NOAO/NSO Newsletter

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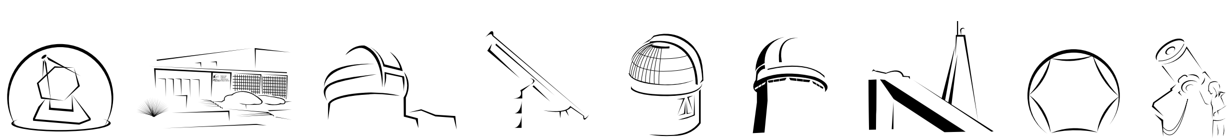

NSF Budget Request for 2007

The White House budget plan for fiscal year 2007 requests $6.02 billion for the National Science Foundation—an increase of $439 million, or 7.9 percent, over fiscal year 2006. Total funding requested for Major Research Equipment and Facilities Construction is $240.45 million (up $49.57 million or 26 percent). The request includes two new projects, the Alaska Region Research Vessel and the Ocean Observatories Initiative.

The fiscal year 2007 budget request for the NSF astronomical sciences division is $215.11 million, an increase of $15.46 million (7.7 percent) over the current plan for fiscal year 2006. Within this division, a total of $40.05 million has been requested for the National Optical Astronomy Observatory and the National Solar Observatory, an increase of $3.14 million over fiscal year 2006. However, this increase is completely committed to increased funding for the Telescope System Instrumentation Program (+ $2 million) and the Adaptive Optics Development Program (+ $1.14 million). "The operations base for [NOAO-NSO] remains constant," according to budget documents.

John Marburger, director of the White House Office of Science and Technology Policy, discussed the administration's science funding request during an "Ask the White House" online chat on 1 February 2006, directly following President George W. Bush's State of the Union address. Here are some excerpts from that exchange:

***Norman**, from **Stanford, California** writes:*
Dear Dr. Marburger, I applaud your efforts to raise the priority of funding for basic research and appreciate the fact that the American Competitiveness Initiative seeks to double the funding for the National Science Foundation, the Department of Energy's Office of Science, and the Department of Commerce's National Institute of Standards and Technology over the next ten years. Are there any major new projects (such as the International Linear Collider) being considered as part of this initiative, or do you expect to better support existing projects (such as ITER) and basic infrastructure?

John Marburger:
Each of the priority agencies in the American Competitiveness Initiative has detailed plans and programs that are developed in consultation with the science community. Projects like ILC and ITER are included in their plans, which are usually detailed on the agency websites.

***Collin**, from **Chicago** writes:*
What is the White House definition of 'Basic Science' - the funding of which the president proposed to double in 10 years? For example, does the definition (and proposed doubling) include particle physics? What about nanotechnology? And a mission to Mars? Thanks

John Marburger:
The American Competitiveness Initiative identifies three priority agencies that are critical to basic research in the physical sciences that provides the foundation for future economic competitiveness. Areas like nanotechnology, information technology, materials science, and quantum coherence will be an important part of the initiative. Particle physics and space exploration are important, but not necessarily a focus of the Initiative.

On the Cover

Two different views of the southeast portion of the Small Magellanic Cloud show the optically emitting gas of the interstellar medium in unprecedented detail. The Magellanic Cloud Emission Line Survey (MCELS) used the Curtis Schmidt telescope at CTIO to obtain narrowband images of this nearby galaxy in the southern sky in H-alpha (shown in red), twice-ionized oxygen [O III] (blue) and singly ionized sulfur [S II] (green), which have been assembled into the color mosaic shown at the bottom. Additional emission-line-free images were subtracted to make the top image, which effectively removes most of the stars and reveals faint diffuse emission.

Planetary nebulae and H II regions generally appear pink, red, or purple. Shock-excited supernova remnants, as well as low-ionization gas, appear yellow or green. The full mosaic of the galaxy covers 3.5 × 4.5 degrees, more than twice the area shown here.

For more information, see page 6.

Credit: Frank Winkler, Darius Braziunas, Rhiannon Condon, Amber Young (Middlebury College), Blair Reaser (Swarthmore College), Chris Smith (NOAO), and the MCELS Team.

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Light Echoes of Ancient Supernovae in the Large Magellanic Cloud

Armin Rest, Nicholas Suntzeff, Chris Smith, Knut Olsen (NOAO)
& the SuperMACHO Collaboration

In the past decade, light echoes have been discovered around some nearby extragalactic supernovae well after the explosion, most notably the light echoes from SN 1987A. However, no light echoes of historical SNe of Galactic or extragalactic origin have been discovered to date.

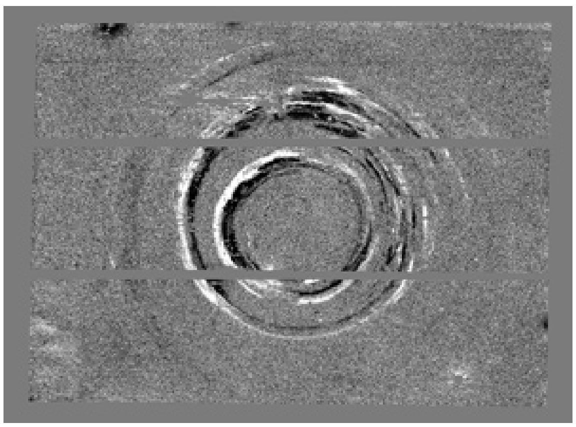


Figure 1. Light echoes from SN 1987A.

In the SuperMACHO project, we have imaged the bar of the Large Magellanic Cloud (LMC) repeatedly and used an automated pipeline to subtract point-spread function matched template images from the recent epoch images. The resulting difference images are remarkably clean of the constant stellar background and are ideal for searching for variable objects. Using these difference images, we have mapped the extensive light echo complex around SN 1987A. The image in Figure 1 reveals echoes of SN 1987A further out, and fainter, than previously detected. In these images, white represents flux enhancements in the 2002 and 2004 images, and black in the 2001 image. Faint echo arcs can be seen as far out as 6.6 arcmin and 7.3 arcmin from the explosion site, or 0.9 and 1.1 kpc in front of SN 1987A.

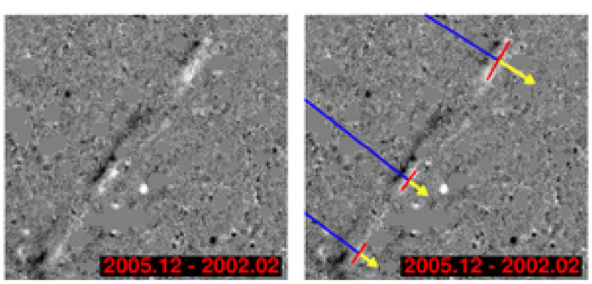


Figure 2. Candidate light echoes from pre-historical supernovae (left). These are extrapolated backward (right) to determine the positional origin of the light echoes.

Beside the SN 1987A light echoes, we found a number of other very faint linear structures that had high proper motions, generally superluminal. However, these echoes were spatially in a very different location than the SN 1987A echoes. We suspected that these were light echoes from pre-historical supernovae. The left panel of figure 2 shows such a light echo candidate. In order to find the source of the light echoes, we fit each light echo segment with a straight

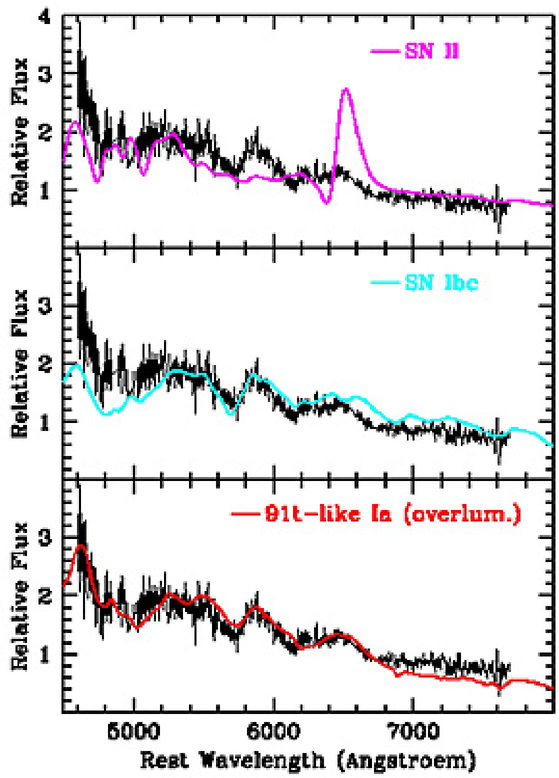


Figure 3. Spectrum of the brightest echo from light echo group LE2 (black line) compared with supernovae spectra of different types (light lines).

continued

Light Echoes of Ancient Supernovae continued

line. The apparent proper motion is given by the vector and extrapolated backward.

The extrapolated vectors point to four well-defined positions as the origins of the echo complexes, one of which is SN 1987A. The three unidentified echo origins correspond within arcminutes to the positions of known supernova remnants (SNRs; Mathewson et. al. 1985), which are also three of the six youngest SNRs in the LMC (Hughes et. al. 1995).

These three SNRs are precisely the three that are classified as likely Type-Ia events based on chemical abundances derived from the X-ray emission spectra. Given the positional match with young SNRs and the high apparent proper motions of the variable diffuse light, we conclude that these newly detected structures are scattered light echoes from Type-Ia supernovae in the LMC. We can derive ages for the echoes based on their position and motion, and we find ages between about 400 and 800 years. Such Type-Ia supernovae would have reached V=-0.5 and would have been the third brightest star in the southern sky. Our discovery paper was published in *Nature* (Rest et. al. 2005).

We have recently obtained a spectrum of the brightest echo from light echo group LE2 with Gemini South using GMOS with slitlets aligned along the echo segments. With careful reduction, we extracted the relatively high S/N spectrum of the echo light shown in figure 3.

We fit integrated and dust-scattered spectra of various SNe types. We find that Type II spectra do not fit the observed spectrum (upper panel). The best fit we obtain is for SN 1991T, an over-luminous Type Ia (lower panel). The spectrum of the Type Ibc (middle panel) produces a noticeably worse fit than the Type Ia, but cannot be completely ruled out at this time.

The spectrum proves beyond a doubt that we are seeing light from ancient supernovae. It should be possible, in principle, to find similar echo arcs in recent historical supernovae in our Galaxy, such as the probable Type-Ia events of Kepler, Tycho, and 1006/Lupus. If such arcs are found, we would be able to obtain spectra of the light of the supernova, and firmly establish whether they were core collapse or thermonuclear explosions.

The SLACS Survey: A Bumper Crop of New Gravitational Lenses

Adam Bolton (Harvard/Smithsonian CfA)

Strong gravitational lensing, the dramatic bending of light paths by massive objects, is both a beautiful phenomenon and a powerful tool for the measurement of mass in galaxies and clusters of galaxies. Strong lensing by elliptical galaxies is particularly valuable, since their rotation curves cannot generally be observed through direct kinematic tracers, and the role of dark matter in bright ellipticals remains the subject of controversy (e.g. Binney 2003, astro-ph/0310219; Kochanek 2004, astro-ph/0412089). However, the scientific power of lensing to tackle this problem has historically been limited by the rarity of confirmed lens systems.

Most of the known examples of galaxy-scale strong lensing in the optical band involve a distant quasar lensed by an intervening elliptical galaxy. Quasar lenses have an extremely heterogeneous (and usually serendipitous!) discovery history, and the light of lensed quasar images often overwhelms the image of the lens galaxy, rendering detailed study of the latter quite difficult. Strong lenses, consisting of one galaxy lensed by another, in principle should be quite numerous but are much more difficult to identify in imaging surveys. The discovery of the galaxy-galaxy lens 0047-2808 in 1996 (Warren et al. 1996 MNRAS, 278, 139) suggested the possibility of detecting significant numbers of such lenses in *spectroscopic* surveys, via a search for high-redshift emission lines in the spectra of lower-redshift galaxies.

With the advent of the Sloan Digital Sky Survey (SDSS), and its massive spectroscopic component, our group (The Sloan Lens ACS, or SLACS, Survey: Bolton et al. 2006, ApJ, 638, 703, astro-ph/0511453; Treu et al. 2006, ApJ, in press, astro-ph/0512044; Koopmans et al. 2006, ApJ, submitted, astro-ph/0601628) has successfully implemented this type of spectroscopic lens survey. We have also discovered 19 previously unknown strong gravitational lenses, composed of two aligned galaxies, with an additional 10 still to be published. The SLACS lens sample is uniformly selected

continued

The SLACS Survey continued

(Bolton et al. 2004, AJ, 127, 1860), with relatively bright lens galaxies that are amenable to detailed photometric and dynamical study.

Central to the success of our survey has been the use of the Hubble Space Telescope (HST) and the Gemini GMOS-N Integral Field Unit (IFU). With HST, we obtain imaging of these new lenses at the highest possible spatial resolution (figure 1), thus permitting detailed morphological and photometric measurement of the lens galaxy, along with mass modeling using the lensed images of the background galaxies. The three-dimensional (two spatial plus one wavelength) capability of the GMOS IFU then allows us to confirm the coincidence of the high-redshift line emission detected by SDSS with the lensed images seen by HST and cement the lensing interpretation over other possible explanations for the observed image features (figure 2).

One of the many initial results of the SLACS Survey is that, within the context of simple power-law mass models, these elliptical lens galaxies show the same "conspiracy" between luminous and dark matter as disk galaxies, leading to an approximately constant rotational speed as a function of position within the galaxy (an "isothermal" density profile). We will again look to ground-based spectroscopy with instruments such as the GMOS IFU to constrain more detailed models of stellar and dark-matter components. Deeper observations with these instruments will determine the full two-dimensional stellar kinematics of the lens galaxies. These data are related to the mass and light in the lens galaxy through the Jeans equation, and the mass profile of the lens galaxy is additionally constrained by the lensed images.

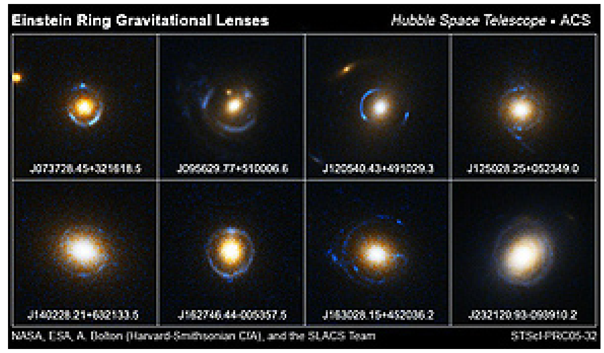


Figure 1. HST ACS-WFC imaging of eight newly discovered gravitational lenses from the SLACS survey. Credit: NASA, ESA, A. Bolton (Harvard-Smithsonian CfA) and the SLACS Team.

With its 5 arcsec × 7 arcsec field of view and 0.2 arcsec spatial sampling, the GMOS IFU is the perfect tool for spectroscopy of galaxy-scale gravitational lenses such as the SLACS sample. The instrument will undoubtedly deliver many more ground-breaking results in this field.

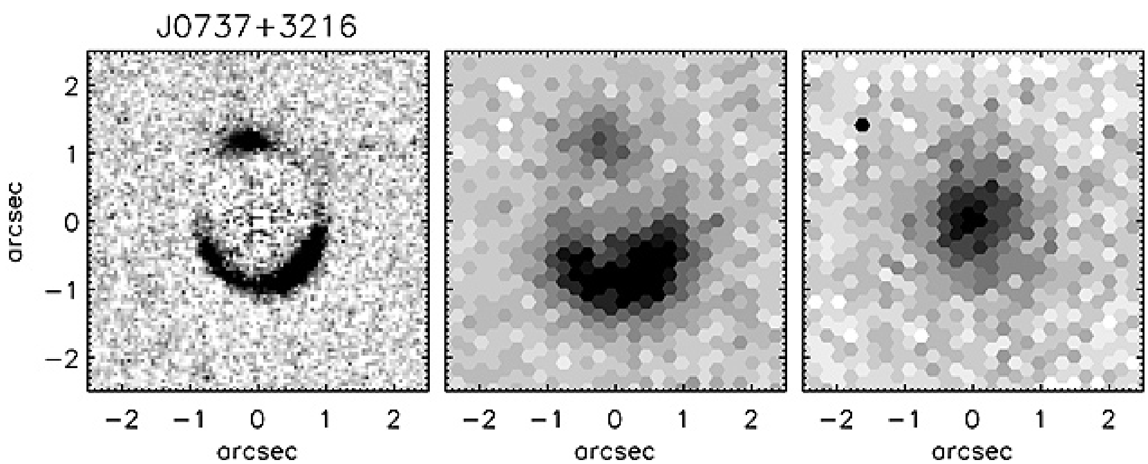


Figure 2. Left: HST I-band image of the gravitational lens SDSSJ0737+3216 from which a model of the lens-galaxy image has been subtracted. Center: GMOS-N IFU continuum-subtracted narrowband emission-line image at the wavelength of redshifted [OIII] λ 5007 Å emission, showing strong coincidence with the image of the lensed galaxy. Right: GMOS-N IFU narrow-band continuum image at same wavelength, showing the lensing galaxy (Bolton et al. 2006, ApJ, in press, astro-ph/0511453).

The Magellanic Cloud Emission Line Survey (MCELS)

Chris Smith, Sean Points (NOAO) & Frank Winkler (Middlebury College)

The interstellar medium (ISM) of galaxies is no longer thought to be a quiescent distribution of gas, but rather a dynamic and complex interaction of the ambient gas and dust with stellar winds, HII regions, planetary nebulae (PNe), supernovae (SNe), supernova remnants (SNRs), superbubbles, and gigantic supershells. Nowhere is this more apparent than in the Magellanic Clouds, as shown in this month's cover images of a portion of the Small Magellanic Cloud (SMC). Their relative proximity and low extinction makes the Magellanic Clouds ideal laboratories for studying the ISM, its constituents, its energetics, and its interaction with the underlying stellar populations.

We have recently completed the University of Michigan (UM)/CTIO Magellanic Cloud Emission Line Survey (MCELS), an optical emission-line survey of these two nearby galaxies which, together with parallel surveys at other wavelengths, provides the foundation upon which to build a deeper understanding of the ISM in the Clouds (and other galaxies), from small scales (~1 pc) to global scales.

Taking advantage of the wide field of view of the UM/CTIO Curtis Schmidt telescope coupled with the sensitivity of a 2K × 2K CCD, we have mapped both Clouds in narrow bands corresponding to Hα, [O III] λ5007 Å, and [S II] λ6716, 6731 Å. In addition to these emission-line images, we also obtained images in matched red and green continuum bands, which we use primarily to subtract most of the stars from the images (a contaminant for us!) to reveal the full extent of the faint diffuse emission from the ISM.

We have assembled all the images into large mosaic images, such as that of the SMC shown in full color on the cover with stars (lower image) and with stars subtracted (top), and the Large Magellanic Cloud (LMC) mosaic shown here (figure 1).

