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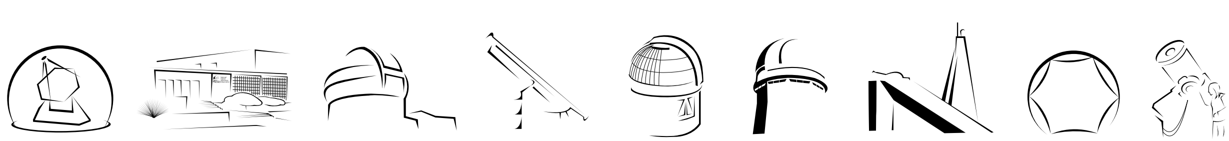

Farewell to Richard Green

Jeremy Mould & Sidney Wolff

After 22 years on the NOAO scientific staff, including leadership of Kitt Peak National Observatory (KPNO) for the past eight-plus years, Richard Green has been appointed as the new director of the Large Binocular Telescope.

"Forty years of discovery have revolutionized our view of the Universe," Richard said at a KPNO anniversary ceremony in 1998, "and Kitt Peak looks to the new millennium with excitement at the prospects of continuing to advance the frontiers of astronomical knowledge."

As director of KPNO, Richard has done much to realize those prospects. He championed the digital prime focus of Kitt Peak's iconic Mayall 4-meter telescope. When commissioned under his stewardship, the Mosaic camera rewarded astronomers at Kitt Peak and Cerro Tololo in Chile with trustworthy data for a Hubble diagram of supernovae that led to the concept of dark energy, a mysterious force that accelerates the expansion of the Universe. Mosaic was the first of a number of new and refurbished instruments developed on Richard's watch, including FLAMINGOS, MARS, Goddard IRMOS, and NEWFIRM. The capabilities of these instruments ensure that KPNO remains on the forefront of discovery. At the same time, Richard relentlessly pursued an image-quality improvement program that kept Kitt Peak in the ranks of the best astronomical sites worldwide. He has also worked tirelessly to keep Kitt Peak well-protected from the potential light pollution of the growing Tucson metropolis.

Few of us can say that our graduate thesis work is as well-remembered as Richard Green's. The "Palomar Green survey" continues to be the definitive catalog of nearby quasars. During his tenure at NOAO, Richard went on to research on degenerate stars, the quasar luminosity function, and galactic nuclei. He was a member of the STIS instrument team for the Hubble Space Telescope and the NASA Far Ultraviolet Spectroscopic Explorer mission science team.

During most of his years at NOAO, Richard has been a member of the management team, including a term as Deputy Director. He served as Acting Director of NOAO while the NOAO Director focused on launching the Gemini project. More recently, Richard has served as president of the WIYN Board. Throughout his career, Richard has combined insight into the important scientific questions of the day with strong management skills, and an unquestioned degree of integrity, leaving a significant legacy for the NOAO community of observers.

Richard moves on to new challenges as the director of the Large Binocular Telescope (LBT) project, an international observatory located in Arizona in which the US community has a strong investment. When its second mirror is installed later this year, the LBT will be a unique facility, part interferometer and part twin flux collector; it has been described as the first of the new generation of very large telescopes.

As we look forward to this pending epoch, all of us at NOAO and its large community want to thank Richard warmly for his leadership of Kitt Peak. We wish Richard the very best in the next chapter of his career.

On the Cover

The T-ReCS instrument on the Gemini South telescope produced this image mosaic of the Orion Nebula in mid-infrared light (11.7 microns), including the well-known Trapezium region.

This unique wide-field view reveals a variety of new details about the preferred locations and inferred lifespans of nascent planetary systems (or proplyds) in the nebula, as well as the first detection of mid-infrared emissions from dust in the collimated jets emitted by Herbig-Haro objects in the region. Many of the isolated stars in the image show evidence of thermal emission from dust, yet they show no extended structure in corresponding visible light images; this suggests that these stars have dusty disks surrounding them that are comparable to the size of our solar system. A paper describing these results has been accepted by the *Astronomical Journal.*

Image Credit: Nathan Smith/University of Colorado and Gemini Observatory.

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Spitzer Mid-Infrared Spectroscopy: Detection of Polycyclic Aromatic Hydrocarbon Molecules in Ultraluminous Infrared Galaxies at z ~ 2

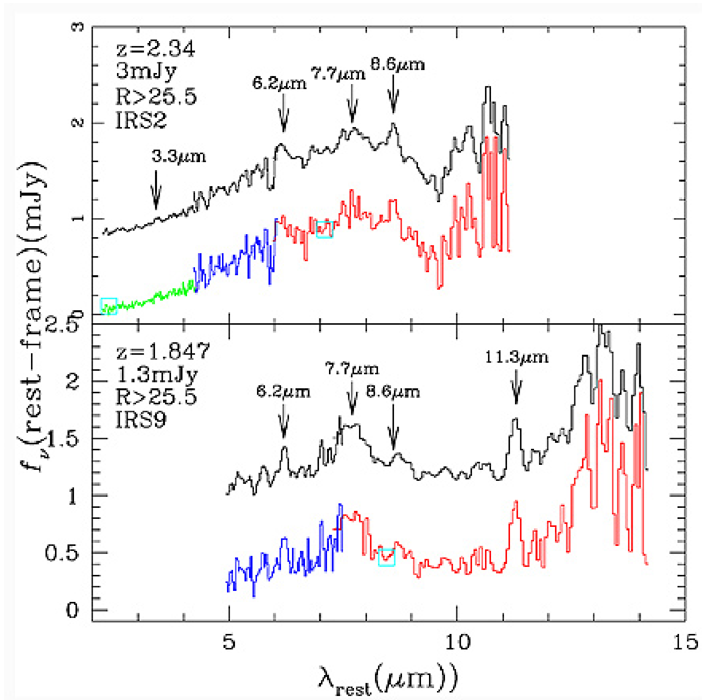
Lin Yan, D. Fadda, L. Armus, R. Chary, H. Teplitz, G. Helou, D. Frayer,
J. Surace & P. Choi (Spitzer Science Center)

The infrared luminous phase of galaxy evolution is thought to be dynamically triggered, lasting roughly 100–1,000 million years (Rieke et al. 1980; Soifer et al. 1987; Murphy et al. 1996). It is expected that a significant fraction of normal galaxies observed today have probably undergone an infrared luminous phase sometime at high redshift (Kim & Sanders 1998; Soifer et al. 1987).

This expectation is supported by the results of many observational studies with ISO, SCUBA, and now Spitzer, which provide evidence of strong evolution in number density and luminosity of dusty starbursts at z>1 (Elbaz et al. 2002; Chapman et al. 2003; Marleau et al. 2004; Yan et al. 2004; Le Floch et al. 2004). Therefore, high-z, dusty infrared luminous sources are believed to play a critical role in the formation and evolution of galaxies.

The successful launch of the Spitzer Space Telescope has provided us with a new tool of unprecedented resolution and sensitivity with which to probe directly the distant, dusty universe. Deep 24-micron images allow us to detect thousands of Luminous Infrared Galaxies (LIRGs) at z>1. In particular, with the InfraRed Spectrograph (IRS) (Houck et al. 2004), it is now possible to measure the mid-infrared spectroscopic properties of such systems at z>1.

We have recently used the IRS to obtain low-resolution, mid-IR spectra (7–38 microns) of a sample of luminous infrared galaxies at z>1. The targets were selected from the Spitzer First Look Survey based on their 24/8 micron and 24/*R* colors (Yan et al. 2004). We utilized the IRAC 3.6– to 8-micron images, as well as deep optical *R*-band data taken with the NOAO Mosaic camera (Fadda et al. 2004). A total of 52 targets were selected. Eight of the targets have been observed with IRS and the data analyses completed. The paper presenting these eight spectra has been published in the August 2005 *ApJ* (Yan et al. 2005).



Spitzer spectra of two Luminous Infrared Galaxies presented in the rest-frame. In each panel, the lower spectrum shows the observed data at the original resolution; the upper spectrum is a smoothed version, to which an arbitrary constant has been added in the Y-axis for viewing clarity. The open squares indicate the broadband rest-frame flux densities computed from the observed, broadband 8-micron and 24-micron fluxes obtained with IRAC and MIPS, respectively. The object name, redshift, R-band magnitude and 24-micron flux density are shown in the upper left corner of each panel.

Of the eight sources analyzed so far, six have mid-IR spectral features, either emission lines from Polycyclic Aromatic Hydrocarbon (PAH) or silicate absorption at 9.7 microns. The figure shows two of the eight spectra we obtained with the IRS. Based on the mid-IR spectra, the inferred redshifts are in the range 1.8–2.7. The two remaining sources have strong continuum emission but no identifiable spectral lines. Of the six sources with measured redshifts, at least four have strong

continued

Spitzer Mid-Infrared Spectroscopy continued

silicate absorption at the rest-frame 9.7 microns. This is an indicator of the heavy dust obscuration in these systems. Strong, multiple PAH emission features are detected in two sources, and weak PAH emission in another two. These data provide direct evidence that PAH molecules are present and directly observable in ULIRGs at z~2.

Based on these eight spectra, we reached the following conclusions:

(1) Redshifts were measured with high efficiency (for six of eight sources).
(2) The six sources with measured redshifts are dusty, infrared luminous galaxies at z~2 with estimated $L_{bol} \sim 10^{13} L_{sun}$.
(3) Four of these six sources have optical magnitudes fainter than *R*=25.5. This demonstrates the great potential of directly probing the high-redshift universe using mid-infrared spectroscopy, particularly, for optically faint and infrared luminous galaxies.
(4) The two galaxies (2/8=25%) with significant detections of multiple PAH emission features are shown to be starburst dominant, based on their line-to-bolometric luminosity ratios and equivalent widths. The two with only power law continua are probably type I QSOs. The remaining four (4/8=50%) are probably composite systems with both starburst and AGN contributions to their luminosities. Their low S/N spectra do not allow definitive classification of the nature of the dominant energy source.

Lyman-α Halos and the Formation of Massive Galaxies

Joan Najita

How do the most massive galaxies form? The current theoretical expectation is that even the most massive galaxies share the formation history of lower mass galaxies and are built up through a series of hierarchical merging events. However, several arguments suggest a more dramatic origin for these behemoths of the galaxy population. Massive galaxies at high redshift (z > 3) that host powerful radio sources are often associated with large (~100 kpc), luminous ($>10^{10} L_{sun}$) Lyman-α (Lyα) nebulae. The large size and luminosity of the nebulae suggest that they arise through a massive gravitational collapse event. In another line of argument, the properties of dusty submillimeter galaxies suggest that they also represent a phase in the evolutionary history of massive galaxies, a phase characterized by rapid, dust-enshrouded star formation.

What is the relationship between large Lyα nebulae and dusty starbursts in the formation history of massive galaxies? Recent observations with the Spitzer Space Telescope made in the Boötes field of the NOAO Deep Wide-Field Survey (NDWFS) may provide important clues to this question.

As reported in Dey et al. (2005, *astro-ph*/0503632), the entire NDWFS Boötes field was mapped at 24, 70, and 160 microns using

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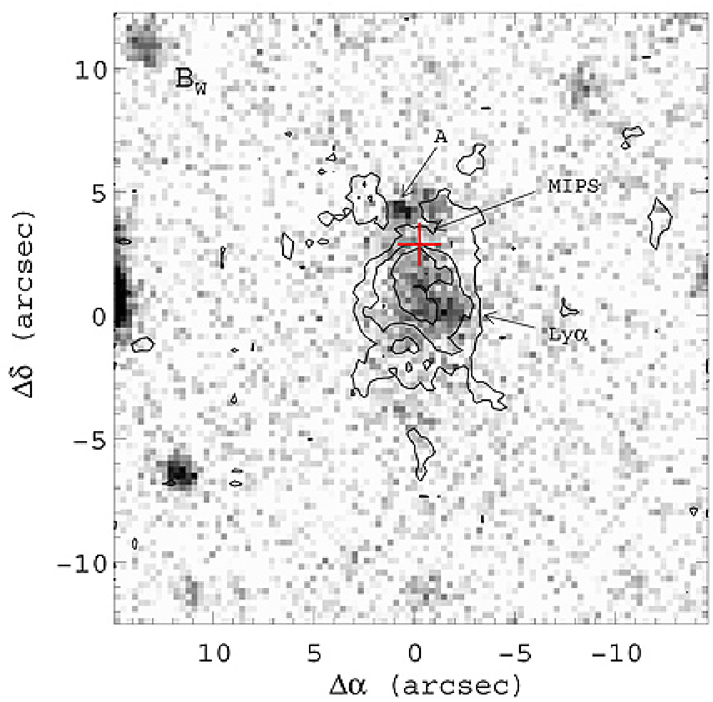


A B_W image from the NOAO Deep Wide-Field Survey showing the z=2.656 Lyα nebula discovered by Dey et al. (2005). The contours demarcate the region of bright Lyα emission (from the WIYN narrowband image). The locations of the embedded Lyman-break galaxy ("A") and the mid-infrared source ("MIPS") are also shown.

Lyman-α Halos and the Formation of Massive Galaxies continued

the Multiband Imaging Photometer (MIPS) for Spitzer. The routine optical identification of the sources detected at 24 microns in the archival NDWFS imaging data led to the discovery of faint, diffuse, spatially extended optical emission in the B_W band (see figure) that was associated with one of the MIPS sources.

Follow-up ground-based spectroscopy using the Keck I telescope and narrowband imaging with the WIYN telescope revealed that the emission is almost pure Lyα emission at z=2.66 with little detectable continuum, the first Lyα halo discovered by its associated 24-micron emission. The nebula has a Lyα line luminosity of 4×10^{10} L_{sun} and a spatial extent of at least 20 arcsec (160 kpc). The central eight arcsec region of the nebula shows remarkably ordered motion. A monotonic velocity profile, when interpreted as rotation, suggests that the mass enclosed within the central 64-kpc region is 6×10^{12} M_{sun}.

Several sources are located in the nebula and at the same redshift (see figure). One is a Lyman-break galaxy. An additional optical source, which is coincident with the luminous MIPS source, has a spectral energy distribution (SED) that is similar to that of a dusty AGN. By comparing its SED to that of local Ultraluminous Infrared Galaxies (ULIRGs) such as Arp 220 and Mrk 231, the mid-infrared source has a luminosity of 1–7 x 10^{13} L_{sun}.

The origin of the ionization of the nebula is an intriguing puzzle. Based on its SED, the MIPS source is unlikely to account for more than 20% of the Lyα luminosity. The source of ionization is more likely shocks and/or multiple ionizing sources distributed within the nebula, possibly star clusters or galaxies. If young hot stars are responsible for the ionization, the required star formation rate of the system is ~150 M_{sun}/yr. However, in addition to Lyα, narrow-emission lines of C IV and He II were also detected from the central region of the nebula. These lines may indicate that some parts of the nebula are ionized by a power-law continuum source.

What do these results say about the origin of the most massive galaxies? The authors speculate that the presence of multiple galaxies within the same extended Lyα halo suggests that the Lyman-break galaxy and the mid-infrared source respectively represent sites of past and present galaxy formation, with the Lyα halo tracing the region in which infall is currently occurring. Exactly how galaxies transform themselves from dust-enshrouded mid-infrared sources to revealed Lyman-break galaxies is a topic for future investigation.

These results may provide some insight into the larger population of highly obscured sources at high redshift (z>2), with extreme infrared-to-optical colors, that has been observed recently with Spitzer (e.g., Houck et al. 2005, *ApJ*, 622, L105). According to Dan Weedman, one of the coauthors of the paper, "the properties of the mid-infrared source within the Lyα blob are very similar to many of the other mysterious, highly obscured sources we have found in the Boötes field. Our currently favored interpretation is that the object buried in the Lyα nebula is an obscured and very luminous AGN, based on similarities to the other sources. That raises the interesting question of whether those other sources are also related to the formation of massive galaxies."

Additional detailed studies of this region of galaxy formation are planned with the Hubble Space Telescope.

An Update on the ESSENCE Project: Supernova Cosmology with the CTIO 4-m Telescope

Tom Matheson (NOAO) & the ESSENCE team

The study of cosmology has yielded dramatic discoveries in the last decade. Among the most surprising was the result found by two different groups, the High-z Supernova Search Team (HZSST) and the Supernova Cosmology Project, studying high-redshift Type-Ia supernovae. The goal of these projects was to determine q_0, the deceleration parameter.

Quite unexpectedly, both groups found that the expansion of the Universe was actually accelerating. This repulsive force came to be characterized as dark energy. Whatever this dark energy may be, it is now known to be the major constituent of the Universe, and an understanding of this force has become the focus of intensive study.

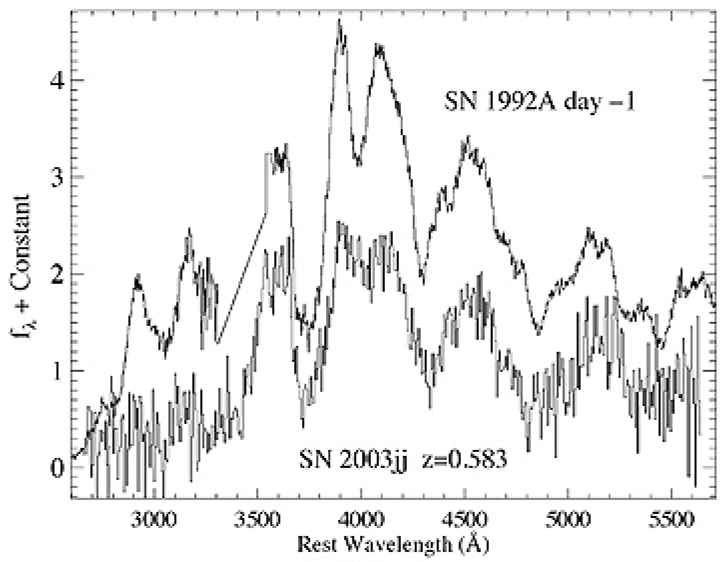
One way to characterize dark energy is to consider the equation of state of the Universe. The equation-of-state parameter, w, relates the pressure to the density of the Universe. Pressure-less matter has w=0 and a cosmological constant (as envisioned by Einstein) has w=-1. In order to achieve cosmic acceleration, any form of dark energy must have w<-1/3. One first test of dark

continued

Update on the ESSENCE Project continued

energy is whether it is the cosmological constant. Other models for dark energy will be difficult to distinguish with an average value of w, but knowing if w=-1 is an important beginning. To that end, the HZSST evolved into the Equation of State: SupErNovae trace Cosmic Expansion (ESSENCE) project. A thorough picture of this program is available at *www.ctio.noao.edu/~wsne*.

The ESSENCE project is an NOAO Survey Program, consisting of a five-year, ground-based supernova search designed to place constraints on the equation-of-state parameter for the Universe using ~200 Type-Ia supernovae over a redshift range of $0.2<z<0.8$. The supernova search uses the Mosaic camera on the Blanco 4-m telescope at CTIO, scheduled each of the five years for 30 half-nights, every other night, for three dark runs. The SuperMacho program uses the other half-nights, and these teams use a common software pipeline to process the images and find optical transients. Discoveries are announced promptly on the ESSENCE Web page, and the images are available to the public through the NOAO Science Archive.



Spectra of SN 2003jj, a Type-Ia at z=0.583, and SN 1992A, a well observed, nearby Type-Ia with ultraviolet coverage. The spectra have been offset for clarity. Note that, despite the noise level, virtually every feature of the low-redshift supernova is reproduced in the high-redshift supernova.

The search returns to each field with a cadence of four days, so follow-up observations are automatic, yielding well-sampled light curves. In addition, spectroscopic observations of each supernova are made, not only to ensure that the objects are Type-Ia supernovae, but also to provide a redshift. The light-curve shape allows the Type-Ia supernovae to be calibrated as standard candles, giving a luminosity distance. This can then be used with the redshift to derive the expansion history of the Universe. Simulations show that the ESSENCE project should be able to constrain the value of w to better than 10%.

