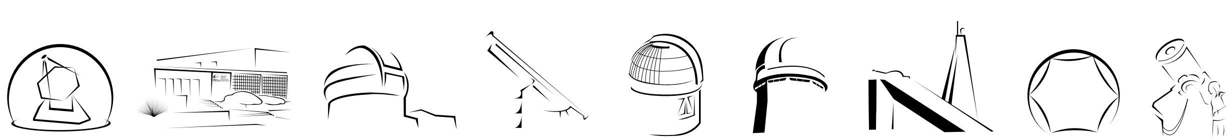
NOAO-NSO Newsletter

Issue 84

December 2005



NOAO @ the 207th AAS Meeting

Be sure to visit the NOAO and Gemini Science Center exhibit booths at the American Astronomical Society meeting in Washington, DC, from 8-12 January 2006.

The NOAO booth will feature a huge new image of the Large Magellanic Cloud produced by the Magellanic Cloud Emission Line Survey (MCELS), tied to a special oral session on the LMC at the meeting, as well as updates on a variety of projects ranging from the Dark Energy Camera to the Thirty Meter Telescope.

At an adjacent booth, staff members from the NOAO Gemini Science Center will be available to answer questions about how to apply for observing time on the Gemini telescopes and how to take best advantage of the latest capabilities of Gemini instruments. They will also be providing tutorials on the Phase II process. Brochures will be available on the Gemini instruments, the Gemini Science Archive, and how to propose for Gemini time.

Be seeing you!

Mark Hanna is retiring from NOAO this month after more than 40 years of service in every aspect of photographic imaging and graphics production at the national observatory.

Mark began working on the Kitt Peak National Observatory newsletter during the formative issues of "Prime Focus" in the 1970s, and has continued straight through the highly digitized production process used on this issue. From the era of photographic plates and the graphic arts camera that he was originally hired to operate to Mosaic CCD camera images many gigabytes in size, Mark has never failed to keep up with the latest technology and software. Virtually every image released in the last four decades by the observatories in Tucson and many from Chile have passed through his capable hands, and numerous astronomers have him to thank for the quality of their final images.

Shown in an archival picture from a mirror evaluation test in the late 1960s, Mark has been an extremely dedicated member of the NOAO staff. His easygoing demeanor in recent years masks a fierce career-long commitment to get the job done and done right. Mark will be missed tremendously, and we wish him all the best in his future endeavors.

On the Cover

The Andromeda Galaxy (M31) is the nearest spiral galaxy to our own Milky Way, located a mere 2.2 million light-years distant. The Local Group Galaxies Survey team used the Mosaic camera on the Kitt Peak Mayall 4-meter telescope to investigate M31's substantial population of young, massive stars over a very large field of view. Each of the squares in the image is half a degree on a side, about the size of the full Moon.

For more information see page 6.

Credit: Phil Massey (Lowell Observatory), Knut Olsen and Mark Hanna (NOAO/AURA/NSF), and the Local Group Galaxies Survey Team

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The Short Burst Revolution

Jason X. Prochaska (UC Santa Cruz and Lick Observatory)

Gamma-ray bursts (GRBs) are among the most energetic explosions in the Universe. They are generally divided into two main classes: long duration-soft spectrum bursts, which last ~2 to hundreds of seconds; and, short duration-hard GRBs, which last less than 2 seconds and are spectrally "harder" than the first class. Over the past few years, the long-soft GRBs have been shown to be associated with supernovae, and to originate in star forming galaxies at redshifts z=0.1 to 6.3. It is generally accepted that these events result from the collapse of a very massive star (Woosley, S. and Bloom, J. Annual Reviews of Astronomy and Astrophysics, in press), but until summer 2005, very little was known of the progenitors of short-hard GRBs.

A major observational leap was facilitated by the rapid localization of four short-hard GRBs by the Swift and HETE missions. In addition to observing gamma-ray emission these satellites detected X-rays from the events, and analyzed this data to provide localizations on the sky of 5" -10". This enabled ground-based groups like our own to investigate the origin and environment of the short-hard GRBs at optical, IR, and radio wavelengths.

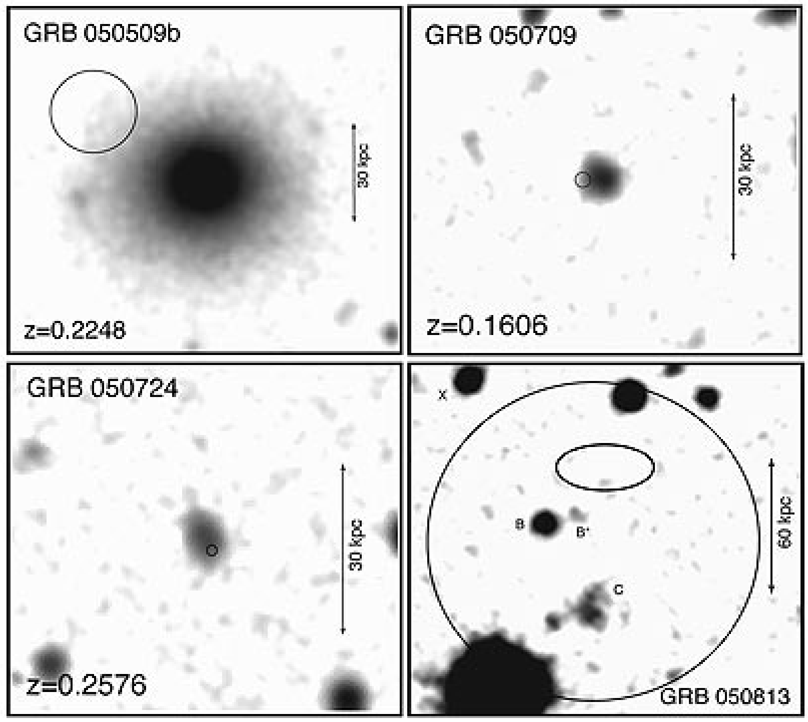

Figure 1. Optical images of the host galaxy environments of four short-hard GRBs. The ellipses indicate the position of the X-ray afterglow, except for GRB 050813 where the 90% and 68% containment radii are instead shown. In the case of GRB 050709 and GRB 050724 where optical afterglows were detected, the GRB is projected to within 2" from the center of a galaxy with apparent magnitude R < 19.5 mag. Similarly, the error circle containing GRB 050509b encompasses a single bright galaxy which is the putative host galaxy. GRB 050813 is associated with a cluster of galaxies, with galaxies B or B the most likely host galaxy.*

Using NOAO facilities (specifically the WIYN and Gemini telescopes) and several other observatories, our group has searched for optical afterglows, examined the host galaxies and galactic environment of these events, and performed late-time searches for associated supernovae. With WIYN, we obtained the deepest early optical images of the field surrounding the first event (GRB 050509b), and demonstrated that this GRB lacked an afterglow about a thousand times fainter than most afterglows of long-soft GRBs (Bloom, J. S. and Prochaska, J. X. et al., ApJ, in press: astro-ph/0505480). With the GMOS spectrometer on Gemini-North, we obtained discovery spectra of the galaxies surrounding GRB 050724 and GRB 050813. When considered with spectroscopy obtained at the Keck telescope, we find that the four events have likely all occurred in z<1 galaxies (Prochaska, J. X., ApJ Letters, submitted: astro-ph/0510022).

Optical and radio afterglows were observed for two of the GRBs, and three of the four have been localized to within 30 kpc of a bright galaxy.

Three of the putative host galaxies are early-type and have upper limits on current star formation at the level of 0.5 solar masses per year. Surprisingly, two of the galaxies reside in clusters. The properties of these three galaxies contrast starkly with the low luminosity and high star-formation rates characteristic of host galaxies for long-soft GRBs. These observations present strong evidence that short-hard GRBs have a different progenitor origin than long-soft GRBs.

continued

The Short Burst Revolution continued

The association with early-type galaxies suggests the progenitor is a merging pair of compact bodies, e.g., a neutron star binary. Such a model could explain the older stellar populations of these host galaxies. Still, one of the hosts (also discovered with GMOS on Gemini North by P. Price and K. Roth) is clearly forming stars. An analogy of the diversity of GRB progenitors with those of SNe is warranted. Like Type-Ibc supernovae, which are almost exclusively found in late-type galaxies, long-soft GRBs are confined to active star forming galaxies. This is because both come from the death of massive stars, which only exist during active periods of star formation. Yet Type-Ia SNe, seen in all types of galaxies, are a result of the explosion of old white dwarfs. Similarly, short-hard GRBs, if they are due to the merger of old degenerate binaries, can (and are) found in a variety of Hubble types. We are in an exciting and enlightening period in the GRB field and we fully expect Gemini and other NOAO facilities to continue to play a major role in the study of short-hard GRBs.

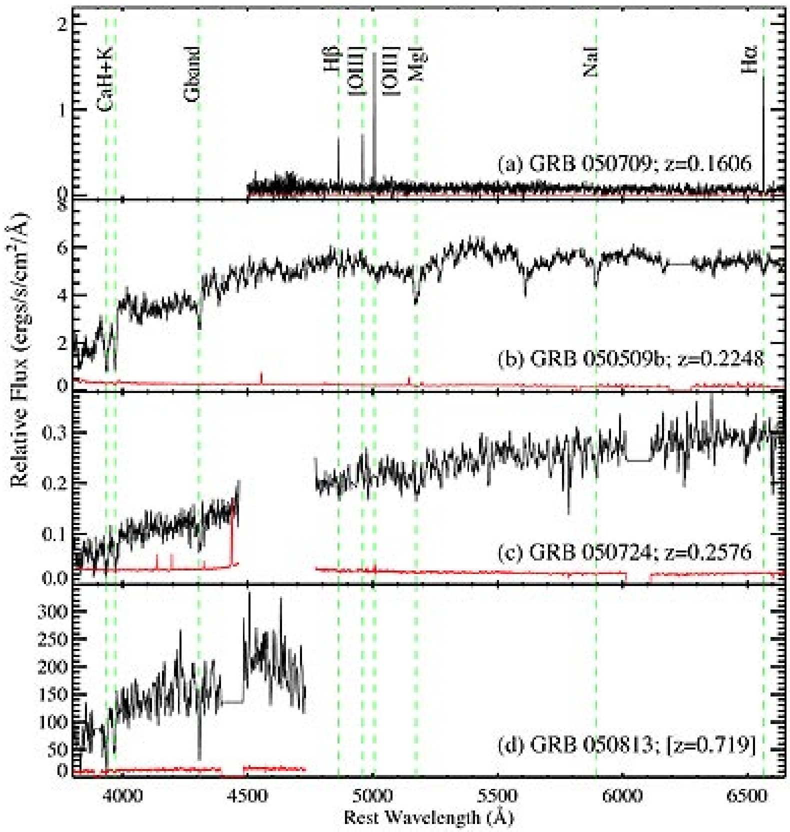

Figure 2. Optical spectra of the host galaxies of short-hard GRBs. With the exception of GRB 50724, these are the spectra that established the redshift of the GRB event and the physical properties of the galaxy host and/or environment. For GRB 050813, the spectrum for galaxy B is shown.

Kinematics of Thick Disk Stars with the Gemini Telecopes

Peter Yoachim & Julianne J. Dalcanton
(University of Washington)

Old stars provide a fossil record of the early stages of early galaxy formation. We know a great deal about the structure and kinematics of old stars in the Milky Way, namely stars in the Milky Way's thick disk and halo. Our understanding of the properties of old stars in external galaxies is limited, however, largely because of the difficulty in separating the diffuse population of old stars from the brighter young stars. By observing disk galaxies oriented edge-on, we have been able to spatially separate the old thick disk stars from the younger thin disk populations in a sample of about 50 galaxies. The color map in figure 1 shows a typical galaxy in our sample and reveals a very blue midplane surrounded by a much redder and older stellar envelope.

After characterizing the photometric properties of old stellar thick disks in a large sample of galaxies (Yoachim & Dalcanton 2005), we undertook a campaign utilizing both Gemini telescopes to observe the kinematics of stellar populations in the thick and thin disks. For each galaxy, we observed with GMOS in longslit mode on the midplane for one hour, and the fainter thick disk dominated regions ~5 arcsec above the plane for 5-10 hours. Because we had no need for photometric conditions or good seeing, our program matched well with Gemini's queue scheduling. The wavelength coverage of the GMOS

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Kinematics of Thick Disk Stars continued

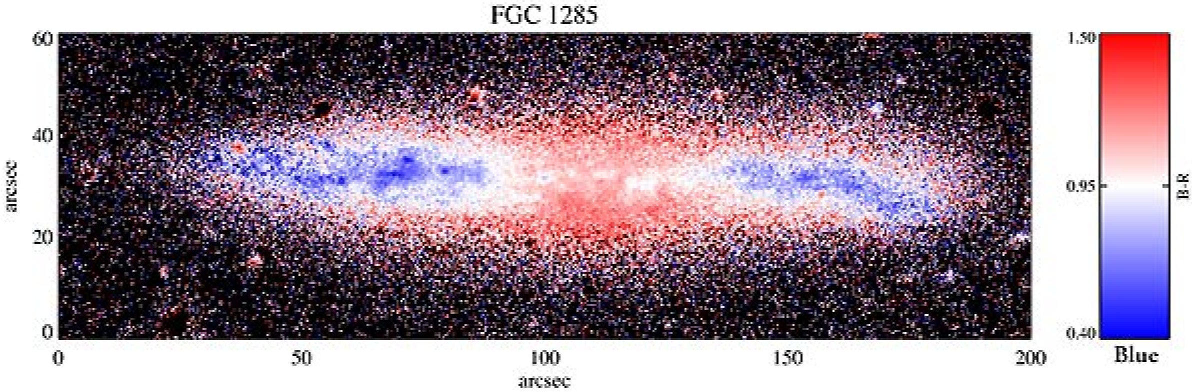

Figure 1. B-R color map of one of the galaxies in our sample. The blue thin disk is surrounded by a redder stellar population, analogous to the Milky Way thick disk.

instruments allowed us to observe both gas emission lines as well as the Ca II triplet absorption features from the stars.

We have completed the rotation curve analysis for two of our galaxies. The thick disk in FGC 1415 looks analogous to the thick disk of the Milky Way, with the thick disk stars lagging behind the rotation of the thin disk stars. FGC 227 presents a much more complicated case, with the off-plane observations showing little if any net rotation. After correcting for the thin disk stars that contaminate off-plane observations, we find the best fitting model for FGC 227 actually includes a *counter-rotating* thick disk. Figure 2 shows how the best fit model for the thin and thick disk stars (top panel) reproduces the observed rotation curve (bottom panel), after correcting for cross-contamination and spatial binning.

Evidence in the Milky Way suggests that there are two viable models for how an old thick stellar disk is formed. In the first, a thin stellar disk is kinematically heated (often during a minor merger event) to form a thick disk. In the second, a satellite galaxy is disrupted before reaching the midplane and deposits its stars directly into a thick disk. For the Milky Way and FGC 1415, either formation pathway is plausible. However, the counter-rotating thick disk of FGC 227 strongly suggests that thick disks can also result from galaxy mergers. Recent numerical simulations of disk galaxy formation by Abadi et al. and Brook et al. find that thick disk stars are accreted or form *in situ* during early accretion events.

While our results from FGC 227 are intriguing, our final goal is to study the properties of thick disks statistically. We have therefore completed thick disk observations on nine individual galaxies that span a wide range in mass. We should soon be able to tell if FGC 227 is anomalous, or if most thick disks show signs of being formed through disruption and accretion. The results for the first two galaxies in our sample have been published (Yoachim & Dalcanton 2005, ApJ, 624, 701) and the analysis of the full sample of nine galaxies is in preparation.

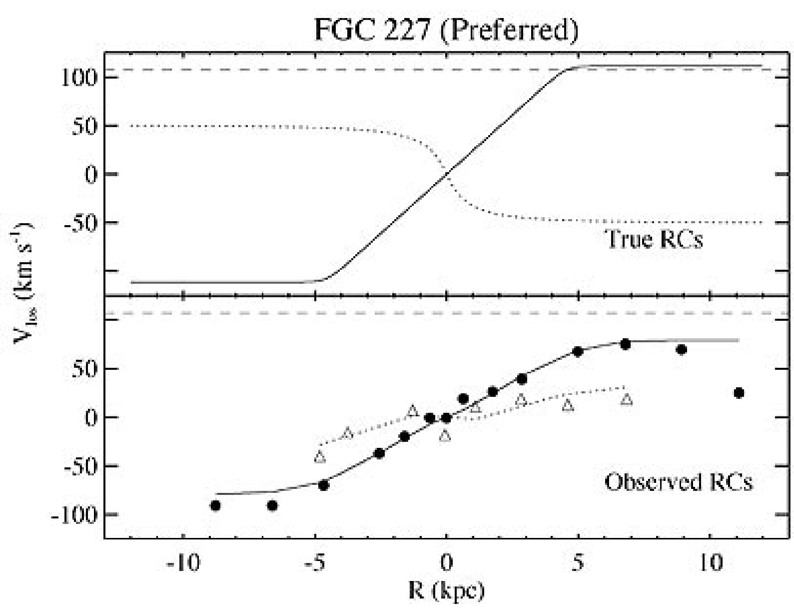

Figure 2. Stellar rotation curves for the midplane (circles) and off-plane (triangles) of FGC 227. Our best fitting model (top panel), has the thick disk counter-rotating compared to the thin disk

A Survey of Local Group Galaxies Currently Forming Stars

Phil Massey (Lowell Observatory), Knut Olsen (NOAO), Paul Hodge (University of Washington), Shay Homes (University of Texas), George Jacoby (WIYN), Chris Smith (NOAO), Abi Saha (NOAO)

The galaxies of the Local Group act as an astrophysical laboratory for studying the effects of metallicity and other environmental factors on star formation and massive star evolution. With 4-m class telescopes and conventional single-object spectrographs, such "galactic" astronomy could be extended to the Magellanic Clouds, where even the modest difference in metallicity (4x from SMC to Milky Way) have resulted in some significant surprises. With the advent of multi-object spectrographs on large aperture telescopes (GMOS on Gemini, DEIMOS on Keck), we can now extend such studies to the more distant members of the Local Group, where the galaxies that are currently forming stars span a range of 20 or so in metallicity.

Such studies do depend on knowing where and what to look at! Our group has taken advantage of time available through the NOAO Survey Program to obtain UBVRI images of stars in M31, M33, NGC 6822, WLM, Pegasus, Phoenix, IC10, Sextans A, and Sextans B. These images, and the resulting photometry, can act as the "finding charts" for our own projects, as well as that of others, for many years to come. In addition, we have included observations at Hα, [OIII] λ5007, and [SII] λ6713 to distinguish stellar Hα emission-line sources from planetary nebulae and supernovae remnants. The project began in August 2000, and ran for two years, with a total of 16 nights of usable data obtained on the CTIO and KPNO 4-m telescopes. Most of this time was spent on our neighboring spirals, as M31 (see the cover of this *Newsletter*) required ten fields and M33 needed three fields. Each of the other galaxies required only one field.