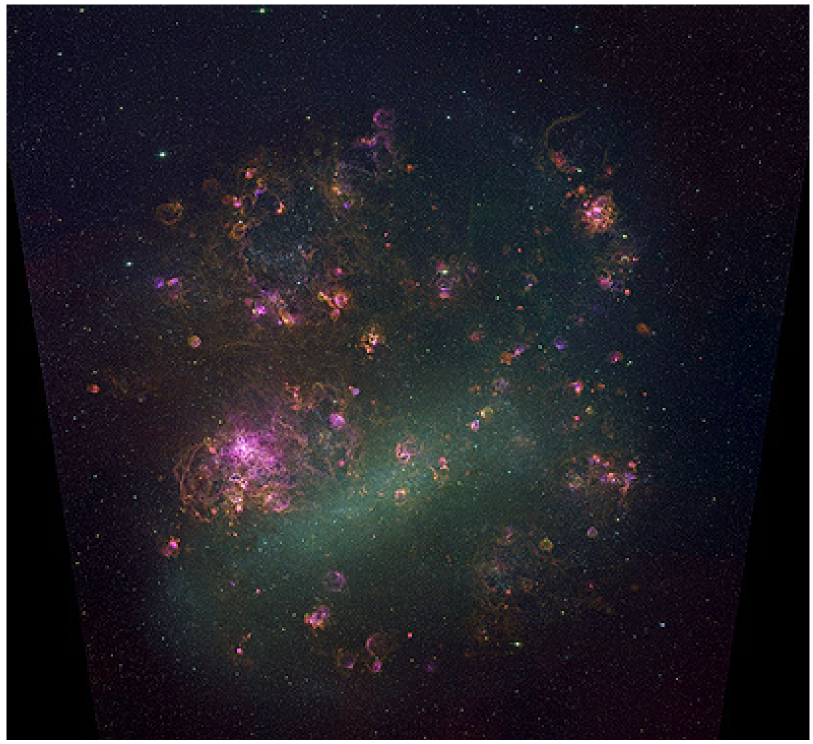


Figure 1. A mosaic of the Large Magellanic Cloud assembled from more than 1,500 images taken by the MCELS survey.

The MCELS observation cover a total of approximately 79 square degrees of sky, including 64 square degrees of the LMC and 15 square degrees of the SMC--most of the gaseous content of both galaxies. Each spot was sampled eight or more times, in four different regions of the detector, to help eliminate flat-fielding problems and other instrumental effects. Specific details of the observations are given in the inset table (figure 2). The data have been taken over roughly a five-year period beginning in 1996, and are currently undergoing final flux calibration and global quality assessment in preparation for both our analysis and the public data release.

Using advanced digital image-subtraction techniques to remove the stellar continuum from the images (the same used by time-domain surveys like ESSENCE and SuperMACHO to find transients), we are able to more accurately measure the emission-line fluxes. Using the three emission lines together through emission-line ratios also provides information about the physical processes that are driving the emission. For example, the [S II]/Hα ratio can be used to differentiate shock-excited emission from photoionization-driven emission. With this information we are studying samples of both small-scale objects such as PNe and SNRs, as well as large-scale structures such as superbubbles and supergiant shells.

MCELS has been a large undertaking by a relatively small group, and although

continued

MCELS continued

we are only now carrying out the final reduction, astrometric calibration and flux calibration, it has produced many publications based on reductions of small portions of the full dataset. Some past, and near future, scientific highlights from MCELS include:

* The discovery of many new SNRs in the LMC based on the [S II] / Hα ratio diagnostic (e.g., Smith et al. 2006, in prep).

* The study of known and suspected supernova remnants in the SMC, including the discovery of several new remnants (Winkler et al. 2006, in prep).

* An investigation into the deposition of energy and chemically-enriched material into the ISM via breakouts from SNRs (Williams et al. 1999, ApJ, 514, 798).

* An examination into shell formation and star formation in the superbubble N51 D (Oey & Smedley 1998, AJ, 116, 1263).

* A multi-wavelength study of the kinematics and physical conditions of the interstellar gas in the N44 superbubble (Kim et al. 1998, ApJ, 503, 729).

* A multi-wavelength investigation of the kinematics, physical structure, and energization of the supergiant shell LMC-2 (Points et al. 1999, ApJ, 518, 298).

MCELS DETAILS

TELESCOPE:	University of Michigan/CTIO 0.6/0.9m Curtis Schmidt
CAMERA:	SITE 2048 × 2048 CCD and STIS 2048 × 2048 CCD
FIELD OF VIEW:	1.7 square degrees (1.3 × 1.3 degrees)
RESOLUTION:	2.3 arcsec/pixel, ~5 arcsec resolution
BANDS:	3 emission lines, 2 continuum:
	Hα 6568/28
	[S II] 6729/50
	[O III] 5012/40
	Continuum 6850/100
	Continuum 5130/155 (DDO51)
COVERAGE:	LMC: 64 square degrees (8 × 8 degrees)
	SMC: 15 square degrees (3.5 × 4.5 degrees)

Figure 2.

Undergraduate students have played a significant role in all phases of the MCELS project. At CTIO, Roger Leiton carried out dozens of nights of observations from the Schmidt, and his contributions to the data analysis became the subject of his bachelor's thesis at University of La Serena. A number of students at Middlebury College in Vermont contributed to many phases of the analysis, including flux calibration and the development of software for combining hundreds of images into near-seamless mosaics, including those used for the cover image of this NOAO/NSO *Newsletter*, the SMC. Four B.A. honors theses in physics at Middlebury have resulted from their work. Many of these same undergraduates are also co-authors on one or more of the papers above.

We are planning the release of all of the MCELS data and data products through the MCELS website and the NOAO Science Archive within the next year. Our preliminary data release of a roughly 2 × 2 degree region including 30 Doradus and LMC-2 is now available at *www.ctio.noao.edu/mcels*.

The final release of reduced data will consist of flux calibrated combined images (emission-line calibration good to better than 10 percent) with accurate astrometric solutions. The individual reduced images will also be available, along with the raw data and calibrations. Catalogs of supernova remnants, planetary nebulae, HII regions, compact Hα sources, and other emission line objects will also be produced.

This project is funded in part by NSF grants AST #9540747 and #0307613 and through the Dean B. McLaughlin Fund at the University of Michigan.

Synthetic CH- and CN-band Images of Solar Magnetoconvection

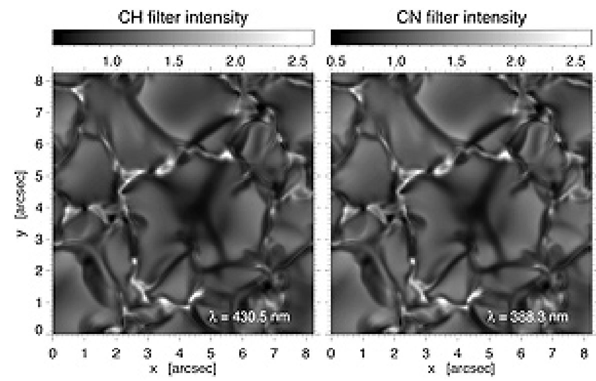
Han Uitenbroek & Alexandra Tritschler

One of the remaining mysteries in solar physics is the nature of the solar dynamo. In order to understand how the magnetic field in the Sun is generated, how it evolves and is redistributed, we have to be able to track the field on all spatial scales, ranging from large active regions with sunspots to the smallest possible scales.

A substantial fraction of the magnetic flux exists in the form of small-scale field concentrations with sizes possibly well below the current resolution limit of solar telescopes. We are concerned with finding the optimal way to track these small-scale flux elements observationally. To this end, we employ a realistic simulation of solar magnetoconvection, which makes predictions of the structure and dynamics of the magnetic field on spatial scales that are beyond the reach of present solar telescopes, but should be resolved by the Advanced Technology Solar Telescope (ATST) under development by NSO.

A popular method for tracking small-scale features is imaging in the so-called G-band (430.5 nm), a region of the spectrum that is dominated by lines of the CH molecule. This method shows magnetic features at high contrast and is advantageous for image improving techniques such as adaptive optics and image reconstruction because of the short exposures made possible by the relatively broad passbands (typically 1 nm FWHM) of the filters employed. A similar band of CN lines exists at 388.3 nm, prompting the question of whether it would allow tracking of magnetic features with higher fidelity because of the higher Planck function sensitivity to temperature, and the slightly better telescope resolution limit at the shorter wavelength.

To test this hypothesis, we computed the spectrum in both passbands for a single snapshot from a high-resolution solar magnetoconvection simulation and integrated the spectra over 1 nm FWHM filters to construct synthetic filtergrams. Magnetic concentrations in the resulting filtergrams, shown in figure 1, stand out as bright ribbon-like features. The computation predicts that the intensity contrast of the magnetic elements is almost equal, surprisingly being slightly lower, on average, by a factor of 0.96 in the shorter wavelength CN band filtergram. Analysis of the computed spectra reveals that the brightness enhancement of the magnetic features does not result from relatively higher temperatures, but from the partial evacuation of the regions of highest magnetic flux concentration.



Synthetic filtergrams in the CH (left) and CN (right) bands at 430.5 nm and 388.3 nm, respectively. Magnetic features stand out as the bright, ribbon-like structures in the inter-granular lanes.

To balance the sum of magnetic and gas pressures inside a magnetic field concentration with the gas pressure of the non-magnetic surroundings, the internal gas pressure is substantially lower than the external one at equal geometric height. In the lower pressure environment, the density of molecules is substantially reduced, resulting in a weakening of the molecular spectral lines for lines of sight that look down into strong magnetic field concentrations. The weakening of spectral absorption lines in the filter passband causes the integrated filter intensity to be higher, leading to the characteristic intensity enhancements of magnetic elements seen in the filtergrams. This brightening-through-evacuation mechanism is wavelength independent, resulting in the similar contrasts in the two molecular bands, in contrast to brightening caused by temperature enhancement, which would preferentially raise the intensity in the shorter wavelength band.

We conclude that, given the similar contrast in the two molecular bands, imaging in the CH band is still the preferred method to track small-scale magnetic fields because of higher detector sensitivity at the longer wavelength.

Direct Measurements of Zonal Winds on Mars through Ultra-High-Resolution Observations of CO_2

Guido Sonnabend & Daniel Wirtz (University of Cologne)

During the first week of December 2005, we successfully operated the Cologne Tuneable Heterodyne Infrared Spectrometer (THIS) at the McMath-Pierce Solar Telescope to observe CO_2 emission and absorption features in the 10 μm wavelength range on Mars. While this absorption occurs in the lowest few kilometers of the atmosphere, the emission originates in a thin layer at around 70 km. Thus frequency shifts in the line positions between absorption and emission can be used to calculate wind speeds in the high atmosphere.

Our heterodyne instrument consists of an optical receiver and common back-end electronics including an in-house built Acousto-Optical Spectrometer (AOS). Inside the receiver, the monomode emission from a local oscillator (LO) is superimposed with the infrared (IR) radiation coming from the telescope and detected on a fast Mercury Cadmium Telluride (MCT) detector. With this method, the spectral information is shifted from the mid-IR to the radio range, allowing amplification, filtering, and frequency analysis of the signal using a standard back-end. A photo of the setup at the McMath-Pierce on Kitt Peak is shown in figure 1 and a schematic of the set-up is shown in figure 2.

The receiver employs tunable Quantum-Cascade Lasers (QCL) as local oscillators which in principle allow operation between 8 and 17 μm wavelength. A spectral resolution of

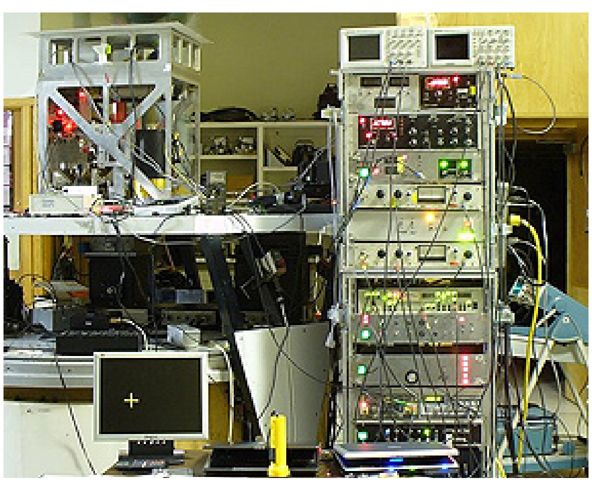


Figure 1. THIS at the McMath-Pierce main telescope: the optical receiver (cubic aluminum structure on the left) and back-end electronics (19-inch rack on the right), including the Acousto-Optical Spectrometer (AOS).

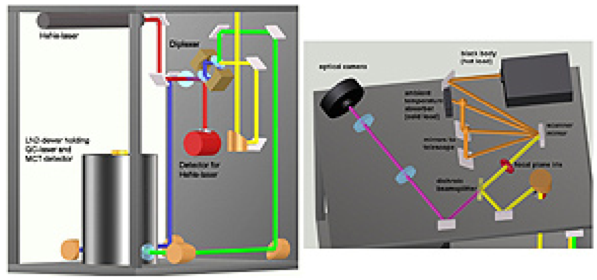


Figure 2. Set-up scheme of the optical receiver: laser (LO) and signal (switchable between telescope and two loads at known temperature for calibration) are combined by a diplexer and focused on the detector. After filtering and amplification, the frequency analysis is carried out using an AOS (not depicted).

3×10^7 can be achieved, which corresponds to 1 MHz or 10 m/s at a wavelength of 10 μm. The band width is temporarily limited to 1.4 GHz and will be expanded to twice that value in the near future. The sensitivity of our instrument is comparable to common CO_2 laser systems.

Various models for Martian atmospheric dynamics recently became available, due primarily to the high number of space missions to the red planet. However, observations of winds in particular are missing. This is not only interesting for Mars but also important in general for planetary atmospheres (Venus, Earth, Titan, etc.). The Mars Global Surveyor Thermal Emission Spectrometer (MGS/TES) provided data to predict zonal winds up to a height of approximately 65 km, for example. The zonal wind fields are estimated from the temperature field as a function of height, latitude, and seasons of the Martian atmosphere.

Information about Martian zonal winds in higher altitudes can be directly retrieved by simultaneous detection of CO_2 absorption in the lower atmosphere (< 5 km) and CO_2 emission in the upper atmosphere (60–80 km). The non-LTE CO_2 emission lines (line width approximately 40 MHz) generated in the Martian mesosphere can only be resolved with high spectral resolution spectroscopy in the mid-IR region.

THIS is ideally suited to perform these measurements. The Doppler width of the emission feature yields information about the temperature of the atmospheric region where the

continued

Direct Measurements of Zonal Winds on Mars continued

emission takes place. The emission line is superimposed on the much broader CO_2 absorption line and the offset of the center positions of these two lines provides direct observation of zonal wind velocities. These results will be compared to predictions made by various models.

A proof of principle result was achieved during an observing run at the McMath-Pierce in 2003 (figure 3). The measured value is in good agreement with models derived from MGS/TES. During the 2005 run, we systematically observed a number of positions on the Martian disk to get an impression of the global wind field during the season we observed (L_S=335). Data analysis is still ongoing, but an unprocessed example spectrum is shown in figure 4.

There are long-term plans for THIS to be operated on the stratospheric airborne observatory SOFIA. The main goal will be the detection of cold interstellar H_2, against moderately hot IR sources, at wavelengths around 17 μm. Until SOFIA becomes operational, further observations of planetary atmospheres, as well as stars or proto-planetary disks, are planned.

Suggestions for further reading: Sonnabend et al., A&A, 435, 1181 (2005) and Sonnabend, Wirtz, & Schieder, Appl. Optics, 41, 2978 (2002).

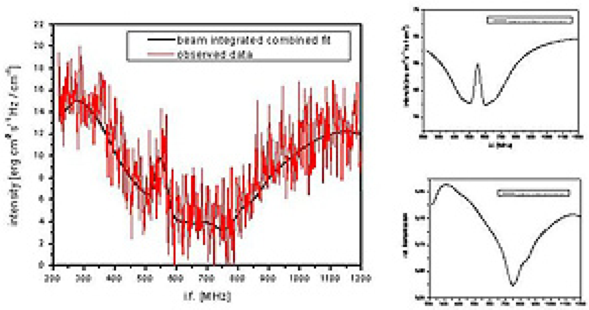


Figure 3. Left: CO_2 P(30) absorption and emission line at 1037.4 cm-1. The spectra are double sideband, binned to a 4 MHz resolution and highly contaminated by telluric ozone absorption. The combined fit (single heavy line) yields the telluric and martian spectra shown separated in the top and bottom right graphs, respectively. The width of the emission peak was determined to be 42 MHz ± 4.0 MHz (FWHM), suggesting an altitude of 60-80 km as the origin of the line. The offset of the emission peak from the center of the absorption line of 7.5 MHz is most likely caused by zonal wind in the higher atmosphere.

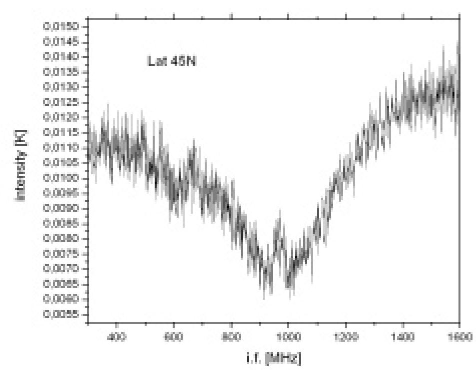


Figure 4. CO_2 P(2) absorption and emission line at 959.4 cm-1 at 45° northern latitude on Mars. The spectra are shown at full resolution of 1 MHz. Analysis of the exact frequencies is ongoing.

Announcing the NOAO NVO Portal

Chris Miller

The NOAO Data Products Program (DPP) has recently unveiled a new Web-based tool to discover, access, and analyze imaging data from public archives. This effort is part of a larger program to provide the astronomical community with simple, consistent, and astronomer-friendly interfaces to the tools and resources of the National Virtual Observatory (NVO).

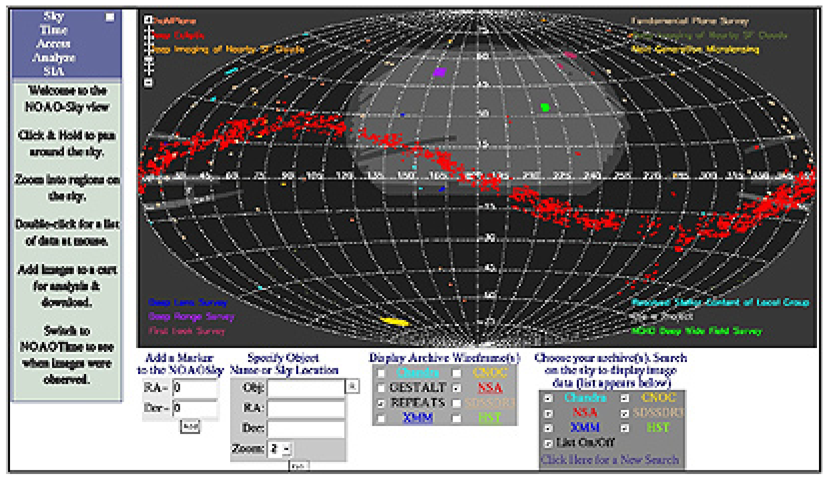


Figure 1. NOAO-Sky: the front page of the new NOAO NVO Portal

There are two new ideas behind the portal. First, the visualization tools for seeing what data are available are a set of linked graphical interfaces, giving the user various ways to browse, explore, and compare data, including a sky map view and a calendar view, as well as the usual text table. The user can switch among these views for any selected data. Second, the portal integrates access to data and access to tools, so the user can construct a dataset that includes data from a number of NVO-compliant archives, and then send this constructed dataset to Web-based analysis services. Only the final product is downloaded to the user's desktop.

The NOAO NVO Portal utilizes modern Web technologies (e.g. Asynchronous Javascript and XML–AJAX), fast database searching, and the availability of NVO-compliant Simple Image Access servers to provide an interactive graphical user interface to data. To try out the working prototype, point your Firefox or Mozilla browser to *nvo.noao.edu*, and click on the image or the link to the NOAO NVO Portal. The front page of the NOAO NVO Portal shows the sky with the NOAO Science Archive Survey Data (described in the June 2002 *NOAO/NSO Newsletter*) highlighted in color (see figure 1).