Year four of the ESSENCE project will begin in September. Over the first three years, we discovered 91 spectroscopically confirmed Type-Ia supernovae. The first year occurred during El Niño, so there were significant weather problems, while year three saw some of the worst seeing ever recorded at CTIO. If the observing conditions for years four and five return to normal, we are fully confident that we will achieve our goal of ~200 Type-Ia supernovae.

The number of supernovae, though, is not the only focus of the project. A detailed understanding of systematic errors associated with calibrating the high-redshift supernovae to the local sample is necessary to measure the expansion history accurately. Accurate and precise calibration of the photometry is one component. Spectra with high signal-to-noise ratio are also important to evaluate any potential evolution of the Type-Ia supernovae over the redshift range sampled.

The discovery of optical transients in the ESSENCE survey is very efficient, yielding more targets than can be observed spectroscopically. The lack of availability of large-aperture telescope time is the single greatest factor limiting our ability to find and confirm Type-Ia supernovae. Our chief spectroscopic resources are Keck, Gemini, VLT, and Magellan. The queue-scheduling mode at Gemini is a particular advantage for a time-sensitive campaign such as ESSENCE.

We have made good use of the time granted so far, with an increase in efficiency in terms of the fraction of transients observed that are Type-Ia supernovae. We recently published the spectra of all objects from the first two years of the program (Matheson et al. 2005, *AJ*, 129, 2352). A representative spectrum of a high-redshift Type-Ia is shown in the figure, along with a low-redshift analog. The similarity of features lends credence to the calibration schemes based on the local sample. The spectra of all other objects observed during the first two years are also included in this publication. The complete sample is publicly available at *www.noao.edu/noao/staff/matheson/spectra.html*.

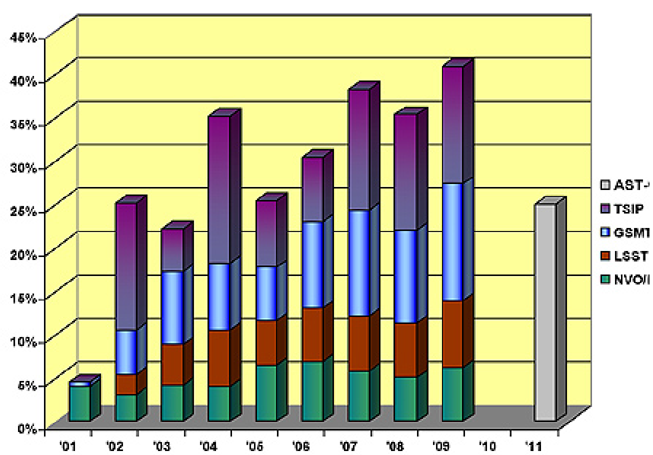
Through careful understanding of the complexities involved in calibrating the high-redshift supernovae, both photometrically and spectroscopically, we believe that the ESSENCE project is well on its way to a successful outcome.

The NOAO Submission to the Senior Review

Jeremy Mould

NOAO's submission to the NSF Senior Review is now available for your comment. You will find it at *www.noao.edu/dir/seniorreview* together with an address for your feedback.

NOAO proposes to divest 50 percent shares of the Mayall, Blanco, and 2.1-meter telescopes to new operating partners in order to complete the transition of resources to decadal survey initiatives shown in the accompanying figure. The national observatory will itself become a public-private partnership, with equal support from each sector for the 1- to 4-meter telescopes that are essential for effective use of Gemini, its siblings in the US system, and the emerging new generation of facilities.



NOAO is approaching the goal of investing 25 percent of program plan funds in decadal survey initiatives—even without including TSIP. The Senior Review's announced purpose is to re-direct $30 million out of $120 million in NSF astronomy division facilities funding to these projects.

We make this proposal in support of the most recent decadal survey, *Astronomy and Astrophysics in the New Millennium*, which envisioned revolutionary advances over the next ten to twenty years. These advances are anticipated in our understanding of how large-scale structure emerged from the density fluctuations imprinted during the Big Bang, how the first stars and galaxies were formed, how the simple galactic morphologies we observe today came to be, how planetary systems form and evolve, and, how frequently planets amenable to life emerge.

The optimism of the decadal survey authors derived first from the enormous progress made over the past two decades by exploiting advances in detector technology and computational power, the launching of NASA's Great Observatories, and the development of a suite of powerful new 8- to 10-meter class telescopes. Second, the authors were confident that the pace of progress would be sustained and accelerated via imaginative combinations of private and federal investment in critical next-generation facilities.

An "effective national observatory" was viewed as central to achieving this vision. The decadal survey challenged NOAO to become that observatory by:

(1) working in partnership with the community and private observatories to exploit a unique strength of the US astronomical community, large-scale private as well as public investment in major facilities, to design and build the next generation of ground-based telescopes.

(2) playing a leading role in shepherding the evolution of the complex "system" of US public and private telescopes, allowing creative scientists working throughout the US community continued access to the full range of facilities and capabilities required to carry out world-leading research.

NOAO embraced this challenge enthusiastically, and in 2001 began to evolve rapidly from an observatory focused primarily on operating and providing access to its own facilities, and serving as a gateway to the Gemini telescopes, to an institution that, over the past five years, has successfully developed:

(1) a broad community and interagency partnership to build the LSST facility with the promise of breakthrough contributions to our understanding of dark matter and dark energy; of opening of the time domain to enable study of weak lensing, transient variables, near-earth asteroids, Kuiper Belt Objects; and bringing to maturity a new style of research, carrying out archival research based on an incredibly rich and ever-evolving imaging database.

LSST
Large Synoptic Survey Telescope

continued

NOAO Submission to the Senior Review continued

(2) a partnership with Caltech, the University of California, and the Association of Canadian Universities for Research in Astronomy (ACURA) to design a 30-meter-class Giant Segmented Mirror Telescope (GSMT), the highest priority for ground-based astronomy identified by the decadel survey. These four partners envision the Thirty Meter Telescope (TMT) as providing a combination of diffraction-limited imaged and light-gathering power that will enable quantitative study of the first-forming stars and galaxies, the constituent populations in galaxies well beyond the Local Group, the early formation of planetary systems, and the imaging and analysis of planets surrounding nearby stars. Through its partnership in the TMT project, NOAO provides a "voice at the table" to express community aspirations during the crucial design and development phase, when key performance and cost trades are made.

TMT

THIRTY METER TELESCOPE

(3) a significant role in planning and shaping the National Virtual Observatory via the key contribution of NVO Project Scientist David De Young, and a lead contribution via the NOAO Data Products Program in developing pipelines, archives, archive access and analysis tools necessary to exploit data obtained with NOAO telescopes, other O/IR facilities, and ultimately with LSST and GSMT.

(4) guiding the evolution of the US public and private system of telescopes, via its leadership of the community-based System Committee, and ongoing interactions with the private observatories and other community groups. One example is NOAO's leadership of successful implementation of the Telescope System Instrumentation Program (TSIP), which provides public access to private facilities in exchange for federal funding of new instrumentation or capabilities at the private observatories, a "win-win" program expanding the capabilities available both to scientists at the private observatories and their partners, as well as to the broader community.

Accomplishing these goals required a dramatic redirection of NOAO resources. The changes, summarized in the figure on page 7, show the evolution in investment at the observatory from operating and instrumenting our 4-meter and smaller legacy telescopes to our current major investment in LSST and GSMT. By FY 2005, *NOAO is approaching its share of the goal set out for the NSF Senior Review*: reinvesting more than 25 percent of its resources into next-generation facilities.

At *www.noao.edu/dir/seniorreview/srnoao.pdf*, we describe in detail the scientific challenges of the next decade, the role of optical infrared (O/IR) astronomy in contributing to these challenges, and NOAO's central role in guiding the evolution of the US system of ground-based telescopes while providing access to the next-generation of facilities.

This report, together with that of the O/IR Long Range Planning Committee (*www.noao.edu/dir/lrplan/strategies-draft.pdf*) lays out a clear roadmap for continuing change at NOAO through the design and development phases of LSST and GSMT, and through the operations phase of these powerful new facilities. Changes within NOAO and in its interaction with its user community will be dramatic and sometimes challenging. The end result, however, will be community access to world-leading new facilities, to the suite of smaller scale facilities crucial for surveys and other path finding observations, and to the rich databases emerging from this complex web of next-generation and legacy telescopes.

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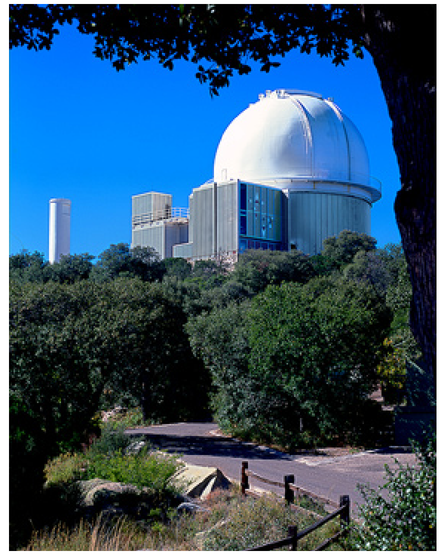
New Acting Director of Kitt Peak National Observatory

Buell Jannuzi has agreed to serve as acting director of Kitt Peak National Observatory (KPNO) with the departure of Richard Green. Buell has been deputy director of KPNO for the past year. He has been heavily involved in issues related to Kitt Peak science instrumentation, including accomodation of the NEWFIRM instrument on the Mayall 4-meter telescope, as well as other duties like serving on the Pima County outdoor lighting-code committee.



Announcement of Opportunity for Partnerships at NOAO

The NOAO Long-Range Plan envisions that by 2010, NSF-provided core funding to the national observatory will focus on support of major new projects, including the Thirty Meter Telescope and the Large Synoptic Survey Telescope. Following the NSF's Senior Review (see *www.noao.edu/dir/seniorreview* for our input), we anticipate that a larger share of the financial support for observing facilities at Kitt Peak National Observatory (KPNO) and Cerro Tololo Inter-American Observatory (CTIO) will originate from other sources.

We are interested in partners who will bring cash to the support needs of the observatory and who will use the resulting observing time for their research and educational activities. While negotiable, our current estimate of a minimum share would be 1/8th of the available time over a three-year period on the 2.1-meter or Mayall 4-meter telescopes, or some combination of the two. Proposers should submit science and management plans in response to this AO by 1 November 2005. Proposers intending to contribute to instrument development as well should provide a technical plan.

At KPNO, shares of observing time on the 2.1-meter and Mayall 4-meter telescopes are available. We are looking to start the lease time on the 2.1-meter and 4-meter as soon as possible, which would be the start of semester 2006A, February 2006, at the earliest. Partners in the 4-meter or 2.1-meter may indicate how they might trade some of their time for observing on other NOAO telescopes.

For more information on Kitt Peak opportunities, please contact Buell Jannuzi (*bjannuzi@noao.edu*).

A partnership for up to 10 percent of the CTIO Blanco 4-meter telescope is also available. Time exchanges with other NOAO facilities, including the SOAR 4-meter, are possible in principle.

The Dark Energy Camera consortium for the Blanco, independent of the above AO, continues to look for partners with funding resources. This Fermilab-led consortium, led by project director John Peoples (*peop@fnal.gov*), aims to build a very large, two-degree-diameter-field CCD imager and new corrector for the Blanco prime focus. The instrument is scheduled to begin the Dark Energy Survey in 2009. See *www.ctio.noao.edu/telescopes/dec.html* for more information on this "Super-Sloan survey." The consortium presently consists of Fermilab, the University of Illinois, the University of Chicago, the University of California Berkeley/LBNL, the University of Michigan, the University College of London, the University of Cambridge, the University of Portsmouth, the University of Edinburgh, and the University of Barcelona Instituts d'Estudis Espacials de Catalunya y de Fisica d'Altes Energies. This is a $20 million project, and partners will need to bring science synergy or the ability to use the survey data for another purpose.

For more information on any of the CTIO opportunities, please contact Alistair Walker (*awalker@noao.edu*).

Any partnership arrangements are subject to the agreement of the National Science Foundation.

NOAO Partners with NCSA

Richard Shaw

The NOAO Data Products Program (DPP) has formed a partnership with the National Center for Supercomputer Applications (NCSA) in Urbana, Illinois, to develop and implement cyber infrastructure in support of NOAO Science Archive, data reduction pipelines, and advanced data discovery, mining, and analysis tools.

The agreement builds upon an existing and successful relationship between the DPP and NCSA. Our organizations have been working over the past two years toward the development of systems for transporting astronomical data via the Internet over long distances, toward the provision of a safe-store for data from NOAO and partner telescopes, and toward the creation of National Virtual Observatory–compliant services for secure public access to data. The new agreement, signed in July, establishes a framework for developing critical infrastructure and systems in support of data-intensive instrumentation projects in optical/infrared astronomy, such as the Dark Energy Camera, the WIYN One-Degree Imager, and the Large Synoptic Survey Telescope (LSST).

This agreement is critical to the success of the NOAO Science Archive. NCSA brings to the table the necessary experience and resources for the long-term storage and physical curation of scientific data, as well as outstanding computational resources, Internet connectivity and strong credentials in the area of cyber-infrastructure research and development. These contributions complement NOAO's experience in the acquisition and processing of ground-based astronomical data, the characterization of instrument and environmental conditions of the observations, the scientific curation of the data from NOAO and partner institutions, and the analysis of astronomical data.

Together, NOAO and NCSA will create advanced data management systems in preparation for a not-too-distant future when research with huge geographically distributed data collections will be possible on the Grid, with Virtual Observatory-enabled tools, services, and storage together forming a seamless extension of the desktop computer platform.

The next release of the NOAO Science Archive is planned for early 2006, and this release will be based on a new distributed architecture and supporting infrastructure. Currently, the data rate from NOAO telescopes and instruments is roughly 16 gigabytes per night, or roughly six terabytes of raw data per year. This rate will grow to more than 25 terabytes per year as calibrated data are added, and as new powerful instrumentation such as NEWFIRM and the SOAR and SMARTS instruments are added to the existing complement of resources. The accumulated data in the NOAO Science Archive will exceed the total in the HST Archive (roughly 22 terabytes at present) within a year of full-scale operations. The ultimate aim is to create an archive and supporting services that will conform to petabyte-scale data sets—that is, characteristic of the volume of data anticipated from the Dark Energy Camera and WIYN One-Degree Imager. LSST will generate many tens of petabytes per year.

Data Products and Software at NOAO — Some Changes Coming

Todd Boroson, Mike Fitzpatrick, Richard Shaw & Frank Valdes

Over the past several years, NOAO's efforts in the areas of software and data management have expanded to encompass archives, automatic data reduction pipelines, and Web-based services for data analysis and visualization. This work complements and builds on our previous strengths in exportable user data reduction software epitomized by the widely used IRAF system. The first release of our end-to-end data flow system, which will enable Virtual Observatory research, is planned for early next year. As we gear up to provide new ways for the community to access NOAO data products and services, we are also announcing changes in how IRAF software and services will be provided.

The NOAO Data Products Program (DPP) data flow system combines new data storage, data reduction pipelines, portals to integrate data access and tools, and a transport system to link these together. This system is NOAO's first step toward establishing a data center that is relevant in the Virtual Observatory era. This effort has been the major undertaking of the DPP group for the past few years. The oversight and advising committees for the program have endorsed this future vision of NOAO's data-related services. Its value lies not only in participation in creating an integral piece of the Virtual Observatory, but also in simply allowing the multiple uses of NOAO data.

continued

Data Products and Software at NOAO continued

The data transport system, running in a prototype version for almost a year, replaces our tape-based Save-the-Bits system, capturing the data streams from the NOAO telescopes and feeding them via network into the archive. The NOAO Science Archive (NSA) itself, currently under development and to be operated in partnership with the National Center for Supercomputing Applications, will handle the physical storage of this raw data, its associated metadata, and ultimately, pipeline-reduced data. Data from NOAO telescopes will be available to everyone after the proprietary period, nominally 18 months, but after a shorter period in some cases. Metadata will be viewable and searchable immediately, and it is an important aspect of our accountability to users and the community.

Pipelines will also begin operation to automatically reduce the data from the CCD Mosaic camera and the new wide-field infrared imager, NEWFIRM, at about this time. These pipelines will characterize the data and document its quality, giving researchers some knowledge of the usefulness of available data prior to retrieval. The reduced images, and ultimately the catalogs they produce, will become available to all.

The NOAO Data Portal is an integrated interface to a combination of data, tools, and services. Through this interface, users will be able to discover and retrieve data from NSA as well as external archives. The portal also provides users with a set of tools for visualizing and analyzing data and metadata, as well as enabling users to query archived data holdings. Tools to aid visualization of time-domain information will be an early emphasis in portal development. The portal will also provide access to some IRAF processing tools as Web services. Future releases will greatly enhance the capabilities of the portal, including the ability to combine image and catalog information.

As we enter into the operations phase of these new capabilities, we are also making changes in IRAF operations toward greater efficiency and self-support. By "IRAF operations," we mean keeping up with changes in systems hosting IRAF, and in direct user support. We are moving toward an "open source" model (although IRAF sources have always been freely available), which relies more on community effort than in the past.

Toward this goal, we will establish a Web site providing forums for people to ask and answer questions, and to post announcements, as well as to provide searchable access to the large archive of e-mail from our help desk and an updated FAQ facility. We hope to make it more attractive for users to contribute bug fixes and enhancements, and we will be relying on the participation of those users to maintain support for the user community. In some areas there will be only small changes (the IRAF project has always maintained a Web site and ftp tree), and in others there will be big changes (by moving to a forum-based help desk). The core IRAF group at NOAO will coordinate and participate in this open-source approach, answering expert-level questions and contributing to the code base, as partners with the community.

Beyond operations, there is the question of new developments in IRAF. A traditional mission of the IRAF project was to provide exportable data reduction tools for NOAO data. These were written so that they could be used with data from other observatories. The high citation rate for IRAF and the wide use of this software in the community illustrate the great success of this project for providing general data reduction tools for astronomers, students, and amateurs on a variety of data. While this aspect of the mission is being phased out, there will still be occasional developments when these tools are needed for other aspects of our program.

We see a new mission to provide analysis and visualization through Web services and the virtual observatory as the traditional mission is phased out. Therefore, the development of traditional exportable data reduction packages at NOAO will be largely replaced by Web and archive services, some of which will be based on IRAF.

Evolution of the core IRAF development platform and system will continue at a low level with emphasis on the needs of the pipeline, archive, and Virtual Observatory projects. We will continue to issue updates as they are needed for new versions of supported operating systems and compilers. There may also be specific collaborative projects, within AURA and outside. More community-driven developments will be addressed through the open-source model, where community participation is essential.

We hope that no one stops using IRAF because of the changes to our operations model. In fact, we hope that the community will embrace the open source model and continue to communicate and contribute. We even expect that new IRAF exportable packages, for instance those for Gemini instruments and interfaces such as a Python (PYRAF) and an error-handling CL (ECL), will continue to development, as well as new tools for interacting with IRAF through Web services.

We are interested in keeping the lines of communication open throughout this period of transition, and will provide forums to facilitate communication at science and technical meetings such as the AAS. The staff of the NOAO Data Products Program is excited about the new opportunities ahead for scientific discovery that the Virtual Observatory is creating, and we anticipate working with the community and other Virtual Observatory developers to ensure that all users of NOAO facilities benefit from its development.

IRAF Help-Desk Users — Don't Panic!

Todd Boroson

The previous article in this *Newsletter* describes our planned new approach to IRAF support. We know that there has been some anxiety about this transition, much of which is based on incorrect or incomplete knowledge of our plan.

We understand that IRAF is a very important NOAO product, and that many researchers depend on it for carrying out their data reduction and analysis. To that end, we want to stress that we are developing an effective model for IRAF users to continue to get their questions answered, in many cases *more quickly* than they can now (the current backlog results in a response time lag of about two weeks).