Our images have been available since 2003 both through the NOAO Science Archive and through the Lowell ftp site. See *www.lowell.edu/users/massey/lgsurvey* for links. We have now completed our UBVRI photometry of M31 and M33, and are preparing our first paper for publication. It thus seemed appropriate to provide some highlights of our work.

What We Did and How We Did It

At the beginning of the project, we decided that our primary goal was to obtain 1% photometry under good (but not always excellent) seeing conditions, covering the whole of the star-forming

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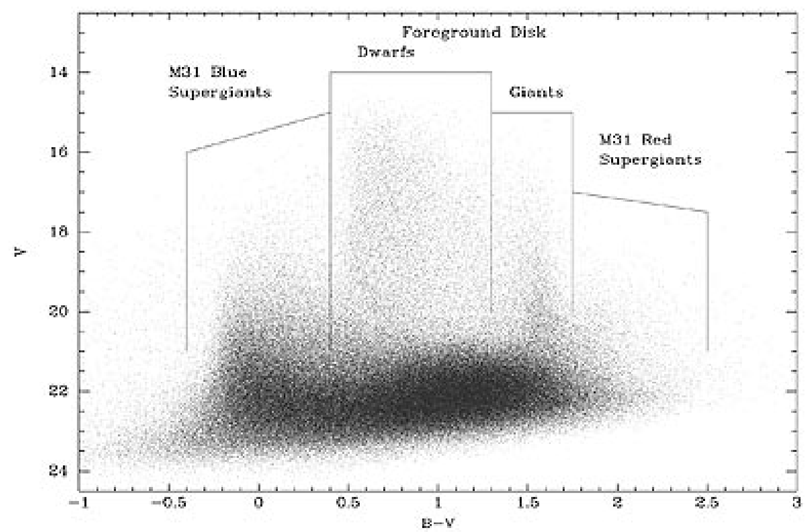


Figure 2. Color magnitude diagram of our M31 sample. Many of the stars at intermediate color are foreground stars in the Milky Way galaxy.

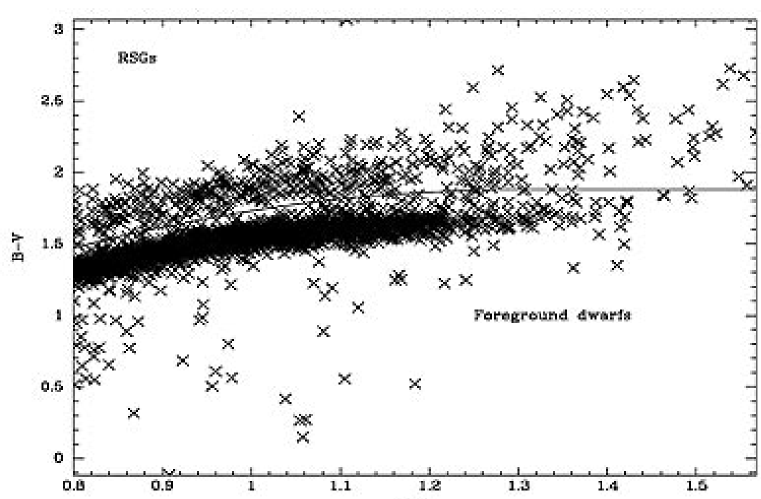


Figure 3. Color-color diagram that distinguishes red supergiants in M31 from Galactic foreground red dwarfs.

Survey of Local Group Galaxies continued

regions of these galaxies. These images could be supplemented by WFPC2/ACS images with HST and with AO for higher resolution studies of small regions, but ours would provide uniform (and photometric) coverage of the entire galaxies.

The Mosaic cameras each consist of eight CCDs, and in order to compensate for the gap between chips, one usually obtains five dithered exposures at each pointing. Since each of the CCDs has its own color terms, we quickly realized that high accuracy photometry meant that we would have to treat each of the CCDs separately, rather than simply use the "stacked" (single) images that were the aim of much of the IRAF reduction software. This required 40x more work, but in the end we would be able to distinguish $50M_{sun}$ O-type stars from $10M_{sun}$ B-type stars. For narrow-band exposures, where color terms are moot, we rely on the stacked images. In order to accomplish this, we needed a fairly automatic means of doing the photometry; the IRAF scripts and FORTRAN programs involved are available to others through our Web site.

Observing sufficient standards on each of the eight chips in order to determine transformation equations each night is highly impractical. Instead, we obtained external calibration of each field using Lowell Observatory's 1.2-m Hall telescope located on a dark site at Anderson Mesa, Arizona. We used 25 pristine photometric nights during 2000-2003 for the calibration. Although it involved as much work as the main project itself, it allowed us the freedom to observe with the 4-m under good, but not necessarily photometric, conditions. When all was said and done, the typical differences in the photometry from one field to another were at the millimagnitude level.

What We Achieved

Our final M31 catalog consists of 370,000 stars with UBVRI measurements. Many of these stars were observed multiple times in overlapping fields, or in separate dithers. The M33 catalog contains 145,000 stars. When we include the dwarfs, we expect the final set of photometry to include approximately a million stars.

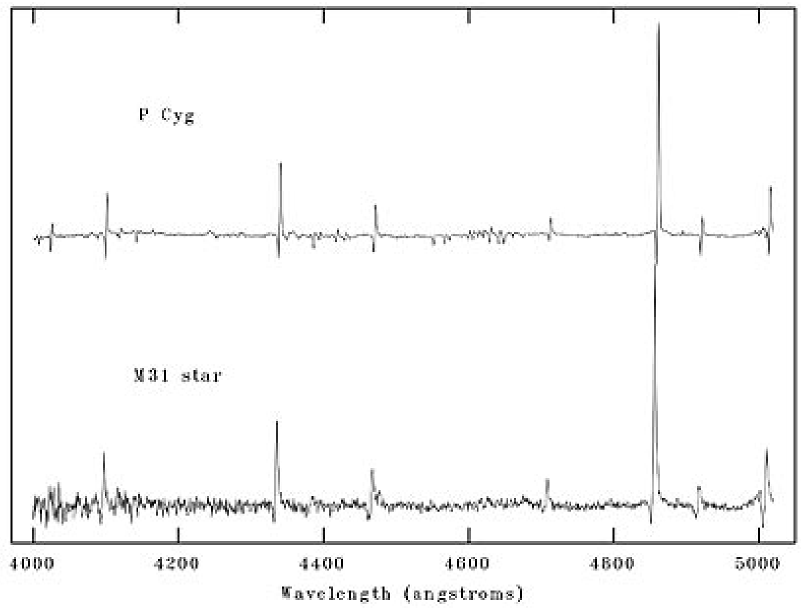


Figure 4. Spectrum of a newly discovered "P Cygni" star in M31.

What We Found

We show a color-magnitude diagram of our M31 sample in figure 2. Many of the stars of intermediate colors are due to foreground stars in our own Galaxy, as indicated. The "good stuff" can be found at either extreme of color.

How can we separate foreground stars from bona-fide M31 members? Here we demonstrate why we needed "real" photometry. Although Galactic foreground red dwarfs will be found at the same apparent magnitudes as the M31 red supergiants, we can distinguish between them by using a two-color diagram, as shown in figure 3. At a given V-R color, a red supergiant will have a redder B-V, due to the effects of metal-line blanketing in the B-band at low surface gravities.

Using Hydra on WIYN, we began to sample the brightest interesting stars this year. More detailed studies will require larger apertures, but there is much work that can be done even among the brightest stars in our neighboring galaxies, once we know which stars are foreground contaminants and which belong to the M31 stellar population. In figure 4 we show the spectrum of a newly discovered "P Cygni" star in M31. Such objects are also known as "Luminous Blue Variables," and are among the intrinsically most luminous and interesting objects in these systems.

Where Do We Go from Here?

Our publications will include analysis of the UBVRI photometry from all the galaxies in our sample, and we will use the emission-line images to identify interesting sources. Perhaps we will have found the next "SS433" by next year.

The premise of the NOAO Survey program is that it should open doors for others' research as well as our own. As our catalogs are published, others can utilize the fruits of these labors. Enjoy!

REU Student Science Part 1:

Angular Momentum in NGC 6611

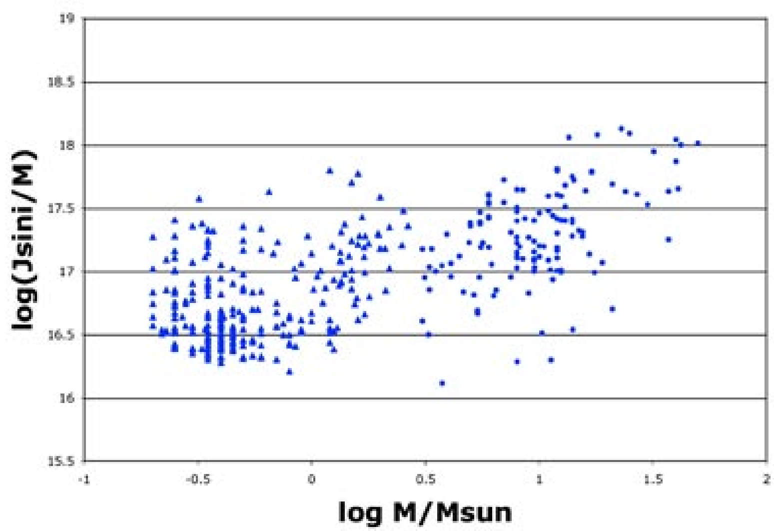
Lauranne Lanz (University of Maryland at College Park) &
Sidney Wolff and Stephen Strom (NOAO)

Stellar angular momentum may provide insight into formation mechanisms for high-mass stars. A recent paper by Bally and Zinnecker summarizes two possible formation scenarios: accretion through a circumstellar disk (the mechanism by which solar-mass stars form), and the merger of proto-stellar objects. If high-mass stars are formed through mergers, we would expect a break in the relationship between angular momentum and mass at the mass where mergers begin to dominate the formation process.

Specifically, we expect the angular momentum of massive stars formed through mergers to be higher than their lower-mass brethren, since for mergers, the large orbital angular momentum of the pre-merger stars is transformed into rotational angular momentum. The goal of my project in the Kitt Peak 2005 Research Experiences for Undergraduates (REU) program was to use observed rotational velocities for a large sample of massive and intermediate mass stars to derive angular momenta and determine whether a break in the angular momentum/mass relationship exists.

Our sample comprised 44 O and B stars in the young (t~1 Myr) cluster NGC 6611. Spectra with resolving power R~30,000 and spanning the wavelength region 4,400–4,600 Angstroms were obtained with the WIYN 3.5-m telescope and the Hydra multi-object spectrograph. Our sample included stars ranging in mass from 5 to 50 solar masses. Rotational velocities were obtained for each star from measurements of He I line profiles. Stellar masses, radii, and moments of inertia were derived from the location of each star in the H-R diagram, along with published models. Together, these quantities allow the plotting of angular momentum per unit mass against mass for the sample.

Examination of this plot reveals no evidence of a break in angular momentum vs. mass over the range 5 to 50 solar masses. Moreover, the angular momentum vs. mass relationship derived for the NGC 6611 sample appears to merge smoothly with the relationship for stars having a mass between 0.1 and 3 solar masses derived for young, lower-mass stars in other star-forming regions. This suggests a common mechanism for establishing initial stellar angular momenta over nearly a factor of 500 in mass, and further, suggests a limited role for mergers in the formation of massive stars.



Specific angular momentum for our sample plotted against stellar mass. The absence of a break in the distribution suggests that a common mechanism is responsible for establishing the initial angular momenta of stars over a wide range in mass.

REU Student Science Part 2:

Searching for Long-Period Cepheids in NGC 4258 with GMOS on Gemini North

Caitlyn Smith (Indiana University) & Lucas Macri (NOAO)

The spiral galaxy NGC 4258 is an object of paramount importance for the extragalactic distance scale because it is the only galaxy in the Local Supercluster with a very accurate and precise geometric distance: D=7.2±0.5 Mpc (Herrnstein et al. 1999). The distance is determined through VLBI observations of the proper motion and acceleration of masers located in a nearly edge-on, warped accretion disk that undergoes Keplerian rotation around the central super-massive black hole of the galaxy. Humphreys et al. (2006, in preparation) are currently analyzing additional VLBI observations that will reduce the total uncertainty in the distance to < 3%.

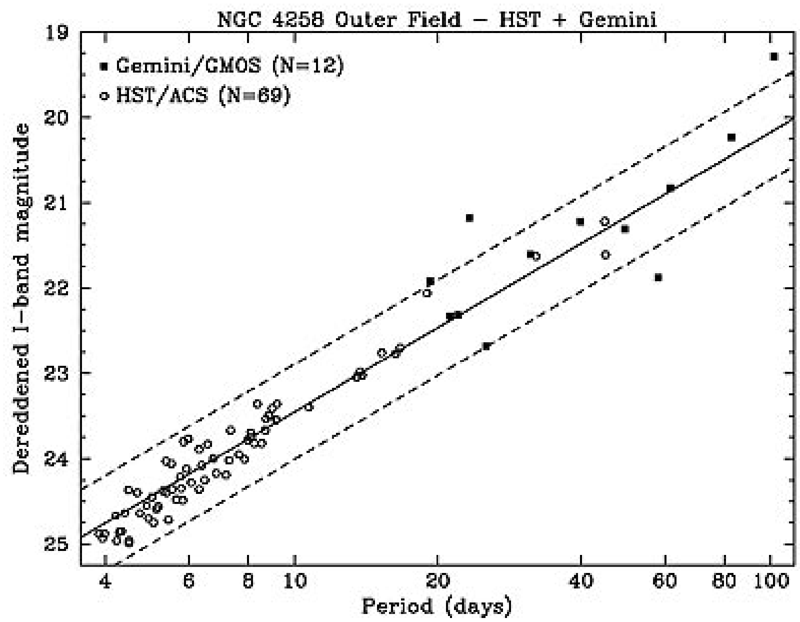


Figure 1: Preliminary Wesenheit P-L relation of Cepheids in an outer field of NGC 4258. Open symbols represent Cepheids detected with HST+ACS; filled symbols represent Cepheids detected with Gemini North +GMOS and transformed to the HST magnitude system. The solid line is the slope of the Wesenheit P-L relation of LMC Cepheids (Udalski et al. 1999) and the dashed lines represent the 1-σ scatter of the Gemini data.

The extragalactic distance scale currently relies on a calibration of the Cepheid Period-Luminosity (P-L) Relation, both in terms of absolute zero-point and slope, based on observations of variables in the Large Magellanic Cloud (LMC). Unfortunately, different methods of determining the distance to the LMC yield widely different results that are inconsistent with each other given the quoted uncertainties. Faced with this situation, most studies adopt a distance modulus of 18.5±0.1 mag for the LMC (see Freedman et al. 2000 and references therein). The maser distance to NGC 4258 provides a crucial opportunity for an entirely independent absolute calibration of the extragalactic distance scale with a significant reduction in the total error budget of the Hubble constant.

To take advantage of this opportunity, the Advanced Camera for Surveys (ACS) on the Hubble Space Telescope carried out synoptic observations of two fields in NGC 4258 over a 45-day window (limited due to spacecraft constraints). The two fields were chosen to yield samples of approximately solar-metallicity and LMC-metallicity Cepheids, with δZ~0.4 dex. A differential study of the two samples will yield a measurement of the so-called "metallicity dependence" of the Cepheid P-L relation, in a manner similar to the differential study of M101 Cepheids carried out by Kennicutt et al. (1998). The lower abundance sample will be used to test the validity of the adopted LMC distance described above, while the higher abundance sample will be used to create new fiducial P-L relations that can be applied to other Cepheids discovered with HST (since their typical abundance is near solar).

The ACS observations yielded several hundred Cepheids (Macri et al. 2006, in preparation), most of which have periods below 10 days. This is an expected consequence of the limited observing window available for the survey, and the relative paucity of high-mass stars that become long-period Cepheids, coupled with their accelerated crossing of the instability strip. A larger sample of long-period Cepheids

continued

Searching for long-period Cephids in NGC 4258 continued

is desirable for several reasons. Most existing samples of HST Cepheids (observed with WFPC2 at distances of 10-15 Mpc) cover the period range between 15 and 70 days, and the new fiducial solar-metallicity relation arising from the observations of NGC 4258 should cover the same range. Furthermore, the P-L relation of LMC Cepheids is known to exhibit a change in slope around P=10 days (Kanbur et al. 2003), and it would be interesting to corroborate this effect in other galaxies, as it would have profound implications for the distance scale.

The Gemini North telescope was the ideal choice for a synoptic survey of long-period Cepheids in NGC 4258 (δ=+47°), given its queue-schedule operation, superb image quality, large collecting area, and instrumentation. We used GMOS, which has a FOV approximately three times larger than HST+ACS. Fifteen epochs were awarded for 2004A, but only three were obtained due to the dismal winter experienced on Mauna Kea that year. Thanks to the recently-instituted "carry-over" policy for Band 1 programs, an additional seven epochs were obtained during 2005A. In accordance with our specified queue requirements, observations were carried out under dark photometric conditions and very good seeing (0.4-0.6").

As part of the NOAO/KPNO 2005 Summer Research Experiences for Undergraduates program, Caitlyn Smith of Indiana University carried out a complete analysis of the entire Gemini data set. She performed the basic data reduction using the Gemini IRAF package and obtained PSF photometry using the DAOPHOT and ALLFRAME packages (Stetson 1994). Then Caitlyn searched for variable stars, identifying the Cepheids among them using several programs developed by Stetson and the DIRECT project. Finally, she placed the mean magnitudes of the Cepheids in the ACS photometric system using transformations derived from constant bright stars spanning a large color range that were present in both our Gemini and HST fields.

Figure 1 shows a preliminary Wesenheit P-L relation for the Cepheids in the outer field of NGC 4258, with near LMC-metallicity. It combines the Cepheids from HST (open symbols) and Gemini (filled symbols). The inner field has also yielded several long-period Cepheids. Parallel analysis of the Gemini data is under way using the difference-image technique, which is expected to substantially increase the sample of variables in both fields (especially the inner field where crowding and blending are more pronounced). The area covered by both Gemini and HST in each field will be used to determine the overall efficiency of the difference-image technique in recovering variables not detected by "traditional" PSF photometry of ground-based data, since the superior image quality of the HST data provides the best spatial resolution in these fields. This analysis will be useful for future Cepheid searches in the post-HST era.