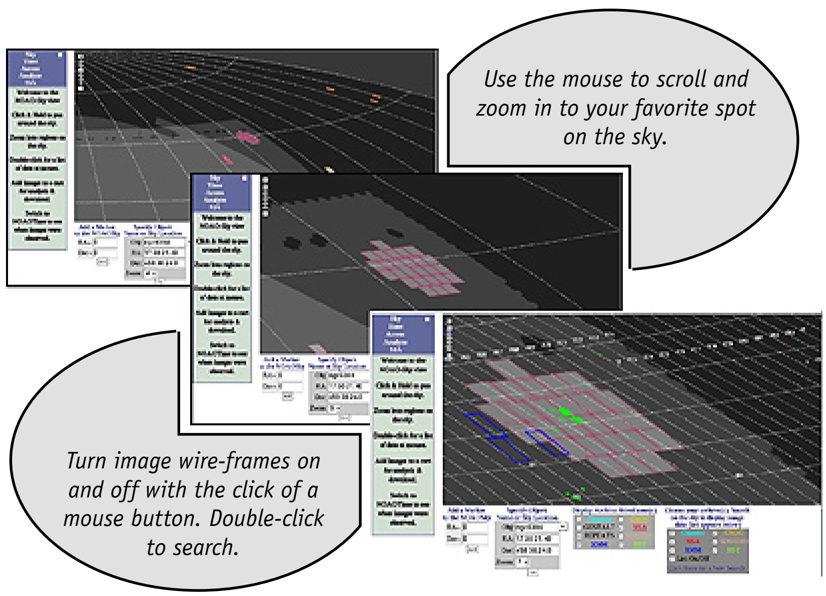


Figure 2: Pan, zoom, and choose from various archives.

The left sidebar of the NOAO NVO Portal lists simple actions for the user, such as: click and hold the mouse button to drag the NOAO-Sky in your browser, zoom into any region on the sky, and double-click the mouse button over a colored image wire-frame to gain direct access to an image (see figuresz 2 and 3). Users can select from a number of image archives (HST Previews, SDSS, XMM, Chandra)

continued

The NOAO NVO Portal continued

to display on the sky, or can search and list image data products within the coordinate ranges of the viewing region. One mode of the display shows regions of the sky that have been observed multiple times ("Repeats").

The four control-panels below the sky window allow the user to: (1) mark positions on the sky; (2) specify an object by name, resolve its coordinates, choose a zoom level, and have the NOAO-Sky zoom in directly on that object; (3) display colored wire-frames from a variety of VO image archives; (4) choose which archives to search within the RA/DEC range of the viewing window.

When a user searches via a control panel, or double-clicks the mouse near an image, a list of available data appears below the sky window. This list contains information describing the available data, as well as a direct download link (via the external archive's SIAP service), and the ability to "add" the image data product to a cart.

Once added to the cart, users can stage their selected data products at an NOAO server for easy access and download. Users never have to point their browsers at other archives. The NOAO NVO Portal acts as an interface to these other public NVO-compliant archives.

Users can also utilize the ever-growing list of NVO analysis tools and services on the data products in their cart. For instance, with the proper plug-in, users can view their selected images in Aladin, create galaxy and star catalogs using WESIX (a Web-service implementation of SExtractor), or attempt to categorize or fix the World Coordinate Systems (WCS) of their images using the new NOAO WCS Fixer prototype.

Finally, users can view NVO data in ways they may not be familiar with. For instance, the NOAO-Time calendar view lets users "see" when data were taken. This module of the NOAO NVO Portal is an attempt to help astronomers discover data in both time and space.

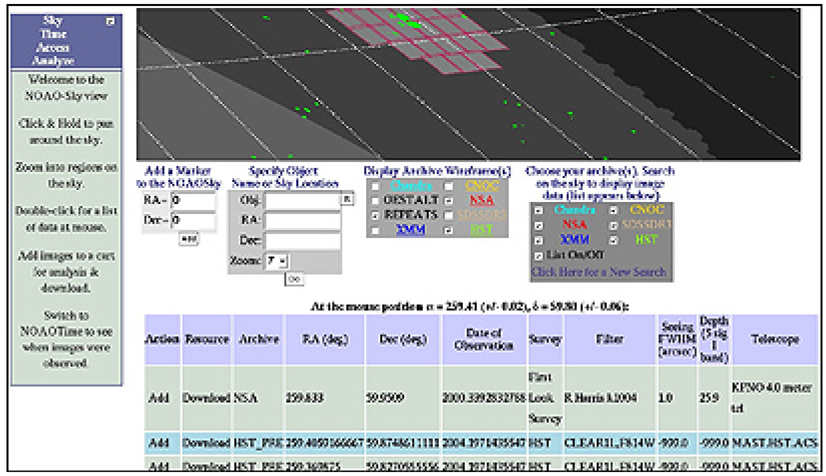


Figure 3: Double-click on an image or search the whole window to display data

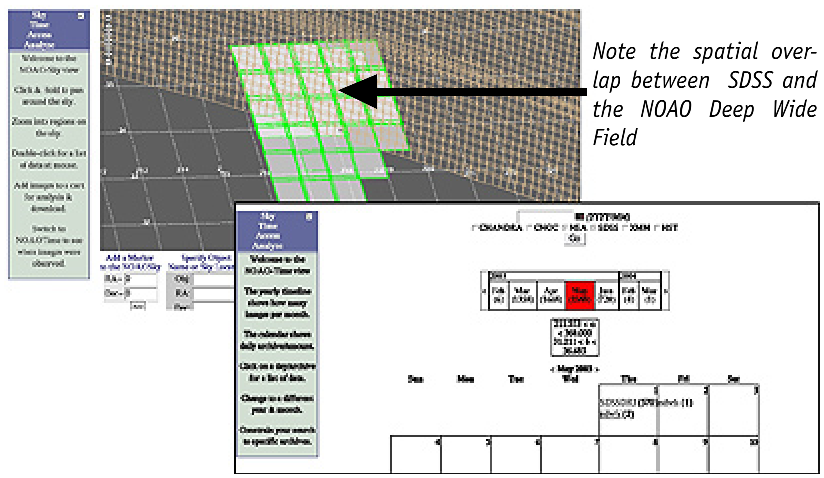


Figure 4: See where and when data were taken.

For first-time users, we suggest reading any one of the four tutorials available for each of the four main NOAO NVO Portal modules (Sky, Time, Access, and Analyze). These are easily located via links at the top of each and every page. Likewise, there is a list of Frequently Asked Questions (FAQs) and step-by-step examples available at *www.nvo.noao.edu/noaonvo/help.shtml*.

The implementation of the NOAO NVO Portal that has been released is intended as a prototype. Future versions will feature many additional analysis functions and access to more available data, including Principal Investigator data taken on NOAO telescopes. One of the purposes of implementing this prototype is to solicit feedback on the types of user interfaces to VO data that astronomers would like to see made available.

The NOAO DPP group encourages feedback on the portal and on any of its other ongoing projects. Please e-mail comments or questions to *vohelp@noao.edu*.

The NOAO NVO Portal development team includes Chris Miller, Exequiel Fuentes, and David Gasson.

Nicholas Suntzeff Leaves to Take Up Mitchell Chair

Jeremy Mould

Twenty years of excellent service to Cerro Tololo Inter-American Observatory come to an end this month, when Nicholas Suntzeff moves to the George Mitchell Chair of Observational Astronomy at Texas A&M University. Nick has the opportunity to build a major research group in astronomy at A&M, and we congratulate him and wish him well in this important endeavor.

Nick's leadership and service to the astronomical community have been truly outstanding. A native of Berkeley, California, Nick earned his first degree at Stanford and his doctorate at UC Santa Cruz and Lick Observatory. After fellowships at Carnegie and Las Campanas, Nick joined the staff of CTIO and spent his next 20 years in La Serena. He has worked tirelessly for the values of the national observatory and for science, contributing to CCD and fiber spectrograph development, the New Technology Telescope and Gemini, site testing, telescope improvements, SOAR, Magellanic Cloud science, supernova research, dark energy, Supernova 1987A, and much more. CTIO's contributions to the study of SN 1987A have been particularly distinguished among the southern hemisphere observatories.

He did all this in great style, winning the Trumpler Award for his thesis from the Astronomical Society of the Pacific, AURA awards for outstanding science (twice), and the Science Breakthrough of the Year Award (with the High-z Supernova search team) in 1998 for the discovery of the accelerating universe. In 2004, he was appointed NOAO Associate Director for Science.

As Nick departs, all of us at NOAO have high expectations for the outcome of his next career move. As the inaugural Mitchell Professor at Texas A&M, Nick will lead a group oriented in part toward the enormous challenge of investigating the accelerating universe. I cannot think of a better person for the job.

His many contributions to the "espirito" of Cerro Tololo helped create the unique and positive atmosphere that all visiting astronomers feel when they visit or come to work at CTIO. Good luck in your new job, Nick.

Sidney Wolff Awarded AAS Education Prize

Jeremy Mould

Former NOAO director and current staff astronomer Sidney Wolff is the well-deserved recipient of the 2006 Education Prize of the American Astronomical Society (AAS). The AAS Education Prize recognizes outstanding contributions to the education of the public, students, and/or the next generation of professional astronomers. The citation for Sidney states:

"For her extraordinary commitment to science education throughout her career, beginning with authoring an introductory textbook, and culminating in the first professional, refereed, astronomy education journal, the "Astronomy Education Review," which has become a highly-valued and influential communication channel for astronomy educators.

"For her dedication, attention and outstanding contributions to astronomy education while in leadership positions at the National Optical Astronomy Observatory, the American Astronomical Society, and the Astronomical Society of the Pacific.

"For her efforts in highlighting and advancing astronomy education policy at the local, national and international levels, creating and promoting new opportunities for educators, students and the public."

The Web-based journal, Astronomy Education Review, which Sidney founded in 2002 and continues to edit, is hosted by NOAO at *aer.noao.edu*. With her help at many key points along the way, astronomy education has become a valued and recognized career path in our field. Well done, Sidney!

Q&A

Adwin Boogert
Scientific Staff NGSC

Adwin Boogert joined the scientific staff of the NOAO Gemini Science Center (NGSC) in December 2005, after two postdoctoral positions at the California Institute of Technology (Caltech) in Pasadena. At Caltech, he worked on studies of the interstellar medium and star formation using the Caltech Submillimeter Observatory and the Millimeter Array at the Owens Valley Radio Observatory. He was also heavily involved in planning and analyzing spectroscopic observations of protostars with the Infrared Spectrograph (IRS) instrument on the Spitzer Space Telescope for the Spitzer Legacy Program “From Molecular Cores to Planet-Forming Disks.”

Adwin received his Ph.D. in March 1999 from the University of Groningen in the Netherlands, on the subject of interstellar ices and astrochemistry with Xander Tielens. Now based in La Serena, Chile, his functional duties at NOAO involve supporting the US astronomical community with their use of the mid-infrared instruments at the Gemini Observatory.

Q. What scientific questions are you currently pursuing?

One of the most important questions in the topic of astrochemistry is how and which complex molecules are formed in space. A popular theory is that energetic photons and cosmic rays provide the energy required to initiate chemical reactions in icy grain mantles. Those ices are abundantly present in dense molecular clouds and circumstellar disks. Simulations in the laboratory show that quite complex molecules (even amino acids) can be formed this way.

Currently I am conducting an infrared spectroscopic survey of low-mass protostars to determine the composition of the ices as a function of time and environment, using the Spitzer telescope and ground-based facilities. Several prominent absorption features have not yet been identified, and might originate from species more complex than were observed so far. It is important to determine the abundance of the simple species (CO, CO_2, H_2O) as well, as they could be the building blocks of more complex molecules after sublimation from the grains.

The composition of these gases can be determined by infrared and millimeter-wave spectroscopy. Their kinematics and excitation can be used to determine the structure of circumstellar disks and the conditions of planet formation. Together with Geoff Blake’s group at Caltech, I am involved in a large five-micron survey at the Keck telescope in which we observe the rotation-vibration lines of CO to do that.

Q. What are your functional duties in the NOAO Gemini Science Center?

I am responsible for supporting the US users of the mid-infrared instruments T-ReCS and Michelle at the Gemini telescopes. This involves technical assessments of proposals, reviewing and answering questions about Phase II schedule files, and promoting these instruments in the astronomical community. To provide the best user support, it is important to collaborate with scientists at Gemini and help with the Gemini queue observations. Here in the south, such interactions are facilitated by the close proximity of NOAO South to the Gemini offices.

Q. In your area of scientific expertise, how do you see the Gemini telescopes and instrumentation making a difference?

The Gemini telescopes are optimized for observations at infrared wavelengths. This makes them well suited for astrochemical studies, because the rotation-vibration transitions of molecules are all in the infrared. Gemini’s large aperture is required to detect weak ice and dust features in star-forming regions and to perform high-resolution spectroscopy of narrow gas features in brighter sources.

Q. Do you see a complementarity between ground and space observations in your science area?

Absolutely! The spectral resolution of space-based infrared spectrometers (such as the IRS spectrometer on Spitzer) is usually insufficient to resolve, or even detect, gas around protostars. The rotation-vibration

continued

Q&A continued

lines of gas phase molecules are powerful tracers of the structure and physical conditions of circumstellar disks and may tell us a great deal about planet formation.

The high imaging sensitivity and efficiency of infrared satellites on the other hand is essential in building up large enough samples of protostars at different ages that can be followed up with spectroscopy from the ground. I did this for my Ph.D. thesis using data from the Infrared Space Observatory and am doing it now with Spitzer data, especially those from the "c2d" Spitzer Legacy team led by Neal Evans. I have used the Keck telescope for high spectral resolution 4.7-micron CO observations, and this April will use the Phoenix spectrometer at Gemini South to search for other species in disks, such as HCN and CH4.

Q. You were at Caltech previously. How would you compare and contrast the strengths of Keck and Gemini for research like yours?

The Gemini telescopes have a strong suite of mid-infrared instruments: Michelle in the northern hemisphere and T-ReCS in the southern hemisphere. At the moment, the Keck telescopes have no instruments operating in the atmospheric N and Q bands. At my first Gemini run last December, I also noted that the guiding is very stable, for more than an hour. On the other hand, as opposed to Keck, each Gemini observation requires an optical guide star and this is not always available for deeply embedded protostars.

One big advantage of observing with Gemini is that most observations are done in queue mode. The conditions required for obtaining good mid-infrared data are in certain ways complementary to good optical weather conditions in that the Moon is usually not a problem in the mid-IR (except when it covers the object as in my last run!), but high water vapor levels often are, even with clear skies. The ability to change between instruments within a few minutes makes queue observing at different wavelengths very efficient.

Q. How are you finding life in La Serena?

I arrived in La Serena a little over a month ago. I don't speak Spanish yet, but the staff and my colleagues at CTIO have been very helpful, for example with finding an apartment. I decided to live outside of the CTIO recinto, so as to experience the Chilean culture better and eventually adapt better. The town itself is larger than I thought it would be, with many big shops. Now that it is summer, there is a lot going on in the town center and near the beach.

Gemini Observing Opportunities for Semester 2006B

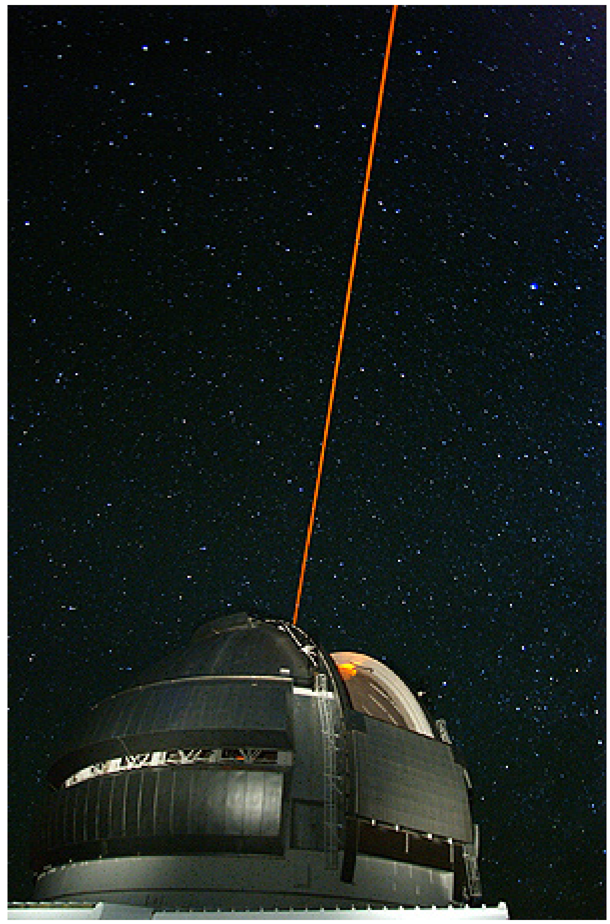
Taft Armandroff

The NOAO Gemini Science Center (NGSC) invites and encourages the US community to submit proposals for Gemini observing opportunities during semester 2006B. US Gemini observing proposals are submitted and evaluated via the NOAO Time Allocation Committee (TAC) process. Although the Gemini Call for Proposals for 2006B will not be released until 1 March 2006 for the US proposal deadline of March 31, the following are our expectations of what will be offered in semester 2006B. Please watch the NGSC Web page (*www.noao.edu/usgp*) for the Call for Proposals for Gemini observing, which will clearly list the capabilities that can be requested.

NGSC is pleased to inform the US community of the following suite of scientifically important instrumental capabilities to be offered in semester 2006B:

Gemini North:

- The integral-field infrared spectrograph NIFS will be offered for the first time in 2006B. See the article on NIFS by Bob Blum on the next page of this *Newsletter*.
- The NIRI infrared imager/spectrograph will be offered in 2006B. Both imaging mode and grism spectroscopy mode will be available.
- The ALTAIR adaptive optics (AO) system will be offered in natural-guide-star mode and, for the first time, in laser-guide-star mode in 2006B. Gemini plans to offer the following modes of ALTAIR in 2006B: AO-enhanced infrared imaging and spectroscopy using NIRI, and AO-enhanced integral-field spectroscopy with NIFS. Please note that the laser-guide-star system is still being commissioned, so prospective users should read the Gemini Call for Proposals and Web pages for the latest information.
- Michelle, the mid-infrared (8-25 micron) imager and spectrograph, will be available for imaging and for spectroscopy.
- The GMOS-North optical multi-object spectrograph and imager will be offered in 2006B. Multi-object spectroscopy and long-slit spectroscopy (both optionally with nod-and-shuffle mode), integral-field unit (IFU) spectroscopy, and imaging modes will be available.
- All the above instruments and modes are offered for both queue and classical observing. Classical observing will be offered only to programs with a length of three nights or longer.
- The TEXES high-resolution mid-infrared spectrograph will be offered as a visitor instrument. It will be scheduled for one observing block. For reference, an article on TEXES appeared in the December 2005 *NOAO/NSO Newsletter*.
- Time trades will allow access to HIRES on Keck and the Suprime-Cam wide-field imager on Subaru.



