NOAO/NSO Newsletter

NATIONAL OPTICAL ASTRONOMY OBSERVATORY/NATIONAL SOLAR OBSERVATORY

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Science Highlights

Director's Office

NOAO Gemini Science Center

Observational Programs

Data Products Program

Cerro Tololo Inter-American Observatory

Kitt Peak National Observatory

National Solar Observatory

Public Affairs & Educational Outreach

focus on>>>

NOAO Town Hall at AAS

Tuesday, 6 January 2009, 12:45 pm–1:45 pm

The National Optical Astronomy Observatory is eager to continue its dialogue with the astronomical community about how best to enable a comprehensive system of facilities to provide world-class, ground-based optical/near-infrared facilities for open-access observers.

Discussion topics will include activities involving mid-sized (2- to 5-m), large (6- to 10-m), and extremely large (30-m ±10 m) telescopes, initiated in partnership with AURA and the NSF as a joint response to the 2006 Senior Review. Thoughts about how to engage the pending decadal survey will also be discussed. Ample time will be allowed for questions and feedback from the audience.

Mark Your Calendar

The *NOAO-NSO Newsletter* is published quarterly
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P.O. Box 26732, Tucson, AZ 85726
editor@noao.edu

Douglas Isbell, Editor

Section Editors

George Jacoby	Science Highlights
Dave Bell	Observational Programs
Mia Hartman	Observational Programs
Christopher J. Miller	Data Products Program
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Publication Notes

See the color versions of images presented in this Newsletter online at *www.noao.edu/noao/noaonews/html.*

On the Cover

A montage of star-forming regions in Cepheus obtained by Robert Gutermuth (FCAD/Smith College) and Erin Allgaier (University of Toledo) with the new, large-format, near-infrared camera NEWFIRM on the Mayall 4-meter telescope at Kitt Peak National Observatory. The J, H, and Ks band images (1.2, 1.6, and 2.2 microns) are mapped to blue, green, and red, respectively.

NOAO Survey Program

George Jacoby

Up to 20% of the observing time available through NOAO may be allocated to Survey Programs (see: *www.noao.edu/gateway/surveys/*). These surveys often have long-term impacts in ways that were never foreseen by their proposers, and the data are distributed through the NOAO Science Archive (*archive.noao.edu/nsa/*). Since 1999, a total of 22 surveys have been approved (*www.noao.edu/gateway/surveys/programs.html*).

Currently, seven programs are underway, and representatives of the survey teams met at NOAO on October 15–16 to present progress reports. For one of these, The NEWFIRM Medium Band Survey (Principal Investigator [PI]: Pieter van Dokkum, Yale University), an overview was given in the June 2008 *NOAO/NSO Newsletter*. The PIs for four additional surveys describe their projects below.

The NOAO DRaGONS Survey
Andrew Connolly (University of Washington)

Andrew Connolly and 11 others have been using FLAMINGOS to image Distant Radio Galaxies Optically Non-detected in SDSS (DRaGONS). This is a K-band survey of 530 FIRST radio sources having $S_{1.4\,Ghz}$ > 100 mJy with no optical counterparts, spread over 5000 square degrees, representing a volume at z = 2 of about 6×10^{10} Mpc^3. These galaxies are very massive, providing signposts of clustering and rapid star formation in the early universe, out to z ~ 5, although the peak of the redshift distribution should be near z = 2.

With 60-minute integrations on-source, and about halfway through their analysis, results indicate a 75% detection rate (5σ), with 64% of the galaxies consistent with being at z > 2, and 29% at z > 3. Figure 1 shows the K-band mag distribution. Figure 2 shows the density distribution as a function of apparent brightness. Of the 250 galaxies analyzed to date, about 10% of these are extremely red (r-K > 6.5), and optical spectroscopic and imaging follow-up is underway at Keck, Gemini, and APO.

Sam Schmidt and Jeremy Brewer from the University of Pittsburgh have used data from this survey in their theses. The data will be made available to the public in early 2009.

A NEWFIRM Survey of the NDWFS/SDWFS Field
Anthony Gonzalez (University of Florida)

A team led by Anthony Gonzalez is using NEWFIRM to obtain deep JHK_s imaging of the Spitzer Deep Wide-Field Survey region (SDWFS, 8.3 sq. deg.), which corresponds to the NDWFS Boötes field. This program is designed to enable a broad variety of investigations—the combination of diverse data sets permits robust photometric redshifts for L* galaxies to z > 3, as well as detection of galaxy clusters to

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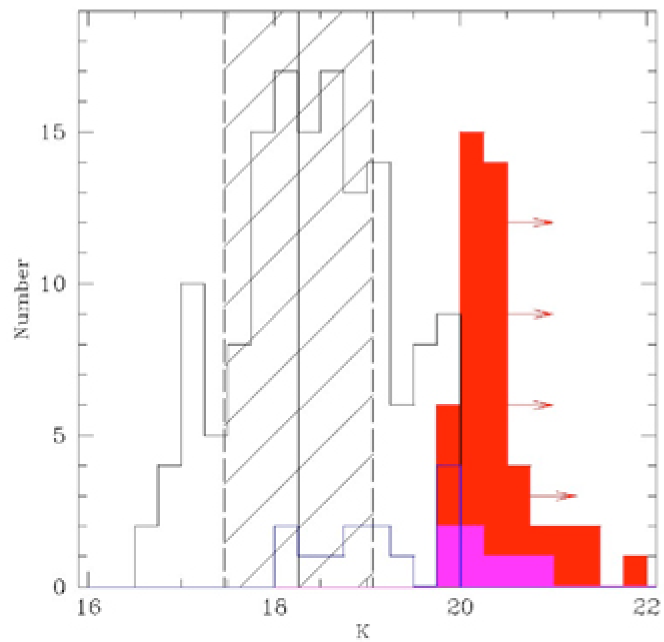

Figure 1: The K-band brightness distribution of recovered DRaGONS objects.

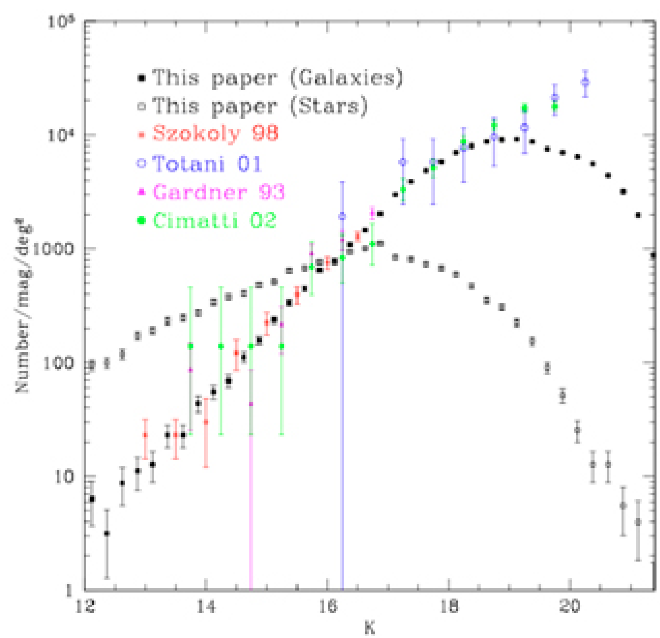

Figure 2: The number density of galaxies and stars identified in the DRaGONS survey as a function of K magnitude.

NOAO Survey Program continued

z > 2, quasars to z > 7, and brown dwarfs as cold as ~500 K within 50 pc. The data will also facilitate measurement of the diffuse infrared background by CIBER, due to be launched in 2009.

The survey commenced in spring 2008 and will finish in spring 2009. The J imaging obtained during the first year is currently being used to confirm the most promising brown dwarf candidates arising from the SDWFS program. A composite J, 3.6 µm, 4.5 µm (BGR) color image of one candidate is shown in figure 3 (Eisenhardt et al., in prep). The image is one arcmin on a side, with the brown dwarf at the center. University of Florida graduate student David Vollbach is using the data for his master's thesis.

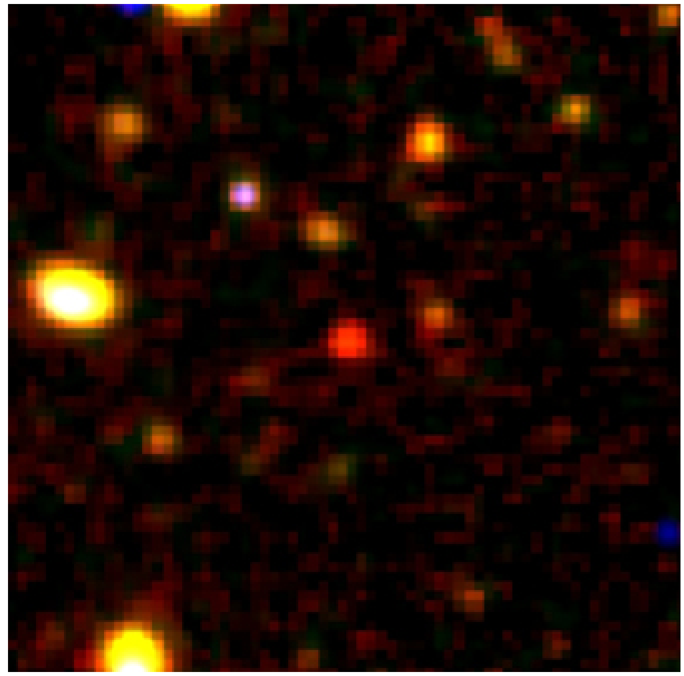

Figure 3: A promising brown dwarf candidate (center).

The NOAO XCS
Christopher J. Miller (NOAO)

The NOAO XMM Cluster Survey (NXS) is designed to optically image candidate galaxy clusters serendipitously detected with the XMM-Newton space telescope by the earlier XMM Cluster Survey (XCS) (Romer et al. 2001). Chris Miller and 15 team members are using Mosaic (north and south) imaging in two colors (SDSS r- and z-band) to measure the photometric redshifts of clusters to z ~ 1. In turn, the redshifts will be used in conjunction with the X-ray data to measure the cluster gas temperatures and/or luminosities.

For those clusters with enough X-ray counts to measure temperatures, the NXS will provide a comprehensive study of the galaxy cluster luminosity-temperature (L-T) relation between z = 0 and z = 1. Understanding the L-T relationship is vital for the ultimate scientific goal of the NXS—to measure the cosmological parameters independent of the CMB or Type-Ia supernovae data. After all, temperature is one of the most accurate cluster mass proxies for galaxy clusters. Based on cosmological models, it is the mass function of these cluster-sized matter halos, and their L-T evolution, that can be used to measure the cosmological parameters.

The NXS completed its main survey component of imaging over 300 clusters this past April 2008 (see figures 4 and 5 for an example). A final extension is scheduled for the 2009A semester. The first data

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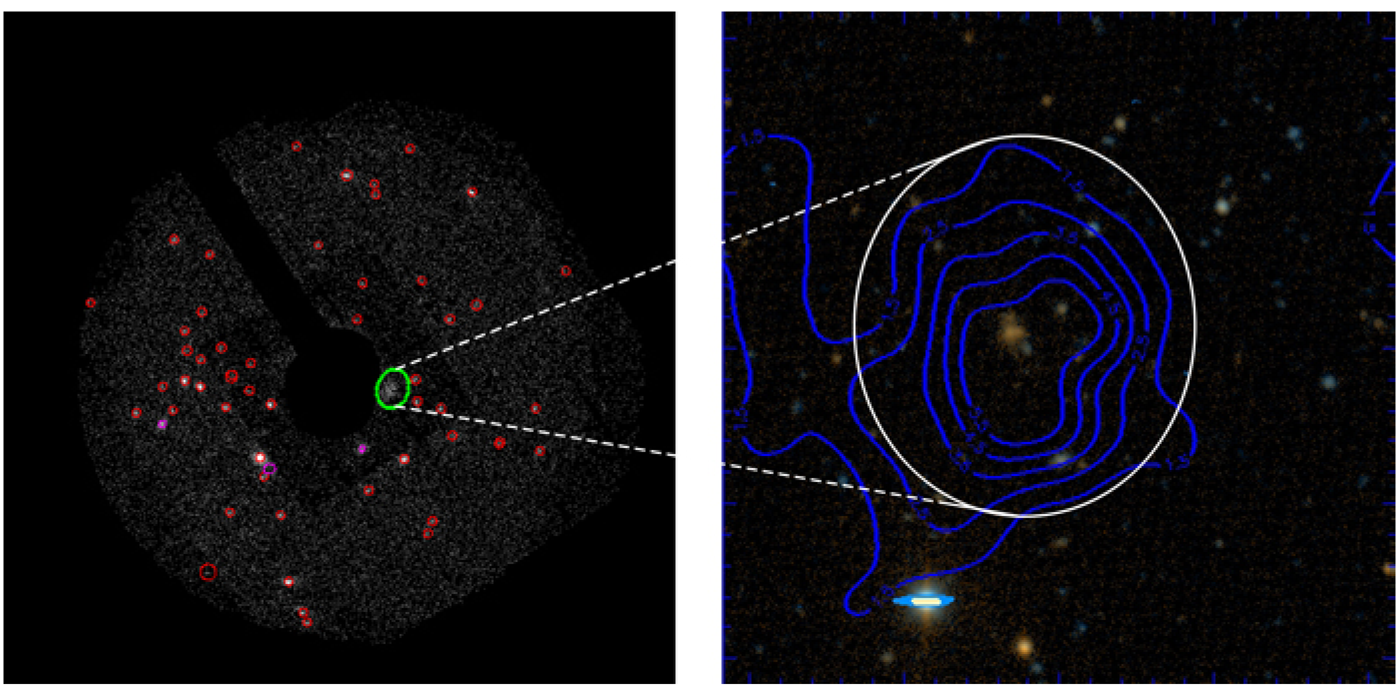

Figure 4: The XMM image and the detected sources (point sources in red and a cluster candidate in green ellipse) on the left. A close-up of the false color combined ground-based Mosaic imaging data for the cluster candidate is shown on the right. The contours indicate the X-ray data.

NOAO Survey Program continued

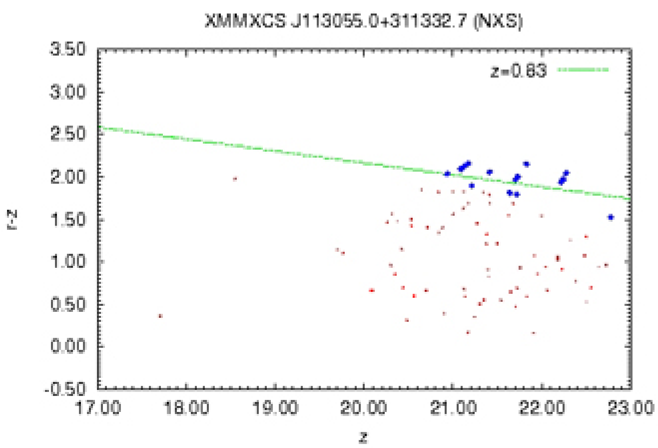

Figure 5: The color magnitude diagram for the galaxies in this cluster field. The blue diamonds are likely cluster members after a background subtraction technique is applied. A fit is then made to the galaxy cluster's E/S0 ridgeline and the estimated redshift for this cluster is z = 0.83. The NXS can identify clusters and their redshifts to z ~ 1.

release of the raw and reduced imaging data will occur in January 2009. Over 100 XMM fields with deep SDSS r- and z-band imaging will be made available to the public through the NOAO Science Archive (reduced Mosaic stacks), as well as through the team's data release Web site. Nicola Mehrtens (University of Sussex, UK) will be using these NXS data for her Ph.D. thesis under the guidance of the NXS PI and her thesis advisor, Kathy Romer (University of Sussex). While Nicola has led most of the observing runs (along with PI Miller and Co-Investigator Adam Stanford), three other Ph.D. students have participated in all aspects of the observing runs.

The ChaMPlane Multi-wavelength Plane Survey (ChamPlane-II)
Maureen van den Berg (CFA, Harvard)

The goal of the Chandra Multi-Wavelength Plane (ChaMPlane) Survey (see Grindlay et al. 2005, ApJ 635, 920) is to constrain the space densities and Galactic distributions of low-luminosity ($L_X \lesssim 10^{34}$ erg-s^{-1}) accreting binaries, such as cataclysmic variables (CVs) and the quiescent low- and high-mass X-ray binaries containing neutron stars or black holes.

The project analyzes serendipitous sources detected in Chandra/ACIS images to locate low L_X X-ray binaries from the center to the edges of our Galaxy. Using the Mosaic cameras on the NOAO Mayall and Blanco 4-m telescopes, we obtain deep VRIHα images of all our X-ray fields (144 as of late 2008, containing 15 000 sources) to look for optical counterparts. In the second phase of the survey, "ChaMPlane-II," we use the Hydra multi-object spectrograph on the CTIO Blanco 4-m telescope to classify the candidate optical counterparts and the ISPI imager on the Blanco telescope to identify counterparts in heavily obscured bulge fields.

Thus far, 2800 ChaMPlane-II spectra have been obtained, and 1270 have been reduced and classified. Most are stars, but several new CVs, symbiotic stars, and background AGN have been identified. Figure 6 shows a newly discovered symbiotic binary (a white dwarf accreting from a late-type giant). Additional spectroscopic follow-up is obtained with other facilities including WIYN/Hydra and Magellan/IMACS. Many of our sources lie within a few degrees of the Galactic center, and we are able to map out the spatial distribution to obtain clues about the origin of the X-ray binary population. We are carrying out two other surveys to support this effort, namely our "Bulge Windows" and "Bulge Latitude" surveys. More information on these can be found on our Web site at *hea-www.harvard.edu/ChaMPlane*.

Allen Rogel received his Ph.D. in 2005 from Indiana University using ChaMPlane data to study the anti-center fields, and Xavier Koenig's (Harvard) thesis to study the Galactic Bulge fields is using survey data.

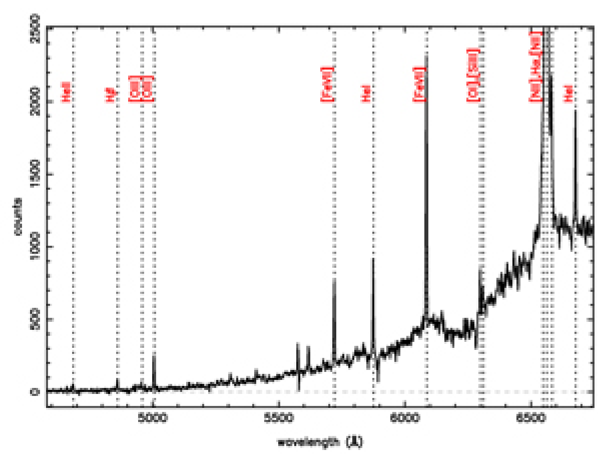

Figure 6: A symbiotic binary system newly discovered by the ChaMPlane-II survey.

Properties of the Host Galaxies of Luminous Quasars

Marsha Wolf & Andrew Sheinis (University of Wisconsin)

A growing understanding of the connection between galaxies and their central black holes has emerged over the last decade. We now know that all galaxies with a bulge contain supermassive black holes at their centers (Kormendy 2004) and that the black hole mass correlates with the host galaxy's stellar velocity dispersion in the bulge (Gebhardt et al. 2000, Ferrarese et al. 2000, Tremaine et al. 2002).

A direct connection between the masses of a black hole and its host galaxy was a bit surprising, and suggests that the growth of the black hole and the galaxy bulge may be coupled. Furthermore, it has been speculated that energy from accreting black holes, or active galactic nuclei (AGN), may have a role in quenching star formation in galaxies, and thus stopping their growth. When an amount of energy equal to that expected from AGN feedback is included in semi-analytic galaxy formation models, the models can correctly reproduce the demographics and properties of galaxies observed in large surveys (Cattaneo et al. 2006, Dekel et al. 2006). Although the physical details of the AGN/galaxy interactions are not yet understood, the fact that these models form galaxies matching those that we observe is yet another clue toward an intimate relationship between the evolution of galaxies and their supermassive black holes.

One way of investigating this connection is to study the nature of galaxies that host AGN. Do AGN exist in galaxies with similar properties? Does something in the galaxy trigger the AGN activity? To better understand this connection, we are conducting an ongoing study of the properties of galaxies that host very luminous quasars ($M_V < -23$), systems in which the black holes are actively accreting material from the surrounding galaxy at a high rate and growing. It is in these systems that we may have a better chance to understand the mechanisms in the galaxies that could trigger or stop the growth of both the black hole and the galaxy. Similar studies have been done on lower luminosity AGN where the light from the galaxy is comparable to that of the AGN. Various groups have reached different conclusions, but the consensus seems to be pointing toward AGN existing in a mix of morphological galaxy types, many of which show signs of some star formation in the last few hundred million years (e.g., Bahcall et al. 1997; McLure et al. 1999; Miller et al. 1996; Canalizo & Stockton 2000, 2001; Miller & Sheinis 2003).

It is much harder to observe host galaxies in systems where the central quasar outshines the surrounding galaxy by as much as 3.5 magnitudes. However, new observing and data reduction techniques have enabled us to successfully make such observations. Figure 1 shows the 10 quasar host galaxies that we have analyzed using off-nuclear spectra obtained with long-slit spectroscopy on the Keck 10-m telescope and with integral field spectroscopy using the SparsePak fiber bundle (Bershady et al. 2004, 2005) feeding the Bench Spectrograph on the WIYN 3.5-m telescope.

The SparsePak fibers are 5 arcsec in diameter, nearly the size of our entire host galaxy. If we centered the quasar on a fiber, the surrounding fibers would sample the host galaxy too far out in radius. Therefore, during setups on the objects, we offset the quasar toward the edge of one fiber, as shown in figure 1, to allow neighboring fibers to

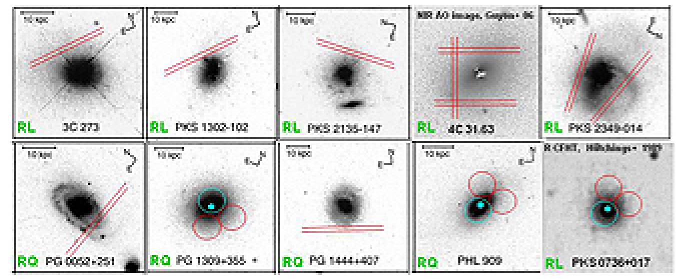

Figure 1: Observations of quasar host galaxies with long slits on the Keck 10-m telescope and with the SparsePak optical fiber bundle on the WIYN 3.5-m telescope. Each panel is 23 × 23 arcsec. Fiber circles are 5 arcsec in diameter, and the dots inside them mark the approximate locations of the quasars. For clarity, only three of SparsePak's 82 fibers are shown. RL denotes radio-loud quasars and RQ denotes radio-quiet. Our sample is drawn primarily from the 20 nearby luminous quasars of Bahcall et al. (1997), from which the underlying images are taken unless otherwise noted.

sample the host galaxy closer in to the nucleus, while isolating most of the quasar light within the first fiber. This configuration, along with the fact that the fibers integrate over a larger portion of the galaxy than the long slits, allows us to obtain spectra with the WIYN telescope that have similar signal-to-noise ratios and less scattered quasar light than those obtained on the larger Keck telescope. This makes the SparsePak integral field unit a powerful tool in studying quasar host galaxies.