Questions and answers will be in a searchable archive so that many questions may be instantly answered by searching this knowledgebase. We will continue to issue patches and updated releases as operating systems change. The IRAF programmers on our staff will answer expert-level questions through the new support mechanism. Finally, we will make sure this new system evolves in response to your input, so that it continues to meet the community's needs.

Page Charge Support for Papers from NOAO Science Archive Data

NOAO has funds available to pay page charges for papers utilizing data from the NOAO Science Archive (NSA) through an NSF grant to support cyber-infrastructure and cyber-science. Data currently available from the NSA are limited to the contributed reduced data sets from the NOAO Survey Program. Over the next year, raw and pipeline reduced data from the NOAO telescopes will be available as well.

Researchers who are submitting papers that use data retrieved from the NSA (*archive.noao.edu/nsa)* should, at the time of journal submission, send an electronic copy of the paper to *library@noao.edu*, stating that they are requesting support from the NSA page charge fund and indicating the journal to which the manuscript has been submitted. Following review for eligibility, the NOAO librarian will respond with confirmation that NOAO will pay the page charges.

Papers for which such support is requested must acknowledge the source of the data (see *archive.noao.edu/nsa/acknowledgement.html* for the NSA acknowledgement). This program will begin 1 October 2005 and will run for one year, after which we will review its effectiveness.

Gemini Observing Opportunities for Semester 2006A

Taft Armandroff

The NOAO Gemini Science Center (NGSC) invites and encourages the US community to submit proposals for Gemini observing opportunities during semester 2006A. US Gemini observing proposals are submitted and evaluated via the NOAO Time Allocation Committee (TAC) process. Although the Gemini Call for Proposals for 2006A will not be released until 1 September 2005 for the US proposal deadline of September 30, the following are our expectations of what will be offered in semester 2006A. Please watch the NGSC Web page (*www.noao.edu/usgp*) for the Call for Proposals for Gemini observing, which will clearly list the capabilities that one can request.

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

Gemini North:

- The GMOS-North optical multi-object spectrograph and imager will be offered in 2006A. Multi-object spectroscopy and long-slit spectroscopy (both optionally with nod-and-shuffle mode), integral-field unit (IFU) spectroscopy, and imaging modes will be available.
- The NIRI infrared imager/spectrograph will be offered in 2006A. Both imaging mode and grism spectroscopy mode will be available.
- The Altair adaptive optics (AO) system will be offered in natural-guide-star mode in 2006A. Gemini plans to offer the following modes of Altair in 2006A: AO-enhanced infrared imaging and spectroscopy using NIRI.
- Michelle is a mid-infrared (8–25 micron) imager and spectrograph. Michelle will be available for imaging and for spectroscopy (with resolutions of R=200 to 3,000, and echelle spectroscopy at R≈10,000 to 30,000).
- All instruments and modes are offered for both queue and classical observing. Classical observing will be offered only to programs with a length of three nights or longer.

Gemini South:

- The GMOS-South optical multi-object spectrograph and imager will be offered during semester 2006A. Multi-object spectroscopy, long-slit spectroscopy, IFU spectroscopy (all optionally with nod-and-shuffle mode), and imaging modes will be available.
- The T-ReCS mid-infrared imager and spectrograph will be available in semester 2006A. Both the imaging and spectroscopic modes of T-ReCS will be available in 2006A.
- The GNIRS facility infrared spectrograph will be offered in semester 2006A. Four GNIRS observing modes will be available: long-slit spectroscopy with resolutions R=2,000 and 6,000; cross-dispersed spectroscopy at R=2,000 (with continuous coverage from 1 to 2.5 microns) and R=6,000 (non-continuous coverage); higher-resolution narrow-slit mode with R=18,000; and IFU spectroscopy (R=2,000 and 6,000).
- The Phoenix infrared high-resolution spectrograph (R=50,000 to 70,000) will be offered in semester 2006A. Phoenix is available only in classical mode (in whole nights, with no three-night minimum). NGSC staff will provide training and start-up assistance to Phoenix classical observers.
- The Acquisition Camera will be available for time-series photometry in 2006A.
- bHROS is a bench-mounted high-resolution (R=150,000) optical spectrograph that features a fiber feed and prism cross dispersion. bHROS is expected to be available during semester 2006A in queue only (see related article in this *Newsletter*). There will be a faint limit on science targets that can be observed. Please see the Call for Proposals for the specific magnitude limit.
- All modes for GMOS-South, GNIRS, and T-ReCS are offered for both queue and classical observing. bHROS is only available for queue observing, while Phoenix is only available for classical observing. Classical observing will be offered only to programs with a length of three nights or longer (except in the case of Phoenix).

Detailed information on these instrument capabilities is available at *www.gemini.edu/sciops/instruments/instrumentIndex.html.*

The percentage of time devoted to observations for science programs in semester 2006A is planned to be 70 percent at both Gemini North and Gemini South. The primary use of the remainder of the time will be instrument commissioning, system verification (SV), and demonstration science (DS) programs. Calls for SV and DS programs will be issued by Gemini for each of these opportunities.

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

continued

Gemini Observing Opportunities for Semester 2006A continued

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

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

The ITCs at the Gemini Web site are an important resource that proposers use in estimating the amount of Gemini time required to meet their scientific goals (*www.gemini.edu/sciops/instruments/instrumentITCIndex.html*). The Gemini ITCs for the infrared (IR) instruments were updated in June 2005 with new near-IR and mid-IR background files and updated throughputs to provide improved agreement with observed instrumental performance.

Pre-Submission Technical Review of Proposals

Proposers for Gemini time may not realize that NGSC staff members check each proposal for technical accuracy and feasibility. Problems are occasionally uncovered that can affect the proposal, but this is often after submission. As an aid to the US community, NGSC offers the opportunity to have proposals undergo a technical review before submission. The NGSC staff will not write the proposal, of course, or develop the observing strategy, but they will provide comments on the operational aspects of the program. Contact the instrument scientist relevant to your proposal at NOAO through the NGSC support Web page (*www.noao.edu/usgp/noaosupport.html)*. The NGSC staff will only be able to respond to requests made well in advance of proposal submission deadlines.

A New Addition to the Gemini Instrument Suite: bHROS

Verne Smith

The bench-mounted high-resolution optical spectrograph (bHROS) for the Gemini Observatory is now coming on-line and should become available to the Gemini user community in the near future. bHROS is mounted in the pier of the Gemini South telescope, where it is fed by optical fibers with input and output micro lenses. The input fibers are mounted inside the Gemini Multi-Object Spectrograph (GMOS), which will position them in the Cassegrain focal plane of the telescope.

The spectrograph itself is a prism cross-dispersed echelle that is designed to operate at quite high spectral resolution (R=150,000, with three-pixel sampling). Lower spectral resolutions can be obtained by pixel binning. There are two observing modes: one mode uses two 0.7-arcsec-diameter fibers separated by 20 arcsec in order to achieve both object and sky spectra; the other mode uses one fiber for object-only, with a fiber diameter of one arcsec. In order to maximize throughput at high spectral resolution and maintain a relatively compact instrument, image slicers are employed. As a result, the imaged spectra consist of eight adjacent bands for each order. The figure shows the fiber bundles emerging from the telescope pier and being routed into the climate-controlled bHROS enclosure. bHROS was designed and built by a team at University College London, with Mike Barlow as principal investigator.

continued

New Addition to the Gemini Instrument Suite continued

The spectrograph can operate over the wavelength range from 400 to 1,000 nanometers using a mosaic of two CCDs having 2048 × 4608 13.5-micron pixels. Due to the high dispersion of the echelle orders, wavelength coverage is not complete. The echelle grating has two degrees of motion, allowing specified wavelength regions to be placed effectively on the CCD arrays.

The first on-sky commissioning run for bHROS at Gemini South was conducted July 21–27, followed by Demonstration Science observations the nights of August 22–27. Contingent on final commissioning, it is anticipated that bHROS will be available to the Gemini community in 2006A as a facility instrument. Stay tuned to the Gemini Observatory Web page (*www.gemini.edu*) for the latest bHROS news.

If you have questions about the status of bHROS, or about instrument specifics, please contact Verne Smith (*vsmith@noao.edu*), the NGSC instrument scientist for bHROS.

The bHROS fiber bundles emerge from the bottom of the pier of the Gemini South telescope and enter the climate-controlled bHROS enclosure.

NICI Planet Search Campaign

Taft Armandroff

The Near Infrared Coronagraphic Imager (NICI) being developed for use at Gemini South will facilitate the detection of faint sources around relatively bright objects. Thus, NICI will be a pathfinder toward Gemini detecting and studying giant planets orbiting nearby stars. The instrument includes a curvature-sensing adaptive optics system and is optimized for coronagraphic imaging. NICI's two imaging channels facilitate the technique of simultaneous differential imaging. The instrument also includes high-quality 1.6-micron narrowband methane filters that will increase the contrast between a giant planet and the brighter stellar source. NICI is expected to be delivered to Gemini South before the end of 2005.

Recognizing the contributions that NICI is expected to make toward the discovery and study of extrasolar planets, Gemini Observatory is organizing a planet-finding campaign using this instrument. The team selected will be allocated approximately 50 NICI nights distributed over two to three years. Proposals are due 1 October 2005. Please see the NICI Planet Search Campaign Call for Proposals on the Gemini Web page (*www.gemini.edu*) for more information.

Proposals for the NICI Planet Search Campaign will likely be required to include information about team membership and Gemini partner participation, proposed observing strategies, possible external resources (student support, data from other facilities, etc.), data processing software, project schedule, and data release plans. Please note that proposals should be sent directly to Gemini and should *not* be submitted to the NOAO TAC or other Gemini partner country TACs. The Gemini International TAC (ITAC) will assess campaign proposals.

NICI will be available for other research projects in addition to the planet search campaign, with such observing time awarded through the regular TAC process starting in semester 2006B.

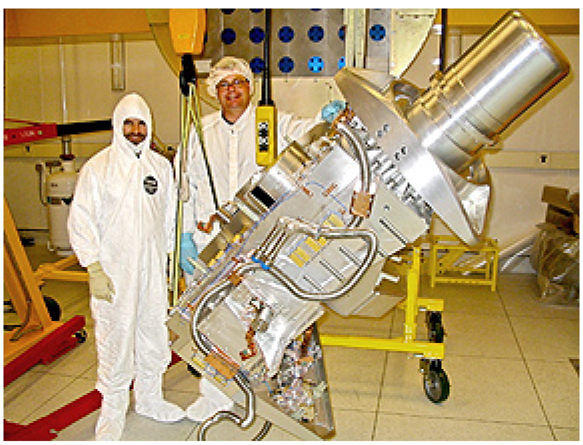
Reminder! All papers containing data from the Gemini telescopes should include the general Gemini acknowledgement (see *www.gemini.edu/sciops/ObsProcess/defAcknowledgement.html*) and the specific acknowledgement for a visiting instrument if any (for example, see the Phoenix-specific acknowledgement at *www.gemini.edu/sciops/instruments/phoenix/phoenixRefs.html*).

GNIRS Servicing Mission

Jay Elias

The Gemini Near-Infrared Spectrograph (GNIRS) was commissioned at Gemini South in January 2004 and has been in general use there since semester 2004B. GNIRS allows spectroscopic observations from 0.9 to 5 microns at different spectral resolutions and pixel scales, of which the most used are R=1,800 and 6,000 at a scale of 0.15 arcsec/pixel. (See *www.gemini.edu/sciops/instruments/nirs/nirsIndex.html* for further information). As prospective users of the instrument are probably aware, GNIRS was taken out of service for portions of semesters 2005A and 2005B to permit an extensive overhaul of the instrument.

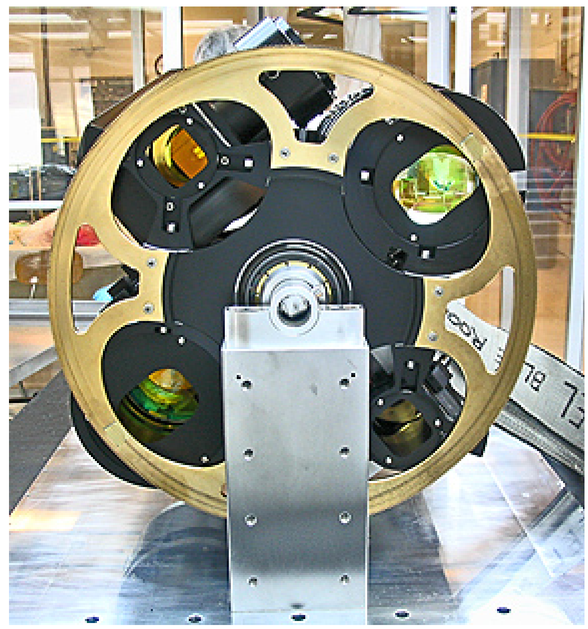
This work was carried out jointly by NOAO and Gemini technical staff and scientists over an eight-week period. During this period, the instrument was removed from the telescope and the internal cold structure was removed in the Cerro Pachón laboratory, where it was then opened to allow access to the camera turret and other mechanisms.



The GNIRS main cold structure after removal from the dewar, prior to accessing the internal mechanisms. The work is done in clean environment to avoid contamination. The individuals in the photo are Felipe Daruich (left, Gemini) and Ron George (right, NOAO).

The following tasks were undertaken on GNIRS:

- The final lens in each of the short-focus cameras (0.15 arcsec/pixel) was replaced with a lens with a thorium-free, antireflection coating. This pixel scale is the most frequently used, since it provides a good match to the telescope's typical image quality. The lens change will eliminate the particle events seen with these cameras, resulting in better signal-to-noise on long integrations. Only the final lenses of these two cameras required replacement, since the detector does not have an unblocked and unfolded line of sight to the other lenses, nor to the lenses in the long-focus cameras. The alpha particles emitted by the thorium do not have enough energy to pass through metal or optical materials.



The GNIRS camera turret after lens replacement, prior to installation in the cold structure. The view is from the rear (a "detector's eye view"). The lenses that were replaced are the two on the top right and bottom left.

- Three new filters were installed:
  - A replacement blocking filter for the cross-dispersed mode, which provides continuous coverage at spectral resolution ~1,800 from 2.5 microns down to below 0.9 microns. The new filter has better overall transmission, especially at wavelengths below 1 micron, where the improvement should be at least 20 percent. There is no "blue" cutoff with the new filter, but performance at and below 0.8 microns may still be limited by the rest of the optics.
  - Two narrowband filters intended primarily for acquisition. One is a 1.5 percent narrowband filter centered on the 2.12-micron H_2 line, and the second is a 1.5 percent narrowband filter centered on the 3.3-micron polycyclic aromatic hydrocarbon (PAH) feature. The H_2 filter is intended for use in acquiring

continued

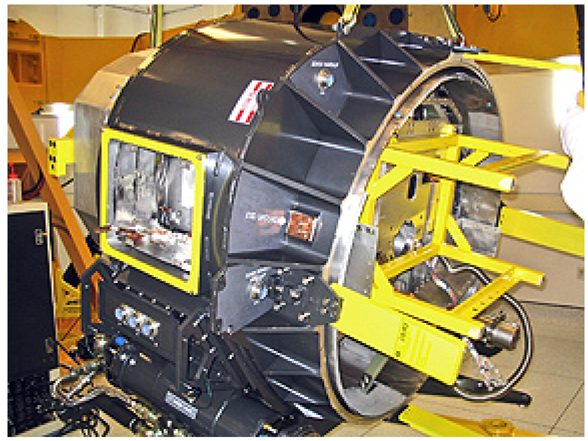
GNIRS Servicing Mission continued

Installing a lens using the NOAO vacuum chuck. This work is done in a "clean room" to prevent contamination of the optics.

bright objects (e.g., standards) and for diffuse objects with molecular hydrogen emission (e.g., Herbig-Haro objects). The PAH filter is intended to allow acquisition of objects at 3 microns, where the standard order sorter has too much background, and should also permit acquisition of diffuse objects with strong PAH emission.

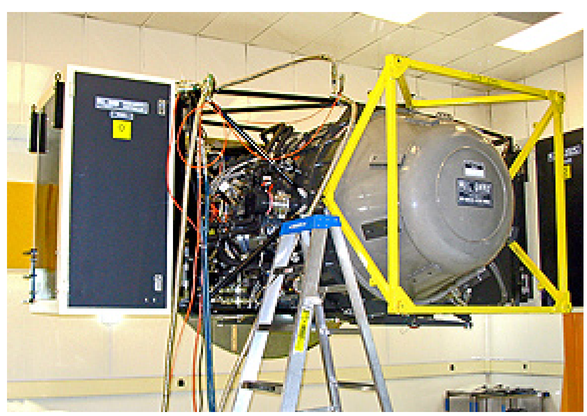
- The on-instrument wavefront sensor (OIWFS) gimbal mirror was modified to cure a mechanical interference that cut off one corner of the patrol field. This modification will allow the OIWFS to be used for better flexure correction or for guiding where there are no visible-wavelength guide stars. Additional software work is required to implement these capabilities, so they will not be available immediately.
- A problem with the detector grounding was identified and cured; this should help with the noise "bands" seen in some GNIRS data. The detector operating parameters (mainly temperature) were also reevaluated.
- All four of the coldheads were rebuilt; this should provide reliable operation for at least another year.
- Finally, the team took advantage of having the instrument fully disassembled to inspect major mechanisms for wear and make minor adjustments.

Following the work detailed above, the cold structure was re-assembled and its optical alignment was verified, after which it was reinstalled in the dewar. The instrument was then fully reassembled for verification.



Going back together. The main cold structure is installed in the dewar mid-section. Note the handling fixtures still attached to the dewar shell (right) and cold structure (at both ends).

Initial verification of the work has been carried out in the Cerro Pachón laboratory, including tests on the flexure rig. These initial tests include mechanism calibration and reoptimization of detector parameters. At the time this article was written, further testing on the telescope was scheduled for mid-August and should be complete prior to the call for proposals, unless bad weather intervenes. Additional commissioning time is scheduled for mid-September, if required.



GNIRS back in service on the Cerro Pachón flexure rig prior to testing.

NGSC Instrumentation Program Update

Taft Armandroff & Mark Trueblood

The NGSC Instrumentation Program continues its mission to provide innovative and capable instrumentation for the Gemini telescopes in support of frontline science programs. This article gives a status update on Gemini instrumentation under development in the United States, with progress since the June 2005 *NOAO-NSO Newsletter*.

NICI

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

NICI is in the final assembly and test phase of the project. A detailed cold test of the integrated NICI system took place in May and June. The two Aladdin array detectors and the NICI array electronics are performing near specification. The NICI high-level software is being used to interface with the NICI arrays/controllers, motors, and temperature controllers.

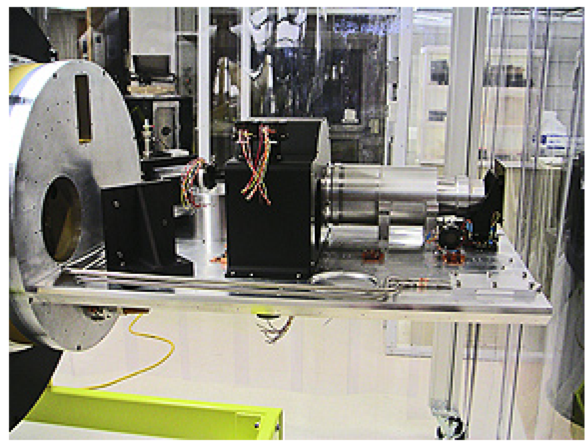
As of the end of June, MKIR reported that 97 percent of the work toward final acceptance of NICI by Gemini is complete. NICI is expected to be deployed on Gemini South in 2005.

