>>>NOAO/NSO Newsletter

NATIONAL OPTICAL ASTRONOMY OBSERVATORY/NATIONAL SOLAR OBSERVATORY

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Science Highlights

Director's Office

NOAO Gemini Science Center

Observational Programs

Data Products Programs

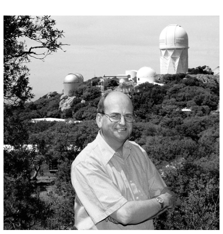
Cerro Tololo Inter-American Observatory

Kitt Peak National Observatory

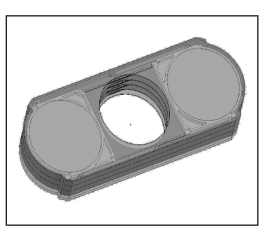
National Solar Observatory

Public Affairs and Educational Outreach

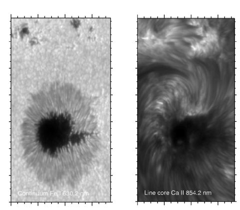
inside...



A Tribute to Jeremy Mould (Page 11)



A Request for Input on the DECam Community Filters (Page 24)



Two-Dimensional Spectropolarimetry with IBIS (Page 32)

Kitt Peak Gets a New Director

Buell T. Jannuzi has been selected for a five-year term as the director of Kitt Peak National Observatory.

"NOAO and AURA conducted a worldwide search to find the best person for this job, and we interviewed some extremely strong candidates. In the end, it was the overwhelming recommendation of the search committee and of the AURA Observatory Council that the job be offered to Buell," said Todd Boroson, acting director of NOAO.

"I look forward to leading Kitt Peak National Observatory during what is sure to be an exciting and challenging period, as we work to implement the improvements at Kitt Peak recommended by the National Science Foundation's Senior Review," Jannuzi said. "I place a high priority on regular interaction with the people of the Tohono O'odham Nation, the city of Tucson, Pima County, the state of Arizona, and the astronomical community, in order to promote and expand our mission of basic science research and education."

Kitt Peak National Observatory sits on land leased by the National Science Foundation from the Tohono O'odham Nation, whose people refer to the 6,875-foot mountain peak as Iolkam. "It is particularly important to me that we treat Iolkam with great respect, and that we strengthen our ties to the Tohono O'odham Community College and the other tribal institutions that work with us to teach their students about the wonders of the Universe," Jannuzi added.

Buell has been acting director of Kitt Peak since fall 2005. He succeeded Richard Green, who now is the director of the international Large Binocular Telescope located near Safford, AZ.

Buell earned degrees at Harvard College (A.B. Astronomy and Astrophysics) and the University of Arizona (Ph.D. in Astronomy and Astrophysics in 1990), and then spent five years as a member of the Institute for Advanced Study in Princeton, N.J. He joined the NOAO scientific staff in Tucson in 1995. His main scientific interests are the formation and evolution of galaxies, the large-scale structure of the Universe, and the physical processes that produce active galactic nuclei. Buell, age 44, and his spouse Alison Lowell Jannuzi are the parents of two boys, ages 14 and 12.

We congratulate Buell and wish him well with his new responsibilities.

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On the Cover

This image shows the magnetic field in the corona of the Sun as derived from GONG^{++} data. Magnetic field lines that are closed on the Sun are shown in blue; those that are open to interplanetary space are shown in red (negative inward-pointing field polarity) and green (positive polarity). The fields are plotted over the magnetic field image, whose flux density is indicated by a colorized grey scale from white (maximum-strength positive flux) to black (maximum-strength negative flux).

GONG^{++} continually obtains a full-disk magnetic field image every minute, and creates several products that are placed on the Web in near real-time for the research community. These products include 10-minute average images, hourly updated synoptic maps, and seven projections of the extrapolated magnetic field (also updated on an hourly basis).

Wide-Field Survey Reveals the Variable Sky

Steve B. Howell (NOAO) & Mark Huber (Lawrence Livermore National Laboratory)

We are entering an era of high interest in the variability of astronomical objects. Modern efforts in this area must not only optimize how data are collected, but also how they are stored and disseminated for most effective use—temporal information is often gleaned in hindsight, by looking back at past behavior, once interest in an object is triggered. In this article, we describe a large imaging survey with variability investigations as its primary goal.

The Faint Sky Variability Survey (FSVS) covers approximately 23 square degrees using B, V, I images. The survey was proposed by Co-Principal Investigators Jan van Paradijs and Steve Howell, et al., in response to the original call for survey proposals using the wide-field camera on the Isaac Newton Telescope (INT). The INT is part of a group of telescopes located at the Roque de Los Muchachos Observatory in La Palma, Spain. The proposal was one of six accepted, and the only one dedicated to galactic science. Extragalactic science emerged as one of the strong points of the survey. NOAO is the partner for data storage and access through its data archive program.

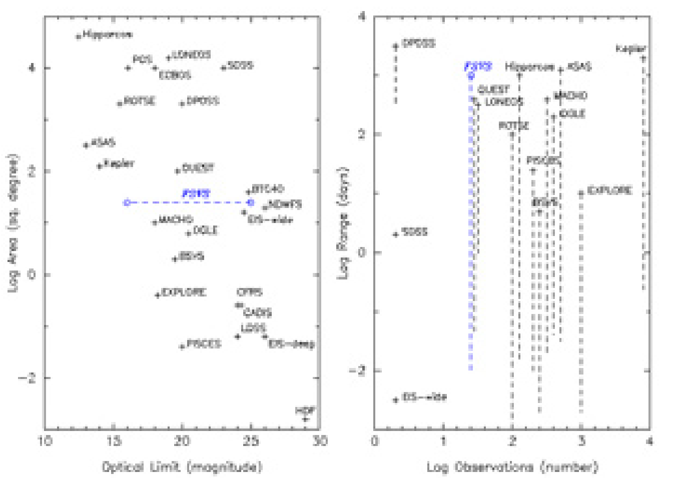


Figure 1. A comparison in area and depth between current major surveys and the FSVS. Adapted from the National Optical Astronomy Observatory (NOAO) Deep Wide-Field Survey Web pages (see *www. noao.edu/noao/noaodeep/*): SDSS, Sloan Digital Sky Survey (York et al. 2000); EIS (deep), ESO Imaging Survey (Deep) (Nonino et al. 1999); Deeprange, (Postman et al. 1998); INT-WAS, INT Wide Angle Survey (McMahon et al. 2001); HDF, Hubble Deep Field (Williams et al. 1996); NOAO, NOAO Deep-Wide Survey (Jannuzi & Dey 1999); CFRS, Canada France Redshift Survey (Lilly et al. 1995); CADIS, Calar Alto Deep Imaging Survey (Hippelein et al. 1998); CFDF,Canadian French Deep Fields (Brodwin, Lilly & Crampton 1999); LDSS, Low Dispersion Survey Spectrograph (Glazebrook et al. 1995); OGLE Optical Gravitational Lensing Experiment (Udalski et al. 1992). Note that most of these surveys have very limited or no variability information. The range in depth for the FSVS corresponds to using each individual image (as in the variability study) or the sum images. (From Groot et al. 2003)

Irene Barg and Phil Warner at NOAO were the archive architects for this survey.

The FSVS covered 79 fields at mid to high galactic latitude (and all right ascensions) to determine their content and variability. Magnitude ranges in each field are from about 16 (saturation) to 24 per exposure, with all variability information obtained in the V bandpass. Figure 1 shows the relationship of the FSVS survey to other well-known surveys. The limiting magnitude range of the FSVS is shown for a single image, or for a summed image over the V time-series sequence. The other surveys shown all have limited or no variability information.

The goal of the FSVS was the discovery and characterization of both photometrically and astrometrically variable sources in each field. Target astronomical objects were close binaries, RR Lyrae stars, rotational periods of active stars, solar system objects, optical transients such as GRBs, solar neighborhood stars, and Kuiper Belt objects. A number of other targeted programs have since made use of the data. To the magnitude depths of the FSVS survey, the sample of variable sources probes a large volume that will be populated by various interacting binaries, and will reach variables at the end of the main sequence (e.g., new CVs and late M- to early L-type dwarfs have been spectroscopically confirmed, and many W UMa stars identified via their phased light curves).

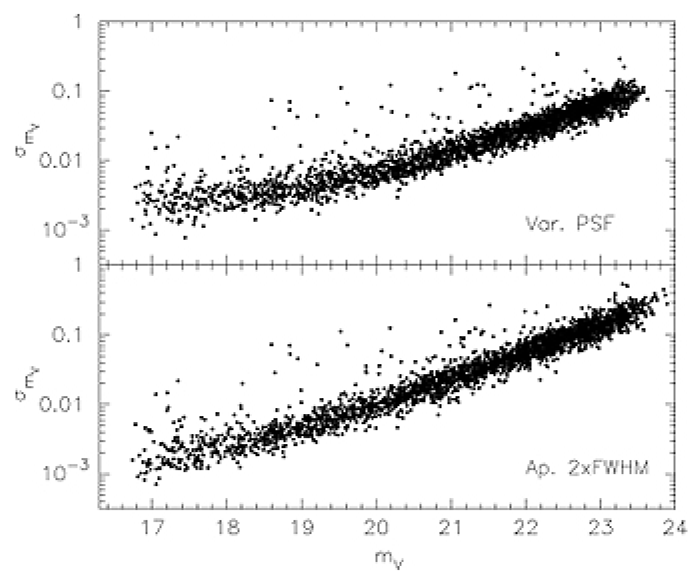


Figure 2. The standard deviation of the total light curves for point sources in a representative FSVS field. The top panel shows results using a variable PSF fitting routine to match seeing, while the bottom panel shows the results using aperture photometry with a fixed 2-arcsec seeing FWHM aperture. (From Groot et al. 2003)

continued

Wide-Field Survey Reveals the Variable Sky continued

The multi-epoch observations in the FSVS consist of 10–30 V images in each field, spanning temporal sampling of 10 minutes over a single night to a log spacing over a week or so, and a final follow-up of each field one year later. Photometry was performed on each point source in each frame, and light curves were produced for approximately one million objects. B-V and V-I colors were determined as well, and we found a number of drop out sources, i.e., sources missing a single color due to faintness. Figure 2 shows our photometric results for a representative FSVS field.

Variability

The FSVS point source selection is formally greater than 90% complete (to V=22) with small galaxies, seeing, and blends being the largest confusion sources. Our light curves are sensitive to amplitudes as small as ~0.015 in V, and we can determine good periods over the range of one day or less from the V band observations. The fraction of point sources found to be variable is 5–8% in the V=17-22 range, and at least 1% are variable down to V=24. About 50% of all variable sources show variability on time scales of less than six hours. Brighter than V=19, the dominant population is low amplitude (< 0.05 mag), blue sources with apparently random variations. These sources are probably pulsating sources such as gamma Doradus or SX Phe stars. One-third of the short time scale variable sources are not detected in either B and/or I bands. Studies of the variable population using cuts of color, brightness, galactic latitude, and the like have been performed. Examples are shown in figure 3, and an example W UMa light curve is presented in figure 4.

Extragalactic Studies

The large area, depth, and colors of the FSVS have made it ideal for searches of galaxy clusters. Our FSVS collaborators Roger Clowes (University of Central Lancashire) and Ilona Soechting (Oxford) used the FSVS images to discover nearly 600 new galaxy clusters covering a wide range in richness, and spanning 0.05 to 0.9 in redshift. Over 100 of the clusters are at z>0.6, and this new sample represents a significant addition to the currently known sample. These clusters are now being used to study quasar environments and the chemical evolution of galaxies. The FSVS cluster catalogue can be accessed at *www-astro.physics.ox.ac.uk/~iks/FSVScatalogue/home.html*.

NOAO Data Archive

Reduced images and light curves for all point sources in the FSVS survey are now available via the NOAO Science Archive at *archive.noao.edu/nsa/*. The archive also lists the most relevant published references to the survey, giving details of the data collection, reduction, and results to date.

We would like to thank Irene Barg for her significant contributions to the FSVS archive project.

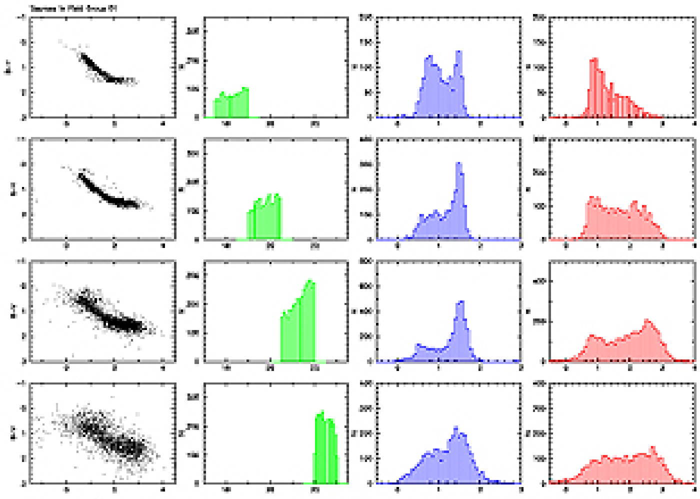


Figure 3. Color space in FSVS field 1 divided into V magnitude groups: V = 17.5–19.0, 19.0–20.5, 20.5–22.0, and 22.0–23.0 mag histograms are shown on the right as a function of V magnitude and color. (From Huber at al. 2006)

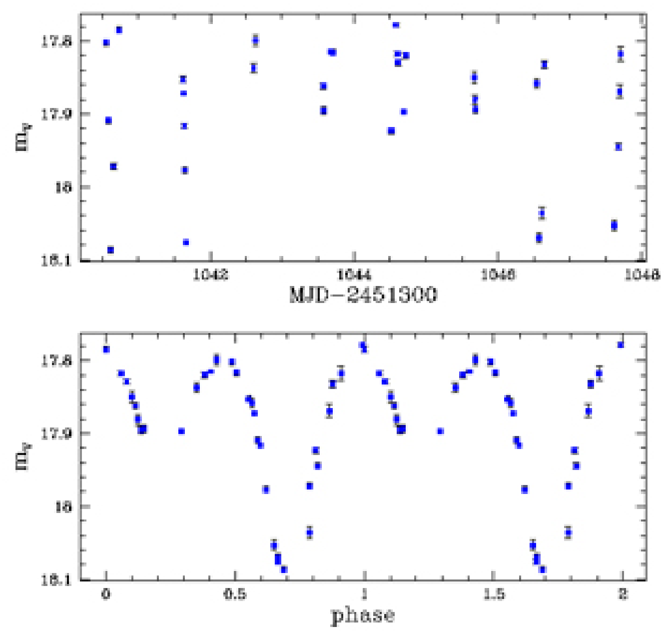


Figure 4. A sample variable (RR Lyrae) light curve from the data set, illustrating the typical time sampling for a field over a week-long timescale. Many fields will also have re-observations after 1-3 years.

A New Component of the Solar Magnetic Field

Jack Harvey, Detrick Branston, Carl Henney (NSO), Christoph Keller (Utrecht University), & the SOLIS and GONG Teams

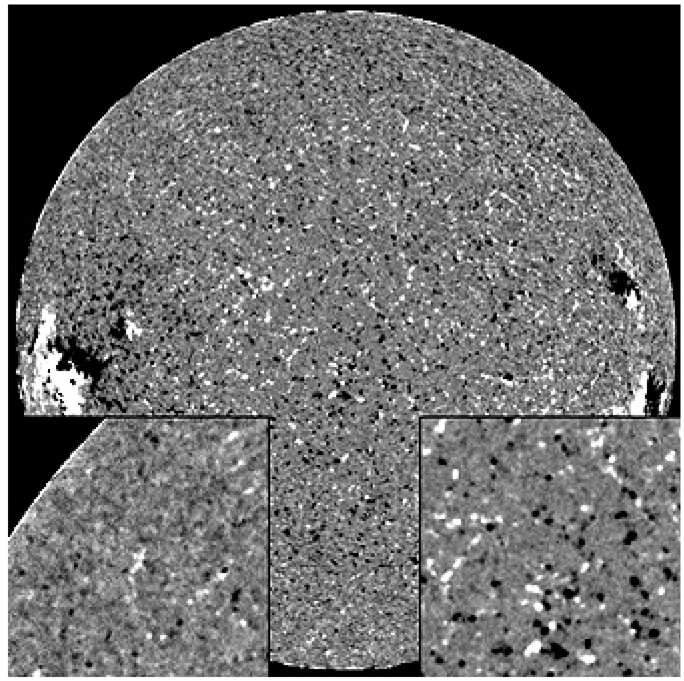
The solar magnetic field is not only the driver of solar activity, but is also a rich source of discovery about the behavior of magnetism throughout the cosmos. Since the first maps of the Sun's magnetic field were made 55 years ago, much has been learned about its structure and dynamics. Several components of the field have been defined in the solar photosphere, where observations of the Zeeman effect readily indicate the strength and orientation of the field.

The strongest field strengths (up to 6 kG) are found in dark sunspots. The umbral field is more or less vertically oriented, while the penumbra has a complicated structure with components that are nearly horizontal as well as ones that are inclined at moderate angles to the solar surface. The next most obvious magnetic components are fields in the vicinity of sunspots that comprise an active region. These fields are 1–2 kG and have a wide range of orientations. Outside of active regions, magnetic flux tends to be concentrated by convective downflows into a network of vertically-oriented, kilogauss-strength structures resembling flux tubes and flux sheets called the network field.

Some thirty years ago, an “internetwork” (IN) field component that is present everywhere in the otherwise quiet Sun was discovered in observations made at the McMath-Pierce Solar Telescope. The IN field consists of arcsec-sized flux elements that remain visible for an hour or so and frequently move as if entrained in convective flows. Because these features are small and do not contain much magnetic flux, they are hard to observe. Little is known about their intrinsic strength or orientation. Observations at the McMath-Pierce a few years ago suggested that there might be two components of the IN field: the relatively strong, mainly vertical-oriented component and a weaker, more nearly horizontal component. However, the observations were not conclusive.

With the advent of the SOLIS vector spectromagnetograph and recent improvements to the GONG magnetogram capability, we have new tools to observe the solar magnetic field with higher sensitivity and rapid cadence. Observations with both facilities show that everywhere outside of active regions, there is a nearly horizontal magnetic field that changes rapidly in time. In movies, it looks like a seething pattern of mottling. We find the orientation to be nearly horizontal because this unrecognized component is most prominent near the limb in measurements of the line-of-sight component of the magnetic field.

Correcting the observations for instrumental noise indicates that the field is inclined on average by about 74° to the local vertical. With our spatial resolution of a few arcsec, the (rapidly varying) field strength is about 1.7 G. With higher spatial resolution, the field would almost certainly be measured as stronger.