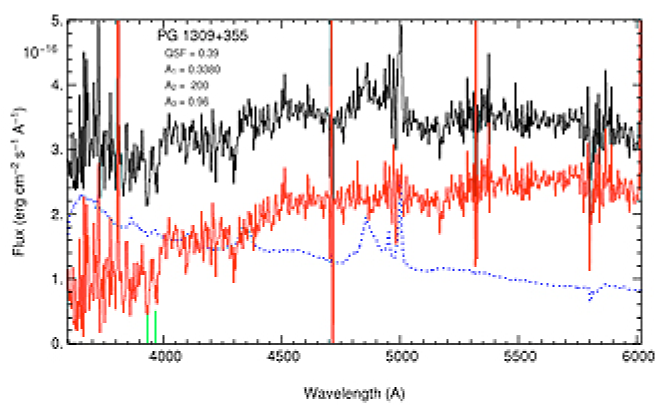

Figure 2: Subtraction of scattered quasar light from the host galaxy spectrum for PG 1309+355, observed on WIYN. The upper black spectrum is as observed in the off-nuclear location, the dotted blue line is the scaled quasar spectrum as observed independently by the fiber dedicated to the quasar, and the solid red spectrum is the host galaxy after scatter subtraction; all of these are presented in the rest frame. For this galaxy, 39% of the light in the observed spectrum was actually scattered quasar light. A_1, A_2, and A_3 are fitted coefficients to the scattering efficiency function, $A_1+A_2\,\lambda^{-A_3}$, that scales the quasar spectrum. The Ca H&K lines, that contribute to the 4000 Å break and are used to measure stellar velocity dispersion, are marked by vertical green lines near the lower left corner.

continued

Properties of the Host Galaxies of Luminous Quasars continued

Even with our careful setup procedures, 30–70% of the light in the observed off-nuclear spectrum can be scattered light from the quasar. We developed a technique to spectrally remove the scattered light by simultaneously fitting a spectrum of the quasar that is scaled by a wavelength-dependent scattering efficiency function, and fitting stellar population synthesis models to the residual galaxy spectrum. An example of this process is shown in figure 2.

Once our host galaxy spectrum is cleaned up, we measure the stellar velocity dispersion from the Ca II H&K lines at 3968 and 3934 Å (see Wolf & Sheinis (2008) for details). This parameter, combined with the galaxy's effective radius and its average surface brightness (both obtained from 2-dimensional brightness profile fits to high-resolution images by Bahcall et al. 1997), allows us to compare the galaxy structural properties with other types of galaxies. Such comparisons are often done on the Fundamental Plane (FP), which is a projection of galaxy structural properties including the effective radius, R_e, the surface brightness, μ_e, and the stellar velocity dispersion, σ_* (Djorgovski & Davis 1987, Faber & Jackson 1976). When a linear combination of σ_* and μ_e are plotted against R_e, all early-type galaxies fall approximately on a plane.

Our hosts are compared to other galaxy samples on the FP in figure 3. Host galaxies from this work are indicated by the large numbered circles. The cloud of small cyan points represents normal early-type galaxies from the Sloan Digital Sky Survey (SDSS). The solid line is a fit to the FP of the SDSS galaxies. The open diamonds above the line are massive galaxies from the SDSS, analogous to giant ellipticals.

The first thing we see about our hosts is a dichotomy between the radio-loud quasars (green) and radio-quiet quasars (yellow). The hosts of radio-loud quasars lie at the upper extreme of the FP because of their higher velocity dispersions, larger effective radii, and lower surface brightness than normal early-type galaxies. Their structural properties are similar to giant elliptical galaxies. Our radio-quiet hosts lie on the FP and have structural properties similar to intermediate mass early-type galaxies. The triangles are radio-quiet quasar hosts from Dasyra et al. (2007). They were selected because their properties were similar to ultraluminous infrared galaxies (ULIRGs), which are thought to be merging galaxies in which a nuclear starburst is ongoing. Merger remnants are the last comparison sample on our FP plot (Rothberg & Joseph 2006), and are shown as squares. It is clear that merger remnant properties overlap those of the Dasyra et al. quasar hosts on the FP. The merger remnants also stretch down below the plane because galaxies with ongoing nuclear starbursts currently have high surface brightness (note that μ_e is in magnitudes, so lower numbers are higher surface brightness). They are expected to fade up to the FP once this phase has ended.

Although we cannot make global claims with our currently small biased sample of nearby bright quasars, if we consider the structural properties of all the galaxy samples presented, there appear to be two populations. First, the hosts of radio-quiet quasars have properties similar to intermediate mass early-type galaxies, including those that formed from gas-rich mergers in which nuclear starbursts were triggered. The morphological classifications of these quasar host galaxies are mixed between ellipticals and spirals, as can be seen in figure 1.

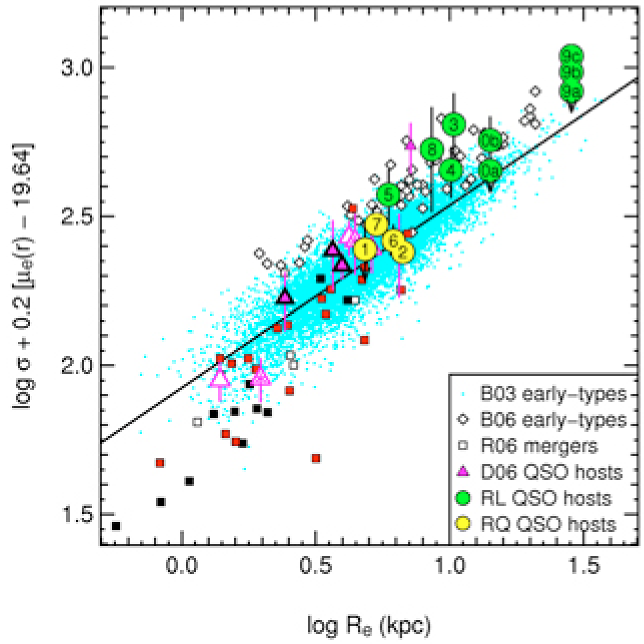

Figure 3: The Fundamental Plane of galaxies. Our quasar hosts are shown as large circles (yellow are radio-quiet, green are radio-loud). Comparison galaxies: small cyan points are early-type galaxies from SDSS (Bernardi et al. 2003), open diamonds are massive early-type galaxies (Bernardi et al. 2006), triangles are radio-quiet PG QSO hosts (Dasyra et al. 2007), and squares of all shades and colors are merger remnants (Rothberg & Joseph 2006). The solid line is the FP fit to early-type galaxies from Bernardi et al. (2006).

Second, the hosts of radio-loud quasars occur in massive galaxies with structural properties similar to giant ellipticals. Compared to normal early-type galaxies, they have higher stellar velocity dispersions, larger effective radii, and lower surface brightness. Their morphological classifications are ellipticals and interacting systems. Their low surface brightness indicates that no nuclear starburst is present. Perhaps these galaxies are the result of dry mergers between two massive ellipticals, rather than the gas-rich, lower-mass progenitors of the first population.

New observing and data reduction techniques have allowed us to probe the properties of the host galaxies of luminous quasars and directly measure stellar velocity dispersions. We continue to add to our sample with observations on the WIYN telescope. Our ongoing analyses include investigating whether these objects follow the same black hole mass/stellar velocity dispersion relation as lower luminosity AGN and quiescent galaxies. We are also estimating the stellar populations of the host galaxies from the entire observed spectral range. We see preliminary indications that populations as young as a few 100 Myr exist in these galaxies. Although the structural properties of the hosts of radio-loud quasars match those of giant ellipticals, five out of six in our sample have spectral features that do not suggest a purely old population. Ultimately, we hope to compare our local sample with one at higher redshift to look for evolution.

continued

Properties of the Host Galaxies of Luminous Quasars continued

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An Innovative Search for Elusive Lyα Blobs

Moire Prescott (Steward Observatory), Arjun Dey & Buell Jannuzi (NOAO)

Lyman-α nebulae—or Lyα blobs—are giant clouds of gas (~100 kpc in diameter) emitting strongly in Lyα. These rare sources are likely sites of ongoing massive galaxy formation, as evidenced by their large Lyα luminosities (~10^{44} erg/s) and their association with star-forming galaxy populations such as Lyman Break Galaxies and Submillimeter Galaxies (e.g., Chapman et al. 2004, Dey et al. 2005, Geach et al. 2007).

Due to the internal complexity of these systems and the paucity of known examples, basic questions about Lyα blobs have been challenging to answer conclusively. First, what is the source of ionization? Are they powered by cooling radiation from gravitational infall, photoionized by hot young stars or AGN, or shock heated by starburst-driven superwinds (e.g., Nilsson et al. 2000, Dijkstra et al. 2006, Dey et al. 2005, Taniguchi & Shioya 2000)? Second, what determines their large extent? Are the 100-kpc diameters representative of their true size, or are we seeing the effects of strong resonant scattering of Lyα (e.g., Dijkstra et al. 2006)? Finally, what is the true space density of Lyα blobs? There is evidence that Lyα blobs are confined to the most overdense regions of the Universe (e.g., Steidel et al. 2000, Matsuda et al. 2004, Prescott et al. 2008a). However, the tally of large Lyα blobs remains small (~12 larger than 50 kpc), and many have been found by specifically targeting known galaxy overdensities.

To make progress in understanding the role Lyα blobs play in the galaxy formation process, we must answer fundamental questions about their prevalence and properties. What is needed is a systematic survey for moderate redshift Lyα blobs over a wide field, where their space density can be accurately measured and their properties investigated in detail. A large-volume survey will allow for unbiased study of the clustering properties of these sources and clarify the relationship between Lyα blobs and matter overdensities. In addition, a larger sample of individual Lyα blobs will provide the basis for the extensive multi-wavelength follow-up essential for building a coherent understanding of their internal structure and emission mechanisms.

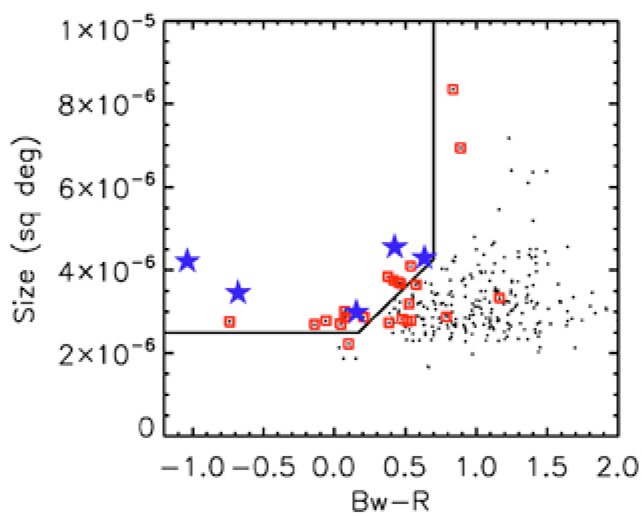

Figure 1: High-priority Lyα blob selection window in size-color space; morphological Lyα blob candidates (black points), spectroscopic targets (red squares), and confirmed Lyα sources (blue stars) are shown.

Numerous groups are now carrying out systematic Lyα blob surveys using narrowband filters in the hopes of measuring the true space density of these rare sources and providing new targets for follow-up study (e.g., Saito et al. 2006, Smith & Jarvis 2007, Yang et al. 2008). While these narrowband programs, covering 1–15 square degrees, are well-designed to find line-emitting sources, they require large quantities of observing time. This, combined with the narrow redshift span of the filters, puts a practical limit on the maximum co-moving volume that can be surveyed. Since covering large co-moving volumes is crucial for constraining the bright end of the Lyα blob luminosity function, we decided to take a complementary approach. Leveraging the power of deep broadband surveys, we have designed a systematic

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Innovative Search for Elusive Lyα Blobs continued

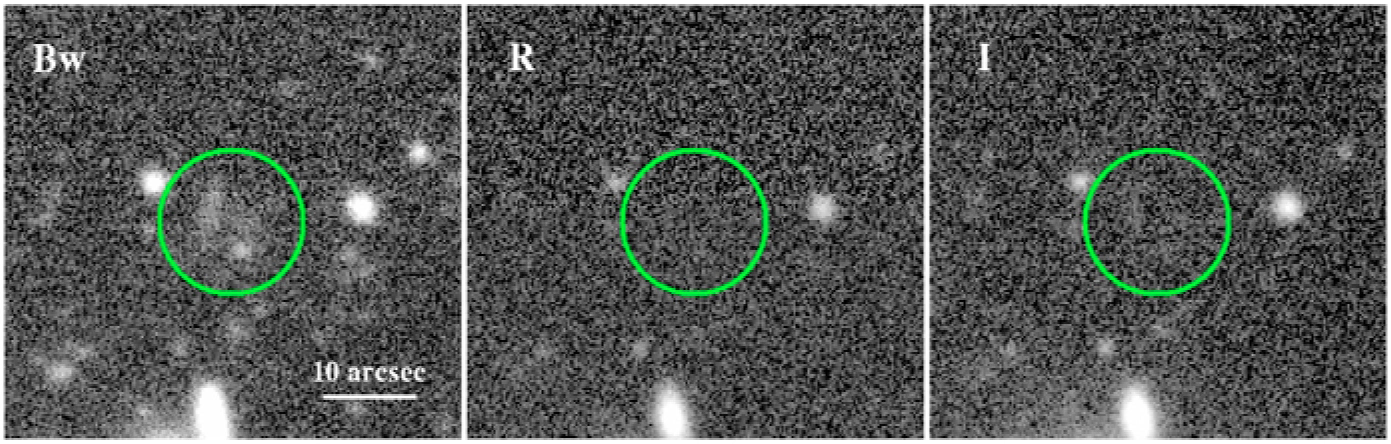

Figure 2: NDWFS B_W, R, and I imaging of a newly discovered 80-kpc Lyα blob at z ~ 2.3. This source was selected as a Lyα blob candidate because of the strong, diffuse Lyα emission dominating the flux in the B_W band.

search for the most luminous Lyα blobs using the archival NOAO Deep Wide-Field Survey (NDWFS) broadband optical imaging (Jannuzi & Dey 1999; NOAO Science Archive).

The inspiration for this unusual approach was the unexpected discovery of a large Lyα blob in the Boötes field at z ~ 2.7 (Dey et al. 2005). Unlike many of the larger Lyα blobs, which were found in narrowband surveys targeting galaxy overdensities, this source came to light because of its very strong 24-micron emission and its diffuse, blue morphology in the NDWFS optical B_W-, R-, and I-band imaging. Thanks to the very dark sky in the blue, strong Lyα emission can dominate even the very broad B_W bandpass. The advantage is the enormous co-moving volume (~$10^8 h_{70}^{-3}$Mpc^3) that can be surveyed efficiently using publicly available archival data.

Our systematic search uses a wavelet-deconvolution algorithm to select large, diffuse sources from the B_W imaging, and we prioritize candidates with blue B_W-R colors (figure 1). As these systems can be quite complex, often with associated galaxies that contribute redder colors, we have chosen to keep our selection simple and fairly broad. Even so, we find only 17 high priority candidates over the entire nine-square-degree field. We carried out spectroscopic follow-up of our high priority candidate sample using the MMT and the Blue-Channel Spectrograph and confirmed five sources with Lyα emission, a success rate of roughly 30%. The details of the search will be discussed in an upcoming paper (Prescott et al. 2009, in preparation).

Due to the enormous volume surveyed, our innovative search provides the first lower limit on the space density of the most luminous Lyα blobs. The preliminary space density from this survey is $N>10^{-8} h_{70}^{3}$Mpc^{-3}, which is two orders of magnitude lower than other estimates from smaller volume surveys. With the search pipeline now in place, we plan to expand our search to the NDWFS Cetus field and other deep imaging surveys.

In addition to putting constraints on the space density, this survey has uncovered lower redshift Lyα blobs that are ideal for detailed spectroscopic follow-up. For two cases in particular, all the standard emission lines out to Hα will be accessible with optical and near-infrared spectroscopy. One is a 45-kpc Lyα blob at z ~ 1.7 (Prescott et al. 2008b)—the lowest redshift Lyα blob known—and one is an 80-kpc Lyα blob at z ~ 2.3 (figure 2). These low-redshift Lyα blobs present a crucial opportunity to study the physical conditions—temperatures, metallicities, and kinematics—of the gas within Lyα blobs and to better understand the role Lyα blobs play in the formation of the most massive galaxies.

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Smith, D. J. B., & Jarvis, M. J. 2007, MNRAS, 378, L49
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Strategy, Tactics, and Budgetary Results

David Silva

Even before the current global financial crisis erupted, the US Congress mandated that most Federal agencies would operate at FY 2008 budget levels until at least March 2009. NSF, and hence NOAO, did not escape this mandate. So in the short-term, NOAO must react to a 15 percent budget cut relative to initial expectations for FY09.

Rather than reduce cost uniformly across NOAO, we have elected to make targeted, deeper reductions in consultation with AURA and the NSF. Choices have been made within the following NSF-approved strategic framework.

Strategy

First, in partnership with other private and public observatories, NOAO must develop an open-access US optical/infrared (O/IR) system of ground-based facilities that spans a balanced range of telescope aperture size and scientific capability. Continued operation of KPNO and CTIO at a robust level is central to system development for the immediate future.

Second, the US O/IR System will be enhanced through NOAO participation in the development of new major facilities such as LSST and GSMT. NOAO participation can come in several ways but the main goal is to assure that the requirements of the community-at-large are satisfied by whatever major facilities seek NSF funding and later reach fruition.

Third, NOAO will broaden participation in the NSF science enterprise by engaging individuals, institutions, and geographical areas "…that do not participate in NSF research programs at rates comparable to others." (Quote taken from *Executive Summary, Broadening Participation at the National Science Foundation: A Framework for Action*, August 2008).

Tactics

Within the overall NOAO program, CTIO and KPNO have the highest priority. NOAO must not lose ground gained in the last 24 months on its comprehensive response to the Senior Review. No significant cuts are planned in either program.

Currently, our most important future initiative is LSST. Our involvement in that project must be protected as much as possible. Even if LSST fails or NOAO needs to withdraw, the engineering talent assigned to that program is crucial to our future, and we want to retain them. Thus, major cuts in our LSST program are not foreseen at this time.

The activities of Public Affairs and Educational Outreach (PAEO) are important but not at the forefront of the NOAO mission. Unfortunately, current PAEO ambitions exceed available resources. Therefore, PAEO has been restructured to reduce cost and focus on mission-critical operational roles, such as media affairs, engaging the astronomical community, and educational outreach activity in local and regional areas within Chile and Arizona. PAEO can expand again later as funding and well-justified activities emerge.

Current Data Products Program (DPP) ambitions also exceed available resources. DPP has been restructured to reduce cost and focus on data capture, science application support, and our obligations to the Dark Energy Survey. It can be expanded again later in a considered manner as funding permits.

Other, proportionally smaller programs face roughly 5–10 percent cost reductions.

Results

In total, the NOAO staff complement has been reduced by roughly 25 positions relative to our original plan for FY 2009. About half of the staff reduction comes from simply leaving positions open or planned positions unfilled. Our total projected expenses have been reduced by roughly $3 million.

While this is a difficult moment, I believe we have protected the NOAO core program and are well positioned to respond quickly to improved financial conditions when they occur. I also remain optimistic about the five-year NOAO outlook. I will keep you abreast of developments through our e-newsletter *Currents*.

Observatoire de Paris Honors Stephen Ridgway

Stephen Ridgway of the NOAO scientific staff was awarded an honorary doctorate degree by the Observatoire de Paris in recognition of more than two decades of forefront work on high angular resolution imaging using the techniques of spatial interferometry.

Known for his work in both experimental and observational infrared astronomy, Ridgway is the author of more than 250 publications. His research has included identification of the molecular constituents of stars, planets, satellites, and gas clouds, particularly water, phosphine, acetylene, and methane. His studies of stellar angular diameters contributed to a recalibration of the effective temperature scale of cool stars.

Ridgway is also an adjunct professor with the Georgia State University, and recently served as a Program Scientist and Program Executive at NASA Headquarters. His work was previously honored with a Blaise Pascal International Research Chair in 2002.

Bob Blum Appointed Interim NOAO Deputy Director

David Silva

Bob Blum has been appointed interim NOAO Deputy Director until at least mid-2009. Bob joined NOAO as a staff astronomer at CTIO in 1997 working in support of near infrared instruments and observers at the Blanco 4-meter telescope and later at SOAR. When Gemini came on line, Bob worked to support US observers within the NOAO Gemini Science Center.

While at CTIO, Bob helped to manage the site testing program in Chile for the Thirty Meter Telescope project. In 2006, Bob and family relocated to Tucson after nine years in Chile.

A Brief Overview of the Governance Structures of NOAO and the International Gemini Observatory

Verne V. Smith & Kenneth H. Hinkle

Future planning for US open-access time to ground-based telescopes is one item that will be discussed by the upcoming decadal survey panels and committees. The NOAO Access to Large Telescopes for Astronomical Instruction and Research (ALTAIR) committee is currently reviewing US future needs for, aspirations for, and access to large ground-based telescopes of aperture 6.5 to 10 meters. ALTAIR will issue a report during the first quarter of 2009.

Within the ground-based open-access system, the US fraction of time available on the international Gemini Observatory's two 8.1-meter telescopes is the largest single block of time in the 6.5- to 10-meter class. Looking toward the next decade and the role of Gemini in the US ground-based system, we present here a brief overview of the management of both NOAO and Gemini to familiarize the US user community with the interactions between these two organizations.

NOAO and Gemini are both managed by the Association of Universities for Research in Astronomy (AURA). AURA is a consortium of universities, educational organizations, and other non-profit institutions that operates several astronomical observatories, termed "centers." AURA members consist of 34 US institutions and seven international affiliates. The mission of AURA is to act on behalf of the science communities that are served by these centers, and as trustees and advocates for the centers' missions. In addition to NOAO and Gemini, AURA also manages the National Solar Observatory and the Space Telescope Science Institute.

Ground-based nighttime astronomy is represented within AURA by NOAO and Gemini. While NOAO is a US-controlled center, Gemini is an international partnership (consisting of the US, the UK, Canada, Australia, Brazil, and Argentina, with Chile and the University of Hawai´i having access as site hosts). The Gemini international partners fund the observatory through their various funding agencies, with the US National Science Foundation (NSF) acting as the executive agency. The relative financial contributions of the Gemini partners are illustrated in figure 1.