Seismic Imaging of Active Region AR-10808

Irene González Hernández & the GONG Farside Team

Until recently, the ever-changing magnetic activity on the solar surface could only be studied when the activity was on the side of the Sun facing the Earth. Helioseismic holography, developed by Lindsey and Braun, made it possible to map the magnetic regions on the *farside* of the Sun. Since its first application in 2000 to SOHO/MDI data, the method has proven to be capable of locating large regions of magnetic activity on the farside and tracking them before they emerge to face the Earth.

The phase-sensitive holography technique is based on the fact that acoustic noise that begins on the near side of the Sun travels through the solar interior and reflects off the far surface. The result is a sort of echo that arrives back to the near surface about seven hours later. Where there is an active region on the far surface, the echo arrives back a few seconds earlier. Phase sensitive holography uses Dopplergrams of the near side of the Sun, obtained by NSO's Global Oscillation Network Group (GONG) instruments, to map the echo times over the far hemisphere.

GONG is routinely calculating farside maps of the Sun using the helioseismic holography technique. Each map, updated and displayed every twelve hours, uses a 24-hour-period of near-real-time images sent to Tucson from GONG's six worldwide network stations. The latest farside maps, along with archived maps, a movie and links of interest, are at: *gong.nso.edu/data/farside/*.

Figure 1 shows four farside maps of the Sun, from 30 August to 9 September 2005, as they track active region AR 10808. The farside maps extend 45° from the center of the non-visible disk at each time. They are projected onto a longitude-sine (latitude) grid with the equator and meridians 60° apart

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Seismic Imaging of Active Region AR-10808 continued

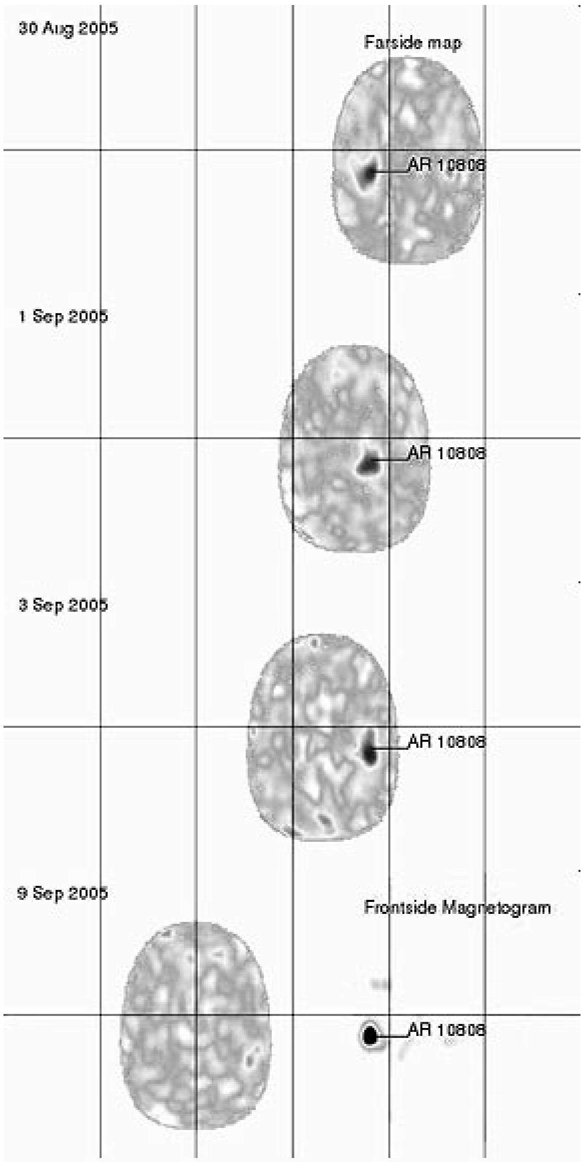


Figure 1: GONG farside maps of the Sun, from 30 August to 9 September 2005, tracking the evolution of active region AR 10808. In the lower section of the figure, a farside image shows a now-quiet backside Sun as compared to the adjacent image of the simultaneous frontside of the Sun, obtained from GONG magnetograms, which shows AR 10808 near the limb on 9 September 2005.

denoted by the grid lines. In the lower section of the figure, a farside image devoid of activity is compared to the adjacent image of the simultaneous front side image from GONG magnetograms with AR-10808, near the limb, on 9 September 2005. AR 10808 appeared at the East limb on September 7 and produced a huge X-17 flare, captured by the Solar X-ray Imager onboard the Geostationary Operations Environmental Satellite (GOES) (see figure 2). It was the fifth most intense solar flare on record, and the position of the active region dramatically coincides with the predicted migration of the sunspot from the farside onto the front side.

Cooperative synoptic seismic imaging of the farside of the Sun using GONG and the Michelson Doppler Imager (MDI) instrument onboard SOHO will facilitate space weather forecasting. Our goal for the near future is to generate full-hemisphere farside images, as well as imaging of the solar poles.

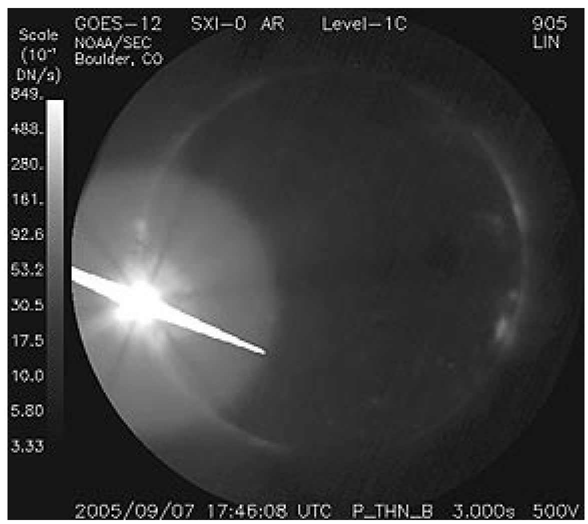


Figure 2: The Solar X-ray Imager onboard the GOES satellite captured the huge X-17 flare produced by AR-10808 on 7 September 2005, dramatically coinciding with the appearance of the sunspot as shown in the farside maps from the previous days. (The flare image is from the Virtual Solar Observatory, cart ID: VSO-NSO-051017-068).

NSF Funding for Decadal Survey Initiatives

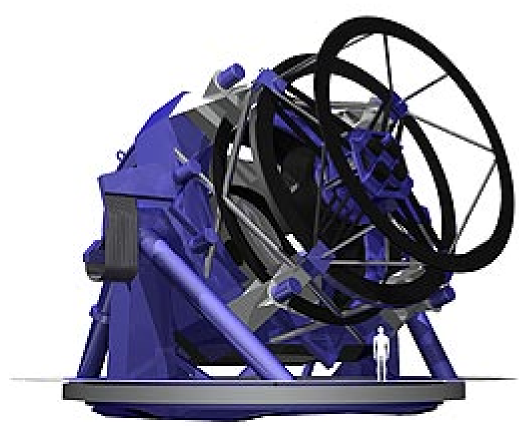
Jeremy Mould

In the lexicon of bureaucratese often used by NSF to demonstrate a responsible funding relationship with researchers, there are few terms as uninspiring as Scientific Program Order (SPO). Despite the term, NOAO was delighted to be awarded both SPO9 and SPO10 in the waning months of Fiscal Year 2005, as supplements to our NSF Cooperative Agreement. These SPOs provide for the design and development of the Large Synoptic Survey Telescope (LSST) and the Giant Segmented Mirror Telescope (GSMT), respectively. We have been working since 2001, near the end of the last five-year Cooperative Agreement governing NOAO operations, to reach this milestone in the implementation of the most recent decadal survey.

This measure of success has come because NOAO and the community have worked together to propose a plausible development program for these extraordinary powerful and diverse facilities of the future. The Science Working Groups played major roles in community consultation on these projects. Even more importantly, institutional initiatives were able to kick start both projects well in advance of FY05's direct NSF funding, and NOAO was able to support those initiatives from the get-go with our core program plan resources.

LSST Corporation, which continues to add new members, wrote the proposal to NSF for the design and development phase (DDP, to use the Major Research Equipment & Facilities Committee acronym). Since the Corporation is in its infancy, NSF awarded the full first year's funds to NOAO. AURA has duly made a sub award to the Corporation of its share of those funds, which will be further sub-awarded to eight university members, who are responsible for designing the data management and calibration systems. A proposal to construct and operate LSST will be submitted to NSF at the end of 2006. A proposal to build the LSST camera will be submitted to the Department of Energy prior to that.

Following the review of a proposal by the New Initiatives Office based at NOAO, AURA has also received FY05 DDP funds for GSMT, and FY06 funds are foreshadowed in SPO10. In the current very dry funding climate, these awards are far below the requested level. The current NSF Senior Review is slated to remedy this matter. Because there is more than one robust GSMT design and development program, AURA will divide these funds between the Thirty Meter Telescope (TMT) project and another Extremely Large Telescope project. AURA has made a solicitation to the Giant Magellan Telescope to provide the relevant Statement of Work for its DDP. If the designs of both projects prosper and mature, the Optical/Infrared (O/IR) Long Range Planning Committee expects both to submit construction and operations proposals to the NSF Astronomy division in 2008. One would emerge to proceed to the MREFC for funding.



The Large Synoptic Survey Telescope (LSST).

A third initiative in which NOAO is playing a role is the National Virtual Observatory. While the five-year grant for "building the framework" enters its ultimate year, attention has turned to both using the framework and operating the entire system. An Announcement of Opportunity from the NSF for proposals to operate the NVO is anticipated within the next few weeks. The funding would be provided jointly by the NSF and NASA. On the content side, NOAO's Data Products Program has been working hard to incorporate the public component of ground-based O/IR data into a form that will make it a part of the NVO. Look for the system to debut in mid 2006.

In the GSMT and LSST cases, we see actual or intended public-private partnerships emerging to realize the two major ground-based O/IR decadal survey projects. This is very much as the decadal survey intended, based on the proven ground-based O/IR philanthropic heritage, and recognizes a present scarcity of public funds not anticipated by the decadal survey. In the case of NVO, we see agencies working together to create a resource for the community that only makes sense as a joint venture.

With the appearance of these SPOs, and with the Telescope System Instrumentation Program (TSIP) commencing its fifth year, NOAO enters the NSF Senior Review of astronomical facilities with a feeling of accomplishment, and in a spirit of optimism that SPO10 for GSMT will receive the needed resources in just a year or two.

TMT Week

Stephen Strom

Nearly 90 scientists and engineers, drawn from within the Thirty Meter Telescope (TMT) partnership and the broader astronomical community met in Aspen, Colorado, from September 27-30 to assess progress toward achieving the highest priority ground-based goal articulated by the most recent decadal survey: designing a Giant Segmented Mirror Telescope by the middle of this decade, so that construction can begin prior to 2010.

Led by Project Manager Gary Sanders, "TMT Week" participants presented a series of technical status reports on the TMT baseline design, telescope controls and software, site evaluation, adaptive optics (AO) systems, instrumentation design, and operations models. One highlight of the meeting was a simulation of the performance of the first-light AO module, which will deliver high-Strehl images to multiple instruments over a 10-arcsecond field of view at wavelengths longer than one micron.

Another impressive session covered design concepts for the six instruments proposed for the first decade of TMT operations: a 20-arcminute field of view, seeing-limited, kilo-slit optical spectrograph; a diffraction-limited imager/spectrograph for the 1—5 micron region; a deployable integral field unit near-infrared (IR) spectrograph; a seeing-limited, high-resolution optical spectrograph; a high-resolution mid-IR spectrograph; and, a high-performance imager enabling diffraction-limited observations of ultra-high contrast scenes.

Of particular note was broad participation by the US and Canadian communities in developing and advancing these instrument concepts. The importance of engaging the best minds in the community was perhaps best illustrated by the highly creative alternative approach to developing the High Resolution Optical Spectrograph presented by a team from the University of Colorado, who bring extensive experience in designing and building space-based instrumentation.

The TMT project is committed to open participation by the community in developing instrumentation and key subsystem concepts, and to input aimed at ensuring that the planned observatory continues to meet community aspirations as expressed in the decadal survey.

The current schedule for TMT envisions a conceptual design review in May 2006 and a full-cost review in early fall 2006. By keeping to this schedule, the unique public-private TMT partnership anticipates being able to prepare a proposal for funding soon ther eafter in order to begin construction in 2009.

Thirty Meter Telescope Project Manager Gary Sanders addresses team members at TMT Week.

NOAO's roles in the project include participating in the TMT Science Advisory Committee and ensuring additional community representation on it. This key committee is responsible for producing and updating the Science Requirements Document, which informs all design decisions for the telescope. NOAO is also providing major support for ongoing TMT site evaluation, particularly for candidate sites in Northern Chile; developing a design concept for the mid-IR, high-resolution spectrograph in collaboration with scientists and engineers from the universities of Hawaii, Texas, and California at Davis; producing design concepts for the secondary and tertiary mirror support systems; and, supporting development of the Observatory Requirements Documents and operations models for TMT.

The staff of NOAO and its New Initiatives Office (NIO) are eager to interact further with the community regarding TMT and are ready to meet with colleagues throughout the community to describe the potential capabilities of a 30-meter class telescope, proposed operations models, and improved mechanisms for community participation. Requests for colloquia and other talks about TMT will be welcomed by the NIO. Please contact me (*sstrom@noao.edu*), or Larry Daggert (*ldaggert@noao.edu*) about any of these issues.

Q&A

Jennifer Lotz
NOAO Goldberg Fellow 2005

Jennifer Lotz graduated cum laude with honors in Physics and Astronomy from Bryn Mawr College in 1996. She continued her studies at Johns Hopkins University, where she obtained her M. A. in 1999, and her Ph.D. in 2003 in Astrophysics. Her doctoral thesis, "The History of the Evolution of Dwarf Galaxies," aimed at tracing the evolution of dwarf galaxies in field and cluster environments over the past 10 billion years, supervised by Henry Ferguson (STScI).

Following graduation, Jennifer worked as a post-doctoral fellow at the University of California, Santa Cruz, where she collaborated with the theory group on morphologies of merging galaxies. Her goal was to tie the spatial distribution of stars to the formation history of the galaxy. Galaxy morphology is a very accessible tracer of how light is organized in galaxies, and is an ideal way to study their contents to infer their formation history. In addition, she is seeking to gain insight on galaxy evolution by studying the role of galaxy mergers using new statistical methods.

Jennifer plans to pursue these scientific questions as the newest five-year NOAO Goldberg Fellow. She arrived in Tucson in early October 2005.

Q. What is the focus of your current research?
My work involves trying to understand the importance of mergers in galaxy evolution. We live in a Universe dominated by cold dark matter, and we know that galaxies grow by merging. It is still unclear when most of that merging took place, and just how important mergers are for building up stars and giving galaxies the general morphology that we see.

I have developed a new statistical technique for identifying mergers out to a high redshift, which allows us directly to observe the importance of merging in shaping galaxies as a function of time.

I am also continuing to work with theorists, such as Joel Primack of UC Santa Cruz and T.J. Cox of Harvard, who are trying to model galaxy mergers. My role is to take their simulations and analyze them just as I would telescope data, and to use the results to calibrate the morphologies and star formation indicators produced by observational data. On the data side, I have been working with the GOODS and DEEP teams to track mergers in deep Hubble Space Telescope images.

I still do some work in dwarf galaxies. My focus there has been on globular cluster populations, which are a good tracer of intense episodes of star formation. They also give us a good handle on when their oldest stars formed.

We found that the properties of globular clusters in dwarf ellipticals are similar to metal-poor globulars in giant galaxies, but their formation histories are definitely tied to the host galaxies. That finding rules out pre-galactic formation models for globulars. They are significantly more metal poor than the surrounding field stars, which implies that they formed in a very early burst, before the majority of stars in those dwarf galaxies.

Q. Why did you pursue a postdoc at NOAO? What was attractive about coming here?
The main thing I will work on at NOAO is seeing how the spatial morphology coordinates with the kinematical structures of galaxies. Integral field units like the ones on Gemini and WIYN have some interesting possibilities for this.

Tucson is a great place for astronomy – there are so many people here [at NOAO and the University of Arizona], and many others come through town. This is very appealing as a young astronomer. It was clear that NOAO in particular is really making an effort to attract postdocs and young researchers, and the five-year term of the fellowship was difficult to pass up! It is an excellent opportunity to focus on research and get some real science done, away from other pressures like job hunting. NOAO's involvement in the Thirty Meter Telescope project also was an attraction – I see that as the future of my career

Q. How could observations with the TMT help with your research interests?
A lot of the action in galaxy mergers is happening at very high redshift. Even with the Hubble Space Telescope, you are really pushing the edge of what you can do with morphologies. With the TMT, you could really begin to see

continued

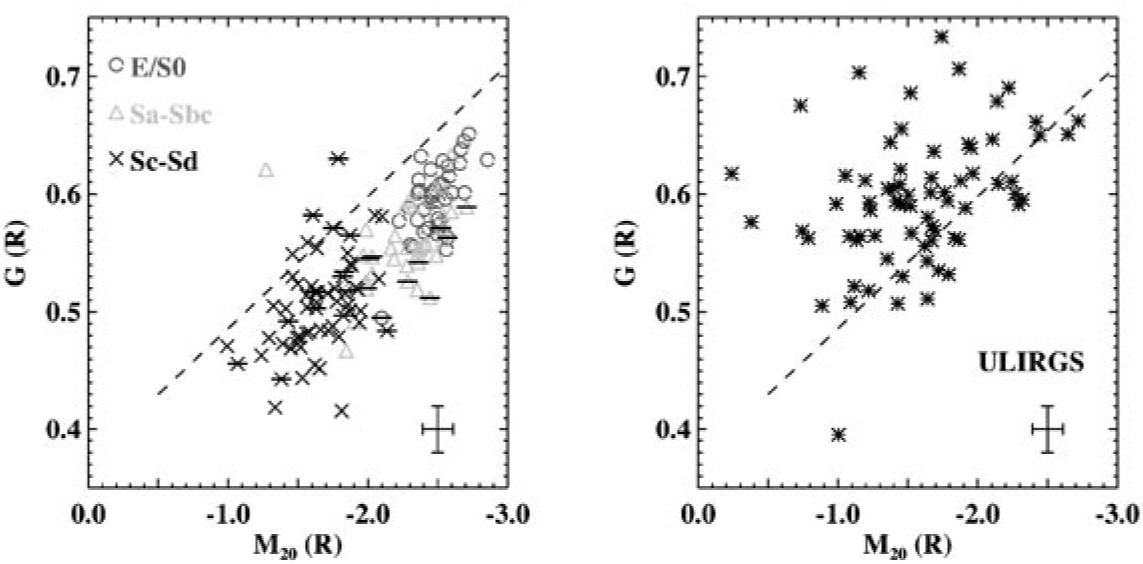
Q&A continued

what happens with the very first objects, in terms of coming together to make the first real galaxies.