The line-of-sight component of the photospheric magnetic field observed with GONG (dark and light indicate away and toward field orientation). Insets are twice magnified sections from the upper left (left) and disk center (right). The newly observed component of the field is seen as mottling near the limb and is much weaker near disk center (being dominated there by the mixed polarity network and barely resolved IN fields). Movies show relatively slow evolution near disk center and rapid fluctuations near the limb.

The significance of this previously overlooked field component is not yet clear. Although inclined to nearly horizontal, the seething component contains significant magnetic flux. A simple calculation indicates 3×10^{22} Mx. This is equivalent to a large active region but is less flux than is present in the network.

Until we know the true field strengths and height variations, the energy content and power production in the dynamic field remain unknown. The seething field is uniformly distributed, which suggests a local origin probably related to convection. More details have been published in the *Astrophysical Journal Letters*, volume 659, page L177 (2007).

The Solar Oxygen Crisis

Hector Socas-Navarro (High Altitude Observatory) & Aimee A. Norton (NSO)

Oxygen is the third most abundant chemical element in the Universe. In the past few years, new research indicates that the well-accepted value for solar oxygen abundance should be lowered. This has sparked controversy and created a "solar oxygen crisis."

Prior to the new results, the solar oxygen abundance was assumed to be well-determined because a decade of results from helioseismology—the science of using sound waves to probe the solar interior structure and dynamics—agreed phenomenally well with theoretical models using the traditional value. If the oxygen abundance is revised (along with cascading effects on nitrogen, carbon, and neon), a thorough reworking of the solar sound speed profile and the solar interior model is needed.

The traditional value of the logarithmic oxygen abundance (log ε_o) was 8.93 dex (with the astrophysics convention that log ε_H = 12). Hydrodynamic simulations of solar granulation in 2004 by Martin Asplund and collaborators advocated lowering the oxygen abundance a factor of two to 8.66 dex. The new value presented the advantage of a better fit of the solar chemical composition within its galactic environment, since stars similar to the Sun have abundances lower than the traditional solar value. However, the lower abundance value was contradicted in 2006 by results from a 1-D semi-empirical model based on observations in CO bands, suggesting a value of 8.85, more consistent with the traditional view.

We decided to contribute to the debate by obtaining new observations that were spatially resolved and could account for the magnetic influences in the solar atmosphere. The new Spectro-Polarimeter for Infrared and Optical Regions (SPINOR) instrument was ideal to explore this topic. In October 2006, clear skies at the NSO/Sacramento Peak Dunn Solar Telescope allowed us to obtain a high-resolution (0.7 arcsec) map of the solar photosphere. For each pixel, we recorded spectro-polarimetric information for two magnetically sensitive Fe I lines and an O I triplet. The results were surprising.

Figure 1 shows a composite image of the temperature and magnetic flux density as derived from the SPINOR data. The cool feature in the lower-left corner is a 'pore'—an area whose magnetic field is strong enough to block the heat of convection but is not as large and developed as a sunspot. The pore was used as a feature that the adaptive optics could lock onto in order to stabilize the image, allowing us to achieve the spatial resolution shown in the image. We obtained a 3-D model from inverting the Fe I lines to derive the vertical stratification of temperature, density, line-of-sight velocity and longitudinal magnetic field.

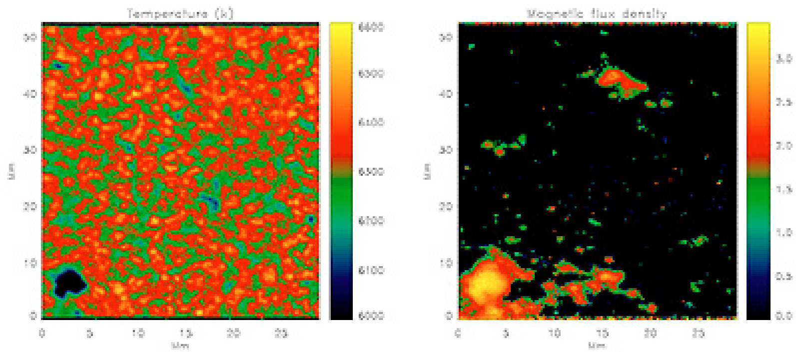


Figure 1. Maps of the temperature (left) and magnetic flux density (right) as derived from the SPINOR data.

The oxygen abundance was determined independently at each pixel of the map, using the model atmosphere from the Fe I inversion and accounting for magnetic fields where appropriate. We employed both a local thermodynamic equilibrium (LTE) and non-LTE approach to the radiative transfer. The spatial distribution of log ε_o obtained with our 3-D semi-empirical model is shown in figure 2.

There is a variation of log ε_o over the map due to fluctuations in the solar atmospheric conditions. Notice that the pore has considerably higher abundance than average. In general, magnetic concentrations exhibit higher abundances. We know of no physical reason why the abundance should show spatial variations in the solar atmosphere. We suspect the variations are caused by imperfect modeling of the atmosphere, especially in the presence of magnetic fields. This also implies that previous abundance determinations could have been biased by solar activity.

The mean values over the entire field of view are log ε_o = 8.94 (LTE) and log ε_o = 8.64 (non-LTE), with uncertainties of ~0.1 dex. If we restrict the analysis to pixels with less than 100 Gauss of magnetic flux density, we obtain log ε_o = 8.93 (LTE) and log ε_o = 8.63 (non-LTE). The non-LTE value should be the one most applicable to the solar atmospheric conditions, and its value advocates for a downward revision of the oxygen abundance, in agreement with the simulations from 2004.

See Socas-Navarro and Norton, 2007, *ApJ*, 660, L153 for more detailed information.

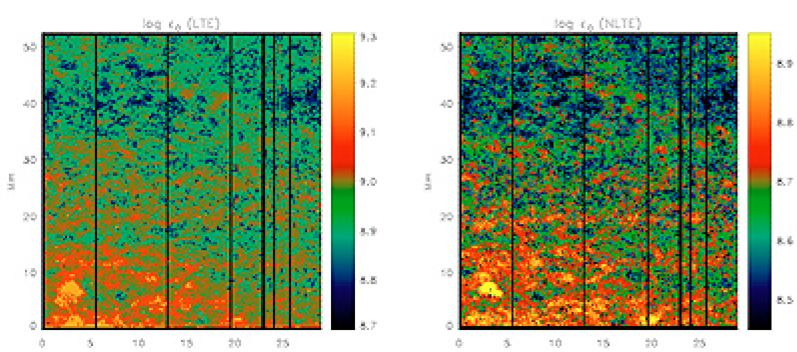


Figure 2. The logarithmic oxygen abundance as determined from LTE (left) and non-LTE (right) calculations.

Disturbing News in the Large Magellanic Cloud

Knut Olsen

The Large Magellanic Cloud (LMC), one of the nearest and most famous galaxies in the sky, is invaluable for its use as an astrophysical laboratory. The LMC is a critical calibrator of the extragalactic distance scale, it serves as the background source in many of the hunts for galactic-halo dark matter through microlensing, and it provides the most accessible environment in which to study the effects of lower metallicity on star formation and the interstellar medium. For all of these distinct purposes, a clear understanding of the LMC's global structure and dynamics is very important.

In October 2001, Phil Massey (Lowell Observatory) and I used the Cerro Tololo Inter-American Observatory (CTIO) Blanco 4-meter telescope and Hydra-CTIO fiber spectrograph to obtain spectra of 167 LMC red supergiants (RSGs), and an additional 118 RSGs in the Small Magellanic Cloud (SMC). Our primary goal was to observe the effect of low metallicity on the properties of the RSGs and compare them with stellar evolutionary predictions (see Massey & Olsen 2003).

At about the time that these observations were collected, van der Marel et al. (2002) completed a comprehensive analysis of the dynamics of the LMC's carbon stars, finding a rotation curve with a significantly different dynamical center and lower amplitude than previous studies, notably those based on HI gas observations (Kim et al. 2001). Thus, our second goal was to compare the LMC's young stellar kinematics, as traced by the RSGs, with that of the older carbon stars and the HI gas.

Our analysis of the LMC's kinematics, which appeared in the *Astrophysical Journal Letters* in February, found some surprising new results. These findings were only made evident by first combining the RSG, carbon star, and HI samples, and then accounting for the most recent accurate measurement of the LMC's proper motion (Kallivayalil et al. 2006). Because the LMC spans a large portion of the sky, its transverse motion imparts a line-of-sight velocity gradient that, left uncorrected, masks the LMC's internal kinematics; Kallivayalil et al. (2007) found that the LMC's space motion is faster than previously thought.

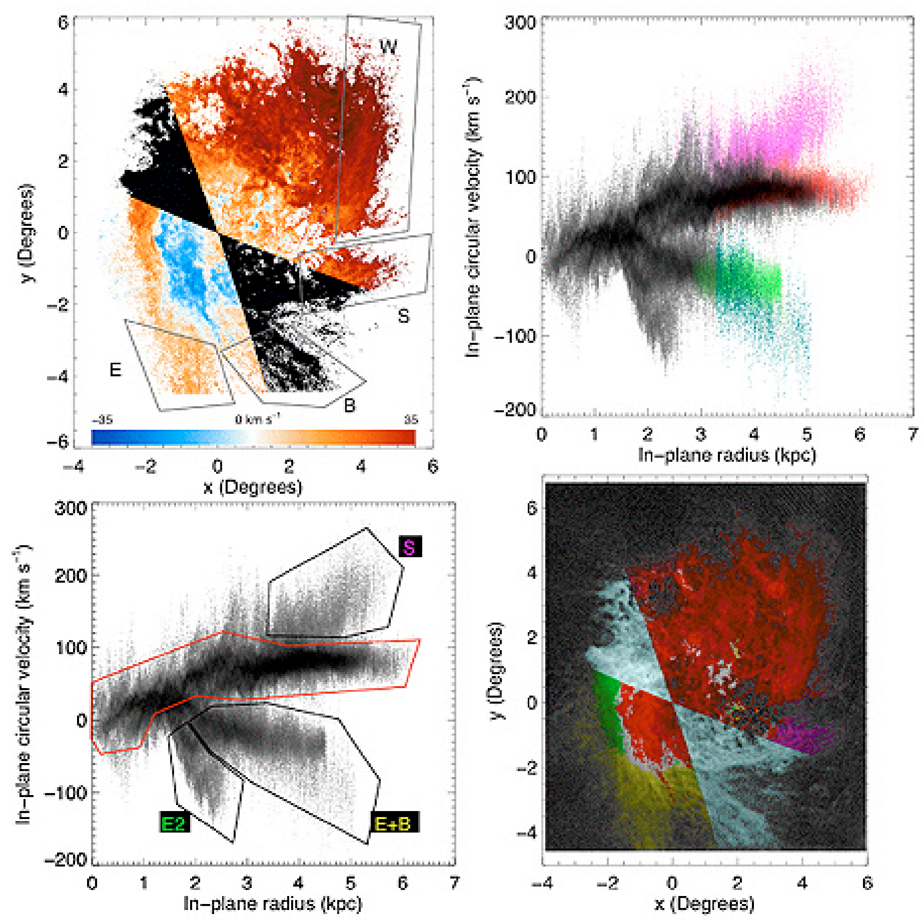


Figure 1. Kinematic signatures of the LMC's HI. Top left: The emission-weighted velocities from the ATCA+Parkes H I survey (Kim et al. 2003), minus the contribution from the LMC's space motion (Kallivayalil et al. 2006), are shown (in color in the electronic version of this *Newsletter at www.noao.edu/noao/noaonews.html*), along with regions marking the locations of previously identified H I tidal arms. The black bowtie-shaped region was excluded from the analysis. The velocity scale runs from -35 km s^{-1} $<v<$35 km s^{-1}; north is up and east to the left. The origin is fixed to the dynamical center derived from the carbon stars, while the image is projected onto the tangent plane. Top right: The velocities shown at left have been converted to in-plane circular velocities and are plotted vs. in-plane radius. Data points belonging in each of the boxes at left are shown in different colors, as follows: arm W in red, arm S in magenta, arm B in cyan, and arm E in green. Bottom left: We identified four regions with distinct kinematic signatures. The red box outlines the main LMC rotation curve and encompasses arm W. The others are a region with velocities like those of arm S, a region containing arms E and B, and a new feature with distinct kinematics that we label E2. Bottom right: The H I gas contained within the regions drawn at bottom left are plotted with different colors as follows: red for the main rotation curve, magenta for the arm S region, yellow for the combined arm E and B regions, and green for region E2. Figure and caption reproduced from Olsen & Massey (2007).

Using a solution of the carbon-star kinematics as a common reference point, we looked for the signatures of internal rotation and other motions in the LMC's HI, carbon stars, and RSGs. In the HI, Staveley-Smith et al. (2003) had previously identified arms of gas that appeared to be connected to larger-scale HI tidal features, such as the Magellanic Bridge and Magellanic Stream. Figure 1 shows that these arms clearly stand out in our

continued

Disturbing News in the LMC continued

analysis. We also found an additional body of gas that appears to have a tidal origin, and showed that the HI that traces the LMC's internal rotation is elliptical in shape and significantly asymmetric around the carbon-star dynamical center.

Comparing the carbon star kinematics with that of the HI (see figure 2), we found that many of the carbon stars on the periphery of the LMC have velocities and spatial distributions that associate them with the HI tidal arms. This is the first evidence of disturbed *stellar* kinematics in the LMC, and suggests that many more stellar velocities will be needed to decipher the LMC's internal kinematics and define its gravitational potential. The RSGs, by contrast, are entirely confined to the region of HI gas that traces the LMC's rotation. This means that the tidal arms formed longer than ~50 Myr ago, and that no star formation has occurred in them.

Our results fit well with the general picture of a tidally disturbed LMC that has been developed over the past few years through studies of the galaxy's geometrical structure. These studies have found that the LMC's disk is elongated (van der Marel 2001, van der Marel & Cioni 2001) and has significant out-of-plane structure (Olsen & Salyk 2002, Nikolaev et al. 2004), all attributed to the gravitational influence of the Milky Way and SMC.

The only problem with the internal consistency of this picture stems from the same proper-motion measurement on which the dynamical analysis is based. The proper motion measured by Kallivayalil et al . (2006) is so large that it appears that the LMC is not gravitationally bound to the Milky Way (Besla et al. 2007), meaning that the Magellanic Clouds are passing by our galaxy for the first time, leaving minimal opportunity for the Milky Way to inflict heavy damage on the LMC. We clearly have much to learn about one of our nearest neighbors!

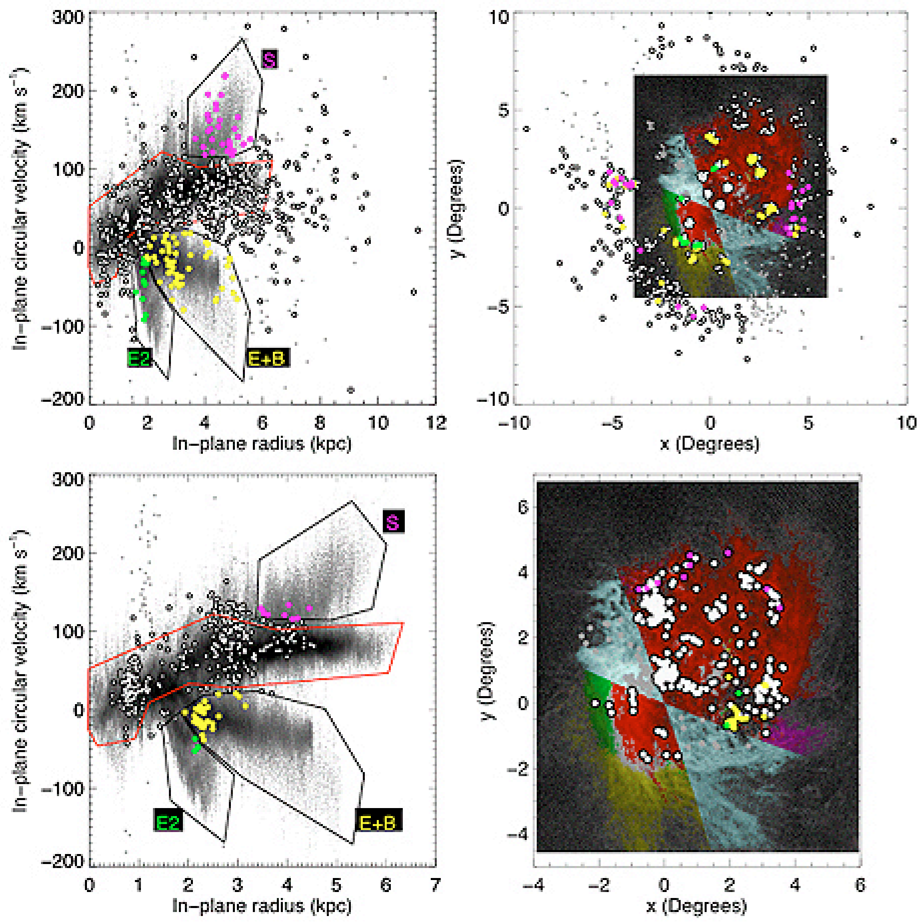
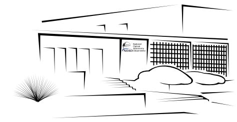


Figure 2. Comparing the LMC's stellar kinematics to that of the H I (for color figure, see the electronic version of this *Newsletter at www.noao.edu/noao/noaonews.html*). Top left: As in figure 1, the line-of-sight H I velocities converted to in-plane circular velocities are shown vs. in-plane radius; the distinct kinematic regions from figure 1 are also reproduced. Overplotted as circles are the carbon star velocities. Carbon stars falling within the regions S (magenta circles), E+B (yellow circles), and E2 (green circles) are labeled in color. The small gray points are carbon stars falling in the excluded region where in-plane circular orbits are nearly perpendicular to the line of sight. Top right: The positions of the carbon stars and H I on the sky are shown, with symbols and color labels for the carbon stars as on the left and as in figure 1 for the H I. Many of the carbon stars that have kinematics like that of the tidal H I arms are also spatially coincident with those arms, implying physical association. Bottom panels: Comparing the red supergiant kinematics to that of the H I. Symbols and colors are as in top panels. The RSGs are all confined to the HI region that traces the LMC's rotation. Figure and caption reproduced from Olsen & Massey (2007).



Implementing the Senior Review Recommendations – the Renewal Proposal Takes Shape

Todd Boroson

Since the last *NOAO-NSO Newsletter* in March 2007, we have made good progress in developing plans for how the NOAO program will change in response to the NSF Senior Review. First of all, the schedule has changed. The National Science Board granted an 18-month extension on the current cooperative agreement between AURA and NSF, resulting in a revised due date for the new proposal of 1 December 2007, rather than the June 15 deadline we had been working toward. One benefit of this extension is that we can take more time to discuss the impact of the changes with a wider swath of the community, and then incorporate this input.

