>>>NOAO/NSO Newsletter

NATIONAL OPTICAL ASTRONOMY OBSERVATORY/NATIONAL SOLAR OBSERVATORY

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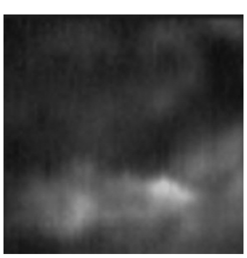

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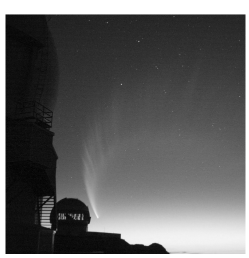

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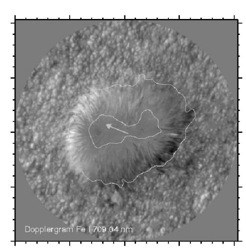

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focus on>>>

The highly successful first-light observations of the NOAO Extremely Wide-Field Infrared Imager (NEWFIRM) in early February were the result of many weeks and months of hard work by numerous NOAO staff members in the Major Instrumentation group, Kitt Peak engineering and facilities, the Data Products Program, and our partners at the University of Maryland (see page 23).

But one person who deserves some special accolades is NEWFIRM Project Scientist Ron Probst (see photo). Ron recognized the scientific need for a wide-field infrared camera years ago, and has been gently but firmly guiding the project since the beginning. He has shown great skill at converting performance goals to engineering specifications, at working with the engineering and technical staff during the design and construction phases, and at setting plans and priorities for the integration and testing. Most importantly, he has kept the diverse team working smoothly through good times and bad, always keeping one eye on the immediate problem at hand and the other on the ultimate goal of a successful instrument.

During the past several years, Ron has also made major contributions to NOAO educational and public outreach, from conducting frequent star parties for local community groups to writing and translating very creative curriculum in comparative Earth science for our ASTRO-Chile videoconferences between Tucson and La Serena (see article on page 33).

Ron does both of these tasks, and more, for NOAO with great intelligence, dedication and a sharp sense of humor. Thanks, Ron, for all that you contribute to the national observatory!

Ron Probst with NEWFIRM at the Kitt Peak Mayall 4-meter telescope.

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On the Cover

This image of the OMC 1/2 region in Orion was obtained on 3 February 2007 during the initial science verification run of the NEWFIRM infrared imager on the Kitt Peak Mayall 4-meter telescope.

These data were taken in the 2.12-micron line of H_2, which is excited by shocks and by fluorescence at boundaries between ionized and molecular gas. The monochrome image is color-coded by intensity. The image shows the full 28 x 28 arcmin field of view of NEWFIRM, covered by four 2K x 2K Orion InSb arrays in a closely packed mosaic. This large field is a key feature of NEWFIRM. One of the detectors is an engineering-grade array that will be replaced with a science-grade unit before the instrument is fully commissioned.

This image is the result of the initial processing of only four dithered exposures (in eight minutes total integration time), using software developed by the NOAO Data Products Program group for the NEWFIRM data pipeline. The minimal amount of dithering did not permit removal of all detector defects in the composite image.

The initial NEWFIRM science verification data were obtained by John Bally (University of Colorado) and Josh Walawender (University of Hawaii).

Image credit: Ron Probst, Frank Valdes, the NEWFIRM team and NOAO/AURA/NSF

The Evershed Flow: From the Chromosphere to the Photosphere

Alexandra Tritschler & Han Uitenbroek

It has been known for almost a century that sunspots are the visible manifestations of strong concentrations of magnetic field on the solar surface. Yet despite a hundred years of intense study, many physical details of sunspot structure and dynamics remain uncertain. Among the unexplained features is the characteristic outflow that occurs at photospheric levels in sunspot penumbrae discovered by Evershed in 1909 at almost the same time the magnetic nature of spots was determined. In spots observed toward the solar limb, this predominantly horizontal flow manifests itself very clearly in the shifts of spectral lines toward the blue in the center-side penumbra, and to the red on the limb side, as illustrated in the Dopplergram taken in the magnetically insensitive 709.04 nm line of Fe I (figure 1).

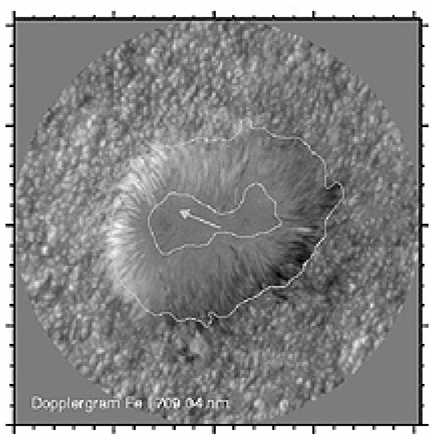


Figure 1. Dopplergram derived from the line-wing intensity of the Fe I 709.04 nm line. Positive velocities (dark) point away from the observer and correspond to redshifts, while negative velocities (bright) point toward the observer and correspond to blueshifts. The arrow points toward disk center. Contour lines mark the visible umbral and penumbral boundaries. The field of view is 81 arcsecs.

When higher layers of the penumbral atmosphere are probed with stronger spectral lines, the visible picture changes considerably. This is illustrated by the image in the Ca II 854.21 nm line, which samples chromospheric layers (figure 2). Higher up, the atmosphere is dominated by dark fibrils — loop-like structures that are more or less aligned radially and extend far beyond the visible penumbra. They are also clearly visible in the Hα line, where the structure they outline is named the superpenumbra. The fibrils carry an inward flow toward the umbra, called the inverse Evershed flow, which is almost certainly associated with the larger scale organization of the magnetic field around sunspots.

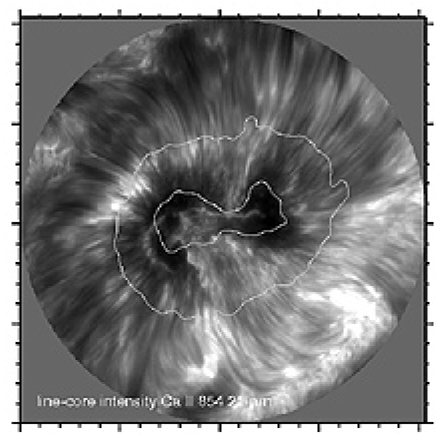


Figure 2. Line-core intensity of the Ca II 854.21 nm line.

As in the case of the photospheric Evershed flow, the driving force of the inverse flow remains unclear. It has been suggested that the inflow is a siphon flow, driven by the difference in gas pressure between the two footpoints. In this case, the flow direction is from lower magnetic field strength to higher field strength. This is plausible if the fibrils arch into the chromosphere from the high field strength umbra to connect to weaker field concentrations such as pores, or magnetic network elements, outside the spot.

The Interferometric Bidimensional Spectrometer (IBIS), a new instrument at the Dunn Solar Telescope (DST) on Sacramento Peak, now allows monitoring of the chromospheric layers above sunspots through the Ca II 854.21 and H I Hα lines at high spatial and temporal resolution, optimally using the telescope's adaptive optics (AO) system.

The Dopplergram in the Ca II 854.21 nm line shown in figure 3 is an example of the high quality data that are achievable with this setup. It is part of a two-hour observation obtained with IBIS in summer 2006 during excellent seeing conditions. Although we lack magnetic field information for the present observations, polarimetric capabilities have recently been added to the instrument to aid future investigations on the bewildering nature of chromospheric penumbra. Present observations provide strong evidence for a significant vertical component of the chromospheric inflow. While the flow seems to be almost horizontal in the superpenumbra, it becomes increasingly vertical towards the penumbra. In the chromospheric Dopplergram (figure 3), this configuration, in combination with the viewing angle, causes the flow pattern to be visible beyond the photospheric signature of the penumbra on the limb side, while on the center-side penumbra it is well observed within the visible penumbra.

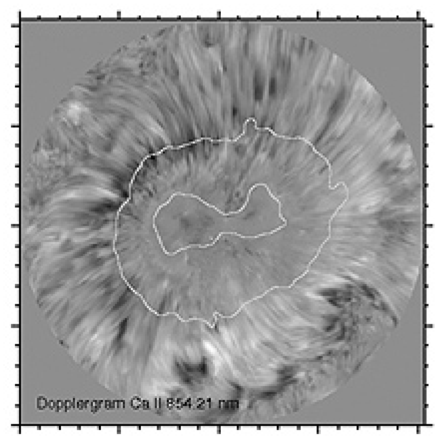


Figure 3. Dopplergram derived from the line-core intensity of the Ca II 854.21 nm line.v

The origin of these counter flows is unresolved, as are many other questions related to the chromospheric penumbra. What is the connection between the photospheric and chromospheric penumbral flow systems? Where are the photospheric counterparts of the chromospheric down flows? Where do the loops have their foot points? Are the chromospheric flows stationary or periodic? What is the magnetic field structure of the chromospheric loops, and how does it connect to the observed flows in both the chromosphere and the photosphere?

Determination of the physical forces that drive both the regular and the inverse Evershed flow is essential to our understanding of the formation, evolution, and decay of sunspots, and highly relevant to the prediction of active region evolution and its influence on space weather.

High Spectral Resolution in the Mid-IR with TEXES on Gemini

Matthew J. Richter (University of California, Davis), John Lacy (University of Texas) & Dan Jaffe (U. Texas)

With the arrival in 2006 of the Texas Echelon-Cross-Echelle Spectrograph (TEXES) at Gemini North, a new capability became available: R=100,000 spectroscopy in the mid-infrared. TEXES (see Lacy et al. 2002, PASP, 114, 153) has spatial resolution set by the telescope diffraction limit and operates between 4.5 and 25 microns. Such high spectral and spatial resolution make TEXES well-suited for studying gas composition, temperature, and dynamics using molecular and ionic tracers.

Discovery of massive high-velocity ionized outflow

As part of the Demonstration Science run in July, TEXES mapped the high-mass star forming region W51 IRS2, which has been compared to Orion (see Genzel et al. 1982, *ApJ*, 255, 527). As described in Lacy et al. (*ApJL*, submitted), the 0.6" wide slit was stepped across the area of interest, roughly 8" by 12", to produce high spectral and spatial data cubes of the W51 IRS2 region in [Ne II] ($\lambda = 12.8\ \mu m$) and [S IV] ($\lambda = 10.5\ \mu m$) forbidden lines, along with neighboring continuum. This mapping mode, one of the two standard TEXES science observing modes, is the most efficient method for TEXES to study extended objects.

Most prominent in our maps is a fairly compact region of gas that is blue-shifted with respect to the ambient cloud velocity by roughly 100 km/s. This gas is most prominent in the [S IV] line. We believe the high-velocity material originates near a known, more deeply embedded maser source within the molecular cloud. As the material punches through into the HII region, it becomes ionized and we are able to trace its behavior. The mass flow rate for this material is at least $1.2 \times 10^{-5}\ M_{\odot}$ / year. Our maps also show ionized gas near the cloud velocity and gas at intermediate velocities that appears to come from the interaction of the jet and the ambient cloud (see figure 1). A closer look at the dynamics of the ionized material on the cloud surface suggests a flow along the interface of the HII region and the molecular cloud. This is a pattern we have seen toward several compact HII regions (Zhu et al. 2005, *ApJ*, 631, 381).

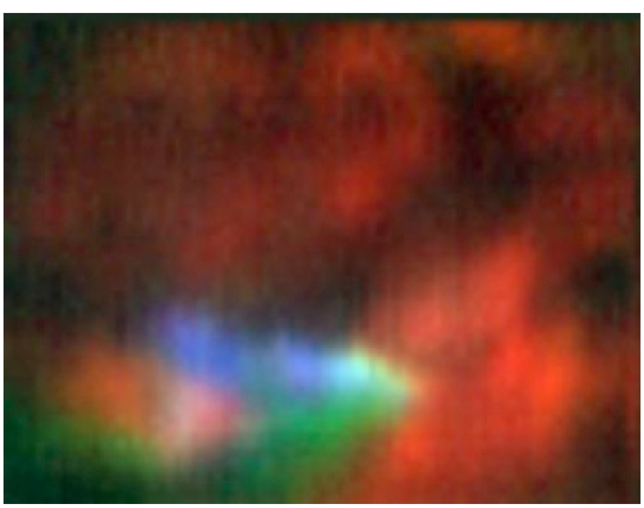


Figure 1:TEXES observations of [SIV] (λ=10.5 μm) emission from the W51 IRS2 region. The image comes from a slit scan covering 10" by 7" with spatial resolution of 0.3". The colors (see *www.noao.edu/noao/noaonews/mar07/*) represent different gas components as identified by their velocities: the cloud surface (+30 to +80 km/s: red), partially accelerated gas (-25 to +30 km/s: green), and the high velocity jet (-80 to -25 km/s).

Chemical and dynamical analysis of protoplanetary disk gas

Investigations of protoplanetary disk gas have made much use of near-IR CO observations (see Najita et al. 2007, *PPV*, eds Reipurth, Jewitt, and Keil, University of Arizona Press, Tucson, 507). The transitions are seen in emission and absorption; the large number of rotational states measured allows determination of gas excitation temperatures as well as column densities; and, where available, resolved spectral lines allow for analysis of the region's dynamics.

Three TEXES projects during the November Science Campaign observing focused on extending the basic technique to other molecules. Broad rotational H_2O emission was seen in one source; line widths suggest an origin at around 1 AU from the central star. H_2 emission was seen in four sources, arising in either the disk or surrounding envelope. The mid-IR H_2 transitions are better probes of gas with T<1000 K then H_2 lines at shorter wavelengths.

One binary, known to show C_2H_2, HCN, and CO_2 bandhead absorption in Spitzer IRS data, was detected in H_2 emission as well as C_2H_2, HCN, NH_3, and HNCO absorption. The C_2H_2 and HCN lines show asymmetric line profiles (figure 2). The other molecules, which also show strong absorption with intriguing line profiles, are only seen with TEXES and its high spectral resolution. The high spatial resolution allowed each component to be observed separately in order to determine which line-of-sight contained the absorption.

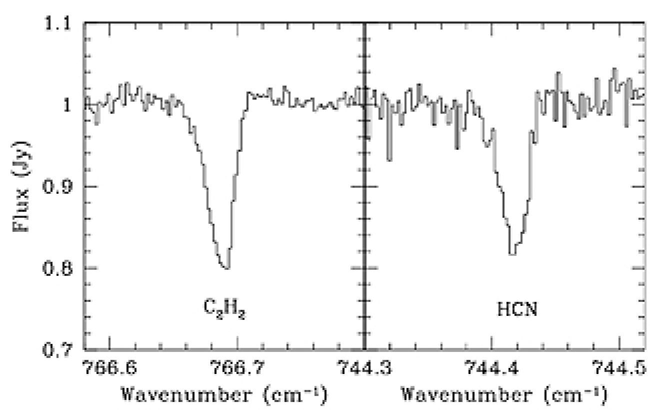


Figure 2: Examples of TEXES molecular absorption toward a low-mass star with a disk. Unlike the Spitzer IRS spectra for this binary target, these data spectrally and spatially resolve the absorption.

