed some nighttime observing with the Kitt Peak Visitor Center's 16-inch telescope, as well as telescopes from the Tucson Amateur Astronomy Association. An added treat was the chance to experience the new temporary Space Weather Exhibit at the Visitor Center.

For the fourth consecutive year, the book *Moon Journals: Writing, Art and Inquiry through Focused Nature Study* served as a central presentation of the workshop. "Kinesthetic Astronomy," an approach to teaching basic astronomical concepts through choreographed body movements, made its debut this year, as did a NASA lunar rocks and meteorite certification by a staff

continued

Project ASTRO continued

member from Dryden Flight Research Center. More than 10 hands-on activities based on the workshop theme (the Moon) were performed by the Project ASTRO teachers and astronomers; classroom kits for many of these activities were provided to the teachers. A total of 52 teachers and astronomers attended.

Just after the workshop, Project ASTRO-Tucson Coordinator Connie Walker and NOAO Public Outreach Coordinator Robert Wilson traveled to San Francisco to receive training as site leaders for the Astronomical Society of the Pacific's new Family ASTRO program. NOAO will serve as one of the founding locations for this new effort in 2003, working with teachers and families connected with Tucson's Sunnyside School District, the local Girl Scouts, and the Tohono O'odham Nation.

Undergraduates Needed for 2003 KPNO REU Program

Kenneth Mighell

Kitt Peak National Observatory (KPNO) seeks up to six talented undergraduates to participate in its Research Experiences for Undergraduates (REU) program for summer 2003.

Sponsored by the National Science Foundation (NSF), the KPNO REU program provides an exceptional opportunity for undergraduates considering a career in science to engage in substantive research activities with scientists working in the forefront of contemporary astrophysics.

Each REU student is hired as a full-time research assistant to work with one or more of the KPNO staff members on specific aspects of major ongoing research projects at NOAO. As part of their research activities, these undergraduates gain observational experience with KPNO's telescopes and develop expertise in astronomical data reduction and analysis.

During summer 2002, five students participated in the KPNO REU program and worked on a diverse range of astrophysical research topics. They also took part in a weekly lecture series, conducted observing runs using telescopes on Kitt Peak, and took a field trip to New Mexico to visit NSO's Sacramento Peak Observatory and the NRAO's Very Large Array. At the end of the summer, the students shared their results with the Tucson astronomical community through oral presentations describing their research.

All five 2002 REU participants will be presenting posters about their research projects at the January 2003 American Astronomical Society meeting in Seattle. One of last summer's participants, Allison Heinrichs, also offered a student's perspective on the KPNO REU experience in an article for the September 2002 issue of the *Newsletter.*

As required by the NSF, student participants must be US citizens or permanent residents. The KPNO REU positions are full time for 10 to 12 weeks between June and September, with a preferred starting date of early June. The salary is $425 per week, with additional funds provided to cover travel costs to and from Tucson.

Further information about the 2003 KPNO REU program, including the on-line application form, can be found at *www.noao.edu/kpno/reu*. Completed applications (including basic applicant information, official transcripts, and at least two letters of recommendation) must be submitted no later than 1 February 2003.