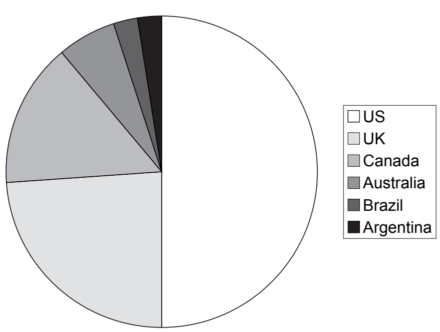
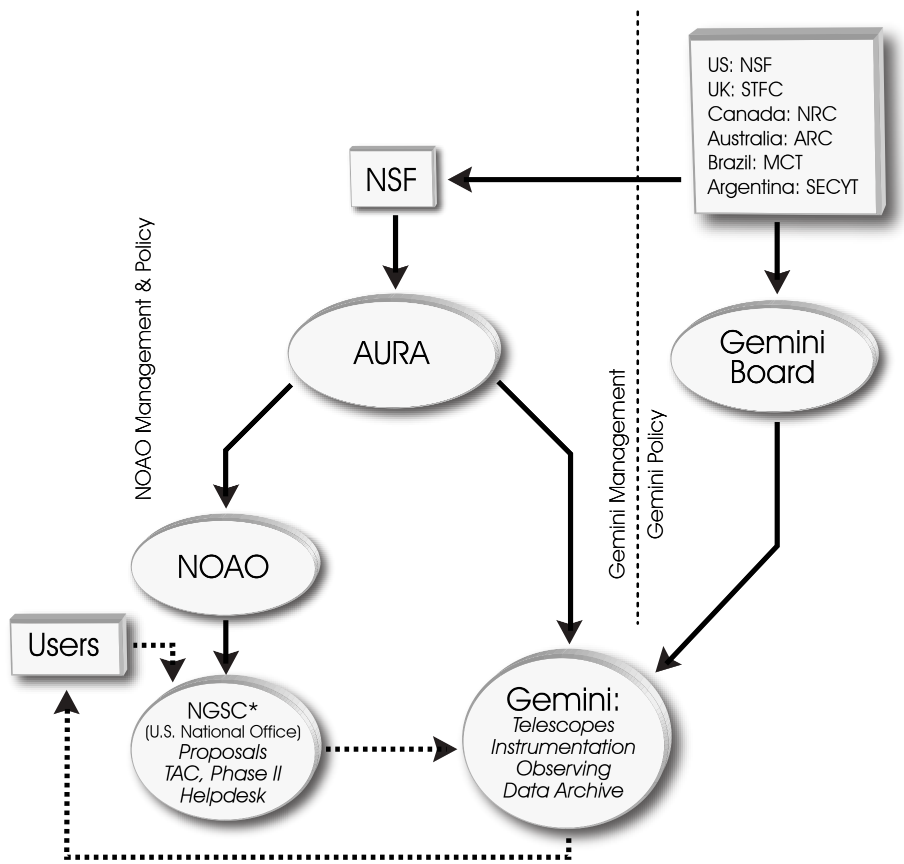


Figure 1: Relative financial contributions of the Gemini partners.



*Each partner country has a national office.

Figure 2: A simplified view of the management and policy structures of NOAO and Gemini.

continued

Governance Structures of NOAO & Intl. Gemini Observatory continued

Figure 2 illustrates a simplified view of the organizational structure of both NOAO and Gemini. Looking first at NOAO, funding for the US national observatory flows from the NSF, with operations managed by the AURA Board of Directors. The AURA Board of Directors and the Observatories Council (OC) fall under the AURA oval on the chart. The OC is a management council appointed by the AURA Board that provides management oversight and advocacy for NOAO. The OC has the specific authority to act for the AURA Board in all matters pertaining to the mission of NOAO (except as specifically reserved for the AURA Board). The OC purview thus involves both management and science policy issues.

Focusing next on Gemini, AURA is the management arm of Gemini. However, science policy is set by the Gemini partnership as represented by the Gemini Board of Directors. Within AURA, the managing committee is the AURA Oversight Committee for Gemini (OC-G), which deals with management issues only and does not provide independent scientific direction to Gemini. Unlike NOAO, science policy for Gemini is not discussed within AURA (since Gemini is an international partnership), but rather is the purview of the Gemini Board.

Each Gemini partner country has a National Gemini Office (NGO). The NOAO Gemini Science Center (NGSC) is the US NGO. The NGOs are operations service providers and community science interfaces. NGSC deals with operational issues involving Gemini, such as answering questions, performing proposal technical reviews, and dealing with Phase II observing programs.

As shown in figure 2, NOAO/NGSC has no management authority over Gemini. NGSC provides input to Gemini through two international Gemini committees: the Gemini Science Committee (GSC) and the Operations Working Group (OpsWG). These two committees report to the Gemini director. GSC members are picked by the Gemini Director's Office, usually in consultation with some representative from the perspective member's partner country. Membership on the OpsWG consists of the heads of the partner NGOs.

Planning for the US role in Gemini into the next decade involves discussions not only within the US community but also within the partnership as a whole. The organizational structures and committee memberships are available on the AURA and Gemini Web sites:

AURA Board of Directors:
www.aura-astronomy.org/g/ag.asp?gid=82
Gemini Board:
www.gemini.edu/science/#gbod
AURA OC:
www.aura-astronomy.org/g/ag.asp?gid=80
AURA OC-G:
www.aura-astronomy.org/g/ag.asp?gid=69
GSC:
www.gemini.edu/science/#gsc
OpsWG:
www.gemini.edu/science/#owg NL

Don't Miss NGSC at the 2009 AAS Meeting

Kenneth H. Hinkle

Were you at the January 2008 American Astronomical Society (AAS) meeting in Austin? Did you stop at the NOAO Gemini Science Center (NGSC) table at the NOAO booth? If you did, you know we had two raffles. An NOAO town hall meeting attendee won an iPod touch for entering the NOAO raffle. Matt Richter (University of California, Davis) won a $250 gift certificate for entering the NGSC raffle, which required filling in the NGSC questionnaire. The questionnaire allowed us to collect quite a bit of information about you, our users or potential users. We thank the more than 200 people who filled out our questionnaire. Additional information about the results of the survey and NGSC's presence in Austin is available at: *www.noao.edu/noao/noaonews/mar08/pdf/93ngsc.pdf* (p. 14) and *www.noao.edu/usgp/ngsc-aas-211.html*, respectively.

Look for NGSC at the NOAO booth in Long Beach in January 2009. We will have something amusing as well as informative! If you are a Gemini user, please take the time to stop and talk to us. We value your comments on your interactions with Gemini and NOAO/NGSC. Since most of you are queue observers, our interaction with you is mostly limited to email. The AAS meeting is one of the few chances we have to meet face to face.

NGSC staff member Dara Norman helps Marcel Agüeros (Columbia University) with his Phase II at the January 2008 AAS meeting.

And, of course, if you have been granted Gemini observing time in 2009A, NGSC staff present at the AAS meeting will help you with your Phase II observing program. This is an opportunity for you to get expert one-on-one help with the Phase II process.

Community Input to the Gemini Long Range Plan

Verne V. Smith

In anticipation of operations into the next decade (2011–2020), the international Gemini Observatory has begun the process of drafting a Long Range Plan (LRP). This plan will provide overall direction for the observatory, making sure that near-term projects are consistent with reaching long range goals, as well as ask the question "what should Gemini look like in 2020?"

Input will cover such areas as engineering, administration, safety, outreach, development, and science operations. The timescale for this plan envisions a draft LRP in early 2011 that will define an optimal set of science goals for Gemini out to 2020.

Some of the parameters that need to be considered include:

- Science trends
- Gemini viewed in the context of other ground- and space-based observatories
- Technology frontiers
- Playing to Gemini's strengths within a global view of astronomy
- Long-term north/south instrument deployment plans
- Resource constraints
- Recommendations from various existing and soon-to-be completed national astronomy priority assessments, such as—for the US—the Access to Large Telescopes for Astronomical Instruction and Research (ALTAIR) committee report or the 2010 decadal survey

The time period covered by the LRP includes the planned deployment of the James Webb Space Telescope (JWST) and the possible beginning of operations of a ground-based Extremely Large Telescope (ELT) of the 20- to 30-meter class. Within this context, consideration could be given to some of Gemini's identified strengths, such as a well-developed queue-based system, excellent thermal infrared (IR) sensitivity, and superb image quality. These natural strengths must then be counterbalanced by other community aspirations, which include continued interest in broadly capable optical instruments for the Gemini partnership, wide-field multiplex capabilities, such as those provided by FLAMINGOS-2 or WFMOS, or high-dispersion optical and near-IR spectroscopy. All of these variables must be combined to develop an optimized set of capabilities for the future Gemini Observatory.

Broad community input into defining future Gemini capabilities is essential, and some of the questions that need to be addressed include:

- Which instruments should be on which telescope (should instruments move between north and south)?
- What new instrument capabilities are needed?
- Which instruments could be upgraded?
- What balance should be sought between community-defined workhorse and niche instruments?
- What balance should be sought between large survey science and principal-investigator-driven science?
- How might we prioritize visiting instruments?
- How much can we work to build inter-observatory collaborations, allowing some room to specialize telescopes?

Further thought will be needed on how to best gather input into the long-range planning for Gemini. However, one good route for the community to provide initial comments is through the membership of the US Gemini Science Committee (GSC).

The GSC members are listed below, along with their email addresses. These individuals welcome any and all comments from you concerning the Gemini LRP, so I encourage you to give the issues pointed out above some thought and to share these thoughts with your GSC members!

US Members of the GSC:

Nancy A. Levenson (University of Kentucky)
levenson@pa.uky.edu
Christopher C. Packham (University of Florida)
packham@astro.ufl.edu
Henry G. Roe (Lowell Observatory)
hroe@lowell.edu

GSC Chair (acting for the entire partnership)**:**

Timothy C. Beers (Michigan State University)
beers@pa.msu.edu

Joint Gemini-Subaru Science Meeting in May 2009

Timothy C. Beers (Michigan State University) & Verne V. Smith

The Subaru and Gemini observatories will host a jointly sponsored science meeting at Kyoto University, in Kyoto, Japan, from 18–21 May 2009. This international conference will include scientific results from any projects undertaken using the Subaru and Gemini telescopes. The principal goal of the meeting is to bring together astronomers from the Subaru and Gemini communities to discuss and understand the science being done by both groups, with particular emphasis on mutual communication, collaborations, and synergies between the communities. This get-together will help to define new scientific frontiers, with an eye toward future users and observational capabilities of the Gemini and Subaru telescopes.

The Local and Scientific Organizing Committees (LOC and SOC, respectively) have been appointed. The LOC is chaired by Kouji Ohta (Kyoto University), while the SOC is co-chaired by Masashi Chiba (Tohoku University) and Timothy C. Beers (Michigan State University).

Additional members of the SOC are:

Toru Yamada (Tohoku University),
Motohide Tamura (NAOJ),
Kazuhiro Shimasaku (University of Tokyo),
Yoshiko Okamoto (Ibaraki University),
Kouji Ohta (Kyoto University),
Isobel Hook (Oxford University),
Chris Packham (University of Florida),
Scott Croom (Sydney University), and
Marcin Sawicki (St. Mary's University).

Subsequent to the joint science meeting, a Gemini users meeting will be held on 22 May 2009 at the same venue.

At the time of this writing, the details of registration, travel, and accommodations had not been announced; check the NGSC Web site (*www.noao.edu/usgp/*) for the latest news on "Kyoto 2009." The LOC is preparing a conference Web site where all necessary information will be available.

Report on Classical Observing at Gemini South

Pieter van Dokkum (Yale University) & Mariska Kriek (Princeton University)

NGSC encourages Gemini users to consider requesting classical time for observing blocks of one night or more. We have solicited comments from previous observers to highlight the advantages of classical observing. This commentary from Pieter van Dokkum describes his experience observing with the Gemini Near-Infrared Spectrograph (GNIRS) on Gemini South.—Kenneth H. Hinkle (NGSC)

While it was on Gemini South, GNIRS was one of the best and most versatile faint-object, near-infrared spectrographs in existence. Its ability to obtain spectra over the entire wavelength range of 1–2.5 µm was particularly well-suited to our science program. Mariska Kriek and I measured redshifts of a complete sample of K-selected galaxies at $2.0 < z < 2.7$, using emission lines or (in about half the cases) the redshifted Balmer or 4000 Å continuum break. The GNIRS spectra formed the basis of Mariska Kriek's Ph.D. thesis (see Kriek et al. 2006, 2007, 2008). She is now a Russell Fellow at Princeton University.

Pieter van Dokkum and Mariska Kriek on the Gemini South observing floor underneath GNIRS.

Early on, we chose classical rather than queue mode for our program. We did not know beforehand what the galaxy spectra would show: for some galaxies, a 30-minute spectrum would show emission lines at a redshift outside of the $2.0 < z < 2.7$ window, which meant that we could move to another target; for other galaxies, we had to integrate several hours to obtain a redshift from the continuum emission. Mariska wrote software that allowed us to reduce the spectra immediately, so that we could make these real-time decisions and optimize our observing time.

continued

Report on Classical Observing continued

I also think that we greatly benefited from getting to know the instrument really well. For the first run, we actually went to the telescope a day early to sit in and help out during an engineering night. The detailed knowledge we gained over the course of several years helped us with developing both efficient observing strategies and optimal reduction techniques. Also, the Phase II forms of Gemini can be somewhat daunting, so it was very useful to have been to the telescope to see firsthand how the software, the telescope, and the instrument interact. We would like to think that this interaction was mutually beneficial: we could give instant feedback on operational issues, and we aided in the development of the acquisition script and some of the reduction tools.

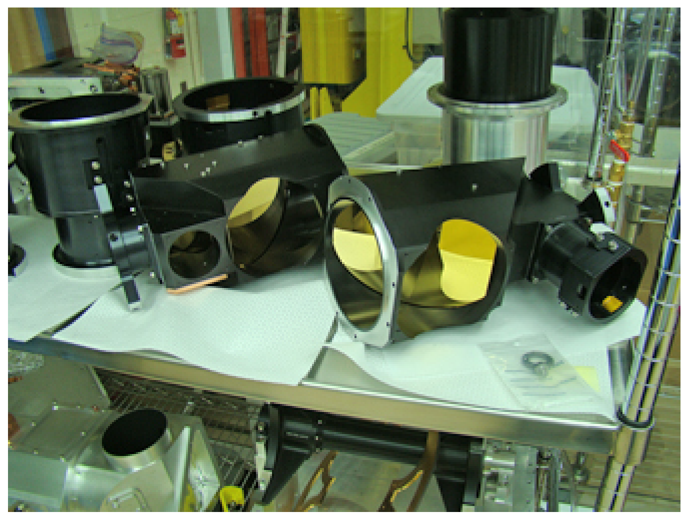
Finally, there is a more subjective aspect to this. Going to the telescope and interacting with the people who make it all happen gives a sense of co-ownership and of a shared responsibility to ensure the success of the observatory. Although there are excellent scientific reasons for queue observing, I encourage astronomers with a long-term interest in Gemini to make the bumpy ride up Mauna Kea or Cerro Pachón at least once! NL

An Update on GNIRS

Jay Elias & Katia Cunha

As reported in the September 2007 *NOAO/NSO Newsletter*, the Gemini Near-Infrared Spectrometer (GNIRS) was seriously damaged when the instrument was accidentally overheated in April 2007. A number of optical and electrical components, including the detector, were either damaged or destroyed. The bulk of the recovery effort has been taking place at the Gemini facilities in Hilo.

GNIRS was built by NOAO, and the NOAO staff involved in the original design and construction work are being consulted on the repairs. Some NOAO support services are being used to evaluate optics and detectors, and to assist with final re-integration. Detailed progress reports on GNIRS can be found in the June 2008 and December 2007 issues of *Gemini Focus* (see *www.gemini.edu/sciops/instruments/nir/GemFocusMay08-GNIRS.pdf* and *www.gemini.edu/files/pio/newsletters/35-200712_gemini_focus.pdf* [pp. 43-45]).



GNIRS camera barrels during re-integration. The two short cameras are on the left, the two long cameras are on the right. The flats in the long cameras are among the optics that were damaged during the accident and replaced.

GNIRS will be re-deployed at Gemini North, where it can be used with the Altair adaptive optics (AO) system and take advantage of the superior conditions for L- and M-band spectroscopy. Gemini's schedule calls for re-integration and lab testing to be completed during the first quarter of 2009.

If all goes as expected with the detector and optics procurements, GNIRS will be included in the 2009B Gemini call for proposals. GNIRS will be offered in seeing-limited modes previously used at Gemini South. GNIRS will not be offered for AO observations during 2009B because those modes will not have been commissioned yet. It is possible that science verification time will be offered in 2009B once GNIRS is commissioned with Altair.

NICI–AO Imaging Capability at Gemini South

Kenneth H. Hinkle & Ron Probst

The Near-Infrared Coronagraphic Imager (NICI) is an adaptive optics (AO) dual-channel camera with a coronagraph that is optimized to search for and image large Jovian-type planets around nearby stars. However, many people may not know that NICI can be used without the coronagraph.

In this mode, NICI becomes a natural guide star AO imager. The detector is a 1024 × 1024 ALADDIN InSb array with 18 mas/pixel yielding a field of view (FOV) of 18 × 18 arcseconds. A variety of broadband and narrowband filters are available including J, H, K, and Ks. The FOV and pixel scale are similar to those of the Hokupa'a/QUIRK system used at Gemini North until 2003. AO imaging is a new feature at Gemini South, and users interested in this capability should look for NICI in the 2009B call for proposals.

Helpful Hint: Gemini Science Archive

One common question asked through the Gemini HelpDesk concerns the accessibility of the Gemini Science Archive. As the archive (*cadc.hia.nrc.ca/gemini*) is the primary distribution mechanism for Gemini data, lack of access can be frustrating. Occasionally, although the Web interface to the archive is accessible, the data may not be (and you may get errors from the download tool). Even the most robust archives have occasional downtime. If you are not able to access your data in the archive, please wait for a few hours and then try again to connect.

NGSC Instrumentation Program Update

Verne V. Smith & Mark Trueblood

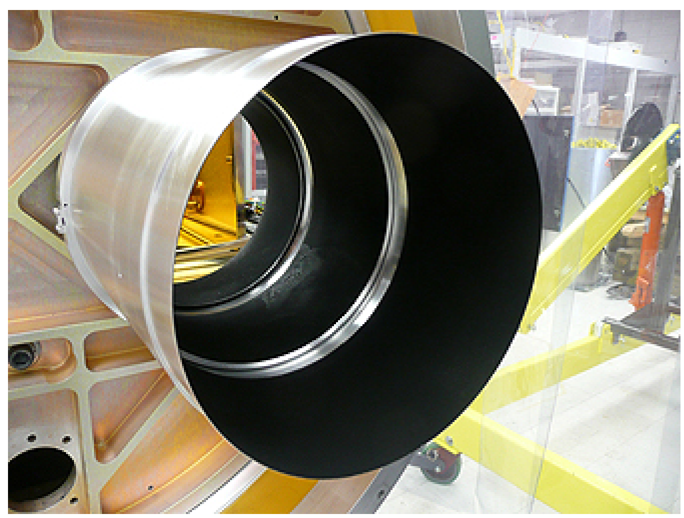
The NGSC Instrumentation Program continues its mission to provide innovative and capable instrumentation for the Gemini telescopes in support of frontline science programs. This article gives a status update on Gemini instrumentation being developed under the oversight of the NGSC, with progress since the September 2008 *NOAO/NSO Newsletter*.

FLAMINGOS-2

The Florida Multi-Object Imaging Near-Infrared Grism Observational Spectrometer (FLAMINGOS-2) is a near-infrared multi-object spectrograph and imager for the Gemini South telescope. FLAMINGOS-2 will cover a 6.1-arcminute-diameter field at the standard Gemini f/16 focus in imaging mode, and will provide multi-object spectra over a 6.1 × 2-arcminute 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 Pre-ship Acceptance Test was held in Gainesville, FL, August 4–8. The Camera Dewar cold head failed shortly before the test was scheduled to begin. The decision was made to proceed with the test knowing that many sections of the test could not be performed with a warm Camera Dewar. Despite this impediment, approximately half the requirements were successfully tested and passed. Following the test, the Gemini Observatory produced a punch list of items to be completed before the instrument is shipped to Cerro Pachón. The University of Florida team responded promptly with a schedule showing completion of all items by the end of October 2008, with the resumption of the Pre-ship Acceptance Test occurring in November 2008. If this schedule is followed, the authors expect the instrument to be shipped to Gemini South by the end of the calendar year.

As of mid-October, the University of Florida team reported that 74 percent of the punch list work on FLAMINGOS-2 has been completed.



The Pre-ship Acceptance Test for FLAMINGOS-2 showed that a deployable light baffle was needed to shield thermal emission from the gate valve separating the multi-object spectrograph and camera units. The baffle extends through the open gate valve to connect baffling on both sides of the valve. The completed baffle assembly is shown.

2009A Proposal Process Update

Dave Bell

NOAO received 385 observing proposals for telescope time during the 2009A observing semester. These included 144 proposals for Gemini, 97 for KPNO, 95 for CTIO, 53 for Keck, 17 for MMT, and 9 for Magallen. Thesis projects accounted for 29 percent (110 proposals) of those received, 15 proposals requested long-term status, and 11 requested time through the NOAO Survey program. Time-request statistics by telescope and instrument appear in the following tables. Subscription rate statistics will be published in the March 2009 edition of this *Newsletter*.

Proposals were reviewed in October and November +by members of the NOAO Time Allocation Committee (see the following listing). We expect all telescope schedules to be completed by 12 December 2008, and plan to notify principal investigators of the status of their requests at that time.

Looking ahead to 2009B, information and forms will be available online around March 1. The March 2009 issue of this *Newsletter* will contain updated instrument and proposal information.