TEXES and Gemini

TEXES was offered to the Gemini community as a result of the "Aspen" instrumentation process and its recommendation that Gemini provide high spectral resolution in the mid-infrared. A total of 15 PIs requested almost 40 nights of TEXES time for 2006B.

As per the agreement with Gemini, TEXES was open for use by the entire community and all time was awarded through the TAC. The TEXES team would like to continue working at Gemini in 2007B and beyond, but no decision has been made at this time. For details regarding TEXES, its capabilities, and its availability, see *www.gemini.edu/sciops/instruments/texes/TexesIndex.html,* or contact the author at *mjrichter@ucdavis.edu.*

Implementing the Senior Review Recommendations – a Progress Report

Todd Boroson

Since the NSF Senior Review report was released in early November, we have been working with the staff of the NSF astronomy division to develop a plan for implementing the report's recommendations. The fast-approaching context for this implementation turns out to be the proposal to renew AURA's cooperative agreement with the NSF to operate NOAO. That proposal, covering the years FY 2009-2013 (1 October 2008 – 30 September 2013), will be submitted by June 15.

As described in the December 2006 *NOAO/NSO Newsletter*, we find the "base program" recommendation—that NOAO should deliver community access to an optimized suite of high-performance telescopes of all apertures—to be well aligned with our own view of our mission. We understand that the desired adjustment to the balance concerns the relative priority of the small and mid-sized facilities and the pace of the new national initiatives. On the small and mid-sized end, we must work to improve those capabilities and access to them. On the national initiative end, we must not exceed the pace at which the NSF can fund true national involvement.

As a result of this recommendation, we see the NOAO program changing in the following ways:

- We will develop a plan for renewing the infrastructure at our observatories, Kitt Peak and Cerro Tololo. This will include both maintenance and modernization, so that we can effectively support state-of-the-art instruments. We expect access to these telescopes to increase back to the maximum, and we will explore expanding the level of user support

- We will work with the community to develop a robust system of small and mid-sized telescopes. We believe that there already exists a suite of telescopes of 4-meter class and smaller that can provide the required access. What is needed is modernization, a reasonable level of support, and instrumentation that spans the range of community needs

- We have already reconfigured our Giant Segmented Mirror Telescope (GSMT) effort to address the concerns expressed by the Senior Review report. These concerns fall into two categories: an unreasonable expectation for the timing of significant NSF funding for a GSMT project, and the existence of two comparable projects. At the request of the NSF, the new national GSMT office at NOAO will represent the community and the NSF in whichever project goes forward. The principal short-term tasks of this national office will include scientific liaison activities between the two projects and the community, and ongoing technical review of the two projects at a level sufficient to inform NSF decisions about future funding and participation. This transition is well under way.

Most of the other programs will not change much from their planned activities and evolution in the next few years. Both NOAO's instrumentation and data products programs have commitments to provide support or infrastructure to projects currently underway. Both of these programs are aimed at improving capabilities of and access to the current facilities, high priorities from the Senior Review perspective. The NOAO Gemini Science Center must continue supporting access to the Gemini telescopes and NOAO's effort on the Large Synoptic Survey (LSST) is moving through the last stages of pre-construction as the NSF Major Research Equipment and Facilities Construction proposal is submitted.

How these changes will be integrated into the NOAO program—and the impact this integration will have on future budgets—is not yet clear. We are satisfied, though, that a responsive and effective program will emerge from the current discussions.

Users Committee Report Available

The 2006 NOAO Users Committee report has been posted on the NOAO Web site at *www.noao.edu/dir/usercom/2006/UC2006report.pdf*.

Report from the Third System Workshop

Todd Boroson

The Third Community Workshop on the Ground-Based Optical/Infrared System was held in Scottsdale, Arizona, on 16-17 November 2006. This workshop was initiated by a request from the AURA Coordinating Council Of Research Directors (ACCORD) for a community-based discussion that would develop a strategic plan for instrumentation on the large telescopes of the US system.

The organizing committee included members of ACCORD, as well as astronomers representing both institutions that operate their own facilities and those who do not. Seventy-three astronomers attended the workshop.

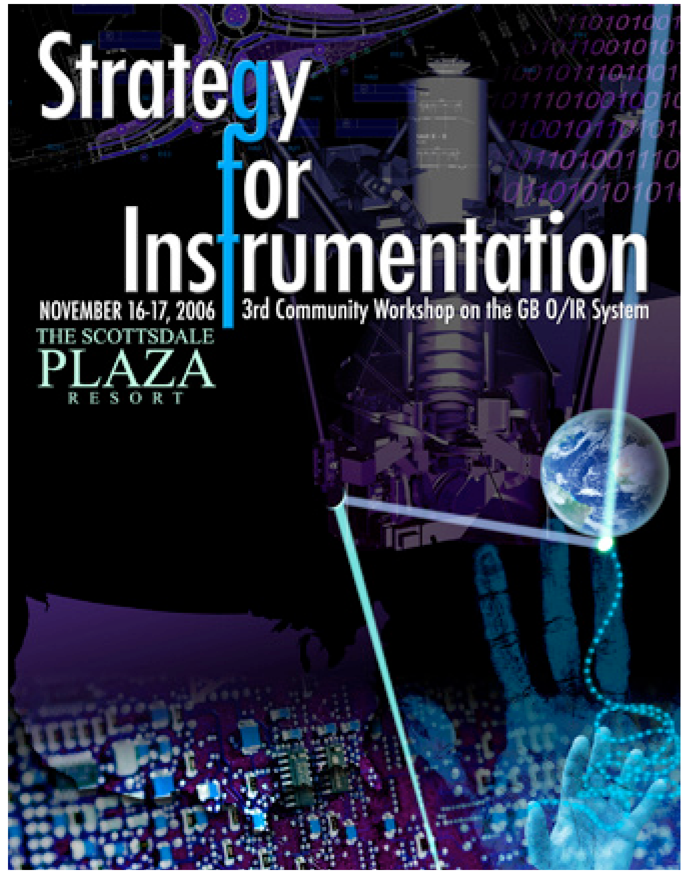
The workshop was structured similarly to the previous system workshops: presentations on the facilities themselves and their capabilities, scientific overview presentations, breakout groups that conducted science-based discussions of community needs in instrumentation, and a plenary discussion of the reports of those breakout groups. Detailed information about the meeting, including the presentations, can be found on the workshop Web site at *www.noao.edu/system/system3.html*.

Although the discussions did not get as far as developing a true plan for providing the needed instruments for the large telescopes, a number of interesting recommendations emerged from the workshop. Instrumental capabilities that received high demand include high-dispersion spectroscopy over both the visible and near-infrared range, medium-dispersion optical spectroscopy of very large numbers of objects over a wide field, and high-angular resolution (adaptive optics) imaging and spectroscopy. An additional capability that received a strong endorsement was increased access to a well-instrumented suite of mid-sized telescopes, with the ability to schedule target-of-opportunity and monitoring observations.

The organizing committee met following the workshop, and synthesized the workshop discussion into the following points:

- Based on the interests of the independent observatories to make additional time available to the community, the Telescope System Instrumentation Program (TSIP) at the NSF (funded at $2 million in FY06) has the potential to grow to about $7 million per year. This would provide approximately 120 nights of large-telescope time

- A new program that creates a robust system of mid-sized telescopes could benefit both the operators of those telescopes and the community



- A future discussion that explores applicability of the system of facilities to follow-up of time-domain astronomy discoveries is essential; this is an opportunity to anticipate the scientific need and provide effective capabilities in an efficient manner

- The NSF Program for Research and Education with Small Telescopes (PREST), which funds improvements and community access to small telescopes, holds promise but has been limited by the effectiveness of the participating observatories in advertising their access

- Further time trades between observatories should be explored.

An official report from the workshop is being written, and will be advertised through the NOAO Web site as soon as it becomes available.

Gemini Observing Opportunities for Semester 2007B

Verne V. Smith

The NOAO Gemini Science Center (NGSC) encourages the US community to take advantage of Gemini observing opportunities for semester 2007B (1 August 2007 – 31 January 2008). US Gemini observing proposals are submitted to and evaluated by the NOAO Time Allocation Committee (TAC).

The formal Gemini "Call for Proposals" for 2007B will be released on or about 1 March 2007, with a US proposal deadline of Monday, 2 April 2007 (since the nominal 31 March deadline is on a Saturday). As this article is prepared well before the release of the Call for Proposals, the following list of instruments and capabilities are only our expectations of what will be offered in semester 2007B. Please watch the NGSC Web page (*www.noao.edu/usgp*) for the Gemini Call for Proposals, which will list clearly and in detail the instruments and capabilities that will be offered.

NGSC anticipates the following instruments and modes on Gemini telescopes in 2007B:

Gemini North:
- Near-infrared Integral Field Spectrometer (NIFS).
- Near Infra-Red Imager (NIRI) and spectrograph with both imaging and grism spectroscopy modes.
- Altair adaptive optics (AO) system in Natural Guide Star (NGS) mode, as well as in Laser Guide Star (LGS) mode. LGS science verification (SV) runs are taking place in 2007A and LGS full science mode will be offered in 2007B, contingent on the success of these runs. Altair can be used with NIRI imaging and spectroscopy and with NIFS IFU imaging and spectroscopy, as well as NIFS IFU spectral coronagraphy.
- Michelle, mid-infrared (7-26 micron) imager and spectrometer, which includes an imaging polarimetry mode.
- Gemini Multi-Object Spectrograph (GMOS-North) and imager. Science modes are multi-object spectroscopy (MOS), long-slit spectroscopy, integral-field unit (IFU) spectroscopy and imaging. Nod-and-shuffle mode is also available.
- All of the above instruments and modes are offered for both queue and classical observing. Classical runs are offered only to programs that are three nights or longer in length.
- Time trades will allow community access to the high-resolution optical spectrograph, HIRES, on Keck, as well as to the Suprime-Cam wide-field imager and the infrared imager and spectrograph (MOIRCS) on Subaru.

Gemini South:
- Gemini Near Infra-Red Spectrograph (GNIRS).
- Thermal-Region Camera Spectrograph (T-ReCS) mid-infrared (2-26 micron) imager and spectrograph.
- Gemini Multi-Object Spectrograph (GMOS-South) and imager. Science modes are multi-object spectroscopy (MOS), long-slit spectroscopy, integral-field unit (IFU) spectroscopy and imaging. Nod-and-shuffle mode is also available.
- All modes for GMOS-South, GNIRS, and T-ReCS are offered for both queue and classical observing. Classical runs are offered only to programs with a length of three nights or longer.

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

The percentage of telescope time devoted to science program observations in 2007B is expected to be greater than 90 percent at Gemini North and greater than 75 percent at Gemini South.

We remind the US community that Gemini proposals can be submitted jointly with collaborators from other Gemini partners. An observing team requests time from each relevant partner. Multi-partner proposals are encouraged because they access a large 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 Gemini Phase I Tool (PIT).

Efficient operation of the Gemini queue requires that it is populated with programs that can effectively use the full range of observing conditions. Gemini proposers and users have become increasingly experienced at specifying the conditions required to carry out their observations using the on-line Gemini Integration Time Calculators (ITCs) for each instrument.

NGSC reminds you 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 greatest demand are excellent image quality and no cloud cover. We understand the natural high demand for these excellent conditions, but wish to remind proposers that programs that make use of less than ideal conditions are also needed for the queue.

There is continuing need for proposals that can be run under the poorest conditions. To help fully populate the queue, a category of "Poor Weather" proposals has been established. Poor weather programs may be submitted for any facility instrument; for these proposals, neither the PI nor the partner country will be charged for any time used. For additional information, please see the link at *www.gemini.edu/sciops/ObsProcess/ObsProcCfP_background.html.*

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

Feel free to contact me (*vsmith@noao.edu*) if you have any questions about proposing for US Gemini observing time.

Avoid Fear and Loathing in January: Prepare your Gemini Phase II Plan at the AAS Meeting

Ken Hinkle & Dick Joyce

All users granted time on the Gemini telescopes must complete a Phase II observing plan. The Phase II plan is a script executed at the telescope by the Observing Tool (OT) to carry out the observations. All Gemini programs, both queue and classical, are carried out by the OT and must therefore have an associated Phase II plan.

At the January 2007 AAS meeting in Seattle, NGSC staff member Tom Matheson shows Marcel Agüeros (Columbia University) how to set up the Phase II for his 2007A program.

Since most Gemini observations are made in queue mode, the Phase II plan is the only link most users have to the actual observations. In queue mode, each science target is observed at an optimum time subject to the constraints specified in the proposal. As a result, a science program will be broken into groups that can be observed at any one time. Typically, a program will be observed in pieces throughout the semester by different Gemini observers who will not know the user or the details of their program. The observations at the telescope will therefore be carried out exactly as defined in the Phase II plan.

Gemini has provided several sets of instructions to help users prepare their Phase II plan. The Web site *www.gemini.edu/sciops/ObsProcess/ObsProcPh2Index.html* contains a tutorial on using the OT for Phase II preparation. Many of the instrument descriptions provide further details as well as "Library Examples" — templates that can be copied into your Phase II plan to greatly simplify the process. Click on one of the instruments on *www.gemini.edu* and follow the links to these templates.

Nevertheless, completing a Phase II plan can be arduous and requires significant attention to detail to ensure that every aspect is correct. One of the functions of the NGSC is to check all of the US Phase II submissions. Gemini performs an additional check, all in an effort to eliminate errors that could result in slow or improper execution of programs at the telescope.

Principal Investigators granted time in semester "A" can get help completing their Phase II plans at the January meetings of the American Astronomical Society (AAS). NGSC has a booth outfitted with high-speed Internet access at every winter AAS meeting, and our staff is eager to assist users with this process. The OT has a number of visual features that are much easier to demonstrate in person.

At the January 2007 AAS meeting, about ten teams came to the NGSC booth to either prepare their Phase II plans or seek advice. We plan to have an expanded space at the AAS meeting next January, and encourage all US Gemini users to meet with us. Working on Phase II plans with the help of our staff at the AAS meeting affords the user an opportunity to receive immediate advice and complete this required task as quickly and painlessly as possible.

NGSC staff member Bob Blum follows the Phase II progress of Sean Brittain (Clemson University) at the January 2007 AAS meeting. Here they are identifying guide stars using the image editor of the Observing Tool.

bHROS May Move from Gemini to SALT

Since the bench-mounted High Resolution Optical Spectrograph (bHROS) was first offered by Gemini in semester 2006A, the demand for the instrument has been low – bHROS has never met the minimum time required to keep it scheduled. Several new instruments will be commissioned at Gemini South over the next two years. The pressure from these instruments makes it unlikely that bHROS would be scheduled in the future.