The laser-guide-star beacon at Gemini North. Laser-guide-star adaptive optics will be offered for the first time in semester 2006B. (Image Credit: Gemini Observatory)

Gemini South:

- The GMOS-South optical multi-object spectrograph and imager will be offered during semester 2006B. Multi-object spectroscopy, long-slit spectroscopy, IFU spectroscopy (all optionally with nod-and-shuffle mode), and imaging modes will be available.
- The T-ReCS mid-infrared imager and spectrograph will be available in semester 2006B.
- The GNIRS facility infrared spectrograph will be offered in semester 2006B.

continued

Gemini Observing Opportunities for Semester 2006B continued

- The bHROS high-resolution (R=150,000) optical spectrograph will be available in semester 2006B.
- The Phoenix infrared high-resolution spectrograph will be offered in semester 2006B. Phoenix is available only in classical mode (in whole nights, with no three-night minimum). NGSC Staff will provide training and start-up assistance to Phoenix classical observers.
- The Acquisition Camera will be available for time-series photometry in 2006B.
- All modes for GMOS-South, GNIRS, bHROS, and T-ReCS are offered for both queue and classical observing. Phoenix is available only for classical observing. Classical observing will be offered only to programs with a length of three nights or longer (except in the case of Phoenix).

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

The percentage of telescope time devoted to observations for science programs in semester 2006B is planned to be 90 percent at Gemini North and 75 percent at Gemini South.

We remind the community that US Gemini proposals can be submitted jointly with collaborators from another Gemini partner country. An observing team requests time from each relevant partner country. Such multi-partner proposals are encouraged because they access a larger fraction of the available Gemini time, thus enabling larger programs that are likely to have substantial scientific impact. Please note that all multi-partner proposals must be submitted using the Phase I Tool (PIT).

Proper operation of the Gemini queue requires that it is populated with programs that can profitably use the full range of observing conditions. Gemini proposers and users have become accustomed to specifying the conditions required to carry out their observations, with the help of the Gemini Integration Time Calculators (ITCs). NGSC wishes to remind the US community that a program has a higher probability of being awarded time, and of being executed, if ideal observing conditions are not requested. The two conditions that are in the greatest demand are excellent image quality and no cloud cover. We understand the high demand for these excellent conditions, but wish to remind proposers that programs that make use of less than ideal conditions are also needed in the queue.

NOAO accepts Gemini proposals via the standard NOAO Web proposal form and the Gemini PIT software. We remind proposers that NOAO offers a tool to allow PIT submitters to view how their proposal will print out for the TAC (see *www.noao.edu/noaoprop/help/pit.html*).

NIFS Commissioning at Gemini North

Robert Blum

In October and November 2005, the Gemini Near-infrared Integral Field Spectrograph (NIFS) was successfully commissioned on the Fredrick C. Gillett telescope at Gemini North. The commissioning was so successful that the call for NIF System Verification observations followed within just two weeks. These observations are being carried out as of the writing of this article in January 2006.

NIFS is a near-infrared spectrometer that simultaneously observes a 3-arcsec by 3-arcsec field of view. The field is sliced by a fully cryogenic reflective image slicer, which produces 29 segments of the field. Each segment is a 3-arcsec by 0.1-arcsec spectrum covering one of the Z, J, H, or K bands at spectral resolutions of about 5000 (two pixels). A NIFS observation thus results in a three-dimensional data cube. NIFS was designed to work with the Gemini facility adaptive optics (AO) system, Altair, to produce near-diffraction-limited observations. The NIFS image slices correspond to 0.1-arcsec slits and each is sampled in the spatial dimension at 0.043 arcsec/pixel. This is just undersampled with respect to the 8-meter diffraction limit in the spatial dimension at two microns.

Currently, there are at least three main modes in which NIFS will see normal operations. These have all been commissioned, with System Verification observations underway for each of the three.

By far the most common mode is NIFS with Altair AO correction. Using Altair with a bright "natural" guide star (NGS) is often referred to as NGS AO. With a bright guide star (R < 12 for full AO correction), one observes on-axis (usually the science target) or with an off-axis star within the Altair patrol field (up to about 25 arcsec from the science target). Off-axis stars should be as close as possible and bright. Details for selecting and configuring NIFS/Altair in this mode are available on the Gemini NIFS pages at *www.gemini.edu/sciops/instruments/nifs/NIFSIndex.html*. A useful option in this mode is to use the near-infrared on-instrument wavefront sensor (OIWFS) with a second (fainter, K<14) guide star. By tracking the relative

continued

NIFS Commissioning at Gemini North *continued*

positions of the AO and OIWFS guide stars, differential flexure between NIFS and Altair can be accounted for. An option for K-band polarimetry is currently not commissioned.

The second main mode is NIFS without AO. This mode might be useful under good-to-excellent image quality conditions for science targets that have no suitable AO guide stars. The guiding in this case is done by the peripheral wavefront sensor, which patrols a 6-arcmin field around the NIFS science field. It is expected that this mode will be used infrequently.

The final commissioned mode is NIFS/Altair with a focal plane coronagraphic mask. NIFS has three masks with focal plane diameters of 0.1, 0.2 and 0.5 arcsec, respectively. This mode will be useful in searching for faint companions near bright central sources. Commissioning observations suggest that using the OIWFS in this mode can help keep the spot well centered when moving between science and sky positions. It is expected that the 0.2-arcsec and 0.5-arcsec masks will be used most often.

A fourth mode for NIFS will hopefully be commissioned toward the end of semester 2006A. This is the use of NIFS/Altair in conjunction with the sodium laser guide star (LGS). The Gemini North LGS+Altair facility is partially commissioned at this time, following excellent progress in 2005B. The system uses a 14-watt laser, which is launched from a small telescope behind the secondary mirror of the Gemini telescope. This laser beam excites a naturally occurring layer of sodium atoms in the atmosphere at about 90 kilometers altitude. To date, the LGS has been in use with Altair and NIRI (the Gemini facility infrared imager). The system has locked on the LGS while properly interfacing with the other telescope systems for fully functional NIRI/Altair observations. Further work will involve making this process more fully automatic and more robust. Improvements to the optics of the launch telescope are expected in 2006A that will produce as-designed image quality of the sodium spot (i.e. the LGS).

The development of end-user data reduction tools is critical to NIFS commissioning, System Verification, and community science aspirations. A NIFS IRAF package, based in part on the Gemini GNIRS package, has been developed and will be released to the community. Current plans call for an initial release shortly after the System Verification observations are complete in early 2006A. The development package handles basic Gemini processing of header information and tracking/propagating multi-extension FITS (MEF) files with science, variance, and data-quality data planes. Other included tools handle wavelength calibration, rectification of the spatial distortion along each image slice, construction of a data cube, and tools to extract one-dimensional spectra from data cubes. NOAO IRAF developers have worked with their Gemini counterparts and NIFS team astronomers to help build this initial

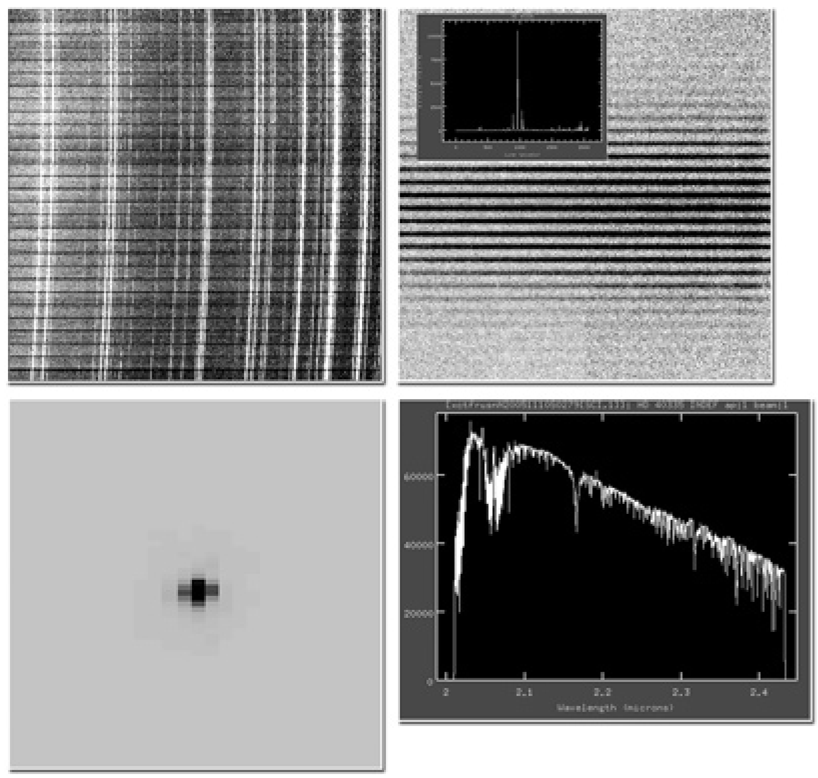


Figure 1: Fully reduced images and spectrum from NIFS. The upper left image is a K-band Xe-Ar lamp image showing the characteristic NIFS curvature and effect of the staircase slit (see text). The upper right image is a flat fielded, sky subtracted, wavelength calibrated, and rectified image of standard star HD40335, showing each of the NIFS 29 spatial slices. The inset testifies to the excellent image quality on this night. The lower left image is the spatial reconstruction of HD40335, showing the 3 arcsec × 3 arcsec field and the 0.043 arcsec × 0.1 arcsec pixels. Finally, a summed spectrum of HD40335 is shown in the lower right panel from a software aperture of the central 0.5 arcsec (diameter).

continued

NIFS Commissioning at Gemini North continued

package. While significant checking and documentation are still necessary, the full framework of an end-to-end IFU processing package is in hand.

Figure 1 shows a sample NIFS observation with associated calibrations and reduced frames. In the upper left, a K-band Xe-Ar arc lamp image depicts the sliced field and line curvature due to anamorphic demagnification in the spectrograph. The effect of the "staircase" long slit that feeds the spectrograph is also seen as each slice has slit images (i.e., emission lines) which step up and right in each successive slice (starting from the bottom). Another way to think of this is that a NIFS slit image would show a long slit from top to bottom of the image, but instead of being straight along the Y-axis, it would step a few pixels in X for each slice in Y in order to separate each slice on the sky. The upper right image shows a full K-band image of HD40335 that has been sky subtracted, flat fielded, corrected for distortion, and wavelength calibrated. Light from the wings of this bright star spills over into many of the off-center slices, but the inset image testifies to the good image quality on this night. Most of the light is clearly in the central 0.1-arcsec slice. The lower left image shows the NIFS imaging field for this same observation. This image was constructed by collapsing each slice along the wavelength direction. The final image in the lower right shows an extracted spectrum of HD40335. This spectrum is comprised of a sum of all the IFU pixels in a 0.5-arcsec-diameter aperture. This A-type star shows strong Brackett gamma absorption near 2.17 microns and many telluric absorption features. The signal-to-noise ratio in regions near 2.1 microns is in excess of 300.

The author would like to thank NIFS Principal Investigator Peter McGregor and Gemini NIFS scientist Tracy Beck for their invitation to participate in NIFS commissioning and System Verification, their explanation and help with NIFS data reduction, and their useful input for this article.

NGSC Staff Comings and Goings

Taft Armandroff & Verne Smith

Adwin Boogert Joins NGSC as Assistant Astronomer

Adwin Boogert joined the NOAO Gemini Science Center (NGSC) as an Assistant Astronomer, based at NOAO South, on 23 December 2005. Adwin comes to NOAO following postdoctoral fellowships at the Caltech Submillimeter Observatory and the Owens Valley Radio Observatory. He is an expert on molecular clouds and star-forming regions, the abundances and physical conditions of interstellar molecules, and infrared observations. A recent example of his work is the detection of molecules that are precursors to proteins in the planet-forming disk around a young star. Already a user of Michelle on Gemini, Adwin has assumed support responsibilities for US users of the Gemini mid-infrared instruments T-ReCS and Michelle. Please join us in welcoming Adwin to NGSC, and see the Director's Office section of this *Newsletter* for an interview with him.

Knut Olsen Joins NGSC

Knut Olsen shifted his service responsibilities from CTIO to NGSC, beginning dedicated effort for NGSC in mid-September. Knut has experience with several Gemini instruments, and his initial responsibilities with NGSC involve supporting the US NIRI/ALTAIR and GMOS programs. He is expert in the area of resolved stellar populations. One notable example of his recent work is a study of the stellar populations in M31 using high-resolution infrared imaging from the Gemini North telescope and NIRI/ALTAIR. We are very glad to have Knut as part of the NGSC Team!

Rachel Mason Transitions to Science Fellow at Gemini Observatory

Rachel Mason has transitioned from her position with the NOAO Gemini Science Center to become a Science Fellow at the Gemini Observatory in Hilo as of mid-February. Rachel joined NGSC in September 2003 as the first NGSC Postdoctoral Fellow. She began her NGSC position in Tucson and later relocated to NOAO South in La Serena. She has become expert in the use of the Gemini mid-infrared instruments T-ReCS and Michelle, and has ably supported US users of these instruments. Rachel has used the Gemini telescopes and instrument complement to address a number of compelling scientific issues for her own research, and recently published a paper on Michelle observations of NGC 1068 that allowed her to probe the central torus of this active galaxy and its more distant heated dust. We wish Rachel every success at Gemini, and look forward to our continued association with her.

National Gemini Offices & Gemini Staff Meeting

Taft Armandroff

The NOAO Gemini Science Center hosted a meeting of the Gemini and National Gemini Offices (NGO) staff on 29-30 November 2005, in Tucson, AZ. Select Gemini staff and almost all staff members of the National Gemini Offices of the US (NGSC), UK, Canada, Australia, Brazil, University of Hawaii, and Chile attended. The meeting focused on training and idea sharing for the support of Gemini observing, instruments, and users, and builds on the May 2004 meeting held in Victoria, Canada. These meetings seek to optimize NGO staff training and interchange with Gemini staff in support of a highly effective Gemini distributed support model.

The meeting included eleven talks on developments with, and support of, Gemini instrument capabilities. Of particular interest were presentations on the new instruments NIFS, bHROS, TEXES, and NICI. There were also four talks on Gemini data reduction and archiving. Several round table discussions served as forums on the best ways to support the community of Gemini users through international teamwork. A number of recommendations resulting from the meeting will be presented to the Gemini Operations Working Group for implementation.

Greg Doppmann (Gemini Observatory) gives a presentation on GNIRS new features and user support at the Gemini Staff/NGO Staff meeting.

Participants in the meeting of Gemini staff and National Gemini Offices staff held in Tucson, AZ, 29-30 November 2005.

Probing the Dark Universe with Subaru and Gemini

Arjun Dey (NOAO), Naoshi Sugiyama (Subaru) & Joe Jensen (Gemini)

In early November 2005, a group of astronomers from the Gemini and Subaru user communities met on the Big Island of Hawaii to discuss the joint use of future instrumentation on their telescopes to investigate one of the outstanding and mysterious questions of our decade: the origin and nature of dark energy.

The meeting, which was attended by approximately 80 astronomers from Japan and the Gemini partner countries, was motivated primarily by the perceived synergies between two ambitious future instruments: HyperSuprime Camera, the next generation two-degree field imager currently being designed for Subaru; and the Wide-Field Fiber Multi-Object Spectrometer (WFMOS) that resulted from the Gemini Aspen future instrument selection process. The two observatories are engaged in discussions on how to economize on these instruments by sharing a common telescope platform (Subaru) and design elements (e.g., top-end telescope modifications and wide-field corrector elements), as well as shared intellectual and monetary resources in carrying out the ambitious key scientific projects.

The meeting in Hawaii provided a broad overview of the various innovative observational strategies for investigating the nature of dark energy, particularly weak lensing and

continued

Probing the Dark Universe with Subaru and Gemini continued

Participants in the workshop "Probing the Dark Universe with Gemini and Subaru," held 6-9 November 2005 in Waikoloa, Hawaii.

baryon oscillation surveys. Many surveys aimed at constraining w(z) are in their planning stages, and a few are already underway. The meeting provided a frank discussion of the relative merits of many different strategies, and most compellingly underscored the need to follow many different and complementary approaches (with different inherent systematics) to the problem. Supernovae studies have provided the most robust constraints to date and, as the most mature approach, provide valuable lessons in the importance (and difficulties) of constraining systematic errors. There was also an obvious need for the proponents of different strategies to calculate performance metrics using a similar set of assumptions.

The meeting demonstrated that both the baryon oscillation and weak-lensing methods are quite developed as cosmological probes. An attractive aspect of both the weak-lensing and baryon-oscillation approaches to measuring dark energy is that they naturally provide exquisite datasets for the investigation of a myriad of other astrophysical problems. For example, the joint capability of a very wide-field imager and a hugely multiplexed multi-object spectrometer on a large-aperture telescope will enable studies of Galactic structure and galaxy evolution of unprecedented scale and detail. At the meeting concerns and support were voiced variously about the sociology of doing science on a large scale. The scientific gains are large, but the observatories have to ensure that their resources are still available for smaller-scale, Principal Investigator-driven experiments.

Our astronomical ambitions in investigating dark energy are limited only by the cost of these projects, and the most ambitious studies will undoubtedly require multinational collaborations. The Gemini and Subaru observatories are taking the first steps in this direction by investigating a possible partnership to build HyperSuprime Camera and WFMOS. The Gemini Observatory has now commissioned two competing Conceptual Design Studies for WFMOS on Subaru. The Subaru Observatory has also designated resources and started an investigation of modifications to the telescope top end and to the design of HyperSuprime Camera. The two observatories are committed to working together to investigate the feasibility, benefits, and risks of jointly undertaking these ambitious projects. The November meeting in Hawaii was but one important step in this direction.

The presentations from the November meeting and other details can be found at *www.noao.edu/meetings/subaru/* and *www.naoj.org/Information/News/*, respectively. Financial support for the meeting was generously provided by Gemini, Subaru, PPARC, the NOAO Director's Office, and the NOAO Gemini Science Center.

NGSC Booth at the AAS Meeting in Washington, DC

The NOAO Gemini Science Center hosts an exhibit booth at the winter American Astronomical Society (AAS) meetings so that you can meet our staff and we can answer your questions about our mission as the gateway to Gemini for US astronomers. The booth, usually located between the NOAO and Gemini Observatory booths, features information on how to apply for time on the Gemini telescopes, their currently available instrument capabilities, and the Phase II process, including one-on-one tutorials. Brochures are available on the Gemini instruments, the Gemini Science Archive, and how to propose for Gemini observing time. Look for us at the January 2007 meeting in Seattle.

NGSC booth at the January 2006 AAS meeting in Washington: Top row, left to right: Bruce Carney (University of North Carolina at Chapel Hill) and Taft Armandroff (NGSC) with back to camera; Taft Armandroff and Jean-René Roy (Gemini Observatory); John Rayner (NASA-IRTF) and Ken Hinkle (NGSC). Bottom row, left to right: Eric Gawiser (Yale University), Taft Armandroff, and Bill Smith (AURA); Doug Simons (Gemini Observatory) and Taft Armandroff; John Lacy (University of Texas at Austin).

NGSC Instrumentation Program Update

Taft Armandroff & Mark Trueblood

The NGSC Instrumentation Program continues its mission to provide innovative and capable instrumentation for the Gemini telescopes in support of frontline science programs. This article gives a status update on Gemini instrumentation being developed in the US, with progress since the December 2005 *NOAO/NSO Newsletter*.

NICI

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

NICI is in the final assembly and testing phase of the project. In particular, the integration and testing of NICI's adaptive optics (AO) system is receiving a great deal of attention. Extensive optical tests of the AO system have been undertaken and are being used to optimize the focal positions of the camera and wavefront sensor. The resulting image quality, in both the cryostat and AO portions of the instrument, is within specification. MKIR has also been working to eliminate excess array noise.