We have already presented many of the ideas for the evolution of the program to various oversight groups, and some were explained in the March *Newsletter*. One of the dominant themes will be renewed emphasis on the "System"—the idea that the combination of public and private (or federally-funded and non-federally-funded) facilities can be viewed as a complete suite of capabilities, if access and strategic planning and development are coordinated effectively by discussions involving the whole community. We intend to use this concept both to address specific Senior Review recommendations, such as increased access to small and mid-sized telescopes, and to manage the priorities and evolution of the NOAO program.

In order to do this, we will make a structural change to the NOAO organization. The programs that can provide benefit to the distributed System will be managed together as a System Division. These programs will include our Major Instrumentation Program (now called System Instrumentation), the Data Products Program, our telescope Time Allocation Committee activity, the new GSMT Program Office, and a new program, called System Development, which will lead community interaction to guide the development of a more robust System. These programs, most of which are often lumped into the category of administration by program reviews, are actually science-driven activities, and not overhead of operating the organization. The goals of these programs will be more coordinated with each other and aligned with the development of the System through integrated planning discussions.

Another activity that will receive increased attention in the changing program is engagement of the community. It is obvious that this is a complex and difficult thing to do effectively. The "community" is so diverse in scientific interests and in expectations for the role of NOAO that frequent effective communication in both directions is essential.

Given limited resources, it may not be possible to ever establish a program that satisfies the entire community, but NOAO is expected to try. Thus, you will see us take many more opportunities to present and explain our program, and many more requests for input from you. We will explore new mechanisms and new media for doing this. Please be proactive in providing feedback, in whatever ways are convenient for you.

Renewing Small Telescopes for Astronomical Research (ReSTAR) Seeks Community Input

Todd Boroson

One of the strong points made by the report of the NSF Senior Review was the community's desire for more access to small and mid-sized telescopes with powerful, modern instruments.

The Senior Review recommended that "NOAO take a hard look at the capabilities of the full suite of telescopes with which NOAO is involved and to work with the community to consider new ways to use these telescopes more creatively and efficiently to execute better science programs." Moreover, "it recommends that NOAO continue to see managing the provision to the community of facilities to execute first rank science using small and mid-sized telescopes as a core part of its mission." NOAO is committed to achieving these goals and needs your help in doing so.

The full suite of telescopes with NOAO involvement includes Gemini, KPNO, CTIO and the TSIP facilities, which are predominantly 6.5 meters in aperture or larger. We have already begun to improve the infrastructure, and will explore additional capabilities at Kitt Peak

continued

ReSTAR Seeks Community Input continued

National Observatory (KPNO) and Cerro Tololo Inter-American Observatory (CTIO). We note that additional community access will be gained on NOAO 4-meter telescopes by restoring the observing time sold to operations partners when those agreements expire.

New operating modes, new instruments, or new telescopes may be needed at KPNO and CTIO. In considering how NOAO's program should move forward, we also want to explore the possibility of creating a real system from the existing telescopes operated by US institutions with apertures less than 6.5 meters. A prerequisite for all of this is knowing what the community wants—not just the underlying science goals, but the required instrumental capabilities, site conditions, operations modes, and numbers of nights.

Following discussions with our NSF program manager, Tom Barnes, I have asked Caty Pilachowski (Indiana University) to chair a community panel charged to put this information together. In addition to Caty, the membership of this committee includes Charles Bailyn (Yale University), Michael Briley (University of Wisconsin/Oshkosh and NSF observer), Chris Clemens (University of North Carolina), Deidre Hunter (Lowell Observatory), Jennifer Johnson (Ohio State University), Bob Joseph (University of Hawaii), Steve Kawaler (Iowa State University), Lucas Macri (NOAO), Randy Phelps (California State University - Sacramento), John Salzer (Wesleyan University), Michele Thornley (Bucknell University), and David Weintraub (Vanderbilt University).

This committee, named Renewing Small Telescopes for Astronomical Research (ReSTAR), will meet for the first time in mid-May and will try to conclude their activities and issue their report by the end of 2007. ReSTAR members will accomplish part of their work by bringing their wisdom to the meetings and by analyzing statistical information on requests and publications, but much of the information they gather should come from the users and potential users of these facilities. At their first meeting, the members of ReSTAR will establish a strategy for incorporating broad community input into their analysis.

ReSTAR has already set up or is planning several mechanisms for community input. There is a Web site at *www.noao.edu/system/restar/* with instructions on how to submit information and opinions. This Web site will announce meetings and track some aspects of their progress. The committee is also planning a forum at the Honolulu AAS meeting for discussion of their activity and to solicit ideas. Finally, ReSTAR may form subpanels and coordinate virtual meetings with those in the community who want to contribute input on specific disciplines or techniques. Watch the Web site for further information. NL

GSMT Program Office News - Evolution of the Science Working Group

Jay Elias

One of the primary activities of the NOAO Giant Segmented Mirror Telescope (GSMT) Program Office (the successor to the New Initiatives Office) is support of the GSMT Science Working Group (SWG). The SWG is intended to provide scientific advice through NOAO to the NSF regarding community needs for access to an extremely large telescope in the era of the Atacama Large Millimeter Array and the James Webb Space Telescope.

Specifically, these activities are expected to include:

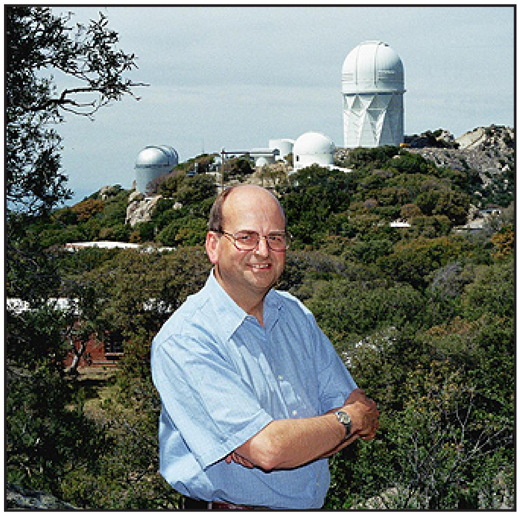
- Establishing and maintaining the national GSMT Design Reference Mission (DRM) to set scientific performance expectations for candidate designs
- Providing an independent evaluation of the community's operational needs, the costs, and the scientific sociology of a GSMT, and then helping the community to understand the implications of these elements for both the facility and the underlying capabilities of its science instruments and human resources
- Providing the results of these studies in a timely fashion as input to the next decadal survey. The NSF considers that a re-affirmation of GSMT's priority in the resulting decadal survey report is a necessary condition for commitment of construction or operations funding.

At present, the membership of the GSMT SWG is being modified to ensure that it provides a broad representation of US community interests and scientific expertise. Updates on future SWG activities can be found on the GSMT Program Office Web site at NOAO (*www.gsmt.noao.edu*).

A Tribute to Jeremy Mould

Todd Boroson & the Staff of NOAO

On April 29, Jeremy Mould stepped down as director of NOAO. Jeremy had served as the NOAO director since April 2001, and he has provided critical leadership, both within the organization and in the community. Jeremy began his directorship by writing the previous five-year proposal to manage and operate the national observatory, at a time when NOAO had just been criticized by the 2000 decadal survey for not being an "effective national organization." This criticism arose, in part, from the lack of a clear process for implementing the decadal survey recommendations for ground-based, optical/infrared (O/IR) astronomy, including particularly the Large Synoptic Survey Telescope (LSST) and the Giant Segmented Mirror Telescope (GSMT).



Jeremy took on this challenge directly, and he was instrumental in restructuring NOAO to be a more effective national organization, and one that is perceived that way in the community. Under Jeremy's leadership, NOAO staff started the NOAO LSST program and the New Initiatives Office. The NOAO LSST program became the seed of what is now the LSST project, which has just submitted a construction proposal to the NSF. The NOAO New Initiatives Office effort on GSMT merged into the ambitious project now known as the Thirty Meter Telescope (TMT). The NOAO pieces of both of these projects continue to provide input from the community and representation in these flagship projects of the near future.

Although these new programs were the most visibly changing parts of the NOAO program during Jeremy's directorship, he also oversaw and coordinated many other new activities, including astronomical site testing in Antarctica, the development of partnerships to build large-scale instruments such as NEWFIRM, the One-Degree Imager, and the Dark Energy Camera (see the CTIO section in this *Newsletter* for the latest developments with it). He also increased the attention given to data archives and our involvement in the National Virtual Observatory, the completion and commissioning of the SOAR telescope, and the transition of the NOAO Gemini Science Center, as Gemini itself evolved from a construction project to an operating observatory.

Jeremy performed all of these tasks with a keen intelligence, a sharp eye for detail, and a dry sense of humor peppered with the occasional bit of Aussie slang.

Jeremy will remain on the NOAO scientific staff, and the entire staff and organization wish him continued success in his new role.

Users Committee Seeks Input

James Lowenthal (Smith College)

The NOAO Users Committee provides the national observatory with feedback and advice on all aspects of its operations that might impact you as a user of NOAO facilities and services. The more input we receive directly from users, the more effectively we can carry out this charge.

The committee will have its 2007 annual meeting in Tucson in early October. On the agenda will be discussion of the short- and long-term instrumentation plans for KPNO, CTIO, and Gemini; implications of the NSF Senior Review for NOAO facilities and operations; and the role of NOAO facilities in the national telescope system.

2007 NOAO Users Committee
Ian Dell'Antonio, Brown University (*ian@het.brown.edu*)
James Lowenthal, Smith College (*Chair*) (*james@ast.smith.edu*)
Stacy McGaugh, University of Maryland (*ssm@astro.umd.edu*)
Ata Sarajedini, University of Florida (*ata@astro.ufl.edu*)
Nathan Smith, University of California, Berkeley (*nathans@astro.berkeley.edu*)
Angela Speck, University of Missouri (*speckan@missouri.edu*)
Nicole Vogt, New Mexico State University (*nicole@nmsu.edu*)

Please take a few minutes to fill out a form at our Web site (*www.noao.edu/dir/usercom/*) or send one of us an email about what is good and bad regarding the NOAO facilities that you use, or additional capabilities that you think NOAO should offer.

AURA Turns 50

Jeremy Mould

AURA celebrated its 50th birthday in April at its annual general meeting in Tucson. Steve Strom addressed the AURA Member Representatives, recalling the achievements fostered during AURA's "career," starting from the 36-inch, 84-inch, and McMath telescopes, through the construction of the 4-meter telescopes. Steve traced the parade of scientific discoveries from the flat rotation curves of disk galaxies to the distant supernovae that heralded dark energy.

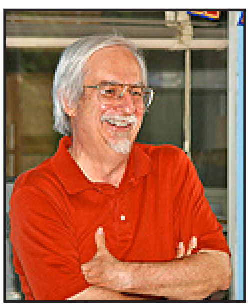
From an original seven members, AURA now includes 32 institutions and seven international affiliates. AURA has expanded its centers from Kitt Peak through Cerro Tololo Inter-american Observatory to the Hubble Space Telescope Science Institute and now the Gemini Observatory, which has an 8-meter telescope in each hemisphere.

Astronomy has swept forward on a wave of technology, and AURA has enhanced that progress with national centers that operate on the principle of peer-reviewed access for astronomers from all institutions.

Kitt Peak will celebrate its 50th birthday this time next year. Recently, I visited the Titan Missile Museum, south of Tucson, and saw technology of the 1960s frozen in time. Some of the infrastructure of Kitt Peak dates from the same era, but the capabilities of our telescopes advance continually with every new instrument built, and renewal of some key elements of that infrastructure is underway thanks to the NSF Senior Review (see pages 23 and 26 for more on this topic.)

Stephen Strom Retires From NOAO

Sidney Wolff



Steve Strom—retired! To those who know him well, that phrase will seem like an oxymoron. Officially, Steve "retired" from NOAO on 11 May 2007, but given his plans for the future, the quotation marks around the "r" word are definitely appropriate.

The key milestones in Steve's career are well known: undergraduate and graduate degrees from Harvard University, four years at Stony Brook, where he put the astronomy program on the map, followed by his first appointment at Kitt Peak (1972-1984). He then chaired the Five College Astronomy Department before returning to NOAO in 1997.

Steve's earliest series of papers took advantage of new computer capabilities to develop non-local thermodynamic equilibrium (non-LTE) models and apply them to abundance studies of early-type stars. He was briefly tempted by the study of galaxies, publishing important papers on surface brightness profiles, globular cluster systems, and compositions and composition gradients. However, even at this stage in his career, there were hints of what was to come in a handful of papers on young clusters and Herbig Ae/Be stars.

Beginning in the 1980s, his research began to focus increasingly on the formation of stars and planetary systems. As early as 1989, he, Karen Strom, and their collaborators used infrared excesses to estimate disk lifetimes to be 3-10 million years, thereby constraining the time scale for planet formation. With Suzan Edwards and other collaborators, he published the pioneering paper on the regulation of angular momentum by accretion disks. Recent papers have focused on accretion and transition disks, using their properties to obtain information about the likelihood that planets are forming within these disks.

Steve's influence on astronomy extends well beyond his research. He has always been committed to developing young people, and many of us—myself included—can trace key milestones in our careers to opportunities that Steve made possible. An illustration of his commitment to helping others to advance in the field is the fact that of his ten most cited papers, he is first author on only two—even though I know from personal experience that on many of them he was a more than an equal contributor of key ideas, and did much of the observing, data reduction, and writing.

Most significant, however, is Steve's impact on the overall strategic directions of US astronomy. He played a major role in all four of the last decadal surveys. He wrote the "Future Directions" report for NOAO, which set it firmly on the path toward what became the successful Gemini telescopes project. Even in his "retirement," Steve is committed to working to ensure that the US community gains access to a 20-30 meter class telescope. Always, Steve has inspired those who work with him to try to achieve stretch goals—never to settle for the status quo or the merely easy.

Steve has long been motivated by the vision set forth by Leo Goldberg: "*What this country needs is a truly National Observatory to which every astronomer with ability and a first-class problem can come*…" In his remarks to the annual meeting of the AURA member representatives on the occasion of AURA's 50th anniversary, Steve laid out how he thinks this vision must evolve during the coming decades, with the independent observatories and the national observatory working in partnership to build a system of complementary facilities that, taken together, will provide open, competitive access to the full range of capabilities for "every astronomer with ability and a first-class problem." This is surely a stretch goal, and our best tribute to Steve would be to continue on the path that he has so effectively advocated.

In addition to continuing his research and participating in the science working group for the 20-30 meter telescope, Steve plans to devote more time to his other passion—photography of the southwest—as well as writing a popular guidebook to the observatories of the region in partnership with Doug Isbell of NOAO. Check out his Web site to see examples of his photography (*www.stephenstrom.com*).

Recent Spectroscopic Highlights from Gemini

Verne V. Smith

The Gemini telescopes offer US astronomers access to queue observing on 8-meter class facilities with a powerful suite of instruments and full-sky coverage. Among these instruments are a capable set of optical, near-infrared, and mid-infrared spectrographs deployed at both Mauna Kea and Cerro Pachón.

At Gemini North, the spectroscopic opportunities include those in the optical with GMOS, having R=670–4400, multi-object capability, as well as an IFU mode. In the near-infrared (from ~1–5 microns) there is NIRI (R=500–1600) or NIFS (~1–2.5 microns with R=5000). Both spectrographs are capable of accepting the adaptive optics-corrected beam from Altair in either natural or laser guide-star modes. In the mid-infrared, from 8–26 microns, Gemini offers Michelle with R=100–30,000. In addition, the very high spectral resolution mid-infrared echelle TEXES (with R=100,000) has been offered twice (in 2006B and 2007B) as a visitor instrument and may be offered in future semesters. It is worth noting that the capability provided by TEXES on Gemini fulfills one of the scientific goals laid out in the Aspen project.

At Gemini South, the available spectrographs include another GMOS, with capabilities very similar to the one in the North, as well as the 1- to 5-micron capable spectrograph GNIRS (R=1700, 6000, 18,000), which also has an IFU mode. In the near-infrared, there is T-ReCS for R~100 or 1000 spectroscopy from 8–26 microns.

Potential users should check the Gemini instrument Web site at *www.gemini.edu/sciops/instruments/instrumentIndex.html* for the latest news about instrument capabilities. The following two articles highlight recent scientific results based upon spectroscopy from the Gemini telescopes.

A Direct Distance to M33

Alceste Bonanos (Carnegie Institution of Washington)

The first direct distance to a detached eclipsing binary in M33 was recently determined by the DIRECT Project (Bonanos et al. 2006 ApJ, 652, 313), using data obtained in part at Gemini. The goal of the DIRECT project is to obtain accurate distances to two important galaxies in the cosmological distance ladder, M31 and M33. The long-term plan is to replace the current anchor galaxy of the extragalactic distance scale, the Large Magellanic Cloud, with galaxies more similar to those used by the Hubble Space Telescope Key Project (Freedman et al. 2001, *ApJ*, 553, 47).

The DIRECT Project has involved three phases: the initial survey of M31 and M33 to search for bright and detached eclipsing binaries (~200 nights with the F. L. Whipple Observatory 1.2-meter telescope and the MDM 1.3-meter telescope at Kitt Peak during 1996–1999), the follow-up of the best candidates to obtain precise light curves (27 nights with the Kitt Peak National Observatory 2.1-meter telescope in 1999 and 2001), and finally spectroscopic follow-up of the brightest system (V=19.5 mag) for 4 nights with the Keck II 10-meter telescope and 19 hours of queue time with the Gemini North 8-meter telescope. In this targeted system, absorption lines from both stars are clearly resolved in the spectra, making it a double-lined spectroscopic binary.