As a result of this low demand, the Gemini board asked the observatory to consider a proposal from the South African Large Telescope (SALT) to loan bHROS to them in exchange for telescope time. This would not only benefit SALT, it would also allow continued access to high-resolution optical spectroscopy for the Gemini community. Gemini is currently negotiating such an agreement with SALT.

—Katia Cunha

GEMINI SCIENCE 2007

Gemini Science Meeting – June 11-13
Gemini Users Meeting – June 14
Gemini/National Offices Staff Meeting – June 15
Foz do Iguaçú, Brazil

Gemini Science 2007 will highlight recent science results from the Gemini North and South telescopes, and will include talks about future Gemini instruments and software development.

Don't miss this opportunity to learn about Gemini's scientific productivity and meet fellow Gemini users – and visit the spectacular Iguaçú Falls. There is no registration fee for the conference. You may register and make hotel reservations online via the conference Web site (*www.lna.br/~gsm2007/*).

Registration Deadline – April 10, 2007

Travel Tip: Domestic airline service to Foz do Iguaçú is readily available from Sao Paulo (airport code GRU) and Rio de Janeiro (airport code GIG), the major points of entry into Brazil.

NGSC Instrumentation Program Update

Verne Smith & 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 2006 *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.

After arriving at the Gemini Hilo Base Facility, NICI was thoroughly inspected by the MKIR team. NICI then underwent a series of flexure tests and interface testing with Gemini software systems. All tests were passed, after which the instrument was crated for transport and shipped to Cerro Pachón.

Figure 1. NICI arrives at the Gemini South telescope on Cerrro Pachón.

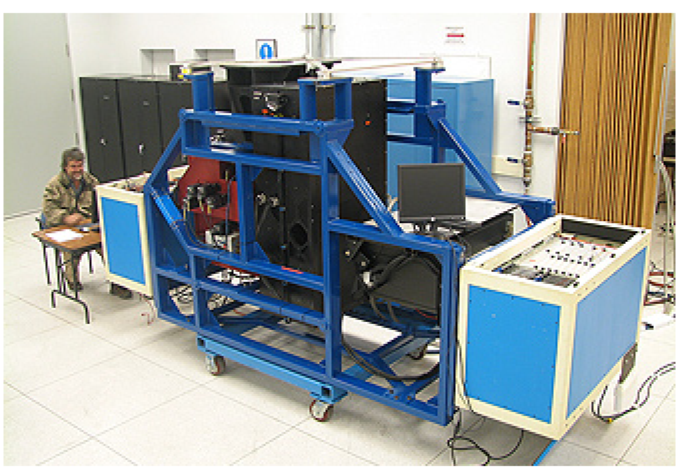


Figure 2. NICI in the Gemini South Instrument Lab.

NICI arrived at Gemini South as shown in figure 1, and is being checked out in the instrument lab prior to commissioning as shown in figure 2.

As of the end of December, MKIR reports that 99 percent of the work toward final acceptance of NICI 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.

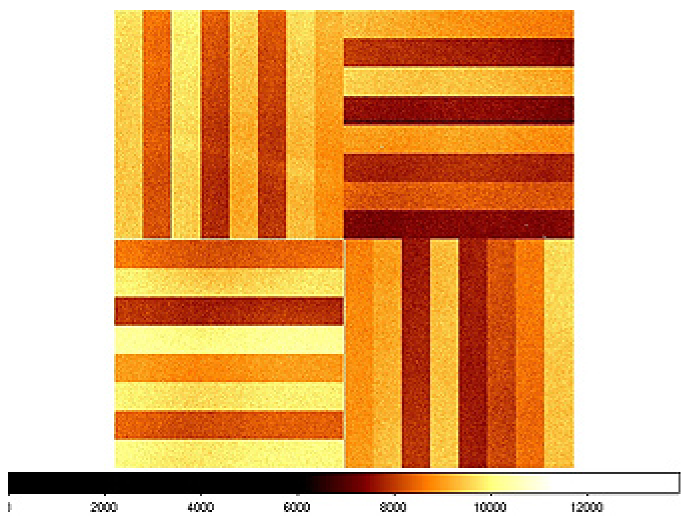


Figure 3. Warm readout of the Flamingos-2 Science Grade Hawaii-2 focal plane array.

The NGSC held a quarterly review of the FLAMINGOS-2 instrument in Gainesville with the University of Florida team on January 12. The instrument continues in the integration and testing phase of the project. Progress was made in solving problems in the electronics and mechanical subsystems, leading to the warm readout of the Science Grade array shown in figure 3. Additional progress was made in addressing problems of image quality and flexure, with efforts now focused on testing these improvements and addressing some mechanical issues. Once these are addressed, work will turn to preparing for the Pre-ship Acceptance Test.

As of December, the University of Florida team reports that 95 percent of the work toward final acceptance of FLAMINGOS-2 has been completed.

NGSC Booth at the 2007 AAS Meeting in Seattle

The NOAO Gemini Science Center is an active participant in the winter meetings of the American Astronomical Society (AAS). NGSC staff members attend the meeting and staff a booth to meet with you and answer your questions—a major part of our mission as the gateway to Gemini for US astronomers. Featured information includes guidance on how to apply for time on the Gemini telescopes, details about currently available instrument capabilities, and tips on 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 time. Look for us at the January 2008 AAS meeting in Austin, Texas.

Snapshots from the NGSC booth at the January 2007 AAS meeting in Seattle. Top right, from left to right: Aaron Grocholski (University of Florida) and Verne Smith (NGSC); Malcolm Hicken (Harvard University) and Tom Matheson (NGSC); Sean Brittain (Clemson University) and Katia Cunha (NGSC). Bottom row, from left to right: Edo Berger (Carnegie Observatories), Alicia Soderberg (California Institute of Technology), and Tom Matheson (NGSC); Doug Welch (McMaster University), Verne Smith (NGSC), David Sprayberry (NOAO) seated in background, Bob Blum (NGSC), and Phil Puxley (National Science Foundation) with back to camera; and a potential Gemini user browsing NGSC-produced instrument brochures.

2007B Observing Proposals Due 2 April 2007

Letizia Stanghellini

Standard proposals for NOAO-coordinated observing time for semester 2007B (August 2007 – January 2008) are **due by Monday evening, 2 April 2007, midnight MST.** 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 (*www.noao.edu/noaoprop/*). There are three options for submission:

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

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

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

Note that proposals for Gemini time may also be submitted using the standard NOAO form, and 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.*

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 email	*noaoprop-submit@noao.edu*
Gemini-related questions about operations or instruments	*usgemini@noao.edu*
	www.noao.edu/gateway/gemini/support.html
CTIO-specific questions related to an observing run	*ctio@noao.edu*
KPNO-specific questions related to an observing run	*kpno@noao.edu*
HET-specific questions related to an observing run	*het@noao.edu*
Keck-specific questions related to an observing run	*keck@noao.edu*
MMT-specific questions related to an observing run	*mmt@noao.edu*
Magellan-specific questions related to an observing run	*magellan@noao.edu*

Community Access Time Available in 2007B with Keck, HET, Magellan, and MMT

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 2007B:

- **Keck Telescopes**
A total of eight 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 five 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 expected to be available in semester 2007B can be found at the end of this section. As always, investigators are encouraged to check the NOAO Web site for any last-minute changes before starting a proposal.

The Hobby-Eberly Telescope. *Photo credit: Marty Harris/McDonald Observatory*

Observing Request Statistics for 2007A 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	203	203.26	1	55.49	0	0	55.49	3.66
GEM-S	93	111.89	1.2	33.36	0.35	0	33.36	3.35
CTIO								
CT-4m	46	172.7	3.75	110	0	0	110	1.57
SOAR	20	43.6	2.18	27	0	0	27	1.61
CT-1.5m	13	34.6	2.66	38.52	0	0	38.52	0.9
CT-1.3m	15	38.6	2.57	37.25	0	2.55	34.7	1.11
CT-1.0m	10	54	5.4	75	0	0	75	0.72
CT-0.9m	15	41.4	2.76	33	0	0.5	32.5	1.27
KPNO								
KP-4m	71	280.2	3.95	75	2	0	75	3.74
WIYN	33	97.3	2.95	46	0	0	46	2.12
KP-2.1m	24	153.2	6.38	106	0	0	106	1.45
KP-0.9m	2	14	7		0	0		
Keck/HET/MMT/LCO								
HET	8	13.24	1.66	9.24	0	0	9.24	1.43
Keck-I	20	31	1.55	4	0	0	4	7.75
Keck-II	22	31	1.41	4	0	0	4	7.75
Magellan-I	1	3	3	0	0	0	0	0
Magellan-II	6	11	1.83	5	0	0	5	2.2
MMT	9	22	2.44	10.5	0	0	10.5	2.1

*Nights allocated by NOAO Director

CTIO Instruments Available for 2007B

Spectroscopy	Detector	Resolution	Slit
4-m Blanco			
Hydra + Fiber Spectrograph	SITe 2K×4K CCD, 3300-11,000Å		138 fibers, 2" aperture
R-C CCD Spectrograph	Loral 3K×1K CCD, 3100-11,000Å	300-5000	5.5'
4-m SOAR[1]			
OSIRIS IR Imaging spectrograph	HgCdTe 1K×1K, JHK windows	1200, 3000	1.3', 3.3'
1.5-m[2]			
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 (2K×2K 1.0-2.4µm)	0.3	11'
4-m SOAR[1]			
Optical Imager	E2V 4K×4K Mosaic	0.08	5.5'
OSIRIS IR Imaging spectrograph	HgCdTe 1K×1K	0.14, 0.35	1.3', 3.3'
1.5-m[2]			
CPAPIR IR Imager	HgCdTe 2K×2K	0.9	30'
1.3-m[2 3]			
ANDICAM Optical/IR Camera	Fairchild 2K×2K CCD	0.17	5.8'
	HgCdTe 1K×1K IR	0.11	2.0'
1.0m[4]			
Direct Imaging	Fairchild 4K×4K CCD	0.29	20'
0.9-m[5]			
Direct Imaging	SITe 2K×2K CCD	0.4	13.6'

[1] The amount of science time available on SOAR in 2007B will be at least 50%. Classical (i.e. visitor) observing is the only observing mode offered for NOAO proposals. The availability of the Goodman spectrograph is uncertain.
Please consult the NOAO Proposals Web pages for the latest information.

[2] Service observing only.

[3] Proposers who need the optical only will be considered for the 1.0m unless they request otherwise. Note that data from both ANDICAM imagers is binned 2×2.

[4] Classical observing only - Observers may be asked to execute up to 1 hour per night of monitoring projects which have been transferred to this telescope from the 1.3m. In this case, there will be a corresponding increase in the scheduled time. No specialty filters, no region of interest.

[5] Classical or service, alternating 7-night runs. If proposing for classical observing, requests for 7 nights are strongly preferred.

Gemini Instruments Expected to be Available for 2007B

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	3x2048×4608 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"x24" 43" slit length
NIFS	2048×2048 HAWAII-2RG	1-2.5μm R~5000	0.04 x 0.10	3" x 3"
NIFS + Altair (AO)	2048×2048 HAWAII-2RG	1-2.5micron R~5000	0.04 x 0.10	3" x 3"

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" x 21"

KPNO Instruments Available for 2007B

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)	30,010,003,000	3.4’	single/multi
WIYN 3.5m[3]				
Hydra + Bench Spectrograph	T2KA CCD	700-22000	NA	~100 fibers
DensePak[4]	T2KA CCD	700-22000	IFU	~90 fibers
SparsePak[5]	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)[6]	CCD (4K×4K, 5000-5640 Å)	See Note	Fiber (2.5”)	

Imaging	Detector	Spectral Range	Scale (“/pixel)	Field
Mayall 4m				
CCD Mosaic	8K×8K	3500-9700Å	0.26	35.4’
NEWFIRM[7]	InSb (mosaic, 4, 2k×2k)	1—2.3µm	0.4	28.0’
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[8]	4K×4K CCD	3300-9700Å	0.14	9.3’
OPTIC[9]	4K×4K CCD	3500-11000 Å	0.11	9.3’
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[10]	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, built by Dr. John MacKenty and collaborators. Availability will depend on proposal demand and block scheduling constraints.

[3]A new Volume Phase Holographic (VPH) grating, 740 l/mm, is now available for use. Please contact Di Harmer for information.

[4]Integral Field Unit: 30”x45” field, 3” fibers, 4” fiber spacing @ f/6.5; also available at Cass at f/13.

[5]Integral Field Unit, 80”x80” field, 5” fibers, graduated spacing

[6]Exoplanet Tracker (ET) is an instrument provided by Dr. Jian Ge of the University of Florida and his colleagues. It enables very high precision measurements of radial velocities for suitably bright enough targets. Details regarding this instrument are available via our instrument web pages. It is capable of providing Doppler precision of 4.4 m/s in 2 minutes for a V = 3.5 mag. G8V star.

[7]NEWFIRM is being offered on a “shared-risk” basis for this semester. Please see *www.noao.edu/ets/newfirm/* for more information. Available filters: J, H, Ks, 1.64 µm [Fe II], 2.12 µm H2, 2.16 µm Br gamma.

[8]OPTIC Camera from the University of Hawaii may be assigned as alternative if it meets proposed imaging needs and making such an assignment would further observatory support scheduling needs. Fast guiding mode of operation of OPTIC is now a supported mode for NOAO users of the instrument.

[9]We anticipate that OPTIC will again be available through an agreement with Dr. John Tonry of the University of Hawaii. The instrument should be available for scheduling October 2007 through January 2008.

[10]FLAMINGOS is an instrument built by Richard Elston and collaborators at the University of Florida. Steve Eikenberry is currently the PI of the instrument.

HET Instruments Available for 2007B

	Detector	Resolution	Slit	Multi-object
LRS (Marcario low-res spec)	Ford 3072×1024			
	4100-10,000Å	600	1.0”-10”x4’	13 slitlets, 15” × 1.3” in 4’ x 3’ field
	4300-7400Å	1,300	1.0”-10”x4’	13 slitlets, 15” × 1.3” in 4’ x 3’ field
	6250-9100 Å	1,900	1.0”-10”x4’	13 slitlets, 15” × 1.3” in 4’ x 3’ field
MRS (med-res spectrograph)	(2) 2K×4K, 4200-9000 Å	70,009,000	1.5” or 2” 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 2007B

	Detector	Spectral Range	Scale (“/pixel)	Field
BCHAN (spec, blue-channel)	Loral 3072×1024 CCD	0.32-0.8µm	0.3	150”
RCHAN (spec, red-channel)	Loral 1200×800 CCD	0.5-1.0µm	0.3	150”
MIRAC3 (mid-IR img, PI 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 2007B

	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’
LDSS3 (mslit spec/img)	4096×4096 CCD	R~200-1700	0.4-0.8 µm	0.19	8.25’ circ.
MIKE (echelle)	2K×4K CCD	R~19000-65000	0.32-1.0µm	0.14	

Keck Instruments Available for 2007B

	Detector	Resolution	Spectral Range	Scale (“/pixel)	Field
Keck 1					
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 2					
ESI (optical echelle)	MIT-LL 2048×4096	1000-6000	0.39-1.1µm	0.15	2x8’
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 (near IR IFU)	1024×1024 Hawaii	~3800	1-2.4µm	0.02	20”
Interferometer					
IF (See http://msc.caltech.edu/kisupport/)					

The NOAO Data Products Program (DPP)

Christopher J. Miller, Chris Smith & Todd Boroson

As a national observatory operating a wide range of telescope facilities distributed throughout the world, NOAO is inherently one of the most significant data providers in the US astronomical "system," including both ground-based and space-based facilities. This significance can be quantified both in the variety of instruments supported and the volume of data produced.