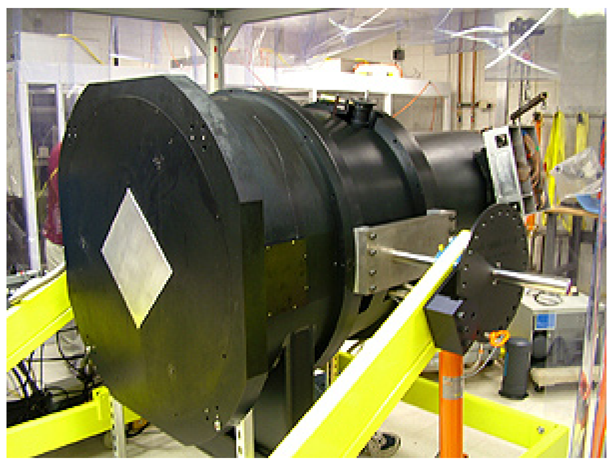
As of the end of December, MKIR reports that 99 percent of the work to NICI final acceptance by Gemini has been completed.

FLAMINGOS-2

FLAMINGOS-2 is a near-infrared multi-object spectrograph and imager for the Gemini South telescope. FLAMINGOS-2 will cover a 6.1-arcmin-diameter field at the standard Gemini f/16 focus in imaging mode, and will provide multi-object spectra over a 6.1 × 2-arcmin field. It will also provide a multi-object spectroscopic capability for Gemini South's multi-conjugate adaptive optics system. The University of Florida is building FLAMINGOS-2, under the leadership of Principal Investigator Steve Eikenberry.

The FLAMINGOS-2 Team is continuing with the integration and testing phase of the project. Alignment of the FLAMINGOS-2 imaging optical train is now complete. The camera dewar was cooled down to operating temperature with all components installed (including lenses, but not grisms) and then warmed back to room temperature. No adverse effects resulted from this thermal cycling. The grism vendor delivered the completed JH grism in January, and its transmission curve exceeded the FLAMINGOS-2 requirements. As of this writing in late January, the instrument is integrated and is being tested using an engineering-grade HAWAII array.

As of mid-January, Florida reports that 90 percent of the work to FLAMINGOS-2 final acceptance by Gemini has been completed.



The integrated FLAMINGOS-2 instrument in late January.

2006B Standard Proposals Due 31 March 2006 Surveys Due 15 March 2006

Todd Boroson

Standard proposals for NOAO-coordinated observing time for semester 2006B (August 2006 – January 2007) are **due by Friday evening, 31 March 2006, midnight MST**. (NOAO Survey Program proposals are due by 15 March 2006 and require a letter of intent to have been sent in January.) The facilities available this semester include the Gemini North and South telescopes, Cerro Tololo Inter-American Observatory (including SOAR), Kitt Peak National Observatory, and community-access time with Keck, HET, Magellan, and MMT.

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

- **Web submissions**—The Web form may be used to complete and submit all proposals. The information provided on the Web form is formatted and submitted as a LaTeX file, including figures that are "attached" to the Web proposal as encapsulated PostScript files.

- **E-mail submissions**—As in previous semesters, a customized LaTeX file may be downloaded from the Web proposal form, after certain required fields have been completed. "Essay" sections can then be edited locally and the proposal submitted by e-mail. Please carefully follow the instructions in the LaTeX template for submitting proposals and figures.

- **Gemini's Phase-I Tool (PIT)**—Investigators proposing for Gemini time only may optionally use Gemini's tool, which runs on Solaris, RedHat Linux, Mac, and Windows platforms, and can be downloaded from *www.gemini.edu/sciops/P1help/p1Index.html*.

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

Also note that our policies (or at least our willingness to bend them) have changed for proposals from graduate students. Appropriate letters from faculty advisors (see proposal instructions) must be received by the proposal deadline in order to ensure consideration for telescope time and travel support (for thesis observations). In addition, travel arrangements must be coordinated with the relevant NOAO office, and requests for reimbursement must be submitted promptly after the completion of the observing run.

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

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

Community Access Time Available in 2006B with Keck, HET, Magellan, and MMT

Todd Boroson & Dave Bell

As a result of awards made through the National Science Foundation's Telescope System Instrumentation Program (TSIP) and a similar earlier program, telescope time is available to the general astronomical community at the following facilities in 2006B:

- **Keck Telescopes**
  A total of 12 nights of classically scheduled observing time will be available with the 10-meter telescopes at the W. M. Keck Observatory on Mauna Kea. All facility instruments and modes are available, including the Interferometer. For the latest details, see *www.noao.edu/gateway/keck/*.

- **Hobby-Eberly Telescope**
  About 76 hours of queue observations are expected to be available at the 9.1-meter effective aperture Hobby-Eberly Telescope at McDonald Observatory. Available instruments include the High-, Medium-, and Low-Resolution Spectrographs. For the latest information on HET instrumentation and instructions for writing observing proposals, see *www.noao.edu/gateway/het/*.

- **Magellan Telescopes**
  A total of four nights will be available for classically scheduled observing programs with the 6.5-meter Baade and Clay telescopes at Las Campanas Observatory. For updated information on available instrumentation and proposal instructions, see *www.noao.edu/gateway/magellan/*.

- **MMT Observatory**
  Twelve nights of classically-scheduled observing time will be available with the 6.5-meter telescope of the MMT Observatory. For further information, see *www.noao.edu/gateway/mmt/*.

A list of instruments we expect to be available in 2006B is available at the end of this section. As always, investigators are encouraged to check the NOAO Web site for any last-minute changes before starting a proposal.

Gemini Instruments Possibly Available for 2006B*

GEMINI NORTH	Detector	Spectral Range	Scale ("/pixel)	Field
NIRI	1024×1024 Aladdin Array	1-5µm R~500-1600	0.022, 0.050, 0.116	22.5", 51", 119"
NIRI + Altair (AO)	1024×1024 Aladdin Array	1-2.5µm R~500-1600	0.022	22.5"
GMOS-N	3×2048×4608 CCDs	0.36-1.0µm R~670-4400	0.072	5.5' 5" IFU
Michelle	320×240 Si:As IBC	8-26µm R~100-30,000	0.10 img, 0.20 spec	32" × 24" 43" slit length
NIFS	2048×2048 HAWAII-2RG	1-2.5µm R~5000	0.04 x 0.10	3" × 3"
TEXES	256×256 Si:As IBC	5-25µm R~100000	0.13	3" slit length

GEMINI SOUTH	Detector	Spectral Range	Scale ("/pixel)	Field
GNIRS	1K×1K Aladdin Array	1-5.5µm R~1700, 6000, 18000	0.05, 0.15	3"-99" slit length 5" IFU
GMOS-S	3×2048×4608 CCDs	0.36-1.0µm R~670-4400	0.072	5.5' 5" IFU
T-ReCS	320×240 Si:As IBC	8-26µm R~100,1000	0.09	28" × 21"
Phoenix	512×1024 Aladdin Array	1-5µm R ≤70,000	0.085	14" slit length
bHROS	2048×4608 CCD	0.4-1.0µm R~150000		0.7" or 1" fiber
Acquisition Camera	1K×1K frame-transfer CCD	BVRI	0.12	2' × 2'

*Please refer to the NOAO Proposal Web pages in March 2006 for confirmation of available instruments.

CTIO Instruments Available for 2006B

Spectroscopy	Detector	Resolution	Slit
4-m Blanco			
Hydra + Fiber Spectrograph	SITe 2K CCD, 3300-11,000Å	300-2000	138 fibers, 2" aperture
R-C CCD Spectrograph[1]	Loral 3K CCD, 3100-11,000Å	300-5000	5.5'
4-m SOAR[2]			
Goodman Spectrograph	Lincoln 4K × 4K mosaic 3100-11,000 Å	1400-6000	5'
OSIRIS IR Imaging spectrograph	HgCdTe 1K, JHK windows	1200, 3000	1.3', 3.3'
1.5-m[3]			
Cass Spectrograph	Loral 1200 × 800 CCD, 3100-11,000Å	<1300	7.7'

Imaging	Detector	Scale ("/pixel)	Field
4-m BLANCO			
Mosaic II Imager	8K × 8K CCD Mosaic	0.27	36'
ISPI IR Imager	HgCdTe (20482, 1.0-2.4mm)	0.3	11'
4-m SOAR[2]			
Optical Imager	E2V 4K × 4K Mosaic	0.08	5.5'
OSIRIS IR Imaging spectrograph	HgCdTe 1K	0.14, 0.35	1.3', 3.3'
1.5-m[3]			
CPAPIR IR Imager	HgCdTe 2K	0.9	30'
1.3-m[4]			
ANDICAM Optical/IR Camera	Fairchild 2K CCD	0.17	5.8'
	HgCdTe 1K IR	0.11	2.0'
1.0m[5]			
Direct Imaging	4K CCD	0.29	20'
0.9-m[6]			
Cass Direct Imaging	SITe 2K CCD	0.40	13.6'

[1]Availability of this instrument in 2006B will depend on the status of the Goodman spectrograph on SOAR.
[2]The amount of science time available on SOAR in 2006B will be announced later. Classical (i.e. visitor) observing is scheduled to begin in 2006B

KPNO Instruments Available for 2006B

Spectroscopy	Detector	Resolution	Slit	Multi-object
Mayall 4m				
R-C CCD Spectrograph	T2KB/LB1A/F3KB CCD	300-5000	5.4’	single/multi
MARS Spectrograph	LB CCD (1980 × 800)	300-1500	5.4’	single/multi
Echelle Spectrograph	T2KB/F3KB CCD	18000-65000	2.0’	
FLAMINGOS[1]	HgCdTe (2048 × 2048, 0.9-2.5μm)	1000-1900	10.3’	single/multi
IRMOS[2]	HgCdTe (1024 × 1024, 0.9-2.5μm)	300,1000,3000	3.4’	single/multi
WIYN 3.5m				
Hydra + Bench Spectrograph	T2KA CCD	700-22000	NA	~100 fibers
DensePak[3]	T2KA CCD	700-22000	IFU	~90 fibers
SparsePak[4]	T2KA CCD	700-22000	IFU	~82 fibers
2.1m				
GoldCam CCD Spectrograph	F3KA CCD	300-4500	5.2’	
FLAMINGOS[1]	HgCdTe (2048 × 2048, 0.9-2.5μm)	1000-1900	20.0 ‘	
Exoplanet Tracker (ET)[5]	CCD (4k × 4k, 5000-5640 Å)	See Note	Fiber (2.5”)	

Imaging	Detector	Spectral Range	Scale (“/pixel)	Field
Mayall 4m				
CCD Mosaic	8Kx8K	3500-9700Å	0.26	35.4’
SQIID	InSb (4-512 × 512)	JHK + L (NB)	0.39	3.3’
FLAMINGOS	HgCdTe (2048 × 2048)	JHK	0.32	10.3’
WIYN 3.5m				
Mini-Mosaic[6]	4K × 4K CCD	3300-9700Å	0.14	9.3’
OPTIC[7]	4K × 4K CCD	3500-11000 Å	0.11	9.3’
WTTM	4K × 2K CCD	3700-9700Å	0.11	4.6’ × 3.8’
2.1m				
CCD Imager	T2KB/F3KB CCD	3300-9700Å	0.305	10.4’
SQIID	InSb (4-512 × 512)	JHK +L (NB)	0.68	5.8’
FLAMINGOS[8]	HgCdTe (2048 × 2048)	JHK	0.61	20.0’
WIYN 0.9m				
CCD Mosaic	8K × 8K	3500-9700Å	0.43	59’

[1]Resolution for 2-pixel slit. Not all slits cover full field; check instrument manual
[2]IRMOS availability will depend on proposal demand and block scheduling constraints.
[3]Integral Field Unit: 30”x45” field, 3” fibers, 4” fiber spacing @ f/6.5; also available at Cass at f/13.
[4]Integral Field Unit, 80”x80” field, 5” fibers, graduated spacing
[5]Exoplanet Tracker (ET) is an instrument provided by Jian Ge of the University of Florida and colleagues. It enables very high-precision measurements of radial velocities for suitably bright targets. Details regarding this instrument will be available via our instrument Web pages, but it is capable of providing Doppler precision of 4.4 m/s in 2 minutes for a V = 3.5 mag. G8V star.
[6]OPTIC Camera from University of Hawaii may be assigned as alternative if the program is scheduled in August or early September 2006; fast guiding is not a supported mode for NOAO users.
[7]OPTIC, available thanks to John Tonry of the University of Hawaii, will only be available in August and the first two weeks of September 2006.
[8]FLAMINGOS is an instrument built by Richard Elston and collaborators at the University of Florida. Steve Eikenberry is currently the PI of the instrument.

Keck Instruments Available for 2006B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
Keck I					
HIRESb/r (optical echelle)	Tek 2048 × 2048	30k-80k	0.35-1.0µm	0.19	70" slit
NIRC (near-IR img/spec)	256 × 256 InSb	60-120	1-5µm	0.15	38"
LRIS (img/lslit/mslit)	Tek 2048 × 2048	300-5000	0.31-1.0µm	0.22	6×7.8'
Keck II					
ESI (optical echelle)	MIT-LL 2048 × 4096	1000-6000	0.39-1.1µm	0.15	2×8'
NIRSPEC (near-IR echelle)	1024 × 1024 InSb	2000, 25000	1-5µm	0.18 (slitcam)	46"
NIRSPAO (NIRSPEC w/AO)	1024 × 1024 InSb	2000, 25000	1-5µm	0.18 (slitcam)	46"
NIRC2 (near-IR AO img)	1024 × 1024 InSb	5000	1-5µm	.01-.04	10-40"
DEIMOS (img/lslit/mslit)	8192 × 8192 mosaic	1200-10000	0.41-1.1µm	0.12	16.7×5'
OSIRIS (IR IFU w/AO)	2048 × 2048	3800	1-2.4µm	0.02-0.10	0.32x1.28"-3.2x6.4"
Interferometer					
IF (See http://msc.caltech.edu/kisupport/)					

HET Instruments Available for 2006B

	Detector	Resolution	Slit	Multi-object
LRS (Marcario low-res spec)	Ford 3072 × 1024			
	4100-10,000Å	600	1.0"-10"×4'	13 slitlets, 15" × 1.3" in 4' × 3' field
	4300-7400Å	1,300	1.0"-10"×4'	13 slitlets, 15" × 1.3" in 4' × 3' field
	6250-9100 Å	1,900	1.0"-10"×4'	13 slitlets, 15" × 1.3" in 4' × 3' field
MRS (med-res spectrograph)	(2) 2K × 4K, 4200-9000 Å	7,000	2.0" fiber	single
		9,000	1.5" fiber	single
HRS (high-res spectrograph)	(2) 2K × 4K 4200-11,000Å	15,000-120,000	2"or 3" fiber	single

MMT Instruments Available for 2006B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
BCHAN (spec, blue-channel)	Loral 3072 × 1024 CCD		0.32-0.8µm	0.3	150"
RCHAN (spec, red-channel)	Loral 1200 × 800 CCD		0.5-1.0µm	0.3	150"
MIRAC3 (mid-IR img, PI inst)	128 × 128 Si:As BIB array		2-25µm	0.14, 0.28	18.2, 36"
MegaCam (optical imager, PI)	36 2048 × 4608 CCDs		0.32-1.0µm	0.08	24'
Hectospec (300-fiber MOS, PI)	2 2048 × 4608 CCDs		0.38-1.1µm	R ~1K	60'
Hectochelle (240-fiber MOS, PI)	2 2048 × 4608 CCDs		0.38-1.1µm	R ~32K	60'
SPOL (img/spec polarimeter, PI)	Loral 1200 × 800 CCD		0.38-0.9µm	0.2	20"
ARIES (near-IR imager, PI)	1024 × 1024 HgCdTe		1.1-2.5µm	1.1, 2.1	20", 40"

Magellan Instruments Available for 2006B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
Magellan I (Baade)					
PANIC (IR imager)	1024 × 1024 Hawaii		1-2.5µm	0.125	2'
IMACS (img/lslit/mslit)	8192 × 8192 CCD	R~2100-28000	0.34-1.1µm	0.11, 0.2	15.5', 27.2'
Magellan II (Clay)					
MagIC (optical imager)	2048 × 2048 CCD		BVRI, u'g'r'i'z'	0.07	2.36'
LDSS2 (mslit spec/img)	SITe#1 CCD	R~200-1000	0.4-0.8 µm	0.38	6.4'
MIKE (echelle/multi spec)	2K × 4K CCD	R~19000-65000	0.32-1.0µm	0.14	30' (~200 fibers)

Observing Request Statistics for 2006A Standard Proposals

	No. of Requests	Nights Requested	Average Request	Nights Allocated	DD Nights (*)	Nights Previously Allocated	Nights Scheduled For New Programs	Over-subscription For New Programs
GEMINI								
GEM-N	142	168.21	1.18	48.48	4.77	0	48.48	3.47
GEM-S	106	164.97	1.56	43.02	3.71	0	43.02	3.83
CTIO								
CT-4m	58	202.4	3.49	141.5	3	8.5	133	1.52
SOAR	14	35.25	2.52	14.75	0	0	14.75	2.39
CT-1.5m	11	39	3.55	24.4	0	5	19.4	2.01
CT-1.3m	26	62.44	2.4	26.89	0	0.75	26.14	2.39
CT-1.0m	14	45	3.21	80.6	8	7.6	73	0.62
CT-0.9m	20	88.25	4.41	58.9	0	0	58.9	1.5
KPNO								
KP-4m	83	315.9	3.81	126.5	0	0	126.5	2.5
WIYN	35	111.95	3.2	49	0	11	38	2.95
KP-2.1m	31	165.5	5.34	129	0	0	129	1.28
KP-0.9m	10	49	4.9	30.5	0	0	30.5	1.61
Community Access								
Keck I	20	40	2	6	0	0	6	6.67
Keck II	18	29.2	1.62	6	0	0	6	4.87
HET	5	5.25	1.05	5.25	0	0	5.25	0.69
Magellan-I	6	10.75	1.79	4	0	0	4	2.69
Magellan-II	10	18	1.8	3	0	0	3	6
MMT	21	50.5	2.4	13	0	0	13	3.88

*Nights allocated by NOAO Director

SOAR Update

Steve Heathcote

Final preparations are underway to install the new active lateral support system for the primary mirror of the Southern Astrophysical Research (SOAR) telescope. This significant upgrade is expected to greatly improve system performance and operational efficiency, and to propel SOAR toward full science operations later this year.

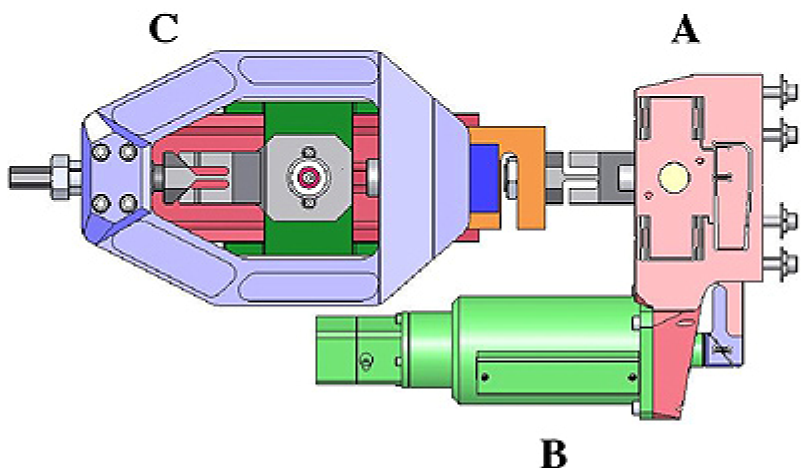
As reported previously, the current passive lateral links over-constrain the 4.1-meter primary mirror, warping it in response to tiny position- and temperature-dependent distortions of the telescope structure. Consequently, while the mirror figure can be properly optimized using wavefront sensor measurements, this process must be repeated for each new object and at intervals during tracking, which seriously impacts observing efficiency.