Careful modeling with non-local thermodynamic equilibrium model spectra yielded effective temperatures $Teff_1$ = 37000 ± 1500K and $Teff_2$ = 35600 ± 1500K. The primary star is defined as the hotter star eclipsed at phase zero. We measured radial velocities from the spectra and, using the photometric and radial-velocity curves, derived

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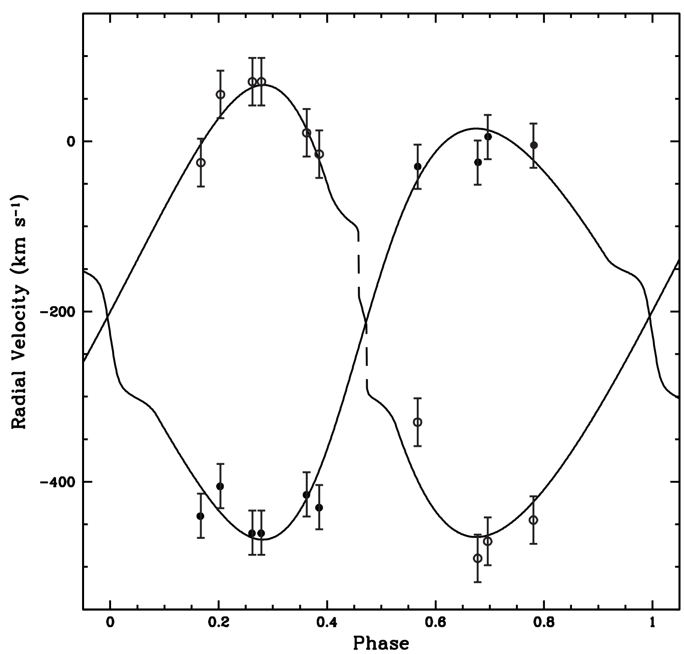

Radial velocities for the detached eclipsing binary in M33 measured by two-dimensional cross correlation with synthetic spectra. The model fit is from the Wilson-Devinney program. Error bars correspond to the rms of the fit: 26.0 km/s for the primary (filled circles) and 28.0 km/s for the secondary (open circles). The four measurements at quadrature were taken thanks to the queue-observing capability of Gemini.

A Direct Distance to M33 continued

the parameters of the component stars. The radial velocity curve is presented in figure 1. The rms residuals are 26.0 kilometers per second (km/s) for the primary and 28.0 km/s for the secondary star. Note that ~4 hours of observations per epoch were required for radial velocity measurements, a large investment of 8- to 10-meter class telescope time. We find the components to be O7 type stars with masses: $M_1 = 33.4 \pm 3.5\ M_{Sun}$, $M_2 = 30.0 \pm 3.3\ M_{Sun}$ and radii $R_1 = 12.3 \pm 0.4\ R_{Sun}$, $R_2 = 8.8 \pm 0.3\ R_{Sun}$.

Additional infrared photometry from Gemini helped constrain the extinction to the system and yielded a distance modulus of 24.92 ± 0.12 (964 ± 54 kpc), which is 0.3 mag longer than the Key Project distance to M33. This possibly indicates unaccounted sources of systematic error in the calibration of certain distance indicators and demonstrates the importance of accurately calibrating the distance scale and determining H_0, which are vital both for constraining the dark energy equation of state (Hu, W. 2005, in ASP Conf. Ser. 339, Observing Dark Energy, S. C. Wolff & T. R. Lauer [San Francisco: ASP], 215) and complementing the cosmic microwave background measurements from the Wilkinson Microwave Anisotropy Probe (WMAP; Spergel, D. N., et al. 2006, *ApJ*, submitted (astro-ph/0603449).

GNIRS Infrared Spectroscopy and the Origins of the Peculiar Hydrogen Deficient Stars

Verne V. Smith

The Gemini Near-Infrared Spectrograph (GNIRS) recently conducted fascinating observations of a normally rare isotope of oxygen, ^{18}O, in the atmospheres of two classes of unusual stars. The GNIRS spectra have provided the key clue in understanding the origins of these stars. The peculiar stars in question are the hydrogen-deficient carbon (HdC) stars and their variable cousins, the R Coronae Borealis (RCrB) stars. These particular stellar types are characterized by having almost no hydrogen, but quite large amounts of carbon.

Two scenarios have been suggested to account for these chemically unusual classes of H-poor yet C-rich stars. In the first, it is postulated that in the normal transition from a luminous, cool asymptotic giant branch (AGB) star to its later planetary nebula stage, a final pulse of triple-alpha helium burning occurs in a thin shell near the stellar surface, with the observable stellar atmosphere being polluted by the products of this burning. The combination of He-burning, to produce carbon, coupled to the mass loss of a hydrogen-rich envelope in the AGB-PN transition results in the C-rich and H-poor characteristics.

In the second formation scenario, a binary system consisting of a carbon-oxygen white dwarf (CO-WD) and a helium white dwarf (He-WD) merge through a combination of magnetic braking and gravitational radiation. Such a white dwarf binary system results from the evolution of two normal low- to intermediate-mass stars in a relatively close binary system. The merging sequence would release large amounts of energy, driving nuclear reactions that could produce oxygen-18.

Using GNIRS infrared spectra obtained with Gemini South, Geoffrey Clayton (Louisiana State University) and an international team of observational astronomers and nuclear astrophysicists detected significant enhancements of oxygen-18 in seven HdC and RCrB stars; the overabundances of oxygen-18 are enormous, being several hundred to a thousand times larger than in the Sun when compared to the usually more abundant oxygen-16 isotope. The spectra showing the detection

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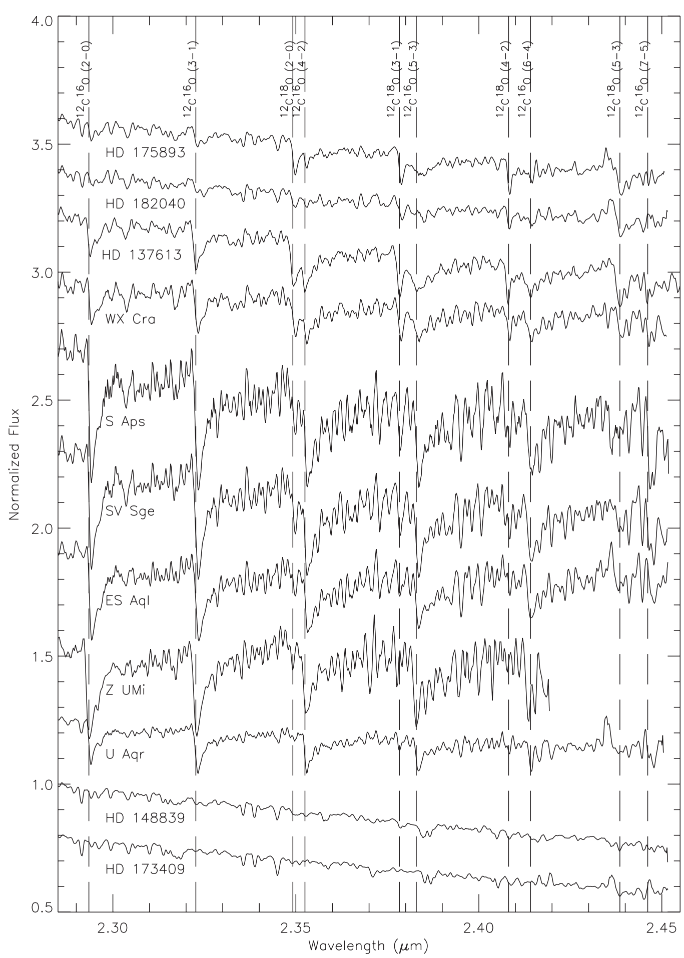


GNIRS spectra of HdC stars (top three and bottom two) and RCrB stars (the six in the middle) with molecular absorption from CO indicated. The bandheads due to both $^{12}C^{18}O$ and $^{12}C^{16}O$ are indicated.

GNIRS Infrared Spectroscopy continued

of oxygen-18, via molecular absorption from $^{12}C^{18}O$ is shown in figure 1. This absorption is detected due to the isotopic shift from absorption due to what is usually the much more abundant $^{12}C^{16}O$, which is also indicated in the figure. In modeling the two possible formation mechanisms, Clayton and collaborators conclude that the oxygen-18 can only survive in significant quantities as a result of the binary white dwarf merger picture. In the shell helium-burning pulse, the temperatures are so hot for such a length of time as to burn virtually all of the oxygen-18 to neon-22.

This work provides key input for attempts to understand the physics involved in white dwarf mergers. Such mergers in binaries with more massive components are believed to be one possible source of supernovae of type Ia (SNe Ia). Supernovae of this type provided the first evidence for an accelerating universe, so any data that pertain to white dwarf mergers is potentially significant in understanding the physics involved in these very important SNe Ia systems.

The Gemini-Subaru Time Exchange Program

Verne V. Smith

The NOAO Gemini Science Center (NGSC) would like to remind US astronomers about the Gemini-Subaru time-exchange program. This agreement exchanges service observing time at Subaru for queue observing time at Gemini. This program is currently in operation for semesters 2007A and 2007B.

The Subaru instruments currently available to the Gemini community are Subaru Prime Focus Camera (Suprime-Cam), which offers wide-field optical imaging, and the Multi-Object Infrared Camera and Spectrograph (MOIRCS) for near-infrared imaging and multi-object spectroscopy. In exchange, the Subaru community has access to both GMOS instruments (North and South) and NIFS, in queue mode only. Joint proposals for Gemini time between the Japanese community and Gemini partners are permitted and encouraged. See the Gemini Call for Proposals for more information on applying for time on Subaru through Gemini at *www.gemini.edu/sciops/ObsProcess/ObsProcIndex.html*.

This agreement is likely to be continued for semester 2008A, so keep an eye on both the Gemini Web site (*www.gemini.edu*) and the NGSC Web site (*www.noao.edu/usgp*) for current information about the Subaru exchange program. Semester 2008A proposals to NOAO will be due near the end of September 2007. US users interested in applying for Subaru time should keep this agreement in mind when planning their 2008A proposals. Questions about the Subaru exchange program can be directed to Verne Smith (*vsmith@noao.edu*).

Technical Reviews of US Gemini Observing Proposals

Dara Norman, Ken Hinkle & Dick Joyce

Everyone who submits an NOAO observing proposal knows that the proposal will be reviewed and ranked on the basis of scientific merit by a Time Allocation Committee (TAC). Each Principal Investigator (PI) then receives notification of the TAC decision and a summary of the discussion of the proposal. It is less well known that a complementary and equally important review of the technical aspects of the proposal occurs in parallel with the TAC process.

Each proposal is read prior to the TAC meeting by a member of the NOAO scientific staff, who assesses its technical feasibility based on information provided by the PI and then writes a summary report which is made available to the TAC. This is usually a matter of verifying that the telescope/instrument configuration and observing time requested in the proposal are consistent with achieving the scientific goals of the proposal. Most proposals have no technical problems. Many simple problems can be resolved after a discussion with the PI and TAC notification of any changes. In some cases, reviewers are also able to make suggestions to improve the efficiency of the proposal. The goal of this process is to ensure that PIs get the highest-quality data with which to achieve their scientific goals, and avoid the awarding of time to scientifically meritorious proposals which turn out to be impossible to carry out.

Almost all Gemini proposals are for queue-based observations. While these observations are carried out by Gemini staff, the technical reviews are done by the National Gemini Offices (NGOs). The NGO for the United States is the NOAO Gemini Science Center (NGSC). Each NGSC scientific staff member is responsible for reviewing proposals for at least one Gemini instrument; multiple reviewers are assigned to instruments with large numbers of proposals, such as GMOS or GNIRS.

Because the Gemini queue mode observations are ultimately carried out exactly as specified in the Phase II version of the proposal, and the fundamental parameters (targets, observing constraints, total requested time) are usually carried over from the Phase I proposal, the technical review of Gemini proposals is quite comprehensive, including a check of:

- The target list and compliance with any RA restrictions set by Gemini for the instrument
- The appropriate telescope/instrument combination for the proposed observations
- Instrument parameters (filters, slit widths, spectral resolution) which are both appropriate to the science and possible with the instrument
- Observing condition constraints appropriate to the proposed observations
- Observation times (using the Integration Time Calculator) required to achieve the desired signal-to-noise for the specified

continued

Technical Reviews of US Gemini Observing Proposals continued

target brightness under the observing conditions requested, including overheads for acquisition, readout, and telescope motions. The total time is checked against the overall time requested for the proposal
- Lunar phase requirements and (for bright-time proposals) lunar position with respect to the targets to identify any time constraints
- Proper transcription of proposals submitted using the Gemini Phase I Tool (PIT) into the NOAO form which is seen by the TAC

However, a technical review can be accurate only if sufficient information is provided to the reviewer, and so PIs should take care to provide all relevant details for evaluation. For example, PIs who use the Integration Time Calculator to determine exposure time should provide all input parameters in the Technical Section of the proposal. This level of detail allows the reviewer to easily understand how exposure times were determined and to identify any problems that might prevent the PI from reaching their stated goals.

While the technical review can be time consuming, we have found that identifying potential problems as early as possible in the proposal process facilitates our ability to work with the PI and the TAC to alleviate them. In this light, the best technical review is one that occurs prior to the submission of the proposal. We encourage PIs who are considering challenging scientific programs, or who may be uncertain whether a particular instrument is appropriate for their program, to consult with the NGSC instrument contact well in advance of the proposal deadline. This will not only result in a stronger proposal, but will also make the job of technical review during the TAC process that much easier. A list of NGSC staff contacts is available at *www.noao.edu/usgp/noaosupport.html*. NL

Phoenix Leaves Gemini South

The last night for the Phoenix spectrograph at Gemini South was 6 March 2007, concluding more than five years of use on Gemini. During this time, the instrument exhibited a high level of performance thanks to the attentive support of NOAO and Gemini staff.

High-resolution infrared spectra obtained with Phoenix on Gemini have produced a large number of scientific papers. At the time of this article, Phoenix has led to the second highest number of peer-reviewed papers from US community usage of Gemini (exceeded only by GMOS on Gemini North), with many more papers to come. Some of the scientific results include detailed studies of physical conditions and chemistry of gas and stars in obscured regions, such as the Galactic center or star-forming regions. Phoenix spectra have been used to determine the kinematical and physical structure in circumstellar gas, such as that found around Eta Carinae. High-resolution infrared spectra provided by Phoenix resulted in radial velocity measurements that were used to establish the first-ever direct measurements of brown-dwarf masses and radii.

Phoenix was scheduled to be moved to the SOAR 4.1-meter telescope and, if everything had proceeded as planned, to be available to the SOAR community in semester 2008A. However, as this article was going to press, an accident occurred with GNIRS that rendered it out-of-service for the 2007B semester. Because of this, Phoenix is now slated to remain at Gemini South for the 2007B semester (see the link to the related article at *www.gemini.edu*).

—Katia Cunha & Ken Hinkle

Altair and the Laser Guide Star System

Robert Blum

Altair, the facility adaptive optics system at the Gemini North telescope, has been in routine science use and continues to provide excellent images in Natural Guide Star (NGS) mode. In semester 2007A, basic commissioning and science verification of the Altair Laser Guide Star (LGS) system were completed.

The LGS may be used for targets with zenith distances up to 50 degrees (elevation > 40 degrees). Because the LGS system needs high throughput and stability when it is launched to the atmospheric sodium layer at 90 kilometers, good conditions are required (IQ=70, CC=50). The LGS will be used regularly throughout the semester, one to two weeks per month, depending on the science balance coming out of the International Time Allocation Committee.

The LGS system can be used to feed either the facility near-infrared imager NIRI (for imaging or long-slit spectroscopy) or the integral-field spectrometer NIFS (for IFU spectroscopy). It is expected that normal queue observing with Altair+LGS, as well as Altair+NGS, will continue in 2007B. Please see *www.gemini.edu/sciops/instruments/altair/altairIndex.html/* for details.

NGSC Instrumentation Program Update

Verne V. Smith & Mark Trueblood

The NGSC Instrumentation Program continues its mission to provide innovative and capable instrumentation for the Gemini telescopes in support of frontline science programs. This article gives a status update on Gemini instrumentation being developed in the US, with progress since the March 2007 *NOAO/NSO Newsletter*.

NICI

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

NICI had its first commissioning run on the Gemini South telescope in late February. On its first night, NICI successfully closed the adaptive optics loop on the internal 85-element curvature-sensing AO system and produced acceptable Strehl ratios and FWHM performance. Although some software bugs, cryocooler issues, and other items will be addressed in a future commissioning run scheduled for June, Gemini instrumentation staff appear to be pleased overall with the instrument's performance to date.

As of the end of March, MKIR reports that 99 percent of the work toward NICI final acceptance by Gemini is complete.

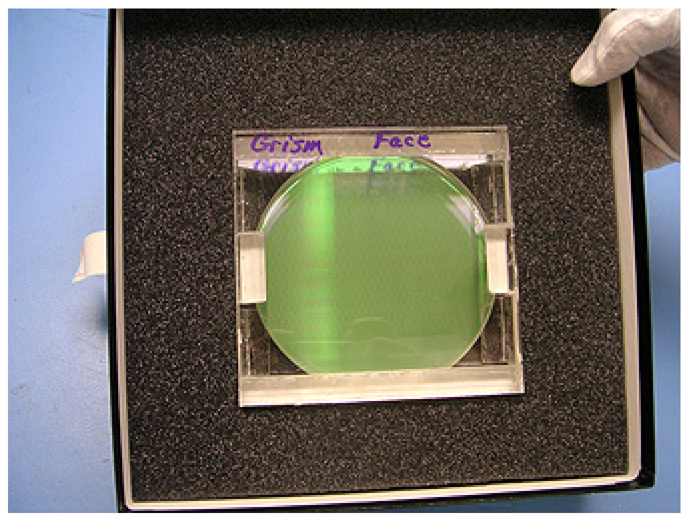
FLAMINGOS-2

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

The NGSC held a Quarterly Review of the FLAMINGOS-2 instrument at Gainesville with the University of Florida Team on April 12. The instrument continues in the integration and testing phase of the project. The Team received the R~3000 grating (shown in the figure), and it passed a visual inspection. The matching prism is expected to be delivered in May, at which time both optical elements will be placed with an intervening air space in a single optical mount.

Instrument team efforts are focused on improving image quality, mechanical reliability, and reducing electronic noise. Previous image quality issues appear to have been addressed, and some problems with mechanisms have been diagnosed and fixed.

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



The R~3000 transmission grating for Flamingos-2 shown in its protective case. A separate cross-dispersing prism has been ordered and will be mated in a cell with this grating to form the grism.