2009A Time Allocation Committee Members

Solar System (30–31 October 2008)
David Trilling, Chair, University of Arizona, Steward
Travis Barman, Lowell Observatory
Amanda Hendrix, Caltech, JPL
Renu Malhotra, University of Arizona, LPL
Bill Merline, Southwest Research Institute
Beatrice Mueller, Planetary Science Institute

Extragalactic (3–4 November 2008)
Jill Bechtold, Chair, University of Arizona, Steward
Mark Dickinson, Chair, NOAO
Richard Green, Chair, Large Binocular Telescope Observatory
Ranga-Ram Chary, Spitzer Science Center
Mike Eracleous, Pennsylvania State University
Karl Gebhardt, University of Texas, Austin
Michael Gregg, Lawrence Livermore National Laboratory
Andy Howell, University of Toronto
Mark Lacy, Spitzer Science Center
Jennifer Lotz, NOAO
Knut Olsen, NOAO
Ravi Sheth, University of Pennsylvania
Tom Statler, Ohio University
Daniel Stern, Caltech/JPL
Alan Stockton, University of Hawai'i, IfA
Louis Strolger, Western Kentucky University
Pieter van Dokkum, Yale University
Liese van Zee, Indiana University

Survey (15–16 October 2008)
Mauro Giavalisco, Chair, University of Massachusetts
Debra Elmegreen, Vassar College
Scott Gaudi, Ohio State University
Davy Kirkpatrick, Caltech, IPAC
Dick Shaw, NOAO
Adam Stanford, University of California, Davis

Galactic (5–6 November 2008)
Steve Howell, Chair, NOAO
Ata Sarajedini, Chair, University of Florida
Jeff Valenti, Chair, Space Telescope Science Institute
Ted Bergin, University of Michigan
Bob Blum, NOAO
John Carr, Naval Research Laboratory
Geoffrey Clayton, Louisiana State University
Anne Cowley, Arizona State University
Orsola de Marco, American Museum of Natural History
Don Garnett
Steve Kawaler, Iowa State University
Sebastien Lepine, American Museum of Natural History
Phil Massey, Lowell Observatory
Raghvendra Sahai, Caltech, JPL
Simon Schuler, NOAO
Tammy Smecker-Hane, University of California, Irvine
Angelle Tanner, Jet Propulsion Laboratory, IPAC
Stefanie Wachter, Spitzer Science Center

2009A Instrument Request Statistics by Telescope

Gemini Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
GEM-N		**95**	**120**	**125.8**	**48.3**	**38**	**1**
	GMOSN	48	58	71.3	42.2	59	1.2
	MOIRCS	2	2	1.3	0.9	68	0.7
	Michelle	6	6	4.6	2.6	56	0.8
	NIFS	13	14	13.5	0	0	1
	NIRI	34	38	32.1	2.6	8	0.8
	SuprimeCam	2	2	3	0	0	1.5
GEM-S		**52**	**64**	**83**	**16.8**	**20**	**1.3**
	GMOSS	27	34	34.2	16.8	49	1
	Phoenix	16	20	33.2	0	0	1.7
	TReCS	10	10	15.6	0	0	1.6

Kitt Peak National Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
KP-4m		**44**	**54**	**198.5**	**88.5**	**45**	**3.7**
	ECH	2	2	9	0	0	4.5
	FLMN	2	2	3.5	0.5	14	1.8
	IRMOS	1	1	2	0	0	2
	MARS	1	1	3	0	0	3
	MOSA	16	20	64	55	86	3.2
	NEWFIRM	11	11	55	12	22	5
	RCSP	13	17	62	21	34	3.6
WIYN		**21**	**24**	**76.5**	**47.5**	**62**	**3.2**
	HYDR	9	11	34	19	56	3.1
	MIMO	5	5	21.5	18.5	86	4.3
	OPTIC	3	4	10	10	100	2.5
	SPSPK	2	2	7	0	0	3.5
	VIS	1	1	3	0	0	3
	WHIRC	1	1	1	0	0	1
KP-2.1m		**26**	**33**	**174.5**	**57**	**33**	**5.3**
	CFIM	10	12	66	37	56	5.5
	ET	2	5	29	0	0	5.8
	FLMN	3	3	12	0	0	4
	GCAM	10	10	51.5	20	39	5.2
	VIS	2	3	16	0	0	5.3
KP-0.9m		**3**	**3**	**13**	**6**	**46**	**4.3**
	MOSA	3	3	13	6	46	4.3

Cerro Tololo Inter-American Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
CT-4m		**43**	**48**	**174**	**67**	**39**	**3.6**
	HYDRA	10	10	38	14	37	3.8
	ISPI	6	6	18	0	0	3
	MOSAIC	21	23	90	46	51	3.9
	RCSP	8	8	24	7	29	3
	VIS	1	1	4	0	0	4
SOAR		**18**	**20**	**53.4**	**13.8**	**26**	**2.7**
	Goodman	5	6	17.3	5.3	31	2.9
	OSIRIS	8	8	19.8	0	0	2.5
	SOI	6	6	16.3	8.5	52	2.7
CT-1.5m		**11**	**13**	**65.5**	**4**	**6**	**5**
	CSPEC	8	9	50.5	4	8	5.6
	FECH	3	4	15	0	0	3.8
CT-1.3m		**9**	**11**	**25.6**	**0**	**0**	**2.3**
	ANDI	9	11	25.6	0	0	2.3
CT-1.0m		**4**	**6**	**42**	**24**	**57**	**7**
	CFIM	4	6	42	24	57	7
CT-0.9m		**14**	**19**	**74.5**	**15.7**	**21**	**3.9**
	CFIM	14	19	74.5	15.7	21	3.9

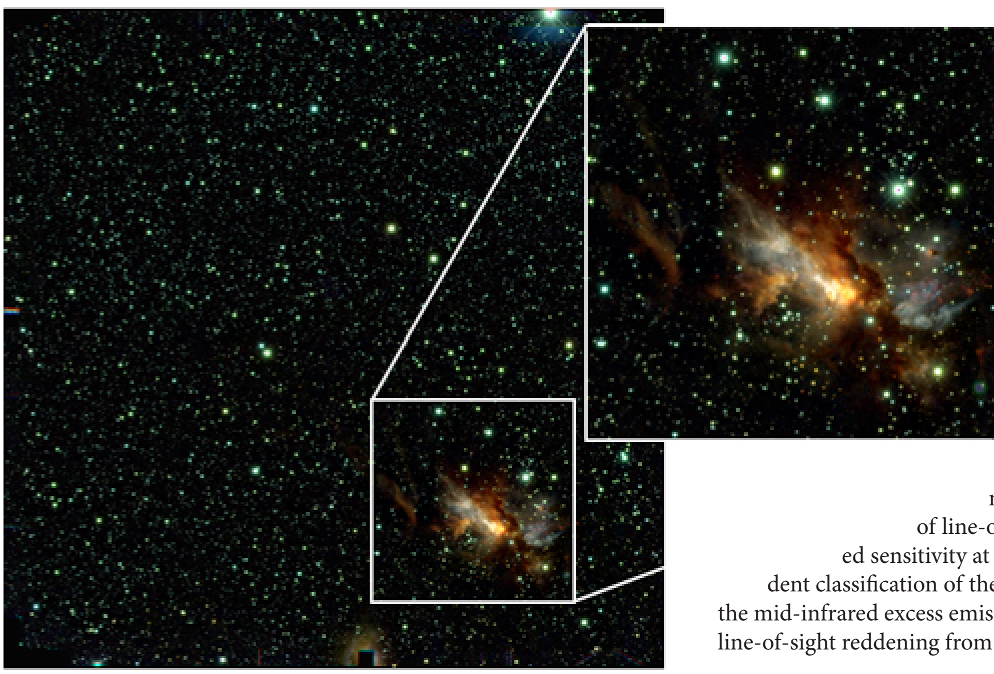
Community Access Observatories

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Keck-I		**31**	**34**	**49.5**	**13.5**	**27**	**1.5**
	HIRES	17	19	29.5	3	10	1.6
	IF	4	5	5	0	0	1
	LRIS	10	10	15	10.5	70	1.5
Keck-II		**27**	**29**	**41.5**	**11**	**27**	**1.4**
	DEIMOS	6	6	9	5	56	1.5
	ESI	2	2	3	3	100	1.5
	IF	3	3	2	0	0	0.7
	NIRC2-LGS	1	1	1	0	0	1
	NIRSPAO-NGS	1	1	2	0	0	2
	NIRSPEC	14	15	21.5	0	0	1.4
	OSIRIS-LGS	1	1	3	3	100	3
Magellan-I		**3**	**3**	**3.3**	**3**	**91**	**1.1**
	IMACS	2	2	3	3	100	1.5
	MagIC	1	1	0.3	0	0	0.3
Magellan-II		**6**	**6**	**11**	**2**	**18**	**1.8**
	MIKE	3	3	5	0	0	1.7
	MagE	3	3	6	2	33	2
MMT		**15**	**15**	**36.5**	**19**	**52**	**2.4**
	ARIES	1	1	2	0	0	2
	BCHAN	4	4	11	8	73	2.8
	Hectochelle	1	1	3	0	0	3
	Hectospec	8	8	19.5	11	56	2.4
	PISCES	1	1	1	0	0	1

Large-Scale Surveys of Nearby Molecular Clouds with NEWFIRM Assisted by Quick-Reduce Pipeline

Robert Gutermuth (Five College Astronomy Department/Smith College) & Mark Dickinson

The NEWFIRM wide-field near-infrared imager has seen heavy use at the Kitt Peak Mayall 4-meter telescope throughout both the spring and fall semesters this year, aided by an effective quick-reduction data processing pipeline that gives observers extra insight into the quality of the ongoing observations.



In semester 2008A, NEWFIRM was heavily used for extragalactic deep-field programs (for example, see the article from Pieter van Dokkum and colleagues in the June 2008 NOAO/NSO Newsletter). The fall semester saw more galactic programs, including a survey of the nearby, high-mass, star-forming molecular clouds, Cep OB3, MonR2, and S140 by Rob Gutermuth and colleagues, which takes full advantage of NEWFIRM's wide field of view to map large areas to previously unachieved depths.

Gutermuth's program is meant to supplement previous Spitzer mid-infrared surveys of these regions. The primary goal is to uniformly identify and classify all young stellar objects (YSOs) in these clouds with excess infrared emission from their warm inner disks. By combining these results with similar surveys of other nearby clouds (such as those surveyed by the c2d and Gould Belt Spitzer Legacy surveys), the team hopes to understand how star formation is initiated, regulated, and terminated in molecular clouds, and how the different star formation environments in such clouds—clusters, groups, isolation—impact star and planet formation.

Gutermuth and his colleagues have used Spitzer data to identify and classify any YSOs with dusty circumstellar material down to the Hydrogen-burning mass limit, but measurements of the line-of-sight extinction towards any sources detected are predominantly obtained from ground-based near-infrared photometry. Until recently, the Two Micron All-Sky Survey (2MASS) was the only feasible source for uniform near-infrared photometry over such wide fields of view, and its shallow sensitivity has been a major limitation.

However, new, large-format, near-infrared imagers on 4-meter-class telescopes, like NEWFIRM, make it possible to observe the many square-degree areas covered by Spitzer to a near-equivalent depth over a wide range of line-of-sight dust column densities. This added sensitivity at shorter wavebands enables more confident classification of the YSOs, making it possible to differentiate the mid-infrared excess emission in the warm, dusty inner disks from line-of-sight reddening from cool dust in the natal molecular cloud.

Furthermore, the additional sensitivity of the NEWFIRM data permits the detection of many more background stars that can be used as probes of the projected spatial structure of the dense, star-forming material in the cloud as traced by the inferred dust column density. These "extinction maps" are some of the most robust column density tracers in star-forming molecular clouds. With the additional background stars to probe the cloud structure, the resolution and the dynamic range of these maps can be improved simultaneously. This should enable a more precise positional comparison between forming stars and their natal cloud.

The images illustrating this article (and on the cover of this *Newsletter*) were created by Gutermuth during his run, based solely on products generated by the NOAO NEWFIRM Quick-Reduce Pipeline (QRP). The only additional processing was combining the J, H, and K images based on the pipeline-generated astrometry to create the color composite picture. After each NEWFIRM observing sequence, the

continued

Large-Scale Surveys with NEWFIRM continued

QRP processes the data, performing dark, flat, and linearity correction. It carries out sky subtraction using strategies that depend on the observing sequence, e.g., running median sky frames for dithered sparse-field data, or offset sky images for sequences that alternate between target and background fields. In each field, 2MASS stars are used to derive an astrometric solution and photometric zero-point for the images, which are re-projected onto a tangent plane and combined into a stack, and delivered to the observer. The magnitude zero-point, seeing FWHM, and sky brightness are reported for each image. Web pages are generated reporting this information and providing preview images for all individual and stacked frames.

The QRP is not intended to produce science-ready data products. It takes several shortcuts designed to speed data processing, and it may not always have the best calibration data (e.g., flats and darks) on hand at the time an observation is processed. For the best processing, there is the Science Pipeline, which NOAO is commissioning during the 2008B semester. The Science Pipeline runs at the NOAO Tucson office, processing data after each observing run. It uses more advanced algorithms, such as second-pass sky subtraction with object masking, sophisticated outlier rejection when stacking images, latent image masking, and higher-order interpolation for image resampling. The Pipeline Team, an NOAO/University of Maryland collaboration, is now implementing and testing the last features of the Science Pipeline. The team expects to start providing processed data to principle investigators of NEWFIRM programs for science verification by the end of the year.

Meanwhile, the NOAO Mosaic Science Pipeline is now routinely processing data taken with the Mosaic CCD imagers at both KPNO and CTIO. The Mosaic pipeline is also undergoing a major upgrade to incorporate stacking of images taken with "mosdither" observing sequences. A two-pass procedure is used to identify and mask transient features (cosmic rays, satellite trails, etc.) before stacking.

By November, the new Mosaic pipeline will be reprocessing all 2008B Mosaic observations, and the data products will be delivered to the principal investigators. Currently, pipeline data products are staged to a password-protected ftp area for delivery to observers. However, the next version of the NOAO Science Archive will ingest and store pipeline data products, which then can be queried and retrieved in the same manner as is currently done for raw data. Reduced data will be available to the general community after the end of the proprietary period (normally 18 months). In 2009, all data from both Mosaic and NEWFIRM should be routinely processed through the pipelines, and the resulting data products will be archived. NL

Who Are the Users of the NOAO Archive?

Christopher J. Miller

The NOAO Data Products Program (DPP) operates the NOAO Science Archive and its services. Over the past year, DPP has added significantly to its arsenal of tools, data, and services available to principal investigators (PIs) and the community. Here are some highlights of the DPP products and services as they exist today:

- The legacy NOAO Science Archive enables the public to discover and access over 70,000 science-ready, PI-reduced images from 15 different NOAO Survey Programs.
- The new NOAO Archive provides PI access to raw Mosaic and NEWFIRM data.
- DPP's Mosaic pipeline automatically processes Mosaic data for PI evaluation.
- The NOAO Portal provides access to NOAO Survey data, Mosaic and NEWFIRM raw data, and Mosaic reduced data, as well as multi-wavelength imaging data from Virtual Observatory (VO) archives for HST, SDSS, Chandra, XMM, and others.

What does this mean for the NOAO user? For starters, there is a significant increase in the amount of NOAO data available to the community. At the same time, there is growth in user access to the Web sites and ftp areas that serve this data.

Currently, DPP supports access to NOAO archive holdings through two browser-based mechanisms. The NOAO Science Archive (*archive.noao.edu*) is the original (now legacy) access point to NOAO Survey data. The newer NOAO NVO Portal (*www.nvo.noao.edu*) provides access to the NOAO Survey data through a graphical interface as well as access to imaging data from VO archives for HST, SDSS, Chandra, XMM, and more. PIs use the NOAO Portal to access their Mosaic and NEWFIRM raw and reduced data.

Over the last two years, we have seen usage of the original NOAO Science Archive grow by 25 percent. On average, users from well over 1,000 unique IP addresses search for archival NOAO Survey data each month. These users also download hundreds of gigabytes of PI-reduced NOAO data per month.

We have seen even more dramatic growth in usage of the NOAO Portal (*portal-nvo.noao.edu*). Since its release in 2006, monthly access to the NOAO Portal has doubled to over 400 unique IP addresses

continued

Who Are the Users of the NOAO Archive continued

per month. Users return to the Portal an average of three times per month. In many cases, they are using the Portal to discover VO archival data. However, the bulk of the many hundreds of gigabytes of data-volume transferred from the NOAO Portal consists of raw data delivered to PIs from their Mosaic and NEWFIRM observations.

DPP is building the data management system that our community needs, both now and for the future. As the size of mirrors, the number of instruments, and the number of people in the astronomy community continues to grow, so will the need for effective management of the data that is produced.

At this juncture, input from the community is vital. What features does the community like? What features are missing? What enhancements could be made? This input can guide DPP in not only shaping the look and feel of the Archive and its Portal, and the quality of the pipeline reductions, but also in strengthening their scientific use for both PIs and the public. Please email your comments and suggestions to DPP at *vohelp@noao.edu.*

NOAO Staff at the NVO Summer School 2008: Faculty, Students, and Award Winners

Douglas Isbell

The 2008 summer school for the National Virtual Observatory (NVO) was held in Santa Fe, NM, September 3–11.

NOAO faculty at the summer school included Dave De Young and Mike Fitzpatrick from NOAO North, and Chris Miller from NOAO South; "students" hailing from NOAO included Ken Mighell, Katy Garmany, Irene Barg, Jerry Schneider, and Dick Shaw from NOAO North, and Exequiel Fuentes from NOAO South.

During the hands-on program, the participants became familiar with how to discover, access, visualize, and analyze data using the Virtual Observatory. In addition to exploring the various tools and data sets available through the NVO, all the students in the workshop worked in teams to complete a final project.

A group including Ken and Katy developed an education outreach-oriented project on the construction of color magnitude diagrams from online data, which won first place in the education category. The PDF version of the presentation, "Using NVO Tools for Astronomy 101," and detailed information for replicating the educational activity described in the presentation, is available at: *www.noao.edu/staff/mighell/nvoss2008/*.

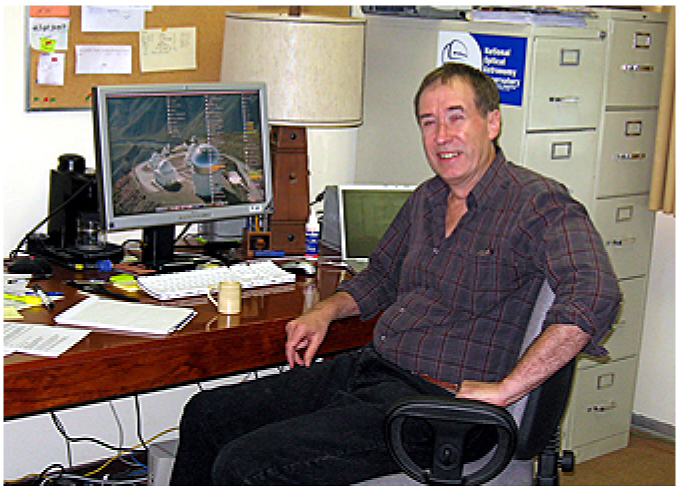
The faculty presentations and student project talks are available at the NVO Summer School Twiki: *nvo-twiki.stsci.edu/twiki/bin/view/Main/SummerSchool2008*

NVO Summer School 2008 students and faculty in Sante Fe, NM.

Thanks to Alistair Walker for Multiple Contributions as CTIO Director

Malcolm Smith

Alistair Walker stepped down as director of Cerro Tololo Inter-American Observatory on November 10 after five remarkable years. In fact, Alistair has been consistently and efficiently guiding large parts of the observatory for many more years than this, through several crucial stages in its evolution.



Alistair Walker.

Alistair's research interests—in stellar populations, the Magellanic Clouds, and the distance scale—involve use of a wide range of instrumentation and detectors. These research interests have provided the motivation to acquire the expertise that has allowed him to play a key role, for several decades, in the support and development of the instrumentation program at CTIO. His work for the observatory has ranged from instrumentation at the detector level up through the full range of telescope sizes, and from broad strategic planning through to pragmatic implementation of fine detail. It is this breadth and depth that has made him such an asset to the observatory.

His talent was well recognized even before he first arrived in Chile several decades ago. A well-known colleague from South Africa once described Alistair's move to Chile as one of the most serious losses to astronomy in South Africa at that time.

Several years before he became director of CTIO, Alistair anticipated the need for a careful yet fundamental restructuring of the operation of our observatory on Cerro Tololo. This would prove essential to the continuation of a balanced approach to the provision of telescopes for the community in the face of a decadal review that heavily emphasized the need for very large facilities. Alistair worked with several energetic and talented university astronomers, led by Charles Bailyn at Yale, to set up the initial Small and Moderate Aperture Research Telescope System (SMARTS) consortium—thus preserving, coordinating, and upgrading productive smaller facilities (telescopes with dedicated instrumentation) at a first-class Southern Hemisphere site, in a cost-effective way. If not for these efforts, these telescopes—along with the research and training opportunities that they provide—would have been lost to astronomy by now. Alistair took primary responsibility for the contribution by NOAO to that transition. One perhaps unexpected positive outcome is the large amount of interesting solar-system science that is being done with these telescopes.

Figure 2: Handing over the "steering wheel" to Chris Smith, the new CTIO director.

Alistair played one of the most crucial roles in CTIO's direct response to the most recent decadal review. His carefully argued case explaining the advantage of our experience in telescope operations at a world-class site in the Southern Hemisphere provided a foundation for the decision to locate the Large Synoptic Survey Telescope (LSST) on Cerro Pachón. But Alistair did not relax once that LSST decision was announced. He realized, more clearly than most, that significant upgrades to the Blanco telescope and its wide-field imaging capabilities would be an essential introduction for our community and our observatory in preparation for the start of LSST operations. Strong and growing support for the Dark Energy Survey is being secured, based on first-class science matched with wise, strategic preparation for the longer-term future.

Fortunately, Alistair continues as a staff astronomer at CTIO, and he will certainly enjoy having more time for his research. His input, both at a strategic and a detailed level, will remain crucial to the optimum development of the observatory in the coming years.

Spartan Infrared Camera Arrives at SOAR

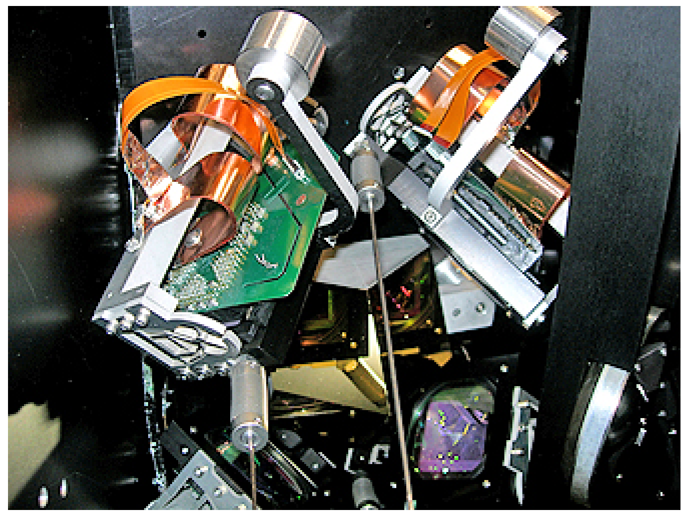
Sean Points, Jayadev Rajagopal (NOAO), Ed Loh (Michigan State University) & Steve Heathcote (SOAR/NOAO)

The Spartan Infrared Camera (IRC) was delivered to the Southern Astrophysical Research (SOAR) 4.1-meter telescope facility on Cerro Pachón on October 7. Laboratory tests performed on arrival successfully reproduced the results of similar tests carried out prior to shipping, demonstrating that the instrument arrived in good condition. Thus all is ready for initial testing on the telescope, expected to begin in mid November.

Built at Michigan State University (MSU) under the leadership of Ed Loh, the Spartan IRC is a high-angular resolution, near-infrared (NIR) camera with a spectral range from 1.0–2.5 micrometers. Two different plate scales are provided: the f/21 channel has a field of view (FOV) of 1.5 × 3.0 arcmin with a scale of 0.043 arcsec/pixel chosen to resolve the diffraction limited core of Tip-Tilt corrected images in the H and K bands; the f/12 channel offers an FOV of 2.5 × 5.0 arcmin at 0.073 arcsec/pixel.

When deployed for regular science observing, the Spartan IRC will have a focal plane consisting of four "Hawaii-II" 2048 × 2048 pixel HgCdTe detector arrays. Furthermore, the Spartan IRC has two filter wheels, which together can hold a total of 29 50-millimeter-diameter filters of thickness up to 15 millimeters. The initial filter compliment consists of broadband Y, J, H, and K filters (based on the MKO-NIR prescription). In addition, a set of narrowband filters purchased by Cassio Leandro Barbosa of UNIVAP, Brazil, will be available to all users of Spartan. This set includes HeI (1083/10 nm), [FeII] (1644/15 nm), Cont. 1 (2045/30 nm), HeI/CIV (2070/30 nm), H_2 (2121/20 nm), Cont. 2 (2140/30 nm), Br-gamma (2161/20 nm), Cont. 3 (2210/30 nm), and CO (2325/70 nm).

Commissioning and science verification testing of Spartan is expected to continue through the 2009A semester, with regular science use beginning in 2009B.



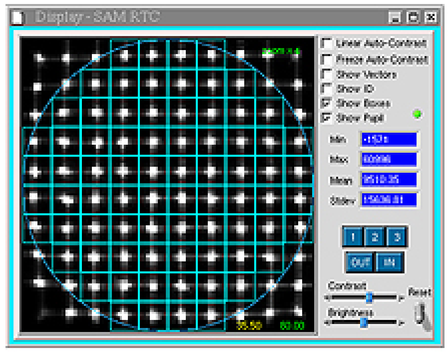
The Spartan detector arrays.