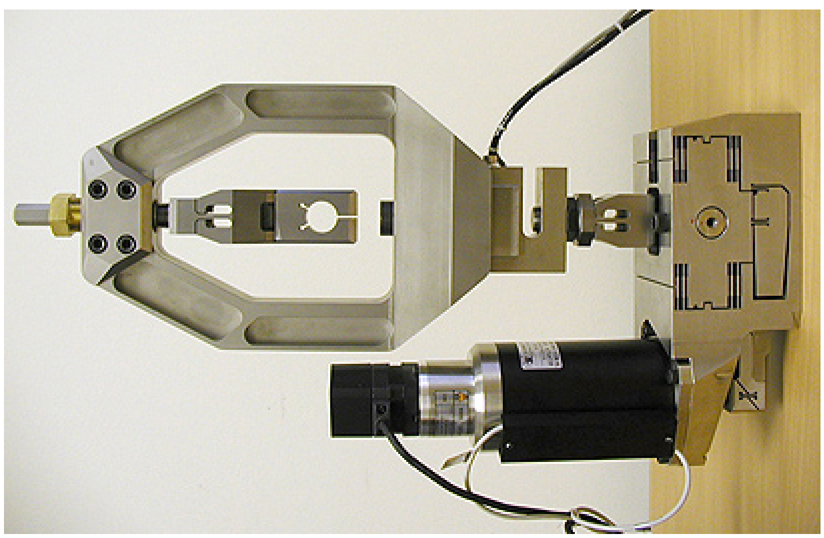
Understanding this problem, and subsequently developing a solution to it, has been a collaborative effort between SOAR, the Large Synoptic Survey Telescope (LSST) group led by Victor Krabbendam, and the original contractors for the SOAR optical system and telescope mount, Goodrich and Vertex RSI, respectively.

In the adopted solution, each of the six passive links is replaced by an active support incorporating an actuator and in-line load cell, so that the force applied to the mirror can be servo-controlled to the correct value. Because this is a retrofit, a significant design challenge arises: the new, more complex hardware must fit within the limited available space envelope, and must mount to the existing attachment points on the mirror and cell. In addition, for reasons of cost, it was decided to use commercial off-the-shelf actuators and load cells. Opto-mechanical Engineer Doug Neill of the LSST group solved this problem by proposing a novel lever and flexure mechanism, fabricated from a single block of material, using Wire Electric Discharge Machining.

As of mid-January 2006, we have successfully completed the testing of a single prototype link, and the production units are being fabricated by

continued





The new actuated lateral supports for the SOAR primary mirror in design (above) and in reality (below). The heart of the design is the custom lever and flexure mechanism (righthand upper box in the design image, "A") that amplifies the force applied by the actuator (lower cylinder "B"), while insuring that it only acts parallel to the link axis. The new hardware attaches to the existing mounting. The outer structure ("C") serves to "fold" the link so that it is effectively almost twice as long as the current passive links—this in turn proportionately reduces the magnitude of the undesirable bending moments that the link transfers to the glass.

SOAR Update continued

Phoenix-based contractor Landmark Tool and Gauge. The control electronics and software are nearing completion at SOAR as well. Installation of the new hardware, currently scheduled for mid-March, will be followed by a period of test and commissioning, with the upgraded telescope scheduled to resume operation in May.

The telescope tip-tilt tertiary mirror and fast-guide cameras have been brought into regular operation, achieving a significant improvement in delivered image quality through partial compensation of atmospheric tip-tilt and telescope wind shake. The SOAR Optical Imager (SOI) and OSIRIS infrared spectrometer are now in regular use, and we have made steady progress with the commissioning of the Goodman Spectrograph, despite delays due to vacuum cryogenic problems with its CCD system.

Additionally, as planned, 25 percent of semester 2005B telescope time was used for science, with data collected for all of the approved NOAO early science programs requesting the SOI or OSIRIS.

Provided the installation of the new lateral support system goes more or less as planned, we also anticipate carrying out the scheduled 2006A programs (again, 25 percent of the telescope time is scheduled for science). Plans for 2006B are still being finalized, but will be announced on the SOAR and NOAO Web sites in advance of the proposal deadline.

Filter-Buying Consortium Sought For SOAR

The SOAR Telescope will soon have two optical imagers (the SOAR Optical Imager and the imaging mode of the Goodman Spectrograph), and one major infrared imager (the Spartan Infrared Camera). All of these imagers are being delivered with fairly limited filter sets, geared mostly to standard broadband applications.

We are eager to find astronomers interested in sharing in the purchase of narrowband filters for any of these instruments. Our goal is to coordinate purchases so that we can build up publicly available filter sets, whose normal home would be Cerro Pachón, with a minimum of unnecessary duplication.

The SOAR Optical Imager is already on line. It uses 4 × 4 inch square filters (although 3 × 3 will work). Such filters cost about $3,500 each. The available filters (see *www.soartelescope.org*) include narrow(ish) band ones for the [O III] 5007 Ångstroms, H-alpha and [S II] emission lines. It would be desirable to gradually add filters that would cover more of the common emission lines at zero and Magellanic Cloud redshifts, as well as a set similar to the 80-Ångstrom wide, red-shifted H-alpha set that currently exists in 2 × 2 inch square size.

Jack Baldwin (*baldwin@pa.msu.edu*) and Hugo Schwarz (*hschwarz@noao.edu*) would like to hear from anyone interested in contributing to such a set. Please copy both of them on any e-mail.

SOAR Adaptive Module Passes PDR

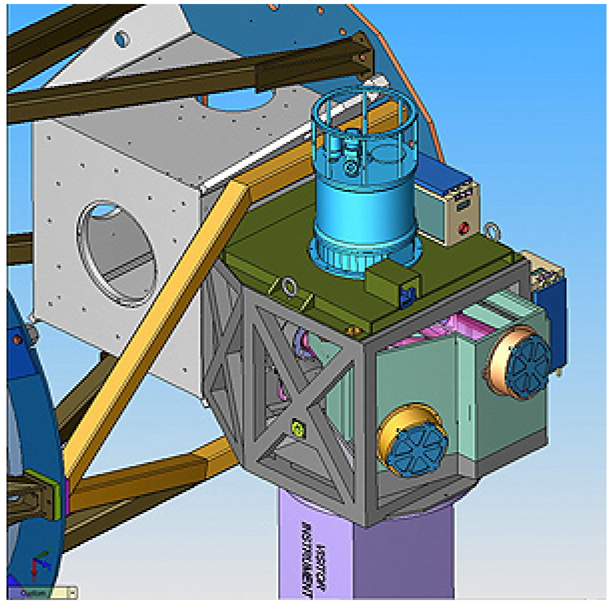
Nicole S. van der Bliek & SAM Team

The SOAR Adaptive Module (SAM) project passed its Preliminary Design Review (PDR) on 2 December 2005. SAM will be working at optical wavelengths, and will be primarily a ground-layer adaptive optics (GLAO) instrument operating with a laser guide star. SAM will deliver seeing-improved images, with a typical FWHM of 0.3 arcsec instead of 0.7 arcsec, over a fairly large field of view (3 × 3 arcmin). The instrument will use a ultraviolet laser to ensure complete sky coverage.

The SAM team presented the project to a panel of seven external reviewers at the PDR: Gabriel Perez (Gemini Observatory), Steve Heathcote (SOAR), Gereld Cecil (University of North Carolina at Chapel Hill), Norbert Hubin (European Southern Observatory), Clemens Gneiding and Bruno Castilho (Laboratório Nacional de Astrofísica Brasil — LNA), and chair René Rutten (Isaac Newton Group). Various parts of the design are already well advanced, and the panel was asked to evaluate those parts as if they were at the Critical Design Review stage. This level of evaluation would allow the team to proceed with detailed design and fabrication as soon as possible.

The review included an expanded science case presented by Eduardo Cypriano (SOAR and LNA) and Henri Plana (Universidade Estadual Santa Cruz, Brazil), and a demonstration of the SAM prototype in the lab. The prototype serves to test the software and parts of the hardware at an early stage in the project. The review did not include discussion of the implementation of the laser guide star system; this will be presented at a separate review to be held before the end of 2006.

The PDR panel was pleased with the advanced state of most of the design, as well as with the expertise of the project team. Their feedback, in the form of a report, was constructive at a detailed level and encouraged the team to remain focused on the first priority for SAM — delivering a GLAO instrument.



Conceptual drawing of what SAM will look like when mounted at the ISB cage of SOAR.

The team will proceed with detailed design and fabrication of the SAM main module, including a turbulence simulator and a wavefront sensor optimized for use with natural guide stars, over the coming year. Integration and testing of subsystems will take place in the first half of 2007 and, according to the current plan, the instrument will be integrated and commissioned at SOAR in the second half of 2007. The laser guide star system, including a wavefront sensor module modified for range gating and laser optics, will be designed in parallel with the integration and commissioning of the main module in the natural guide star mode. The laser guide star system of SAM will be operational at the end of 2008.

Other Happenings at CTIO

Arrivals & Departures

We welcome Roberto De Propris, who joined CTIO as an assistant astronomer in January. Roberto comes to us from the University of Bristol. Prior to that, he was in Australia at the Australian National University and the University of New South Wales, where he was a leading member of the team conducting the 2DF Galaxy Redshift Survey on the Anglo-Australian Telescope. Roberto has published many papers on the properties and distributions of galaxies from this survey, and will put this expertise, both astronomical and instrumental, to good use as he takes over responsibility for Hydra on the Blanco telescope from Knut Olsen.

We also say goodbye to Chris Smith, but only for a year! Chris is moving to Tucson at a time when the NOAO Science Archive will be evolving into the critical operations phase, where Mosaic imaging data from both the Blanco and Mayall instruments will be pipeline processed and moved into the archive in near-real time. Apart from leading the Data Products Program here in La Serena, Chris plays a leading role in many other NOAO South activities, and we doubtless will be asking him to continue some of these roles remotely from Tucson.

New SMARTS instrument available in 2006B

The Camera Panoramique Proche InfraRouge (CPAPIR), a 2K × 2K infrared imager on the 1.5-meter telescope, will be available for NOAO users in semester 2006B (see *ftp.astro.umontreal.ca/cpapir/*). This instrument has been devoted to a galactic plane survey by the American Museum of Natural History, a partner in the Small and Moderate Aperture Research Telescope System (SMARTS) consortium, since 2005. It comes with a wide selection of filters and covers a 30 arcmin-square field of view, with a pixel size of approximately 0.9 arcsec. All CPAPIR observing will be carried out in service mode by SMARTS observers, with no visiting astronomers.

CTIO REU/PIA 2006 program in full swing

The 2006 CTIO Research Experience for Undergraduate program began on January 16. This year we have six US students, two Chilean students in our parallel Program of Investigation in Astronomy (PIA), and one Chilean research student. More details on these programs can be found at *www.ctio.noao.edu/REU/ctioreu_2006/REU2006.html*.

The Moon, planet Venus, the bright star Spica and planet Jupiter are seen (in descending order) over Cerro Tololo Inter-American Observatory in September 2005.

(Credit: A. Pasten, A. Gomez and NOAO/AURA/NSF)

The Future of Imaging at WIYN

Steve Howell

Some of you may remember the transition from the original WIYN imager, known as S2KB, to today's workhorse, Mini-Mosaic. S2KB was used to help commission WIYN and for early science. It was removed from service at the WIYN 3.5-meter telescope in 1999 and moved to the WIYN 0.9-meter, where it is still in use today. "Mini-Mo" offers smaller pixels (higher spatial resolution) than S2KB and approximately four times the imaging area. To date, Mini-Mo has imaged the skies over Kitt Peak for more than 1,200 nights, generating roughly 100,000 science frames.

WIYN continues to stay at the forefront of astronomical imaging through the development of new imaging cameras that are larger in areal coverage and provide electronic image stabilization, as well as conventional use, across their entire field of view. For the past few years, WIYN has made available a prototype CCD camera called OPTIC, which uses a new type of CCD called an Orthogonal Transfer CCD (OTCCD). (See the September 2004 *NOAO/NSO Newsletter* for more details.)

WIYN is now nearing completion of the next step toward its ultimate goal, a full One-Degree Imager (ODI). This step, known as the QUAD OTA camera (QUOTA), will consist of four Orthogonal Transfer Arrays (OTAs), each of which is a 4K × 4K checkerboard arrangement of OTCCDs (see the March 2005 *Newsletter*). The field of view for QUOTA will be 16 arcmin on a side, and full array readout will take about four seconds. QUOTA is slated to begin on-sky testing in the 2006B semester, and to be offered on a shared-risk basis in 2007A. It is anticipated that QUOTA will replace Mini-Mo as the default imager at WIYN beginning in 2007B.

continued

This image of UGC 2302 in H-alpha was taken at the WIYN 3.5-meter telescope with OPTIC using orthogonal transfer image motion stabilization. UGC 2302 is similar to M33 in size and gas mass, yet it is five times less luminous. WIYN data are being combined with HST data to determine the star formation history of this system, and thus to better understand how star formation proceeds in "quiescent" galaxies.

Imagers available at WIYN - Past, Present, and Future					
Instrument	**CCD Type**	**CCD size**	**Pixel size(microns,"/pix)**	**FOV (arcmin)**	**Available**
S2KB*	STIS	2K × 2K	21, 0.20	4.8 × 4.8	1997-1999
Mini-Mo	SITe	two-2K × 4K	15, 0.14	9.6 × 9.6	1999-2007
WTTM/WEEV	EEV	2K × 4K	13.5, 0.11	3.8 × 4.7	2003-2007
OPTIC	OTCCD	two-2K × 4K	15, 0.14	9.6 × 9.6	2003-2006(7)
QUOTA	OTAs	four~4K × 4K	12, 0.11	16.0 × 16.0	2007-2009
ODI	OTAs	64~4K × 4K	12, 0.11	60.0 × 60.0	2009-TBD
WHIRC (IR)	Raytheon	2K × 2K	13, 0.11	3.8 × 4.7	2007-TBD

* S2KB is currently in use at the WIYN 0.9-m telescope

Future of Imaging at WIYN continued

QUOTA is a large step toward the future of direct imaging at WIYN in the form of ODI. This new technology camera will consist of 16 QUOTAs, placed together in the focal plane to provide a full square degree of sky per image, with an anticipated readout time equal to that of QUOTA, as each OTA is read out in parallel. ODI is expected to arrive on Kitt Peak in 2009.

The new OTCCD imagers are designed to take full advantage of the great seeing at WIYN, both in conventional mode (working as a normal CCD), and in "OT" mode, where they provide electronic tip-tilt-type image motion compensation. The WIYN OTCCD cameras are designed to provide delivered image quality ranging from the median seeing at WIYN (0.65–0.7 arcsec) to the optical performance limit near 0.28 arcsec.

In addition to optical imagers, WIYN is currently well along in the construction of a new infrared camera, the WIYN High Resolution Infrared Camera (WHIRC), to be placed on the WIYN Tip-Tilt Module (WTTM) in early 2007. WHIRC will use the WTTM to provide near diffraction-limited performance in near-infrared bands. Once QUOTA and WHIRC are fully commissioned, it is expected that Mini-Mo and WTTM/WEEV will be retired from service at WIYN. The future of imaging at WIYN is bright indeed.

Yunnan Observatory Mirrors Coated by KPNO

Buell T. Jannuzi

The British company Telescope Technologies Limited is currently building a telescope at the Yunnan Observatory in the People's Republic of China. This telescope will have a 2.4-meter primary mirror and a 0.7-meter secondary mirror, both of which were configured at Rayleigh Optical Corporation in Baltimore, Maryland. These mirrors were brought to Kitt Peak on their way to China to be aluminized in our 4-meter telescope chamber.

Thanks to the careful and skillful work of Will Goble, Jose Montes, Hector Rios, Wally Thurn, and Fred Wortman, both mirrors were safely unloaded, successfully coated, and safely repackaged in their shipping containers. These mirrors (see photo) were the first to be coated using the new Filament Power Controller commissioned in fall 2005. Final coating thickness was 118 nanometers on the inner monitor and 102 nanometers on the outer monitor.

Kitt Peak was allowed to coat these mirrors for a commercial contractor because the telescope is being used for peaceful scientific purposes in China, and there is no commercial vendor with a coating chamber large enough for the 2.4-meter primary mirror. In addition to coating the mirrors of the Mayall 4-meter, KPNO 2.1-meter, and WIYN 3.5-meter telescopes, and those of the National Solar Observatory, the coating chamber is used every year to coat the mirrors of many telescopes in North America, including the Astrophysical Research Consortium (ARC) 3.5-meter at Apache Point and the Sloan Digital Sky Survey telescopes.

NEWFIRM Moves Up – and Forward

Ron Probst

The NOAO Extremely Wide-Field Infrared Imager (NEWFIRM) project passed a significant milestone last month. Following internal modifications, reassembly, a thorough electronics checkout, and installation of an engineering grade array, the NEWFIRM instrument was moved from the basement clean room area of the main NOAO Tucson building, across a parking lot, and attached to the Flexure Test Rig.

Here, NEWFIRM is undergoing on-axis optical flexure tests that simulate orientations it will experience on the telescope. These activities test the passive flexure compensation design by which the internal optical assembly and the external guider, working together, keep the infrared focal plane registered to the sky. On-axis testing is enabled with small temporary lenses while we await delivery of the remaining large aspheric optics. The MONSOON array control system is also being verified with multiple arrays installed in the cryogenic focal plane.

We presently expect first light in October-November 2006, followed by commissioning and science verification in Semester 2007A, and transition to full science use in Semester 2007B. Potential users interested in science planning for Science Verification and subsequent Survey projects are encouraged to visit the project Web site *www.noao.edu/ets/newfirm* (click on "Science Planning").

1. NEWFIRM Dewar is hoisted out of the basement clean-room assembly area
2. ...and relocated to the Flex Rig Facility.
3. Truss and guider are fitted to the Dewar.
4. First flight! NEWFIRM installed and in motion on the Flex Rig.
5. The Integration Team is all smiles, From left to right: Ron Harris, Ron George, Ron Probst, John Andrew, Bill Ditsler, and Roger Repp.

Changes In KPNO Support Office Staff

Buell T. Jannuzi

We would like to welcome Kiki Atkinson and Sheryl Falgout to the Kitt Peak National Observatory (KPNO) Support Office. The Support Office works with all areas of KPNO to meet the needs of our visiting observers, Kitt Peak technical staff, and the WIYN Observatory. Kiki Atkinson joined the office in June 2005 and Sheryl Falgout joined in February 2006.

Kiki was familiar with NOAO before joining the KPNO Support Office, having done contract work with several divisions of NOAO. She brings more than 15 years of administrative support experience in academic environments, as well as several years in public outreach for museums. In addition to general support for KPNO and WIYN, Kiki assists the NOAO public affairs office as Managing Editor of the *NOAO/NSO Newsletter*.

Sheryl joins us from the College of Public Health at the University of Arizona. Sheryl has more than 15 years of experience in administrative support and budget management/analysis for astronomy. She worked for the User Support Branch of the Space Telescope Science Institute during the exciting early days of the operation of the Hubble Space Telescope (1989-1992), and for the Department of Physics and Astronomy of The Johns Hopkins University. In addition to general KPNO and WIYN support, Sheryl will support the WIYN One-Degree Imager (ODI) project. We are very happy to welcome her back to AURA, this time in a sunnier local!

Kiki and Sheryl join Judy Prosser, who has agreed to postpone her retirement until the end of February in order to facilitate this transition. An article celebrating Judy's exemplary service to KPNO and WIYN will appear in the next *Newsletter*.