Five or ten years ago, few cosmologically motivated models would have predicted we would find that old, red galaxies already exist at high redshift. The picture is more complicated – just because you see something that appears relaxed, and has old stars in it at high redshift; this does not mean that it is static. It may just be a phase that is passing through, and will accrete something later. It may not look so static and "dead" when you look at it a billion years later.

The common wisdom is that mergers dominate star formation in the last 10 billion years (at redshifts less than one), but as we are getting better data with Spitzer and getting better at identifying galaxy mergers, this assertion does not seem to be holding up. The galaxies that dominate star formation in this epoch appear to be fairly normal spiral galaxies, so people are starting to think that the real action is taking place at redshifts higher than one.

Q. How do you find life here in Tucson?
I have only been here a few weeks, but it is has been great so far. I grew up on the East Coast, and I was worried that there would be no trees and no green plants, but that is not the case. I love being surrounded by the mountains – I just bought my first mountain bike so I can try that out. Everyone has been really friendly and supportive.



Jennifer Lotz has developed a new way to quantify galaxy morphology and identify merging systems using the Gini coefficient, which is a measure of the relative distribution of galaxy pixel flux values and the second-order moment of the brightest 20 percent of a galaxy's light (M20). Local galaxies of normal Hubble type (ellipticals and spirals) lie on a well defined sequence in G-M20 (left). Morphologically disturbed galaxies such as ultra-luminous infrared galaxies lie above this sequence in G-M20 (right). (From Lotz, Primack & Madau 2004, AJ, 613, 262).

NIFS and Gemini North Adaptive Optics in 2006A

Robert Blum

A good deal of activity is taking place at Gemini North in 2006A to enhance existing adaptive optics (AO) facilities and to deploy new ones, including instruments that depend critically on the corrected wavefront to achieve their scientific goals.

The Near-infrared Integral Field Spectrograph (NIFS), built by the Research School for Astronomy and Astrophysics at the Australian National University (ANU), is being commissioned on Mauna Kea in 2005B. NIFS was almost completely destroyed in the tragic wildfire that swept over Mount Stromlo in January 2003. Having risen literally from the ashes to be rebuilt by the Australian aerospace firm AUSPACE, NIFS is now mounted on the Frederick C. Gillett Gemini North telescope and undergoing on-sky commissioning. Figure 1 shows an image of the NIFS cryostat and associated electronics cabinets.

Figure 1. NIFS mounted on the up-looking port of the Gemini North telescope. The hexagonal cryostat is a copy of the NIRI design. The electronics for instrument control, the detector, and the on-instrument wavefront sensor are deployed in the two blue environmental cabinets mounted with the cryostat. The Altair facility adaptive optics system is mounted on a side port above NIFS (Photo credit: Peter McGregor and Gemini).

At the same time, Gemini has been installing and testing the Altair facility AO Laser Guide Star (LGS) system, as well as optically reconfiguring Altair to improve its off-axis performance. Earlier in 2005, a 14-Watt solid-state laser, beam transfer optics, and a launch telescope were installed at Gemini North. The system produces a bright laser "star" by exciting the atmospheric sodium layer at an altitude of 90 kilometers and has achieved first laser light. The technical staff at Gemini North has been commissioning the laser to integrate it fully with Altair and the telescope. While the initial results and performance are looking good, there is an issue with the launch telescope that should be resolved by early 2006A. At that time, it is hoped that the laser system and NIRI (the facility infrared imager) will be offered to the community for System Verification observations.

Independent of the laser, a new field lens was adapted to Altair to reconjugate its deformable mirror to the ground from the original design altitude of 6.5 kilometers. This change dramatically improves the off-axis performance of Altair by decreasing the effects of anisoplanatism across the corrected field (in most atmospheric turbulence conditions). Prior to the fix, the off-axis Strehl ratio dropped precipitously at distances of ~5 arcseconds (arcsec) from the natural guide star.

With the new field lens, the areal coverage of good image quality is increased by a factor of as much as 20 to 30. The Strehl reduction at 10 arcsec from the guide star may be reduced to a loss of only ~10 percent from 45 percent or more previously. The field lens currently deployed is temporary and is not anti-reflection coated, resulting in an 8 percent loss of throughput. The permanent version will be coated. With this current limitation, on-axis programs (with roughly 5 arcsec or less distance between the guide star and target) may choose not to use it. The lens may be moved in or out of the beam, and users can specify which mode they prefer in the Phase II observing plan. The field lens is offered with Altair in 2006A. Interested users should visit the Gemini Altair pages for more information.

The addition of an LGS system and improvements to Altair are good news for NIFS. The integral field spectrograph was designed to take advantage of a near diffraction-limited point spread function (PSF) from the 8-meter Gemini telescope. NIFS is a fully cryogenic near-infrared spectrograph. It will deliver a spectral resolution of 5,300 (two-pixel sample) and the full J, H, or K band in each image. Its real strength, however, is in spatially sampling the spectrum over a 3 arcsec × 3 arcsec field of view. NIFS produces a 3-D spatial-spectral data cube by slicing up the input field into 29 0.1-arcsec slitlets, each of length 3 arcsec. The spatial dimension of each slitlet is sampled at approximately 0.04 arcsec per pixel. The optics reformat the 29 slits into a long "staircase" slit, which is passed to a conventional spectrograph. The

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NIFS and Gemini North Adaptive Optics in 2006A continued

spectra corresponding to the different 0.1-arcsec × 3-arcsec slitlets are imaged onto a 2048 × 2048 Rockwell HAWAII-2RG HgCdTe detector.

As of this writing, NIFS has been mounted on the up-looking port at Gemini North, with first light achieved on October 18. On-sky commissioning of the instrument has begun, and it will be fully integrated into the Gemini observing system. Standard observing sequences are developed with the Observing Tool (OT) and then executed through the seqexecutor like other Gemini facility instruments. IRAF data reduction tools tailored for NIFS and IFU images exist and are in use to reduce the commissioning data. The reduction tools will be available to the community as part of the Gemini IRAF package.

The author gratefully acknowledges the input of Peter McGregor and Tracy Beck in the writing of this article.

TEXES Arrives at Gemini in 2006

Dan Jaffe & John Lacy (University of Texas)

One strong recommendation coming out of Gemini's 2003 "Aspen" future instrumentation process was for Gemini to develop a capability for high-resolution, mid-infrared (IR) spectroscopy. Gemini North will offer a new and unique capability to the user community, beginning in 2006B, in response to the recommendation: R=100,000 spectroscopy at 5–25 microns. The University of Texas group has modified TEXES, the Texas Echelon Cross-Echelle Spectrograph (Lacy et al., 2002, PASP, 114, 153) for use at Gemini in order to make this capability available. TEXES has been in regular use at the NASA Infrared Telescope Facility (IRTF) on Mauna Kea since fall 2000, and will be shared between the IRTF and Gemini.

The high background at mid-infrared wavelengths means that ground-based spectrometers are still limited by background noise, even with very large resolving powers. Greater resolving power is then an advantage when lines are narrow, where the line-to-continuum ratio is low, or where the line shapes contain astrophysically useful information. The Aspen Report lists some of the many areas where high-resolution spectroscopy in the mid-IR can help solve important astronomical problems. The following examples of science results from TEXES at the IRTF illustrate areas where the community can reap substantial scientific benefit from the superior spatial and spectral resolution of Gemini/TEXES, as well as the better sensitivity that Gemini will provide.

Protostellar Disks: The pure rotational lines of H_2, of which the S(1), S(2), and S(4) lines at 17.0, 12.3, and 8.0 microns are regularly accessible from Mauna Kea, should be good probes of the anthropically interesting region of protoplanetary disks at a radius of 1-10 Astronomical Units (AU). These

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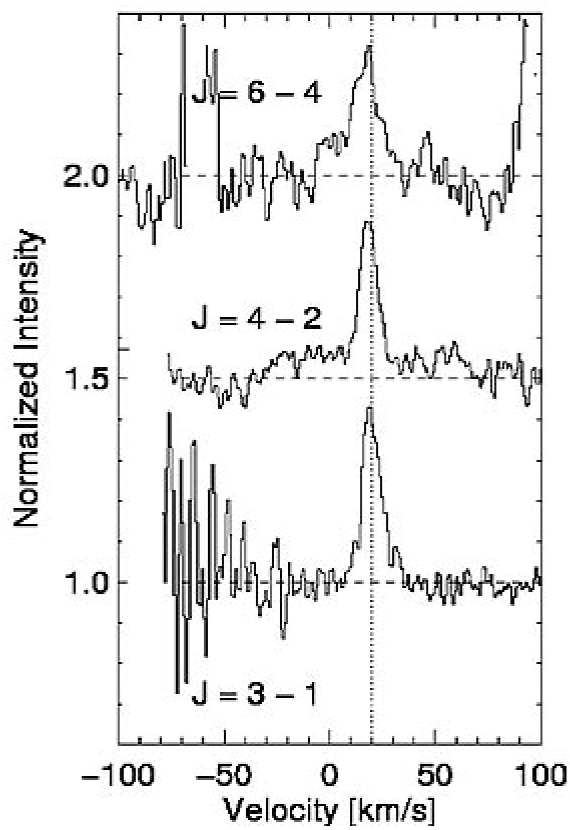

Figure 1: Observations of H_2 ground-state rotational transitions toward T Tau (Richter et al. 2006). These observations were made with TEXES at the 3-meter NASA IRTF.

TEXES Arrives at Gemini in 2006 continued

transitions should be thermalized, optically thin, and adequately excited at temperatures found at these disk radii. Measurements of the intensities and Doppler profiles of the three lines can provide information about the temperature and distribution of the emitting gas. The superior sensitivity available at Gemini will make several hundred Young Stellar Objects (YSOs) available for study, including not only the optically thick sources like T Tau studied at the IRTF (figure 1), but also optically thin Class II and even Class III YSOs. Lines of other molecules may provide information about disk chemistry as well.

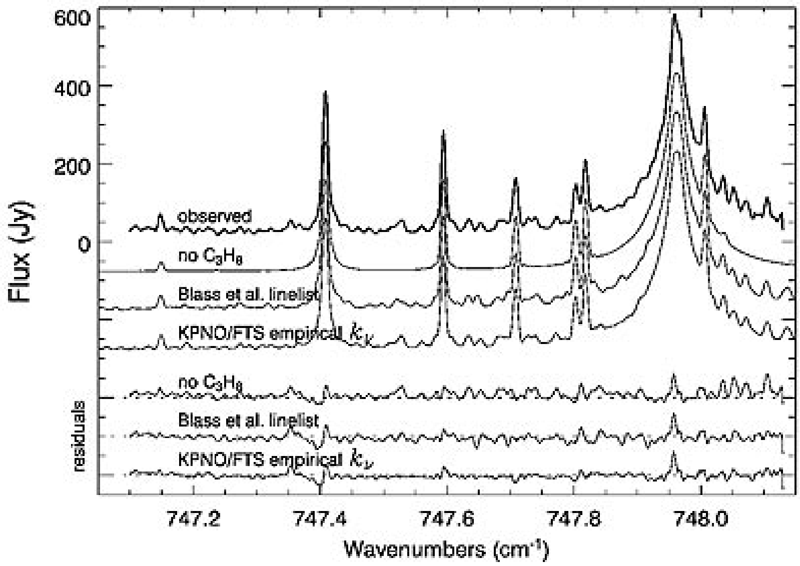

Figure 2: A section of Titan's 13-micron spectrum observed by TEXES. The strong emission features are due to C_2H_2 and HCN. These are modeled in the curve labeled "no C_3H_8". Propane (C_3H_8) contributes the many weak features, as demonstrated by the Blass et al. and KPNO/FTS fits. This observation was the first to unambiguously resolve propane features from other stratospheric emissions originating in the atmosphere of Titan. (From Roe et al. 2003, ApJ, 597, L65).

Outer Planets and Planetary Moons: Even on a 3-meter telescope, it has been possible to make some path-breaking observations of the outer planets and their moons. These observations include the detection of propane in Titan's atmosphere (Roe et al. 2003, figure 2); the detection of H_2O_2 in the atmosphere of Mars (Encrenaz et al. 2004); studies of the rotational quadrupole lines of H_2 toward Uranus (Trafton et al. 2003); and observations of SO_2 above volcanoes on Io (Spencer et al. 2002). Gemini will provide improved spatial resolution and better sensitivity for the smallest objects.

Ultra Compact HII Regions: Radio continuum and recombination line observations of ultra compact HII regions have not been able to resolve the puzzle of why, despite their small sizes and high internal pressures, these regions last as long as they appear to. Using TEXES to observe the 12.8 micron [NeII] line (Jaffe et al. 2003, Zhu et al. 2005), it has been possible to map the kinematics of several UCHII regions and to conclude that their gas motions are dominated by surface flows rather than expansion, at least alleviating the "lifetime problem."

Observing Opportunities: Gemini is still forming plans for the integration of TEXES into the observing schedule. We expect an engineering run to occur in February 2006, followed by a science verification run in summer 2006, and a longer science run in fall 2006. The opportunity to propose for both 2006 science runs will be announced in the Gemini 2006B Call for Proposals and/or via a special Demonstration Science or other call (that would be advertised on the Gemini and NGSC Web pages).

Observations with TEXES will be made in collaboration with one or more instrument team members. The TEXES team will provide complete support for users, including assistance in proposal preparation, operation of the instrument, pipeline data reduction, and collaboration in data interpretation.

For further information about proposing or observing with TEXES, contact John Lacy (*lacy@astro.as.utexas.edu*).

bHROS Update

Verne V. Smith

The High-Resolution Optical Spectrograph (bHROS) has now been commissioned and is available for use on Gemini South. The spectrograph underwent initial on-sky commissioning in July 2005 and began Demonstration Science observations in August 2005. bHROS is a fiber-fed, bench-mounted, cross-dispersed echelle spectrograph located in the pier of the Gemini South telescope.

bHROS is designed to operate at very high spectral resolution, R=150,000 with 3-pixel sampling. Of course, lower spectral resolution can be obtained by pixel binning. There are two observing modes: the first uses two 0.7-arcsecond-diameter fibers separated by 20 arcseconds to observe object and sky spectra simultaneously; the second uses one fiber for object only, with a fiber diameter of one arcsecond. Image slicers are employed to maximize throughput at high spectral resolution while maintaining a relatively compact instrument. As a result, the imaged echelle orders consist of adjacent bands from the slicer. The operational wavelength coverage is from approximately 400 nanometers to 1,000 nanometers. The detector is a 2048 × 4608 CCD with 13.5-micron pixels. Wavelength coverage is not complete. For a setting centered on H-alpha, seven or eight orders will fall on the CCD, with about 6.0 nanometers of spectral coverage from each order. A graphical observing tool on the Gemini Web site can be used for fine-tuning the grating angles to place the desired wavelengths on the CCD array.

The approximate sensitivity of bHROS is illustrated in figure 1. Currently, the limiting magnitude is set by detector read noise (5.3 electrons) and background within the instrument enclosure. Acquisition strategy for placing the target on the input fiber,

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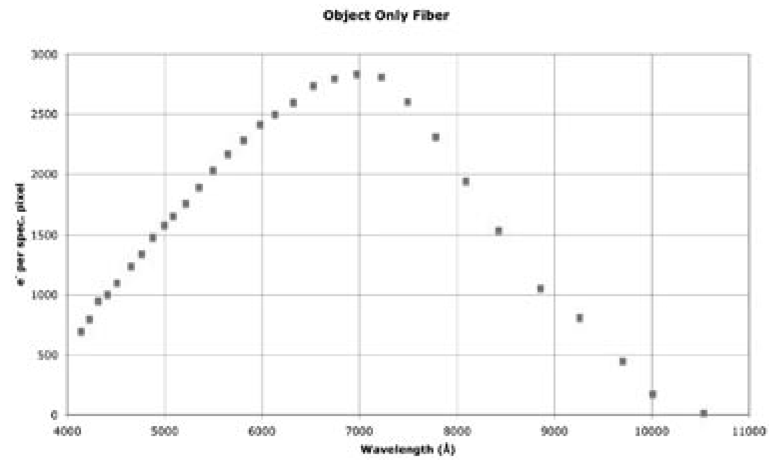

Figure 1: Electrons per pixel versus wavelength for a monochromatic magnitude 15 source, after a total integration time of 10,000 seconds at spectral resolution R=150,000.

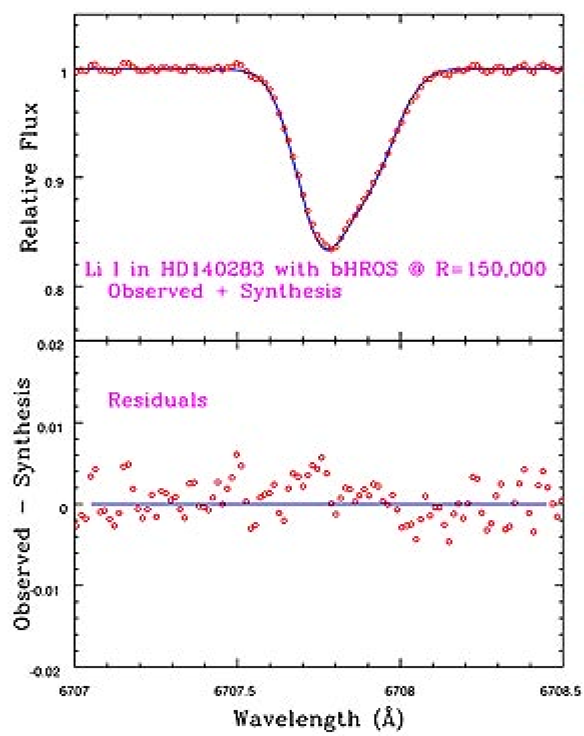

Figure 2: Demonstration science data for HD 140283 illustrating the Li I feature in this old, metal-poor halo star. Top panel: data (open symbols), synthetic fit (solid curve). Bottom panel: differences between observed and synthetic data (open symbols).

bHROS Update continued

critical for maximizing sensitivity, is evolving as well.

A Demonstration Science data sample is shown in figure 2. The illustrated section of spectrum is the 6707.8 Å neutral lithium line in the metal-poor halo subgiant HD140283 ([Fe/H] = -2.5). The data result from two 20-minute integrations and have an unsmoothed signal-to-noise ratio of about 1,000 at R=150,000. A demonstration of the quality of the spectrum is seen in the residuals (bottom panel) to the synthetic spectral fit (solid line). Spectra of this quality can be used to study the abundances of the stable lithium isotopes, Li-6 and Li-7, in stars and interstellar gas. Detection of the wavelength shift between Li-6 and Li-7, about 0.16 Å, requires very high resolution. In the case of HD140283, the synthetic fit contains no Li-6. A stringent upper limit to the fractional amount of Li-6 to total lithium content of the star can be set at about 1%.