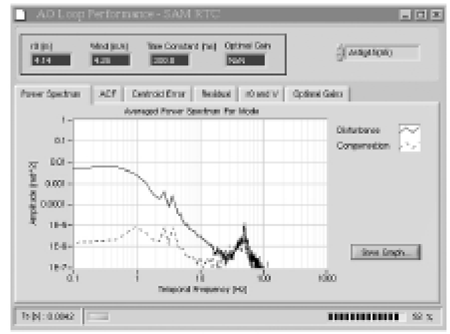
Spartan leaving MSU (left) and arriving at SOAR (right).

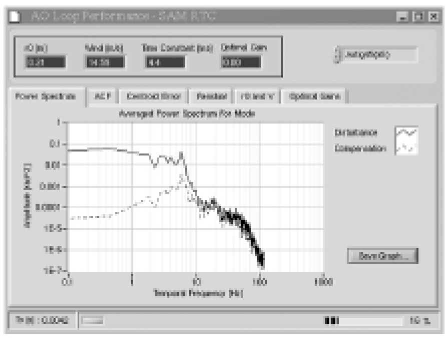
Integration & Testing of the SOAR Adaptive Module Proceeds Well

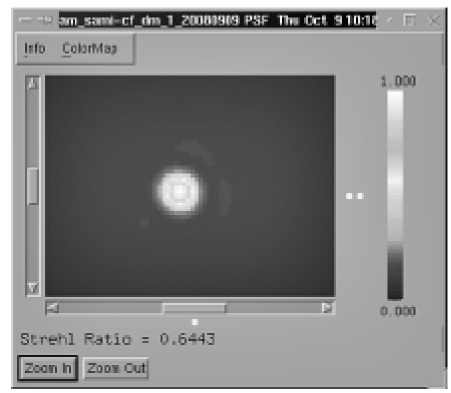
The SAM Team

Significant progress has been made with the integration and testing of the SOAR Adaptive Module (SAM) since our last report in the September 2008 *NOAO/NSO Newsletter*. All hardware related to the Natural Guide Star (NGS) mode of SAM has been fabricated, and most of it is installed in the main module. Cabling and wiring of the hardware is well underway, as is the development of the motion-control software. And with all optical elements in place and aligned, we were able to test the real-time software with the actual instrument by closing the loop, while introducing turbulence into the beam.



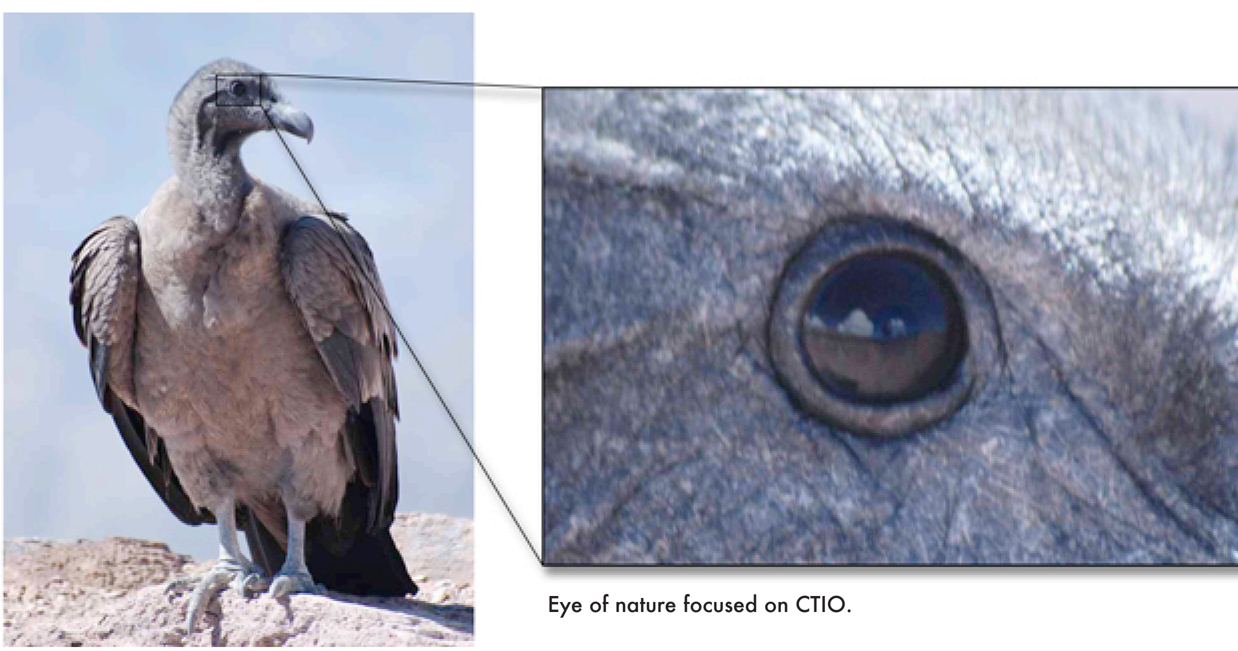






The figures to the right illustrate the results of these tests. At the top left are Shack-Hartmann spots for "closed loop" operation. The top right and bottom left images give the "Adaptive optics loop" performance, showing the uncorrected power spectrum (solid, black line) and the corrected power spectrum (dashed, blue line) for one of the Zernike modes, in this case astigmatism: the top right image shows it without turbulence and the bottom left shows it with turbulence. The amplitude of the power spectrum is an order of magnitude higher under the presence of turbulence. The predicted image at the SAM Imager focus, reconstructed from delivered wavefront data measured with a Wavescope wavefront sensor, appears in the bottom right image.

The instrument is currently scheduled to be commissioned on the SOAR 4.1-meter telescope in NGS mode in mid 2009. For updates and pictures on the integration of SAM, go to *www.ctio.noao.edu/new/Telescopes/SOAR/Instruments/SAM/*.



Eye of nature focused on CTIO.

Goodman Spectrograph Update

Sean Points (NOAO) & Steve Heathcote (SOAR/NOAO)

Commissioning and shared-risk science use of the Goodman High-Throughput Spectrograph (HTS) continued during the 2008B semester at the SOAR 4.1-meter telescope, located on Cerro Pachón, Chile. As shown by the example results illustrated in the figures, the Goodman HTS is now well on its way to becoming a regular facility instrument.

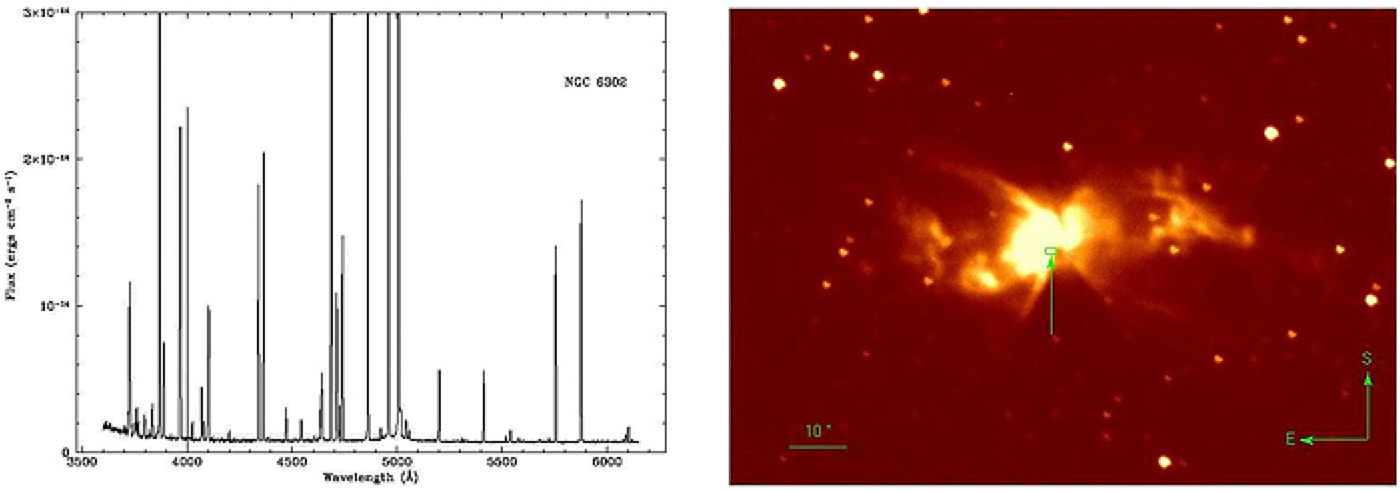


Figure 1: A one-dimensional spectrum of the planetary nebula NGC 6302 obtained with the Goodman HTS in the 600 l/mm Blue setup (left). This one-dimensional spectrum corresponds to an aperture of 1.5 arcsec by 1.03 arcsec shown in the false-color image on the right. Credit: A. Krabbe (SOAR)

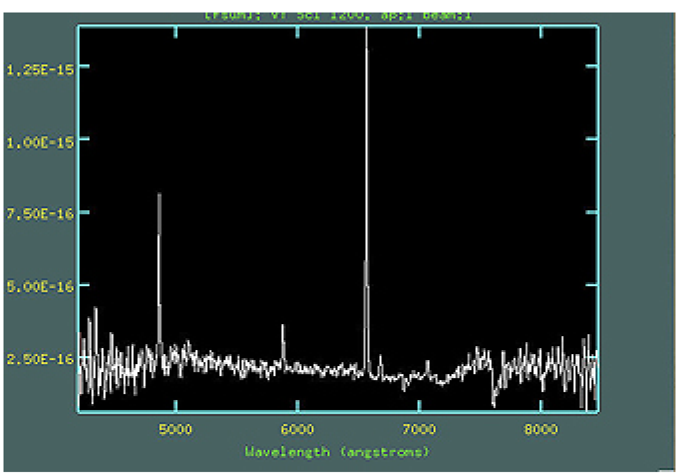


Figure 2: A spectrum of the interacting binary star VY Scl obtained on 10 October 2008 UT. The star was near magnitude V = 19 and the spectrum is a median of 3×20-minute observations with the 300 l/mm grating. This SOAR observation is the first spectrum of VY Scl ever obtained while the system was in this faint state. Narrow Balmer and He I emission are seen, indicating that during such extreme low states the accretion disk in the interacting binary disappears. Credit: S. Howell (NOAO)

Surveying the WIM with WHAM

Ronald J. Reynolds, L. Matthew Haffner (University of Wisconsin-Madison)
& Gregory J. Madsen (University of Sydney)

The interstellar medium (ISM) plays a vital role in the ongoing cycle of stellar birth and death and galactic evolution. Not only do the properties of the ISM govern the formation of new stars, but the radiation, kinetic energy, and matter from these stars in turn influence the properties of the ISM, from which the next generation of stars will be born.

One of these feedback processes is the large-scale ionization of the medium by the youngest and most luminous stars, the O stars. Even though these stars are located near the galactic midplane in rare, isolated regions of massive star formation and are often surrounded by opaque clouds of neutral hydrogen, a significant fraction of their Lyman continuum luminosity is somehow able to propagate large distances throughout the disk and into the halo to produce extensive ionization of the interstellar hydrogen.

In our Galaxy, this Warm Ionized Medium (WIM) is characterized by densities ~10^{-1} per cubic centimeter (cm^{-3}), temperatures near 10^4 degrees Kelvin (K), and a large 1–2 kiloparsec (kpc) extent above and below the Galactic midplane, significantly higher than that of the H I. The WIM accounts for more than 90 percent of the H II within the ISM, and along lines of sight at high Galactic latitude, the column density of the ionized hydrogen is observed to range from 20 to 60 percent of that of the neutral hydrogen. Similar warm plasmas also permeate other spiral galaxies (e.g., Rossa & Dettmar 2003). As a result, the existence of the WIM directly impacts our understanding of the morphology of the ISM and the ionization and heating processes occurring within the disks and halos of spiral galaxies.

Although originally detected by radio techniques (Hoyle & Ellis 1963), later advances in high-throughput, Fabry-Perot spectroscopy and CCD detectors have demonstrated that the primary source of information about the distribution, kinematics, and other physical properties of the WIM is through the detection and study of very faint interstellar emission lines at optical wavelengths. One of the most powerful tools dedicated to the exploration of the WIM is the Wisconsin H-alpha Mapper (WHAM), a remotely controlled, Fabry-Perot spectrometer facility funded by the National Science Foundation (figure 1). From January 1997 through March 2008, WHAM was located at Kitt Peak National Observatory (near the McMath-Pierce Solar Telescope), where it was in use nearly every clear, dark-of-the-moon night to survey the WIM and other faint extended sources of emission in the sky above Kitt Peak. WHAM is now on its way to Cerro Tololo, where it will resume its unique observations with a southern perspective.

As its name suggests, WHAM's primary mission is to provide the first sky survey of the distribution and kinematics of the wide-spread interstellar H II using the H-alpha (Hα) recombination line that is comparable to earlier surveys of the H I using the 21-cm line. The northern sky survey, consisting of 37,565 spectra at 1-degree angular resolution and

Figure 1: The Wisconsin Hα Mapper (WHAM) at Kitt Peak (1997–2008).

12 kilometers per second (km s^{-1}) velocity resolution above declination −30 degrees (°), has been completed (Haffner et al. 2003). A portion of the survey is shown in figure 2, which reveals ionized interstellar hydrogen in the velocity interval -75 km $s^{-1} < v_{LSR} < -50$ km s^{-1} extending over much of the northern sky. Because of differential Galactic rotation, this velocity interval selects the H II associated with the 2-kpc distant Perseus spiral arm between 70 and 160 Galactic longitude. Extensive clouds of infalling ionized gas are detected at high Galactic latitudes, and numerous ionized filaments and loops are seen extending away from the Galactic midplane. The bipolar loop structure reaching ±30° (±1200 pc) above and below the midplane near $\ell = 140°$ appears to be ionized by O stars in the Cas OB6 association at $\ell = 135°$, b = +1° and is a beautiful illustration of how a superbubble created by past generations of supernovae can provide a 1200-pc-long, H I-free conduit so that O-star ionizing photons are able to produce wide-spread ionization of gas in the disk and halo (Reynolds et al. 2001). However, the degree to which such cavities are responsible for the extensive ionization of the WIM is not yet clear.

With these new maps it is now possible to carry out systematic investigations of the physical conditions of the WIM and its relationships to other components of the interstellar medium and to the sources of ionization and heating within the Galaxy. In particular, because WHAM has the capability to observe any portion of the spectrum between 4,800 and 7,300 Angstroms (Å), standard nebular line diagnostic techniques have begun to be employed to examine the physical

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Surveying the WIM with WHAM continued

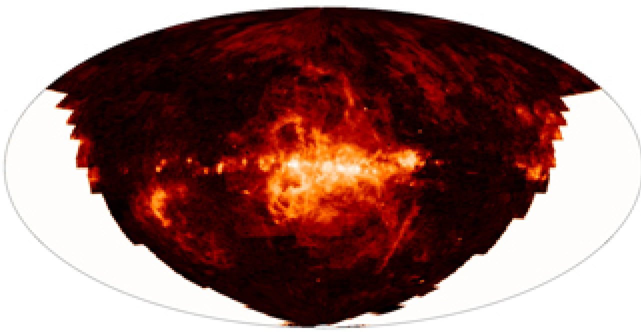

Figure 2: WHAM Northern Sky Survey: a view of the Perseus arm. This all-sky Hammer-Aitoff projection (centered at $\ell = 120°$, $b = 0°$) shows the full spatial extent of the northern sky surveyed by WHAM from Kitt Peak. The velocity range (-75 km s^{-1} < v_{LSR} < -50 km s^{-1}) in this image highlights diffuse ionized emission from the 2.5 kpc distant Perseus arm toward the outer Milky Way. At the distance of the arm, these filamentary features are 1.5 kpc above the Galactic disk.

conditions in the gas. In the low density (~10^{-1} cm^{-3}) environment of the WIM, the collisional excitation of an ion to a metastable state 2–3 eV above ground by the thermal (~10^4 K) electrons is followed by the decay back to the ground state via a "forbidden" optical transition. Specifically, the ion's excitation rate $r_i \propto n_i n_e T_e^{-0.5} \exp(-E/kT_e)$, where n_i and n_e are the volume densities of the ions and electrons, respectively, T_e is the electron temperature, and E is the energy of the metastable state above ground. Thus, a variation in the photon emissivity of a forbidden line from one direction to the next traces variations in the temperature, density, and abundance of the ion. The effects of density variations can be eliminated by dividing the forbidden line intensity by the H-recombination line intensity, both of which are proportional to the product of the densities, $n_i n_e$. From the intensities of lines from a number of different ions and atoms, it has been possible to study separately variations in the temperature and the ionization state within the WIM and to compare the properties of this wide-spread plasma to other regions of interstellar ionized hydrogen mapped by the WHAM survey, including superbubbles and classical O star H II regions.

For example, in the WIM, the forbidden lines [S II] λ6716 and [N II] λ6584 are found to have intensities with respect to Hα that range from a few tenths to unity or higher, significantly larger than what is observed for the bright, classical emission nebulae immediately surrounding O stars. Such a difference implies that the physical conditions in the WIM differ significantly from conditions in classical H II regions, even though the ionizing radiation from the O stars is almost certainly responsible for the ionization of the WIM. Moreover, the results reveal that not only are the temperature and ionization conditions of the WIM significantly different from the conditions in classical O star H II regions, but that the conditions within the WIM itself vary considerably from one direction to the next and even along a single line of sight.

The ability to track physical conditions within the emitting regions is illustrated in the line ratio diagram presented in figure 3. Using a grid of temperatures and ionization states of sulfur, S^+/S, we can compare the ratios [S II] λ6716/Hα and [N II] λ6584/Hα along numerous lines of sight (see, e.g., Madsen et al. 2006 for details). Figure 3 shows that within the WIM there are variations in temperature ranging between about 6,000 K and 10,000 K and variations in S^+/S from about 0.3 to about 0.8.

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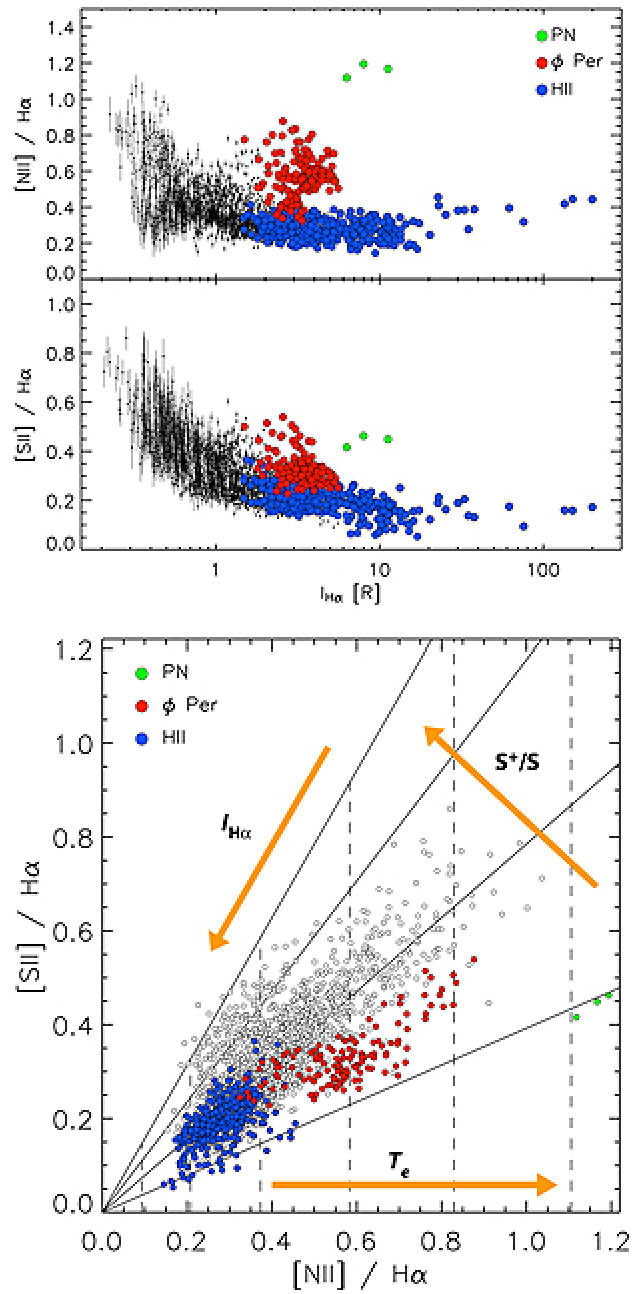

Figure 3: Diagnostic Line Ratio Diagram. A large portion of the Galaxy in the direction of the Perseus arm ($\ell = 130°$ to $160°$ and $b = -30°$ to $+30°$, approximately) has been surveyed in Hα, [S II], and [N II] with WHAM. This plot shows the relationship between the line ratios for the "local" gas component ($|v_{LSR}|$ < 15 km s^{-1}). A few specific spatial regions are highlighted to show effects of local ionizing sources: the planetary nebula (PN) S216, the H II region surrounding the B0.5+sdO system φ Per, and regions near O-star H II regions. Other points are sightlines through the WIM. In the lower diagram, the vertical dashed lines represent T_e, 5,000 K, 6,000 K, 7,000 K, 8,000 K, 9,000 K, and 10,000 K, left to right. The slanted solid lines represent S^+/S, 0.25, 0.50, 0.75, and 1.00, lowest to highest slope. These WIM data reveal significant variations in T_e and S^+/S from one line of sight to the next. In contrast, classical H II regions cluster in the lower left corner of this diagram near [N II] λ6584/Hα ≈ 0.25, [S II] λ6716/Hα ≈ 0.1. Adapted from Madsen et al. 2006.

Surveying the WIM with WHAM continued

For comparison, bright classical H II regions immediately surrounding O stars are all found to cluster near the lower left corner of the plot, [S II] λ6716/Hα ≈ 0.1 and [N II] λ6584/Hα ≈ 0.25, where T = 6,000–7,000 K and $S^+/S \approx 0.25$. The lower ionization state of sulfur (i.e., the higher ratio of S^+/S) in the WIM is likely due to a low ionization parameter (ionizing photon density to gas density ratio) in the WIM. However, the reason for the higher temperatures as well as the large variations in temperature within the WIM is not yet understood, and it poses a challenge for future investigations. They do not appear to be explained solely by photoionization heating of the gas (Reynolds et al. 1999, Wood & Mathis 2004), suggesting that the WIM is influenced by additional heating sources (such as the dissipation of turbulence or photoelectric heating from grains) that may dominate over photoionization heating at the low densities of the WIM (see discussion in Reynolds et al. 1999).

In addition to studies of the ISM, WHAM's uniquely powerful capabilities at Kitt Peak were applied to numerous other astrophysical investigations, including studies of High Velocity Cloud complexes in the Galactic halo, the search for H II in dwarf spheroidal galaxies and beyond the outer H I disk of M31, helping to characterize free-free and IR Galactic foreground emissions, measuring the orbital motions of the zodiacal dust, detecting emission lines from comets, mapping the distribution and kinematics of the moon's neutral sodium tail, and monitoring the earth's hydrogen exosphere. After WHAM is installed at Cerro Tololo, its initial tasks will be to complete the Hα sky survey and resume its exploration of the WIM, including observations of the Magellanic Clouds and Stream, the Carina spiral arm, the Gum nebula, and other features in the sky not accessible from Kitt Peak.