FLAMINGOS-2

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

The FLAMINGOS-2 team is proceeding with the integration and testing phase of the project. FLAMINGOS-2 has two cryostats: the main cryostat that contains the collimator, grisms, camera, and detector; and the "MOS" cryostat that contains the masks for multi-object spectroscopy, and the wheel and mechanism that select a mask for observing. Both cryostats are now assembled and mostly populated. Florida has successfully carried out cold testing and vacuum testing of both cryostats. In addition, the FLAMINGOS-2 array controller has been used to read out the detector multiplexer.

As of July, Florida reports that 78 percent of the work toward FLAMINGOS-2 final acceptance by Gemini is complete.



The FLAMINGOS-2 camera bench and bulkhead, with the filter wheel box, mirror mounts, camera lens tube assembly, and detector focus stage visible. The liquid nitrogen pre-cool lines are visible on the left, and running along the optical bench.

FLAMINGOS-2, supported vertically in its handling and flexure-testing cart, is shown with University of Florida engineering team members Jeff Julian (left) and Greg Bennett (right).

NOAO 2006A Observing Proposals Due 30 September 2005

Todd Boroson

Proposals for NOAO-coordinated observing time for semester 2006A (February–July 2006) are **due by Friday evening, 30 September 2005, 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 the Keck Telescopes, the Hobby-Eberly Telescope, 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 the Gemini 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.*

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

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

Todd Boroson & Dave Bell

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

- **Keck Telescopes**—A total of 12 nights of classically scheduled observing time will be available with the 10-meter telescopes at the W. M. Keck Observatory on Mauna Kea. All facility instruments and modes are available, including the interferometer. For the latest details, see *www.noao.edu/gateway/keck/*.
- **Hobby-Eberly Telescope**—About 76 hours of queue observations are expected to be available at the 9.1-meter-effective-aperture Hobby-Eberly Telescope (HET) 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. Recently added PI instruments include MegaCam, Hectospec, Hectochelle, and ARIES. For further information, see *www.noao.edu/gateway/mmt/*.

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

Three New NOAO Survey Programs

Tod Lauer

Three new NOAO Survey Programs have been approved, with observations beginning in the second semester of 2005. The programs were selected from 14 proposals submitted in response to an announcement of opportunity.

The three new surveys selected are "A Census of the High Redshift Radio Universe," Principal Investigator (PI) Andrew Connolly (University of Pittsburgh); "Optical Follow-up of the XMM Cluster Survey: The XCS-NOAO Survey," PI Christopher Miller (NOAO); and, "SZE+Optical Studies of the Cosmic Acceleration," PI Joseph Mohr (University of Illinois).

The Connolly et al. survey will use the FLAMINGOS instrument at the KPNO 4-meter, in conjunction with existing optical and radio surveys, to identify a large and complete sample of radio galaxies at z>1.7. The survey's primary science goals are to understand the timescales for evolution of stellar populations at high redshift, as well as to determine the clustering and luminosity function evolution of the most massive galaxies in the Universe. The goal is to observe 13 square-degrees of the sky to a limiting depth of K_s=20.5. The survey team will deliver the calibrated images and source catalogs, as well as immediate release of the raw images.

The Miller et al. program will use both the KPNO 4-meter and CTIO 4-meter Mosaic imagers to image more than 500 clusters detected in XMM-Newton observations. The survey's scientific goals are to study the evolution of the X-ray luminosity-temperature relation, cluster formation, and the evolution of the interaction of cluster galaxies and cluster intergalactic medium over the last eight billion years. The survey should also yield interesting constraints on Ω_m and Ω_Λ. Images will be obtained in the SDSS r' and z' bands to depths of 24.7 and 22.2 (Vega) respectively, for more than three hundred Mosaic fields. The team will provide reduced images and source catalogs.

The Mohr et al. survey will use the CTIO 4-meter Mosaic imager to survey 100 square-degrees of the sky in the *griz* bands to target depths of 24.0, 23.9, 23.6, and 22.3. The images will be used to identify galaxy clusters in conjunction with ongoing millimeter-wavelength Sunyaev-Zeldovich effect (SZE) surveys studying the expansion history of the Universe out to z=1. Stacked images and source catalogues will be delivered to the NOAO Science Archive.

CTIO Instruments Available for 2006A

Spectroscopy	Detector	Resolution	Slit
4-m Blanco			
Hydra + Fiber Spectrograph	SITe 2K CCD, 3300–11000Å	300–2000	138 fibers, 2" aperture
R-C CCD Spectrograph[1]	Loral 3K CCD, 3100–11000Å	300-5000	5.5'
4-m SOAR[2]			
Goodman Spectrograph	Lincoln 4K×4K mosaic 3100–11000 Å	1400–6000	5'
OSIRIS IR Imaging spectrograph	HgCdTe 1K, JHK windows	1200, 3000	1.3', 3.3'
1.5-m[3]			
Cass Spectrograph	Loral 1200×800 CCD, 3100-11000Å	<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 (2048×2048, 1.0–2.4μm)	0.3	11'
4-m SOAR			
Optical Imager	E2V 4K×4K Mosaic	0.08	5.5'
OSIRIS IR Imaging Spectrograph	HgCdTe 1K	0.14, 0.35	1.3', 3.3'
1.3-m[4]			
ANDICAM Optical/IR Camera	Fairchild 2K CCD	0.17	5.8'
	HgCdTe 1K IR	0.11	2.0'
1.0-m[5]			
Direct Imaging	4K CCD	0.29	20'
0.9-m[6]			
Cass Direct Imaging	SITe 2K CCD	0.4	13.6'

[1] Availability of this instrument in 2006A will depend on the status of the Goodman spectrograph on SOAR.
[2] The amount of science time available on SOAR in 2006A will be announced later.
[3] Service observing only, instrument will be on the telescope 6 weeks on, 6 weeks off, alternating with CPAPIR. The latter will not be available to the NOAO community.
[4] Proposers who need the optical only will be considered for the 0.9m unless they request not to be.
[5] Classical observing only. No specialty filters, no region of interest.
[6] Classical or service, alternating 7-night runs.

Gemini Instruments Possibly Available for 2006A*

GEMINI NORTH	Detector	Spectral Range	Scale ("/pixel)	Field
NIRI	1024×1024 Aladdin Array	1–5µm R~500–1600	0.022, 0.050, 0.116	22.5", 51", 119"
GMOS-N	3x2048×4608 CCDs	0.36–1.0µm R~670–4400	0.072	5.5' 5" IFU
Michelle	320×240 Si:As IBC	8–25µm R~200–30,000	0.10 img, 0.20 spec	32"×24" 43" slit length
Altair (feed to NIRI)	1024×1024 Aladdin Array	1–2.5µm R~500–1600	0.022	22.5"

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	8–25µm R~100,1000	0.09	28"×21"
Phoenix	512×1024 InSb	1–5µm R ≤70,000	0.085	14" slit length
Acquisition Camera	1K×1K frame-transfer CCD	BVRI	0.12	2'×2'
bHROS[1]	2–2048×4608 CCDs	0.4–1.0µm R~150000		0.7" or 1" fiber

* Please refer to the NOAO Proposal Web pages in September 2005 for confirmation of available instruments
[1] Pending complete commissioning.

KPNO Instruments Available for 2006A

Spectroscopy	Detector	Resolution	Slit	Multi-object
Mayall 4m				
R-C CCD Spectrograph	T2KB/LB1A CCD	300–5000	5.4'	single/multi
MARS Spectrograph	LB CCD (1980×800)	300–1500	5.4'	single/multi
Echelle Spectrograph	T2KB 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, 0.9–2.5mm)	300, 1000, 3000	3.4'	single/multi
WIYN 3.5m				
Hydra + Bench Spectrograph	T2KA CCD	700–22000	NA	~100 fibers
DensePak[3]	T2KA CCD	700–22000	IFU	~90 fibers
SparsePak[4]	T2KA CCD	700–22000	IFU	~82 fibers
2.1m				
GoldCam CCD Spectrograph	F3KA CCD	300–4500	5.2'	
FLAMINGOS	HgCdTe (2048×2048, 0.9–2.5µm)	1000–3000	20'	

Imaging	Detector	Spectral Range	Scale ("/pixel)	Field
Mayall 4m				
CCD Mosaic	8K×8K	3500–9700Å	0.26	35.4'
SQIID	InSb (4-512×512)	JHK + L (NB)	0.39	3.3’ circular
FLAMINGOS	HgCdTe (2048×2048)	JHK	0.3	10’
WIYN 3.5m				
Mini-Mosaic[5]	4K×4K CCD	3300–9700Å	0.14	9.3'
WTTM	4K×2K CCD	3700–9700Å	0.11	4.6'x3.8'
2.1-m				
CCD Imager	T2KB/F3KB CCD	3300–9700Å	0.305	10.4'
SQIID	InSb (4-512×512)	JHK +L(NB)	0.68	5.8' circular
FLAMINGOS	HgCdTe (2048×2048)	JHK	0.61	20'
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 will only be available on a shared risk basis during either April or May.
[3]Integral Field Unit: 30"×45" field, 3" fibers, 4" fiber spacing @ *f*/6.5; also available at Cass at *f*/13.
[4]Integral Field Unit, 80"×80" field, 5" fibers, graduated spacing.
[5]OPTIC Camera from Univ. of Hawaii may be assigned as alternative; fast guiding is not a supported mode for NOAO users.

HET Instruments Available for 2006A

	Detector	Resolution	Slit	Multi-object
LRS (Marcario low-res spec)	Ford 3072×1024			
	4100-10,000Å	600	1.0"-10"×4'	13 slitlets, 15" × 1.3" in 4' × 3' field
	4300-7400Å	1300	1.0"-10"×4'	13 slitlets, 15" × 1.3" in 4' × 3' field
	6250-9100 Å	1900	1.0"-10"×4'	13 slitlets, 15" × 1.3" in 4' × 3' field
MRS (med-res spectrograph)	(2) 2K×4K, 4200-9000 Å	7000	2.0" fiber	single
		9000	1.5" fiber	single
HRS (high-res spectrograph)	(2) 2K×4K 4200-11,000Å	15000-120000	2"or 3" fiber	single

MMT Instruments Available for 2006A

	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 2006A

	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)	2048x2048 CCD		BVRI, u'g'r'i'z'	0.07	2.36′
LDSS3 (mslit spec/img)	4K×4K CCD	R~850-1900	0.36-1.0μm	0.19	8.3′
MIKE (echelle/multi spec)	2K×4K CCD	R~19000-65000	0.32-1.0μm	0.14	30′ (~200 fibers)

Keck Instruments Available for 2006A

	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	2 × 8′
NIRSPEC (near-IR echelle)	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′
Interferometer					
IF *(see http://msc.caltech.edu/KISupport/)*					

Observing Request Statistics for 2005B Standard Proposals

	No. of Requests	Nights Requested	Average Request	Nights Allocated	DD Nights (*)	Nights Previously Allocated	Programs For New Scheduled Nights	Over-subscription
GEMINI								
Gemini North	121	156.81	1.3	45.06	5.7	0	45.06	3.48
Gemini South	107	183.58	1.72	48.075	16.4	0	48.075	3.82
CTIO								
CT-4m	74	257.5	3.48	98.5	1	9	89.5	2.88
SOAR	10	24.5	2.45	14	0.5	0	14	1.75
CT-1.5m	7	29	4.14	21	0	0	21	1.38
CT-1.3m	15	52.82	3.52	17.95	0	0.4	17.55	3.01
CT-1.0m	12	58	4.83	67.53	0	0	67.53	0.86
CT-0.9m	15	112.5	7.5	45	0	0	45	2.5
KPNO								
KPNO-4m	63	226.5	3.6	70.5	0	0	70.5	3.21
WIYN	40	122.35	3.06	46	11	5	41	2.98
KPNO-2.1m	30	156.2	5.21	117.5	0	7.5	110	1.42
KPNO-0.9m	10	49	4.9	32.5	0	0	32.5	1.51
Community Access								
HET	8	13.15	1.64	7.15	0	0	7.15	1.84
Magellan-I	3	8	2.67	3	0	0	3	2.67
Magellan-II	8	15	1.88	4	0	0	4	3.75
MMT	9	19	2.11	11	0	0	11	1.73

*Nights allocated by NOAO Director

PROMPT Progress

Dan Reichart (University of North Carolina at Chapel Hill)

The University of North Carolina (UNC) at Chapel Hill is currently building the Panchromatic Robotic Optical Monitoring and Polarimetry Telescopes (PROMPT) on Cerro Tololo, on the ridge between the GONG and 1.3-meter telescopes. PROMPT's primary objective is rapid and simultaneous multiwavelength observations of gamma ray burst (GRB) afterglows, some when they are only tens of seconds old. In addition to measuring redshifts by dropout, and early-time spectral flux distribution (SFDs) and extinction curves of sufficiently bright afterglows in unprecedented detail, PROMPT will facilitate quick response observations at 8.1-meter Gemini South and 4.1-meter SOAR telescopes. PROMPT will also serve as a platform for undergraduate and high school education throughout the state of North Carolina.

Four of the six PROMPT enclosures have already received 12-foot diameter clamshell domes built by Astro Haven. The remaining two enclosures will receive domes in September 2005. Live images of PROMPT can be viewed at www.physics.unc.edu/~evans/promptcam/promptcam.html.

When complete in late 2005, PROMPT will consist of six 0.41-meter Ritchey-Chrétien telescopes built by RC Optical Systems on rapidly slewing (9°/sec) Paramount ME mounts by Software Bisque, each under a clamshell dome by Astro Haven. Five of these telescopes are being outfitted with rapid-readout (<1 sec) Alta U47+ cameras by Apogee, which make use of E2V CCDs. The sixth is being outfitted with an LN2-cooled Micro-Cam by Rockwell Scientific for near-infrared (NIR) imaging. Each mirror and camera coating combination is optimized for a different wavelength range, including a u-band optimized telescope. Although other filters will be available, PROMPT will automatically observe GRB localizations in ugrRizYJH, six of them simultaneously. The R-band telescope

From left to right, the PROMPT-5, -3 and -2 telescopes. We have been using three 0.36-meter Schmidt-Cassegrain telescopes from Celestron while our final optics are being prepared. In September 2005, we will upgrade to six 0.41-meter Ritchey-Chrétien telescopes by RC Optical Systems.

will additionally measure polarizations. The polarimeter is being designed and built at UNC-Chapel Hill's Goodman Laboratory for Astronomical Instrumentation.

PROMPT is being built in two phases: Phase I, funded by $130,000 from UNC-Chapel Hill and a $100,000 gift from alumnus Leonard Goodman, began in September 2004 and is now complete. Phase I consisted of enclosure construction and assembly of temporary 0.36-meter Schmidt-Cassegrain telescopes from Celestron, with the goals of establishing reliable and robust operations, and testing software. Phase II, funded by $912,000 from NSF's MRI and PREST programs, begins in September 2005 and will consist of upgrading to final optics: the NIR camera, and the polarimeter.

Although early science technically does not begin until after the September trip, PROMPT has already observed nine GRB localizations, two within minutes of the burst, and two with detected afterglows. These results are being prepared for submission to the *Astrophysical Journal* in combination with Follow-Up Network for Gamma-Ray Bursts (FUN GRB) Collaboration data from SOAR, the 3.5-meter ARC, 1.5-meter Kuiper, and 0.9-meter SARA telescopes. PROMPT collaborating institutions (see list on next page) will gain access to 30 percent of PROMPT's time beginning in January 2006. The broader US astronomical community will be invited to apply for 10 percent of PROMPT's time, with awards beginning in Semester 2006B.

continued

PROMPT Progress continued

"Skynet," a prioritized queue scheduling system under development at UNC-Chapel Hill, controls PROMPT. This queue scheduling system, written in LabVIEW, runs on a computer at UNC-Chapel Hill's Morehead Observatory. Skynet interacts with MySQL databases and commands dumb-by-design "Terminator" programs at each telescope. Images are automatically transferred back to a 1.1-terabyte RAID 5 with tape backup at Morehead Observatory, making use of communication libraries written for remote use of SOAR. Users can submit jobs and retrieve data from any location via a PHP-enabled Web server that interacts with the MySQL databases. GRBs receive top priority, and are added automatically to the queue via a socket connection.

Furthermore, we have written Terminator very generally to allow any mount that can be controlled by "The Sky" and any camera that can be controlled by MaxIm DL, or mounts and cameras that are ASCOM compliant, to be easily integrated into Skynet. On this note, work is underway to integrate a few half-meter-class facilities across the United States this academic year, supported in part by an NSF CAREER grant. Skynet will then synchronize GRB observations across these telescopes, which makes interpreting SFDs much easier, especially if the afterglow is not fading as a power law at early times. When not chasing GRBs, which is most of the time, network members will be able to queue jobs on each other's telescopes, including PROMPT, at a guest priority level, giving them access to additional facilities and instrumentation, not to mention sky coverage and weather flexibility.

Between HETE-2, Integral, and now Swift, we expect PROMPT to observe GRB localizations on the rapid timescale about once every three months, and on longer timescales about once every week. Given our best estimates about the star-formation rate at high redshifts, we might observe $z > 5$ GRBs on the rapid timescale as often as once per year, and $z > 7$ GRBs on the rapid timescale perhaps once every two to three years. PROMPT's ability to observe afterglows simultaneously in many filters, including near-IR filters, and to do so quickly before the afterglow fades away, will allow it to "promptly" pick out record-breakers.

Record-breaker or not, we will use PROMPT to facilitate our quick response programs on Gemini South and SOAR, which are only one mountaintop away. UNC-Chapel Hill and the FUN GRB Collaboration, in a coalition with the US/UK Gemini GRB Collaboration, have been awarded 21 hours of quick-response time on Gemini South in Semester 2005B. Additionally, UNC-Chapel Hill has a three-year commitment from the SOAR Board to interrupt on the rapid timescale. Both telescopes are capable of near-IR and optical spectroscopy and imaging, and are able to switch instruments within minutes. A trained GRB observer will help coordinate PROMPT, SOAR, Gemini South, and FUN GRB Collaboration efforts from UNC-Chapel Hill's new Henry Cox Remote Observing Center each night.

PROMPT will also be used by undergraduate and high school students from across the state of North Carolina for a wide variety of projects. In addition to UNC-Chapel Hill, PROMPT Collaboration institutions include Appalachian State University, Elon University, Fayetteville State University, Guilford Technical Community College, North Carolina Agricultural and Technical State University, UNC-Asheville, UNC-Charlotte, UNC-Greensboro, UNC-Pembroke, Western Carolina University, and Hampden-Sydney College just across the state line in southern Virginia. Each of these institutions will have about 420 hours per year of observing time distributed among the six PROMPT telescopes, giving them guaranteed access to a professional observatory and the southern sky.

UNC students Matt Bayliss and Melissa Nysewander, with PROMPT-2's temporary telescope in the background. Nysewander is the lead graduate student on PROMPT. Bayliss is writing GRBFAST, general-purpose software for afterglow and extinction curve modeling for PROMPT and other FUN GRB telescopes.

Furthermore, since PROMPT is fully robotic, none of these institutions will have to raise additional money to send students to Chile to use the telescopes — a very expensive proposition. Rather, students will simply submit observing requests to Skynet using the Web interface.

Finally, UNC-Chapel Hill's Morehead Planetarium and Science Center (MPSC) will have about 2,300 hours per year for K-12 education and public outreach. MPSC hopes to bring PROMPT into every high school in the state of North Carolina. Funded by a $50,000 NASA/STScI IDEAS grant, MPSC is developing a curriculum for high school science classes allowing them to submit observing requests to Skynet using the same interface that the undergraduate college students will use. This curriculum will also satisfy new statewide graduation requirements.

Charon Occultation Observed at SOAR and CTIO

Leslie Young, Cathy Olkin, Trina Ruhland, Eliot Young (Southwest Research Institute), Dick French (Wellesley College), Kevin Shoemaker (Shoemaker Labs), Ramon Galvez & Brooke Gregory (NOAO)

How can we measure the size of Pluto's moon, Charon, when it subtends only one-twentieth of an arcsec? Even with the Hubble Space Telescope or adaptive optics, imaging cannot resolve Charon. One solution was to observe Pluto and Charon during Pluto's equinox, when the two bodies eclipsed and transited each other, but this method gave conflicting radius measurements ranging from 593 to 620 kilometers (Tholen & Buie 1990, BAAS 22, 1129; Young & Binzel 1994, Icarus 108, 219).