For additional details on the status of bHROS or instrument specifics, see the Gemini Web site at *www.gemini.edu/sciops/instruments/hros/* or contact Verne Smith (*vsmith@noao.edu)*.

Electronic Distribution of Gemini Data

Tom Matheson

The Gemini Observatory has recently changed its mechanism for data distribution. In the past, the principal investigator (PI) had to wait patiently by the mailbox for CDs or DATs to be delivered. Data will now be available for electronic download from the Gemini Science Archive (*www2.cadc-ccda.hia-iha.nrc-cnrc.gc.ca/gsa*).

Use of the Gemini Science Archive (GSA) requires that a user account be established to download any data. User accounts are created by selecting '*Register*' on the GSA home page. The GSA uses this account information to contact you via e-mail when the data you request are ready for download. In addition to proprietary data, publicly available data and calibrations are also accessible through the GSA.

After data quality assessment, the data are transferred to the GSA. A weekly process generates a package of data for the PI. This includes the science data, calibrations, and any other relevant information, such as weather images and observing logs. An e-mail will notify the PI, as well as the National Gemini Office (NGO) and Gemini contact scientists, when the data are available in the GSA. Once the data are in the GSA, the PI may retrieve it at any time. Access to proprietary science data requires the Gemini program identification number as well as the Phase II program key.

The new observing classes that were implemented in the most recent release of the Gemini Observing Tool (OT) facilitate the association of calibration data with a particular science program. When designing a Phase II, be careful to assign each observation an observing class. This controls how time is charged for the program, as well as helping to ensure that calibrations are connected to the proper science observations. Observing class is set on the Observing Tool "Observing Sequence Component" page.

If a PI is unable to download the data from the GSA, it is still possible to request that it be shipped. The new formats for shipped data are DVDs or DATs. Such a request should be made through the Gemini Helpdesk (*helpdesk.gemini.edu*). This direct shipment will produce delays in receipt of the data, and possible complications if international shipping is required. Gemini Observatory and the NOAO Gemini Science Center strongly encourage PIs to use the electronic distribution system for all Gemini data.

More information may be found in the Gemini PI electronic data distribution announcement (*www.gemini.edu/sciops/data/PhaseII-GSA.html*).

NGSC Instrumentation Program Update

Taft Armandroff & Mark Trueblood

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

NICI

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

The NICI project is in its final assembly and testing phase. The most important NICI developments over the past three months relate to its adaptive optics (AO) system. A deformable mirror, fabricated by CILAS, was delivered to MKIR in late October. In addition, MKIR integrated the AO system's lenslet array with the AO electronics. The NICI AO interface software is complete and in testing. MKIR can now proceed with the remaining integration and testing of NICI's complete AO system.

As of the end of September, MKIR reports that 98 percent of the work to NICI final acceptance by Gemini has been completed.

FLAMINGOS-2

FLAMINGOS-2 is a near-infrared multi-object spectrograph and imager for the Gemini South telescope. FLAMINGOS-2 will cover a 6.1-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 FLAMINGOS-2 Team is continuing with the integration and testing phase of the project. Warm mechanism testing was successfully completed, with all mechanisms meeting specifications. Preliminary cryogenic testing also showed the mechanisms meeting specification at operating temperature. Florida completed acceptance testing of the FLAMINGOS-2 On-Instrument Wavefront Sensor (OIWFS), which was designed and built by the Herzberg Institute of Astrophysics (HIA). The OIWFS is being shipped from HIA to the University of Florida during the first week of November.

The FLAMINGOS-2 camera dewar optical bench, with Florida engineer Jeff Julian working. The dewar wiring is visible.

As of mid-October, Florida reports that 84 percent of the work to FLAMINGOS-2 final acceptance by Gemini has been completed. FLAMINGOS-2 pre-ship acceptance and shipment to Gemini South is anticipated around the middle of semester 2006A.

2006A Proposal Process Update

Dave Bell

NOAO received 485 observing proposals for telescope time during the 2006A observing semester. These included 185 proposals for Gemini, 136 for KPNO, 120 for CTIO, 36 for Keck, 19 for MMT, 15 for Magellan, and five for HET. Twenty-three of the Cerro Tololo proposals were processed on behalf of the Chilean National Time Allocation Committee (TAC), and ten of the Kitt Peak proposals were processed on behalf of the University of Maryland TAC. Thesis projects accounted for 22 percent (105 proposals) of those received. Thirteen proposals requested long-term status. Time-request statistics by telescope and instrument appear at the end of this section. Subscription rate statistics will be published in the March 2006 edition of the *NOAO/NSO Newsletter*.

Figures 1–3 show breakdowns of proposals by science category for the past five semesters. These types of science metrics are being used by Letizia Stanghellini to predict the scientific expertise needed in the NOAO TAC, and to plan recruitment of panel members. More details on this project will be presented in a future *Newsletter*.

As of this writing, proposals are being reviewed by members of the NOAO TAC (see the following listing). We expect all telescope schedules to be completed by 9 December 2005, and will notify PI's of the status of their requests at that time. Mailed information packets will follow e-mail notifications by about two weeks.

Looking ahead to 2006A, Web information and forms will be available online in February 2006. The March issue of the *Newsletter* will contain updated instrument and proposal information.

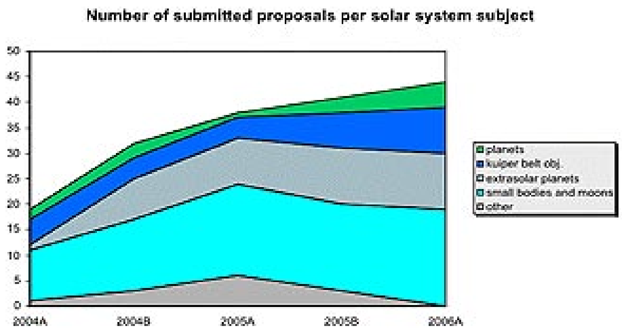

Figure 1: Solar System submissions have steadily increased, particularly in the "extrasolar planets" category.

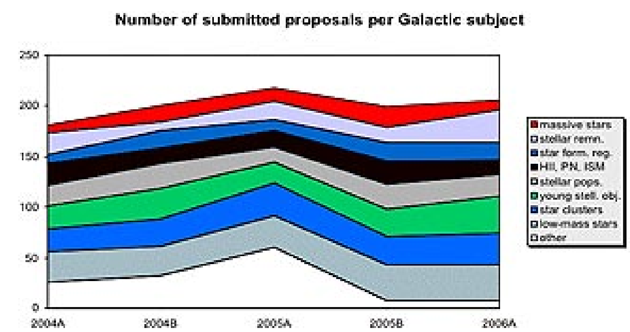

Figure 2: Galactic submissions have been reasonably steady. A notable exception in 2006A is the increased interest in science related to stellar remnants.

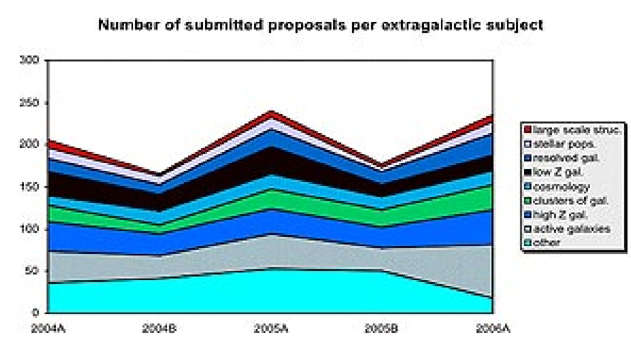

Figure 3: Extragalactic submissions show an (expected) semester variation though on average have been rather steady, both as a total and in each science category.

NOAO Survey Program to Resume, Letters of Intent due January 31

Tod Lauer

Proposals for the next round of the NOAO Survey Program are due 15 March 2006. Investigators interested in applying for time under the Survey Program MUST submit a letter of intent by 31 January 2006 (by e-mail to *surveys@noao.edu*), describing the broad scientific goals of the program, survey team membership, the telescopes and instruments to be requested, the approximate amount of time that will be requested, and the duration of the proposed survey.

Surveys are aimed at identification and study of complete, well-defined, samples of objects that can yield both conclusions based on analysis of the survey data itself, and important subsets for more detailed observations with larger telescopes. All survey teams are expected to work with the NOAO Science Archive project to ensure effective, timely community access to the survey data.

Up to 20 percent of the total telescope time at CTIO and KPNO may be awarded through the Survey Program, including time allocated in the earlier rounds to continuing programs. A portion of the available time at the KPNO 4-meter telescope will likely be reserved in anticipation of NEWFIRM, which will not be available for the 2006 round of the Survey Program, but which is expected to be a highly demanded instrument for future surveys.

A more detailed description of Survey Program requirements and guidelines is available at *www.noao.edu/gateway/surveys*. Proposals must be initiated using the NOAO Web proposal form at *www.noao.edu/noaoprop/noaoprop.html*, which will be available approximately 15 February 2006.

2006A Time Allocation Committee Members

Solar System (October 31, 2005)
Caitlin Griffith, Chair, University of Arizona-LPL
Anita Cochran, McDonald Observatory
Debra Fischer, San Francisco State University
Matthew Holman, Harvard-Smithsonian CfA
David Trilling, University of Arizona-Steward

Extragalactic (November 1-2, 2005)
Dave De Young, Chair, NOAO
John Mulchaey, Chair, Carnegie Observatories
Lisa Storrie-Lombardi, Chair, Spitzer Science Center
Stephane Courteau, Queen's University
Romeel Davé, University of Arizona-Steward
Ian Dell'Antonio, Brown University
Arjun Dey, NOAO
Megan Donahue, Michigan State University
John Feldmeier, NOAO
Harry Ferguson, Space Telescope Science Institute
Mauro Giavalisco, Space Telescope Science Institute
Brad Holden, University of California-Santa Cruz
Robert Knop, Vanderbilt University
Henry Lee, University of Minnesota
Tom Matheson, NOAO
Alice Shapley, Princeton University
Malcolm Smith, CTIO
Adam Stanford, University of California-Davis

Galactic (November 3-4, 2005)
Letizia Stanghellini, Chair, NOAO
Steve Strom, Chair, NOAO
Sidney Wolff, Chair, NOAO
Suchitra Balachandran, University of Maryland
Ed Guinan, Villanova University
Tom Harrison, New Mexico State University
Inese Ivans, Carnegie Observatories
Ray Jayawardhana, University of Toronto
Greg Laughlin, University of California-Santa Cruz
Kevin Luhman, Pennsylvania State University
Mario Mateo, Space Telescope Science Institute
John Monnier, University of Michigan
Nathan Smith, University of Colorado
Verne Smith, NOAO
Charlie Telesco, University of Florida
Nicole Van Der Bliek, CTIO
Eva Villaver, Space Telescope Science Institute
Lisa Young, New Mexico Tech

2006A Instrument Request Statistics by Telescope Standard Proposals

KPNO

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
KP-4m		**74**	**83**	**315.9**	**73.8**	**23**	**3.8**
	ECH	9	9	35.5	0	0	3.9
	FLMN	18	18	77	0	0	4.3
	FLMU	4	4	15	0	0	3.8
	IRMOS	2	2	7	0	0	3.5
	MARS	2	2	6	2	33	3
	MOSA	22	23	87	48.8	56	3.8
	RCSP	20	23	86	23	27	3.7
	SQIID	1	2	2.4	0	0	1.2
WIYN		**32**	**35**	**112**	**65.2**	**58**	**3.2**
	DSPK	2	2	10	5	50	5
	HYDR	13	15	44.5	16	36	3
	MIMO	11	12	32.5	24.2	75	2.7
	SPSPK	3	3	13	13	100	4.3
	VIS	2	2	9	4	44	4.5
	WTTM	1	1	3	3	100	3
KP-2.1m		**25**	**31**	**165.5**	**53**	**32**	**5.3**
	CFIM	8	9	42.5	17	40	4.7
	FLMN	3	3	15	7	47	5
	GCAM	10	10	51	29	57	5.1
	SQIID	5	6	29	0	0	4.8
	VIS	1	3	28	0	0	9.3
KP-0.9m		**8**	**10**	**49**	**43**	**88**	**4.9**
	MOSA	8	10	49	43	88	4.9

Gemini

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
GEM-N		**106**	**144**	**170.8**	**65.7**	**38**	**1.2**
	GMOSN	61	81	94.1	59.5	63	1.2
	Michelle	17	20	23.5	5.9	25	1.2
	NIRI	37	43	53.2	0.3	1	1.2

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
GEM-S		**94**	**106**	**165**	**30.1**	**18**	**1.6**
	AcqCam	3	3	3.1	1.8	58	1
	GMOSS	34	37	41.5	24.5	59	1.1
	GNIRS	23	23	39	0.8	2	1.7
	Phoenix	21	22	52.2	0	0	2.4
	TReCS	14	14	14.2	3	21	1
	bHROS	7	7	15	0	0	2.1

Cerro Tololo InterAmerican Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
CT-4m		**51**	**58**	**202.4**	**40.5**	**20**	**3.5**
	HYDRA	17	18	67	20	30	3.7
	ISPI	15	15	44.7	0	0	3
	MOSAIC	12	13	47.7	14.5	30	3.7
	RCSP	11	11	38	6	16	3.5
	VIS	1	1	5	0	0	5
SOAR		**14**	**14**	**35.2**	**10.4**	**30**	**2.5**
	Goodman	4	4	15	5	33	3.8
	OSIRIS	5	5	13.6	0	0	2.7
	SOI	4	4	5.9	5.4	92	1.5
	VIS	1	1	0.8	0	0	0.8
CT-1.5m		**8**	**9**	**39**	**4**	**10**	**4.3**
	CSPEC	8	9	39	4	10	4.3
CT-1.3m		**20**	**26**	**62.4**	**8.2**	**13**	**2.4**
	ANDI	20	26	62.4	8.2	13	2.4
CT 1.0m		**7**	**8**	**45**	**17**	**38**	**5.6**
	CFIM	7	8	45	17	38	5.6
CT-0.9m		**13**	**17**	**88.2**	**48.8**	**55**	**5.2**
	CFIM	13	17	88.2	48.8	55	5.2

Community Access

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Keck-I		**20**	**20**	**40**	**18**	**45**	**2**
	HIRES	5	5	13	0	0	2.6
	IF	1	1	1	0	0	1
	LRIS	11	11	20	18	90	1.8
	NIRC	3	3	6	0	0	2
Keck-II		**17**	**18**	**29.2**	**5**	**17**	**1.6**
	DEIMOS	3	3	4	2	50	1.3
	ESI	2	2	2	1	50	1
	IF	1	1	1	0	0	1
	NIRC2	1	1	2.2	0	0	2.2
	NIRSPEC	8	9	17	2	12	1.9
	OSIRIS-LGS	2	2	3	0	0	1.5

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
HET		**5**	**5**	**5.2**	**0**	**0**	**1.1**
	HRS	3	3	3	0	0	1
	LRS	1	1	0.2	0	0	0.2
	MRS	1	1	2	0	0	2

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Magellan-I		**6**	**6**	**10.8**	**9**	**84**	**1.8**
	IMACS	4	4	9	9	100	2.2
	PANIC	2	2	1.8	0	0	0.9
Magellan-II		**9**	**10**	**18**	**0**	**0**	**1.8**
	MIKE	9	10	18	0	0	1.8

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
MMT		**19**	**20**	**50.5**	**13**	**26**	**2.5**
	BCHAN	7	7	21	4	19	3
	Hectochelle	4	5	11	0	0	2.2
	Hectospec	2	2	6	6	100	3
	MegaCam	3	3	5.5	3	55	1.8
	PISCES	1	1	3	0	0	3
	RCHAN	2	2	4	0	0	2

CTIO/CERROTOLOLO
INTER-AMERICAN OBSERVATORY

Applied Astronomy: A Survey for Space Debris with the Curtis-Schmidt

Patrick Seitzer
(University of Michigan)

The University of Michigan's Curtis-Schmidt telescope on Cerro Tololo is currently being used in an applied astronomy project: an optical survey for space debris at and near Geosynchronous Earth Orbit (GEO). The goal of this project is to characterize the population of material in this critical orbital regime, and to answer such questions as: How much material is there? Where did it come from? What is the risk to current active, station-keeping satellites? The project is funded through NASA's Orbital Debris Program Office at Johnson Space Center, Houston, TX.

Every survey night, the telescope tracks a field near the anti-solar point but outside of Earth's shadow. The ARCON CCD is used in drift-scan mode taking five-second exposures all night long. On average, any GEO object is detected eight separate times as it drifts across the 1.3-degree field of view during the 5.3-minute observing window. Thus positions, angular rates, and brightness are all measured, but not orbits. The 5.3-minute window is not long enough to reliably establish an orbit with the period expected for GEO (23 hours and 56 minutes).

Figure 1 shows the observed histogram of R magnitudes for one such debris campaign. The sample excludes all station-keeping objects (defined by their small angular rates) and thus includes just objects likely to be debris. The bright peak near R=12 consists of the population of uncontrolled intact satellites no longer in active service. The fainter peak near R=17 consists of a population of smaller objects. The limit at R=18 is the sensitivity limit of the current system: Signal-to-Noise (S/N)=10 for a five-second exposure corresponds to R=18, or an object about 25 centimeters in diameter at GEO. All objects shown here have been detected at least four separate times during one observing window.

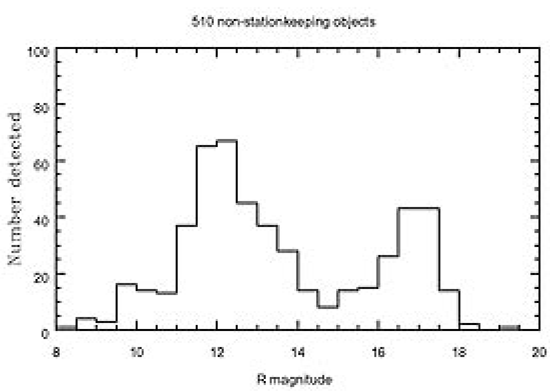

Figure 1: Histogram of observed R magnitudes for uncontrolled objects at GEO found during observing runs over six months. Bright peak is intact spacecraft, faint peak is smaller debris plus falloff in system sensitivity.

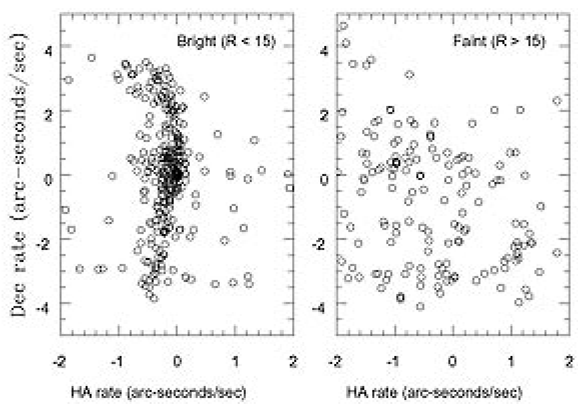

Figure 2: Observed angular motions for all objects detected during the observing campaign. The locus of points are objects on circular orbits with inclinations up to a maximum of 15 degrees.