We thank the NSF for its long-term support of WHAM and our efforts on exploring diffuse ionized gas. However, WHAM's northern campaign would not have been a major success without the essential help of many others. Steve Tufte was an important colleague early in the project and contributed significantly to the design, building, and testing of the instrument. Kurt Jaehnig, Jeff Percival, and their technical staff from Wisconsin Astronomy provided the essential hardware and software platforms that allow us to operate all aspects of WHAM remotely. Wisconsin's Physical Sciences Laboratory designed and built our unique siderostat. The infrastructure at Kitt Peak made possible by NOAO and the Tohono O'odham Nation as well as the exceptional staff gave us the opportunity to run such an efficient, but extremely productive facility. Early on, Bob Barnes, Jeff Barr, and John Leibacher helped us realize our goal to locate WHAM on Kitt Peak. Ongoing support and amazing responsiveness from Mike Hawes, John Dunlop, Jim Hutchinson, and their crews kept us running with very little downtime for more than a decade. Last, but not least, Trudy Tilleman was our nightly, local contact for weather for more than three years as we gained confidence getting good data from miles away. Thanks to all who helped us do great science!

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QUOTA—A Prototype Camera for the WIYN One-Degree Imager

George Jacoby, Steve Howell & Daniel Harbeck

The Quad Orthogonal Transfer Array (QUOTA) camera is the prototype camera for the WIYN One-Degree Imager (ODI). QUOTA utilizes four OTAs (8K × 8K pixels), giving it a 16 × 16-arcmin field of view at the WIYN 3.5-meter telescope with 0.11 arcsec pixels (figure 1). ODI builds upon QUOTA by using 64 OTAs.

QUOTA's focal plane is comparable in size to that of the NOAO Mosaic cameras, and QUOTA can use the Mosaic filters. However, QUOTA is far more complex than Mosaic due to the unique design and capabilities of the OTA detectors. For example, QUOTA has 256 CCDs instead of Mosaic's 8 CCDs, and QUOTA reads out through 32 data channels in 30 seconds instead of Mosaic's 8 (or 16) channels in 150 seconds. QUOTA also provides its own guiding and focusing functions using the science CCDs, and it offers the special ability to obtain photometry at rates up to 30 Hz.

QUOTA's 2008 visits to the WIYN telescope included nine T&E nights of mixed weather conditions, but these nights still yielded enough on-sky observing time to be useful for proving the technology to be used in ODI and testing OTA observing techniques.

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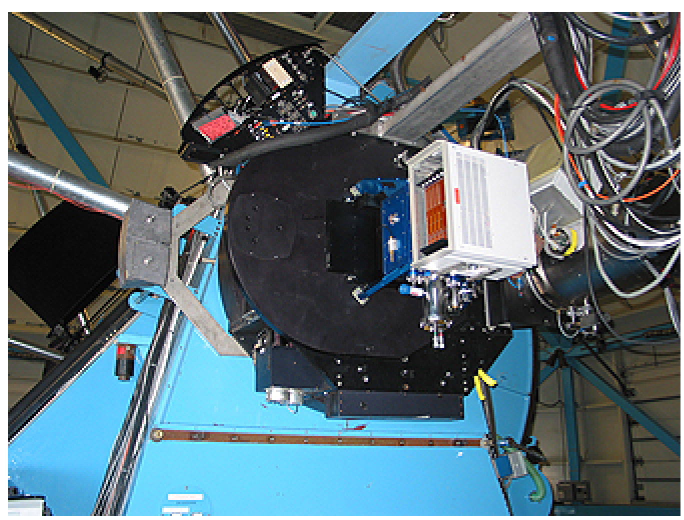

Figure 1: QUOTA on the WIYN 3.5-meter telescope (covers removed) showing the Dewar (blue), the MONSOON controller (white/bronze). The new infrared imager WHIRC is mounted to the right of QUOTA.

QUOTA continued

Each OTA is a 4K × 4K sensor made up of 64 nearly independent CCD "cells" of roughly 500 × 500 pixels (12 microns each). An array of logic circuits on the OTA provides the pathways to control and read out a subset of the CCD cells. One can read up to eight CCD cells quickly (30 Hz) to obtain guide star and centroid data, while the remaining 56+ cells continue to integrate like a normal CCD. In addition, the pixel structure of the CCD cells allows the charge within the pixels to not only be shifted up and down, as in a normal CCD, but also left and right to follow the image motion of the scene being observed—all while integrating. The WIYN OTAs were designed by Semiconductor Technology Associates (STA), in collaboration with MIT Lincoln Laboratory and PanSTARRS, and fabricated at Dalsa in Toronto.

QUOTA has four thick OTAs rather than the originally envisaged thinned OTAs due to delays in delivery of thinned devices. The primary negative with thick CCDs is that they have relatively low sensitivity, especially in the blue and ultraviolet (UV). However, they are robust against fringing in the red, relatively easy to obtain, and cheap. In order to provide some UV sensitivity, one device is coated with a material called Lumigen, which will "upconvert" UV photons into green ones that a thick device can see.

A look through QUOTA's Dewar window (i.e., its two-element corrector) in figure 2 reveals four OTAs. A dark mask within the blue outer housing reduces scattered light. The mask is behind the two-element corrector, which is essentially invisible here, thanks to the excellent quality of the antireflection coating applied by Infinite Optics. Within the mask, the four OTAs are visible. The upper right device with a yellowish cast has the Lumigen coating. In this photo, the other three appear to produce colorful diffraction patterns, but normally the thick OTAs simply look like reflective aluminum. (A light sensor that looks like a mirror is a bad thing! Detectors should be black if they are collecting photons.) The silvery cylinder on top of the blue box is the Cryotiger cooling head.

Figure 2: The QUOTA Dewar.

QUOTA uses a 32-channel NOAO MONSOON controller specifically tuned for use with QUOTA. It can collect data from four OTAs, having up to 3–4 guide stars per OTA, at guide rates from 1 to 30 Hz. Once initialized, the system is as robust as any camera currently in operation on Kitt Peak. Guide stars are selected manually by pointing to them in an image display. For ODI, an automated approach will be necessary because observations may require 100–200 guide stars. A real-time video is available to view the guide star data, complete with a quick analysis of the flux and point spread function (PSF) for each star.

QUOTA also provided us with a way to develop techniques for fabricating the 400-millimeter-square filters needed for ODI. We purchased a set of five filters for use with testing QUOTA: Johnson U and Sloan g', r', i', and z'.

QUOTA on-sky testing achieved several accomplishments of interest to the development of ODI. One of these was the demonstration of observing tool (OT) guiding. During a period of poor telescope tracking and with the telescope guiding turned off, we were able to illustrate the effectiveness of fast guiding. One of the OTAs was enabled for tip/tilt correction while the other three were not. Figure 3 shows the

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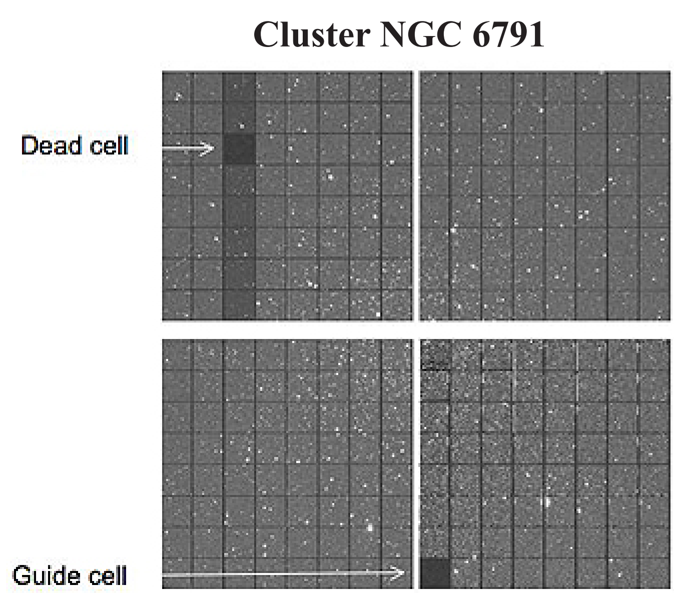

Figure 3: A sample QUOTA observation of an open cluster.

QUOTA continued

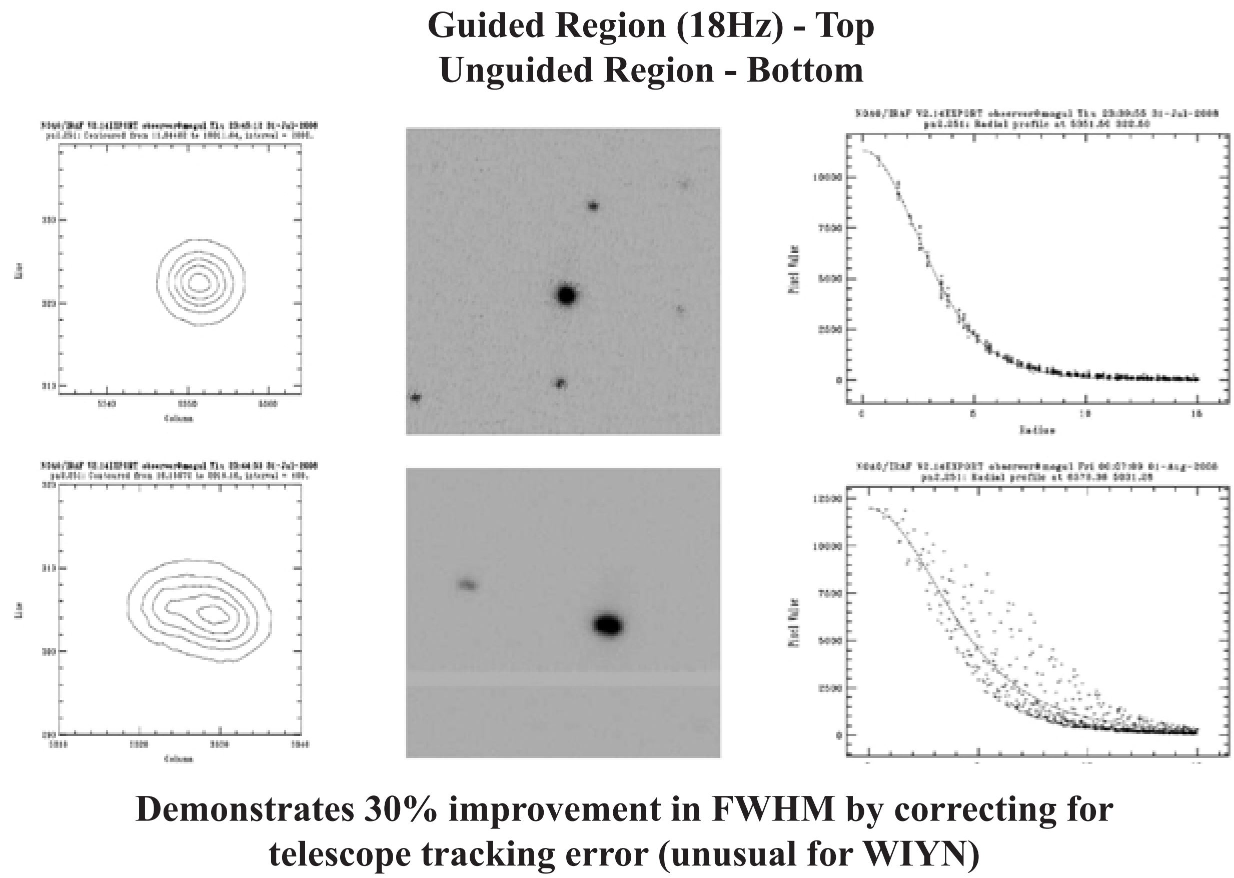

Figure 4: A comparison between fast guided and unguided OTAs when the telescope tracking was not in use.

four OTAs with one cell used for a guide star test (the black square at bottom middle). Figure 4 illustrates that the correction completely removed the telescope motion errors and produced a nice round image. Figure 5, made from the same data, shows the PSF variations as a function of distance from the guide star. Clearly, the tip/tilt correction removed atmospheric effects (non-coherent errors) as well as the telescope drift problem. Our long-standing argument, and the fundamental design concept for the use of OTAs in ODI, is that atmospheric motions decorrelate beyond distances of ~3 arcmin from the guide star (which is why just using a tip/tilt tertiary will not work for a wide-field instrument like ODI).

We were also able to test the use of QUOTA for high-speed photometry. We have obtained numerous data sets with multiple guide stars (up to 10 at a time). The guide star software automatically generates real-time flux measurements for each star at each guide cycle. By dividing the flux ratios among the stars, relative photometry is immediately available. An example is shown in figure 6. This time series was taken in 3-arcsec seeing (yikes!) of 11–12 mag stars with 1-second cycles. The simple real-time high-speed algorithms of the MONSOON-based photometry routines yield better than one percent relative photometry.

Even better results can be gained by going back to the original data and using more sophisticated photometry software. A section of a time series for 10 stars looks like that shown in figure 7. Each guide star is shown along a horizontal row. Some are bright, while others are very faint. The coherent wandering due to wind buffeting on this particular night is easy to see.

Preliminary reductions of QUOTA data show that a dithered sequence can be combined effectively to provide a good clean image. A sequence of 10 g' and 10 r' images (120-second exposures) of M15 were processed to produce a two-color image. In figure 8, three fourths of the QUOTA field (about 12 arcmin on a side) is shown. Notice that the bright star in the lower left has a blue ghost image. This is due to the fabrication method for these developmental filters. To eliminate these ghosts, ODI filters will be built from a single, thick substrate instead of four to five thin, laminated segments. In figure 9, several background galaxies are easily seen. The telescope was not guided and OT correction was turned off for these data. Therefore, images are not quite as sharp as possible, although these data have a delivered image quality of 0.8–0.9 arcsec.

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QUOTA continued

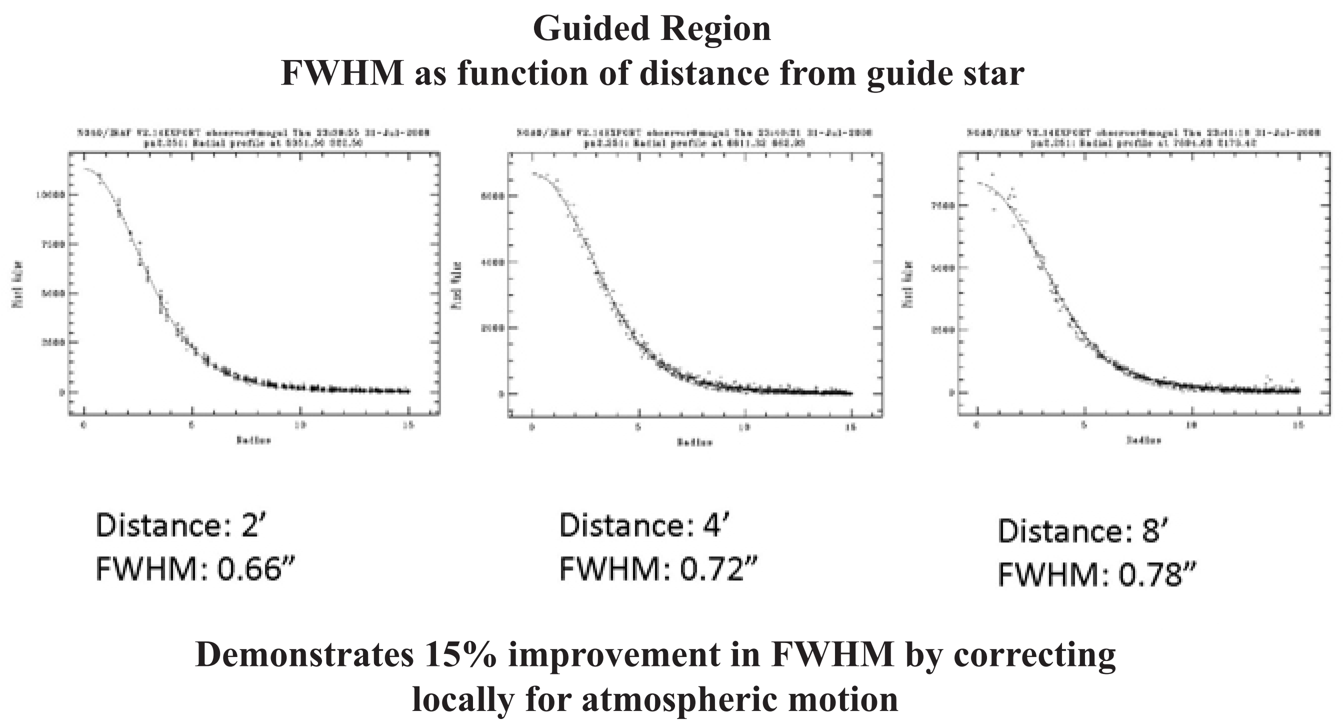

Figure 5: A comparison of image quality for stars as a function of distance from the guide star.

As a prototype camera, QUOTA has provided invaluable lessons as WIYN moves into the final stages of construction of ODI. The past three years of testing with QUOTA have unveiled many of the potential traps that we might have fallen into with ODI, and we have identified and implemented solutions in each case. By going to the telescope, QUOTA forced the astronomers to focus on its operation and data, something that sitting in the lab never seems to achieve. Consequently, QUOTA has accomplished many achievements toward ODI. These include advances and better knowledge in the areas of detectors, optics, software, and operations. QUOTA has fulfilled its mission and no further testing is planned. A much more detailed presentation of the accomplishments and operations of QUOTA is given at *www.wiyn.org/ODI/QUOTA_NL_article.pdf*.

The development of QUOTA was supported in part by NSF/AST grant 0352979.

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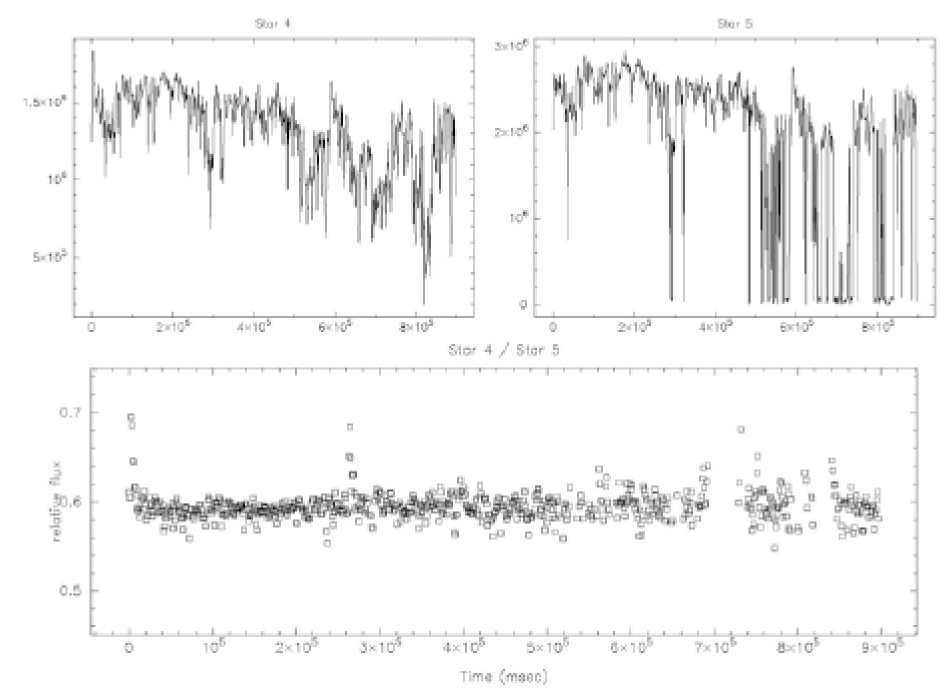


Figure 6: The two upper panels show the flux history for two guide stars. The lower panel shows the ratio of the upper left star to the upper right star. Notice how the large variations in the raw fluxes cancel almost completely.

QUOTA continued

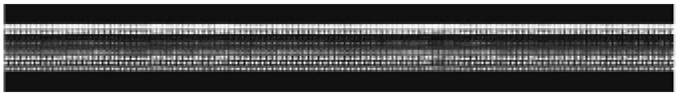


Figure 7: The raw image data for a 10-star time series—time runs from left to right.

Figure 8: A composite g′ and r′ image of M15.

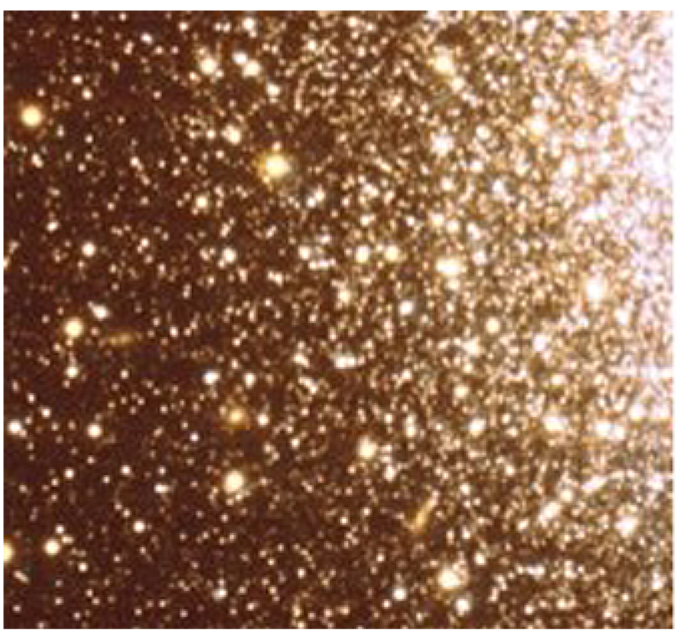


Figure 9: A close-up of the left side of the M15 cluster.

WIYN Bench Upgrade—New VPH Grating and All-Refractive Collimator

Matt Bershady (University of Wisconsin), John Glaspey & Pat Knezek

The amazing 3300 l/mm Volume-Phase Holographic (VPH) grating is now housed in its permanent cell, and ready for routine use. This grating, along with its lower dispersion 740 l/mm cousin, delivers higher efficiency, by a factor of ~2, than comparable conventional (surface-relief) gratings. Although the VPH blaze functions are highly peaked, the spectrograph can be tuned precisely to any desired central wavelength at peak efficiency; the diffraction efficiency remains higher than conventional gratings even at the edge of the wavelength range.

The 3300 l/mm VPH grating delivers spectral resolution in first order similar to the 316@63.4 Echelle in 11th order near 5100, and operates near peak efficiency between angles of 50 and 65 degrees, corresponding to central wavelengths between 4,643 and 5,493 Å. The dispersion yields roughly 235 Å across the detector, with spectral resolution increasing with angle from 11,000–19,800 for Red Hydra, 7,340–13,200 for Blue Hydra, and 4,400–7925 for SparsePak.

As we go to press, the new all-refractive collimator for the WIYN Bench Spectrograph is being implemented on the bench and is undergoing final alignment and testing. The three lenses were installed in their new mounts in the NOAO optical shop by Gary Poczulp and Dan Blanco and met all expected performance criteria. The faster, f/5 collimator, combined with the high QE CCD “STA1,” will allow considerably shorter exposures than the old system yet achieve the same signal-to-noise ratio in the delivered spectrum.