A more direct method is to measure stellar occultation by Charon passing in front of a star, as seen by observers within the shadow path on Earth. If the velocity of Charon is known, then a chord length can be derived from the duration of the star's disappearance. Combining observations from multiple sites gives a raster scan across Charon, revealing its shape and size. One Charon occultation has been observed previously, in 1980 by current CTIO Director Alistair Walker (MNRAS 192, 47), but with one chord across Charon, this observation only set a lower limit to the radius.

An accurate value of the radius of Charon would improve our understanding of the Pluto-Charon system. Charon's energy budget and spectral modeling depend on its radius through its albedo. Charon's surface gravity, escape velocity, and density depend on its radius, which affects our models of Charon's composition and formation. The current uncertainty in Charon's radius allows for Charon densities ranging from 1.6 to 1.8 grams per cubic centimeter. Finally, an occultation is capable of detecting even a tenuous atmosphere, if one is present.

In the summer of 2004, three groups coordinated plans to observe the predicted 11 July 2005 (UT) occultation by Charon: a group from Meudon, France, led by Bruno Sicardy; a group from MIT/Williams College led by Jim Elliot; and our group, from SwRI/Wellesley College/Lowell Observatory, led by Leslie Young. Our group observed at SOAR, the CTIO 4-meter Blanco and the CTIO 0.9-meter telescope.

The location of these telescopes, on two mountaintops next to each other, simplified logistics and provided redundancy in case of equipment problems. This coordination was crucial, as the maximum duration of the occultation was predicted to be only 56 to 58 seconds. Everything needed to be working for one critical minute near 11:36 p.m. on July 10 (local time).

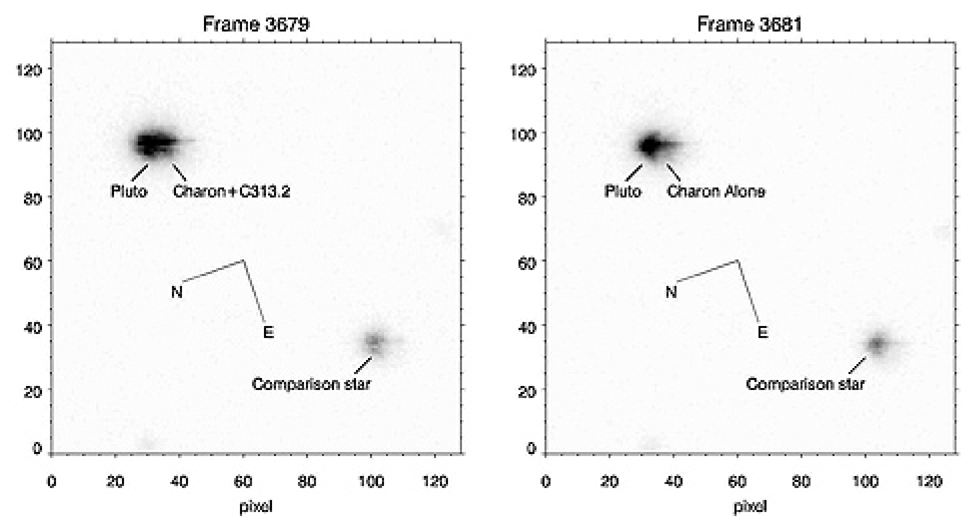


Figure 1. Two frames from the 7200-frame event sequence from SOAR/PHOT: pre-event (left) and during the event (right).

For the SOAR observations, we used one of our Portable High-speed Occultation Telescope (PHOT) cameras, a new camera and timing system that had not been mounted on SOAR before. The observers were Eliot Young, who leads the PHOT development, and Kevin Shoemaker, who designed and built the GPS-based timing unit for PHOT.

Thanks to sterling support from SOAR and NOAO, including Steve Heathcote, Hugo Schwarz, Clark Enterline, Patricio Schurter, Daniel Maturana, Esteban Parkes, Herman Diaz,

continued

Charon Occultation Observed continued

and Sergio Pizaro, we were able to get first light with SOAR/PHOT on Eliot and Kevin's first evening on Cerro Pachón, July 7. The camera, a Princeton Instrument MicroMAX:512BFT from Roper Scientific, is a 512×512 frame-transfer CCD with essentially no dead time. We mounted with no reimaging optics, so our 13-micron pixels gave us a field of view of only 21 arcsec. For the event, we ran at 0.2-sec integrations from the GPS-slaved timing unit, binning 4×4 on-chip for an effective plate scale of 0.16 arcsec/pixel. Figure 1 shows two frames from the event sequence, with Pluto-Charon-C313.2 and our comparison star. These observations are the first science results from these new, NSF-funded cameras.

Dick French and Brooke Gregory, who had observed Uranus occultations in the infrared, together at CTIO a decade earlier, observed the two half-nights dedicated to this program (June 8 and 10) at the CTIO 0.9-meter using the Tek2K #3 CCD. The High-Speed Photometry (HSP) mode written by Roger Smith was used, which allows high-speed readout of two selectable Regions of Interest (ROIs) next to the serial register by alternately erasing, exposing, and then reading the same small number of rows during a long sequence. This is precisely the mode needed for occultations.

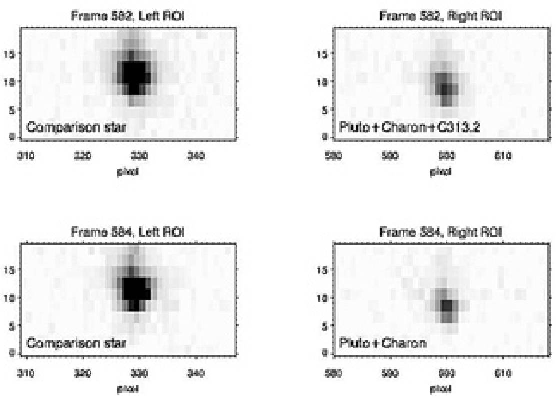


Figure 2. Two frames from the 600-frame event sequence from CTIO 0.9-meter telescope: pre-event (top) and during the event (bottom).

In practice, this rarely used mode needed considerable "dusting off," but with the help of Rolando Cantarutti, David Rojas, Javier Rojas, Enrique Schmidt and Humberto Orrego, we managed to get the HSP mode up and running before the observing run. During the practice night, Dick, Brooke, and Ramon Galvez (with Cathy Olkin, Trina Ruhland, and Leslie Young) were able to rotate the CCD to align the ROIs with the serial register and set up ROIs on both C313.2 and the comparison star USNO B1.0 0749-0387850.

Brooke, Dick, and Ramon spent much of July 8, 9 and 10 exercising the system and running tests that will allow us to confirm absolute timing. During the morning of July 9, we were facing two instrument problems: a time-out error for integration sequences longer than about four minutes, and a limit on the number of total rows recorded in one file, in effect a limitation on the number of exposures. This situation was problematic in light of a large change in the predicted shadow path released by the MIT group that morning. Although the update altered our predicted miss distance more than our event times, we took this as an indication of the level of uncertainty, suggesting the time of the event could plausibly be off by 60 seconds. We were facing difficult choices: at one extreme, we could save only four rows per image with 1.5 arcsec per pixel binned resolution, compromising our photometry; while at the other extreme, we could run for only two minutes, risking missing either ingress or egress entirely.

Thanks to the intervention of old Arcon-hand Steve Heathcote, who came over from Cerro Pachón, both problems were solved by the afternoon of July 10. We were able to choose our observing mode to maximize our science. For the event, we ran a ten-minute sequence at 0.5-second exposures, with 38×20 pixel ROIs (14.9 arcsec × 7.8 arcsec), binned by two in rows (see figure 2).

The observations at the CTIO Blanco 4-meter telescope with the Mosaic II CCD were the most challenging. Since the readout time of Mosaic II is 100 seconds, longer than the maximum event duration, we instead used the technique of trailing the images. By driving the telescope at a nonsidereal rate, the merged Pluto-Charon-C313.2 image was smeared out, letting us use location along the trailed image as a proxy for time.

Observers Cathy Olkin, Trina Ruhland, and Leslie Young had only the hours before the event to make some critical decisions: What filter to use? Which of Mosaic II's eight CCDs to use? What direction to trail, and at what speed? How long to trail? This last was the most complex of the questions. A trail with a shorter angular length has less overlap between stars, but needs either a short duration (which might miss the event) or slow rates (which makes us more sensitive to pointing errors from tracking or seeing).

We had an idea of our optimum choices from the Mosaic II exposure time calculator, and simulated trails we had made from images taken at SOAR in I and R, but they had to be confirmed at the telescope. Further, we needed to work out a scheme to assure ourselves of the timing of the images. With the support of Knut Olsen, Tim Abbot, Mauricio Fernandez, and Hernan Tirado, we were able to work out a timing scheme (comparing the time of the audible

continued

Charon Occultation Observed continued

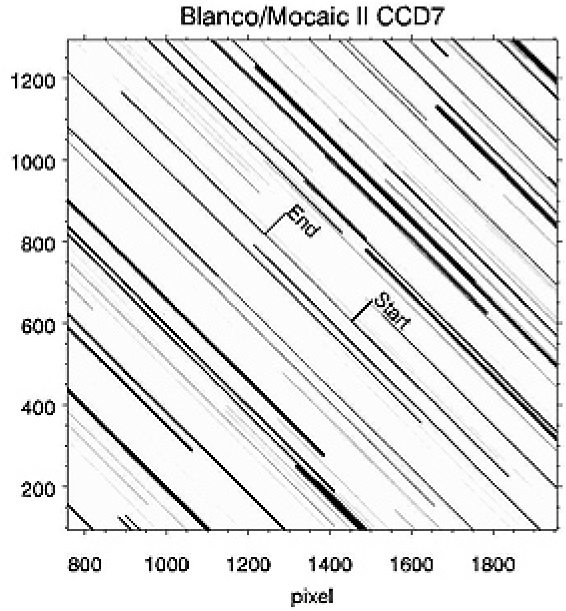


Figure 3. The occultation image obtained at the CTIO 4-meter telescope. Between "Start" and "End," the trail has only Pluto and Charon, while the rest of the trail also has C313.2.

operation of the pneumatic pump that opens the shutter with the header information). We were also able to get familiar enough with the data viewing and quick-analysis software to decide to use I-band to slew the telescope at 1.5-arcsec-per-second trailing to the North-West (see figure 3).

The weather on the night of the event was photometric, with 0.5- to 0.6-arcsec seeing. All three telescopes observed the event, with sequences immediately before and after, and observations taken an hour or more before and after, when Pluto-Charon and C313.2 were clearly separated.

Within a half-hour of the event, observers at all three telescopes reported a successful observation of Charon, with estimated durations near 55 seconds (see figure 4), and no evidence of an atmosphere. We will use the three chords together to confirm the absolute timing of the event, as each instrument used a different scheme to establish the timing, to give a more accurate duration of the event, and to place tighter limits on a Charonian atmosphere.

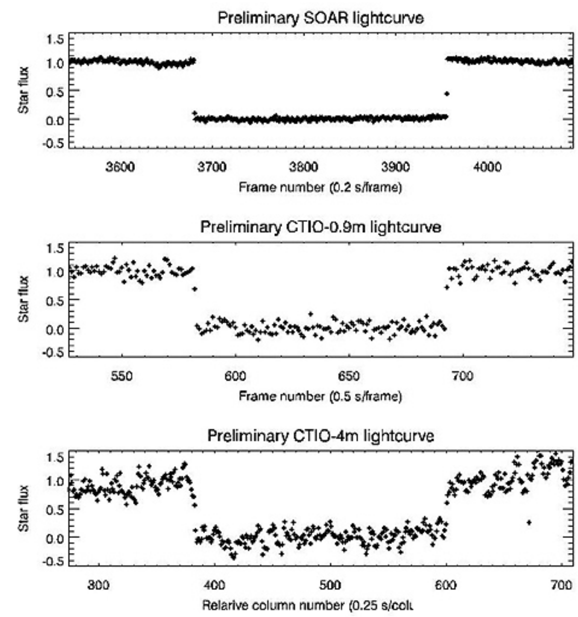


Figure 4. Preliminary lightcurves from SOAR (reduction by Eliot Young), CTIO 0.9-meter (reduction by Dick French) and CTIO 4-meter (reduction by Cathy Olkin).

SMARTS 2

Alistair Walker

The SMARTS consortium has been operating the small telescopes, regarded by all as an unqualified success, at CTIO since February 2003. As a consortium member, NOAO provides three of the four telescopes (the fourth is the Yale 1.0-meter) and some of the instruments, in exchange for 25 percent of telescope time for the general community. Other consortium members provide instruments and operations funding, plus day-to-day operations support. Members also schedule the telescopes under the leadership of the SMARTS Principal Scientist, Charles Bailyn of Yale University.

One of the reasons for the success of SMARTS has been that it has NOT been running as a cut-price operation! The telescope operators employed by SMARTS are considered full members of the CTIO TelOps group, and the two observer support

continued

SMARTS 2 continued

specialists, Edgardo Cosgrove and Arturo Gomez, are long-time CTIO employees with much small telescope experience. CTIO engineering staff is on-call, responding to instrument and telescope faults; rapid response is also provided by Ohio State University and the University of Montreal for their instruments, holding the downtime to a very low level. Consortium resources have allowed for installation of new instrumentation, with a variety of observing modes offered: queue scheduled service observing on the 1.3-meter, mixed service-classical on the 0.9-meter and 1.5-meter, and classical on the 1.0-meter. This coordination of resources has allowed for a great variety of programs to be efficiently carried out by consortium members and the NOAO community, from synoptic programs requiring a few minutes per night to large multinight surveys.

The SMARTS agreement expires at the end of 2005, and we hope to continue the program. We have dubbed this phase SMARTS 2, but plan to carry on with only a few changes from the original SMARTS program. All the present consortium members would like to continue, although some members' contribution level will change. There are prospective new consortium members, and space for more participants. We also plan to make SMARTS 2 consortium membership a bit more flexible. It will no longer be necessary to make a three-year commitment—institutions will be able to join, and then drop out when their scientific/financial needs require, as long as they give adequate notice so a replacement partner can be found.

What will it cost to become a member of the SMARTS 2 consortium? Cash contributors should use the algorithm of one night (service observing) = 1.5 nights (on-site observer) = $1,400 for planning purposes.

What telescope/instrument combination will be part of SMARTS 2? We plan to continue with CCD imaging on the 0.9-meter (SITe 2K CCD, 13.5-arcmin square field) and the 1.0-meter (Fairchild 4K CCD, 20-arcmin field), and the simultaneous CCD-infrared (IR) imager ANDICAM on the 1.3-meter. For the 1.5-meter, we expect to begin with a combination of IR imaging alternating CPAPIR (30-arcmin field) with CCD spectroscopy using the RC spectrograph. Much of the IR time in 2006 will be used to complete a SMARTS consortium program. For more details, see *www.ctio.noao.edu/telescopes/smarts.html*.

We are excited about the potential of SMARTS 2, and appreciate any comments you would like to provide (*awalker@noao.edu*). We would also be very pleased to talk to potential new participants!

Other Happenings at CTIO

Staffing Changes at NOAO South

Patrice Bouchet left on July 1 to take up a position at Paris Observatory, after eight years as a CTIO staff scientist. Patrice supported infrared (IR) instrumentation on the Blanco telescope and, more recently, Gemini IR observers via the NOAO Gemini Science Center, particularly for the mid-IR imager/spectrometer T-ReCS. Patrice's research focused primarily on study of the environment of Supernova 1987A, by monitoring evolution of the interaction between the ejecta and the circumstellar ring. Patrice also found time to participate fully in outreach, and is well known throughout Chile as a speaker for schools and the general public.

Also leaving us recently were Gustavo Rahmer and Rafael Hiriart. As a senior electronic engineer, Gustavo was a key developer of the Monsoon detector controller system. Gustavo is taking a position at Caltech. Rafael resigned recently for an opportunity to work on the Atacama Large Millimeter Array at the National Radio Astronomy Observatory in Socorro, NM. While at NOAO, he worked as a computer programmer in the Data Products Program, leading pipeline development.

New SMARTS Instrument

The 4K CCD imager for the 1.0-meter telescope has finally arrived! Regular operations began July 11, after Darren DePoy and associates from the instrumentation group of the OSU astronomy department commissioned the Ohio State University–built camera. The heart of the camera is a thinned, back-illuminated Fairchild 486 CCD, which has back-surface treatment and antireflective coating applied by Mike Lesser of the Steward Observatory Imaging Technology Laboratory. The CCD has a 4096 × 4096 format with 15-micron pixels and four readout amplifiers operated with an Astronomical Research Cameras GenIII Controller. In particular, the CCD has superb U-band quantum efficiency, and excellent cosmetics. More details are available at *www.astronomy.ohio-state.edu/Y4KCam*. For a description of all the SMARTS instruments and other information relating to the SMARTS operation, see *www.ctio.noao.edu/telescopes/smarts.html.*

Judge Dismisses Tohono O'odham Lawsuit

Richard Green

On July 26, US District Judge David Bury issued a judgment that the lawsuit brought by the Tohono O'odham Nation against KPNO, NSF, and Smithsonian over the Very Energetic Radiation Imaging Telescope Array System (VERITAS) project be dismissed.

The Nation had sought a declaratory judgment that we were in violation of the law by not properly consulting with them about the placement of the VERITAS telescopes on Kitt Peak. The judge found that the NSF's decision to restart the Environmental Assessment and Historical Preservation consultation process from the beginning satisfied the Nation's claim sufficiently, and that a declaratory judgment was not warranted. He then went on to state:

> *This Court notes that this entire litigation could have likely been prevented had Plaintiff [the TO Nation] exercised a modicum of diligence from the outset. Defendants repeatedly reached out to Plaintiff's leadership as part of Defendants' original NEPA and NHPA review process.*
>
> * * *
>
> *Plaintiff's obstinate refusal to respond to Defendants' repeated overtures is, frankly, inexplicable. Indeed, this Court is hard-pressed to conceive of a more egregious example of a party sitting on its rights. As such, it would behoove Plaintiff to be more actively involved in Defendants' de novo NEPA and NHPA review. If Plaintiff continues to be as dilatory as it has been in the past, it may find that any future efforts to challenge the VERITAS project barred by laches.*
>
> *Accordingly, IT IS ORDERED that Defendants' Motion to Dismiss is GRANTED and Plaintiff's lawsuit is dismissed without prejudice.*

The Nation may choose to appeal, but the judge's opinion on the merits of the case is very clear. The VERITAS Project is now going through the formal consultation process, which must be successfully concluded for a restart of work on the mountain.

We are very appreciative of the skilled defense presented by the NSF's General Counsel's Office and the Department of Justice. It is also gratifying that the Court recognized our good faith efforts to engage the Nation from the beginning. We will now work for resumption of a more normal two-way dialogue in resolving issues of mutual concern between KPNO and the Tohono O'odham Nation.

SQIID to Be Retired After Semester 2006A

Buell Jannuzi

The anticipated arrival of the new wide-field infrared imager NEWFIRM next year (see companion articles in this *Newsletter*), as well as our need to limit operations costs by constraining the total number of instruments we support, has led to the decision to remove SQIID from the list of available instruments starting with observing semester 2006B. If for some reason NEWFIRM is not available for general proposals in 2006B, we will consider scheduling SQIID in 2006B.

Retiring SQIID has been our stated plan since the development of NEWFIRM began (e.g., NOAO Long-Range Plan from 2001). NEWFIRM will be able to pursue nearly all types of observations previously undertaken with SQIID, with the notable exception of simultaneous multiband observations. SQIID was initially deployed as a wide-field-of-view instrument on the KPNO 1.3-meter telescope. It has since been used extensively at the Mayall 4-meter and KPNO 2.1-meter telescopes, studying a wide range of topics from asteroids, to star-forming regions, to distant galaxies.