This is not suprising, as based on observations of the debris field at Low Earth Orbit (LEO) one would expect to find all sorts of small debris from explosions and fragmentations in orbit. The real surprise comes from the striking difference in the observed angular motions between bright and faint objects. Splitting the above sample in two at R=15 produces the result illustrated in figure 2.

Since this experiment measures the angular rate in hour angle, a motionless object would be at (0,0) in figure 2. But such an object is not in a stable configuration: gravitational influences of the Earth's bulge, the Sun, and the Moon all act to perturb the motion. An object released at zero velocity would, over time, migrate to orbits of higher and higher inclination, reaching a maximum inclination of nearly 16 degrees. The left hand side of figure 2 demonstrates that the majority of bright GEO objects are close to a well-defined locus as predicted by the above behavior.

continued

Applied Astronomy continued

However, objects fainter than R=15 show a much more uniform angular rate distribution (the right hand side of figure 2). The most likely explanation is that these objects are on eccentric orbits, although some of them could be on circular orbits but not at GEO. This explanation is supported by theoretical work done by Liu and Weaver of the Orbital Debris Program Office, predicting that objects of high area to mass (like aluminum foil or spacecraft insulation blankets) are most perturbed by solar effects, with gravitational effects being secondary. Depending on the area-to-mass ratio, the orbital inclination and eccentricity will change rapidly on timescales as short as one year.

Long time observers on the Schmidt telescope may remember (perhaps fondly) that this telescope was one of the last to require physical exercise to move the telescope and dome. No longer, for during March 2005, NASA funded a modernization of the drives and electrical system of the Schmidt by DFM Engineering. The telescope and dome are now completely under computer control, with new drives on both right ascension and declination axes, and encoders on both axes (meaning no more setting circles). The dome was encoded as well.

The telescope can now be used for the follow-up observations critical to establish orbits.

Scientific Staff Changes & Other Happenings

Alistair Walker

Alan Whiting completed a four-year postdoctoral fellowship at CTIO on September 30, accepting a position at the University of Birmingham, U.K. During his time at CTIO, Alan was very effective in his tenure as director of the Research Experiences for Undergraduates (REU) program, and in looking after the small telescopes as CTIO's representative in the SMARTS Consortium. Alan volunteered for both of these tasks, and we are very grateful he did. One of Alan's main research projects involved the search for new dwarf galaxies in the Local Group — the sheer effort needed for this non-digital (i.e., by eye) examination of the Sky Survey Plates, resulting in the discovery of the Antlia and Cetus dwarfs, typifies Alan's extreme dedication to any task faced, no matter how difficult. We will miss Alan's occasion appearance in Navy Whites, and his quietly expressed, nevertheless well-argued contributions at staff teas and meetings.

We welcome **Styliani (Stella) Kafka**, who has arrived to take up a postdoctoral fellowship position at CTIO. Stella comes to us from Indiana University, where she has just finished her PhD, working on cataclysmic variables with her supervisor, Kent Honeycutt. She will be spending most of her time on research, but will also be directing the NSF-funded REU program and the Prácticas de Investigación en Astronomía (PIA) program, which together each year bring eight students to La Serena for three months.

We also welcome **Sebastian Els**, who will be working as an NOAO postdoc for the New Initiatives Office. He will work strengthening the local Thirty Meter Telescope (TMT) site testing team at a critical time as we begin characterizing our first high-altitude Chilean site. Sebastian has been working most recently at Caltech for the TMT project, after having supported adaptive optics instrumentation for the Isaac Newton Group on La Palma. His scientific interests are multiwavelength studies of exoplanetary systems and precision radial velocities in the search for young planetary companions.

The Super Massive Coronal Halo Objects (**SuperMACHO**) and Equation of State: SupErNovae Cosmic Expansion (**ESSENCE**) projects have returned to the Blanco 4-meter telescope this southern spring (October through December 2005). These projects were granted NOAO Survey Program status as five-year surveys. The SuperMACHO project seeks to better understand dark matter by investigating the characteristics and location of the microlensing population originally identified in the MACHO search. The ESSENCE project seeks to characterize dark energy by constraining its equation of state. These projects together take over every other night on the Blanco during the dark and grey nights of October, November, and December. Both surveys have begun publishing results (two in press for SuperMACHO, and four in press for ESSENCE); be sure to check astro-ph for their new results!

The NOAO Data Products Program (DPP) has been going through many changes and the Chilean component has certainly not been left out. We welcomed **Alvaro Egaña** and **Exequiel Fuentes** to the DPP-South staff in August 2005. Both are playing key roles in moving the program forward, specifically in the NOAO Science Archive (Alvaro) and the NOAO Virtual Observatory Portal (Exequiel). While the current NOAO Science Archive (*archive.noao.edu/nsa*) continues to provide access to NOAO Survey Program data, users can look forward to new and more advanced tools and services in the near future.

Delay for NEWFIRM First Light

Ron Probst

We regret to announce that there will be a significant delay in the delivery of the NEWFIRM instrument to the Mayall 4-meter telescope. As of nine months ago, the project plan called for first light in January 2006. Vendor problems with optics completion were evident at that time, so the plan included a review point in early October 2005 to assess progress and revise the schedule if necessary. From our October review, it became clear that continued delay in delivery of crucial elements of the camera optics prevents any chance of first light for NEWFIRM prior to semester 2006B. The revised schedule has a tentative first-light date in October 2006.

This schedule slip also impacts planning for Science Verification (SV) observations. The SV process was discussed in the September 2005 *Newsletter*. A variety of projects have been proposed, and brief descriptions are posted on the NEWFIRM Website (*www.noao.edu/ets/newfirm)*.

Since the SV dates are now uncertain, planning will proceed by considering the SV projects as generic, with flexibility as to specific targets. For example, we will plan for broadband and narrowband surveys of a Galactic star-forming region or molecular cloud, and for very deep imaging of an extragalactic field. This will permit definition of time requirements, observing protocols, and data reduction methodologies appropriate to the science goals. The selection of specific targets to observe will be postponed until the observing window is known.

We continue to welcome comments and expressions of interest in participation from members of the potential NEWFIRM user community (contact the project scientist at *rprobst@noao.edu*). We thank those of you who have already expressed an interest.

SQIID Available for Observing in Semester 2006B

Buell T. Jannuzi and Michael Merrill

The delay in commissioning of NEWFIRM until late 2006 has led us to postpone retiring SQIID from service. SQIID will be available for observing in 2006B. SQIID can be used to take simultaneous images of the same field with J, H, Ks filters and has a useful field of view of 3 × 3 arcminutes when used at the 4-meter and 5 × 5 arcminutes when used at the 2.1-meter.

Together with FLAMINGOS, this will ensure continued access to near-infrared imaging capabilities on Kitt Peak telescopes until NEWFIRM can take over the load from SQIID. The adjacent image shows NGC 7538, a star-forming region, as seen by SQIID (composite image from J, H, and Ks band images) at the KPNO 2.1-meter telescope.

Have Leatherman, Will Travel

KPNO Staff

John Glaspey left the staff of Kitt Peak National Observatory on October 17 to start a new job as the Operations Director for the Multiple Mirror Telescope (MMT) project. All of us at KPNO wish John continued success as he takes on new challenges.

John was very successful leading Science Operations on Kitt Peak. He joined us in the fall of 1998 and we immediately began to benefit from his patience, good humor, and intelligence. He has successfully kept us focused on producing quality science while improving the working conditions for all. His relaxed management style and positive encouragement allowed everyone to find ways to contribute to the success of the observatory while satisfying their own creative and professional needs.

Hector Rios presents a going-away gift to John Glaspey.

When John first arrived with his Leatherman tool and his jeep, he set out to explore Kitt Peak and learn all he could about the operation. He was particularly valuable in developing strong working relationships with members of the Tohono O'odham Nation government that work with KPNO to provide safety and services for the visitors and scientists. We are sure John will be as successful at the MMT as he has been everywhere that he has worked.

We are very happy to announce that Michael Merrill has agreed to replace John as Supervisor of Mountain Scientific Support for KPNO. Mike joined Kitt Peak in 1979, and has been an active part of our infrared (IR) detector and instrument development programs for many years. Over the past few years he has been the Mayall 4-meter telescope scientist, as well as being active in supporting the Gemini Observatory through his work with the NOAO Gemini Science Center and the MONSOON project. We congratulate both Mike and John on their new positions.

In Appreciation: Khairy Abdel-Gawad

Tony Abraham & Buell T. Jannuzi

Khairy Abdel-Gawad retired from NOAO at the end of September after 32 years of distinguished service. As both an engineer and engineering supervisor, Khairy played a major role in the design, development, and maintenance of many of our facilities at both Kitt Peak (1967-1973, 1985-2005) and CTIO (1974-1979). These include the Coudé Feed, NSO vacuum telescope, and the Mayall 4-meter telescope on Kitt Peak, and the Blanco 4-meter telescope on Cerro Tololo.

In recent years Khairy has been responsible for many mechanical upgrades and new designs for Kitt Peak telescopes and buildings. These include the 4-meter dome vents and dome shutter upgrade, the 4-meter primary mirror active support system, and the construction of the new aluminizing room at the 4-meter (used to recoat many other mirrors as well).

We wish Khairy the very best retirement and appreciate that he has agreed to continue to share his extensive knowledge of our telescopes with us in the years ahead, as he continues to support observatory and its production of first-class science.

From the Director's Office

Steve Keil

The NSF Senior Review of facilities is now in full swing, and the NSF has held a series of town hall meetings around the country as part of this process. The NSO met with the Senior Review panel in October to answer questions about our formal submission (available at *www.nso.edu/senior_review)*. What the review will mean for current operations, NSO plans for developing the ATST, and for bringing SOLIS and GONG++ into full operation is not yet clear. In any case, we would like to encourage the community to make your opinions known to us and to Wayne van Citters at NSF. The next NSO Users' Committee meeting will be held in early December 2005, and will provide an opportunity to express concerns and thoughts on future developments at the NSO. We invite you to contact committee members, listed at *www.nso.edu/general/committees/*.

The ATST project achieved a major milestone in early November when NSF Director Arden Bement announced to the National Science Board that he has approved the ATST as a "Readiness Stage MREFC Project." ATST is the first project to be given such status in the revised MREFC process. The next series of steps is through the approval processes of the National Science Board, NSF/OMB budgeting, and Congress. Congratulations to the ATST team for the good work! We are now working with the NSF to understand what readiness entails, and to move the project into the approval phase and funding cycle.

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The commissioning phase of SOLIS continues, with the vector spectromagnetograph (VSM) and the integrated sunlight spectrometer (ISS) operating on Kitt Peak in the Kitt Peak SOLIS Tower (KPST). The full-disk patrol (FDP) is currently in Tucson, where it is being used to test the guider. All optics are now in hand to complete the FDP tunable filter, and we estimate that the FDP will be deployed to Kitt Peak in late spring of next year. In other SOLIS news, the VSM will be dismounted in January 2006 in order to replace two polarization modulators and the grating mount. The VSM is expected to be down for several weeks while the replacement of its polarization modulation package is performed. Other major SOLIS work in progress includes the guider, the ISS extinction monitor, and further development of the data archive and the data product pipeline. I am pleased to report that the community has expressed great interest in the vector magnetograms from the VSM, with users beginning to present results from SOLIS data at meetings such as the SPD/AGU, held this past June in New Orleans, and the recent 4th Solar Polarimetry Workshop in Boulder during September.

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We would like to remind the community of the extensive NSO data archives accessable from the NSO digital library at *diglib.nso.edu/*, and now partially through the Virtual Solar Observatory at *umbra.nascom.nasa.gov/vso/*. Holdings include Kitt Peak Vacuum Telescope magnetograms and spectromagnetograms, SOLIS VSM data, GONG solar oscillation data, FTS spectral atlases, spectroheliograms, and much more. The H-alpha flare patrol that ran from 1966-2003 is not in the library. These data are on film, having been obtained at a one-minute cadence typically between approximately 14UT-23UT, and are available by special request for short time periods (contact Alexei Pevtsov at *apevtsov@nso.edu)*. For more extensive data, community members are welcome to visit the observatory in Sunspot and digitize as many frames as you require. Current images and the ISOON archive are available at *nsosp.nso.edu/data/latest_solar_images.html.*

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In addition to Thomas Wentzel, Michael Soukup, and Gordon Petrie, who have the joined the GONG staff (see the GONG article for details), we're delighted to welcome Alexandra Tritschler and Ronald Long to Sac Peak, and Valorie Burkholder to Tucson. Alexandra joins us as a scientist on the ATST project, supporting instrumentation and adaptive optics efforts. She will work on the design of the ATST broadband filter instrument and the implementation of phase diverse and speckle reconstruction techniques for this instrument. She will also provide modeling support for the adaptive optics design effort and the upcoming wavefront control systems design review. Ron is an instrument maker, replacing Rick Dunbar. Ron and his wife, Donell, have relocated from Albuquerque, where Ron was employed by InSync Inc., an optical business spin-off from Boeing. Ron has strong experience in optics and machining and is proving to be an excellent addition to our staff. Valorie Burkholder comes well-prepared to replace Jeremy Wagner (who is now the ATST Project Manager) as manager of the NSO technical and engineering staff in Tucson. With a BA in physics from Mount Holyoke College, an MS in Astronomy from the University of Arizona, and six years of experience working in an electro-optical subsystems team at Raytheon, Valorie will assume primary responsibility for management and commissioning of the SOLIS project, as well as other instrument, telescope, and software projects in Tucson, outside of the ATST project.

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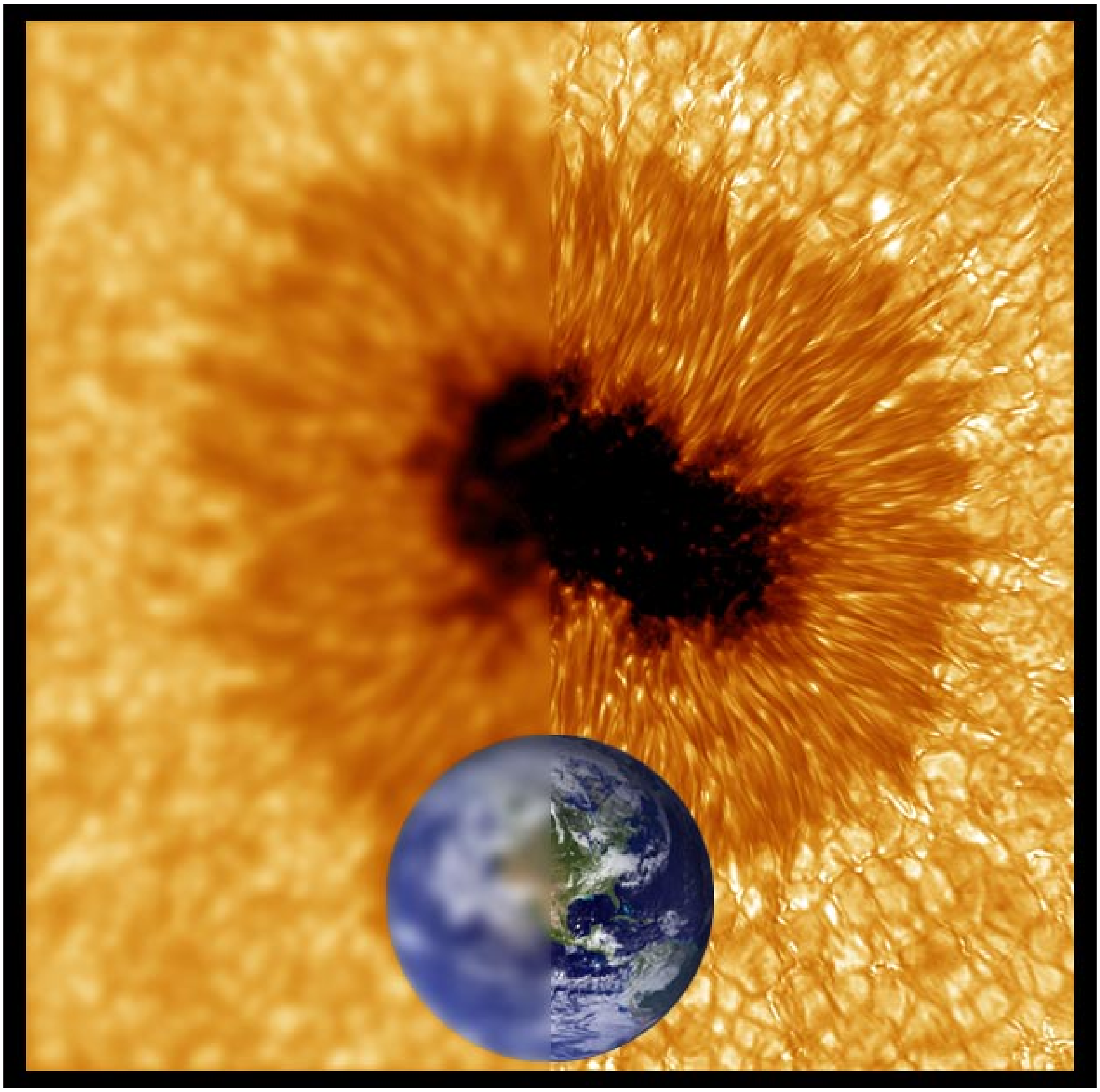
Finally, I am sad to note that Richard B. (Dick) Dunn passed away on 28 September 2005. Dick was a major driver of modern solar telescopes and instruments. He will be greatly missed. Our memories of Dick are expressed in the tribute that follows.



A scaled image of Earth superimposed on sunspot AR 10810 depicts the enhanced resolution made possible with the Dunn Solar Telescope's high-order adaptive optics (AO76) system. Bright points in the G-band (430.5 nanometers) that indicate the presence of small-scale magnetic flux tubes can be seen near the sunspot and between several granules. The dark cores of penumbral fibrils and bright penumbral grains are also seen in the sunspot penumbra as fluted structures radiating outward from the spot. These features hold the key to understanding the magnetic structure of sunspots, and can be seen only in ultra high-resolution images such as this one. A complete understanding of the role of magnetism in solar activity is a problem being tackled in solar physics today that rivals the challenge of explaining dark energy being pursued by nighttime astronomy.