Combined with the new STA-1 CCD with its NOAO-built MONSOON controller, the VPH 3300 l/mm grating and the new all-refractive collimator, the Bench is now able to produce photon-limited science at or below the dark-sky level at high dispersion. Check for the latest status of the Bench upgrade at: *www.wiyn.org/instrument/bench_upgrade.html.*

WHIRC Accepted as a General Use Instrument for WIYN

Dick Joyce & Pat Knezek

At their October meeting in Bloomington, Indiana, the WIYN Science Advisory Committee recommended that the WIYN Board accept the WIYN High-Resolution Infrared Camera (WHIRC) as a general-use instrument, based on the Acceptance Report provided by WHIRC Principal Investigator Margaret Meixner (STScI). WHIRC meets the criteria specified in the Memorandum of Understanding between WIYN and STScI and is now available to the WIYN community of observers. The WIYN Board accepted this recommendation. Congratulations to the extended WHIRC team for their efforts in the design, construction, delivery, and commissioning of WHIRC, which we anticipate will have a long and scientifically productive life at WIYN.

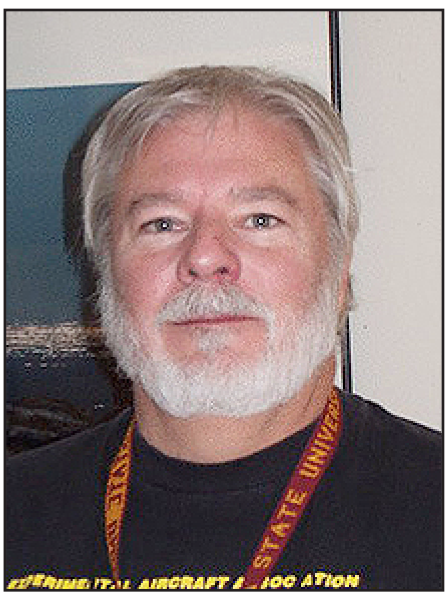
Information about WHIRC can be found at: *www.noao.edu/kpno/manuals/whirc/WHIRC.htm*.

With Deepest Thanks for Many Years of Service to Our Observatory

Buell T. Jannuzi

As 2008 winds down, both staff and visiting astronomers at KPNO will miss seeing three veteran mountain staff as they transition into retirement. William "Hal" Halbedel, Ruth Ramon, and Joanne Wilcox Hudson have supported our science operations for a total of 67 years. NOAO thanks them for their exceptional dedication and support or our national observatory. We will miss working with them. We wish each of them well and hope for frequent updates about their future activities.

"Hal" Halbedel
Skip Andree & Mike Merrill



After more than 36 years at KPNO, William Halbedel—known by all as Hal—retired effective October 1. Hal started at KPNO on 1 March 1972. During his tenure, Hal wore many hats, starting as a technical assistant and moving through the ranks to senior observing associate. Not one to be limited by his duties as operator at the 2.1-meter and Mayall 4-meter telescopes, Hal has been a firefighter, first responder, emergency medical technician (EMT), safety officer, ambulance driver, and unofficial caretaker of Kitt Peak. On occasion, Hal and his wife Elaine have been the only people on the summit to look after its safety and keep essential operations running smoothly over the holidays. His dedication to assured, dependable service as the interface between astronomers and their observations has helped build Kitt Peak into the world-renowned and respected astronomical facility that it is today. If you see Hal around, it is because he has not yet given up all his ties to the observatory: he will continue as a seasonal employee. Given his new shop and garage in Silver City, New Mexico, we are assured that his life will continue to be entertaining.

Ruth Ramon
Dave Murray & John Dunlop

Ruth Ramon, a member of the kitchen staff for over 13 years, will retire at the end of 2008. Ruth started with Kitt Peak on 5 September 1995. As the second-longest-serving kitchen employee, she has been a cornerstone of the dining hall. Ruth began as a cook's helper, was promoted to cook and has worked with Walter Vermilye (now retired), Casey Muse, and Glenda Manuel. Her efforts have been focused on salad bar preparation, night-lunch requests, box lunches for the public Nightly Observing Program, preparations for main dinners, and periodically cooking some meals. It has been a pleasure to have Ruth be so integral to the kitchen, the place where everyone on the mountain comes together. We wish her well in her retirement.

continued

With Deepest Thanks for Many Years of Service continued

Joanne Wilcox Hudson
Mike Merrill

After nearly 18 years at KPNO, Joanne Wilcox Hudson will retire at the end of 2008. Strategically ensconced in the front office of the Administration Building on the Kitt Peak summit, Joanne has been the face, heart, and hands of KPNO Science Operations to visiting astronomers, tenants, and staff alike. Joanne started at KPNO on 20 February 1991. Her job classification as administrative assistant fails to capture her myriad duties.

Depending on the time of day and the ever-changing needs of mountain operations, she has served as receptionist, reservation clerk, keeper of the keys for rooms and cars, central communicator, archivist, bookkeeper, postmaster, purveyor of office supplies…. (The list goes on!) Joanne still finds time to act as voluntary curator for mountain lore and resident naturalist for all the flora and fauna that come her way. A true professional, she has enabled both those who practice and those who support astronomy to concentrate on their respective observing tasks while trusting the administrative details to her capable hands. We wish her well in her retirement. NL

Share Your Memories of the First 50 Years of KPNO

We plan to continue celebrating the first 50 years of your national observatory through March 2010, the anniversary of the dedication of Kitt Peak National Observatory. This timeline allows us to leverage other special activities such as the International Year of Astronomy 2009, and to include all the diverse people and groups who have been so crucial to the successes of the national observatory.

We invite you to visit our 50th anniversary Web page at *www.noao.edu/kp50* and to submit your memories. How has our national observatory affected you? Are there special people or experiences that you recall and would like to share? Do you have images of the observatory, its telescopes, or its people that you would like to share? As we collect your comments, we'll post many on the Web site, so that everyone may enjoy the stories of our historic past and our ongoing evolution.

Please join in. The landmark concept of a national observatory open to all astronomers based on the merit of their scientific proposals would not have been possible without support from our user community!

Director's Corner

Steve Keil

Diversity

Increasing staff diversity and broadening participation in solar physics has been a long-standing goal of the National Solar Observatory (NSO). As part of the renewal of its current National Science Foundation (NSF) Cooperative Agreement, NSO is developing a multi-pronged approach to increase the diversity within its staff and more generally within solar physics. The goal of this plan is to provide a better focus and to establish connections with other underrepresented minority programs, combined with an advisory structure that will help NSO meet its and NSF's goals for increased diversity.

Some important elements of this plan include: establishing a Diversity Advocate on the NSO staff (along with a diversity advisory panel), establishing stronger relationships with universities conducting programs for underrepresented minorities through both the NSF Partnerships in Astronomy & Astrophysics Research and Education (PAARE) program and through joint programs with selected schools and universities, recruiting at professional meetings of minority organizations, and establishing an assessment mechanism to determine what does and does not work.

NSO currently has a comprehensive public affairs and educational outreach plan that includes public programs, media information, elements of distance learning (Internet) education, K-12 education, undergraduate and graduate research, teacher research, and research-to-classroom experiences. These programs, while playing an important role in developing the next generation of solar astronomers and instrumentalists and having some effect on bringing more women into astronomy, have not yet had a major effect on diversity in the NSO staff or solar physics in general.

After receiving guidance from several successful programs, NSO believes the most effective approach toward broadening participation is through personal contact at both the professional and student levels. Thus, the plan we are developing includes taking advantage of our geographic locations—New Mexico, Arizona, and our planned presence on Maui with the Advanced Technology Solar Telescope—to create programs that would reach Hispanic, Native American, and Native Hawai´ians. To involve more African-Americans, NSO's initial efforts include developing working relationships through Fisk/Vanderbilt University in Nashville, Tennessee, and through Alabama A&M University in Huntsville.

Over the next few months, we will establish an advisory group for diversity and effective education and public outreach. If you would be interested in serving on such a group, please contact me at *skeil@nso.edu*.

Developments

It has been a long road moving the Advanced Technology Solar Telescope (ATST) toward construction, but—hopefully—the end appears to be in sight. Final National Historic Preservation Act (NHPA) Section 106 meetings were held on Maui in June and August 2008. The Advisory Council on Historic Preservation, National Park Service (NPS), Haleakalā National Park (HNP), and the State Historic Preservation Division participated actively in the discussions. A summary of the consultation was prepared and will be incorporated into the Final Environmental Impact Statement (FEIS).

The draft FEIS is now under final preparation at NSF. Discussions with NPS and HNP included the contents of a Memorandum of Understanding (MOU) for development of a Supplemental Use Permit to allow access to the road through HNP up to the observatory site. The MOU has been signed by AURA and HNP and covers cost recovery and National Environmental Policy Act, NHPA, and Ecological Society of America compliance. The next step is to complete and publish the FEIS, pass a Final Design Review, and obtain NSF's Record of Decision on whether to proceed with construction. Hopefully, all of this will come together by next summer, which could potentially allow construction to begin in the fall. Meanwhile, the ATST project team is conducting a series of System Design Reviews with outside reviewers in preparation for the Final Design Review at NSF in March 2009.

SOLIS full-disk vector magnetograms from the Vector Spectromagnetograph (VSM) took a big step toward becoming routine with the development of a robust method of removing fringes in the images. As soon as the fringe removal algorithm can be added to the reduction software pipeline, SOLIS full-disk vector magnetograms should become routinely available. We are currently shooting for the first part of next year. The new SOLIS Data Acquisition System and Sarnoff cameras were delivered and characterized. The new camera mounting hardware was designed, fabricated, and is now in place. Software interfaces have been successfully modified. Installation of the new camera system into the VSM is expected before the end of the first quarter in FY 2009. This will allow the VSM to perform to the original specifications.

The NSF Division of Astronomy (NSF/AST) Senior Review recommended that GONG should either find non-NSF/AST funding for the majority of its operations or that it should close down one year after the Solar Dynamics Observatory (SDO) is successfully commissioned. SDO is now scheduled to launch in January 2010. Assuming about six months for commissioning and one year of overlapping observations, the GONG closure could commence in mid-2011. To avoid this, NSO has been actively seeking funding from other sources. Because of GONG's rapid, full-disk magnetograms and farside imaging, the Air Force has shown strong interest in helping to support GONG. As a first step, they plan to fund an H-alpha capability at the GONG sites. This should be followed by operational funding.

The Dunn Solar Telescope (DST) on Sacramento Peak (SP) has seen lots of action over the past few months with successful engineering runs for the University of Hawai´i Facility Infrared Spectropolarimeter (FIRS), the Queens University Belfast Rapid Oscillation

continued

Director's Corner continued

of the Solar Atmosphere (ROSA) experiment, and the joint NSO/High Altitude Observatory Spectro-Polarimeter for Infrared and Optical Regions (SPINOR), which is currently the main NSO/SP focus. All three of these should become user-qualified instruments in 2009 and available for use at the DST.

The Arcetri Observatory Interferometric Bidimensional Spectrometer (IBIS) is now a fully functioning imaging spectropolarimeter that can be rapidly tuned in wavelength. It will soon be integrated into the DST data acquisition system, making data handling more robust and efficient. The multi-conjugate adaptive optics program (MCAO) made progress with measurements of the height of turbulent layers and comparing MCAO-corrected images with modeled performance. A dedicated MCAO bench was set up at the DST.

The McMath-Pierce Solar Facility on Kitt Peak has seen further progress to enhance the capabilities in forefront research, particularly in the solar infrared. The venerable PDP 11/73—the heart of the telescope control system—has been replaced with new hardware and emulation software so that the original FORTH language control software does not have to be substantially rewritten. Hardware has been purchased for computer monitoring of the spectrograph tank position, and the adaptive optics system has been rebuilt to accommodate a new guider. The new limb guiding system is in a preliminary design phase. In the meantime, we hope that the PDP 11/73 finds its way to the Smithsonian Institution.

Several program milestones for the workhorse infrared instrument at the McMath-Pierce, the NSO Array Camera (NAC), have been achieved. Streamlined polarimeter control, real-time flat and dark correction, and a looping capability are now features in the operation of the NAC. All of these improvements enable rapid observations to study dynamics in the solar atmosphere such as one-minute cadence magnetograms in sunspots and surrounding regions or the rapid evolution of CO clouds. In this regard, a large CO filter has been acquired that doubles the field of view in CO from 35 arcsec to 70 arcsec. This filter will be used in forthcoming visitor runs.

A collaborative project with California State University, Northridge (CSUN) to build an Integral Field Unit/Advanced Image Slicer (IFU/AIS) for diffraction-limited 3-D spectroscopy and polarimetry as a facility instrument at the McMath-Pierce is approaching completion. The IFU is scheduled to be installed and operational by January 2009. The refurbished and upgraded Fourier Transform Spectrometer is undergoing tests, and it will resume normal scheduling in January 2009.

Changes

Carl Henney, who has had responsibility for the SOLIS data program at NSO, has left to join Boston College working at Kirtland Air Force Base for Air Force Research Laboratories in Albuquerque, New Mexico. Carl plans to continue working with SOLIS data in his new job, which will focus on the study of space weather. We are pleased to note that Carl will continue an official association with the NSO as an adjunct astronomer. We wish him the best of success.

ATST Update

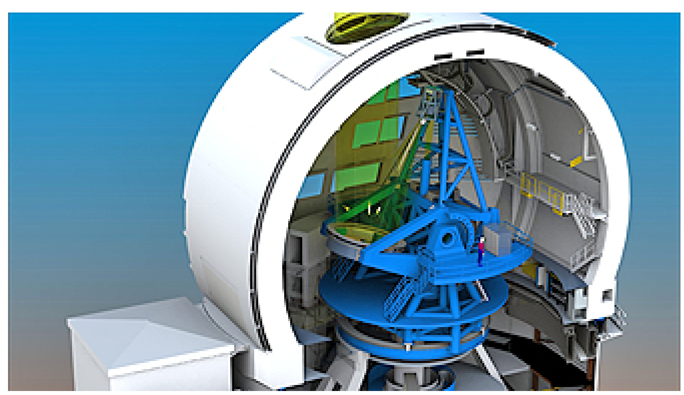
The ATST Team

The Advanced Technology Solar Telescope (ATST) team spent the last quarter preparing for a series of design reviews in Tucson at the end of October and the first week of November. These reviews set the stage for a Final Design Review to be conducted by the National Science Foundation in early 2009.

The Enclosure Control System and Mount Control System (ECS/MCS) Design Reviews were held October 29. Three Systems Design Reviews (SDRs) were also held recently: the Site and Science & Operations Building on November 4; the Enclosure on November 5; and the Telescope Mount Assembly on November 6.

The NSF-conducted Final Design Review, set tentatively for March 2009, is intended to identify all risks and define the budget and schedule baseline for construction. Team managers developed a white paper for the NSF describing the project's budget requirements in light of the potential funding available for fiscal year (FY) 2009 and also a possible FY 2010 construction start scenario.

Preparations for the reviews included extensive work on Interface Control Documents (ICDs) to ensure that all subsystems interact



properly. This was essential given how various parts of the ATST have evolved and been refined over the last few years. ICD preparations ranged from minor edits to complete rewrites. As ICDs moved from draft to final release form, the team held many meetings to touch up details on the giant interface control (N^2) chart. These meetings produced some subtle changes in nomenclature, Work Breakdown

continued

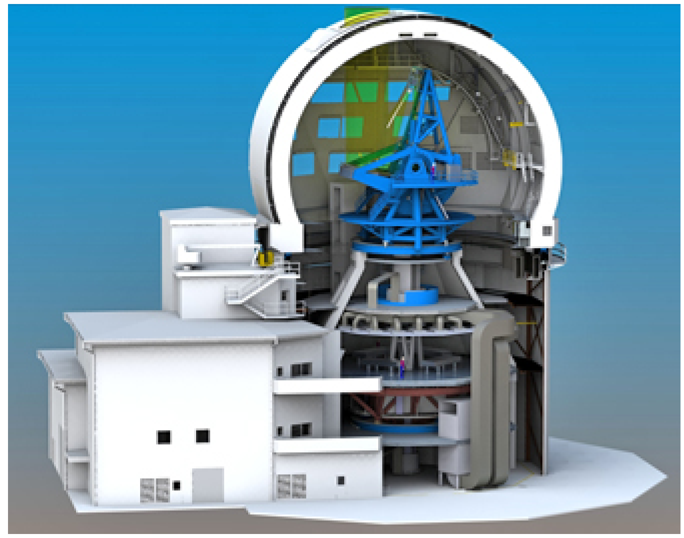
ATST Update continued

Structure (WBS) dictionary entries, and other details that significantly clarified and simplified the ATST ICDs. Since both the WBS and the N^2 chart are under change control already, these updates are carefully scrutinized before submitting them to the change control board. Finalized ICDs will allow the ATST team to prepare Request for Proposal packages.

In the Wavefront Correction System (WFS), multi-configuration Zemax designs are being studied for placing the Deformable Mirror (DM) just above the coudé floor and M10 at instrument height. This particular example has the WFS systems at optical bench height in the rotator undercarriage that was enlarged in 2007. An alternative with the DM and WFS systems located on an optical bench in the coudé room is being studied as well. Higher up, trade-offs established the optimum size for the carousel's entrance aperture for the new geometry of the Telescope Mount Assembly. The solution is a one-centimeter change in the aperture that (1) keeps M1 fully illuminated even during off-pointing for extreme coronal observations, (2) keeps sunlight off of all telescope structures (except the cooled M1 mask), and (3) has enough room for the 60-millimeter auxiliary guide telescope to have an unvignetted view of the Sun in any on-disk position.

Extensive hazards analyses—including "modern ATST" safety meetings that considered the latest design changes—were conducted with the assistance of the NOAO Safety Officer to ensure that the ATST facility and site will provide a safe working environment for all who use it. Current planning is to base the global interlock system (GIS) on the Brookhaven National Labs model.

The Observatory Control System (OCS) design paper now uses a version of the Spectro-Polarimeter for Infrared and Optical Regions (SPINOR) as the "simple instrument" for examples. SPINOR, developed by the High Altitude Observatory and NSO, is a precursor to the Visible Spectro-Polarimeter (ViSP) and is well defined, and therefore provides a convenient vehicle for discussing OCS behavior without requiring details of an actual instrument. Science-use case examples being developed by the Science Working Group will be based on "A Day in the Life of SPINOR," written by Chris Berst at Sunspot and adapted for the ATST environment. Science instrument interfaces were reviewed in a meeting held October 13–17 at the Kiepenheuer Institut für Sonnenphysik in Freiburg, Germany.



The team also worked with the National Park Service to develop a memorandum of understanding leading to a Special-Use Permit for the road through Haleakalā National Park to the observatory site. In August, the team met with consulting and potentially interested parties regarding Section 106 of the National Historic Preservation Act, which covers cultural issues. The list of invitees was widened per advice from the Advisory Council on Historic Preservation, which also had representatives at the meetings, both in person and by teleconference. Comments at the afternoon and evening sessions included some pragmatic advice on potential mitigation.

In education and public outreach, NSO was invited by the National Air and Space Museum to propose activities to go with the museum's proposed Temporary Public Observatory and other activities during the International Year of Astronomy 2009 (IYA2009). NSO anticipates funding from the state of New Mexico to build its Sunspot Solar System Model as part of IYA2009. The model is designed with an eye toward deploying a copy on Maui to help educate students and the public about ATST as the project moves ahead. NL

SOLIS

Aimee Norton, Kim Streander & The SOLIS Team

The Solar Optical Long-term Investigations of the Sun (SOLIS) team has implemented a two-stage approach to cleaning up the spectro-polarimetric data taken by the SOLIS Vector Spectromagnetograph (VSM). The spectra contained polarization fringes with an amplitude of $\approx 3 \times 10^{-4}$ of Stokes *I*. The fringing had variable amplitude and spacing. After we fit the fringes and removed them (Stage 1), it was necessary to further process the data to remove bias and imperfections (Stage 2). For an example of the VSM data after Stages 1 and 2 fringe removal procedures, see figure 1.

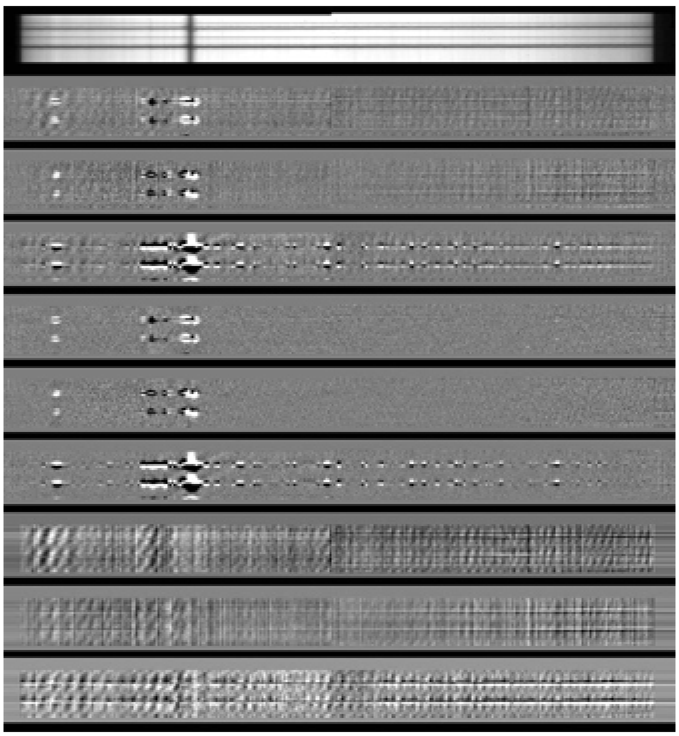


Figure 1: Example of spectro-polarimetric data observed by the SOLIS VSM for a single scanline. The x-direction is the spatial direction of the slit across the Sun. The y-direction is the spectral direction. Each column represents grayscale intensity as a function of wavelength. The top four panels show the Stokes I, Q, U, and V after Stage 1 processing. The very top panel is Stokes I, simple intensity, with the two dark horizontal lines being the 630.2- and 630.1-nanometer absorption lines, and the one dark vertical line representing the decreased intensity in a sunspot. Panels 5, 6, and 7 represent Stokes Q, U, and V after Stage 2 processing. The bottom three panels show the difference between the Stage 1 and Stage 2 results.

The code developed for the removal of polarization fringes was finalized, for both Stages 1 and 2, and installed on the Kitt Peak computers for automated processing of routinely observed data. Full-disk, fringe-free sample spectra can be downloaded at: *ftp://solis.nso.edu/synoptic/level1/vsm/special/betadata/20080326*.

In addition to fringe removal efforts, the SOLIS team reprocessed VSM 630.2-nanometer and 854.2-nanometer data, accounting for the location of bad pixels in the CCD, as a function of time from 2004 until the present. There were also improvements to code that predicts and tracks the evolution of solar surface magnetic fields as viewed in a synoptic Carrington rotation format. This is work being done in tandem with Air Force funding for improved space weather prediction purposes. Integrated Sunlight Spectrometer (ISS) data calibration methods were compared with those of the McMath-Pierce Solar Telescope. It was determined that slight discrepancies between spectra observed simultaneously with the ISS and the McMath-Pierce were due to a two-point calibration of the ISS data while a one-point calibration was used for the McMath-Pierce data.