We thank those that built, upgraded, and supported this successful instrument over its long and valuable lifetime. In particular, we acknowledge Mike Merrill, Al Fowler, Dick Joyce, Ron Probst, Nick Buchholz, Paul Schmidt, Duane Miller, Steve Rath, Andy Peters, and Rich Lund.

Planning for NEWFIRM Scientific Verification Observations in 2006A

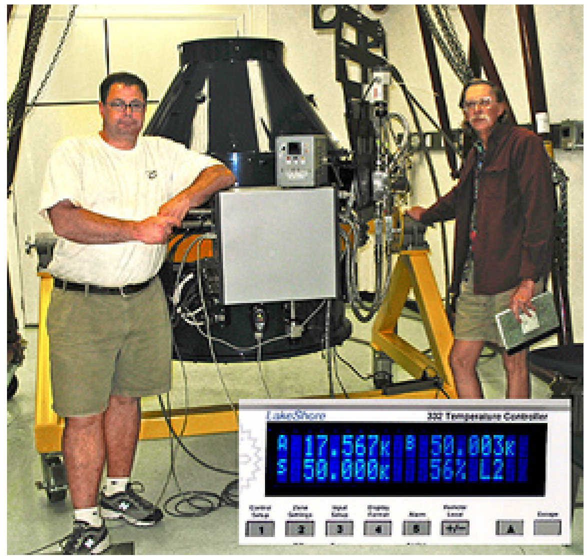
Ron Probst & Buell Jannuzi

The wide-field infrared array camera NEWFIRM is expected to arrive at the Mayall 4-meter telescope for first light early in 2006. We are now planning initial science observations to begin once engineering functionality is demonstrated. As of early August, the instrument had just gone through cold test in the lab, some of the optics were not yet delivered, and we were still producing and evaluating infrared arrays in a foundry run. Thus, it would be premature to schedule NEWFIRM for full public access in 2006A. However, we anticipate a need for science-driven usage in the latter part of this semester. This usage would be for such purposes as identifying and pursuing subtle performance issues, optimizing operating protocols, and finalizing automated data reduction pipelines. We will also need to systematically characterize performance of all the operating modes .

Our approach is to define and carry out a program of science verification (SV) observations, using approximately three to five weeks of 4-meter time in two blocks, likely to be scheduled in May and June 2006. These will be scientifically motivated investigations intended to produce new and interesting results, with perhaps some follow-on utility for data mining. The scale of the observing efforts will range from Principal Investigator-style, two or three night runs with very specific objectives, to possibly a mini-survey with multiple, perhaps exploratory, ends. These data sets will have no proprietary period. They will flow from pipeline reduction directly to a publicly accessible archive.

Ideas for science verification projects have been solicited from NEWFIRM's Science Advisory Group and from project scientific staff. Collectively, this group represents a wide range of scientific interests. Brief preliminary proposals are posted on the NEWFIRM project Web site, *www.noao.edu/ets/newfirm* (click on the link to Science Verification). These scientific ideas must now be fleshed out into real observing proposals, mapped onto operational modes to be sure all modes are exercised, and trimmed to fit the time allocation.

At this time, we are soliciting comments to improve the science value and to help craft these ideas into executable projects. Individual project initiators will carry out the observations, with the possibility of external collaboration. It is vital that the resulting data be rapidly reduced and critically examined in order to provide performance characterization input for the 2006B and 2007A proposal opportunities.



NEWFIRM during first cooldown, with Engineering Associate Ron George (left) and Project Scientist Ron Probst (right). INSET: Coldest temperatures achieved for the array mount (17 K) and the optical bench (50 K).

Parallel reductions with other pipelines or toolkits will be an important part of the validation of NEWFIRM methodologies. Serious offers of assistance with the observation, reduction, and comparative analysis of results will be entertained. While the data will have no proprietary period, hands-on participants can expect some advantage of timeliness.

We plan to have specific projects and their associated science verification teams identified by 1 December 2005. This selection may still over-fill the time allocation. There will be a final review of the science verification plan, after the first light engineering runs with NEWFIRM, in February or March 2006. We expect to carry out the bulk of SV observations in May-June 2006. The project will work with the Science Advisory Group throughout this process to insure that both scientific and technical ends are optimally met.

Comments on the proposed science and its execution, and expressions of interest in participation, may be directed to *rprobst@noao.edu* or *bjannuzi@noao.edu*. Your input may be shared with the Science Advisory Group and internal project participants as we finalize this program.

NEWFIRM: A Look into the Future

Ron Probst, Todd Boroson & Buell Jannuzi

As explained in the previous article, NEWFIRM will see first scientific use in Semester 2006A with a program of science verification observations. This program is intended to produce interesting new scientific results and publicly accessible data sets. However, this initial science verification program will be conducted outside of the normal proposal process.

Contingent on the successful commissioning of the instrument in 2006A, we anticipate that NEWFIRM will be available as a facility instrument for general proposals starting in 2006B. Instrument performance information available before the March 2006 proposal due date will be limited. More complete characterization is one purpose of the science verification program. There will also be some element of "shared risk" in using the instrument system for the 2006B semester, in terms of available filters beyond the J H K_S set and in the performance of the automated reduction pipeline.

The NEWFIRM system is being optimized for large-scale survey science. This is responsive to community needs as identified in several workshops on the US system of facilities and support needs for 6– to 10-meter telescopes. To maintain this objective through the proposal process, we expect to announce the next call for NOAO Survey proposals in 2006, with selected programs beginning observations in the 2007A semester. Under this tentative schedule, the Survey proposal deadline would be in September 2006. The call will be for all instruments and telescopes normally available for Survey proposals, not just NEWFIRM.

Finally, usage in both hemispheres has been a core component of the NEWFIRM concept. NEWFIRM will move between the Mayall 4-meter and the Blanco 4-meter telescopes in the years ahead. Move schedules and time frames are topics of ongoing programmatic discussion within NOAO, with our external advisory and oversight committees, and with the members of our user community.

Stay tuned to the *NOAO-NSO Newsletter*, the NOAO Web site, and the NEWFIRM Project Web site, *www.noao.edu/ets/newfirm*, to keep informed on further developments as this exciting new capability comes into service at NOAO.

IRMOS — Current Status and Opportunity for Shared-Risk Observing

John MacKenty (STScI), Richard Green, Buell Jannuzi & Dick Joyce

The Infrared Multi-Object Spectrometer (IRMOS) is an innovative near-infrared instrument employing an array of MEMS micromirrors for focal plane target selection. IRMOS is a joint project of the Space Telescope Science Institute, the NASA James Webb Space Telescope project and Goddard Space Flight Center, and Kitt Peak National Observatory. We are pleased to announce the availability of the instrument at the Kitt Peak Mayall 4-meter telescope for a portion of the 2006A semester (one lunation in either April or May) on a shared-risk basis.

IRMOS uses a Texas Instruments 848×600 element Digital Micromirror Device (DMD) as a focal plane mask to synthesize slits within a 3×2-arcmin field of view. It provides R~300, 1,000, and 3,000 spectroscopy in the J, H, and K bands plus R~1000 in Z, together with imaging in all bands. On the 4-meter, the image scale is 0.2-arcsec per detector pixel or micromirror element. The instrument spectral resolutions are stated for three mirror-wide (0.6-arcsec) slits (see table), but slits of arbitrary width are allowed. Generally, the image quality is limited to approximately 3 pixels FWHM by the internal optics, with the point spread function of a micromirror being about two detector pixels FWHM.

We have completed five commissioning runs that have validated the basic functions of the instrument and supported continuing software development. At present, software development for basic instrument operation is complete. Mechanisms, detector, and DMD operation via a graphical user interface is well-tested and stable. The thermal operation and monitoring of IRMOS is also mature and mainly transitioned to support by the KPNO staff. Images are provided in FITS format with fairly extensive headers documenting the state of the instrument at the time of the observation.

Future software development is now focused on three aspects: (1) improved tools for slit (micromirror) selection, (2) automation of sequences of operations (scripting), and (3) communication with the telescope control system computer (to first incorporate telescope data into the image headers and

continued

IRMOS—Current Status continued

then to allow IRMOS to command small telescope offsets). These functions should be available by spring 2006. Beyond these, development of a data reduction pipeline and related tools are planned. However, for the 2006A semester, observers will need to handle their own data reduction. Except for the additional step of sky subtraction, existing IRAF multislit reduction routines should be suitable for IRMOS data.

IRMOS will support two primary target definition modes: direct slit positioning and "point-and-click" slit positioning. In the former, the observer defines rectangular regions within the 848×600 element field using either a spreadsheet or GUI interface. Individual slits may be edited and mask patterns saved. Distortion maps for the DMD to Detector and Sky to Detector will be available in November 2005. For programs where the targets are visible in reasonably short exposures (IRMOS can see magnitude 17–18 point sources in J or H in <300 seconds), "point-and-click" mode may be preferred. In this mode, the observer can interactively select slits by clicking with the IRMOS control computer mouse on an image acquired immediately prior to obtaining the spectra. We have also been experimenting with an integral field mode using Hadamard transforms. Some limited software support to generate Hadamard masks and obtain these observations now exists, but data reduction software is still in the experimental stage. This enables full integral field spectroscopy over all (or part) of the IRMOS field of view, with a 2.5×1 arcmin field of view representing a realistic program.

Band Filters	Z(0.85–1.15)	J (1.13–1.35)	H(1.437–1.80)	K(1.947–2.50)
Sub-Band Filters		J1(1.13–1.236) J2(1.235–1.35)	H1(1.437–1.609) H2 (1.608–1.80)	K1(1.947–2.207) K2 (2.206–2.50)
Low Dispersion		188	246	327
Medium Dispersion	1063	1035	1047	1183
High Dispersion		3145 3456	2631 2992	3315 3090

IRMOS Filters and Gratings

Our analysis of IRMOS performance is ongoing. Our imaging backgrounds appear comparable to those reported by FLAMINGOS (in April 2005, IRMOS observed on the 2.1-meter: J=14.8, H=13.5, K=12.0 magnitudes per square arcsec in the CIT/CTIO system). The contrast of the DMD is proving somewhat difficult to quantify but exceeds 100, and may be several hundred. Generally, spectroscopy appears limited by the flux through the "slit" with some diffuse contribution.

Detailed values will be posted to the NOAO proposal Web site in September to aid proposers. However, the general advice is that IRMOS is not yet tested on faint targets, and is probably best used on relatively bright sources and where its multiplex capabilities are most useful. While capable of taking images, IRMOS is not intended as an imaging instrument, and the photometric precision with the DMD is presently unknown.

More details regarding the IRMOS instrument may be found in MacKenty et al., *SPIE* 5492, 1105 (2004).

Advantages to KPNO observers using IRMOS (as compared to FLAMINGOS) are opportunities to obtain spectra with R=3000, create nonrectilinear slit patterns for continuous spatial coverage of nebular features, obtain higher-density coverage of crowded fields with the eventual option of "nodding" a pattern of relatively short slits, and, to experiment with data cube reconstruction through sparse sampling with the Hadamard transform technique. In support of initial programs to gain experience with IRMOS data, the instrument will be scheduled for shared-risk observing on the 4-meter telescope for one lunation in April or May in semester 2006A. The KPNO instrument scientist is Dick Joyce; the principal investigator (John MacKenty) will be actively involved in providing technical information and supporting the inaugural observing runs.

Exabyte Decommissioning

John Glaspey & Buell Jannuzi

Advances in both data storage techniques and data transfer bandwidth have led to the decision to decommission the Exabyte tape drives at the KPNO telescopes. These are seldom used by observers and are becoming difficult and expensive to maintain and repair. Effective at the start of semester 2006A, 1 February 2006, only DAT and DLT tape drives, along with DVD and CD-ROM writers will be available for the 4-meter, WIYN, and 2.1-meter telescopes. We will try to simplify the process of writing data onto whichever media observers choose. Observers are asked to bring blank tapes or disks, but in case of need, some supplies will be available for purchase at the Admin building.

From The NSO Director's Office

Steve Keil

Thanks to everyone who provided input for NSO's response to the NSF Senior Review regarding the utility of current facilities and planning for future facilities. We have incorporated your input into our formal submission, which can be found online at *www.nso.edu/senior_review*, along with the NSO Long-Range Plan. A committee appointed by the NSF is reviewing the responses from the various foundation-supported national facilities, and will make recommendations to the NSF on modifications to facility operations. We strongly encourage anyone interested in a well-planned evolution of the national solar facilities to contact the NSF astronomy division directly with their views.

✷

Although NSO has encountered a delay in obtaining construction funding for the Advanced Technology Solar Telescope (ATST), we believe our long-range plan remains highly responsive to the science goals expressed in the recent decadal surveys of astronomy and the solar and space sciences, as well as the Parker report on ground-based facilities. Over the next few years, the ATST science working group will address the operational modes for the ATST that will best meet the science goals expressed in these documents. We invite the solar community to provide input, and we will organize a community workshop next year to begin laying out operational plans. Please let us know if you are interested in participating. Currently, the ATST project is conducting an environmental impact study of placing the ATST on Haleakala, Hawaii (see related article).

✷

After leading GONG for the past Hale Cycle (22 years), John Leibacher will be handing the reins over to Frank Hill. John shepherded GONG from its infancy into a full-blown, 24-hour-a-day solar-oscillation network that operated from 1995 through 2003 as a global probe of the solar interior. Together with SOHO/MDI data, GONG has yielded new insights on the internal structure and dynamics of the Sun and solar dynamo processes.

At the beginning of the new millennium, John led the upgrade of GONG to GONG++, a high-resolution network capable of imaging not only the global structure of the interior, but local structures in the layers just below the surface, allowing detailed imaging of flows and magnetic field before they emerge into the solar photosphere, as well as high-cadence magnetic flux measurements. Many thanks to John and the excellent service he has provided to the solar community. Frank Hill has been a major player in GONG from the outset, especially in the handling of GONG data and the development of algorithms and techniques to exploit the data. We look forward to working with Frank as GONG++ enters the new era of high-resolution studies of the solar interior.

✷

The NSO Users' Committee has undergone several changes in the past few months. Ernie Hildner (NOAA/SEC), Phil Goode (NJIT), Greg Ginet (AFRL/VSBS, and Phil Judge (HAO) have rotated off the committee. We wish to express our sincere thanks for the guidance they provided as NSO transitioned from a division of NOAO to an independent observatory. Their advice helped make the transition mostly transparent to the users of NSO facilities. Tom Ayres (University of Colorado), who has served as chair for the past several years, is stepping down but has agreed to remain on the committee. Don Jennings and Doug Rabin (NASA Goddard) and Ed Seykora (East Carolina Universtiy) will also remain on the committee. K.D. Leka (NorthWest Research Associates/CORA) was unanimously chosen as the new chair at the latest Users' Committee meeting in New Orleans. We would like to welcome K.D. to that role and we look forward to working with her. As her first act, she organized a very thoughtful response from the committee to the issues of the Senior Review. New members of the committee are Sarbani Basu (Yale University), Carsten Denker (New Jersey Institute of Technology), Joel Mozer (Air Force Research Laboratory), and Steve Tomczyk (High Altitude Observatory). Their next meeting is planned for the end of November. If you have user needs or issues you wish to bring to the committee's attention, please forward your comments to *nso@nso.edu*, or directly to K.D. Leka (*leka@cora.nwra.com*).

✷

Some exciting new science capabilities are now coming on line at NSO facilities. The NSO Array Camera (NAC) obtained first light in July and is undergoing commissioning tests at the McMath-Pierce telescope facility. The NAC is a 1K×1K camera operating in the range from 1000 to 4600 nanometers. This new instrument for forefront investigations in the infrared has enormous potential to collect unique scientific data using spectroscopy and polarimetry. See the related article by Matt Penn for more information, including a "first look" spectrum.

The SOLIS Integrated Sunlight Spectrometer (ISS) is now running a preliminary program of regular observations. The ISS data will become available when comparisons and cross-calibration with other ongoing programs of observation are complete. The Diffraction-Limited Spectro-Polarimeter (DLSP) at the Dunn Solar Telescope (DST) has undergone a series of tests and is now available on a shared-risk basis. We plan to have the final calibration schemes worked

continued

From the NSO Director's Office continued

out in the next month or so and will commission it as a full user instrument. The joint HAO/NSO Spectro-Polarimeter for Infrared and Optical Regions (SPINOR), also at the DST, underwent extensive testing late this spring. SPINOR is intended to extend the spectral capabilities of the Advanced Stokes Polarimeter (ASP) from 750 nanometers to 1600 nanometers with new cameras and polarization optics, and to provide improved signal-to-noise and field of view. Commissioning as a full user instrument is currently planned for 2006. The Italian-built Interferometric BI-dimensional Spectrometer (IBIS) was recently paired with a liquid crystal variable retarder to do diffraction-limited imaging spectropolarimetry at the DST. Observations were made in the Fe I 630 nanometer iron lines, as well as in the chromospheric calcium and sodium lines. Further engineering is needed to optimize the polarimetric performance, at which point IBIS will become available to the community.

NSO is pleased to provide the venue for a Summer School on Solar Physics at Sac Peak from 12–16 June 2006, to be organized by Joe Giacalone of the University of Arizona's Lunar and Planetary Laboratory. This will be an introductory course for beginning graduate students, providing them with a week of lectures, hands-on exercises, and an opportunity to work with the telescopes. Please mark the dates, get the word out to prospective students, and stay tuned!

✷

"SteinFest" – NSO Summer Workshop Honors Bob Stein

Dave Dooling

Theory confronted observation on a mountaintop in New Mexico this summer. No clear winner was declared, but the 23rd Sac Peak Summer Workshop, held 19–22 July 2005, provided a forum for looking toward a new generation of observational tools that will challenge theorists in the coming decades.

It also was an opportunity to honor Bob Stein of Michigan State University on his 70th birthday.

"Bob Stein's work? There are almost no words," said Han Uitenbroek, co-chair of the conference with John Leibacher. "He has done so much."

Stein pioneered computer simulations of magneto-hydrodynamics (MHD), the behavior of electrified gases constrained by magnetic fields. This discipline has applications as varied as the rise and fall of solar activity, supernovae research, and controlled nuclear fusion. In particular, Stein's simulations have helped illuminate events and processes beyond the view of current solar telescopes, either below the visible surface or at finer scales than can now be resolved.

"These simulations are now treated almost as the real Sun," Uitenbroek explained. "They show what happens at deeper layers, and all the physics that goes on, and how this translates into signals we see." But the simulations also challenge the observational side of the field, he added, because "these are the things that you want to verify."

Bob Stein and family during a workshop field trip to White Sands.

NSO Director Steve Keil cautioned the 70-plus attendees, "Don't let the theorists bamboozle you. Ask them about their assumptions and their boundary conditions. Observational physicists will show pretty movies and say, 'This is what's happening' and then make a hand-waving explanation. Don't believe a word of it. Make them write down their equations. Pundits will offer their views saying they did that 30 years ago. Make them write it down on the board. Finally, students,

continued

"SteinFest" continued

in spite of what you hear over the next three days, the Sun knows exactly what it is doing. It always gets it right."

The title of the conference was "Solar Magnetohydrodynamics: Theory and Observations, A High Spatial Resolution Perspective." Major topics included subsurface structures and dynamics down to the tachocline; flux emergence, active regions, and sunspots; surface models and observations; chromospheric models, observations, and diagnostics; and future prospects. The workshop tried a new format, with each session having one- or two-hour-long invited overviews, followed by a discussion session with short contributed presentations. The goal was freewheeling discussion, not merely questions for the speakers.