However, until recently, most of the data obtained at NOAO and affiliated facilities was only captured for backup purposes in case principal investigators lost their own data, using the tape-based "Save-The-Bits" system.

In 2000, NOAO created a Data Products Program (DPP) in order to establish a unified data management infrastructure for the distributed observatory facilities and their users. The program initially focused on the data sets that were thought to hold the most rapid impact, specifically those from the NOAO Survey Program. These survey projects, which account for up to 20 percent of the telescope time on NOAO facilities in some semesters, were obligated to provide community access to their reduced data as a consequence of their original selection.

The NOAO Survey Archive debuted in 2002, providing the permanent platform for access to the reduced data and data products from these surveys. The scope was soon broadened to include several other surveys, and the name was changed to NOAO Science Archive, or NSA. The NSA (*archive.noao.edu/nsa/*) now hosts several terabytes of data from 13 surveys, with additional survey data being added on roughly a quarterly basis.

As our efforts advanced to develop the data capture systems, archival storage and access, and pipeline processing, we realized the need to bring them together to form a single, integrated system. Our End-to-End (E2E) data management system does just this by: integrating the capture of raw data from a wide variety of instrumentation, transporting data to the multiple distributed sites of the NOAO Science Archive (NSA), automatically processing data from selected instruments via the NOAO High-Performance Pipeline, and delivering data to the users through the advanced NOAO NVO Portal (*nvo.noao.edu*).

This E2E data management system (see related story in this section) forms the core of the NOAO's participation in the National Virtual Obseratory (NVO) initiative, providing the necessary data management to collect and archive the data produced from ground-based facilities while also providing the access to this content through VO interfaces to the worldwide astronomical community. We have been operating the data capture and transport part of the system for two years, and have collected over 20 terabytes of FITS files. In January 2006, the prototype of the NOAO NVO Portal went online at the 207th Meeting of the American Astronomical Society. In early 2007, we will begin beta testing the full E2E data management system, opening access to selected NOAO users for testing and end-user feedback.

DPP's role within NOAO and the larger community is to enable users to discover, access, understand, and analyze astronomical data available through the Virtual Observatory. Of course, our focus is on data from NOAO and affiliated observatories, but our goal is to make the NOAO NVO Portal a general tool useful for combining data from a variety of VO resources (for example, HST, Chandra, XMM, and others). Our "NOAO Sky" Web-based archive browser is but one example of these efforts to bring together a variety of resources to enable and promote multi-resource science.

In upcoming editions of the *NOAO/NSO Newsletter*, we will provide updates on our progress, the deployments of the NOAO data management system and its related tools and services, and our future plans. We encourage all users to send ideas, suggestions, and concerns to *vohelp@noao.edu*. Your input and feedback as users of the data, tools, and services which NOAO DPP provides can be an invaluable aid to our planning.

NOAO DPP at ADASS XVI

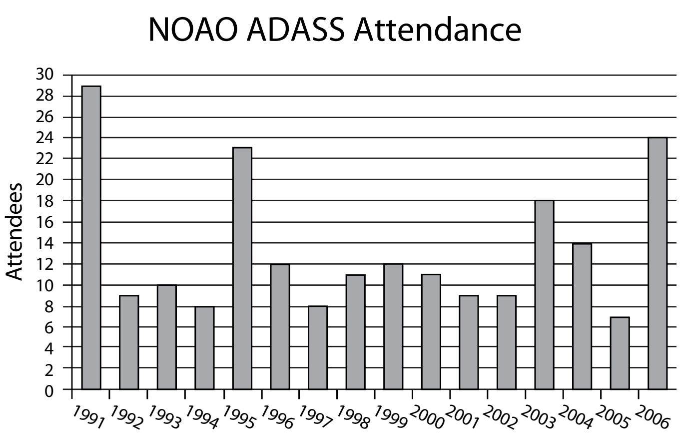
Christopher J. Miller

The Astronomical Data Analysis Software and Systems (ADASS) conference is held each year to provide an international forum for scientists and programmers concerned with algorithms, software, and software systems employed in the acquisition, reduction, analysis, and dissemination of astronomical data. The ADASS meetings are an important venue for the NOAO Data Products Program (DPP). They afford an opportunity to announce or demonstrate the tools and services we are developing, and keep us informed about what other archive, pipeline, or virtual observatory developers are doing. Collaborations with these groups are often established at these meetings.

Over the years, ADASS attendance by NOAO staff has remained strong. This year was the second highest level of attendance since the inception of ADASS in 1991. Of course, much of that high attendance has to do with the fact that the meeting was held in Tucson. Accordingly, DPP would especially like to thank the many members of the NOAO staff who selflessly joined the Local Organizing Committee that made ADASS 2006 a great success.

What is especially pleasing this year is the sheer number of talks and posters led by DPP staff members: 18 by DPP members in total, plus two "Birds-of-a-Feather" sessions led by Rob Seaman and Mike Fitzpatrick. Rob Seaman also organized an NOAO DPP demo booth that highlighted some of the new developments for the NOAO NVO Portal.

The strong showing by DPP staff at this well-known conference provided important exposure for our soon-to-be released NOAO End-to-End (E2E) data management system, and crucial interaction with the astronomical software community to coordinate our development and operations efforts with the worldwide efforts on archives, pipelines, and the Virtual Observatory.



- **Irene Barg** et al. *The NOAO Data Management System – Day-to-Day Challenges of Managing the DMS*
- **Tim Cline** et al. *The NOAO High-Performance Pipeline System: Architecture Overview*
- **Andrew Cooke** et al. *FITS Files and Regular Grammars: A DMaSS Design Case Study*
- **Evan Deaubl** et al. *Agile Development Processes: Delivering a Successful Data Management Platform Now and in the Future*
- **Alvaro Egana** et al. *VOTable Construction and a Lazy Little Language: Technical Aspects of the DMaSS*
- **Mike Fitzpatrick** et al. *Integrating IRAF with the Virtual Observatory*
- **Exequiel Fuentes** et al. *The NOAO NVO Portal: Overall Design and Implementation*
- **David Gasson** et al. *The NOAO NVO Portal: Client-side VO*
- **Howard Lanning** et al. *Commissioning the NOAO Data Management System*
- **Sonya Lowry** et al. *NOAO DMaSS Solutions Platform: An Integrated Approach to Services*
- **Christopher J. Miller** et al. *The NOAO NVO Portal*
- **Rob Seaman** et al. *Astronomical Tiled Image Compression: How & Why*
- **R. Chris Smith** et al. *The NOAO End-to-End Data Management System: An Overview*
- **Frank Valdez** et al. *The NOAO High-Performance Pipeline System: The Mosaic Camera Pipeline Algorithms*
- **Phil Warner** et al. *Data Service: Distributed Data Capture and Replication*
- **Nelson Zarate** et al. *FITS Foreign File Encapsulation*
- **Brian Thomas** et al. (affiliated with NOAO DPP*) Knowledge Discovery Framework for the* Virtual Observatory
- **Swaters et al**. (affiliated with NOAO DPP) *The NOAO High-Performance Pipeline System: The Mosaic Camera Pipeline*

Developing the NOAO End-to-End Data Management System

Chris Smith & the DPP Team

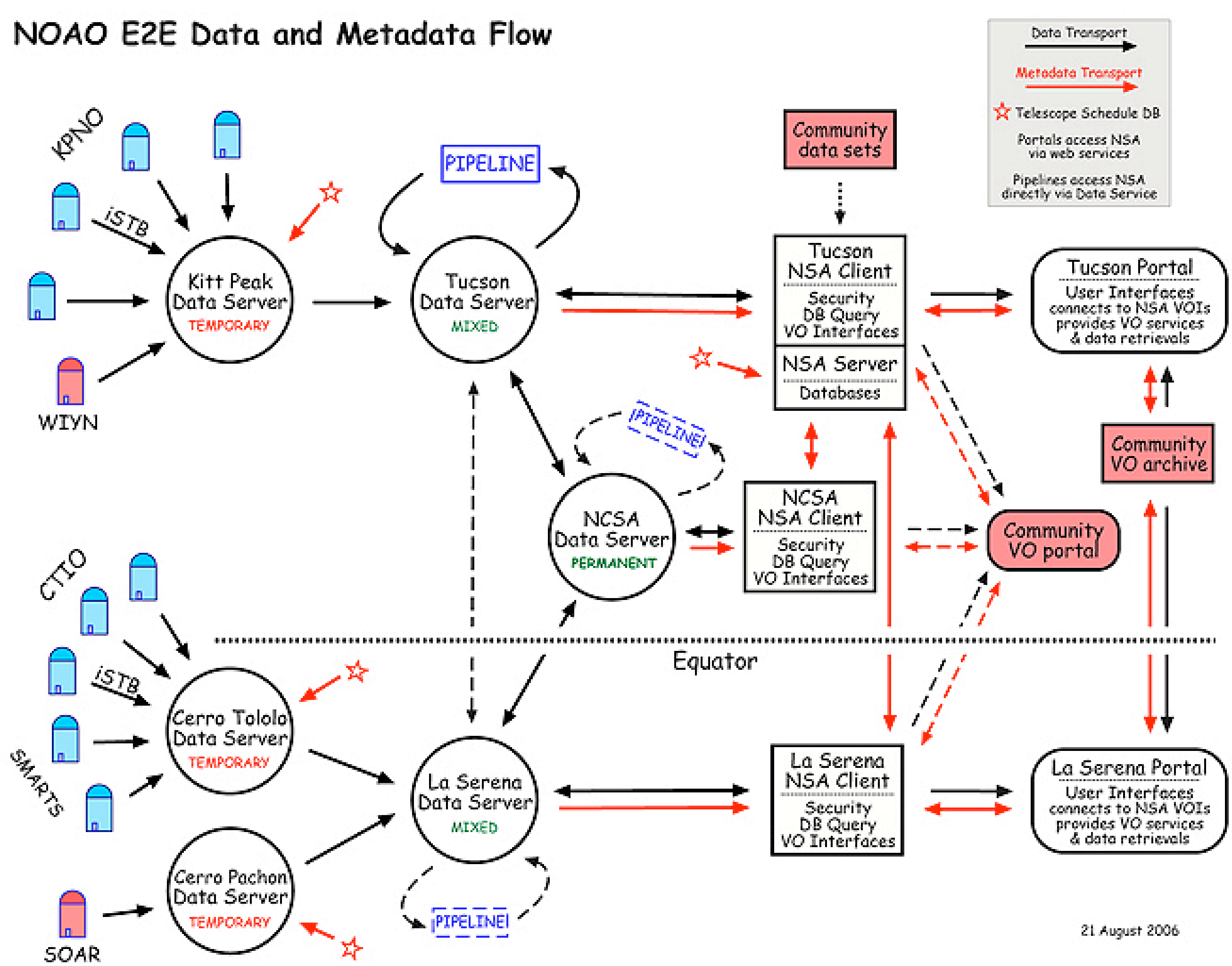
The NOAO End-to-End (E2E) Data Management System integrates components across the full range of the NOAO science data flow, from the telescope to a user of the Virtual Observatory (VO). The Data Products Program (DPP) archives data from NOAO and affiliated observatories beginning at the instruments, capturing images both from the advanced Mosaic and NEWFIRM data handling systems and from legacy instruments through the internet-Save-the-Bits (iSTB) agent. The iSTB feeds the data into the distributed NOAO Data Transport System (DTS).

Raw data products flow via DTS to data centers in La Serena and Tucson, and are replicated bi-directionally across the Equator. A third copy of all data is safely stored at the National Center for Supercomputing Applications (NCSA) at the University of Illinois in Urbana-Champaign.

DPP will be providing processed Mosaic and NEWFIRM data using the NOAO High-Performance Pipeline system. All raw and pipeline reduced data products are ingested into the NOAO Science Archive (NSA), whose content is served worldwide through standard and prototype VO interfaces.

This back-end VO system is complemented by a variety of front-end, user-oriented VO initiatives. The NOAO NVO Portal (*www.nvo.noao.edu*) is the principal interface. The NOAO portal not only provides user access to NOAO holdings, but more importantly, provides advanced access to a wide variety of services and tools available throughout the distributed VO system.

The NOAO DPP group is also working to provide alternative VO access methods, including libraries that users can integrate into their own code to access the VO, as well as interfaces with existing data processing systems such as IRAF, IDL and Ruby.



SOAR Science Operations Ramping Up

Steve Heathcote

The first semester of regular science operations at SOAR (semester 2006B) has just drawn to a successful close with favorable feedback from the principal investigators of the six supported NOAO programs, which totaled 21 nights of observing. Semester 2007A is about to get underway, during which 11 programs totaling 27 nights are scheduled.

Looking ahead to 2007B, we anticipate scheduling 50 percent of the time for science—with a goal of 60 percent—so that at least 27 nights will be available through the NOAO time allocation process. Again, the instruments available will be the SOAR Optical Imager and the OSIRIS near-infrared (IR) imager/spectrometer (See *www.soartelescope.org* for further information on these instruments).

The remainder of the year will see intensive work on instrument commissioning, with three additional instruments slated to come on line during 2007.

The new detector package for the Goodman Spectrograph, a custom version of a camera manufactured by Spectral Instruments containing a 4k × 4k Fairchild CCD 486, has been received at the University of North Carolina at Chapel Hill, and software integration work is underway. Once this has been completed, the camera will be shipped to Chile for integration with the spectrograph, allowing us to complete commissioning of this instrument.

Pre-shipment testing of the Spartan IR camera at Michigan State University is nearing completion, with delivery to Chile and the subsequent start of commissioning now expected to take place in the second quarter of 2007.

The Phoenix high-resolution IR spectrometer will move to SOAR in April, upon completion of its very successful stint as a visiting instrument on Gemini-South.

While we do not expect commissioning of these instruments to be advanced far enough to allow us to offer them as general-user instruments in 2007B, we expect to issue an announcement of opportunity to participate in science verification testing of one or more of the instruments later in the year.

Comet McNaught as seen from Cerro Pachón on 20 January 2007, with the Moon at lower right, and the SOAR and Gemini South telescopes in the foreground. *Credit: Joao Santos.*

Knut Olsen & Dara Norman Move to NOAO North

Knut Olsen and Dara Norman, with daughter Tyra, moved from Chile to Tucson in late February, after almost eight and five years at CTIO respectively.