This image was built from 80 images, each 1/100th of a second long, taken over a period of three seconds by a new high-resolution Dalsa 4M30 CCD camera in its first observing run coupled to the AO76 system at the Dunn on 23 September 2005. Speckle-imaging reconstruction then compiles the 80 images and greatly reduces residual seeing aberrations. The left half of the image is artificially blurred to simulate uncorrected seeing; the right half of Earth is blurred to a resolution comparable with the Dunn's 0.14-arcsecond resolution with adaptive optics.

Credit: Friedrich Wöger (KIS), and Chris Berst and Mark Komsa (NSO/AURA/NSF). [Earth image: NASA.]

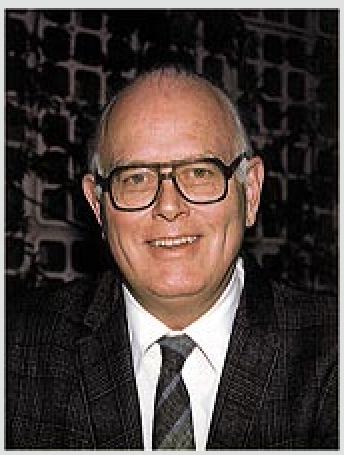
Richard B. Dunn

1927–2005

Richard B. Dunn, Astronomer Emeritus at the National Solar Observatory and a pioneering solar physicist who developed several advanced optical solar telescopes, died 28 September 2005, in Las Cruces, New Mexico, of a heart attack. He is survived by his wife, Alice Dunn.

More than 100 people attended a memorial service in his honor held at the Sunspot Astronomy and Visitor Center in Sunspot, New Mexico, on October 14.

Dunn was the second director of what was originally the US Air Force's Sacramento Peak Observatory (SPO) at Sunspot. The Sac Peak facility became a major component of the National Science Foundation's National Solar Observatory (NSO) in the 1980s. Dunn's career at Sacramento Peak began in 1953 while he was a graduate student working toward his doctorate at Harvard University, and he remained with the observatory until his retirement in 1998. He lived in Las Cruces, and continued to work part-time at Sunspot until 2003.



"Dick Dunn's legacy is a major part of AURA's heritage," said William Smith, president of the Association of Universities for Research in Astronomy (AURA). "He has been central to the progress of solar astronomy in the United States."

"Dick has left a lasting legacy for solar physics. He will always be remembered for his contributions to observational solar science, and for his engaging personality that provided both warmth and humor to the field," said Stephen Keil, current director of the NSO. "Dick mentored many of the current generation of solar instrumentalists and challenged theorists by constantly improving observing capabilities."

"Dunn was recognized as one of the foremost experimental solar physicists of his generation," said Jack Zirker, a past director at Sac Peak. "He was one of the first two astronomers to join the newly established Sacramento Peak Observatory in 1953. He was responsible for the design and construction of many of the telescopes and instruments that made the SPO one of the premier solar observatories in the world. His work was admired and copied over the world."

"Dick was one of the great instrument builders in the history of solar astronomy," said Michael Knölker, director of the High Altitude Observatory in Boulder, Colorado. "The National Solar Observatory, Sacramento Peak Observatory in particular, and the world community in solar astronomy have benefited tremendously from his genius. Many young scientists interested in instrumentation were mentored by him and grew up to be leaders at observatories all over the world…I met Dick for the first time when I was a summer student at Sacramento Peak Observatory in 1980. In all the years since then I enjoyed his sense of humor when we met at Sac Peak summer workshops. In recent years I admired his strength in dealing with adversity observing how he stood up to his illness."

In 1998, the Solar Physics Division of the American Astronomical Society awarded Dunn its George Ellery Hale Prize: "For his bold and imaginative innovation of instrumentation for solar physics, his discovery of important new phenomena on the Sun, and the impact of his contributions on solar physicists worldwide."

"Dick played a major role in the advancement of our understanding of the Sun and its impacts on Earth and on space weather," Keil recalled. "His work from 1952 to 1976 as an Air Force employee was instrumental in making the facility at Sacramento Peak into the world's outstanding solar observatory. When the NSF took over Sac Peak, and eventually made it a major component of the National Solar Observatory, Dick first led and then continued to play a vital role in its

continued

Richard B. Dunn continued

telescope and instrument programs. The Vacuum Tower Telescope at Sac Peak, renamed the Richard B. Dunn Solar Telescope by NSF in Dick's honor in 1998, played a fundamental role in developing our understanding of solar magnetism and activity. His contributions, first as an Air Force employee and later as a member of the NSO staff, made possible the worldwide Air Force solar monitoring system."

Much of our current knowledge of the solar atmosphere, including its magnetic field structure, solar flares, prominences, and the solar corona, resulted from Dunn's work. Solar astronomers worldwide called on his expertise in designing their telescopes. He also gave generously of his time and energy to such projects, and thus was involved in the design of many more solar telescopes than anyone else.

"Dunn's career was in large part aimed at obtaining solar observations of the highest possible spatial resolution," noted Zirker. "Only by studying the small magnetic structures near the surface, he thought, could we hope to understand the powerful solar flares that periodically disturb the Earth. His instruments were, for the most part, designed for this purpose and he was proven correct in the end. Most recently, he pioneered the development of special electronic equipment for sharpening solar images."

His landmark contribution was the design and development of the 108-meter-tall Vacuum Tower Telescope. When put into service by the Air Force in October 1969, the telescope revolutionized the capabilities of solar telescopes. The innovative design employs a vertical vacuum tube (more than half of it underground) with the instrument platform attached so it rotates with the telescope tube as it tracks the Sun during the day.

Dunn eliminated many image deterioration effects by evacuating the telescope and by careful control of the environment at the telescope entrance. The success of his new vacuum telescope concept is best measured by its implementation in several major solar telescopes constructed since.

Dunn also initiated work that has led to new adaptive optics technologies to compensate for atmospheric blurring in solar observing. His innovative spirit was not limited to solar physics but ranged from musical instruments to aides for the blind. His many talents and interests included music, sculpture, and sailing. His quirky sense of humor was a delight to his many close friends.

ATST Project Achieves "Readiness"

The ATST Team

The National Science Foundation has approved the Advanced Technology Solar Telescope (ATST) as a "Readiness Stage Project" in the Major Research Equipment and Facilities Construction (MREFC) review process. The project team and NSF are discussing the criteria required to be met in order to move the project from readiness to the approval phase of the review process. The approval phase includes consideration by the National Science Board for a new start in the Federal budget process. The earliest new start opportunity is in the fiscal 2008 budget. If awarded then, first light for ATST in 2014 would be a possibility. ATST is the first project to achieve "readiness" status in the new NSF MREFC procedure.

The Environmental Impact Statement (EIS) process for ATST has passed the halfway mark, and major aspects of the ATST design will soon be frozen to prevent disruption of the EIS process. Following the public comment period and community information meetings (see the September 2005 *NOAO/NSO Newsletter*), ATST entered the "most expensive and intense phase of the EIS process," according to ATST EIS Lead Jeff Barr. This phase includes impact assessment surveys and consultations for both the primary site, next to the Mees Solar Observatory on Haleakalā, Hawai'i, and the alternative site at Reber Circle, near the Air Force Advanced Electro-Optical System. These surveys require rechecking

continued

ATST Project Achieves "Readiness" continued

An artist's rendering of ATST at the primary site on Haleakalā. Elevation view is from the north. Note the white concrete apron located on the eastern (left) side of the facility that is used to reduce radiated thermal loading from the ground.

sites for archaeological artifacts and sensitive biological points to ensure that none are missed.

During this phase, the team is working closely with those who know the Haleakalā environment best. Project manager Jeremy Wagner and Jeff Barr met in mid-September with O'ahu-based US Fish and Wildlife Service biologist Holly Freifeld, Maui-based National Park Service biologist and petrel (seabird) monitor Cathleen Bailey, NSO's environmental consultants from KC Environmental and TetraTech, and Mike Maberry of the University of Hawaii Institute for Astronomy. The talks covered the biologists' concerns, as well as appropriate or required petrel-related mitigations such as incidental take permitting and construction blackout dates. The team also learned more about the petrels' feeding, flyway, and nesting habits.

Wagner and Barr toured the sites and updated the GPS positions of the two closest burrows, which are farther by about nine to fifteen meters from the primary site than previous measurements had indicated. Bailey will update and refine the positions of all the burrows near the primary site for accurate mapping. Bailey and Freifeld indicated that the population of petrels near the telescopes is growing, a positive turn of events.

From a geological standpoint, the Haleakalā site continues to appear suitable. Geotechnical surveys confirm that the site consists of six to nine meters of rock, volcanic cinder, lava, and other materials atop basalt. The site is undergoing studies to determine the best placement of soils removed during construction, and the efficacy of rebuilding a hill leveled in an earlier project.

The ATST team is addressing several facilities issues. The overall design is advanced enough that team members are beginning discussions on the challenging timing and responsibility issues of how to coordinate foundation and concrete work for the buildings, enclosure and telescope pier. KC Environmental and Tetra Tech are addressing strategies for handling storm water run-off and wastewater disposal. Maui Electric is working with the team to develop a facility that makes ice at night, using off peak electrical loads, and serves as a heat sink for ATST during the day. Existing power lines to the peak are sufficient to handle the additional demands from ATST, although a new substation will be proposed to minimize its impact and use power most efficiently. The team is also studying internal systems to minimize power demand.

A "30 percent finished" set of plans will be produced by February 15, following the January Systems Design Review, then frozen pending completion of the EIS. The plans will effectively form a "do not exceed" envelope. Internal changes will be allowable as long as they do not expand the exterior. Reductions, such as deleting the mirror-coating chamber if ATST can use the Air Force's planned chamber, should be straightforward, as they reduce the impact of ATST.

The first, or alpha, release of the Common Services software—comprising libraries, tools, and services required by all systems—occurred during the summer to the vendor and several evaluators, according to software manager Bret Goodrich. This is the only major software component yet written, as the team is focused on designing software for ATST systems in the critical design path (equivalent to an architect making top-level blueprints but not designing walls and fasteners). The software team's latest design effort was software to support the preliminary design review for the M1 mirror assembly in late October. The team now turns to supporting the ATST System Design Review in early 2006 and the Telescope Control System design review in April.

NSO Array Camera Observes X1.8 Flare in He 1083 nm

Matt Penn

A sequence of observations were taken with the new NSO Aladdin Camera (NAC) on 13 October 2005 of the He I 1083 nanometer (nm) spectral line of the active region NOAA 10808. During the afternoon, the region experienced an X1.8 flare, and very strong emission was seen in the He 1083 nm line.

The intensity at line center was measured at over 2.5 times the continuum intensity in a bright emission kernel (see graph in figure 1), and a slight Doppler redshift is seen in the emission regions. The field-of-view of the NAC was limited to the immediate sunspot umbra and penumbra, as shown in the continuum (figure 2) and He 1083 nm line core images (figure 3). The He 1083 nm line center image shows several regions of bright line emission that lie at the edges of the dark sunspot umbra seen in the continuum image. This is clearly seen in a spectral frame taken while the slit was crossing a bright emission kernel (figure 4). The data have only been very briefly examined.

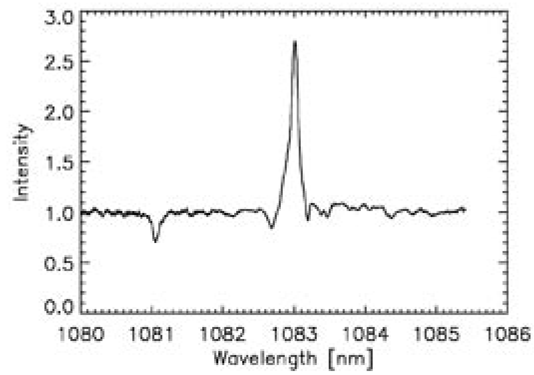


Figure 1. Graph of the spectrum in a bright He 1083 nm flare kernel. The line emission reaches at least 2.5 times the continuum intensity in the line center.

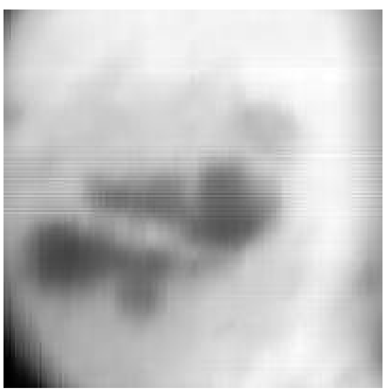


Figure 2. Continuum map at 1080 nm showing the main sunspot of NOAA 10808.

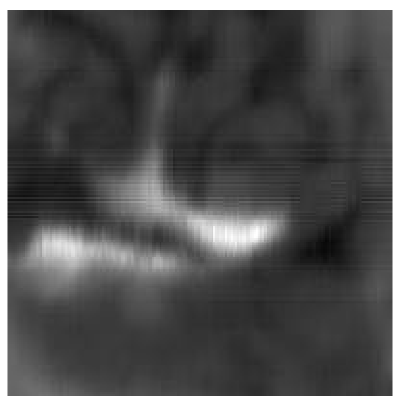


Figure 3. Map in the He 1083 nm line, showing bright flare emission.

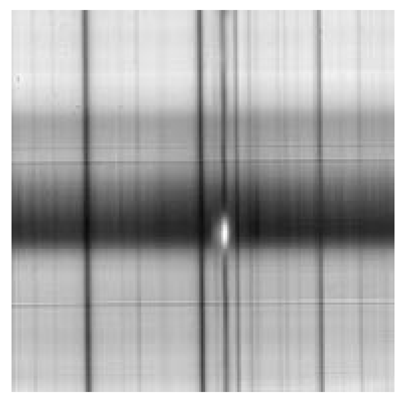


Figure 4. Sample spectral frame showing a region from about 1080–1085 nm showing a bright flare kernel in the He 1083 nm line.

Solar IR Observations at the McMath-Pierce Telescope

Don Jennings, Tom Moran, Drake Deming, George McCabe (NASA Goddard Space Flight Center), Pedro Sada (Universidad de Monterrey) & Robert Boyle (Dickinson College)

The solar infrared (IR) group from NASA Goddard Space Flight Center (GSFC) continues a very productive observation program at the McMath-Pierce Telescope. They have made multiple observations in the IR Mg I 12 micron line to measure solar magnetic fields using a liquid Helium-cooled grating spectrograph, CELESTE, coupled with an automated Stokes polarimenter. The Mg I 12 micron line is advantageous for solar magnetic field measurements for several reasons. Zeeman splitting in the line is especially large, owing to its long wavelength, so true field strengths as low as 200 Gauss can be measured. The line is optically thin and therefore interpretation of Mg I spectra is simplified. The line is formed 200 kilometers above the formation heights of visible photospheric spectral lines used for magnetic field studies providing a unique diagnostic of 3-D magnetic field structure.

Recent observations of a disk-center sunspot in the Mg I 12 micron line were made using CELESTE and the facility tip-tilt system at the McMath-Pierce Telescope during October 2004. A sequence of 40 spectra, measured with the slit oriented across the spot, were recorded with a 4-minute cadence. The spectra were summed to obtain high-resolution Stokes I, Q, U and V line profiles demonstrating the presence of two magnetic field components in the line, consistent with visible magnetic field measurements. Measurements of field strength at each exposure time showed fluctuations at all locations along the slit at levels of 20 to 50 Gauss, on time scales of 15 to 25 minutes. Since the two sides of the V profile are recorded at one-second intervals, velocity effects on the line splitting are negligible. These results were presented in Boulder, Colorado, at the 4th Solar Polarimetry Workshop in September 2005.

The GSFC group made more recent measurements in the Mg I line at the McMath-Pierce Telescope during October 2005, recording time series of Stokes I and V spectra in a small spot and a pore at 16-second cadence. These data will be analyzed to determine whether magnetic field fluctuations at the Mg I line formation height are present in these structures, and if so, to determine their amplitudes and frequencies.

Summer School on Solar Physics

12 – 16 June 2006

Sunspot, New Mexico

Organized by the University of Arizona's Lunar & Planetary Laboratory and the National Solar Observatory

An introductory course for beginning graduate students, providing a week of lectures, hands-on exercises, and an opportunity to work with telescopes.

For more information, contact Joe Giacalone (*giacalon@lpl.arizona.edu*), John Leibacher (*jleibacher@nso.edu*), or Rex Hunter (*rhunter@nso.edu*)

GONG++

Frank Hill

This quarter was marked by transition. As I settle into the "big chair" that John Leibacher so ably filled for more than 20 years, my main impression is that the GONG program is vigorous, successful, and extremely busy. Many thanks to John for his superb leadership in building GONG to its present state, and we wish him well on his return to scientific research. Many thanks also to the entire GONG staff for their dedication and hard work in keeping the network running, reducing the data, and doing science.

By the time you read this, I will have interviewed every member of the staff to gather input on the program and help me formulate decisions on possible organizational changes. These will be outlined in the next *NOAO/NSO Newsletter*.

In October, GONG marked its 10th birthday dating from the completion of deployment and the start of routine operations. Many past GONGsters were able to join us for a celebration. Bill Marquette, now retired, was presented with the GONG HOG (Hero of GONG) award for his 20 years of service operating the GONG site at Big Bear Solar Observatory.

Frank Hill presenting the GONG HOG award to Bill Marquette for 20 years of service at Big Bear.

Network Operations

After the troubles experienced in the previous quarter, we were reluctant to pursue a standard preventative maintenance (PM) schedule, since it was possible that the changes and upgrades we have been employing were actually causing problems with the instrument. We therefore redirected our efforts more toward testing and certifying the modifications before deploying them to the sites. This strategy paid off promptly with the discovery that the turret to be deployed to Udaipur was "leaky" despite the modification designed to make it more resistant to moisture intrusion. We also acquired cabling designed to withstand repeated flexure to replace the camera power cable bundle at most of the sites. This replacement, along with improved strain relief between the cable and connectors, is expected to decrease the likelihood of failure of these parts. A second reason for a disrupted PM schedule was the unexpected departure of Candido Pinto, who accepted an optics position in the private sector.

Despite multiple visits to the Mauna Loa site, the symptom of the instrument control computer hanging and rebooting persisted. The camera's cooling fan was also beginning to fail. With remote troubleshooting providing limited progress, and the need for a camera replacement looming, a third trip to Mauna Loa took place. For this visit, the team brought along monitoring instruments, but as Murphy's Law would dictate, the instrument experienced no further unwarranted reboots. Faced with this circumstance, it was proposed that some software bug might be involved such that when cycling power to the instrument, the system is reset, and only after some period of normal operation will the problem arise again. With the allotted time drawing to a close, the team changed cameras, replaced the camera power cable bundle with the new flex cable version, and downgraded the software to an earlier version. Since the team's departure, no further reboots have occurred. So what, if anything, fixed the problem?