Conference co-chair Leibacher—who was Stein's first graduate student—outlined challenges that the field faces over the coming years. Computer power continues to increase in line with Moore's Law, Leibacher noted, and upcoming facilities and spacecraft like the Advanced Technology Solar Telescope (ATST) and the Solar Dynamic Observatory will provide fresh insights into solar activity.

The largest next-generation tool now in development is the 4-meter ATST, which is made possible by high-order adaptive optics (AO) systems compensating for Earth's atmosphere, to which Stein has also contributed. "We have used his simulations [of magnetic flux evolution in the solar atmosphere] to define specifications for the telescope's AO system," said Project Scientist Thomas Rimmele.

Stein also teaches introductory astronomy and advanced astrophysics, plays the fiddle, and dances; his family is shown in the photo, enjoying the workshop field trip to White Sands.

Because Stein's impact extends far beyond the complexities of MHD codes or telescope specifications, Leibacher closed the workshop by thanking him for "being the magnet that brought us all together."

Conference proceedings will be published by the Astronomical Society of the Pacific in 2006.

ATST Project Developments

Jeff Barr, LeEllen Phelps, Mark Warner, Thomas Rimmele, Jeremy Wagner & the ATST Team

The selection of Haleakala, Maui, Hawaii as the proposed location for ATST has allowed significant design progress to occur in a number of areas, including site development, environmental permitting, enclosure design, and development of support and operations buildings.

Environmental Permitting

Environmental approvals for ATST at Haleakala will require the preparation of a full Environmental Impact Statement (EIS), as mandated by federal and state statutes. The Maui-based firm of KC Environmental, Inc. has been contracted to lead the effort, including subcontracted consultation from Tetra Tech, a large national environmental engineering firm, and Charles Maxwell, a cultural specialist in the indigenous Maui community. The EIS contract kicked-off in May and the required Notices of Intent were published. Three Public Scoping Meetings were held on Maui in the middle of July to solicit community input on issues that will need to be addressed in the EIS. At the beginning of each public meeting, the ATST team gave presentations on the nature and status of the project, the strong science case for locating the ATST at Haleakala, and an overview of the EIS process.

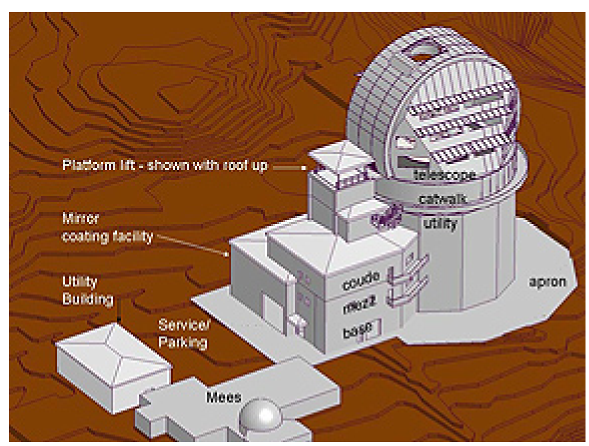


Figure 1. An aerial view of ATST at the primary site. Note its proximity to the existing Mees solar facility.

These discussions revealed that the people of Maui are not universally in favor of building ATST on Haleakala. At each of the meetings, at least one person spoke eloquently of respecting and preserving Haleakala as a sacred place. In

continued

ATST Project Developments continued

addition, concerns were raised about the visibility of ATST from below, due to its required height and white color; the potential impact of ATST on native wildlife, including the endangered Hawaiian petrel; the increased traffic on the observatory road during construction and operations; and, the potential economic and educational benefit that ATST offers to the people of Maui. Some of these concerns were addressed directly at the meetings, while other deeper and more complex issues will be addressed as part of the EIS. This process may conclude with a Record of Decision around the end of 2006.

A substantially finalized version of the entire ATST facility was developed to support the public meetings. Layouts of the required ATST buildings were defined for a primary and alternate site at Haleakala, taking into account existing structures and topography. The primary site, and the current location of the site test tower, is directly adjacent to the Mees Solar Observatory, which allows for some potential use of this existing building for ATST support functions. The alternate site is a large flattened hill, called the Reber circle, where a radio astronomy experiment was conducted in the 1950s. This alternate site is higher than the Mees site, and may actually offer slightly better seeing. However, this additional height and proximity to an adjacent Air Force telescope (AEOS) raises potential issues of obscuration, as well as increased visibility of ATST from below. Both sites are within the boundaries of the existing 18-acre observatory, and are identified as potential locations for ATST in the recently completed Haleakala Observatory Long Range Development Plan.

Enclosure

The focus of the enclosure design effort has been overall cost reduction of the thermal systems. The final report on the enclosure thermal system design delivered from M3 Engineering in March detailed a baseline system with an estimated cost that was significantly more than the project is able to allocate. A multifaceted approach has been undertaken to reduce the overall cost of the thermal system. This approach includes reducing the exposed surface area that receives direct and indirect solar loads, minimizing the overall thermal load per unit area, and finding both capital and operational cost reductions in the design of the thermal systems. Ways to reduce costs elsewhere in the enclosure design are also under consideration.

The key to any optimization or compromise of the baseline thermal system is a good understanding of the specific site conditions that will be encountered. Statistical analyses of site seeing and weather data show that the majority of excellent seeing conditions (R_0>12 centimeters) occur early in the day, mostly during periods of moderate wind (~5 meters per second) that come generally from the northeast. Additionally, some of the best seeing conditions occur during winter mornings with moderate wind from the northwest. There is also a nontrivial amount of excellent seeing conditions on no-wind and low-wind mornings.

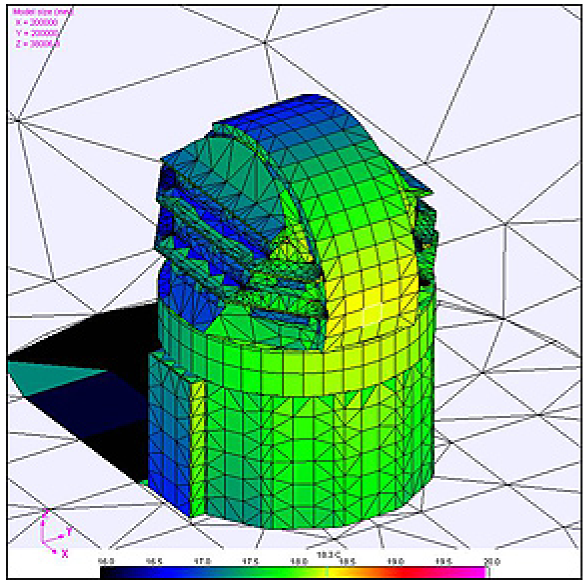


Figure 2. A MuSES thermal model of the enclosure. The exterior stair case shown on the left side of the model has subsequently been moved inside the enclosure, reducing the overall external surface area that is exposed to incoming solar radiation (and hence has to be cooled).

As previously reported, the exterior of the enclosure carousel will be cooled with chilled water/glycol solution circulated through plate coil heat exchangers. Some strategies for maximizing fully shaded areas have the potential to minimize plate coil coverage requirements. For example, adding a five-degree taper back along the sides of the dome resulted in a significant amount of surface area remaining fully shaded as the Sun is tracked during the day. This taper also provides space for larger ventilation gates. Another benefit is the preservation of a more octagonal geometry, with support points that align closely with bogie locations.

While the early MuSES thermal model results are promising, multi-physics modeling efforts using STAR-CD computational fluid dynamics software are underway to verify that the strategic placement of cooling systems does not compromise excellent seeing conditions. The trade of cooling coverage against cost must be done very carefully, leaving easy upgrade paths in case future operational experience reveals different results than model predictions.

continued

ATST Project Developments continued

A less expensive type of plate-coil heat exchanger has been selected to help lower the cooling costs per unit area. This style actually has an advantage in that more of the surface area is in contact with the glycol solution, leaving a more even temperature gradient across each plate coil unit. Another method considered to lower cooling costs was the installation of an ice storage system, which may allow substantial operational savings. This type of system could be eligible for the customized incentives available through Maui Electric's *Energy$olutions[SM] for Business* program, which would help offset some of the capital costs.

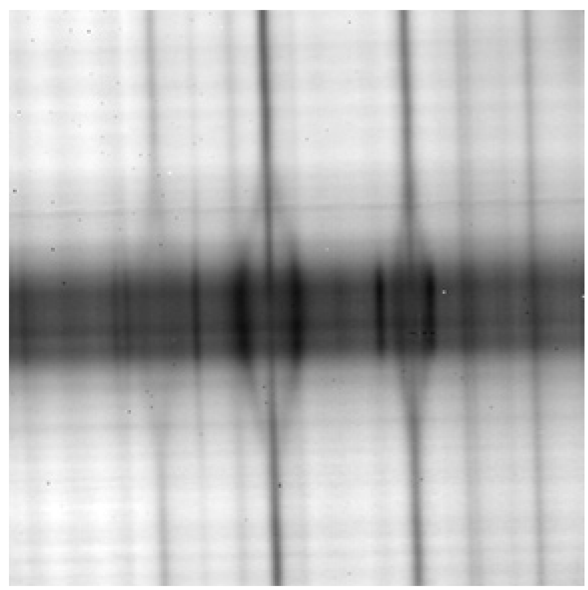
Earlier thermal modeling work by Nathan Dalrymple showed promising results for using different ground treatments to reduce the overall thermal load on the enclosure. This work suggested that white-painted concrete is the best ground treatment for use on Haleakala. A follow-on study explored the load reduction for varying sizes of this concrete apron. This study demonstrated that a 10-meter-wide white concrete apron surrounding the enclosure resulted in a 30 percent reduction of the overall thermal load on the enclosure, and a 40 percent reduction in thermal load for the east side of the lower enclosure. Properly designed, the apron can help contain any leaks in the hydronic cooling system and can serve to catch rainwater.

NSO Array Camera Sees First Light

Matt Penn

The NSO Array Camera (NAC) system was delivered from Mauna Kea Infrared at the end of June 2005. It was immediately shipped to the McMath-Pierce Solar Telescope, where the dewar was pumped out and a closed-cycle cooling system was installed. After a few days of cooling, the internal dewar temperature remained stable and the NAC was placed onto the McMath-Pierce main spectrograph.

The spectrograph is now directly focused onto the array for initial observations, and no re-imaging optics have been used. Sample spectra were taken of the He I 1083-nanometer (nm) limb emission and the Zeeman splitting of the Fe I 1565-nanometer in a small sunspot (see figure). The dewar currently holds two-inch square J- and H-band filters, which look good. There are also some small test filters centered near 4000-nanometer, but these filters have spectral leaks and, unfortunately, saturate the array on a warm dark slide. Testing of the NAC at 4000-nanometer will be done in September using filters from the Near Infrared Magnetograph (NIM) system.



The first He I 1083 nanometer limb spectrum from the NSO Array Camera.

First Tests of the McMath-Pierce IRAO System on Planets and Stars

Christoph Keller (Utrecht University) & Claude Plymate (NSO)

Since it became available to the solar community, the Infrared Adaptive Optics (IRAO) system at the McMath-Pierce Solar Telescope has generated tremendous interest (see the June 2003 *NOAO-NSO Newsletter*). The IRAO system is now requested often to augment the spatial resolution of the telescope's main spectrograph. Planetary observers at the McMath-Pierce have expressed additional interest in the possibility of extending the capability of the IRAO system to other solar system objects (such as Mercury; see the March 2004 *NOAO-NSO Newsletter*).

Numerous optical and software modifications were made to the IRAO to explore the feasibility of using the basic design on fainter nonsolar objects. All nonessential optical filters were removed from the system, and gold-coated mirrors were replaced with aluminum-coated mirrors to increase throughput in the visible. The wavefront-sensing algorithm was changed from image correlation of the Shack-Hartmann subapertures, used for solar features, to a centroiding routine. Sky-background subtraction was implemented. User control of the wavefront-sensing camera was added to allow increased integration time for faint objects. These modifications have the unfortunate consequence of slowing the system response frequency (~950 Hertz on the Sun).

This modified AO bench was tested during the week of 2 March 2005 on selected bright stars down to a magnitude of 2.6. Figure 1 shows images comparing the open-loop (AO off) and closed-loop (AO active) with the 0 magnitude star Vega (Alpha Lyrae). The open-loop image (left) has a FWHM of ~0.7 arcsec, while the closed-loop image appears only ~0.17 arcsec across. The centroiding routine was found to be quite effective at locking onto bright stars against a dark sky and onto the bright planet Venus against a bright daytime sky. Picking the planet Mercury out of a bright daylight sky proved to be more challenging. Still, during mid-morning (~10:30 a.m. MST) of March 9, the sky background was dark enough to allow the system to lock onto the planet, producing the sequences in figure 2. The bottom row is a closed-loop timed-sequence of 10 frames showing the disk of Mercury. The top row is an open-loop comparison sequence taken immediately before. The diameter of the planet's disk was only 6.6 arcsec across.

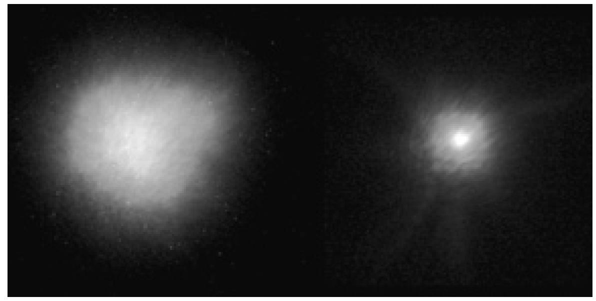


Figure 1. Alpha *Lyrae without adaptive optics correction (left) and with correction (right)*

The IRAO uses a deformable mirror with only 37 actuators. The deformable mirror was selected to minimize the overall cost while still achieving the design goal of attaining diffraction-limited resolution in the infrared. This low number of actuators cannot fully correct for seeing distortions in visible light, but the existing design can significantly improve the visible light image under the proper conditions.

Although we were able to demonstrate that the current IRAO design is capable of locking onto non-solar objects, substantial development remains to be done before results become reliable enough to produce science-quality data on faint sources. Possible enhancements include identifying a more sensitive wavefront camera, or coupling the existing camera to an image intensifier to achieve an increased wavefront-sensing signal, while reducing integration time to allow the system to operate at the maximum possible bandwidth.

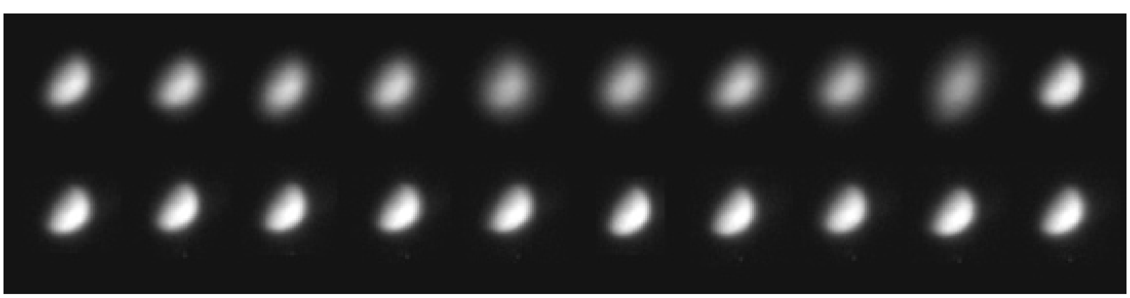


Figure 2. Daylight time-sequences of Mercury on 9 March 2005 with adaptive optics off (top row) and on (bottom row).

GONG++

John Leibacher & the GONG Team

Things are *extra* hot in Tucson: the network is performing well after a difficult spring, near-real time provision of farside images is commencing, two new shelters to replace the structure in Learmonth and provide a "hot spare" are in-house, and the science team is turning the presentations from the recent AGU/SPD meeting into publications.

In the process of restructuring the program's long-term operations plan, GONG staff identified a number of deferred items that were of low priority in the context of the old three-year project, in addition to several major long-period recurring items. For example, we are engineering an automated cover for the turret, because leaving the turret exposed to the elements has proven to be costly. Another major area of concern is the potential loss of a site due to a natural disaster or the need to move a site location. It is estimated that, starting from scratch, it would take two to three years to replace a site lost catastrophically.

Using the Tucson station as a "hot spare" is no longer a viable option, because the "GONG Farm" engineering instrument is fundamental to maintaining our ability to address field problems with proven solutions, and it provides an essential test bed for the development of replacement technologies or potential new capabilities. Operating a five- or even four-site network for two years while building a new station would severely compromise the science, and jeopardize the future of the program. In light of these factors, an external review was held last January to assess a conceptual plan to build a hot spare station. This review was followed by a series of meetings that resulted in decisions to replace the deteriorating shelter at Learmonth and to build a complete, fully instrumented, spare station.

Two shipping containers have been purchased and delivered to the GONG Farm (see figure 1), and we are arranging for contractual services to undertake the needed fabrication. The shelter that will be going to Learmonth will be shipped in the fall, toward an early spring maintenance visit. Work on the hot spare instrument will begin in earnest in October.

Along these lines, we are also moving ahead on new circuitry for the magnetogram modulator to improve the zero-point stability of the magnetograms. Several months ago, the breadboard was successfully installed at the engineering site, and it is producing data well within specifications. Since then, a prototype design has been evaluated, and boards fabricated and populated for testing. On the software engineering side, waveform and communications development has begun, and a full-functioning prototype is expected to be operational at the Tucson site in October. This schedule will allow testing and deployment by the launch of the STEREO mission, scheduled for February 2006. A conceptual design review in mid-July evaluated a set of possible design approaches for a turret weather cover. The team has returned to the drawing board to consider the recommendations, and it will reconvene in August.

Figure 1. Delivery of the containers for the GONG Learmonth and hot spare replacement shelters.

Network Operations

As the second quarter of 2005 began, the Mauna Loa instrument had been locking up intermittently. The camera was considered the likely culprit, but the problem persisted despite a camera swap. Also in April, the camera rotator at Udaipur began malfunctioning, and the Big Bear (BB) camera CCD temperature lost regulation. On April 30, the Learmonth instrument went down as a consequence of rainwater leakage into the turret during an unusually abundant rainfall. As a result of all of these events, three adjacent sites were not functioning properly and the need for "crash team" site visits became apparent.

It was determined that the BB camera needed to be replaced, and the team was able to fix the problem within a productive two-day trip. Troubleshooting of the Udaipur camera rotator was undertaken simultaneously, and after some swapping of items by the local staff, the rotator returned to normal functioning. It was not clear that any

continued

GONG continued

particular item was the cause of the problem, and reseating components may have restored a bad connection, returning the instrument to reliable operation.

The problem at Learmonth definitely required a repair visit and new hardware. There was already a scheduled maintenance visit and turret replacement for CTIO in May, so the decision was made to cancel that visit and reship the turret and tools from CTIO to Learmonth. In the meantime, some troubleshooting was underway at Mauna Loa, but the strategy was to attempt manual intervention necessary to keep the site acquiring data until the adjacent instrument at Learmonth was operational again.

A repair team visited Learmonth during the last week of May to install the new turret. Although the new turret would perform well enough to take normal observations, it was not able to take periodic calibration data because of an incorrect tachometer. This compromised performance was unacceptable, and an appropriate tachometer, accompanied by an instrument-maker to help with the replacement, was required as an extension of the repair trip.

With the Learmonth instrument operating, a troubleshooting and repair trip to Mauna Loa was undertaken. More hardware was replaced and much testing was done. A clear culprit was not identified but instrument behavior improved; a camera power cable appears to have been at fault. Then it was back to Learmonth to replace the tachometer, a job that was finished in just two days. The turret response improved enough to acquire the test data.

All in all, it was a spring we will not soon forget!