More work was done to ready the SOLIS telescope for new Sarnoff cameras. Data output from the new Sarnoff cameras was incompatible with the existing Data Acquisition System (DAS) and therefore required engineering changes. Work on the new DAS to replace the current, non-supportable SOLIS system based on digital signal processing has been completed, and extensive testing in the lab and on the observing site has improved the reliability of the system. In addition, modifications to data analysis software have been completed to the point that to progress further, actual SOLIS observations are required.

Lab data was used to develop routines for removing fringes caused by the interference in the thin silicon layer of each of the new cameras. Figure 2 is an example of the typical improvement to intensity images from the NSO Sarnoff camera once its interference fringe model has been applied. The new data acquisition system will be installed once all intensity fringe-fitting routines have been finalized. Installation of the cameras will proceed as weather permits during the first quarter of 2009.

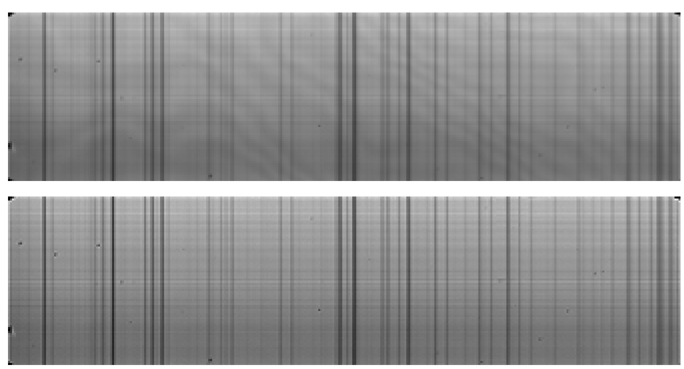


Figure 2: NSO Sarnoff camera data prior to the removal of interference fringes (top panel) and after the removal of interference fringes (bottom panel). The x-axis is the spectral direction and the y-axis is the spatial direction.

GONG++

Frank Hill & The GONG++ Team

We are very pleased to announce that the US Air Force Weather Agency (AFWA) has agreed to join with the Global Oscillation Network Group (GONG) to provide an H-alpha (Hα) observing system at each of the GONG sites. This system will produce 2048 × 2048-pixel full-disk, on-band images once per minute at each site, but with the acquisition time offset by 20 seconds between adjacent sites. This will produce an image every 20 seconds from the network continually around the clock with the same 90 percent duty cycle that GONG routinely attains. The data will be returned within one minute of acquisition to Tucson, and AFWA will pull the data to Nebraska for its flare patrol work.

The data will be fully open to all users and will be useful for studies of flare evolution, filament dynamics, Moreton waves, etc., with magnetograms, Dopplergrams, and subsurface helioseismic data from the same instrumentation. The system is expected to be fully deployed and operational in the spring of 2010. AFWA will also provide a portion of the annual operational cost for GONG. Figure 1 shows the director of AFWA, Dr. Fred Lewis, along with AFWA and GONG staff, on the occasion of his visit to Tucson on 6 August 2008.

Figure 1: Thumbs Up for a GONG-AFWA Partnership! The US Air Force Weather Agency (AFWA) visited GONG headquarters on 6 August 2008 to discuss the plan to install an H-alpha observing system at each of the GONG sites. Shown here at the GONG engineering site are (left to right): SMSgt Craig Kirwin (AFWA), Dr. Fred Lewis (AFWA Director), Pat Eliason (GONG), Frank Hill (GONG), Maj. Herbert Keyser (AFWA), and George Luis (GONG).

Science Highlights

Irene González-Hernández has recently found that, when the phase shift used for the farside maps is averaged over the entire farside, a temporal variation that is highly correlated with the solar cycle is visible, as seen in figure 2. This is a consequence of thermal changes in the outer solar convection zone caused by magnetic fields. The presence of a magnetic field changes the temperature gradient and alters the depth at which the oscillations are reflected inward, creating a variation in the "acoustic radius" of the Sun. The variation is very

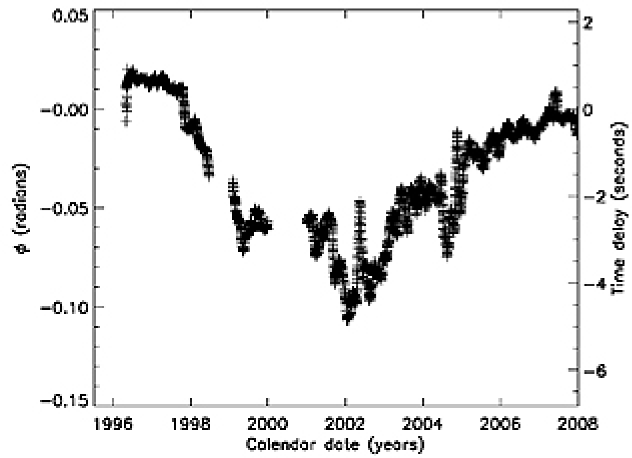


Figure 2: The Mean Phase Delay of seismic waves that propagate to the non-visible hemisphere of the Sun is plotted versus time. The right-hand-side axis presents the corresponding time delay associated with the phase shift. The change in the mean phase is highly anticorrelated with solar activity during cycle 23. A variation of the phase is directly related with changes in the cavity in which the waves propagate, namely, the acoustic radius.

small in terms of actual distance, on the order of five kilometers, and can also be precisely measured using the autocorrelation of low-degree modes, as has been demonstrated recently by Shukur Kholikov (*Solar Phys.* Vol. 251, p. 157). The variation of acoustic radius will constrain models of the outer solar convection zone that include magnetic fields.

Network Operations and Engineering

Motivated by the instability of the turret tracking, a preventive maintenance (PM) trip was conducted at Mauna Loa in August. For much of the year there was a problem of an intermittent oscillation in the pitch axis, which could sometimes last several hours after unstowing and could not be corrected by remotely adjusting the servo parameters. The PM team installed a replacement pitch head to correct the problem. Prior to the trip, the GPS receiver was found to be malfunctioning. The installation of the on-site spare improved the acquisition of satellite signals, but because certain parameters were programmed incorrectly, the data continued to be compromised. A new GPS unit was installed during the PM and configured properly. This situation prompted us to improve the remote monitoring of the GPS status, and new software to do this has since been tested and deployed.

A PM trip to Udaipur began in September and continued through the first week of October. The major effort there was to replace the entire turret, which had suffered a moisture intrusion earlier in the year. Although the turret was operational prior to the monsoon shutdown, it was feared that if any residual moisture remained in the motors, problems could arise later in the year. In addition, the usual PM tasks and upgrades were accomplished.

continued

GONG++ continued

On the engineering front, work has begun on planning for adding observations of the Sun in the Hα band to the GONG instruments. Jack Harvey has developed a promising optical design, so the mechanical design issues can now be addressed. A camera, Hα filter, and computer for data collection have been tentatively identified, and with the AFWA funding in hand, evaluation units can be procured for test and measurement purposes.

We are evaluating a new seal for the turret resolver covers, which present a possible failure point for allowing moisture to penetrate into the lightfeed. We also continue to work with Wind River on real-time software issues related to our instrument chassis central processing unit (CPU). The necessary software tools still do not work properly. The diaphragms in the new clean-air system pumps have been failing well before the anticipated diaphragm's rated lifespan. We are checking with the vendor and evaluating several other materials in hopes of finding one better suited to our application.

Data Operations and Software Development and Analysis

Processing to date includes time series, frequencies, merged velocity, and rings for GONG Month 131 (centered at 9 February 2008), with a fill factor of 0.88. Last quarter, the GONG Data Archive distributed 434 gigabytes of data. All GONG data products can be obtained at *gong.nso.edu/data*.

With few exceptions, nearly all of the GONG data reduction pipeline components are certified and running on Linux. The transition to Linux has not been easy, but our code is faster, more robust, and better documented as a result. On a yearly basis we will continue to add Linux-based servers as needed to support science demand for new data products. By using Conductor, a database-driven pipeline processing manager, we can easily scale up the number of CPUs that we use for any given pipeline.

Program

The GONG 2008/SOHO XXI conference was held at the Center Green Campus of the High Altitude Observatory (HAO), National Center for Atmospheric Research (NCAR) in Boulder, Colorado, 10–15 August 2008. The conference was diverse and well attended, with representatives from all of the continents except possibly Antarctica. While the focus of the meeting was the dynamo, the range of individual topics was broad, including local and global helioseismology, asteroseismology, recent results from ground-based and space-borne observational facilities, and progress reports on observational facilities and instruments in various stages of development. The conference introduced organized one-hour discussion forums for each of the major topics, an innovation for the GONG/SOHO workshops. Figure 3 shows the participants. More photos of the conference are available at *gongsoho08.ucar.edu/photos/*. Many thanks are due to the local organizers: Mausumi Dikpati, Deborah Haber, Charlie Lindsey, and Adrian Trujillo.

GONG will be running the third International Research Experience for Students (IRES) program next year. This program sends four US graduate students studying any discipline of astronomy or astrophysics to work with scientists at the Indian Institute for Astrophysics in Bangalore, India. Applications for summer 2009 are available on the Web and must be received by 16 January 2009. Further information can be found at *eo.nso.edu/ires/*.

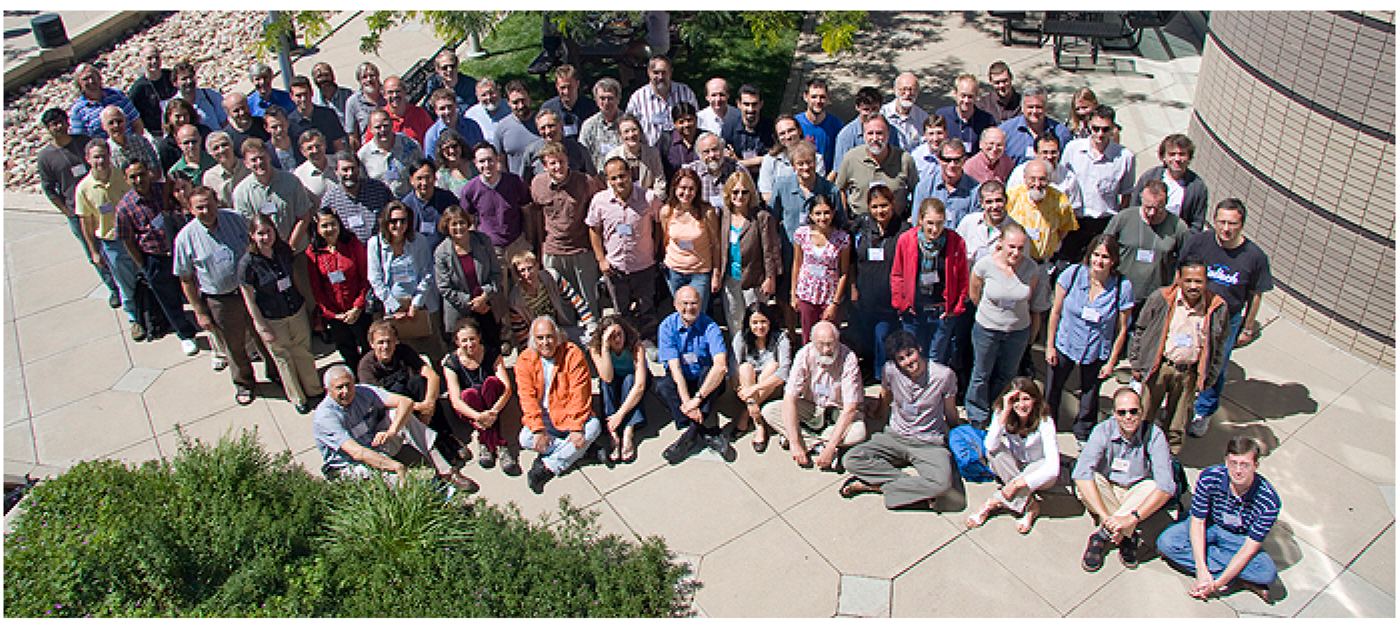


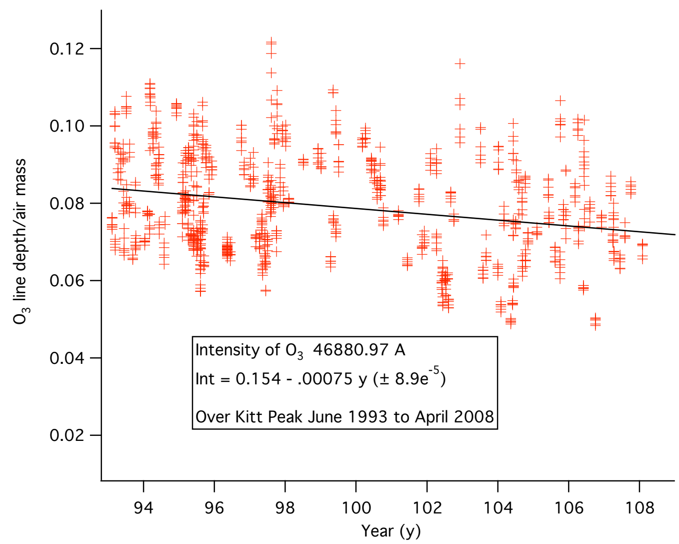
Figure 3: Participants at the GONG 2008/SOHO XXI conference held in Boulder, Colorado, 10–15 August 2008.

International Research Experience for (Graduate) Students (IRES)

INTERNATIONAL RESEARCH EXPERIENCE FOR STUDENTS

NSO/GONG announces a summer 2009 research program for US graduate students sponsored by the NSF Office of International Science and Engineering (OISE). The eight-week program, which begins 10 June 2009, will take place in Bangalore, India, under the auspices of the Indian Institute of Astrophysics (IIA). The goal of the program is to expose potential researchers to an international setting at an early stage in their careers. See *eo.nso.edu/ires/* for additional information and application materials. The deadline for applications is 16 January 2009.

Stratospheric Ozone: No Trends Detected over Kitt Peak 1993–2008



Bill Livingston (NSO) and Lloyd Wallace (NOAO) have determined the strength of ozone using its near-infrared line at 46,880 Angstroms. This measurement was done intermittently over the past 15 years using the 13.5-meter vertical spectrograph of the McMath-Pierce facility. As the much more intensive Total Ozone Mapping (TOMS) satellite records show, ozone is highly variable, and our observations are too infrequent to give a definitive characterization of its presence. The plot shows the individual raw values corrected to one air mass. (The Sun overhead shines through one air mass; at the horizon, this increases to about 40 air masses.) A linear fit through the data (see box) indicates a slight downward trend, but this is not deemed significant.

First and Second Quarter Deadlines for NSO Observing Proposals

The current deadline for submitting observing proposals to the National Solar Observatory is 15 November 2008 for the first quarter of 2009. The deadline for the second quarter of 2009 is 15 February 2009. Information is available from the NSO Telescope Allocation Committee at P.O. Box 62, Sunspot, NM 88349, for Sacramento Peak facilities (*sp@nso.edu*); or P.O. Box 26732, Tucson, AZ 85726, for Kitt Peak facilities (*nsokp@nso.edu*).

The following Web-based information is available:
Instructions at *www.nso.edu/general/observe/*
Observing request form at *www2.nso.edu/cgi-bin/nsoforms/obsreq/obsreq.cgi*
Users' manuals for Sac Peak facilities at *nsosp.nso.edu/dst/*
Users' manuals for Kitt Peak facilities at *nsokp.nso.edu/*
Observing run evaluation form at *ftp.nso.edu/observing_templates/evaluation.form.txt*

Proposers are reminded that each quarter is typically oversubscribed. It is to the proposer's advantage to provide all information requested to the greatest possible extent no later than the official deadline. Observing time at the national observatories is provided as support to the astronomical community by the National Science Foundation.

AURA Observatories in Chile: Friend of the Teletón

Hugo Ochoa & David Orellana

The Teletón is a Chilean charity that provides rehabilitation for handicapped children and young people from toddler age to 24 years old. It operates 10 centers throughout Chile, including one in Coquimbo, which together provide assistance to more than 26,000 children.

The Teleton drew a large, lively crowd.

Funds to operate these centers, and build more, are obtained through an annual campaign. This campaign culminates with a 27-hour-long television marathon (hence the name Teletón) in late November, with the participation of national and international celebrities. Donations are made by diverse companies and organizations, but by far the majority of the funds raised each year come from contributions made by individuals.

The opening event for this year's campaign was held in La Serena's Parque Pedro de Valdivia on August 23. For the first time, this event featured a series of workshops in which the handicapped children themselves took part, each accompanied by a volunteer "friend" of similar age. This activity had the goal of helping build the children's self esteem and independence, motivating them to become more integrated in society, while increasing public awareness of the obstacles to such integration.

One of these workshops, titled "AURA Astronomy: A Friend of the Teletón" was run by the AURA Observatories in Chile, with the collaboration of several members of the scientific and outreach staff of Gemini South, NOAO South, SOAR, the Centro de Apoyo a la Didáctica de la Astronomía (CADIAS), and volunteers from the Star Teachers program.

SOAR Director Steve Heathcote and some of the attendees.

Kids of all kinds got to experience a little bit of astronomy, including the use of binoculars and a solar telescope.

Over the course of the day, five groups, each consisting of 12 handicapped children plus their 12 volunteer friends, were given a tour of the solar system in one of the mobile planetaria. The participants then built a scale model of the Earth-Moon system from modeling clay.

The enthusiasm and energy of the children was infectious, and everyone had a great time. All of us—children and grownups alike—learned something from the experience. This new knowledge, and the obvious joy and gratitude of the children from the Teletón, amply repaid the effort involved.

Students Needed for the 2009 REU Program at Kitt Peak

Ken Mighell

Each summer, a group of talented college students comes to Tucson to participate in astronomical research at Kitt Peak National Observatory (KPNO) under the sponsorship of the National Science Foundation's Research Experiences for Undergraduates (REU) Program. Like the parallel program at Cerro Tololo, the KPNO REU program provides an exceptional opportunity for undergraduates considering a career in science to engage in substantive research activities with scientists working in the forefront of contemporary astrophysics.

Each REU student is hired as a full-time research assistant to work with one or more staff members on specific aspects of major, on-going research projects at NOAO. These undergraduates gain observational experience with KPNO telescopes and develop expertise in astronomical data reduction and analysis as part of their research activities. They also take part in a weekly lecture series and a field trip to New Mexico to visit the National Solar Observatory at Sacramento Peak and the Very Large Array in Socorro.

At the end of the summer, the students share their results with the Tucson astronomical community in oral presentations. As part of their internship experience, all six of our 2008 REU participants will present posters describing their astronomical research projects at the January 2009 American Astronomical Society meeting in Long Beach, California.

We anticipate being able to support six REU positions during the summer of 2009. Student participants must be citizens or permanent residents of the United States to meet NSF requirements.

The KPNO REU positions are full-time for 10–12 weeks between June and September, with a preferred starting date of early June. The salary is $625 per week, with additional funds provided to cover travel to and from Tucson. Further information about the KPNO REU 2009 program, including the online application form, can be found at *www.noao.edu/kpno/reu*. Completed applications (including official transcripts and at least two letters of recommendation) must be submitted to KPNO no later than Friday, 30 January 2009.

The KPNO REU 2007 students. Top: Timothy Arnold (Ohio State University), Taylor Chonis (University of Nebraska, Lincoln), and Matthew Henderson (Clemson University).
Bottom: Matthew Zagursky (University of Maryland), Tiffany Meshkat (University of California, Los Angeles), and Ashley Stewart (University of Arkansas).

Observatory Open House Welcomes Members of the Tohono O'odham Nation

Douglas Isbell & Buell T. Jannuzi

The observatories on Kitt Peak hosted a record turnout of over 1,000 guests during an observatory open house for members of the Tohono O'odham Nation held on 13 September 2008. Beautiful weather, excellent pre-event planning, effective advertising, and hard work during and after the day by many people contributed to the great success of the event.

Held every few years, our open houses are a chance for members of the Tohono O'odham Nation to tour mountain facilities, view the Sun and the night sky through some of the telescopes we operate, meet our staff, and learn about what we do to support astronomical research and education. The open houses also give our staff a chance to learn more about the Tohono O'odham people and their culture.

Coordinated by Nanette Bird, the volunteer-driven event staff drew participants from KPNO, NSO, the Kitt Peak Visitor Center and its docent cadre, WIYN Observatory, Steward Observatory, and volunteers from several other divisions of NOAO. Other important contributors included the Tucson Amateur Astronomy Association, officers from the Nation's Department of Public Safety, emergency medical technicians from Indian Health Services, the Bureau of Indian Education, Grey Line Bus Company, and the University of Arizona CatTran shuttle service.

We appreciate the participation of Earleen Patricio (Miss Tohono O'odham Nation 2008 and now Miss Indian Arizona 2008), the Valenzuela & Company Band, the San Xavier Basket Dancers, the Indian Oasis Dance School, and food and craft vendors from around the Nation. They added significantly to the spirit and value of the evening. We are grateful for assistance in the planning and support of the open house from the Schuk Toak District Council, District Chairwoman Phyllis Juan, District Vice Chairwoman Denise Flores, and the Tohono O'odham Executive Office. We thank *The Runner* newspaper, KOHN FM 91.9 radio, Indian Oasis-Baboquivari School District, Santa Rosa Boarding School, San Simon Elementary School, and all eleven District Offices for their assistance advertising the event.

Our staff and volunteers were well organized and very creative in handling the steady large flow of guests, who were uniformly patient, enthusiastic, and interested both in our work and the larger world of astronomy. Even with the overflow turnout (we were parking cars in all the pull-outs after filling up the picnic grounds—not including the three busloads of visitors), our planned events went smoothly, and we managed to get our last guest safely headed down the mountain by 10:00 p.m. Color photos from the open house later graced the cover of the next edition of *The Runner* (see figures).

It was the support of the Tohono O'odham Nation 50 years ago that enabled the National Science Foundation to establish a national observatory for optical and infrared ground-based astronomy. Kitt Peak open houses are part of our broader efforts to maintain and develop the relationship between the national observatory and the people of the Tohono O'odham Nation, from whose sacred land we are fortunate to study the Universe. We thank everyone that helped make the September 2008 open house a success.

Dragon*Con 2008 Attendees Get Excited about IYA2009

Members of the US team helping to plan the International Year of Astronomy 2009 (IYA2009) garnered an enthusiastic reception at Dragon*Con 2008 in Atlanta over Labor Day weekend. Thanks largely to strong advance planning by US IYA2009 Web Developer and New Media team leader Pamela Gay (Southern Illinois University Edwardsville), the IYA2009 exhibit booth had a great location that drew a steady stream of interested visitors for all four days of the meeting.

Staff at the booth included Pamela Gay, Phil Plait (*Bad Astronomy* Web site and the James Randi Educational Foundation), US IYA2009 Single-Point-of-Contact Doug Isbell (NOAO), and local friends and volunteers from the Skeptics Society. The team handed out thousands of US IYA2009 buttons and informational postcards, and talked with hundreds of attendees. The typical reaction? "Cool!" "Awesome." "I love astronomy!"

Astronomer Bill Keel (University of Alabama) conducted remote telescope observations on several nights in the name of IYA2009, which were greatly appreciated and extremely popular. IYA2009 was mentioned in numerous Dragon*Con sessions in the space, podcasting, and skeptics tracks at the meeting, which drew an estimated 60,000 passionate fans of science fiction, fantasy, comics, futurism, and science reality.

The accompanying photos show a few of the booth visitors and new supporters of IYA2009 who emerged at the 2008 meeting. The US IYA2009 group plans to be back at Dragon*Con in September 2009 with even more creative activities.