Knut came to La Serena as a post-doc—yet another member of the University of Washington "mafia." After 18 months, a tenure-track position became open and we were only too happy to have Knut become a more permanent fixture! Over the years, he did just about everything at CTIO, including supporting a variety of instruments—particularly Mosaic and Hydra on the Blanco telescope—and helping to organize meetings and colloquia, including the first IAU Symposium in Chile.

More recently, Knut did valuable work on science simulations for the next generation of extremely large telescopes exploring the limits of faint and crowded stellar photometry in barely-resolved populations in nearby galaxies. He now works for the NOAO Gemini Science Center (NGSC) supporting US users of Gemini, but has also found time to play a leading part in several collaborations studying stellar populations in the Magellanic Clouds and Local Group galaxies.

Dara, who also now works for NGSC, came to CTIO holding an NSF postdoctoral fellowship to continue working on quasars, Active Galactic Nuclei (AGN), and large-scale structure. Recently, she has used the Deep Lens Survey in combination with Chandra X-ray telescope data to identify AGN candidates in galaxy cluster environments. Further observations to determine their physical characteristics are underway. Dara has also found time to play a very significant role in local educational outreach. We'll really miss Dara and Knut, and we wish them all the best for the next stage of their careers in Tucson.

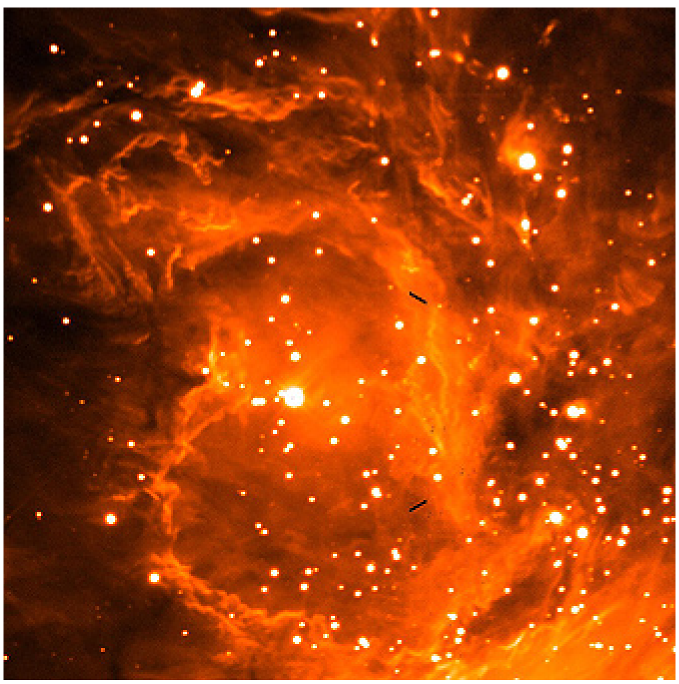
-Alistair Walker

NEWFIRM Achieves First Light!

Ron Probst, Buell Jannuzi & David Sprayberry

The NOAO Extremely Wide-Field Infrared Imager (NEWFIRM) saw first light on the KPNO Mayall 4-meter telescope on 2 February 2007. After several days of delay due to a winter storm front, the scheduled first commissioning run concluded with four successful nights of testing and observing.

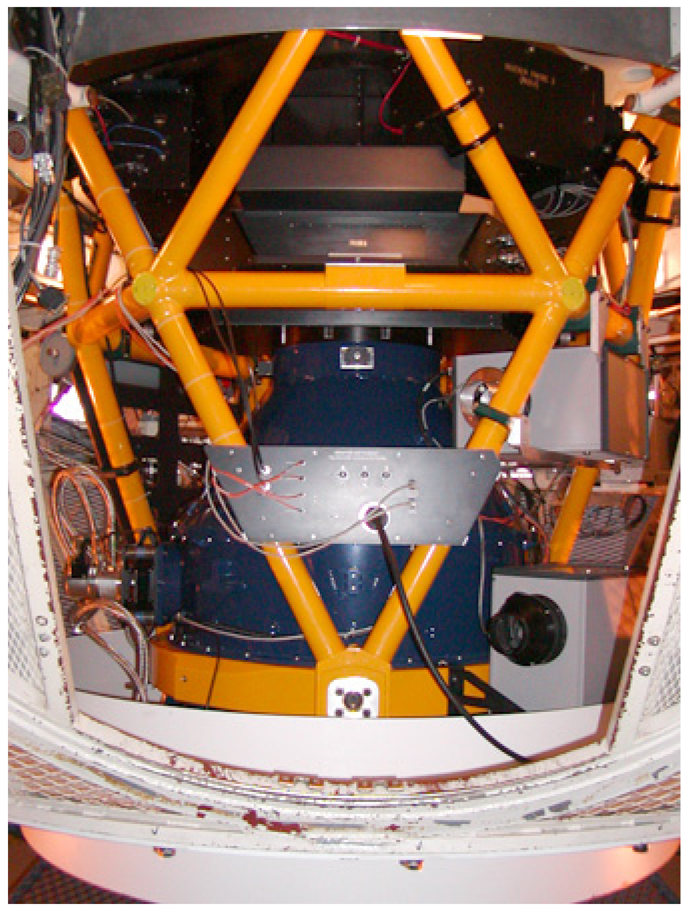
NEWFIRM is NOAO's newest instrument, providing both broadband and narrowband imaging capabilities over a square field of view 28 arcmins on a side, at a resolution of 0.4 arcsecs/pixel. It covers the wavelength range of 1.0 – 2.5 microns. The initial filter complement includes standard J, H and K-short (2.0-2.3 microns) as well as 1.3% narrow-band filters centered on Brackett-γ (2.16 microns), H_2 (2.12 microns) and [Fe II] (1.64 microns), all at zero redshift.



This NEWFIRM image is a portion of the 2.12 micron H_2 image on the cover. This enlargement of the region around the optical nebula M43 illustrates the fine structure captured with 0.4-arcsec pixels in seeing of ~1 arcsec.

Image credit: Ron Probst, Frank Valdes, the NEWFIRM team and NOAO/AURA/NSF

The successful commissioning run was the culmination of a great deal of hard work by many people. The KPNO engineering staff did an outstanding job of preparing the telescope and its support services, including the design and installation of the compressed helium system that runs the NEWFIRM cryo-coolers, and a modified bottom section for the Cassegrain cage. They also produced the handling cart, and actually installed the instrument on the telescope for the first time. Everything was completed on schedule and worked properly the first time. The NOAO Major Instrumentation group staff brought NEWFIRM seamlessly from its third cold test cycle (described in the December 2006 *NOAO/NSO Newsletter*) through the shipment, to restarting on the mountain. The science software group—composed of people from the University of Maryland and the NOAO Data Products Program—also worked hard to get the data handling system, quick-look observer tools, and offline data reduction pipeline to a state of readiness sufficient for first light.



NEWFIRM mounted at the Kitt Peak 4-meter telescope.

Observing targets on the first four nights included standard star and blank-sky flat fields to characterize image quality, throughput, and background sky levels, as well as astrometric fields to determine distortion across the field of view. Tests were also carried out for scattered light and "ghost" images, and for the effects of grazing illumination by very bright sources. In addition to this important work of characterizing the instrument, about half of each night was devoted to narrowband

continued

NEWFIRM Achieves First Light continued

imaging of the Orion Nebula (M42) as part of the science verification program (see *www.noao.edu/ets/newfirm/sv.htm*). John Bally (University of Colorado) and Josh Walawender (University of Hawaii/IfA) carried out these observations as part of the science verification team.

The success of this run confirms that NEWFIRM will be made available for Principal Investigator (PI) science proposals in semester 2007B on a shared-risk basis. Also, the "back end" software, including the quicklook observer tools and the data reduction pipeline, may not be in their final state by the beginning of 2007B. Some or all of the data processing tools may not be available, which is why the availability is considered "shared-risk." Please note that this availability extends to short-term PI proposals only—no survey program proposals for NEWFIRM will be accepted in this first semester.

Information about the instrument will be posted as soon as possible under a prominent banner heading on the NEWFIRM Web page at *www.noao.edu/ets/newfirm*. Posting will be done in time to provide the information needed to support proposal writing. Please check this Web page often for updates about NEWFIRM.

The remaining commissioning and science verification runs are scheduled for April and June 2007. Much remains to be done in the interim, including replacement of the field flattener lens with an updated version to improve image uniformity across the field of view; replacement of the last engineering-grade detector in the focal-plane mosaic to complete the focal plane with science-grade devices; completion of the quick-look observing tools for reliable nighttime use; first trial implementation of the science data reduction pipeline; and resolution of the many small problems identified during the first real use on the telescope. On the return to the Mayall telescope in April, we expect that the remaining runs will see a transition from instrument characterization and problem-solving to science verification. NL

New Senior Electrical Engineer Joins Kitt Peak National Observatory

Tony Abraham & Buell Jannuzi

We are pleased to welcome Maureen Ellis to the staff of KPNO as a Senior Electrical Engineer. Maureen joins us after working for many years at the UK Astronomy Technology Centre (ATC) in Edinburgh. At ATC, Maureen led the design and development of the electronic system for the Submillimeter Common User Bolometer Array (SCUBA-2)—a second-generation camera that utilizes recent advances in technology to build a "CCD-style" detector using Transition Edge Sensors.

Maureen also led the design and development of the electronic system for UIST, a near-infrared imager/spectrometer for United Kingdom Infrared Telescope. Maureen is experienced in the characterization and optimization of detectors, and has already joined the team commissioning the new infrared imager NEWFIRM. She will also be assisting with the MONSOON controller program, as well as supporting KPNO general operations. We are very happy to have her join our team of skilled engineers, and anticipate that she will be involved in bringing many new instruments to Kitt Peak in the years ahead.

FLAMINGOS Imaging Update

Lucas Macri & Dick Joyce

The photometric quality of the FLAMINGOS instrument at the KPNO Mayall 4-meter telescope was recently characterized after removal of the anti-reflective coating in its field lens. This coating had deteriorated and, as a result, images from the instrument exhibited significant variations in the zero-point across the field of view.

We observed a calibration field during a Testing & Engineering night in October 2006 in the JHK_s bands under good seeing conditions (FWHM~2.5 pixels or 0.7 arcsec). Point-spread-function (PSF) photometry was carried out, adopting a constant PSF over the entire field of view. The photometry was matched to the 2MASS Point Source Catalog. About 1,500 stars in the magnitude range of 9-15 were used in the analysis.

We found that the PSF is constant over 80 percent of the array. Within this area, the zero-point exhibits a very mild quadratic variation (see figure 1) at the < 0.05 mag level. The coefficients of this relation changed slightly from band to band, most likely due to slight differences in the telescope focus as a function of time.

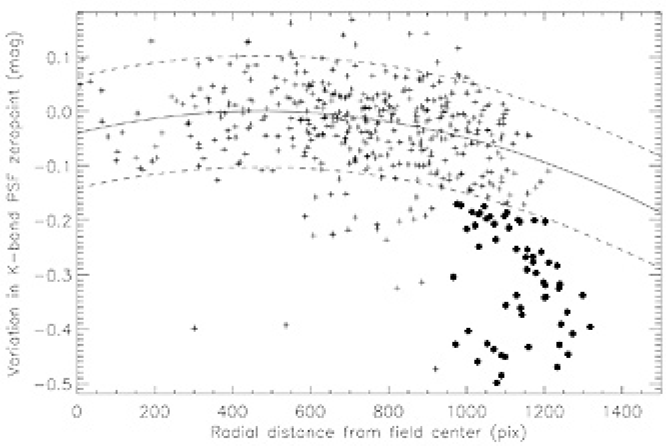


Figure 1. Variation in the zero-point of FLAMINGOS as a function of radial distance from the center. There is a very mild quadratic variation over most of the field. The variation increases drastically at radii greater than 1,000 pixels (filled circles).

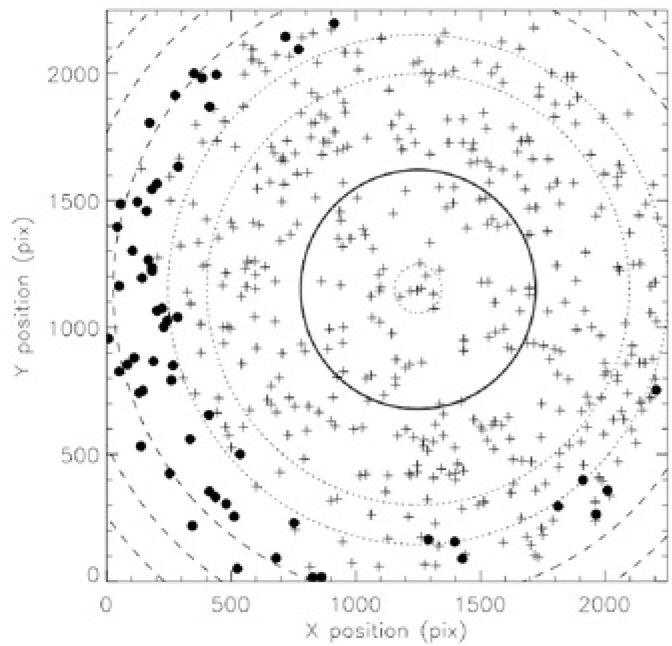


Figure 2. Variation in the zero-point of FLAMINGOS as a function of position within the array. The symbols represent the stars plotted in figure 1. The solid line indicates the annulus where the zero-point reaches its highest value. Dotted lines indicate changes in the zero-point in steps of 0.025 mag, up to 0.05 mag. Dashed lines denote variations in the zero-point in steps of 0.05 mag, up to 0.2 mag.

We found that the image quality degrades significantly at larger radii, especially in the left and bottom edges of the array (see figure 2). Users should expect significant degradation in the PSF at X<300 pixels or Y<200 pixels, and plan additional observations with a substantial offset in both directions if they desire accurate photometry of objects located in this section of the array.

Updated information on FLAMINGOS can be found in the "Performance Reports" section of the Kitt Peak instrument manual at *www.noao.edu/kpno/manuals/flmn/flmn.html.*

From the NSO Director's Office

Steve Keil

The NSO, with AURA, will focus efforts this quarter on AURA's renewal proposal to manage and operate NSO for another five years (2009-2013) as part of our next Cooperative Agreement with the National Science Foundation. During the period covered by the new agreement, NSO's plans include construction of the Advanced Technology Solar Telescope (ATST), with completion targeted for 2013/2014. The start date of construction, however, is still contingent upon National Science Board (NSB) approval. The realities of the NSF Major Research Equipment and Facilities Construction process and the federal budget could also affect the start date, according to the NSF; even if NSB approval is obtained this year, the earliest start date for construction would be 2009. Thus the NSO proposal for the next five years of operation will contain some uncertainties. Nevertheless, we welcome input concerning your observing and instrument support needs over the next five years.