Data Processing and Analysis

A DMAC Users' Committee (DUC) meeting was held in Tucson on May 5–6. In attendance were Jesper Schou (Chair, Stanford University), Doug Braun (CORA), Sylvain Korzennik (CfA), and Ed Rhodes (USC), with Sarbani Basu (Yale University) participating by phone. The DUC gave its approval for GONG to begin routine operation of the new angular coalignment package (CoPipe) and Automatic Image Rejection (AIR) modules (highlighted below), approved the replacement of monolithic GRASP releases by CVS control for individual modules, and recommended that GRASP be maintained for two more years. The committee also recommended that GONG++ reprocessing be done before GONG Classic, approved the new DSDS local helioseismology interface (with a few requested additions), recommended that development on 64-bit hardware be pursued, and discussed input for the upcoming NSF senior review. Meeting materials can be found online at *gong.nso.edu/science/meetings/duc/5May05/*.

The AIR routine is now officially integrated into the data reduction pipeline. Starting with GONG Month 100, we began doing quality control in a "mostly automated" way. We expect that the current backlog will vanish within a couple of months, and that the processing delay will be limited primarily by the 60-day temporal filtering of the calibration, expediting community access to the helioseismic mode frequencies.

We are also upgrading our IRAF/GRASP package, using IRAF 2.12. This evolution includes the new CoPipe II algorithm modifications, which include use of the SOHO/MDI images as a fiducial and frequent noon drift-scans from around the network. These modifications were necessary to achieve the geometric accuracy needed for merging the full-resolution images fed into the GONG++ pipeline. With this revision, the GONG++ local helioseismology data products are now officially part of the Data Storage and Distribution System (DSDS) and will be readily available to the community.

We are in the second year of our five-year hardware upgrade plan, continuing the Sun/Unix to PC/Linux evolution. The plan originally called for purchase of five servers this fiscal year. However, we will acquire only one and defer the other server purchases until next year. The new server will support the expanding catalog of GONG data products and expedite real-time database queries through the Virtual Solar Observatory (VSO) and GONG Web site. This year's workstation purchases sustain our current trajectory of migrating to Linux-based PCs and are tailored to the computing requirements of individual users. The expanding catalog of GONG data products requires higher-density media for long-term cold storage. We have already begun using a LTO robotic library in the main computer room for archiving data products. Two desktop LTO drives are now required for staging data requests directly from the DMAC tape vault, while keeping them securely stored in the DMAC building.

The GONG Program uses large terabyte-scale disk arrays to process, store and analyze GONG data. As the GONG online catalog grows, it becomes increasingly impractical to rely upon tape backups as a disaster recovery mechanism. Currently, we utilize a Redundant Array of Independent Disks–Level 5 (RAID5) system to protect against individual disk failure. This redundancy is not infallible however, and data loss is possible if multiple individual disks fail simultaneously. One solution is to create two RAID5 arrays that mirror each other. We plan to purchase additional RAID units to use as mirror sets for our existing RAID arrays.

We have now extended the ring diagram analysis to 26 November 2004, through Month 96, covering

continued

GONG continued

34 consecutive GONG months, or 46 consecutive Carrington rotations. During the past quarter, month-long (36-day) velocity time series for GONG months 92 through 96 (ending 21 October 2004), with an average fill factor of 0.87, were archived into the DSDS, and 108-day Mode Frequency Tables are also archived. Month 96 achieved a 92 percent fill factor! The DSDS distributed 361 gigabytes in response to 16 data requests.

The GONG scientific staff continues to work in diverse areas of the discipline. Rachel Howe is investigating the spatial distribution of frequency shifts across the disk. Rudi Komm is working on the relationship between subsurface kinetic helicity and flare characteristics (see figure 2). Shukur Kholikov is examining time-distance measurements of the temporal behavior of the deep meridional flows. Irene González Hernández is calibrating the farside signal in terms of the magnetic field. Sushant Tripathy is comparing frequencies derived from rings obtained in intensity and velocity as a function of disk position, as well as the temporal variation of the *p*-mode frequencies. Kirin Jain is working on a comparison of flow fields derived from GONG and Stuart Jefferies' MOTH South Pole experiment. Sasha Serebryanskiy is analyzing time-distance cross-correlation functions for evidence of changes at the base of the convection zone.

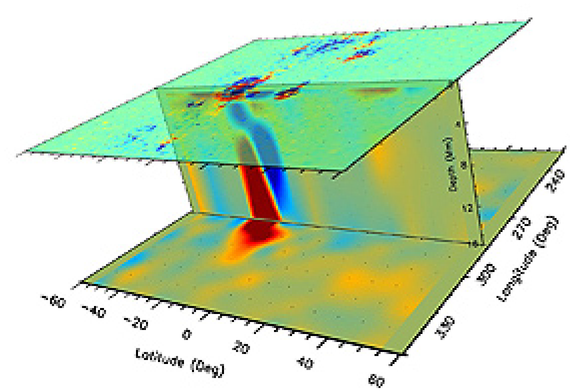


Figure 2. Distribution of kinetic helicity in the first 16 million meters below a concentration of magnetic energy measured by GONG++.

Comings and Goings

The program bid farewell to Jean Goodrich, a good friend and integral member of our team. After 15 years as an AURA employee (starting in 1989 as a telescope operator and observer on Kitt Peak and transferring to GONG in 1992), Jean is moving to Georgia, where she will be an Assistant Professor of Medieval and Renaissance English at Albany State University. Jean's career with GONG has been unique, linking the DMAC and Network Operations with her understanding of the instrument, the data collection process, calibration, and data reduction. She recently played a key role in heading up the development of near-real time data retrieval from the network to support the provision of farside imaging. Thanks, Jean, and best of success at everything! We also said good-bye to Candido Pinto, who is leaving the GONG Program to work in the optics industry.

Frank Hill will be assuming responsibility for GONG and John Leibacher will be taking a sabbatical leave at the Institut d'Astrophysique Spatiale (Orsay, Frances), the Université de Paris-Sud, and the Observatoire de Paris-Meudon.

We welcomed a new postdoctoral GONGster, Olga Burtseva from the Uleg Beg Astronomical Observatory in Tashkent, Uzbekistan, who will be working on time-distance, which is part of the local helioseismology application suite.

We have hosted a number of summer visitors to GONG including Amel Zaatri (Centre de Recherche en Astronomie Astrophysique et Geophysique, Algiers), working on temporal variations of zonal and meridional flows in subsurface layers derived from a ring-diagram analysis of GONG and MDI data, and Sergey Ustyugov (Keldysch Institute of Applied Mathematics, Russia), comparing his hydrodynamic and MHD simulations of convective cells with subsurface flows derived with local helioseismic techniques. REU student Douglas Mason (University of Southern California) worked with Rudi Komm on the relation between active regions, their flare activity and the associated subsurface flows using all available GONG and MDI ring-diagram results; and REU student Paul Anzel (Rice University) worked with Frank Hill on ring diagram analysis of ISOON H-alpha images.

The Solar Physics Division of the American Astronomical Society has undertaken an annual summer school on various aspects of solar physics. The inaugural school was held July 25–29 at the High Altitude Observatory, Boulder, CO, under the leadership of Yuhong Fan, Guiliana de Toma, and Louise Bierle, with financial support by NASA/LWS and NSF/ATM. Computer resources for the hands-on exercises limited our admissions to only 35 official students, but there were 45 participants in the lectures, and the program was a great success. The lectures and materials for the hands-on activities are available at *www.hao.ucar.edu/summerschool/*

Deep Impact — A Big Hit for Science and Public Outreach

Douglas Isbell

The collision between Comet Tempel 1 and a copper-clad impactor probe from NASA's Deep Impact spacecraft was a smashing success for planetary science and for public appreciation of astronomy. All of the research telescopes at Kitt Peak National Observatory and Cerro Tololo Inter-American Observatory gathered good data on the amazing event, and an extra-large public crowd of 55 visitors at Kitt Peak experienced the excitement of the night side-by-side with professional astronomers.

Many hundreds of images were taken of Comet Tempel 1 at the Kitt Peak Visitor Center Observatory over more than two hours. The streak of light shown in the image above is the result of adding all of these images together. Starting from the left, the comet was at its natural brightness; the streak brightens significantly in the middle, immediately after impact of the probe!

The sold-out public event at the Kitt Peak Visitor Center began formally at 7 p.m. on July 3, following a barbeque dinner. The program featured informative "insider" talks from the University of Maryland's Tony Farnham (who began observing the comet at the Mayall 4-meter telescope immediately afterward) and Kitt Peak National Observatory Director Richard Green. The crowd then broke up into groups for some stargazing and dry-ice comet making, among other activities. Soon live NASA-TV coverage was projected in two locations in the Visitor Center — between brief lock-ups from Internet traffic that reached one billion hits worldwide for NASA over 24 hours.

This same public interest froze the NOAO Web site for close to two hours centered around the impact time, as too many people were trying to download a movie of the comet being created live, on the fly, by NOAO public outreach staff from still images taken with the Visitor Center 20-inch telescope. We apologize for any deleterious effects on scientific observing, or on your personal enjoyment. Interesting movies and still images of the comet were posted by 2 a.m. that night, and can be seen at *www.noao.edu/news/deep-impact.*

At about 9:30 p.m., while much of the crowd was outside learning how to use star charts, Humberto Campins from the University of Central Florida, one of the observers at the WIYN 3.5-meter telescope, dropped by the Visitor Center patio to give a dramatic live update on the mission under the dark skies of Kitt Peak — all was GO!

The attentive crowd returned inside to watch the 10:52 p.m. encounter on NASA-TV, and cheered along with the giddy scientists, when the spectacular impact appeared to validate all of the planning and anticipation that went into Deep Impact, from spacecraft design to space telescope observations to a worldwide ground-based observing campaign that included Kitt Peak, Cerro Tololo, and Gemini.

Local newspaper and TV coverage in Tucson before and after the event featured Kitt Peak prominently. Thanks to everyone who contributed to the success of this cohesive campaign.

The Kitt Peak Visitor Center was packed with space enthusiasts the night of the impact event.

Timely Supernova Observations at the TLRBSE Summer Workshop

Katy Garmany

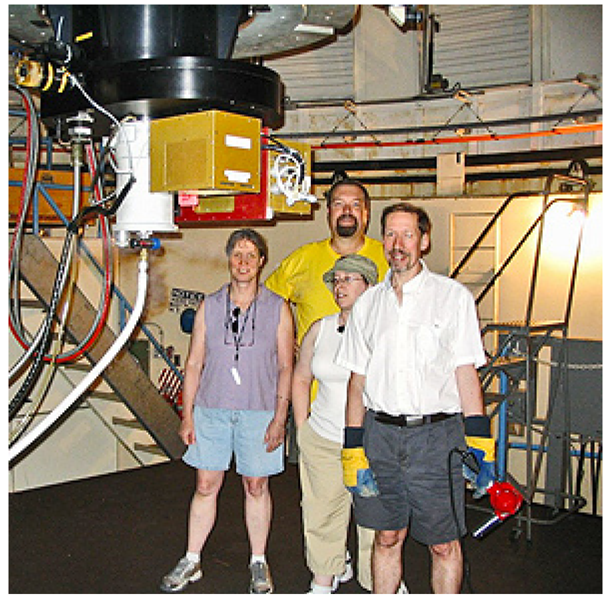
What's more exciting than your first observing experience on Kitt Peak? Well, if you are a high school teacher doing the observing, and you manage to bag a supernova in M51 before the rest of the community has seen the announcement, that is pretty special.

The 9th annual Teacher Leaders in Research Based Science Education (TLRBSE) summer workshop took place June 23 – July 4. Eighteen teachers from across the country came to Tucson after completing a challenging on-line course in the spring covering astronomical spectroscopy, techniques for mentoring junior colleagues, and effective ways to bring research-based projects into the classroom.

The 18 teachers of the 2005 TLRBSE cadre with NOAO educational outreach staff, during their time on Kitt Peak for the summer workshop.

The teachers arrived eager to meet other people they had gotten to know "electronically" in the distance-learning course. After several days of preparatory lectures and activities, the whole group (see photo) headed for Kitt Peak. (The kitchen recorded one of its busiest days in recent years when both this cadre and the AURA Observatories Council showed up for dinner on the same night!) The teachers all spent time observing at the 2.1-meter telescope, the coudé feed, the McMath-Pierce Solar Telescope and the WIYN 0.9-meter telescope.

In the process of learning how to do astronomical imaging at the WIYN 0.9-meter on June 30 (UT), the TLRBSE teachers selected M51 as a target and recorded images of the galaxy in four filters. "These images were taken prior to the arrival of the IAU circular announcing the discovery, and thus are some



Teachers Mary Dunn (Oakland, ME), Thomas Rutherford (Kingsport, TN), Cynthia Gould, (Leomisnter, MA), and Chris Martin (Tucson, AZ) top off the cryogenic dewar on the WIYN 0.9-meter telescope during their observing run on Kitt Peak.

of the earliest images of the supernova taken with broadband filters," said Stephen Pompea, manager of science education at NOAO. The group could barely contain their excitement when they learned of their timely observations, and later carried out spectroscopy of SN 2005 cs from the 2.1-meter. The exploits of this group of teachers are highlighted in detail in an NOAO press release (see *www.noao.edu/news*) that helped garner local newspaper coverage of their Kitt Peak experience, and their plans for using their experience in their Maine and Tennessee classrooms.

The observing experience served as much more than just a chance to learn how data are collected. The teachers will use their observations as part on several ongoing research projects, including a search for novae in the galaxy M31, spectral classification of Active Galactic Nuclei, and the study of sunspots from Zeeman spectroscopy.

With their newfound experience in data collection, reduction, and analysis, these teachers are now well prepared to

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Timely Supernova Observations continued

introduce research-based science to their students. In turn, their students can submit papers on their work to the "RBSE Journal," which is formally reviewed and published by the NOAO educational outreach group. Many of the past students involved with TLRBSE have gone on to local, state and national science fairs.

Recruiting for the 2006 class of TLRBSE will begin soon with a deadline in mid-October. Interested teachers should see *www.noao.edu/outreach/tlrbse/about.html* or contact us at *outreach@noao.edu*. We make no promises about another supernova in the local universe next year!

The REU Experiment

Raelin Schneider

Six distinctly different personalities, seemingly endless data sets, two houses, and a Unix work station. Mix together, let sizzle in a little Tucson summer sun, and observe…we have the Research Experiences for Undergraduates (REU) Experiment—2005 edition.

HYPOTHESIS

We arrived in Tucson one by one. I was one of the last to arrive. June 1 was my first day at work, and I was psyched! I was led into Room 27 in the NOAO Tucson building, my new "home away from home," and introduced to the other students.

Immediately, I could see different personalities emerge: some were outgoing, others more reserved, others quite grumpy. Kitt Peak REU Director Ken Mighell treated the three new arrivals to a meal at Eric's Café, which turned out to be one of the primary hangouts for the local professional astronomy crowd. This seemed due primarily to the slightly quirky menu and the lively personality of the proprietor, who caters to his scientifically inclined clientele with endless enthusiasm.

While we were eating, Dr. Mighell jokingly claimed that the NSF REU program was really a "psychological experiment" and the science was really just a "clever cover." Though completely untrue, this humorous statement got me thinking.

Kitt Peak 2005 REU Students (from left) ShiAnne Kattner, REU Director Ken Mighell, Mark Keremedjiev, Lauranne Lantz, Caitlyn Smith, Raelin Schneider, and Mark Franz.

Thus the "REU Experiment" was born. Can six distinctly different people work together, live together, and play well together for 12 weeks, and still have a successful summer? Will their time in Tucson have any impact on their future goals or aspirations? What were some of the more memorable experiences? Have the willing participants changed as a result?

THE PARTICIPANTS

ShiAnne Kattner, 22, is a student at the University of Wyoming. She is a double major in physics and astronomy. ShiAnne recently had the opportunity to participate in an exchange program at the University of Hawaii, before coming to Tucson to work with Dr. John Glaspey on developing an automated classification system for A-stars.

Mark Franz, 22, is a student at the University of Florida. Originally from Pennsylvania, he is also a dual major in astronomy and physics. Mark F., also known as "Loo" to avoid confusion with the other Mark, drove all of the way from Florida in a Pontiac with one working window and a broken air-conditioner. Crazy? I think so. Mark is working with Dr. Mighell trying to prove that red giants may be variable.

Mark Keremedjiev is an astronomy major at Cornell University. This Montana-grown young man had the privilege of turning 21 right here in Tucson. In addition to all of his birthday presents, he had the opportunity to see his long-time girlfriend, Lauren, who flew all the way to Tucson to celebrate with us. Mark is working with data from the NOAO Deep Wide-Field Survey.

Lauranne Lantz, 20, attends the University of Maryland. She is also a dual astronomy and physics major. Lauranne is the only one of the group not born in the United States. She was born in Switzerland and did not move to the United States until she was six years old. She is working on a project on angular momentum of O and B stars with Dr. Sidney Wolff and Dr. Steve Strom.

Caitlyn Smith, 21, is a student at the University of Indiana. Katie, as she is also known, is actually a veteran of Kitt Peak. As an astrophysics major at one of the three WIYN consortium

continued

The REU Experiment continued

schools, she has had numerous opportunities to observe with Kitt Peak telescopes. Caitlyn is searching for long-period Cepheid variables with Dr. Lucas Macri.

Raelin Schneider, 20, the author of this report, is a space physics major at Embry-Riddle Aeronautical University, here in Arizona. She is the only member of the REU group not living in the same house as the other five. She is working on a study of the variability of the open cluster NGC 2301 with Dr. Steve Howell.

Lauranne Lantz and ShiAnne Kattner observe at the Mayall 4-meter telescope.

TIMELINE

June 11: Sabino Canyon Hike ~ The REU students are given their first organized opportunity for interaction.

June 17: Tour of Kitt Peak ~ Ken Mighell gets his annual chance to tire-out a bunch of "20-somethings" on a Friday afternoon tour around the mountain.

June 18: Glaspey's Pool Party and visit to the International Wildlife Museum ~ The REU students have now adapted to their tight living conditions in Room 27, and are rewarded with a BBQ and a chance to cool down.

July 2: Sunspot, NM ~ The REU students travel to New Mexico for a tour of the VLA and to reclaim the Frisbee-golf championship (though sadly, we ended up falling one point shy of the championship).

July 17–31: Observing time at Kitt Peak.

August 1–5: Presentation time, where we can now distinguish between those that were actually working in Room 27, and the ones that were just really good at faking it.

RESULTS

Any time you put a diverse group of people together, it becomes a potential psychological experiment. No two personalities are quite alike, and the personalities encountered in this year's REU program occupied the entire spectrum of possibilities. There were the introverts, the partiers, the oddballs, the jokesters; we were a regular "Breakfast Club." Of course, there were some conflicts as a result, but ultimately each of the personalities added something to the mix. If you took one person out, something special would be lost, and the REU experiment loses some of its excitement. ShiAnne gave us a voice, Lauranne provided stability, Mark K. gave us excitement, Katie was always there for advice, Mark F. made us laugh, and I was up for anything.

So, can six distinctly different personalities work and play well together for 12 weeks and still have a successful summer? The answer to that is "yes, a very successful summer indeed."

Some of us are going to be published as a result of this REU experience, some have made critical career decisions, and all of us learned more than we ever imagined. Personally, I learned what it takes to be an observational astronomer. Our observing time at Kitt Peak was one of the most productive educational experiences I have ever had.

Each of the students had observing time on the 2.1-meter and the 0.9-meter telescopes. However, due to the monsoon season, observing was kind of "hit-or-miss." I was lucky enough to have at least one clear night on each telescope. It was so exciting watching MY data come up on the computer monitor. I remember looking at an image of the Cocoon Nebula and thinking "Wow, I just took a picture of an object 4,000 light-years away." The nights were long and the bugs were plentiful, but the company was great and the knowledge gained was beyond compare. Observing was, for me, the best and most memorable part of this REU.

CONCLUSIONS

Through this REU program, we have all had the opportunity to make memories, friends, and new discoveries. The newly acquired knowledge each of us has obtained will help us to make decisions about our futures, and we will take it with us wherever we go. Science aside, I believe that the most beneficial part of this REU Experiment has been the diversity of the people and the variety of the experiences we shared.