Scott Bulau Joins NSO and ATST

Tony Abraham

Scott Bulau has joined the Advanced Technology Solar Telescope (ATST) project as Controls Engineer, leaving Kitt Peak National Observatory at the end of 2005. Scott had been Electronic Supervisor for the Kitt Peak engineering group since August 1987. During this time, he played a major role in the design, development, and maintenance of many of our telescopes, facilities and instrumentation projects. His recent accomplishments include the completion of a new guider for NEWFIRM, and technical support for the new IRMOS instrument developed by NASA/Goddard/STScI and tested successfully on both the 2.1-meter and 4-meter telescopes. We thank Scott for all his years of productive service and dedication to Kitt Peak, and wish him continued success at the National Solar Observatory.

From the Director's Office

Steve Keil

Over the past several months, the NSF Division of Astronomical Sciences has been conducting a Senior Review of astronomical facilities. The review is scheduled to wind up this spring. The solar physics community has developed a comprehensive plan to maximize scientific progress over the next decade and beyond. Ground-based observations play a critical role in this plan, as spelled out in the recent decadal survey and the earlier Parker Report on Ground-Based Solar Research. The National Solar Observatory (NSO) has formulated and begun to implement its own long-range strategic plan as part of the road-mapping process. This plan has been well vetted by the solar community through public meetings, reports at the American Astronomical Society Solar Physics Division members' meetings, and input from our Users' Committee and various other advisory committees.

The backbone of the NSO plan is the development of new state-of-the-art facilities, with the Advanced Technology Solar Telescope (ATST) as the flagship. When completed, the ATST will be the world's preeminent ground-based solar observatory. Existing NSO facilities will continue to provide outstanding observations to be used for both independent investigations and collaborative efforts with NASA space missions. The synergy between ground-based and space-based observations will enormously enhance the scientific return from the STEREO and Solar-B missions, to be launched in 2006, and the Solar Dynamics Observatory mission, to be launched in 2008. The Dunn Solar Telescope, with its advanced adaptive optics systems feeding a new generation of Stokes polarimeters, and the McMath-Pierce telescope, with its newly implemented infrared capabilities, will provide detailed magnetic field measurements at several different heights in the solar atmosphere, for example. At the same time, SOLIS will give global views of the vector magnetic field at the solar surface, and GONG will provide amazing diagnostics of sub-surface regions. The structure and dynamics of the solar corona, where most space weather phenomena originate, are fundamentally linked to the lower layers, so the information provided by NSO facilities is vital to the success of these NASA missions.

The all-important ATST project is not independent of activities at the current NSO facilities, in the areas of research, instrument development, telescope control system development, and educational outreach. Rather, these efforts contribute directly to the development of the ATST and other advanced capabilities. Elimination of current NSO capabilities before the ATST is on line would severely impact solar physics and adversely impact the new initiatives. The Senior Review must skillfully address the balance between current research capabilities in solar physics and the need to advance these capabilities to solve fundamental problems in understanding the Sun. The NSO plan as it is now being implemented does just that. It balances the phasing out of old facilities with the commissioning of newer facilities, thus ensuring the ongoing support for the US solar community.

The NSO Users' Committee met in early December and carefully evaluated the use of and need for current facilities. The committee expressed strong support for NSO's high-resolution, infrared, and synoptic programs. The committee also expressed interest in seeing NSO increase its support for coronal science but, given the current budgetary pressures, it is not clear how we can do this. I would welcome your thoughts on current NSO capabilities and long-range planning. The current plan can be reviewed on the NSO Web site, *www.nso.edu*.

The ATST Science Working Group met in late November and considered several issues that have emerged in designing the ATST to meet its scientific specifications. A meeting with representatives from several countries to lay the foundation for an international ATST organization was held as well. We are now in the process of establishing an international board that would begin in an advisory capacity, then evolve into a governing organization with membership based on funding contributions to the project. If you have suggestions for the development of international participation in ATST, please feel free to contact me (*skeil@nso.edu*).

NSO is developing plans for support of Solar-B science objectives. We will develop a scheme for giving high priority to requests for coordinated observations at the Dunn Solar Telescope and McMath-Pierce Solar Telescope. Special requests for non-standard SOLIS observations will also be considered, and our Air Force partners have indicated that a similar policy will be available for the Optical Solar Patrol Network (O-SPAN) (formerly the Improved Solar Observing Optical Network, ISOON) telescope at Sacramento Peak.

ATST Update

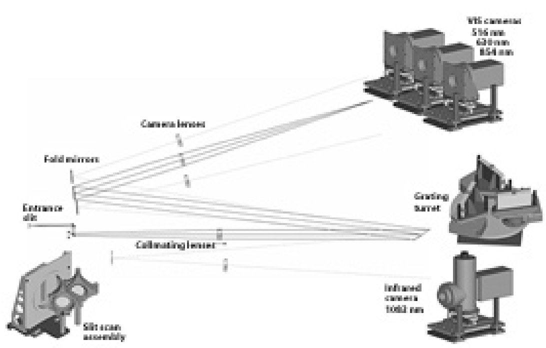
The ATST Team

With the broad outlines of the Advanced Technology Solar Telescope (ATST) solidified, the science and design teams are meeting the challenges of the detailed work needed to realize the observatory. The project is moving into the final phases of its environmental impact assessment, following reviews of its science plan and engineering design held in Tucson, November 2005 and January 2006, respectively.

"These review committees gave suggestions on areas to revisit or expand," said Stephen Keil, NSO director and ATST project director. "They showed us that we need to pay more attention to how we're going to use the instruments. We've frozen the footprint. Now we have to start thinking about where we put people inside the building and other details, and about the best mechanisms for contracting the work when we get the approval to proceed."

The ATST Science Working Group held the equivalent of a "Scientific Design Review" on 28–30 November 2005, including an update on the four "first light" instruments that are expected to be on line during ATST commissioning:

- Visible Spectropolarimeter (ViSP): "The ATST Science Working Group has spent a great deal of effort in defining clear instrument requirements," said David Elmore, the ViSP lead engineer. "These have been used to create a baseline spectrograph design and to clarify how the ViSP fits with other instruments and facilities of the ATST. The ViSP design details are being developed to the extent that its performance can be modeled and the resources needed for its construction estimated."



The ATST Visible Spectropolarimeter (ViSP) will determine the Stokes parameters in at least three different wavelength bands simultaneously, as indicated by this diagram. For clarity, only one of the four dispersion ray paths is shown here. (David Elmore, HAO/NCAR)

The ViSP will analyze the four Stokes parameters to deduce the strength and direction of magnetic fields in active regions. The current design uses refractive optics that will observe up to five lines simultaneously in a range as broad as 380–1600 nanometers (nm). A design review for the ViSP is scheduled at the High Altitude Observatory (HAO) in Boulder from 2–3 March 2006.

- Visible Broadband Imager (VBI): Design of the VBI has abandoned a zoom-lens system in favor of a two-in-one approach to optimize its field of view and image scale at different wavelengths, said Han Uitenbroek, the VBI instrument scientist at NSO-Sunspot. The zoom system would have required 11 elements that would reduce light throughput at short wavelengths. Shifting through a half-meter range with micron accuracies in just a second or so would be difficult, and the rapid movement would heat the gear system, causing positions to creep.

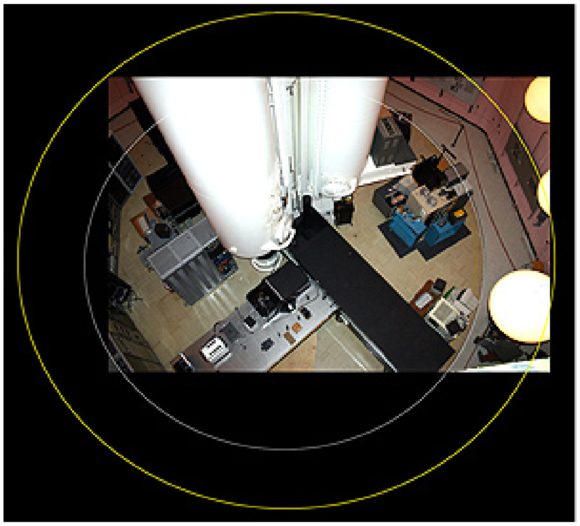
"We abandoned that as not practical," Uitenbroek explained. The new approach will split the incoming light into red (~630–900 nanometers for H-alpha, TiO, and the Ca K infrared triplet) and blue (~350–400 nanometers for CN, Ca IIK, and G-band) beams. Each beam will feed a single 4K × 4K detector; a second camera may be added to each to allow phase-diversity enhancement of images. An area of particular interest being studied by Uitenbroek and Alexandra Tritschler, who recently joined the ATST team at Sunspot, is the CN band (388.3 nm), which may provide sharper contrast than G-band (430.5 nm) images of the photosphere.

- Visible Tunable Filter (VTF): "The Kiepenheuer Institut für Sonnenphysik team from Freiburg, Germany, led by Michael Sigwarth, is investigating techniques to reduce the size and path length of the VTF," said K. S. Balasubramaniam, the instrument scientist at Sunspot. Solid- or liquid-filled spacers in a smaller Fabry-Perot etalon would have higher indices of refraction and reduce the path length and accommodate sharper beams. A design review is anticipated in late 2006.

- Near Infrared Spectropolarimeters (NiRSP): The University of Hawaii Institute for Astronomy is responsible for two instruments: the Near-Infrared Spectropolarimeter (NiRSP), which will be placed, for coronal observations, at the Nasmyth focus on the telescope mount, and the second instrument, placed on the coudé platform for on-disk observations.

continued

ATST Update continued



The ATST's 16-meter coudé platform will have about 80 percent more floor space than the 12.2-meter instrument platform of the Dunn Solar Telescope, as depicted here by the larger circle. Even so, designers know that space will be at a premium. (Credit: Dave Dooling, NSO/AURA/NSF)

The Science Working Group also approved three engineering design changes. The field of view was reduced from the goal of a 5 arcmin square to 2 arcmin square (equivalent to a 2.83 arcmin diameter circular field of view, close to the 3 arcmin minimum) at the coudé level. This was done to reduce the size and costs of various optical elements, and the heat loads on those elements. A 5 arcmin field of view will be possible at the Nasmyth position, and could be restored at the coudé platform later. The science requirement for diffraction-limited image quality was relaxed following the August 2005 Wavefront Correction Workshop that showed achieving high Strehl ratios ($S > 0.6$) under good seeing conditions (r_0 (500 nm) > 15 centimeters) cannot be met. The error budget can be balanced only at wavelengths greater than 630 nm (r_0 (630 nm) > 20 centimeters). Finally, coating changes were approved. The Gregorian and Nasmyth optics will have aluminum, and the transfer, coudé, and imaging optics will have protected silver, as a compromise to balance scientific productivity with throughput at various wavelengths.

Systems Design Reviews (SDRs) on January 17–19 in Tucson addressed the Telescope Mount Assembly (TMA), Enclosure, and Support and Operation (S&O) Building/Site Infrastructure. Jeff Barr, LeEllen Phelps and Mark Warner presented the majority of the material, and took the point on responding to many excellent questions and comments from 13 outside reviewers led by John Dunlop of NOAO on the S&O Building, Steve Hardash of Gemini on the Enclosure, and Mike Sheehan of Gemini on the TMA.

"The team held up quite well under fire and made NSO, and the project, look good," noted Project Manager Jeremy Wagner.

ATST Systems Design Review participants in Tucson from 17–19 January 2006.

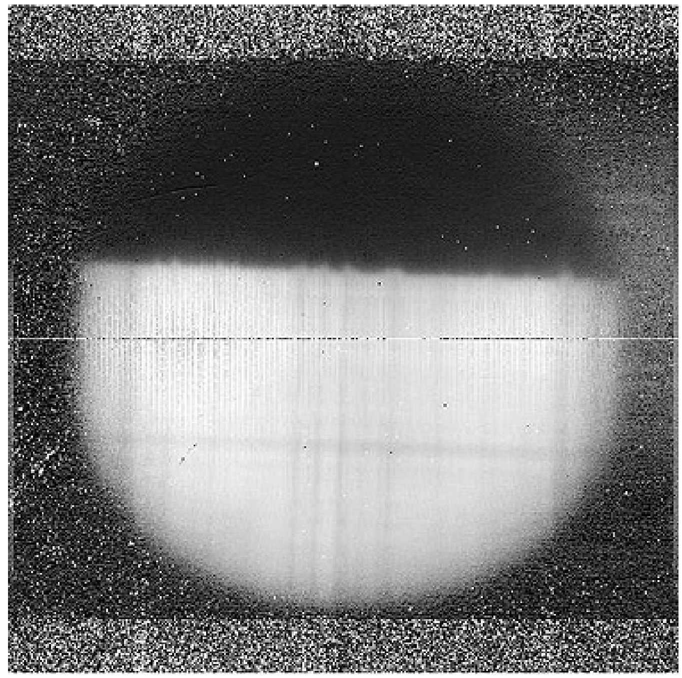
An early result from the review was approval of the ATST footprint and shape. This allowed NSO to freeze the external design so the people involved in the environmental impact assessment at Haleakalā have a fixed design to consider. Some internal adjustments may continue, which was one of the topics discussed at the SDRs as the teams grapple with how best to use the interior space of the enclosure and S&O building. "There's work to be done, but we can give the EIS team a firm commitment to the site layout and buildings that are shown in the schematic design plans," said Project Architect Jeff Barr.

Other major recommendations from the SDR review committees focused on getting the telescope mount assembly and enclosure designs, specifications, and statements of work ready for bid and contracting. "The committee members were very helpful to the project team," said Mechanical Systems Manager Mark Warner. "They offered excellent advice and suggestions. There were many practical lessons to be learned from the collective wisdom of the reviewers. We're in a very good position to move forward and incorporate these ideas into our designs."

NAC Spectroscopy Tests in Thermal Solar Spectrum

Matt Penn

Late in 2005, initial test data with the NSO Array Camera (NAC) were taken at 4666 nanometers (nm), examining limb emission in several lines from the CO molecule. An old filter was used in the test observations, and the array was near saturation with just a 25 micro-second exposure. The thermal background from the dewar window, spectrograph and telescope was at about the same level as the solar signal with a one-inch-diameter round filter. With such full detector wells and a single-sampled frame, systematic noise in the test images was high. Nonetheless, the limb emission is seen in several lines as shown in the figure.



Test observations at the solar limb with the NAC at 4666 nanometers. Tiny bumps at the solar limb are several lines from the CO molecule going into emission at the limb. This frame uses a small one-inch circular filter from the old Near Infrared Magnetograph (NIM) camera. Systematic noise is high because the higher than expected flux levels nearly saturate the NAC array at the shortest exposure time of 25 micro-seconds.

New filters will be ordered for the NAC to explore several spectral windows in the thermal infrared (IR) solar spectrum. Polarization analysis is also planned, with the first thermal-IR polarimetry tests planned for later this year. There are many spectral lines which offer very promising Zeeman measurements of magnetic fields in the photosphere, chromosphere, and possibly the corona in the region from 3600 to 4200 nm. Additionally, Hanle diagnostics in the very strong molecular lines in this part of the spectrum remain unexplored, and offer tantalizing diagnostics of the weak solar magnetic field.

The NAC instrument is currently available for shared-risk observations, and the plan is to release the instrument as a facility-class instrument at the McMath-Pierce Solar Telescope this year.

An IFU for Diffraction-Limited 3-D Imaging Spectroscopy and Polarimetry

Deqing Ren (New Jersey Institute of Technology), Christoph Keller (Utrecht University) & Claude Plymate (NSO)

Ground-based telescopes can achieve diffraction-limited images when equipped with adaptive optics (AO). A major limitation of AO is the small field of view inherent to the size of the isoplanatic patch. Conventional long-slit spectrographs cannot sample the entire AO-corrected field of view in a single exposure. An Integral Field Unit (IFU), equipped with a modern large detector array, will allow a three-dimensional (3-D) data cube to be recorded simultaneously over the entire AO-corrected field of view, maximizing observing efficiency.

Through a joint New Jersey Institute of Technology (NJIT)/National Solar Observatory (NSO) effort, funded by the NSF Advanced Technologies and Instrumentation program, we are developing a state-of-the-art advanced image-slicer IFU for the McMath-Pierce Solar Telescope. It will be the first instrument of its kind for a solar telescope. First light is scheduled for late 2006.

The advanced image-slicer IFU technique, which employs only mirrors to maximize instrument efficiency and

continued

IFU for Diffraction-Limited 3-D Imaging continued

performance for broadband imaging, was originally proposed by Durham University (Proc. SPIE, 2871, 1295, 1997). The two-dimensional field of view on the telescope focal plane is optically cut into a number of slices by a mirror array called the slicer-mirror array. The slices are then rearranged to form a long-slit that can feed a conventional long-slit spectrograph. A dedicated data reduction program allows the reconstruction of a 3-D data cube, which includes 2-D spatial and 1-D spectral information.

Our IFU, consisting of 25 slices, will be one of the largest IFUs, due to the slice number, and will sample the 6.25-inch by 8-inch AO-corrected field of view simultaneously in a single exposure. It produces a 200-inch-long slit for diffraction-limited 3-D spectroscopy and polarimetry with high temporal resolution and high throughput (~90 percent). The IFU is a fully independent and self-contained module, to be located near the telescope focal plane and work with the existing Vertical Spectrograph at the McMath-Pierce. While the IFU is optimized for sampling the point spread function in the near infrared (0.9–5.0 microns), it may also work in the visible with under-sampling.

The greatest challenges faced in constructing the IFU system are the design and manufacturing of the three key components: the slicer-mirror, pupil-mirror and field-mirror arrays, and the optical system alignment. Each array consists of 25 individual mirrors, each of which tilts in a different direction, and each on the order of three millimeters in size. The three arrays need to be made by state-of-the-art single-point diamond turning controlled by a multiple-axis Computer Numerical Control (CNC) machine. Both the pupil-mirror and slit-mirror arrays, which were manufactured by Corning Netoptix, were shipped to NJIT in November 2005. The slicer-mirror array is being manufactured at Durham University, and a sample was delivered to NJIT for evaluation in January 2006.

The completed pupil-mirror and slit-mirror arrays are shown in figure 1. The slicer-mirror array is shown in figure 2. The slicer-mirror array will be assembled in a specially-designed mount, which allows for adjustment of the position of each slicer-mirror to compensate for possible errors induced by design, manufacturing or alignment.

Observations of solar dynamics of the small-scale magnetic fields require uncompromised high resolution, very high magnetic field sensitivity, and high temporal resolution (Paletou & Aulanier, ASP Conf. Series, 286, 45, 2003). Although Fourier transform spectrometers and Fabry-Perot spectrometers are capable of gathering 3-D data, these systems can only gather two of the three dimensions at any given time. The third dimension has to be obtained sequentially by using time for scanning, resulting in reduced temporal resolution. The 3-D imaging spectroscopy and polarimetry will open new applications for detailed research of 2-D small-structures of the Sun, requiring high-temporal, high-spatial and high-spectral resolution, and can also be exploited for nighttime observations.

Figure 1. The slit-mirror array (top) and pupil-mirror array (bottom). Each array consists of 25 individual mirrors that are made on a monolithic aluminum-alloy substrate.