2007B TAC Members

Galactic (30 April-1 May 2007)
Ata Sarajedini, Chair, University of Florida
Jeff Valenti, Chair, STScI
Sidney Wolff, Chair, NOAO
Adam Burgasser, MIT
John Carr, Naval Research Lab
Geoffrey Clayton, Louisiana State University
Don Garnett, University of AZ, Steward
Ed Guinan, Villanova University
Chris Johns-Krull, Rice University
Jennifer Johnson, Ohio State University
Steve Kawaler, Iowa State University
Greg Laughlin, University of California, Santa Cruz
Kevin Luhman, Pennsylvania State University
Mario Mateo, STScI
Randy Phelps, California State Sacramento
Bart Pritzl, Macalester College
Nathan Smith, University of California, Berkeley
Eva Villaver, STScI

Solar System (2 May 2007)
Caitlin Griffith, Chair, University of Arizona, LPL
Anita Cochran, McDonald Observatory
Drake Deming, NASA GSFC
Matthew Holman, Harvard-Smithsonian CfA
Renu Malhotra, University of Arizona, LPL
David Trilling, University of Arizona, Steward

Extragalactic (3-4 May 2007)
Dave De Young, Chair, NOAO
Richard Green, Chair, LBTO
Tod Lauer, Chair, NOAO
John Blakeslee, Washington State University
Alison Coil, University of AZ, Steward
John Feldmeier, Youngstown State University
Andy Fruchter, STScI
Mauro Giavalisco, STScI
Michael Gregg, Lawrence Livermore National Lab
Robert Knop, Vanderbilt University
Mark Lacy, Spitzer Science Center
Henry Lee, Gemini Observatory
Tom Matheson, NOAO
Casey Papovich, University of AZ, Steward
Tom Statler, Ohio University
Alan Stockton, University of Hawaii
Pieter van Dokkum, Yale University
Donna Weistrop, UNLV

NOAO Survey Program Call for Proposals–Letters of Intent Due July 31

Tod R. Lauer

Proposals for the next round of the NOAO Survey Program are due 15 September 2007. Investigators interested in applying for time under the Survey Program MUST submit a letter of intent (by email to *surveys@noao.edu*) by 31 July 2007 describing the broad scientific goals of the program, the members and institutions of the survey team, 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 also provide 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 more detailed description of the 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 August 2007.

2007B Proposal Process Update

Dave Bell

NOAO received 403 observing proposals for telescope time during the 2007B observing semester. These included 163 proposals for Gemini, 114 for KPNO, 87 for CTIO, 34 for Keck, 12 for MMT, 9 for Magellan, and 6 for HET. Thesis projects accounted for 27 percent (107 proposals) of those received, and 20 proposals requested long-term status. Time-request statistics by telescope and instrument appear in the tables that follow. Subscription rate statistics will be published in the September 2007 edition of this *Newsletter*.

As of this writing, proposals are being reviewed by members of the NOAO Time Allocation Committee (see the listing of members). We expect all telescope schedules to be completed by 8 June 2007, and plan to notify Principal Investigators of the status of their requests at that time. Mailed information packets will follow the email notifications by about two weeks.

Looking ahead to 2008A, Web information and forms will be available online around August 15. The September *Newsletter* will contain updated instrument and proposal information.

2007B Instrument Request Statistics by Telescope

Gemini Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
GEM-N		**117**	**159**	**176.9**	**47.6**	**27**	**1.1**
	GMOSN	48	68	69.1	43.5	63	1
	HIRES	1	1	1	0	0	1
	MOIRCS	5	5	7.8	0	0	1.6
	Michelle	15	18	10.6	0.3	3	0.6
	NIFS	12	15	14.1	1	7	0.9
	NIRI	31	38	46.9	2	4	1.2
	SuprimeCam	1	1	0.8	0.8	100	0.8
	TEXES	13	13	26.6	0	0	2
GEM-S		**55**	**79**	**89.9**	**31.1**	**35**	**1.1**
	GMOSS	21	33	34.1	25.8	76	1
	GNIRS	22	27	38.3	2	5	1.4
	TReCS	14	19	17.6	3.3	19	0.9

Kitt Peak National Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
KP-4m		**68**	**78**	**280.8**	**87.5**	**31**	**3.6**
	ECH	4	4	15	0	0	3.8
	FLMN	6	6	28	6	21	4.7
	IRMOS	2	2	7	0	0	3.5
	MARS	5	8	20.1	8	40	2.5
	MOSA	17	22	64.2	42	65	2.9
	NEWFIRM	16	16	68.5	8.5	12	4.3
	RCSP	16	17	64	23	36	3.8
	SQIID	1	1	2	0	0	2
	VIS	2	2	12	0	0	6
WIYN		**21**	**25**	**66.9**	**28**	**42**	**2.7**
	DSPK	1	1	3	3	100	3
	HYDR	9	11	31	11	35	2.8
	MIMO	6	8	11.9	8	67	1.5
	OPTIC/ Other	2	2	10	6	60	5
	SPSPK	2	2	9	0	0	4.5
	WTTM	1	1	2	0	0	2
KP-2.1m		**14**	**16**	**81.2**	**20**	**25**	**5.1**
	CFIM	5	5	21	7	33	4.2
	GCAM	5	5	26	13	50	5.2
	SQIID	2	2	3.2	0	0	1.6
	VIS	2	4	31	0	0	7.8
KP-0.9m		**3**	**3**	**18**	**14**	**78**	**6**
	MOSA	3	3	18	14	78	6

Cerro Tololo InterAmerican Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
CT-4m		**58**	**65**	**236.2**	**79.5**	**34**	**3.6**
	HYDRA	14	15	62	13	21	4.1
	ISPI	8	8	28	0	0	3.5
	MOSAIC	21	24	87.2	51.5	59	3.6
	RCSP	17	18	59	15	25	3.3
SOAR		**13**	**13**	**31.6**	**8**	**25**	**2.4**
	OSIRIS	6	6	19.5	0	0	3.2
	SOI	7	7	12.1	8	66	1.7
CT 1.5m		**5**	**6**	**39**	**9**	**23**	**6.5**
	CPAPIR	1	1	20	0	0	20
	CSPEC	4	5	19	9	47	3.8
CT 1.3m		**4**	**8**	**16.6**	**0.9**	**5**	**2.1**
	ANDI	4	8	16.6	0.9	5	2.1
CT 1.0m		**2**	**4**	**30**	**30**	**100**	**7.5**
	CFIM	2	4	30	30	100	7.5
CT 0.9m		**10**	**18**	**74.8**	**26.2**	**35**	**4.2**
	CFIM	10	18	74.8	26.2	35	4.2

Community Access Observatories

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Keck-I		**16**	**16**	**24**	**8**	**33**	**1.5**
	HIRES	10	10	17.5	4	23	1.8
	IF	2	2	1.5	0	0	0.8
	LRIS	3	3	4	4	100	1.3
	NIRC	1	1	1	0	0	1
Keck-II		**18**	**19**	**26.5**	**2**	**8**	**1.4**
	ESI	5	6	8	2	25	1.3
	NIRC2-LGS	2	2	3	0	0	1.5
	NIRC2-NGS	2	2	2.5	0	0	1.2
	NIRSPAO-LGS	1	1	0.5	0	0	0.5
	NIRSPEC	6	6	9.5	0	0	1.6
	OSIRIS-LGS	2	2	3	0	0	1.5
HET		**6**	**9**	**41.3**	**0**	**0**	**4.6**
	HRS	3	3	8.2	0	0	2.7
	LRS	2	4	2.5	0	0	0.6
	MRS	2	2	30.6	0	0	15.3
Magellan-I		**4**	**4**	**9**	**4**	**44**	**2.2**
	IMACS	4	4	9	4	44	2.2
MMT		**5**	**5**	**10**	**2**	**20**	**2**
	LDSS3	1	1	2	0	0	2
	MIKE	4	4	8	2	25	2

The NOAO Science Archive: Public Access to zBoötes and FSVS

Christopher J. Miller

The deployment of the NOAO Science Archive (NSA) was announced on 9 April 2002. At that time, the NSA contained data from three NOAO Surveys: the NOAO Deep Wide-Field Survey (NDWFS), the Resolved Stellar Content of the Local Group Survey, and the Deep Range Survey. Since then, the number of survey holdings has quadrupled, growing from ~2,000 FITs images to nearly 70,000 images (68,992 to be exact). This major growth can be attributed to both the efforts of the Survey Principal Investigators (PIs), who have provided the reduced, science-quality images, and the hard work of the NOAO Data Products Program (DPP) archive team.

We are pleased to announce the latest additions to the NSA: the Faint Sky Variability Survey (FSVS) and zBootes.

The FSVS provides data over 23 square degrees at moderate-to-high galactic latitudes for studying faint stellar populations and their variability. Spanning magnitudes 16-24 across the optical regime using the B, V, and I filters, it also has V-band time-domain data over tens of minutes to years. Jan van Paradijs (University of Amsterdam) and Steve Howell (NOAO) are Co-PIs on this NOAO Survey. For more information on the FSVS data products, see Groot et al., 2003 *MNRAS*, 339, 427.

zBoötes is a z-band survey of the NDWFS Boötes Field using the Steward Observatory 2.3-meter Bok telescope and the 90Prime imager. The zBoötes imaging covers 7.62 square degrees of the NDWFS (which is itself ~9 square degrees). It reaches a mean 50 percent completeness limit of magnitude 22.8 in the z-band. Richard Cool (University of Arizona) is the PI, and you can find more information is his recent article, Cool, 2007 *ApJS*, 169, 21.

The NSA also provides science-quality imaging data for the Deep Lens Survey (Tyson et al.), the Fundamental Plane Peculiar Velocity Survey of Rich Clusters (Hudson et al.), Deep Imaging of Nearby Star-Forming Clouds (Bally et al.), Star Formation in HI-Selected Galaxies (Meurer et al.), A Next Generation Microlensing Survey of the LMC (Stubbs et al.), the w Project: Measuring the Equation of State of the Universe (Suntzeff et al.), the Deep Ecliptic Survey (Millis et al.), ChaMPlane: Measuring the Faint X-ray Binary and Stellar Content of the Galaxy (Grindlay et al.), the First Look Survey (Soifer et al.), and FLAMEX DR1 in the Boötes (Elston and Gonzalez et al.).

Check out the growing NOAO Science Archive at *archive.noao.edu/nsa/*.

The NOAO High-Performance Pipeline

Frank Valdes, Christopher J. Miller & The Pipeline Group

For several years, NOAO has had a project to build a high-performance pipeline system, as well as pipeline applications, for the NOAO Mosaic imagers and the NEWFIRM wide-field infrared imager. The three key goals of the pipeline project are to provide Principal Investigators (PIs) with calibrated data quickly after their observations, to provide the community with well-characterized and easy-to-use wide-field imaging data once it becomes public, and to provide NOAO instrument scientists with the ability to monitor data quality.

The pipeline infrastructure is an event-driven, multi-process parallel system based on simultaneous processing of data chunks. Astronomical imaging datasets are well suited to this type of parallelization. The technical details of the pipeline are described in the proceedings of ADASS 2006 (not yet published) and are currently located online at *chive.tuc.noao.edu/noaodpp/Pipeline/PL001.pdf*.

In the near future, PIs will be able to download pipeline-processed Mosaic and NEWFIRM datasets. NOAO Science Archive users will also be able to obtain data under the NOAO proprietary data policy as the pipeline populates the archive.

Figure 1: Combined zero-frames and dome flats automatically created for Mosaic-2 data from CTIO.

The Mosaic pipeline applies standard image-reduction techniques, including bias corrections, flat-field corrections (see figure 1), fringe and pupil-ghost removal, astrometric calibrations, and data quality characterization, such as photometric depth and image quality. As a pipeline for general PI programs, this is an automated process with

continued

NOAO High Performance Pipeline continued

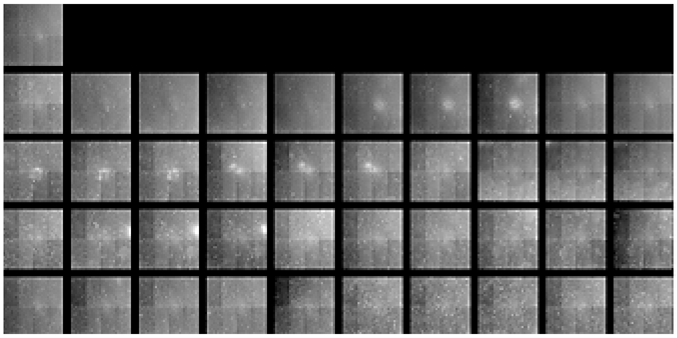


Figure 2: A sequence of Mosaic-2 science frames taken around the time of a PI observing run. These are analyzed and culled to create a final list to combine into a sky flat.

many challenges. For instance, the selection of images needed for dark-sky flat fields must be done entirely automatically (see figure 2).

The current Mosaic pipeline provides the user with two primary data products: the individual calibrated CCD images, and a re-sampled single mosaic of the CCD focal-plane in a standard orientation (see figure 3). We show an example from the CTIO Mosaic-2 camera of the combined zeros and dome flats, and the transformation of a raw image into the primary data products, as well as the data characterization (e.g., the photometric depth).

The NEWFIRM pipeline is now in development. It will provide quick reductions for observers at the telescope and final calibrated data for PIs. It will also provide the traditional detector calibrations and perform the necessary sky subtraction and stacking needed to reduce the dominance of the infrared sky.

The NOAO Mosaic pipeline is entering its Science Verification phase. Future goals of the pipeline project include stacked and mosaicked images from sets of dithered images for NEWFIRM as well as for Mosaic, plus catalogs and variable alerts. Staff from NOAO Data Products Program (DPP) will be asking some Mosaic PIs to help evaluate the reductions in comparison to their own, and for ideas on how to improve the calibrations for greater scientific quality.

The full release of the pipeline reductions to the general astronomical community will occur after this Science Verification process. We would very much appreciate your interest and your support in this endeavor. We believe that an NOAO archive containing well-characterized, pipeline-reduced Mosaic and NEWFIRM imaging data will be an invaluable resource for the astronomical community.

Contributors to the NOAO DPP pipeline include many current and former staff members at NOAO and the University of Maryland, including F. Valdes, R. Swaters, D. Scott, F. Pierfederici, B. Thomas, M. Miller, and M. Dickinson.

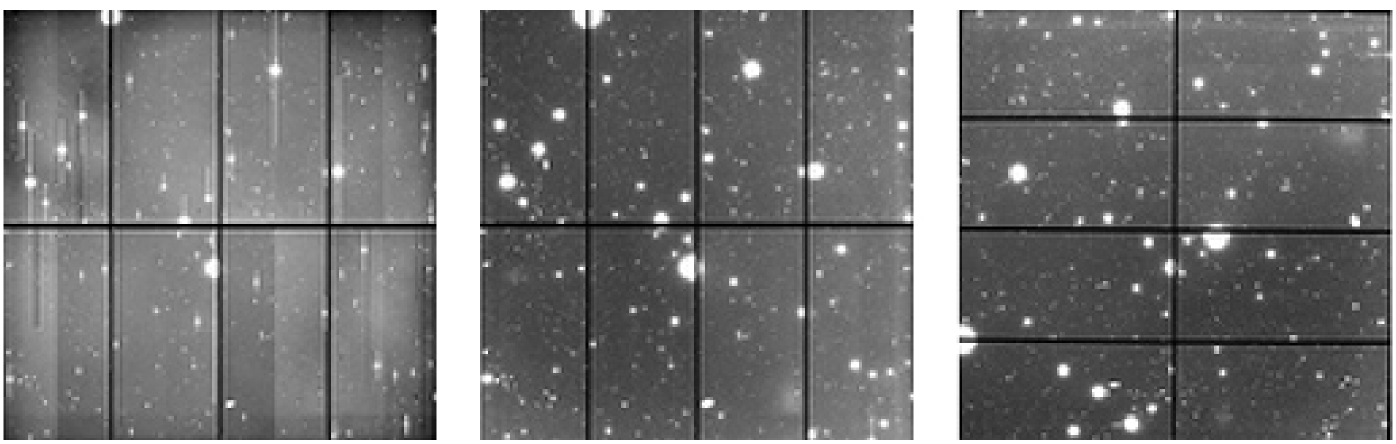


Figure 3: The raw, reduced, and re-projected science frame as automatically created using the NOAO Mosaic pipeline. These data are then automatically characterized to have a zero-point, photometric depth, and seeing estimate: (MAGZERO(i) = 26.61, PHOTDPTH(i) = 22.84, SEEING = 1.0).

The Renewal of CTIO

Alistair Walker

The NSF Senior Review recommended that Cerro Tololo Inter-American Observatory (CTIO) and Kitt Peak National Observatory (KPNO) attend to essential deferred maintenance issues, as well as modernize our telescopes, instruments, and plant so that operations for at least the next decade can be carried out efficiently and effectively. NOAO has responded to this recommendation by reprogramming of funds that will allow an early start to this process.

Longer-term plans are being developed, in the context of the forthcoming AURA Cooperative Agreement renewal proposal for the operation of NOAO from 2009-2013, and are designed to ensure the long-term effectiveness of the observatories. An essential component will be the restoration of a scientific and technical staff that can provide appropriate support and leadership. Accordingly, we intend to reverse the oft-noted decline in the capabilities of CTIO and KPNO over the last few years.

In this article, I report on some near-term improvements that will take place at CTIO. Many of these will not be immediately apparent to our users, but all are intended to be of direct benefit to observatory operations and ultimately should lead to improvement of the scientific usefulness of CTIO.

1. During 2005 and 2006, the SOAR telescope operation partners (NOAO, Brazil, the University of North Carolina, and Michigan State University) raised over $1,000,000 to fund various telescope and facility repairs. The most important of these was the replacement of the primary mirror passive lateral links by an active system so that the telescope could achieve the high-quality imaging expected of it. This repair was completed early this year, and was completely successful. Although NOAO made crucial contributions to the engineering design, testing, and installation of the new lateral links, it did not meet its financial obligations to the repair funds. In principle, this could have led to a redistribution of observing time between the partners, to the detriment of the NOAO user community. The financial obligation ($350,000) has now been met.

2. The SOAR Board has recommended that the partnership establish an operations reserve fund, which could be tapped in emergency situations. Thus, the partners were asked to contribute to this fund in proportion to their observing time shares. NOAO has now made its contribution to the reserve fund.

Credit: T. Abbott

3. CTIO keeps a good stock of spare parts for telescopes and instruments. Of course we hope that most of these will need to be used at very infrequent intervals. Some of these parts, particularly for the Blanco telescope and associated infrastructure, are difficult to obtain, and sometimes must be fabricated as special orders. Those that are critical to the operation of the telescope have been identified. We plan to purchase spares for the telescope drives and dome shutter drive so that we have these specialized parts on hand in case of breakdown.

4. The Blanco 4-meter telescope elevator control system is a marvel of 1960s-era electro-mechanics. It is of course regularly checked and maintained, and is in excellent condition, but it is now very out of date and parts are becoming difficult to locate. Replacement with a modern control system will increase reliability and simplify maintenance.

5. The Cerro Tololo telescope buildings and their surroundings are in many cases in need of refurbishment. These activities will begin later this year, towards the end of the southern winter. We will also be replacing some furniture and floor coverings, and repainting most of the access paths on the mountaintop. These paths get very warm in the daytime sun, and are a source of heating into the night air in the vicinity of the domes.

6. The road-grader, operated by AURA Observatory Support Services, is of 1960s vintage and a maintenance headache; however, it is an essential piece of equipment needed to maintain the heavily used roads from the Guard House to Cerros Tololo and Pachón. Along with Gemini and SOAR, CTIO will provide the funds for purchase of a new road-grader.