In addition to Mauna Loa, the Udaipur, Learmonth and Big Bear sites have also experienced rebooting associated with unstowing the instrument, operating the calibration sequence, and collecting drift scans. The behavior at Udaipur appears to be consistent with an intermittent camera cable and excessive noise on the camera control lines generated by the camera rotator. With Udaipur shut down for the monsoon weather, remote troubleshooting is again difficult. The post-monsoon PM to Udaipur, occurring after the deadline for this *Newsletter* issue, should resolve the issue. Learmonth was

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GONG++ continued

consistently rebooting after the calibration sequence, so we asked site staff to power cycle the instrument to test the faulty software idea. There have been no further reboots, but the reboots actually stopped two days before the power cycle took place. Big Bear has recently been rebooting consistently after unstows and calibrations. A team visited the site to replace only the camera power cable with the new flex version and results of this remain to be determined.

Engineering and Upgrades

Two new shelters have been delivered and transformed from mere shipping containers to homes for a GONG instrument. One of these shelters will be sent to Learmonth to replace the unit that is rusting on the beach. Additional measures to retard this process have been incorporated in the replacement shelter, so we anticipate it lasting for two solar cycles this time. The swap will take place in May 2006; this time frame minimizes the impact on the overall performance of the network.

Members of the GONG scientific and engineering staff are shown working on the new, improved modulator for the GONG instrument. This new component will improve the one per minute magnetograms from GONG, decreasing the background zero point by a factor of 30. The modulator is the cylindrical component in the calibration wheel. Left to right: George Luis, Tim Purdy, Mike Soukup, and Jack Harvey.

The other shelter will be filled with a new instrument and will reside at the Tucson farm as our hot spare station. This strategy provides insurance against catastrophic loss of a site, reducing the down time from two to three years to about six months. Since the production and integration of a complete instrument system is a big job, we have secured temporary help from the engineering department of NOAO to reduce the impact on the network operations staff. With this boost in resources, most of the production will be done this fiscal year.

The project to upgrade the magnetograph modulators and associated circuitry is continuing. The basic hardware operations mode is complete, and work is progressing on the software portion of the design. The new modulators, which include a heater and require a thermal controller, have been characterized in the lab. Work is beginning on incorporating the thermal controllers into the optical table layout, and a modified enclosure needed to house the new modulator controller has been fabricated. Testing of the final design will culminate with a prototype design review at the end of November. Production of the field units should be well underway by the end of the year, and deployment of the new modulators to all the sites should be accomplished before the launch of the STEREO mission in April 2006.

Data Processing and Analysis

GONG's Reduction and Analysis Software Package (GRASP), developed 15 years ago in parallel with the instrument, is a set of algorithms designed for analyzing helioseismic data. It is intrinsically linked to IRAF and is supported by GONG. A new GRASP distribution has been installed, which incorporates a new improved module that determines the angular orientation of the images using frequent noon drift scans from around the network (CoPipe II), as well as the Automated (bad) Image Rejection (AIR) modules, and improvements to the calibration procedure. Following the recommendation of the Data Managment and Analysis Center (DMAC) Users' Committee (DUC), this will be the last monolithic GRASP release; from now on we will be releasing individual modules under CVS version control so that algorithm improvements can be incorporated into the pipeline more rapidly. GONG will support GRASP for two more years.

GONG is continuously computing farside maps of the Sun. Each map uses a 24-hour period, updated every twelve hours, of near-real-time images sent to Tucson from GONG's six network sites. See the "Science Highlights" section of this *Newsletter*.

In anticipation of the modulator upgrade, work is beginning on a magnetogram processing pipeline. Richard Clark is dusting

continued

GONG++ continued

off his earlier zero-point correction code, so that we can process all of the data on hand. Cliff Toner and Harry Jones are working on a histogram equalization scheme to merge the magnetograms.

Two new data products have been added to the suite of "official" GONG products: merged velocity images and ring diagrams are available on the GONG ftp site. The data processing to date includes month-long (36-day) velocity time series, and power spectra for GONG Month 98 (centered at 14 December 2004), with a fill factor of 0.93; 108-day Mode Frequency Tables are now available for Month 97; and, Ring Diagrams are available through Month 98. The calibration backlog is at 699 site days. The data distribution system provided 464 Gigabytes in response to 23 data requests.

Comings and Goings

In late August, Thomas Wentzel joined the data processing group as a Scientific Programmer, and in late September, we welcomed Michael Soukup as our new Instrument Specialist.

Alex (Sasha) Serebryanskiy completed his one-year NATO fellowship and has returned to Uzbekistan.

Gordon Petrie, from the High Altitude Observatory in Boulder, Colorado, joined the GONG analysis team at the end of October. Gordon is a NASA/National Research Council fellow, and will work with Jack Harvey to calibrate GONG magnetograms and support the STEREO mission science.

Sergey Ustyugov from the Keldysch Institute of Applied Mathematics in Russia visited GONG, working with Rudi Komm for two weeks on an analysis of numerical simulations of the outer convection zone.

GONG enjoyed hosting three summer students this year. Amel Zaatri, a graduate SRA from CRAAG in Algiers and the Observatoire de la Côte d'Azure (Nice), worked with Irene González Hernández and Rudi Komm on flows from ring diagrams; Douglas Mason, a Research Experiences for Undergraduates (REU) student from University of Southern California, worked with Rudi et al., on the relationship between flares, magnetic fields, and subsurface vorticity; and, Paul Anzel, an REU student from Rice University, worked with Frank Hill and K. S. Balasubramaniam at Sac Peak, applying ring diagram analysis to H-alpha intensity images from the Improved Solar Observing Optical Newtwork (ISOON) in order to develop a method of measuring filament properties from 3-D power spectra.

Notable Quotes

Cosmology in the Nude?

"As you get older, you realize that you really don't know very much. Cosmology has progressed very slowly. Mainstream cosmological theory is like the emperor who had no clothes."

—Geoffrey Burbidge (University of California-San Diego) quoted by Keay Davidson in a San Francisco Chronicle *story regarding the surprisingly mature-looking high redshift galaxy HUDF-JD2, on 10 October 2005. Burbidge, described as a "veteran foe of orthodox cosmology" in the story, is a former director of Kitt Peak National Observatory. He and his spouse, noted astronomer Margaret Burbidge, recently received the British Royal Astronomical Society's highest award at a ceremony in London.*

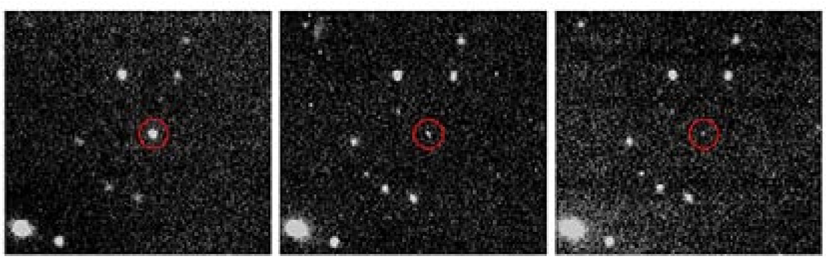
SOAR and PROMPT Team Up for Gamma Ray Burst Discovery

Douglas Isbell

Fulfilling one of its central operational goals in a big way, the Southern Astrophysical Research (SOAR) telescope on Cerro Pachón in Chile made the first observations of the glowing remains of the most distant explosion ever seen in the Universe. The international telescope then provided the first accurate measurement of the incredible distance of this explosion, which earned SOAR a feature role in worldwide media coverage of the discovery.

A network of observers, led by Daniel Reichart and his team from the University of North Carolina at Chapel Hill (UNC), used the Ohio State InfraRed Imager/Spectrometer (OSIRIS), instrument on the SOAR telescope to detect the afterglow of the gamma-ray burst, just three hours after NASA's SWIFT spacecraft discovered the burst using its gamma-ray and X-ray output.

This powerful burst, detected on September 4, marks the death of a massive star and the birth of a black hole. The event comes from an era soon after stars and galaxies first formed, about 500 million to one billion years after the Big Bang. Named GRB 050904, the object has a redshift of 6.29, which translates to an age of about 13 billion years. (The Universe is thought to be 13.7 billion years old, and the previous most distant gamma-ray burst had a redshift of 4.5). The GRB 050904 burst was very long in duration lasting over 200 seconds, while most bursts last only about 10 seconds.



The afterglow of GRB 050904 was discovered in the left panel of this series of images taken with the SOAR 4.1-meter telescope at infrared wavelengths. The afterglow can be seen fading away on subsequent nights, in the right two panels.(Credit: Daniel Reichart)

The observer, Reichart, is director of the Panchromatic Robotic Optical Monitoring and Polarimetry Telescopes (PROMPT), a new array of six small automated telescopes at nearby Cerro Tololo Inter-American Observatory. Funded partly by the National Science Foundation, PROMPT is optimized to observe gamma-ray bursts in six different colors, and is just entering science operations. PROMPT was not able to see the new burst, confirming the idea that the object was either deeply enshrouded in dust or that most of its light was shifted to the longer infrared wavelengths due its very high redshift. "This is when we got really excited, because this is exactly the sort of signature that you are hoping to see if you are looking for very distant objects," Reichart said.

Subsequent observations with SOAR and PROMPT ruled out the dust interpretation. Measurements of the redshift of the object with SOAR using photometric techniques suggested a value of six plus or minus 0.5, very close to the later value determined with spectroscopic techniques.

The SOAR data were first analyzed by UNC undergraduate Josh Haislip, who will be first author on the pending research publication. UNC graduate student Melissa Nysewander played a key supporting role, as did undergrads Chelsea MacLeod and Justin Kirschbrown.

"SOAR is a new telescope that is still in the advanced commissioning phase. The instrument that we used, OSIRIS, was just put on the telescope and made available for science observations a few weeks before this event," Reichart said. "In fact, I had asked Josh to do some extra research on the instrument to be prepared just in case, since my more senior students were away at a gamma-ray burst workshop! He and the other students on the team did an excellent job, and are now well-prepared to work on future bursts with SOAR and PROMPT."

OSIRIS is a multi-purpose infrared imager and spectrometer built by the Ohio State University. It is deployed at the 4.1-meter SOAR telescope as a facility infrared instrument. For the gamma-ray burst observations, OSIRIS was used in imaging mode, where its relatively wide field of view is helpful in looking for nearby stars of known brightness to help calibrate the brightness of the new afterglow.

The observations at SOAR were made by Eduardo Cypriano and Elysandra Figueredo of Brazil, working from the telescope's remote observing room about a two hour-drive away in La Serena, Chile.

continued

SOAR and PROMPT Team Up continued

They were connected by videoconference to the SOAR telescope operators on Cerro Pachón and to the collaborators at UNC.

"One of the design requirements for SOAR is that it should be able to respond quickly to gamma-ray bursts, and then use the expertise of remote observers and the excellent clear skies of the telescope site in Chile to find their optical afterglows," explained SOAR Project Director Steve Heathcote. "The discovery of the extreme distance of this gamma-ray burst is a gratifying confirmation of the possibilities opened up by this mode of operation."

Worldwide media coverage of this result included *Science*, NPR Radio, Voice of America Radio, *USA Today*, Reuters wire service, *Washington Post*, *Indianapolis Star, Chicago Sun-Times, Seattle Times, Los Angeles Times,* Independent Online - South Africa, China View (Xinhua China), ABC Online – Australia, BBC News, Space.com, International Reporter (India), and the *Chronicle of Higher Education*.

Dedicated in April 2004, SOAR is funded by NOAO (through the National Science Foundation), the Ministry of Science of Brazil, Michigan State University and UNC.

Tucson Hosts Productive Week of Outreach Meetings

Douglas Isbell

For five days in September, Tucson was the worldwide center of astronomy outreach, as the city hosted three interrelated meetings carried out with great success.

After touring Kitt Peak during the previous afternoon, the public information officers from the seven international partners in the Gemini Observatory met in the NOAO main conference room on September 12. Among the new Gemini outreach initiatives discussed were kiosk versions of the popular Gemini Virtual Tour CD-ROM, emerging efforts in podcasting, public imaging contests modeled on successful Canadian efforts, and greater use of remote video tours of Gemini in school classrooms.

The next day, approximately 20 members of the international "STARTEC" group of astronomical observatories with public outreach functions also met at NOAO, sharing experiences and lessons-learned from a variety of public programs and visitor center operations. It was also reported that a working group of the International Astronomical Union is laying the groundwork to declare 2009 as the "World Year of Astronomy," similar to the current "World Year of Physics 2005."

Then, from Wednesday through Friday, the Astronomical Society of the Pacific (ASP) held its 2005 annual meeting at the Doubletree Hotel. For the first time, the meeting focused primarily on the emerging profession of astronomy education and public outreach. More than 370 people attended the ASP meeting, which received extremely positive reviews from numerous attendees and participants; it is likely that future ASP annual meetings will carry this outreach theme onward.

Among the highlights was a standing room-only demonstration of the "astronomy in the pub" concept as implemented in

The public information officers for the international partners in the Gemini Observatory during a break in their Tucson meeting.

Australia. Led by Helen Sim, the session moved from a semi-formal presentation in a conference meeting room over to the hotel bar for a taste of the real thing, on the topic of Mars research versus Earth science concerns. NOAO hopes to implement this idea locally, perhaps in La Serena.

Special thanks to Kathie Coil, Katy Garmany, Steve Pompea, Connie Walker, former NOAO staff member Elizabeth Alvarez del Castillo, and everyone else who helped make these meetings so very productive.

An Extreme Makeover at the Kitt Peak Visitor Center

Richard Fedele

Recent improvements to the Kitt Peak Visitor Center (right image) include new tile floors, new wall paint, and a new exhibit structure for the model of the McMath-Pierce Solar Telescope (left rear of image).

The Kitt Peak Visitor Center underwent an extreme makeover worthy of a television special over the summer, completing a full interior face lift. Gone are the tile and carpet floors that covered the main exhibit area. In its place is a rolled linoleum floor in an attractive two-tone blue color. The reason for this change was not only aesthetic, but also one of durability, functionality and ease of maintenance.

The walls and doors were also painted a light blue to match the color scheme of the new floor, giving the Visitor Center a more uniform and welcoming look. With the installation of a new interior wall, ceiling tiles and a new lighting system completed in the previous year, this makeover paves the way for us to focus next on the exhibits, which will be made into one of the highlights for tourists visiting the mountain.

Not only will new astronomy exhibits be developed, but we will also be preparing exhibits on the natural history of the Kitt Peak "sky island" and an expanded exhibit on the Tohono O'odham Nation.

Visitor Center Membership Program

A growing slate of public programs and related outreach activities has spurred the Visitor Center to offer its first-ever membership program for the general public.

As it enters its fifth decade of operation, the Visitor Center has been the hub for more than two million people eager to experience the largest and most diverse collection of research telescopes assembled at any one place in the world. Two of the 25 active telescopes on Kitt Peak are dedicated solely to public viewing, via the world-renowned Kitt Peak Nightly Observing Program, with a third public telescope scheduled to open in early 2006.

The mission of the visitor center is to inspire a sense of wonder and awe about the Universe, through exhibits, tours and public programs. Our goal is to inform and educate the public daily about basic astronomy, current research themes, and the nature of the scientific process. We also explain how Kitt Peak, NOAO and the National Science Foundation have played major roles in U.S, astronomical research since Kitt Peak was founded in 1958.

Kitt Peak membership offers a variety of unique members-only benefits beyond the routine access to the observatory offered to the public 362 days per year. Membership includes star parties, new behind-the-scenes tours, a quarterly newsletter, and first notice of special events, along with discounts in the gift shop, the Nightly Observing program, classes and workshops. An additional benefit of membership is free general admission to more than 275 science centers participating in the Association of Science-Technology Centers Passport Program.

One of the main goals of this membership program is to spur community support for this unique facility. With this support we hope to ensure another four decades or more of creative and informative public outreach.

For more information, see *www.noao.edu/outreach/kpvc* or call (520) 318-8726.

Students Needed for the 2006 REU Program at Kitt Peak

Kenneth Mighell

Each summer, a group of talented college students comes to Tucson to participate in astronomy 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.

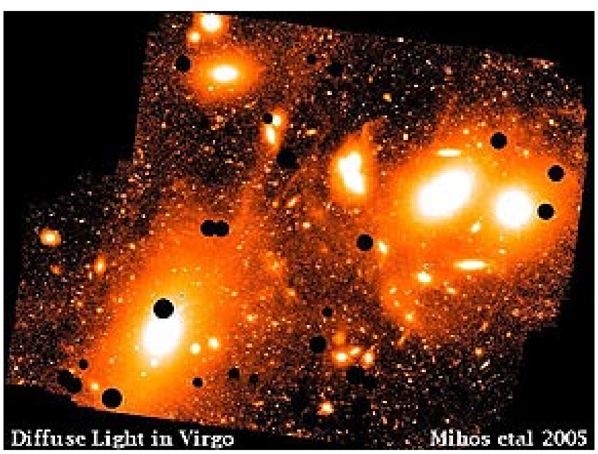
Each REU student is hired as a full-time research assistant to work with one or more staff members on specific aspects of major on-going research projects at NOAO. As part of their research activities, these undergraduates gain observational experience with KPNO telescopes, and develop expertise in astronomical data reduction and analysis. 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 through a series of oral presentations. In addition, as part of their internship experience, all six of our 2005 REU participants will be presenting posters on results from their astronomical research projects at the January 2006 American Astronomical Society meeting in Washington, DC.

We anticipate being able to support six REU positions during the summer of 2006. As required by the NSF, student participants must be citizens or permanent residents of the United States. The KPNO REU positions are full-time for 10 to 12 weeks between June and September, with a preferred starting date of early June. The salary is $470 per week and additional funds are provided to cover travel to and from Tucson at the beginning and end of the summer.

Further information about the KPNO REU 2006 program, including the online application form, is available at *www.noao.edu/kpno/reu*. Completed applications, including official transcripts and three letters of recommendation, must be submitted to NOAO no later than 25 January 2006.

Diffuse Light in the Virgo Cluster



A team led by Chris Mihos of Case Western Reserve University captured the deepest wide-field image ever of the nearby Virgo galaxy cluster, directly revealing for the first time a vast, complex web of "intracluster starlight"—nearly 1,000 times fainter than the dark night sky—filling the space between the galaxies within the cluster. The streamers, plumes and cocoons that make up this extremely faint starlight are made of stars ripped out of galaxies as they collide with one another inside the cluster. They act as a sort of "archaeological record" of the violent lives of cluster galaxies.

The Virgo image (the subject of a 19 September 2005 Case Western press release) was captured through Case's newly refurbished 24-inch Burrell Schmidt telescope at Kitt Peak National Observatory. Over the course of 14 dark moonless nights, the researchers (including John Feldmeier of NOAO) took more than 70 images of the Virgo Cluster, and then used advanced image processing techniques to combine the individual images into a single image capable of showing the faint intracluster light.