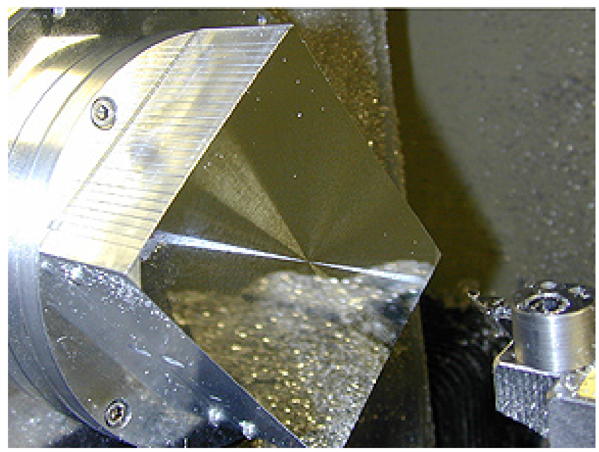


Figure 2. The slicer-mirror array in diamond-turning. The 25 slicer-mirrors have the same spherical radius and are bundled together during manufacture. (Courtesy of Durham University)

One potential major domain is the exploration of galaxy dynamics in the near and far universe including high-redshift galaxies, merging galaxies, starburst galaxies, and supermassive black holes in galactic nuclei. 3-D imaging spectroscopy was recently proposed for NASA's Terrestrial Planet Finder for direct detection, as well as for spectroscopy of Earth-like exoplanets (Ren & Wang, ApJ, 2006, in press).

GONG^{++}

Frank Hill & the GONG Team

This quarter has seen progress in the form of the magnetogram modulator and processing pipeline development, the solution for a nagging instrument problem, faster data processing turn around, and continued scientific productivity. It has also brought ongoing challenges in the areas of camera reliability and software porting. The entire GONG team continues to do a superb job meeting the opportunities and challenges that arise during a long-term scientific program.

We are eagerly anticipating the upcoming biannual GONG and SOHO meeting, to be held in Sheffield, UK, 7–11 August 2006. The title of the meeting is "Beyond the Spherical Sun: A New Era of Helio- and Astroseismology," and the conference image was designed by our very own Rachel Howe. The meeting Web site is at *www.soho18.org*. In even more exciting news, GONG finally has its very own coffee mug!

Science Highlights

Rudi Komm, along with his summer 2005 REU student Douglas Mason (University of Southern California), found that active regions with both strong magnetic fields and a subsurface "tornado" also produce large numbers of energetic flares. This finding may lead to the development of a useful predictor for solar activity and space weather, a result they presented at the January American Astronomical Society meeting in Washington, DC.

Sushant Tripathy is finishing up an initial study of the variation of *p*-mode frequencies on time scales of nine days. He finds a high correlation (greater than 0.9) between the frequencies and various solar activity indices determined on this short time scale, as shown in figure 1. This work demonstrates that solar activity and the frequencies are tightly coupled even over times scales shorter than the solar rotation period.

Kiran Jain has been continuing her work comparing the results of local ring diagram analysis using data obtained in different spectral lines. She has found differences in the apparent flows from GONG data obtained in the Ni I 6768 line and MOTH observations in the K I 7699 line. Studies of this sort are important for, and greatly contribute to, planning NASA's Solar Dynamics Observatory (SDO) mission.

The Ninth Local Helioseismology Comparison (LoHCo) meeting was held 13–14 December 2005 in Tucson. A total of 21 participants provided talks on a range of topics. The agenda and presentations can be found at *gong.nso.edu/science/meetings/lohco/workshop9.html*.

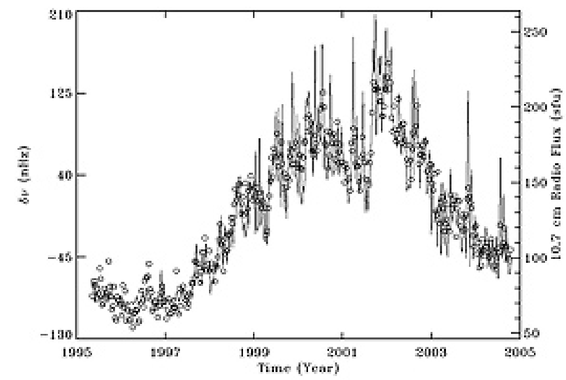


Figure 1. The mean frequency shift as a function of time of solar p modes computed from very short nine-day time series. These shifts, shown as open circles, are compared to a solar activity index derived from the solar 10.7 centimeter radio flux, shown as the solid line. The 10.7 centimeter flux was averaged over the same time periods as the p-mode frequency shift. There is clearly a very high correlation between the two quantities, down to the fine details, during all phases of the cycle expected around solar minimum (1995–1998). This suggests that there could be two types of processes affecting the physical conditions at the upper turning point of the modes—a magnetically dominated regime where the local solar temperature and density are affected mainly by the presence of active regions, and a convectively dominated regime where turbulence is the main source of perturbations of the near-surface conditions.

Data Processing

The data processing group is porting all processing pipelines from Sun-Solaris to Linux-based computer systems. Subtle differences have been found when comparing results from each platform. We are investigating the differences and quantifying the results in an effort to establish their significance before proceeding.

We have been modifying the "Quick Look" code that runs at the remote GONG sites. The code, used primarily to diagnose instrument health and status, now produces calibrated images that are comparable to the downstream calibrated images produced by the data processing pipeline in Tucson.

The magnetogram data processing pipeline is being developed in parallel with the development of the modulator hardware. A month of GONG magnetograms is being processed with zero-point correction software, necessary for reprocessing magnetograms collected with the old GONG++ modulators. A histogram-equating technique to merge the images

continued

GONG++ continued

is being developed. The synoptic map production code has been resurrected; and the magnetograms are being processed with various field extrapolation codes. The goal is to have the pipeline running in time for the Solar Terrestrial Relations Observatory (STEREO) launch.

Figure 2. Last summer, two shipping containers were delivered to the GONG Farm. Now, a little more than six months later, thanks to Terry Bender and Jim Mason (shown in the inset photo) and the rest of the team, the new GONG shelters are ready to go. One was shipped to Australia in February to replace the one that's rusting away. The swap is scheduled to begin in May 2006. The other one will house GONG's "hot spare." The hot spare project is currently ramping up and is scheduled to be complete by the end of FY 2007.

A new 20-Terabyte RAID-10 disk array has been installed to support the data storage requirements. The Data Storage and Distribution System (DSDS) is upgrading and migrating its Oracle database, which will facilitate faster queries and distribution of GONG data products through the Virtual Solar Observatory (VSO).

Processing to date includes month-long (36-day) velocity time series and power spectra for GONG Month 98 (centered at 14 March 2005), with a fill factor of 0.83. 108-day mode frequency tables are available for Month 99, and ring diagrams are available through Month 100. Last quarter, the DSDS distributed 512 Gigabytes in response to 21 data requests. Backlog reduction continues to be a high priority. With our new disk arrays, we are committing more CPU and disk resources to reduce the calibration backlog. The results are encouraging, as the backlog dropped by about 15 percent last month.

Network Operations & Engineering

The operations issues this quarter have been:

- Installation of a new camera power flex cable to eliminate system reboots.
- Maintenance visit to Udaipur, where the turret was swapped with a newly refurbished one.
- Repair visit to Big Bear to replace electronics.
- Noisy cameras at Cerro Tololo Inter-American Observatory (CTIO) and Udaipur.

Operations personnel have been developing the new magnetograph modulators and drivers. Testing of the new modulator circuit has been completed, and an internal review held. The goal of 0.1 Gauss uncertainty in the zero-point has been achieved. After initial testing in the lab, the components are organized into field-ready kits and moved to the Tucson engineering site for final acceptance testing and certification. A deployment readiness review is scheduled for early February, with deployment to begin in late February. The deployment of the modulators provides an extra trip around the network, offering an opportunity to tend to outstanding site-specific problems and to standardize the onsite software.

The Learmonth replacement shelter is largely complete. The shelter will be shipped in February and the replacement will be performed in May 2006. The "hot spare" shelter is also largely complete. While preparing the shelters, modifications and upgrades were made to the existing structures at the GONG Farm to better accommodate the hot spare project. Many thanks to "jack-of-all-trades" Terry Bender, who led the construction work at the Farm.

We want to say thank you and good-bye to Bob Martinez. Bob has been working with the operations team to update the complete set of electronics drawings of the GONG instrument and bring them up to "as-built" status.

AAS Meeting Exhibit and News Activity Draws Strong Interest

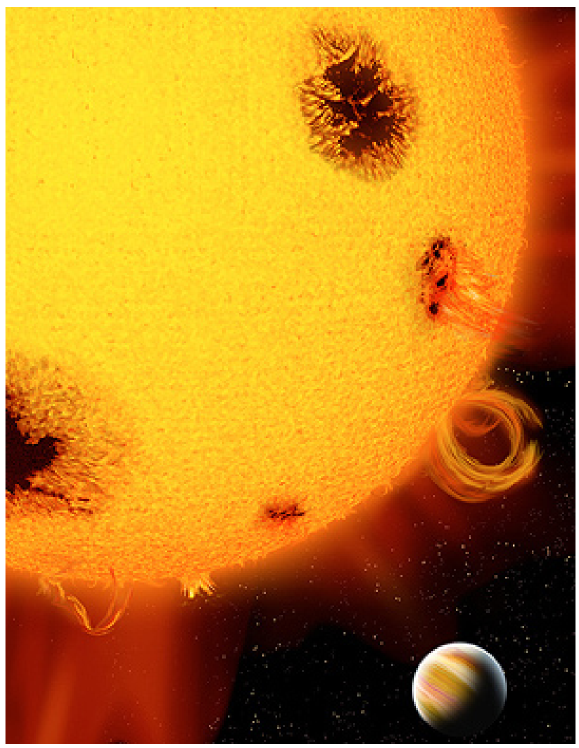
Douglas Isbell

The 207th annual meeting of the American Astronomical Society (AAS), held in Washington, DC, from 8-12 January 2006, was very likely the largest astronomy-related meeting in history, with more than 3,130 registrants. NOAO contributed a lively exhibit booth and a very active media presence at the meeting.

The NOAO exhibit booth was dominated by colorful new panoramic images of the Large and Small Magellanic Clouds from the Magellanic Cloud Emission Line Survey (MCELS), led by Chris Smith and Sean Points of Cerro Tololo Inter-American Observatory (CTIO); see the cover of this *Newsletter* and the story on page 6 in Science Highlights. Frank Winkler (Middlebury College) of the MCELS team contributed the image files of the Small Magellanic Cloud.

Released publicly on the first day of the meeting via the NOAO Web site, the images of the galaxies were cited almost immediately in the online blogs of several press room attendees, such as the Bad Astronomer. The image of the Large Magellanic Cloud (*www.noao.edu/image_gallery/html/im0994.html*) has since appeared on the "Astronomy Picture of the Day," the Space.com "Image of the Day," and the back cover of the March/April 2006 "StarDate" magazine. Chris Smith and Chris Miller of the NOAO scientific staff spent a lot of time at the booth presenting live demonstrations of the new portal to the National Virtual Observatory developed by the NOAO Data Products Program (see story on page 11).

By happenstance, Washington DC Mayor Anthony Williams stopped by the NOAO booth for an extensive discussion about Kitt Peak's role in astronomy, following his well-received opening remarks to the AAS.



An artist's rendition shows a planet orbiting a very young, active star pocked with dark star spots and speckled with flares and other surface activity. A team led by University of Florida astronomer Jian Ge announced the discovery of the planet using the Exoplanet Tracker instrument at Kitt Peak during the January 2006 AAS meeting. (Credit: P. Marenfeld and NOAO/AURA/NSF.)

The first press briefing of the meeting on Monday morning focused on the latest news about black holes from two speakers, including results from a team led by Kambiz Fathi (Rochester Institute of Technology) based on data from the Gemini Multi-Object Spectrograph (GMOS) on the Gemini South 8-meter telescope. Fathi presented analysis of two-dimensional spectral data from the center of active galaxy NGC1097, obtained with the GMOS integral field unit, which showed it takes approximately 200,000 years for the material feeding the black hole to complete the final part of its one-way trip from the inner region of the galaxy to oblivion.

The observations from Gemini, combined with images from the Advanced Camera for Surveys on the Hubble Space Telescope, enabled the team to zoom 10 times closer to the black hole than any previous measurements, reaching clouds of spiraling material within 10 light-years of the galactic core. "It is the first time anyone has been able to follow gas this close to the supermassive black hole in the center of another galaxy," Fathi said. "The work of our team confirms the main theories that have never been observationally confirmed at this level."

"This is a major leap forward in our understanding" of how to fuel a supermassive black hole, said press briefing commentator Kimberly Weaver (NASA Goddard Space Flight Center). "It is a monumental observation," she added, that provides "a clear way for the black hole to obtain the mass that it needs." This result was covered by Reuters wire service (widely reprinted around the world), *Science*NOW, SpaceDaily.com, Space.com, PhysOrg.com, and many others.

The second press briefing of the meeting included two topics with NOAO connections. Armin Rest and Nicholas

continued

AAS Meeting Exhibit and News continued

Suntzeff of CTIO expanded on a result reported in the December 22 issue of *Nature*, which described the discovery of light echoes from ancient supernovae that exploded 400-860 years ago in the Large Magellanic Cloud, using a differential imaging technique. (See the Science Highlight on page 3 of this *Newsletter.*)

At the AAS meeting, they announced their ability to obtain a spectrum of one of the light echoes using Gemini South, which can in theory be analyzed to diagnose the precise type of supernova that occurred. "We were jumping up and down we saw this truly amazing spectrum," Rest said. "We find a clear association with a Type-Ia supernova."

"We can scale these results and search for echoes of historical supernovae in the Northern Hemisphere," such as the landmark stellar explosion recorded by Tycho Brahe in 1572, Suntzeff said. "We should be able to find these things inside wide-area surveys."

"It's an incredible trick, and getting the spectrum is absolute evidence," said briefing commentator Robert Kirshner (Harvard University and AAS president). "This result is a fantastic example…of the way that detectors and computers have improved." This story was covered by Astronomy.com and SkyandTelescope.com, among other astronomy news sites, and it was the subject of a "SlackerAstronomy" podcast.

Steve Howell (NOAO and WIYN) was co-presenter of another finding at this press briefing, which used Hubble Space Telescope data to identify a binary system that is a likely precursor to a Type-Ia supernova.

Jian Ge (University of Florida) was part of a lively Wednesday AAS press briefing panel on exoplanets. Ge announced the first planet to be discovered by "ET" – the Exoplanet Tracker instrument in use by his team at the 2.1-meter telescope and Coudé feed at Kitt Peak National Observatory. This result was covered by a wide variety of more than 100 news outlets around the world. The exoplanets press briefing also included results on planets in double and triple star systems from the SMARTS telescopes at CTIO, presented by Deepak Raghavan (Georgia State University).

An NOAO press release issued at the meeting about new data on the cool dark equator of the star Vega, by a team led by NOAO postdoc Jason Aufdenberg with data from the CHARA array on Mount Wilson, was covered by Space.com and SkyandTelescope.com.

Please contact the NOAO office of public affairs (*outreach@noao.edu*) if you have results that you would like to publicize at future AAS meetings. See you in Calgary.

NASA-NOAO Spitzer Teachers Continue to Exhibit Infrared Excess

Stephen Pompea

At the January meeting of the American Astronomical Society (AAS) in Washington DC, six newly selected teachers met to plan infrared observations with the Spitzer Space Telescope, joining 12 teachers who are currently doing scientific research with NOAO and NASA scientists. Seven Spitzer-based research projects are underway at this time. Several of the science teams also presented posters and talks at the AAS meeting on science results and related educational activities.

The teachers from last year's cadre and this year's new class were selected through a highly competitive process. Each teacher was required to be a graduate of one of NOAO's NSF-funded research programs for teachers (either Research Based Science Education [RBSE] or Teacher Leaders in Research Based Science Education [TLRBSE]), in which they received extensive training on astronomical research, including several nights of observing at Kitt Peak National Observatory. Many of the teachers had also taken a 15-week distance learning course on astronomical research that is part of TLRBSE.

Each applicant wrote a multi-page application describing their scientific aptitude for the program, as well as the outreach and professional development activities they would lead at a regional, state, or national level, if chosen. Each selected teacher then received additional training in a workshop on the Spitzer Space Telescope instrument capabilities, and on infrared astronomy in general. Each project team, consisting of teachers and science mentors, then wrote a standard

continued

NASA-NOAO Spitzer Teachers continued

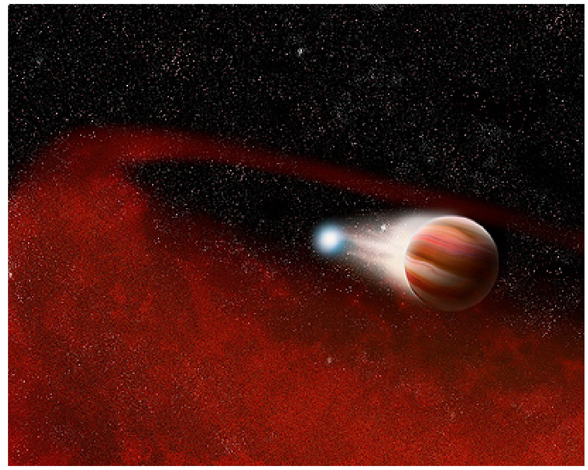
Spitzer observation proposal intended to make use of the Spitzer Science Center (SSC) director's discretionary time.

Project mentors include Greg Rudnick and Steve Howell (NOAO), John Feldmeier (formerly NOAO, now at Youngtown State University), Luisa Rebull, Don Hoard, Mark Lacy, Varoujan Gorjian, and Ranga Ram-Chary (SSC), Rose Finn (Sienna Collage) and Vandana Desai (Caltech). Program coordination was provided by Doris Daou and Michelle Thaller (SSC), and myself, Connie Walker, and Katy Garmany (NOAO).

Original Teacher Participants :

Jeff Adkins,
Deer Valley High School, Antioch, CA
Howard T. Chun,
Cranston High School East, Cranston, RI
Lauren K. Chapple,
Traverse City East Junior High School, Traverse City, MI
Harlan V. Devore,
Cape Fear High School, Fayetteville, NC
Anthony R. Maranto,
Phillips Exeter Academy, Exeter , NH
Steve Rapp,
Linwood Holton Governor's School, Abingdon, VA
Theresa Roelofsen,
Bassick High School, Bridgeport, CT
Babs Sepulveda,
Lincoln High School, Stockton, CA
Linda Stefaniak,
Allentown High School, Allentown, NJ
Timothy S. Spuck,
Oil City Area Sr. High School, Oil City, PA
Beth Thomas,
Great Falls Public School, Great Falls, MT
Cynthia Weehler,
Luther Burbank High School, San Antonio, TX

Two Spitzer teachers calibrate themselves in the thermal infrared during meetings of the Spitzer Research Program for Teachers team at the AAS.



This artist concept illustrates new Spitzer Space Telescope teacher research observations of an unusual class of interacting binary stars that emit excess amounts of infrared radiation, suggesting that these odd objects are surrounded by large disks of cool dust. (Credit: P. Marenfeld and NOAO/AURA/NSF.)

Newly Selected Teachers:

Ardis Herrold,
Grosse Pointe North High School, Grosse Pointe Woods, MI
John Blackwell,
Phillips Exeter Academy, Exeter, NH
Thomas Loughran,
Saint Joseph's High School, South Bend, IN
Dwight Taylor,
South Anchorage High School, Anchorage, Alaska
Rosa Hemphill,
Oregon Episcopal School, Portland, OR
Velvet Dowdy,
Graves County High School, Mayfield, KY

Projects titles include "Star Formation in High Redshift Clusters," "Supermassive Black Hole in Arp102B," "Observations of Iron Stars," "Intergalactic Star Formation in Tidal Dwarf Galaxies of M81," "Young Stars in IC 2118," "AGN Spectral Energy Distributions," and "Brown Dwarfs in Interacting Cataclysmic Binaries." SSC Director Tom Soifer has been extremely supportive and engaged in the program since its inception.

Sponsored by NOAO and SSC, this teacher program represents an attempt by NASA and the astronomical community to engage the general public in the experience of exploration and discovery, while also enticing middle and high school students into pursuing careers in science, technology, engineering and mathematics.