7. In La Serena, we will replace the air conditioning unit that is responsible for cooling the computer room. The present unit is of marginal capacity, and is irreparably failing.

8. The CTIO Engineering and Technical group in La Serena is an essential component, both in day-to-day operations of CTIO and in improvements and developments of telescope systems and instruments. A major activity that this group will be starting immediately is a two-year project to replace the Blanco Telescope Control System, based on the system now in use at SOAR, and under development for the Large Synoptic Survey Telescope. We will also be enhancing tools (such as oscilloscopes and new software packages) and providing more training opportunities to enhance the general effectiveness of the ETS group.

More long-term activities, such as improvements to instruments, are included in our planning. We will also be making some critical scientific and technical hires, and changing some of the ways we operate. Many of our users have made suggestions for improvements, often in their end-of-run reports, and we will be taking action to address many of these that have necessarily been deferred due to lack of staff and/or funding. We will be presenting our plans to our oversight committees, and publicizing them in forums such as future editions of this *Newsletter*. As always, input from our user community is very welcome.

Dark Energy Camera Project Achieves Important Milestone

Alistair Walker

The Dark Energy Camera (DECam) is a facility-class, 500-megapixel CCD imager being built for the CTIO Blanco 4-meter telescope prime focus by a Fermilab-led consortium of more than 110 scientists from 14 institutions. In exchange for providing DECam and a community data pipeline, the consortium will carry out a five-year Dark Energy Survey (DES) to improve our understanding of dark energy.

The complete DES Project was recently reviewed jointly by the National Science Foundation Division of Astronomy (NSF-AST), and the Department of Energy Office of High Energy Physics (DoE-HEP). At the conclusion of the review on May 3, the committee stated that it would recommend to the leadership of DoE-HEP and NSF-AST that DES receives Critical Decision-1 approval. This is an important milestone on the path toward delivery of DECam in 2010.

Since it is rather unusual for the two agencies to jointly review a project, it is worth describing the process in some detail:

The DES collaboration has asked DOE-HEP to provide somewhat more than two-thirds of the cost of DECam; other funding agencies in the United Kingdom, Spain, and Brazil—as well as the US partner institutions—are being sought to provide the remainder of the necessary funds. The collaboration has also asked the NSF-AST for funds to support the DES data management effort at the National Center for Supercomputing Applications. The collaboration has also asked NOAO to develop the infrastructure to support DECam operations for both the DES and community use of DECam. Given the high need for coordinated interagency decision making on this project, NSF-AST and DOE-HEP have jointly developed a process to reach decisions on DES.

In October 2006, the DoE and NSF jointly requested an end-to-end DES project description proposal, with scientific justification, technical realization, and complete schedule and funding planning for the three parts of the project: the camera, the data management system, and the Blanco telescope upgrades being carried out by CTIO.

The DES collaboration submitted this proposal to the agencies in early January 2007. In April 2007, the leadership of NSF-AST and DoE-HEP signed a Record of Agreement that described how DoE-HEP and NSF-AST would review the full DES project. In accordance with that Record of Agreement, the agencies requested that the DoE Office of Project Assessment carry out a full review of all of the components of the DES project, including the science. The agencies agreed that the review would be carried out in two parts between April 30 and May 3 at Fermilab in Batavia, Illinois.

On April 30, NSF conducted a traditional panel review as part one. From May 1–3, the Office of Project Assessment carried out part two in accordance with DoE procedures as adapted to the needs of the joint review. One of the purposes of the second part of the review was to establish whether DES would fulfill the requirements for a DoE "Stage III" ground-based dark energy experiment, including the selection of CTIO as the site for that experiment. This is a necessary step for DOE to execute a Critical Decision-1 (CD-1). (See the Dark Energy Task Force report at *www.nsf.gov/mps/ast/detf.jsp* for a definition of Stage III and related details.)

A Request for Input on the Dark Energy Camera Community Filters

Christopher J. Miller

The Dark Energy Camera (DECam) will be a facility instrument on the CTIO 4-meter Blanco telescope delivered by the Dark Energy Survey (DES) consortium in exchange for 30 percent of the observing time over a five year period. As such, NOAO anticipates that the DECam will be used extensively by the astronomical community during the time allotted through the standard NOAO peer-reviewed time allocation process.

A document outlining community needs was written for this instrument (see the CTIO Web site at *www.ctio.noao.edu*). A major scientific component of this instrument will be the selection of filters available to the community. The cost and complexity of DECam filters will intrinsically limit the number and variety of filters CTIO will support. These filters are very large (greater than 600 millimeters in diameter and a mass of 8 kilograms) and expensive. Thus, CTIO wants to work closely with the community to develop a prioritized list of possible filter purchases in addition to those acquired by the DES.

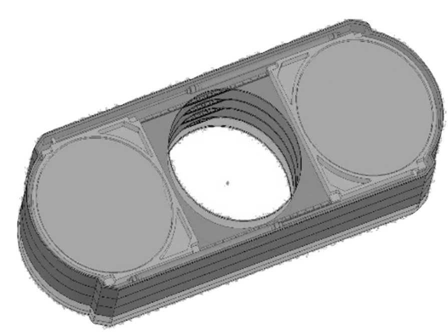


Figure1. A preliminary design of the DECam FIlter Assembly. Each side will hold four filters, which are then moved into the aperture.

In June 2006, the DES collaboration formed a panel to study the choice of filters to be used in the project and for the community

continued

A Request for Input on the DECam Community Filters continued

DECam instrument. Specifically, the panel was charged with determining whether the default Sloan Digital Sky Survey (SDSS)-like *g,r,i,z* system would suffice for the DES science, and how this choice of filters compares to other large multi-band surveys, as well as what additional filters the community might request. The report will provide input to the design of the filter assembly (see figure 1).

The conclusions of this panel are to move forward with the SDSS *g,r,i,z* filters, or to split the SDSS-like z-band into both a Z-band and Y-band filter to bridge the gap between DES and proposed J, H and K-band VISTA VHS Survey, if approved.

Additionally, a survey of current and past filter-usage statistics was undertaken for the NOAO Mosaic instruments to better understand the needs of the astronomical community. Figures 2 and 3 show the number of exposures and the total exposure time in the different filter groupings over the past eight years. From this usage study, it is clear that there is a demand for the BVRI system filters, as well as wide filters such as V+R and narrow-band filters like H-alpha and OIII.

At the same time, NOAO has held discussions, both internally and through a public session at the January 2007 meeting of the American Astronomical Society, to solicit input on a community filter set. Items discussed included whether the SDSS-like *g,r,i,z* or SDSS-like *g,r,i* plus Z and Y systems can and will replace the Johnson-Cousins UBVRI; whether filters could be removed from the assembly during DES observing periods; and, what other filters the community might want to use.

The DES Filter Panel report indicates the need for eight filter slots in the filter assembly to allow for enough community filter options (i.e., outside of the notional DES *g,r,i,z* or *g,r,i,* Z,Y) during the DES observing periods. This eliminates the need to handle and change the filters from the assembly during the DES survey periods. Likewise, the report lists filters of interest from the community, including SDSS u, Washington C, DDO 51, [OIII], H-alpha, and [SII] (in no order of priority).

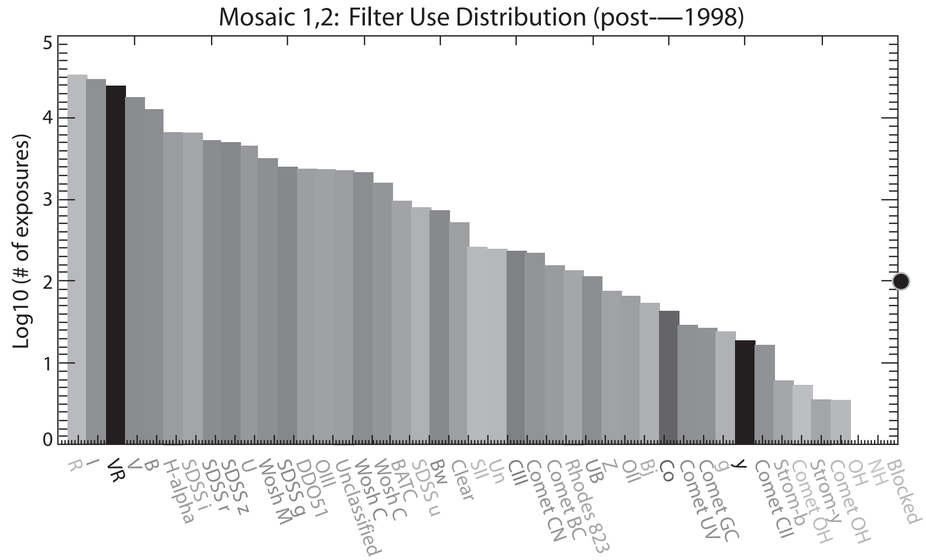


Figure 2. Total number of exposures taken with Mosaic-1 and -2 per filter since 1998.

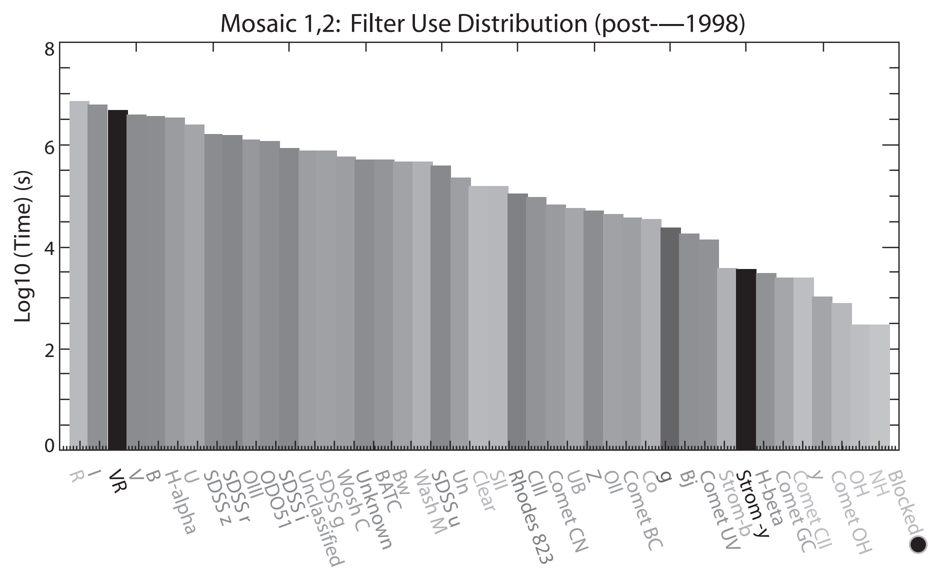


Figure 3. Total exposure time per filter on Mosaic-1 and -2 since 1998.

Over the next year, NOAO will be discussing these issues with the NOAO Users Committee and the astronomical community. In the meantime, potential users are encouraged to send input on the DECam filters to *cmiller@noao.edu*. The DECam will be an extraordinary wide-field instrument available to anyone in the US astronomical community (and beyond), and its success as both a survey instrument and a facility instrument depends on an actively involved user community. NL

Getting Ready for the Next 50 Years

Buell T. Jannuzi

As AURA celebrates its 50th anniversary, Kitt Peak National Observatory is preparing for its own 50th birthday next year. We will mark our half-century while we work with the NSF to implement the recommendations of the recently completed NSF Senior Review.

One of the more important recommendations for Cerro Tololo Inter-American Observatory (CTIO) and Kitt Peak National Observatory (KPNO) was for us to address deferred maintenance issues and to modernize our telescopes, instruments, and support facilities in order to provide the community with the confidence that these telescopes, the core of the mid-sized US telescope system, are going to be maintained and supported at a high level of quality. We are also encouraged to consider what new facilities and instruments might significantly augment the capability of NOAO to provide the community with access to state-of-the-art observational facilities over the full range of telescope aperture. NOAO is responding to these recommendations, including the reprogramming of funds in our base budget to enable a renewal of KPNO.

Over the past 20 years, the size of the KPNO staff—general facility, technical, engineering and scientific—has greatly decreased. To successfully undertake improvements in our facilities requires additional staff members. By the start of 2008 we will have added five people to our technical and engineering staff in order to undertake the modernization efforts recommended so strongly by the Senior Review. Our initial efforts to improve the observatory are detailed below. Working with the community, we will also be developing longer-term projects, including new instruments, to maintain KPNO as a scientifically productive observatory.

1. We need to improve our ability to care for instruments on the mountain. Over the next few years, KPNO is fortunate to have several new and very capable instruments coming to our telescopes. These include NEWFIRM, a wide-field near-infrared imager, at the Mayall 4-meter telescope; the orthogonal transfer array optical imagers QUOTA and the One-Degree Imager at the WIYN 3.5-meter telescope; the near-infrared imager WIYN High-Resolution Infrared Camera (WHIRC) at WIYN 3.5-meter; and the Half-Degree Imager at the WIYN 0.9-meter telescope. Several of these instruments are quite large and difficult to physically manipulate and service on the mountain. We will be purchasing a new forklift, large instrument handling cart, and other equipment to enable the safe transport and installation of these instruments. We will repair and upgrade the Mayall 4-meter instrument shop, and purchase and install a crane/hoist for the WIYN 3.5-meter Bench Spectrograph room. We will study the feasibility of developing an instrument-handling facility (including clean room) on the mountain to allow significant servicing of instruments to be carried out on the mountain, rather than subjecting the instruments to the risks incurred during transport to and from Tucson.

2. We need to improve our ability to make any necessary repairs in a timely manner and help prevent the need for major repairs. This requires improving our stock of spare components for critical systems (some of which are more than 30 years old) and developing a more robust program of preventative maintenance. For all three of our main telescopes (Mayall 4-meter, WIYN 3.5-meter, and the 2.1-meter telescopes), we have identified significant systems that either do not currently have spare components available or need to be replaced in order to make them easier to maintain. These range from items as major as the Mayall 4-meter telescope drive brake and motor armature to items that are easier to replace, like the hydrostatic oil bearing pump.

continued

Getting Ready for the Next 50 Years continued

3. The Mayall 4-meter telescope was built before the age of computer-controlled telescopes. Many aspects of using computers to control telescopes and instruments were pioneered at the Mayall. Unfortunately, computer systems age more quickly than the steel comprising the telescope structures, and many of the electronic and computer systems at the Mayall and WIYN 3.5-meter need to be replaced if they are to sustain effective scientifically productive operations for the next decade. This work will begin in 2008 and continue for several years.

4. The KPNO support buildings are 30 to 45 years old. They are in need of repair. We will begin a program to renovate essential buildings starting with the mountain dormitories in 2008.

5. The 26 telescopes that are located on Kitt Peak will all benefit from a new suite of site-monitoring equipment that will be installed over the next year. Based on the systems currently available at CTIO and used for the site-testing underway for a Giant Segmented Mirror Telescope, the new equipment will include an all sky-camera, a Differential Image Motion Monitor, and a weather station. These will be integrated into the observatory operations (including storage of the resulting data in the NOAO Science Archive) and will be available to all the tenant observatories.

6. Our existing instruments would benefit from modern guide-camera systems and detector controllers. As the MONSOON controller system being deployed for NEWFIRM and QUOTA becomes available, we will work over the next five years to selectively upgrade the controllers for our older instruments that are still in heavy demand. This work will begin in 2008 and will result not only in improved operations of the instruments, but in systems that are easier for our staff to maintain.

Other obvious maintenance and safety issues will be addressed over the next year. Longer-term activities, such as new instruments or telescopes, require active consultation with the community and discussions with the NOAO Users Committee and other advisory bodies. However, all members of the community are encouraged to share their desires and aspirations for improvements at KPNO with us (*jannuzi@noao.edu*). With these and future improvements in the years ahead, we look forward to at least another 50 years of successful operation of KPNO.

Another Instrument Visits the 2.1-meter Telescope at Kitt Peak

A. E. Szymkowiak (Yale University) & Buell Jannuzi

The 2.1-meter telescope at KPNO has a venerable set of regularly used instruments, including GoldCam and SQIID. The telescope is also a valuable test bed for the development of innovative new instruments from many different institutions. These have included the University of Florida's FLAMINGOS (the first fully cryogenic, multi-slit near-infrared (IR) imaging spectrograph), NASA Goddard Space Flight Center's Infrared Multi-Object Spectrograph (the first near-IR spectrograph to use a digital micro-mirror device to provide controllable micro-mirror slits), and the University of Florida's Exoplanet Tracker, or "ET."

The latest example of a university-built instrument using the 2.1-meter for testing and commissioning is a new optical long-slit spectrometer being built by Yale for eventual use on the WIYN 3.5-meter telescope. Equipped with Volume-Phase Holographic gratings, the new spectrograph is designed for use at the modified Cassegrain port of the WIYN telescope.

However, nights on a 3.5-meter telescope are too valuable to spend on initial debugging and commissioning activities if there is another alternative. The KPNO 2.1-meter telescope, when equipped with its $f/15$ secondary, is a good optical match to the new Yale spectrometer. All that was required was an appropriate spacer plate to fit the 2.1-meter instrument adapter (also known as the Gold Guider) and the instrument was ready to test.

The Yale spectrometer team brought the instrument to KPNO during Testing and Engineering (T&E) time in November 2006, and with the able assistance of Skip Andree, Dick Joyce, and Dianne Harmer of the KPNO staff, the instrument was mounted and performing observations in short order. The Yale team took spectra of some spectrophotometric standard stars to characterize the throughput and other properties of the spectrometer. The team will have a second T&E run on the 2.1-meter in June 2007 to continue the commissioning, and they have proposed to begin science observations during darker nights in semester 2007B. KPNO encourages instrument builders interested in testing their ideas on a convenient and easy-to-use telescope to contact the observatory about opportunities for observing time with their instrument.

Will Emmet (Yale University) attaches one of the cables to the Yale long-slit spectrometer during its first visit to the Kitt Peak 2.1-meter telescope in November 2006.

From the NSO Director's Office

Steve Keil

Congratulations to our colleagues with the Hinode project on the spectacular data being returned from the Hinode satellite, formerly known as Solar-B. Hinode ("Sunrise") is a mission led by the Japanese Aerospace Exploration Agency in collaboration with NASA, the Particle Physics and Astronomy Research Council (United Kingdom), and the European Space Agency. Hinode data will further our understanding of the processes of magneto-convection and its consequences in the solar atmosphere.