Our long-range plan will include: establishment of an operations center at or near the ATST location, consolidation of the NSO staff into a single headquarters location once ATST operations start to ramp up, and ramping down of current operations at NSO major telescopes, with eventual closure or divestiture of these facilities. As indicated in NSO's response to the recommendations of the NSF Senior Review, NSO will strive to maintain continuity of support for the solar physics community as it undertakes the development of the new facility.

We are currently working closely with several universities and other solar groups to implement state-of-the-art instrumentation that will provide the bridge into the ATST era. These efforts include collaboration with the High Altitude Observatory to modernize the Advanced Stokes Polarimeter and extend its capabilities into the near-infrared. The spectropolarimeter for Infrared and Optical Regions (SPINOR) will allow the multi-wavelength polarimetry capability at the Dunn Solar Telescope (DST) to remain available throughout the ATST construction phase. The collaborative development of a Facility Infrared Spectropolarimeter (FIRS) between NSO and the University of Hawaii Institute for Astronomy (IfA) will also provide a facility-class instrument for infrared spectropolarimetry at the DST. This instrument will take advantage of the diffraction-limited resolution provided by the adaptive optics (AO) system for a large fraction of the observing time at infrared wavelengths.

The Rapid Oscillations in the Solar Atmosphere (ROSA) imaging system is an NSO joint program with Queen's University Belfast. ROSA is a synchronized, multi-camera, high-cadence, ground-based solar imaging system that is expected to arrive at the DST in 2008 and will be available as a user instrument to the solar community. The NSO is also working closely with a group at the Arcetri Observatory on upgrading the Arcetri Interferometric BIdimensional Spectrometer (IBIS) filter system located at the DST to do imaging spectro-polarimetry. Simultaneous use of SPINOR and IBIS, both fed by AO, is one possible set up for high powered measurements of solar magnetic fields.

The NSO Array Camera (NAC) is now available to users at the McMath-Pierce Solar Telescope facility on Kitt Peak and can be used in combination with the vertical spectrographs and the infrared AO to work at wavelengths up to 5,000 nanometers. The NAC is a closed-cycle cooled, InSb 1024 × 1024 pixel camera that will obtain images, spectroscopy and polarization data in the 1,000-5,000 nanometer (nm) window. Over the next few years, an effort will be made to develop solar polarimetry in the 3,000-5,000 nm wavelength region. There are several promising spectral lines in this region, which will produce the most sensitive magnetic diagnostics of the solar photosphere, chromosphere and corona. Also in development at the McMath, as a collaborative effort between NSO and California State University Northridge, is a state-of-the-art, all-reflective advanced image slicer (AIS) integral field unit (IFU). The AIS IFU will be the first instrument of its kind for a solar telescope. The unit will enable simultaneous sampling of the AO-corrected field at the McMath-Pierce for 3-D spectroscopy and polarimetry throughout the ATST construction phase.

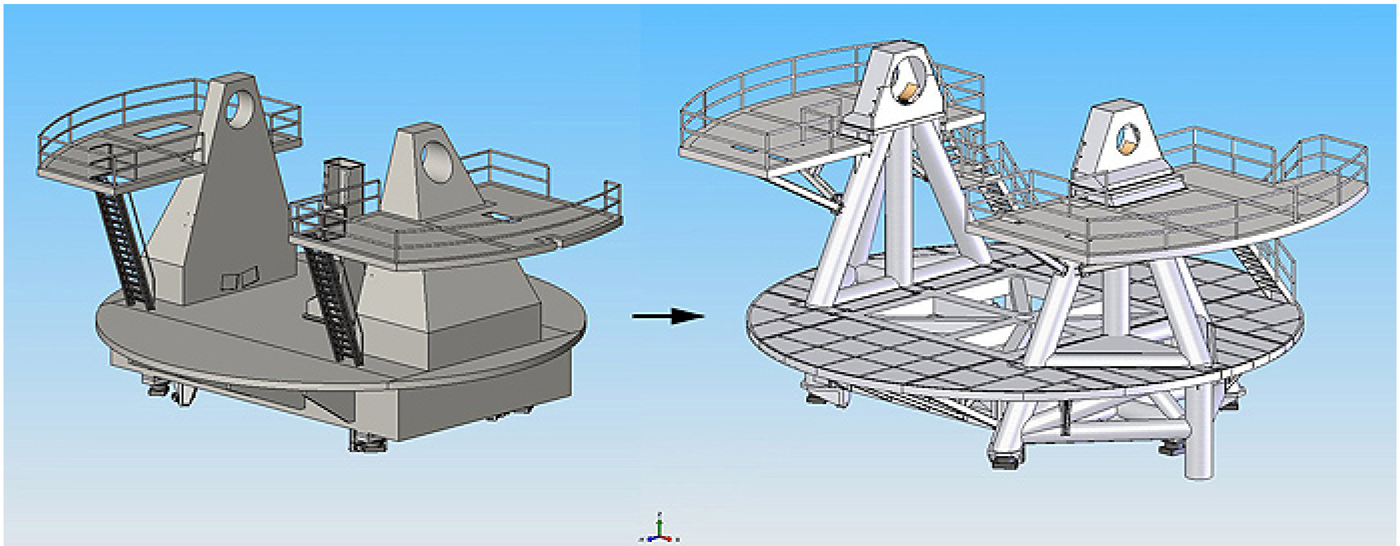
All of these instruments are exciting precursors to the planned instruments for the ATST. They will offer the solar community a variety of tools for pursuing many aspects of solar magnetic activity and the opportunity to develop the techniques and skills required to fully exploit the ATST. These new capabilities at our current telescopes also are important for the acquisition of observations that are complementary to current and forthcoming space observatories, such as the Solar Dynamics Observatory.

The Senior Review recommendation for GONG has produced considerable uncertainty about its future. This has complicated the process of planning for GONG maintenance, upgrades, and other decisions that impact the future. For now, we are being conservative on tasks that are aimed at long-term scenarios, such as the integration of the hot spare unit. On the other hand, short-term critical maintenance issues cannot be ignored. Thus, the GONG program is developing plans for new camera and tape drive systems. The finishing touches are also being put on a real-time, high-cadence continuous magnetogram data delivery system, available now on the GONG Web pages. This new capability should be valuable for space weather studies and other research on rapid changes of the solar magnetic field.

Since their workshop in November, the SOLIS VSM Vector Working Group (VVWG) has held weekly teleconferences in their development effort for the production of calibrated full-disk vector magnetograms. The VVWG has made progress in removing polarization fringes from the current vector data, and expects to make daily quick-look images available soon. In addition, SOLIS Integrated Sunlight Spectrometer (ISS) Ca II K spectral data are planned to become publicly available via the SOLIS Web site within a few weeks. These data will become the continuation of the long-term Sun-as-a-star programs conducted by Bill Livingston and colleagues at the McMath-Pierce during the past four decades and at Sacramento Peak. The Decadal Survey advocated the establishment of a global SOLIS network as its primary recommendation for ground-based initiatives in the small projects category. The NSF Senior Review strongly endorsed this recommendation in their report. The NSO is now engaged in preliminary discussions with a potential international partner for the collaborative development of a VSM instrument as the first node in a SOLIS network. We look forward to a successful conclusion to this discussion.

ATST Passes Preliminary Design Review

The ATST Team



The mount base structural design has evolved from a monocoque-type system to a more structurally efficient and cost effective truss-type design.

The Advanced Technology Solar Telescope (ATST) project successfully passed its four-day, NSF-conducted Preliminary Design Review (PDR), held 31 October – 3 November 2006. The PDR was a significant team effort and represents a major milestone in the NSF's new MREFC review guidelines. The PDR review panel, selected by the NSF, agreed that the current design of the ATST will meet the science requirements and has no technical showstoppers, and that its budget and schedule are appropriate for the scope of the project.

"The panel unanimously agrees that the ATST design and management plan are at a satisfactory level for expeditious promotion to the National Science Board as a candidate for inclusion in the NSF budget," the review concluded.

The PDR committee made a number of very helpful suggestions regarding elements of the design, our approach to contracting, and our planning. The project is now busy implementing the committee's suggestions and recommendations.

A variety of **systems engineering** activities have occurred since the PDR. We have designed a relational flow-down/trace-back database to support the contracting activities that we anticipate early in the construction phase of the project. This database will allow us to respond to the inevitable exceptions proposed by contractors during both the bid process and the construction process. If a vendor asks for a relaxation of a specification, systems engineering will be able to trace the requirement back to its origins and evaluate the consequences of the proposed change.

The design of many **optical components** within the telescope has been maturing since the PDR. Particular emphasis has been placed on the secondary mirror assembly and related components in preparation for a systems review of that equipment later this year.

Design and analysis contracts are moving forward with commercial firms to complete reference designs for the M2 articulation equipment, as well as the prime focus heat stop. Joe DeVries, an NOAO mechanical engineer, has been optimizing the secondary mirror itself as well as integrating this equipment within the top-end optical assembly.

Robert Upton, who recently joined the project from NOAO, has been supporting optical design and analysis for adaptive optics, instrumentation and project office requirements. Robert is also conducting a study on how best to allow upgrades to meet evolving Nasmyth instrument station requirements.

We have identified a first-order optical solution for the high-order ATST adaptive optics (AO) system that can be used as a template for its **optical design**. It is currently being evaluated for its suitability in fulfilling the packaging constraints necessary to place it on the ATST azimuthal tower.

We have also developed a mixed-mode ZEMAX model of the conventional AO wavefront sensor. It has similar properties to the Dunn Solar Telescope conventional AO wavefront sensor. The ZEMAX model will allow AO and multi-conjugate adaptive optics (MCAO) wavefront sensors to be developed and modeled in an optical systems

continued

ATST Passes Preliminary Design Review continued

environment that includes the ATST and the designed relay system. In addition to the wavefront sensor, the AO control matrix and reconstructor have been developed. The AO model will also be used to test different kinds of reconstructors that include a Bayes least-error estimate reconstructor, a damped least-squares reconstructor, and the maximum-likelihood estimate reconstructor.

The intermediate goal is to develop the ATST conventional AO relay design, incorporate it into the ATST telescope model, and then simulate AO performance subject to a Von Karman phase screen with a normal statistical law introduced into the ATST entrance pupil.

The AO team's efforts are currently focused on completing the optical design for the active and adaptive optics wavefront and tip/tilt sensors and the completion of the thermally controlled tip/tilt and deformable mirror devices. In addition, performance modeling efforts and reconstructor development are making good progress.

The ATST has contracted with CILAS to a design a thermally controlled **deformable mirror** (M9). CILAS is presently working on correctability of phase errors due to thermally induced distortions of the optical plate; coolant flow induced jitter effects; damping effect of coolant fluid on actuators by actual tests on a prototype DM; and cooling design performance.

A mid-course design review will be scheduled for late January or early February 2007. The final design review is scheduled for April 11, with final delivery of the documentation following on April 26.

The ATST has also contracted with Physik Instrumente for the mechanical design and performance analysis of the **fast tip/tilt platform**. In parallel with the mechanical design, Hofstadter Analytical Inc. was contracted to design the thermal control system that maintains the proper mirror temperature while also meeting the M5 optical performance specifications.

The ATST **software** team has released both updates to the Common Services Java software and a new release for the C++ port. The latter release provides the basic infrastructure for C++ developers; it will follow in about six months with further enhancements to the container and services framework.

The Telescope Control System (TCS) final design was presented by Observatory Sciences and approved by the ATST project. The work included not only design and interface documentation, but also a working simulator of the TCS and a graphical tool to build Common Services user interfaces. The Data Handling System and Observatory Control System have a completed preliminary design, with reviews in early 2007. Work on the Instrument Control System design is also progressing, with both a design document and simulator for the Virtual Internet Service Provider..

Janet Tvedt of the ATST software group has resigned to take a position with Raytheon. We thank her for her significant contributions to the ATST software and wish her the best in her new work.

Following the PDR, work on the **Telescope Mount Assembly** (TMA) has focused on refinements to the structural design of the mount base, improved access to the Nasmyth areas, and investigating various bearing types for use on the altitude axis.

The structural design of the mount base has evolved from a monocoque-type system fabricated from plate steel into a more efficient truss-type system that uses large-diameter steel tubes. This new arrangement allows for a more direct transfer of loads from the altitude bearings down through the azimuth bearings and into the azimuth track. The overall structure is also lighter (76.6 vs. 98.5 metric tons), and relatively easier to fabricate. This should translate into a lower overall cost and reduced risk to the project.

Technical and cost discussions were held with a number of bearing manufacturers. Both rolling element (e.g., tapered rolling bearings, spherical roller bearings, etc.) and hydrostatic bearings were looked at in detail. The Optics Support Structure weight, coupled with the relatively large required bore size and high precision, has led to the conclusion that hydrostatics are preferred for use in the reference design models. Given that the infrastructure for azimuth hydrostatic bearings already exists in the observatory (i.e., for the mount and coudé azimuth bearings) it is relatively inexpensive to implement hydrostatics on the altitude axis.

In response to PDR committee comments regarding the active cooling systems for the **enclosure**, the project has been exploring passive approaches for maintaining acceptable surface temperatures of the lower enclosure. Preliminary modeling indicates that using a minimum of 150-millimeter (6-inch) thick concrete with a white coating may be a viable passive option.

While it is not expected to be a problem, additional fluid and thermal modeling to investigate the likely performance is planned, in light of significant sub-cooling that will result. If performance projections support this option, we can expect significant savings in terms of both capital and operating costs compared to the current baseline of an active cooling system covering half of the lower enclosure.

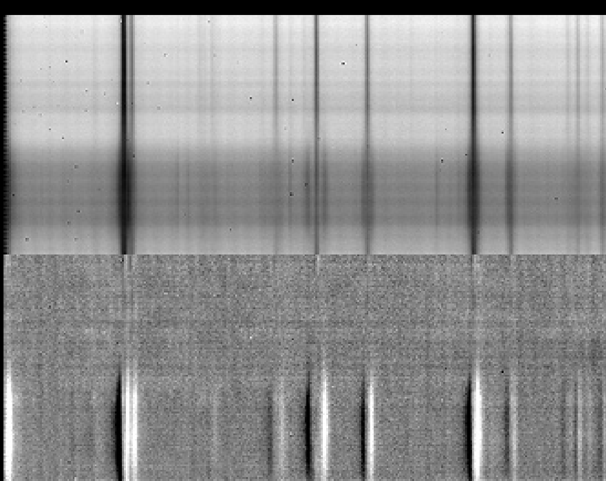
The Draft **Environmental Impact Statement (EIS)** for the Haleakalā site was completed in September and released for a public and agency review period, which ended in late October. Many comments were received, both orally at public meetings held on Maui and by written letters. All of this input will be included as part of the record. Written responses to comments from Haleakalā National Park, the Office of Hawaiian Affairs, the EPA, as well as other agencies and individuals are in progress, led by the environmental engineering team and supported by the Project and the NSF. The Final EIS document is expected to be complete within a few months and will then be forwarded to the NSF for a Record of Decision.

First Spectra from the NSO Array Camera 1000-2000 nm Polarimeter

In late 2006, testing of the NSO Array Camera (NAC) polarimeter was done at the McMath-Pierce main spectrograph. Using just one liquid crystal variable retarder (LCVR) and an exit polarizer, sample Stokes *I* and Stokes *V* spectra were taken of the 1565 nm g=3 Fe I absorption line in a sunspot umbra. The slit spectra from a very small sunspot region observed on 27 October 2006 are shown in the figure. Some residual fringing is seen in the intensity spectrum, and some faint fringes are also visible in the Stokes V spectrum; a wedged input window for the dewar is currently being tested in an attempt to remove these fringes.

In the spectral field-of-view, the Zeeman splitting from the sunspot magnetic field is seen in the intensity spectrum as two satellite σ absorption lines around several spectral lines. These split components are even more clearly seen in the Stokes *V* spectrum with their oppositely signed signals. The g=3 line shows Stokes *V* components that are clearly fully resolved in the sunspot umbra and in the penumbra. The Landé *g* factors for the other spectral lines are smaller, and so these lines are not completely split, but they also provide important diagnostics of the magnetic field in this solar region.

—Matt Penn



The first polarization spectra taken with the NAC in a small sunspot on 27 October 2006. The top portion shows the intensity spectrum, with the g=3 Fe I line running vertically in the center of the frame and the dark sunspot umbra visible as a dark horizontal swath. The lower portion shows the Stokes V spectrum, with splitting visible in all spectral lines in the sunspot umbra.

GONG++

Frank Hill & the GONG Team

The focus of the GONG team this past quarter has been dominated by the preparation of our response to the NSF Senior Review, which recommended that GONG be terminated one year after the successful commissioning of the Solar Dynamics Observatory (SDO), unless the majority of operating costs can be covered from non-NSF sources. This has of course created considerable consternation.

We understand the difficult situation that the NSF faces in striving to develop the new large-scale astronomical facilities of the future. However, helioseismology is the central discipline in the fundamentally important effort to unravel the mystery of the solar activity cycle. Because of the many ways that solar activity affects our daily life on Earth, it is essential that the field have adequate observing facilities over the course of multiple solar cycles. We are thus working on a road map for the long-term future of helioseismology. This plan should be developed now, since neither SDO nor GONG will functionally survive past 2020 in any event, and the lead time for major facility development is measured in decades. A community discussion of the road map will take place at the SDO Helioseismic Magnetic Imager (HMI) team meeting at Stanford in March.

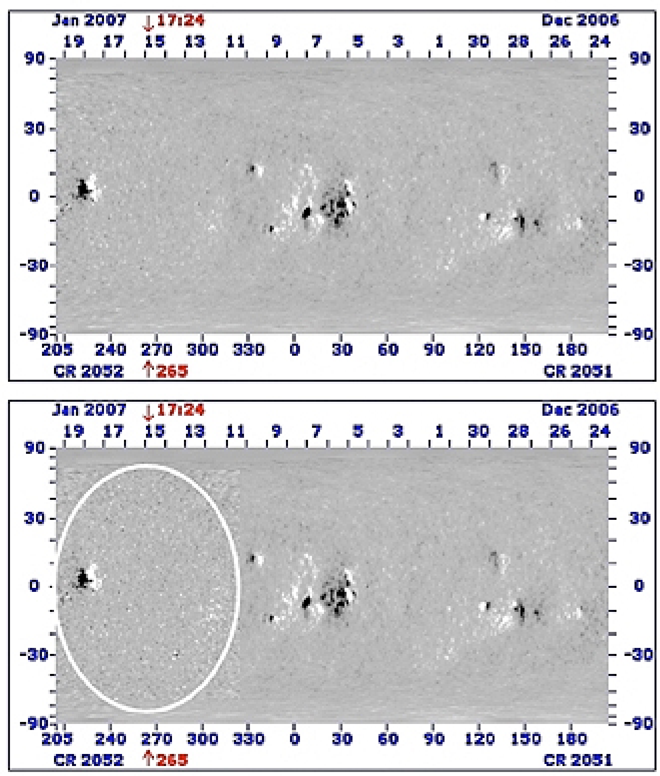


Figure 1. Synoptic maps of the solar magnetic field constructed from GONG magnetograms for 15 January 2007 at 17:24 UT. Top: the "traditional" synoptic map. Bottom: a map with the latest magnetogram inserted in the indicated area. This provides the best estimate of the field over the whole Sun, since the latest frontside data are not averaged with data from the previous rotation.

continued

GONG^{++} continued

We are continuing to operate GONG normally while the Senior Review discussion is underway, but with a somewhat more conservative approach to new development that is also motivated by this year's fiscal conditions. Thus, we have virtually stopped work on the hot spare construction, since that project does not directly enhance the immediate term scientific output of GONG. On the other hand, we have facilitated the development of our magnetogram data processing pipeline in order to get this new and exciting data product out to the community as quickly as possible.

As a result, we now have high-quality synoptic maps generated and delivered to the Web every hour in near-real time. Approximately 8,000 individual magnetograms go into each map, resulting in an estimated noise level of 0.05 Gauss per pixel. We are also developing a synoptic map in which the latest magnetogram is inserted to update the front side magnetic field without including data from the previous rotation. Figure 1 shows examples of the two types of synoptic maps that are available on the Web at *gong.nso.edu/data/magmap/*.

We now routinely generate 10-minute averaged full-disk magnetograms at all the sites immediately after acquisition. These near-real-time images are available on the GONG Web site at *gong.nso. edu/Daily_Images/*. The availability of these high-cadence, continuous magnetic field measurements now enables studies of magnetic variability on all time scales from one minute to years, and on large spatial scales.

Science Highlights

GONG scientific staff participated in the 10th Local Helioseismology Comparison (LoHCo) workshop in Boulder from 7-9 November 2006. The GONGsters gave seven presentations about various aspects of local helioseismology. Links to the presentations are available at *gong.nso.edu/science/meetings/lohco/workshop10.html*

Irene González Hernández has been working on calibrating the farside phase shift signal into physical quantities describing the active regions. She has found that, for large phase shifts, there is a correlation between the size of the sunspot and the observed phase shift (figure 2). This supports the hypothesis that the phase shift is due to the Wilson depression effect, wherein the magnetic field changes the acoustic reflection properties of the solar plasma in a sunspot.

Figure 2 show the first results. On the left is a scatter plot of the sunspot area of long-lasting active regions versus the phase shift. Only active regions a) with tabulated sunspot area >100 millionths of hemisphere, and b) present in two consecutive Carrington rotations have been included. There appears to be a strong correlation between the sunspot area and the calculated phase shift for the same region.

The right panel shows a scatter plot of magnetic field strength versus phase shift in a 20° square surrounding the estimated farside active region position. Five specific active regions that are stable and have a sunspot area >700 millionths for at least one of two consecutive frontside passages have been used. We measure an increase of farside signal for larger magnetic field strength that seems to agree with the hypothesis of a Wilson-like depression as the main mechanism responsible for the phase shift.

Network Operations & Engineering

During the fourth quarter of 2006, there were preventive maintenance trips to Big Bear and Udaipur. The Big Bear visit in October was an opportunity to deploy new hardware such as instrument and data chassis with new power supplies, and new waveplate amplifier hardware. The camera was replaced because the cooling fan had failed, and all of the routine tasks were performed.

The Udaipur trip took place in November. Preventive maintenance tasks were on track until several days before departure, when the instrument synchronization system failed. Then the GONG backup diesel generator cooling system failed and the engine overheated. Neither of these problems could be solved prior to the team's departure. The instrument was able to acquire data intermittently and continued to make a contribution to the farside effort. When the observatory's diesel developed problems in mid-December, the instrument was shutdown. A shipment of parts was sent for the purpose of troubleshooting and did not arrive in Udaipur until after the first of the year. Fortunately, one of the cables sent was able to eliminate the problem and the instrument is operational again. The generator problem is still being investigated by local mechanics and we are hopeful they will be able to repair the unit.

Aside from the field work, efforts in Tucson concentrated on troubleshooting and repair of several cameras, and re-studying the camera thermoelectric cooling circuit and test procedures in order to understand discrepant test results. At year's end, one camera was certified for field use and underwent further burn-in. There was also significant success in upgrading the real-time operating system to a newer VxWorks version and implementing the software version control system.

Work on the Hot Spare Instrument is slowing down. The optical table has been installed in the shelter, and the light feed (turret) assembly has been completely assembled. The turret will be ready for testing after adjustment of the roll-axis counterweight. Our instrument maker is working on completing the camera rotator assembly, as well as the optical table cover components. The external cable raceway is almost completely installed, and work on ground connections is still in progress. On the electronics side, wiring of the power supply chassis has been completed and assembly of the amplifier chassis is under way. The new data and instrument chassis have been modified to accept the connectors required by GONG.

The GONG servers Kalahari and Sonora have been moved to faster machines. The new machines are SunBlade 1000 computers retired from DMAC. They have been configured with redundant hard drives and should be able to support GONG operations for many years to come. GONG's software has been placed under version control in preparation for migrating our data computer code to an updated version of the VxWorks Real-Time Operating System. The new version of VxWorks comes with several new tools that will make maintaining and updating the GONG software easier. Work has begun to migrate the data computer software to the new operating system. This will enable us to troubleshoot problems we are experiencing with some data CPU boards. Two of the four CPU boards purchased from Motorola last year do not work properly in our system, though they pass

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GONG^{++} continued

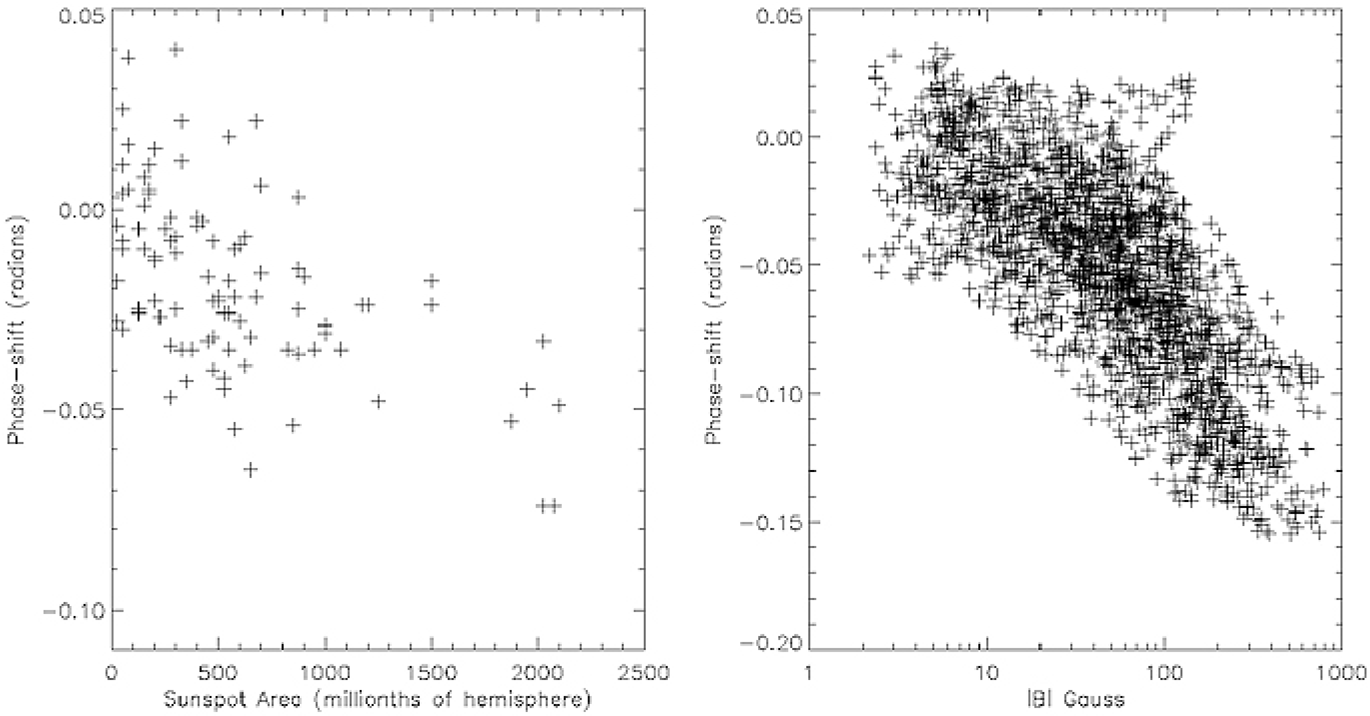


Figure 2. GONG provides maps of the non-visible hemisphere of the Sun based on the helioseismic measurement of wave phase shifts. The technique can reliably detect large active regions before they appear on the visible disk. A calibration of the measured phase shift in terms of morphological and magnetic characteristics of the active regions will eventually lead to a more sophisticated farside activity monitor.

diagnostics at Motorola. We also need to test two new DAS boards that do not work properly in our system, yet pass the manufacturer's diagnostics.

The DLT drives currently in use by GONG are beginning to fail. We have not had good luck with drives that have been repaired, as they seem to fail shortly after installation at a site. We have successfully performed preliminary testing of linear tape open (LTO) drives in the GONG system and it appears that these are the drives that we would like to move to in the future. The upgraded magnetogram modulators have been deployed to all the sites, and the new modulators are continuing to be monitored for proper operation.

Data Processing, Software Development & Analysis
Progress is being made in the porting of data storage and distribution system (DSDS) applications to Linux. All of the major modules have been ported and are currently being integrated into routine operations. The Linux migration of the DSDS will enable near-real time distribution of most GONG products through our Web page and the Virtual Solar Observatory.

Seven hundred 8-millimeter cartridges of GONG Classic calibrated images were extracted to disk. Pending verification, the data will be written to LTO and archived to the DSDS. This completes the bulk of the migration of GONG data on 8-millimeter tape.

We are working on a new procedure to automatically archive global pipeline data products to LTO via the tape robot. Once implemented, the new procedures will help streamline data reduction pipelines by minimizing tape handling on the operator side.

A fully automated, end-to-end Magnetogram Synoptic Map Pipeline was deployed on time and before the launch of the Solar TErrestrial RElations Observatory (STEREO). The latest developments include a flux-conserving heliographic remapping mechanism, automatic generation of standard Carrington Rotation synoptic maps, and Janus (two-faced) synoptic maps. The Janus maps consist of an averaged hourly component combined with the normal magnetogram synoptic map to produce an up-to-the-minute view of the magnetic fields of the Sun.

Processing to date includes month-long (36-day) velocity time series and power spectra for GONG Month 112 (centered at 02 May 2006), with a fill factor of 0.94. The 108-day Mode Frequency Tables and Ring Diagrams are available through Month 111. Last quarter, the DSDS distributed 270 Gigabytes in response to 11 data requests.