The NSO telescope time allocation process is now giving priority to proposals for joint observations with NSO telescopes and Hinode. NSO has already undertaken joint observing runs with the Hinode instruments using the Dunn Solar Telescope (DST) at Sac Peak. The DST can provide high-resolution multi-line spectropolarimetry, imaging polarimetry, multi-line spectroscopy, and simultaneous high-speed imaging at several wavelengths as complements to the superb Hinode imaging and polarimetry. The NSO recently implemented a new queue-observing mode with the Diffraction-Limited Spectropolarimeter (DLSP) at the DST. The queue works by shifting the beam to the DLSP at times when seeing conditions are good during the interval when a Principal Investigator is setting up his or her experiment. If there is sufficient demand, NSO can begin setting aside specific time intervals to run a series of queue observations.

The SOLIS vector spectromagnetograph (VSM) line-of-site magnetograms in the photosphere and chromosphere, 10830 images, and quick-look vector magnetograms have been used and are still available for collaborative Hinode observations, as well as other projects. The Air Force Optical Solar Patrol Network (OSPAN) telescope provides high cadence H-alpha images in the core and red and blue wings. Those images are available at the NSO Web site and are being used for Hinode target selection.

The Global Oscillation Network Group ($GONG^{++}$) has a significant role in magnetogram support for the STEREO mission. $GONG^{++}$ full-disk magnetograms are being collected daily at a one-minute cadence and are being used to extrapolate the coronal magnetic field and predict interplanetary sector boundaries. $GONG^{++}$ far-side imaging is now conducted on a regular basis and can provide early warning of major active regions before they rotate onto the visible solar disk.

* * *

The Advanced Technology Solar Telescope (ATST) project was informed of a decision by the NSF director to complete the environmental impact studies on Maui and to continue moving the project through the MREFC process. The project team continues to work toward a final design and prepare for construction. System-level reviews of major subsystems are being conducted at a rapid pace. A Preliminary Design Review for the M2/M5 optics has been completed, and a review of the wavefront correction package, including the adaptive optics, is scheduled for this summer. Several potential ATST international partners have submitted letters of intent to the NSF for participation in the project. NSO publishes a quarterly ATST Newsletter, and if you're interested in being on the distribution list, send a request to *ddooling@nso.edu*. The newsletter is also posted on the ATST Web site (*atst.nso.edu/*) where updated information on the project is available

* * *

In order to continue providing a suite of observing capabilities that span the entire Sun, NSO is actively seeking funds outside of the NSF for $GONG^{++}$ operations in response to one of the Senior Review recommendations. We are also identifying synergisms between SOLIS and $GONG^{++}$ to streamline operations of the major NSO synoptic programs. In addition, we are exploring options for creating a SOLIS network of vector magnetograph stations. In anticipation of NSO operations in the ATST era, our cooperative agreement proposal will contain a plan for NSO staff consolidation, divestiture of older telescope facilities, establishment of an ATST operations center, and a plan for locating a new NSO headquarters near a university with strong solar research and teaching interests. The latter plan will establish an open process that will allow interested universities the opportunity to express their desire for hosting NSO.

* * *

Over the course of the past year, four NSO tenure-track scientists achieved tenure. K. S. (Bala) Balasubramaniam was awarded tenure last spring. Bala's work on the origins of solar activity, development of methods for analyzing polarized light, and his strong service to the community and NSO were critical factors. Bala has led our student programs, is always willing to help with establishing successful collaborative science programs, and has been a driving force for many of NSO's science workshops.

In the fall of 2006, tenure was awarded to Alexei Pevtsov, whose work on solar helicity as a major component of solar activity has made him a leader in this area of research. As part of his community service, Alex is currently a solar physics discipline scientist at NASA headquarters, and is the program scientist for Hinode and the Solar Dynamics Observatory (SDO).

Matt Penn received tenure in early 2007 based on his pioneering work on the solar corona and infrared observing techniques. He is also a strong participant in NSO educational outreach programs, and serves as the McMath-Pierce Solar Telescope facility scientist.

This spring, Han Uitenbroek received tenure based on his work on understanding the formation of photospheric and chromospheric spectral lines and molecular bands in dynamic motions, magnetic

continued

From the NSO Director's Office continued

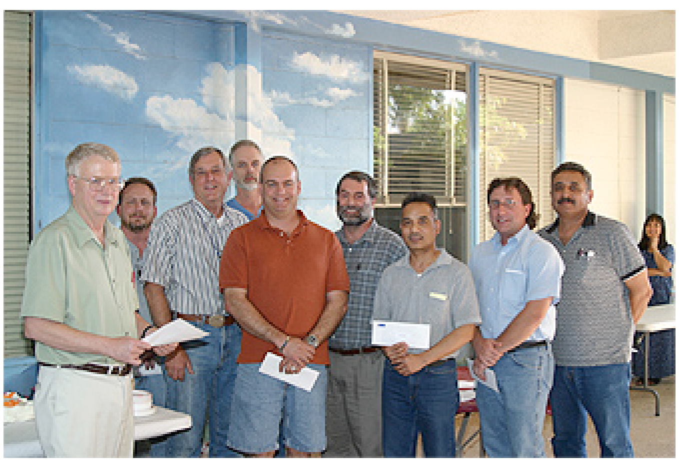
fields, and complex structuring seen in these layers, including the effects of partial redistribution. Han's work is forming the basis for interpreting much of the data now being obtained with sophisticated, diffraction-limited spectropolarimeters. Han also plays an active role in user support and educational outreach.

* * *

Irene González-Hernández is the NSO recipient of the 2007 AURA Science Award, which was presented to her on April 17 at the NSO Workshop at Sac Peak on Subsurface and Atmospheric Influences on Solar Activity. The award is in recognition of Irene's work developing the relationship between active region characteristics and their signature in helioseismic far side images, including her contributions to the implementation of a far-side pipeline, and her contributions to studies of meridional flows below the solar surface.

This year's AURA Team Excellence Award was presented to the GONG^{++} Implementation Team for their design, development, and deployment of the GONG^{++} modulator upgrade, and the parallel development and implementation of the magnetogram data pipeline, subsequently achieving a major milestone in providing high-quality magnetograms to the solar physics community. The team effort involved two groups: the instrument group (Dave Dryden, Jack Harvey, Dave Hauth, Ron Kroll, George Luis, Guillermo Montijo, Sang Nguyen, Gary Poczulp, Tim Purdy, Mike Soukup, Ed Stover, and Humberto Villegas), and the software group (John Bolding, Richard Clark, Kerri Donaldson-Hanna, Jack Harvey, Harry Jones, Gordon Petrie, Cliff Toner, and Tom Wentzel). Congratulations to all! NL

Irene González-Hernández receives the 2007 AURA Science Award from NSO Director Steve Keil at the NSO workshop at Sac Peak on Subsurface and Atmospheric Influences on Solar Activity.



The GONG++ magnetic field team instrument group with Steve Keil. Left to right: Keil, Dave Hauth, Dave Dryden, Ed Stover, George Luis, Ron Kroll, Sang Nguyen, Tim Purdy, Humberto Villegas. Missing: Jack Harvey, Guillermo Montijo, Gary Poczulp, and Mike Soukup.

The GONG++ magnetic field team software group with Steve Keil. Left to right: Keil, John Bolding, Gordon Petrie, Richard Clark, Kerri Donaldson-Hanna, Cliff Toner, Tom Wentzel. Missing: Jack Harvey and Harry Jones.

ATST Design Refinements and EIS Milestone

The ATST Team

The Advanced Technology Solar Telescope (ATST) project recently reviewed the Nasmyth optical design with the Near-Infrared Spectro-Polarimeter (NIRSP) team at the University of Hawaii Institute for Astronomy. The review led to the realization that the following changes are required to optimize the baseline optical design: reduce the time required to change to and from the coudé configuration; redesign the focal plane to be perpendicular to the gut ray to allow simple de-rotation; redesign the ƒ/13 baseline; and adapt the optical design to ensure "high quality" on-disk images.

Initial discussions were aimed at quantifying and prioritizing these new requirements and goals. Optical design options were packaged, based on which goals were best met by each family of designs. Two basic classes of designs were investigated.

The first class of designs used the baseline ƒ/13 configuration with a minimum number of optics, all fixed to the optical support structure, ensuring minimum polarization change with tracking. Using this type design, 0.2-arcsecond delivered image quality (DIQ) could not be achieved over the 5-arcminute field of view. Another drawback was that the optical design was not compatible with use of quasi-static alignment correction, making the high DIQ goal problematic even with additional correctors. The second class of designs delivered an ƒ/54 beam though the elevation trunnion, then assumed that different optics would be used to accommodate the on-disk and coronal instrumentation. This solution incorporated the quasi-static alignment (QSA) correction capability that would likely be required for the on-disk work, and is flexible in terms of rotation-axis orientation. However, the added number of mirrors required was a concern from both a throughput and polarization perspective. This family of designs led to consideration of the use of the coudé optical train until reaching the coudé lab, where imaging optics mounted on the coudé bench could be used to create the ƒ/10 beam. Ultimately, use of the coudé optical train through M8 was selected.

A similar review of the coudé optical design is now underway as other instrument designs mature. The major question is whether it is still the optimum design to include field flattening and tilting correction in the facility optical train.

The ATST Data Handling and Observatory Control systems have completed their preliminary design and are awaiting review. The Common Services software framework is in the process of porting to C++ through a contract with Observatory Sciences, Ltd. This port will allow software developers to use C++ in addition to Java to develop ATST applications.

An important milestone was reached in the Environmental Impact Statement (EIS) for the Haleakalā site with the completion by the US Fish & Wildlife Service (USF&WS) of a Biological Opinion, related to the potential impact of ATST on endangered or threatened species. The Biological Opinion was based on the project description in the Draft EIS, supplemental information from the ATST engineering team, and thorough research by USF&WS of the issues involved. The conclusion of the Biological Opinion is that "with appropriate avoidance and minimization measures…the ATST project is not likely to adversely affect the Hawaiian petrel," an endangered sea bird.

Of primary concern was the affect of ATST construction and operation on the endangered Hawaiian petrels that nest in the 33 burrows near the proposed site. The foundation plan of the facility (figure 1) shows the closest petrel burrows (dots) and proximity zones of 40, 80 and 100 ft. from the burrows (arcs) that were used to assess the potential impact of noise and vibration from construction of the ATST facility.

Similarly, it was determined that the project was not likely to cause adverse impact on the Hawaiian goose, Silversword plant, or several other species of concern. This is an encouraging outcome from what was a very cooperative effort between the USF&WS,

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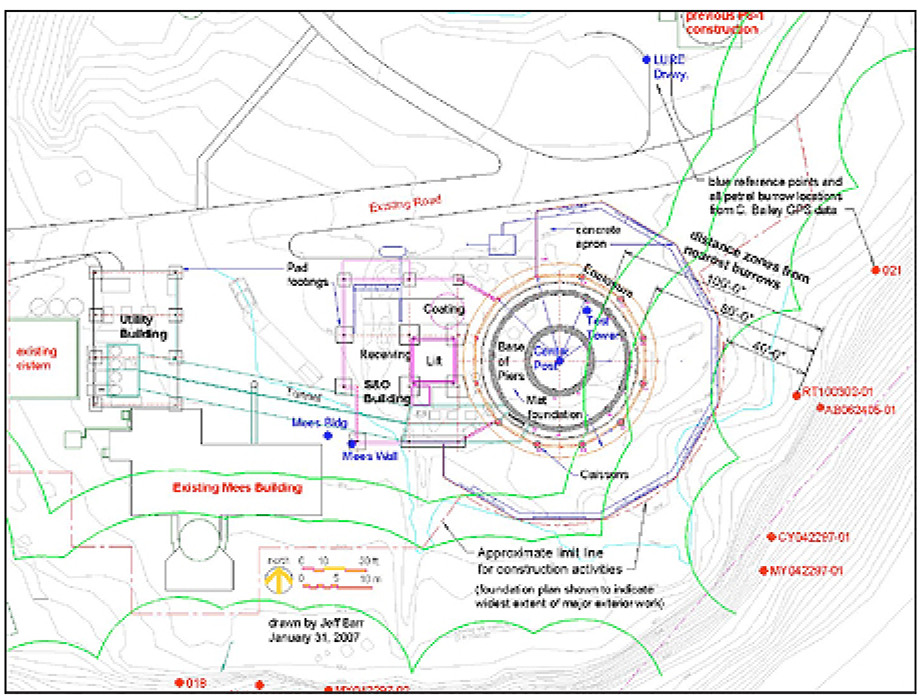


ATST Design Refinements and EIS Milestone continued

Haleakalā National Park biologists, the ATST team, and ATST project consultant KC Environmental Inc.

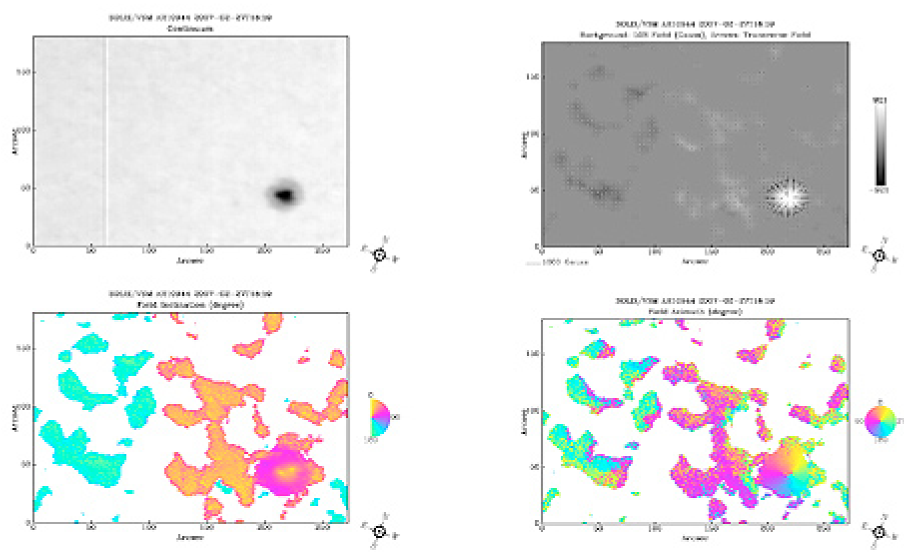
The project responded to inquiries from USF&WS concerning specific measures to minimize disturbance of the petrels. After review and consultation, the ATST agreed to specific limits on the amount of vibration and noise that would be generated by construction, as well as a defined period during early summer months, while the petrels are incubating their eggs, when only quiet work would be allowed.

In addition to monitoring and minimizing the levels of noise and vibration, other stipulated measures would make the construction crane less hazardous to flying birds, avoid potential increase in predator population, and establish procedures to minimize risk posed by construction and operations traffic. The Biological Opinion was formally transmitted to the NSF, the lead agency for the EIS, at the end of March. NL

SOLIS "Quick-Look" Vector Magnetic Field Images Now Available

Carl Henney & the SOLIS Team

Preliminary SOLIS vector spectromagnetograph (VSM) "quick-look" vector magnetic images for active regions are now available for recent observations. The images are corrected for the 180-degree° ambiguity using the Non-Potential Field Calculation (NPFC) method developed by Manolis Georgoulis (Johns Hopkins Applied Physics Lab). The VSM Vector Working Group (VVWG) is in the process of finalizing calibration and pipeline code for processing VSM 630.2 nanometer vector data. Milne-Eddington inversion parameter data will be available soon after this work is completed. During this interim period, qualitative quick-look parameter JPEG images (see sample set, figure 1) will be available for active regions from the most current VSM observations. Note that the SOLIS/VSM quick-look active region interface Web pages currently work best with FireFox and Safari.



These quick-look images of AR 10921, observed with the VSM on 27 February 2007, illustrate the parameters publicly available daily: continuum intensity (upper left), line-of-sight field strength with arrows indicating transverse field strength and direction (upper right), field inclination (lower left), and field azimuth (lower right). The quick-look parameters have been corrected for the 180-degree azimuth ambiguity.

Two-Dimensional Spectropolarimetry with IBIS

Alexandra Tritschler (NSO), Kevin Reardon (Arcetri Astrophysical Observatory),
Han Uitenbroek (NSO) & Lucia Kleint (ETH-Zürich/NSO)

The measurement of the chromospheric magnetic field within individual structures in the solar atmosphere is important for the understanding of the structure of the chromosphere, as well as connection of the sub-surface and photospheric magnetic field to the corona. It continues to be a persistent observational challenge.

Successful measurements throughout different layers of the atmosphere would offer important contributions to our understanding of solar activity, and would provide valuable constraints for theoretical modeling. Even more than the denser photosphere below it, the solar chromosphere is highly dynamic. Coming from below, it is the first layer whose structure is dominated by magnetic, rather than hydrodynamic, forces. Determining the structure and dynamics of the chromospheric magnetic field on the appropriate small spatial and short temporal scales is, therefore, essential for understanding this layer, which is the regulating interface to the Sun's outermost layer, the corona. In the context of fast, high-resolution observations, two-dimensional full-Stokes spectropolarimetry based on narrowband and rapidly tunable filters can offer several unique advantages in contrast to more traditional, grating spectropolarimeters.

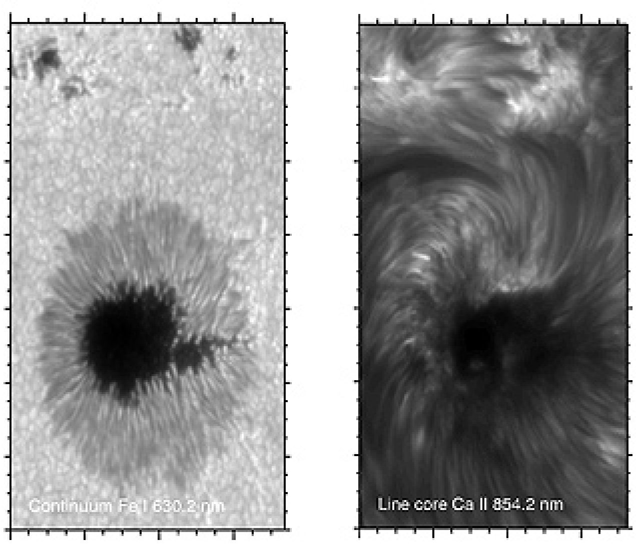


Figure 1. Maps of the continuum near the Fe I 630.25 nm line (left panel), and the core of the Ca II 854.21 nm line (right).

The Interferometric BI-dimensional Spectrometer (IBIS), permanently installed at the Dunn Solar Telescope at NSO/Sacramento Peak, has recently been upgraded to a vector polarimeter with unparalleled capabilities, most notably in the chromospheric wavelength range. IBIS is operated with the high-order adaptive optics system, which provides high spatial resolution over a large field of view (FOV). After a proper calibration for instrumental polarization and correction for image distortions (de-stretch), the full Stokes vector is easily accessible at each point in the FOV.