NOAO Brings Family ASTRO Back to South America

A Family ASTRO workshop in December 2006 in Buenos Aires at the Observatorio Nacional de La Plata attracted 28 participants, led by instructors from NOAO in Tucson and Gemini Observatory in Chile.

In mid 2005, Maria Antonieta Garcia, the public information and outreach officer (PIO) for the Gemini Observatory in Chile, invited Connie Walker, site leader for Project ASTRO and Family ASTRO programs at NOAO, to conduct a pilot training session in Chile for event leaders on two of the Family ASTRO themes. Thanks to excellent support by ASTRO home office staff at the Astronomical Society of the Pacific (ASP), all of the key materials in the leader and family kits for the *Moon Mission* and *Night-Sky Adventure* kits were translated into Spanish, and were ready for the training in Chile in December 2005.

Fifteen educators from nine different institutions were invited to the event-leader training. Most of the participants were teachers from schools of various grade levels in La Serena, Chile, and surrounding towns. Seven Chilean institutions from the initial cohort of trained event leaders conducted a total of 10 Family ASTRO events in 2006, with an average attendance of 10 families, 23 adults and 19 children per event.

Three participants at the original training hailed from Buenos Aires, Argentina, including the local PIO coordinator for Gemini, Viviana Bianchi. She was so excited by the December 2005 training that she planned and hosted a December 2006 training in Argentina. Walker of NOAO was invited back to give the same two workshops near Buenos Aires at the Observatorio Nacional de La Plata to 28 participants. The following week, training workshops on the remaining two themes (*Race to the Planets* and *Cosmic Decoders*) were given to an additional 28 participants again in La Serena, Chile.

These efforts were coordinated by Bianchi in Argentina and Garcia in Chile, with Garcia tirelessly translating at all four workshops. Once again, ASP came through with Spanish translations for all of the family handouts and game instructions for the remaining two themes. These translations and the materials in the kits provide a "turn-key" program that has proven to be adaptable and successful with a wide variety of cultures, social groups and educational levels.

Dates for more than 25 Family ASTRO events in Chile during 2007 were assigned to the newly trained event leaders directly at the end of the training workshop, toward a goal of doubling the 376 people reached in 2006.

Note: The information in this story was drafted originally for a pending article in the ASP's *Mercury* magazine.

Tucson Teacher Connects Students with the National Observatory

Katy Garmany & Connie Walker

Chris Martin, a teacher at Howenstine High Magnet School in Tucson, participated in the Research Based Science Education (RBSE) program at NOAO in 2005. Chris now enthusiastically uses astronomy in all of his science classes, and he has expanded his connections with the national observatory by having his students (including many Spanish speakers) participate in our ASTRO-Chile educational videoconferences between Tucson and La Serena.

In addition, Chris has been a member of the core crew of a half-dozen local teachers in the NOAO outreach program called ASTRO-Chile. These teachers have helped plan and execute a series of bilingual educational videoconferences for students on topics ranging from dark skies measurements in both hemispheres to comparative geography using aerial and satellite imagery (see the June 2006 *NOAO-NSO Newsletter*, page 48).

Chris Martin and two of his 9th grade students, Antonio Solis and Blanca Leon, discuss which stars are members of a cluster, using data from the WIYN 0.9-meter telescope on Kitt Peak.

Student Bisbail Dorame translates during a studen-to-student video conference between Tucson and La Serena, with advisor Ron Probst.

Recently, his 9th grade general science class began an astronomy unit that culminated in a photometric study of the Cocoon Nebula (IC 5146). Every student in the class has been issued a laptop for their schoolwork on the cluster, and Chris has argued persuasively that a study of stellar Hertzsprung-Russell diagrams, and the mathematical exercise of measuring the brightness of stars, converting flux to magnitude and plotting color-magnitude diagrams, easily meets the science standards he is required to teach.

The students are using images collected by former students Aaron Gundy and Donna Guilen, who went to Kitt Peak National Observatory with the extended RBSE teacher-student observing program to measure the distances to these stars. "Science becomes real and the students are motivated to study science further," Martin explains. "The students are learning to use image processing and Excel spreadsheets in this project-based approach. In the process, they gain a real understanding of how scientists use things like H-R diagrams to explore the Universe."

Chris has also collaborated with Arjun Dey and Katy Garmany of the NOAO scientific staff on a project involving the NOAO Deep Wide-Field Survey. Funded by an HST education and public outreach grant, he now has his older students investigating properties of galaxies in this field. These research projects, including data from Kitt Peak, are part of a larger set that will be available soon to any teacher or student through the NOAO Web site.

In 2006, working with NOAO outreach staff member, Connie Walker, Chris and his students were heavily involved with two student-to-student videoconferences on remote sensing that included students from Tucson, Arizona and La Serena, Chile (near the north and south offices of NOAO). Both times, fifty participants at each location reported on a remote sensing activity conducted by hundreds of students. Bisbail Dorame coordinated the student efforts for the classrooms at Howenstine High School.

The students became acquainted with the geography and geology of their area using Landsat satellite remote sensing imaging. The Tucson students then analyzed images of La Serena and students from Chile analyzed images of Tucson. Since top-down satellite views may not provide complete information, students from one country emailed students from the other country, and requested them to be human "rovers," taking local pictures of areas under question to establish ground-truth.

Student reaction to the project was unequivocally positive. "The remote sensing project was one of the most fun things in my junior year," Bisbail says. "I learned how to understand a Landsat image of La Serena, Chile. I learned about the electromagnetic spectrum, which is used to form false color images. It was incredible for us Latino students to use our Spanish language to email students in Chile."

The success of this cross-cultural program has motivated Chris, Bisbail and NOAO outreach staff to broaden the project to schools

continued

Teacher Connects Students with the National Observatory continued

across the US and in other countries, coordinated by students as their service-learning project. To facilitate this effort, a special generic worksheet is being developed. The worksheet can be by teachers to include local landmarks and geographical features.

Once completed and tested, the worksheet will be placed on the NOAO Web site, along with Landsat-7 satellite images for different areas around the world. In 2007, the program will be expanded to examine the surface of Mars using the Arizona State University/NASA "Mapping the Surface of a Planet" activity (translated into Spanish), plus NASA images and Google Mars.

When asked about the ultimate impact of the RBSE and ASTRO-Chile activities, Chris says, "Students that have taken this research class go on with greater motivation to study chemistry, biology and physics. They acquire a knowledge of how scientists do research. Science becomes a subject alive with inquiry and mystery." NL

Calling Dr. Frankenstein! Interactive Binaries Show Signs of Induced Hyperactivty

From NOAO Press Release 07-01

Astronomers studying highly energetic binary stars called polars have obtained the first observational evidence that the intense magnetic fields produced by the white dwarf half of the interacting pair can induce flares, sunspots and other explosive activity in its otherwise low-wattage, low-mass partner.

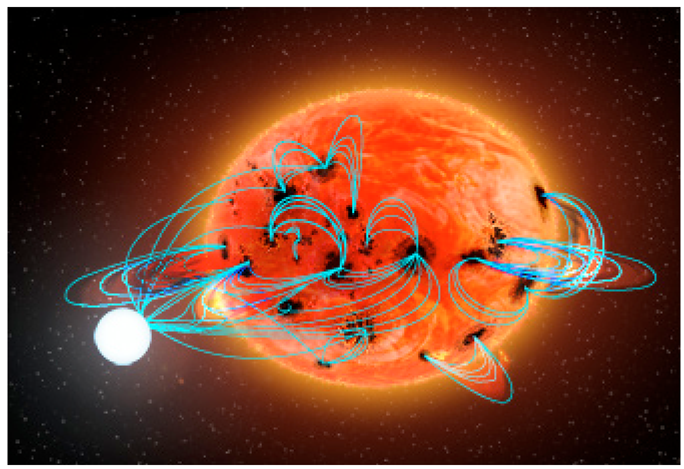
"Like Dr. Frankenstein zapping an inert corpse, the white dwarfs in these systems produce very strong electrical currents inside the bodies of their partner star, which can create violent eruptions where there otherwise would be very little if any," says Stella Kafka, an astronomer at the National Optical Astronomy Observatory (NOAO) and lead author of one of two related poster papers presented on 7 January 2007 in Seattle at the 209th meeting of the American Astronomical Society. "These transitory phenomena occur on human timescales, lasting from minutes to years."

Decades ago, astronomers found evidence that other Sun-like stars show large optical flares, star-spots, x-ray emission and other energetic activity cycles, especially when they are part of binary systems. In binaries, fast rotation rates and tidal interactions between the two stellar components are the primary contributors to the observed activity.

By contrast, the low-mass partners in polars (also known as Magnetic Cataclysmic Variables) can be as small as planet Jupiter, and range in mass from about 20 percent of the Sun down to brown dwarf-like objects with 5 percent or less of a solar mass. The masses of these companions are theoretically too low for conventional Sun-like internal dynamos to be possible.

Thus, the surface activity detected by these studies is likely greatly enhanced by the white dwarf's strong magnetic field passing through the secondary low-mass star, causing large-scale electric currents in its interior. This flow of charged particles creates an effective dynamo mechanism.

"This discovery points to a new mechanism for the generation of stellar activity by forces outside of the star itself, a phenomenon that we have dubbed 'hyperactivity,'" says co-author Steve B. Howell of NOAO and the WIYN observatory.



An artist's concept of a polar consisting of a cool, low-mass red star and a highly magnetic white dwarf locked in a tight orbit by gravity. The interacting magnetic field lines produce large coronal loops on the low-mass red star, allowing for high-temperature material to flow along them as well as become trapped in them, similar to large loop-like prominences observed on the Sun.

Credit: P. Marenfeld and NOAO/AURA/NSF

Over the past two years, a team of astronomers consisting of Kafka, Howell, R. Kent Honeycutt (Indiana University), Fred Walter (State University of New York), Thomas Harrison (New Mexico State University) and Jeff Robertson (Arkansas Tech University) have carefully observed four polars (in particular, EF Eridanus and ST Leo Minor) using the 2.1-meter, 4-meter and WIYN 3.5-meter telescopes at Kitt Peak National Observatory, the Magellan 6.5-meter telescope and the ESO Very Large Telescope in Chile, for more than 20 nights of observing.

"Careful analysis of the resulting data shows strong evidence for the formation and structure of star-spots and gigantic prominences and loops in the low-mass partner in these polars," says Kafka. "Furthermore, we found that this activity seems to be concentrated toward the white dwarf and on both sides of the cool red star."

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Interactive Binaries Show Signs of Induced Hyperactivity continued

This is the first time that astronomers have strong observational evidence that strong magnetic- field interactions between the stars in a close binary system may be the primary ingredient for the formation of large starspots and flares.

Polars are binaries consisting of a white dwarf (an old star with a mass of one-half to one times that of the Sun but a diameter approximately equal to the Earth), and a very cool, red, low-mass stellar object. The two stars are trapped in a close orbit about each other (separated by less than the diameter of the Sun), completing a full circle in only 80 to 180 minutes. A special characteristic of these systems is that the white dwarf contains a very strong magnetic field in the range of 13 to 66 million gauss (13-66 megagauss).

For comparison, the magnetic field at the Earth's surface is 0.3-0.6 gauss. The magnetic field strength of the Sun averages one gauss, but can reach values as high as 3,000 gauss in active sunspot regions. Rapidly rotating solar-like stars are known to have increased levels of starspot activity and higher average magnetic field strengths. Their fast rotation makes the star's internal dynamo rotate rapidly, leading to stronger stellar magnetic fields, more starspots on the star's surface, and energetic activity like flares.

In polars, the low-mass companion is "locked" in its orbit by tidal interactions with the white dwarf; very similar to the way that the Moon always keeps nearly the same face toward Earth. Therefore, the low-mass star spins around its axis with a period of only a few hours (compared to the 25-day rotation of the Sun).

Since rotation is a key ingredient of stellar activity, ultra-fast rotation of the red star in 1-3 hours is expected to increase its average magnetic field strength to values near 2,000-6,000 gauss (2-6 kilogauss). "When mixed with the enormous magnetic field of the white dwarf, the interaction between the two stars creates a spaghetti-like pattern of magnetic field lines between the two stars," Howell says. "These magnetic fields confine gas around and between the two components and are responsible for triggering the enhanced activity on the low-mass star."

"The systems studied by our team can, in some ways, be looked at as scaled-up versions of the 'hot Jupiter' type of extrasolar planetary systems," Howell says. These exoplanet systems consist of a solar-like star and a massive Jupiter-like planet in close orbit. As the planet orbits around its parent star, the outer atmosphere (or chromosphere) of the star responds to the passage of the planet.

Observations suggest that the magnetic field of the star permeates the planet and allows magnetic loops to reconnect by using the planet as a conductor. As a result, energetic activity would be induced in the planet's atmosphere, resulting in small flares and events similar to an aurora (northern lights) on Earth. The similar (though higher-level) phenomena in magnetic cataclysmic variables is easier to study and therefore can provide more detailed information about such interactions, eventually leading to a comprehensive model.

The color artwork that illustrates this result is available at *www.noao.edu/outreach/press/pr07/pr0701.html.* NL

The 2007 REU/PIA PROGRAM AT CTIO

A new Research Experiences for Undergraduates (REU) program started at Cerro Tololo Inter-American Observatory (CTIO) in mid-January. The six US students funded by the NSF joined two Chilean students (participants of the parallel PIA program) in La Serena, Chile, where they will spend the southern summer working on research projects with CTIO and Gemini staff members. During their 10-week internship at CTIO, the REU and PIA students will have the chance to visit the Tololo, Gemini, and Las Campanas facilities; observe at Cerro Tololo; attend seminars and colloquia; and sample the rich social and cultural life of the CTIO compound and of Chile.

At the end of their tenure, the students will present their research in a two-day workshop held in La Serena. The REU students are: Rachel Anderson (University of Wisconsin - Eau Claire), Cassy Davison (Norfolk State University), Stephanie Golmon (Principia College), Daniel Harsono (University of California, Los Angeles), Aisha Mahmoud (University of Puerto Rico - Mayaguez), and Scott Henderson (Lewis & Clark College). The PIA students are Claudia Araya (Pontifica Universidad Católica de Chile) and Rodrigo Hinojosa (Universidad Católica del Norte, Antofagasta). We all wish them an enjoyable stay in La Serena.

—Styliani Kafka

The Intersection of Arts & Sciences

Tohono O'odham artist Mike Chiago has painted a mural depicting Native American life and astronomical images on the original cement blank for the Mayall 4-meter telescope mirror that sits outside of the main entrance to Kitt Peak National Observatory near the Visitor Center. This colorful new artwork definitely helps create a more welcoming mood at this important public location on Kitt Peak.

Some of Mike's other artwork can be found in the Heard Museum in Phoenix, and the Smithsonian Institution's National Musuem of the American Indian in Washington, DC.

Photos credit: J. Kennedy and NOAO/AURA/NSF