Here we present some of the first observations with IBIS, performed on 28 January 2007 in its novel spectropolarimetric mode. The target was the leading sunspot of AR NOAA 10940, observed at E 50 S 05, well away from center. The photospheric Fe I line at 630.25 nanometers (nm) and the chromospheric Ca II 854.21 nm line were scanned successively with 26 and 41 wavelength points, respectively. At each wavelength step, six different modulation states were recorded, amounting to a total scan time of 125 seconds for both lines.

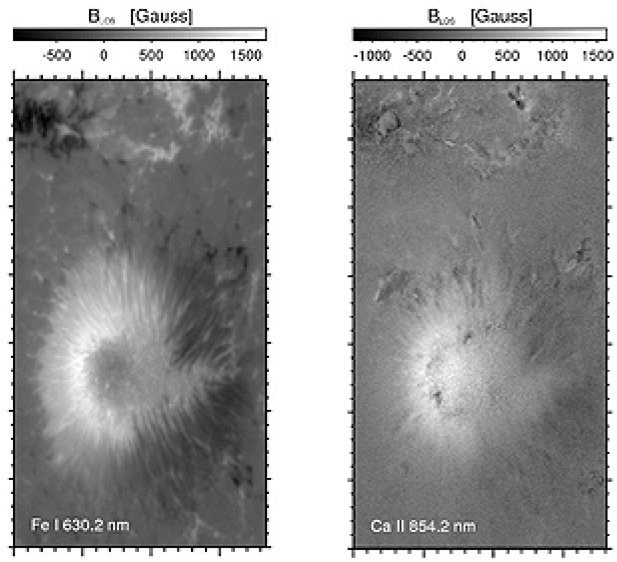


Figure 2. Strength of the photospheric (left panel) and chromospheric magnetic field (right) in the direction of the line of sight.

The well-resolved Stokes profiles observed in the Ca II 854.21 nm line show a large variety of forms, indicating widely varying behavior of the field strength, velocity, and temperature. We show maps of continuum intensity and the line-core intensity of the Ca II line in figure 1. In addition, we show preliminary maps of the line-of-sight magnetic field strength in the photosphere and chromosphere in figure 2, estimated from the relative shift of left- and right-circularly polarized profiles at each point in the FOV.

While photospheric determination of the full vector field from the observed Stokes intensities is well established, the situation is considerably less developed for chromospheric observations. To a large degree, this is caused by departures from Local Thermodynamic Equilibrium (LTE), which make the inversion of Stokes spectra substantially more challenging, theoretically. In the near future, we plan to complement the observational progress achieved with IBIS with a reliable inversion procedure for non-LTE lines to take full advantage of the new chromospheric data.

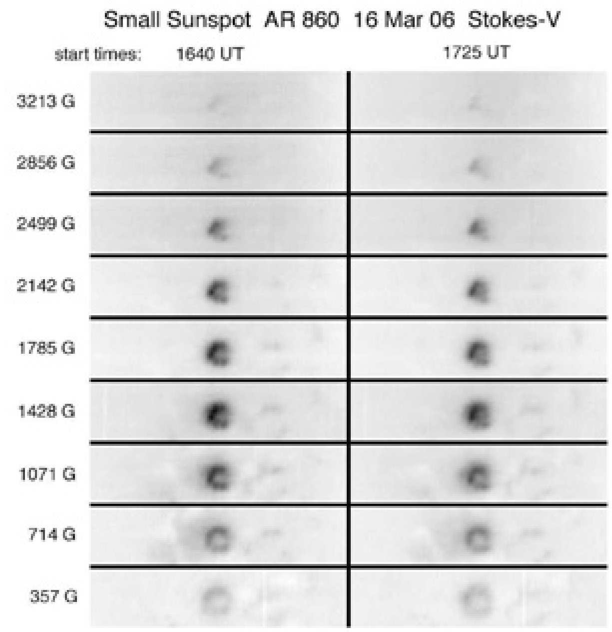
Solar Infrared Observations at 12 Microns with CELESTE

Don Jennings (NASA Goddard Space Flight Center), Pedro Sada (Universidad de Monterrey), George McCabe, Tom Moran, Diane Paulson (NASA Goddard), Claude Plymate (National Solar Observatory), & Christoph Keller (Utrecht University)

In March 2006, the 12-micron CELESTE polarimeter at the NSO/Kitt Peak McMath-Pierce Solar Telescope was used to observe a small, newly forming sunspot. The figure shows two spectral images of this spot recorded about 45 minutes apart. The images were recorded in Stokes-*V* on the 12.3 micron Mg I emission line. Tip-tilt was used to stabilize the spot image and to create a two-dimensional image by stepping across the slit. The imaged area was 98 by 22 arc-seconds, and darker shading in the images corresponds to greater line intensity. The spectral images have been sliced in Zeeman splitting to show the structure at increments of increasing field strength.

This sunspot was just beginning to form at the time of observation, and by the next day it had developed into a complex active region. In the images, a beaded-ring structure of dark dots appears and can be interpreted as a group of emerging flux tubes. The ten-arcsecond size of the beaded ring was the same as the diameter of the spot in a visible continuum image. Each flux tube is smaller than the two-arcsecond diffraction limit, which sets the sizes of the dark dots. At the center of the spot, the flux tubes are tightly grouped and the field strengths are highest. As they spread away from the center, the field weakens. These images imply that at this early stage of spot formation, the flux tubes retain their individual identities and spread radially.

The CELESTE 12-micron polarimeter was built by NASA Goddard Space Flight Center. Rotating waveplates select Stokes *I*, *Q*, *U*, and *V*, and these are followed by a liquid helium spectrometer that records the Mg I emission spectrum along a two-arcminute slit. CELESTE is currently used for prototype development for the Advanced Technology Solar Telescope. The instrument is available for visitor use at the McMath-Pierce Solar Telescope on a collaborative basis.



Two 12-micron Stokes-V images of a small sunspot. The images are sliced in increments of Zeeman splitting to show the field structure at increasing field strengths. They were recorded with the CELESTE 12-micron polarimeter at the NSO/Kitt Peak McMath-Pierce Solar Telescope.

GONG^{++}

Frank Hill & the GONG Team

It has been a very good quarter, and right now GONG^{++} is thriving! Our magnetic field products have been released and well received by the solar physics research community. In fact, one of these images is on the cover of this *Newsletter*. A new aspect of the solar magnetic field, discussed in the "Science Highlights" section (J. Harvey et al.), has been detected thanks to the rapid cadence and high sensitivity of the GONG^{++} magnetic field data.

Science Highlights
Much of the science this quarter has focused on the surface magnetic field. The range of GONG^{++} magnetic field products has been greatly expanded by Gordon Petrie and now includes seven varieties of projections of source-surface potential field extrapolations. These extrapolations are useful for space weather applications, such as predictors of coronal mass ejections (CMEs). The extrapolations are updated on the GONG^{++} Web site every hour, as are the synoptic maps of the surface field. The synoptic maps are vital "ground truth" for solar wind models that are used to anticipate geomagnetic storms which can disrupt satellites, telecommunications, Global Positioning System data, and airline traffic. GONG^{++} also routinely produces ten-minute average full-disk magnetograms around the clock, and will soon start providing one-per-minute magnetograms created by merging together the data from the individual sites.

continued

GONG++ continued

The new products and recent advances of GONG++ would not have been possible without the installation of the new polarization modulators and driving circuitry deployed around the network last year, and the development and implementation of the magnetogram data processing pipeline. This was a team effort that involved 20 staff members in the instrument operations and data processing groups. For their significant achievement, the team was presented with the 2007 AURA Team Excellence award. Congratulations!

While the magnetograms show the field on the near side of the Sun facing the Earth, GONG++ can also detect strong fields on the otherwise invisible far side using acoustic holography techniques developed by Charlie Lindsey and Doug Braun (NorthWest Research Associates, Inc.). The signal is expressed in terms of a phase shift experienced by the acoustic waves when they encounter an active region on the surface. However, it is much more scientifically useful to have more familiar properties of the active regions, such as the magnetic field strength and the area of the region. Irene González Hernández, in collaboration with Lindsey and Frank Hill, has now developed the first calibration between the observed phase shift, magnetic field, and area of the active region. One of the calibration curves is shown in figure 1. The shape of the curve is consistent with the idea that the phase shift arises from an "acoustic Wilson depression," where the magnetic field changes the near-surface temperature gradient and effectively moves the upper reflection point of the waves deeper into the Sun.

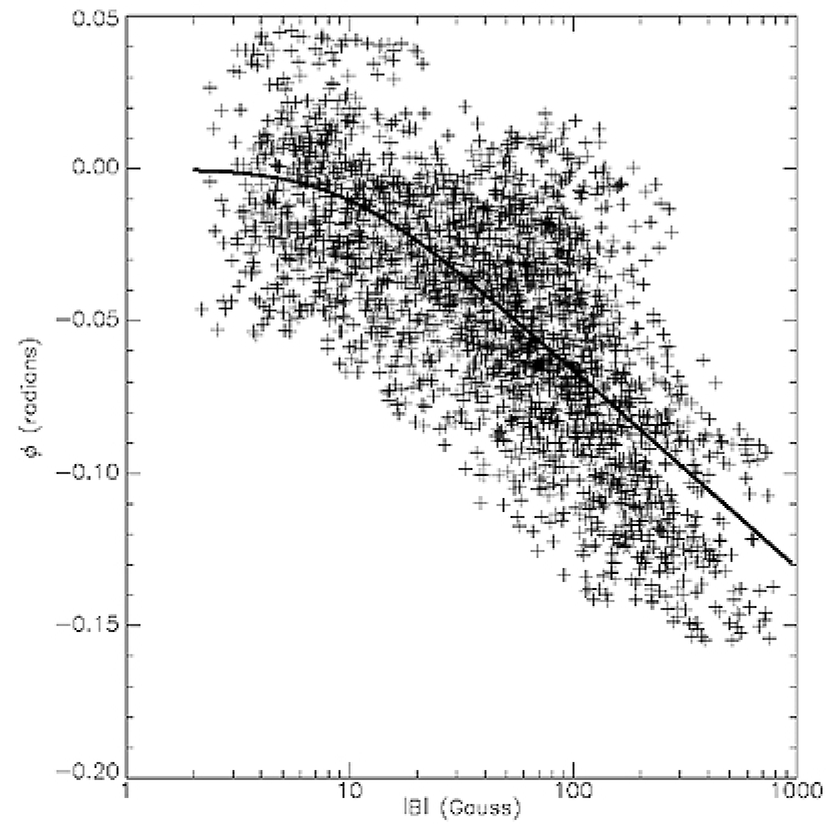


Figure 1. Relationship between acoustic holography phase shift (ϕ) and absolute magnetic field strength (|B|) for large active regions on the solar far side. The shape of the curve suggests that the phase shift arises from an increase in the depth of the upper reflection point of the waves, resulting from the magnetic field in the active regions.

Preparations for the upcoming 2007 International Research Experience for Students (IRES) Summer School are well underway. Thanks to a grant from the NSF Office of International Science and Engineering (OISE), NSO/GONG++ is sponsoring an eight-week summer school for US astronomy graduate students to be held at the Indian Institute for Astrophysics (IIA) in Bangalore, India. This year will be the first of three annual programs. The participants, along with their mentors at the IIA are: Natalie Hinkel (Arizona State University), study focus–stellar, mentor R. T. Gangadhara; Nicholas Moskovitz (University of Hawaii at Manoa), study focus–stellar, mentor B. E. Reddy; Sarah Sonnett (University of Hawaii at Manoa), study focus–solar, mentor R. Ramesh; and Russell Stoneback (University of Texas at Dallas), study focus–solar, mentor D. Banerjee. Our program coordinator, Kiran Jain, will meet the students upon arrival in Delhi, then take a field trip to Udaipur and Mount Abu, and escort them on to Bangalore. Folks at IIA and GONG++ are very excited and expect that this program will result in increased collaborations between US and Indian scientists.

Program

While the challenges presented by the recommendation of the NSF Senior Review remain, talks have begun with the US Air Force, which is considering the possibility of supporting GONG++ operations to supply the new magnetic field products to the Air Force Weather Agency (AFWA). The Air Force is also interested in the calibrated far side signal, as well as possible helioseismic indicators of forthcoming activity.

The SOHO19/GONG++ 2007 meeting will be held at Monash University in Melbourne, Australia, July 9–13. Hosted by Paul Cally, the meeting will focus on "Seismology of Magnetic Activity." Preparations for the 2008 GONG++ meeting have begun. The meeting will be held 10–15 August 2008, at the High Altitude Observatory (HAO) facilities in Boulder, Colorado, and Mausumi Dikpati will chair the local organizing committee. Further details will be forthcoming.

There have been two recent departures from the GONG++ staff. Guillermo Montijo left NSO to pursue a career in power management at the University of Arizona, and Mike Soukup also departed. We wish Guillermo and Mike good luck and success in their future endeavors.

International Solar Workshop Probes Beyond "Skin Deep"

Dave Dooling

Sunspots and solar flares are more than skin deep, and the desire to understand their birth and growth is a driving force in modern solar physics.

To share what's known and what needs to be learned, 60 scientists from across the United States and 10 other nations met at the National Solar Observatory's 24th annual international workshop in Sunspot, New Mexico, April 24-27.

"The main goal of this workshop was to bring together experts in magnetometry, activity, and helioseismology to further our understanding of solar active regions and their creation and evolution," said K. S. Balasubramaniam, one of the organizers at NSO/Sac Peak. "Even when the Sun appears quiet, as it is now, there is a lot going on below the surface as the Sun starts towards the next sunspot maximum."

Magnetometry and helioseismology are key tools in solar physics. Magnetometry involves understanding how electrified gases generate magnetic fields, and how those fields in turn affect the flow of mass and energy in the solar atmosphere. Helioseismology uses the subtle acoustic ringing of the Sun, observed as red and blue shift changes in spectral lines, to deduce the solar structure where massive gas flows lead to activities that appear on the surface and then reach across space.

The workshop, titled "Subsurface and Atmospheric Influences on Solar Activity," focused on active regions, their origin, and their evolution. These are inferred from helioseismology and magnetometry, which lead to new models of the engines that drive solar activity.

The combination of observation and theory makes it possible, for example, to follow a magnetic field's twist and helicity—how the field wraps around itself—and magnetic flux tubes from below the visible surface through the solar atmosphere and into interplanetary space. Helicity-loaded fields are probably responsible for solar phenomena such as flares and coronal mass ejections that can affect Earth.

The workshop sessions covered flows around active regions, both surface and below; flux emergence and cancellation; space weather and active regions; back to front; morphology of active regions and filaments; magnetic flux and magneto-acoustic waves; and influences on coronal complexity.

Participants were drawn from 11 US states and from Australia, France, Italy, Norway, Russia, Spain, Taiwan, and the United Kingdom.

Markus Aschwanden of the Solar & Astrophysics Laboratory, Lockheed Martin Advanced Technology Center in Palo Alto, California, gave the opening keynote on "Solar Active Regions: A Transition from Morphological Studies to Physical Modeling."

Workshop organizers were K. S. Balasubramaniam, Rudi Komm (chair), Rachel Howe, and Gordon Petrie. Sponsors included the NSO, the NSF Division of Astronomical Sciences and Division of Atmospheric Sciences, NASA's Heliospheric Physics Division, and the Air Force Office of Scientific Research.

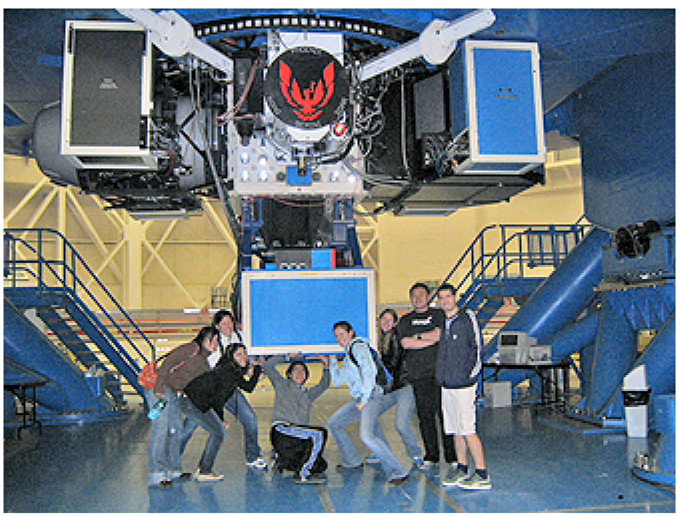
The Scientific Organizing Committee was composed of Bill Abbett (Space Sciences Laboratory, University of California, Berkeley), Tom Bogdan (Space Environment Center, National Oceanic and Atmospheric Administration), Véronique Bommier (Observatoire de Meudon), Todd Hoeksema (HEPL, Stanford University), Terry Kucera (NASA Goddard Space Flight Center), Valentin Martinez Pillet (Instituto de Astrofisica de Canarias), and Saku Tsuneta (National Astronomical Observatory of Japan).

Proceedings from the conference will be published in 2008 in cooperation with the Astronomical Society of the Pacific.

Research Experiences for Undergraduates & Práctica de Investigacíon Programs 2007

Styliani Kafka

From January to March, Cerro Tololo Inter-American Observatory (CTIO) hosted six US and two Chilean students who participated in the 2007 Research Experiences for Undergraduates (REU) and Práctica de Investigación en Astronomía (PIA) programs. The students worked with CTIO and Gemini scientific staff on topics ranging from individual stars to galaxies and galactic clusters. The students attended lunch talks and colloquia, participated in our journal club, mingled with guest observers, and had a first-hand taste of the frustrations and delights of scientific research. They also had a hands-on observing experience, using the CTIO Small and Moderate Aperture Research Telescope System (SMARTS) 1-meter telescope for a total of eight nights and obtained photometric data for a variety of projects. They became an indispensable part of our life in the La Serena compound, participating in our social and athletic activities, and had the chance to experience the rich Chilean culture and taste the local cuisine.



2007 CTIO REU and PIA students "supporting" the Phoenix instrument at Gemini. From left to right: Claudia Araya (Pontificia U. Católica de Chile), Aisha Mahmoud (University of Puerto Rico), Stephanie Golmon (Principia College), Rodrigo Hinojosa (Universidad Católica del Norte, Antofagasta), Rachel Anderson (University of Wisconsin - Eau Claire), Cassy Davison (Norfolk State University), Daniel Harsono (University of California Los Angeles), and Scott Henderson (Lewis & Clark College).

From left to right: Rodrigo Hinojosa, Rachel Anderson, Stephanie Golmon and Aisha Mahmoud in Las Campanas

As a result of their scientific work, each student produced a paper which, in most cases, is a precursor to a scientific publication. The students presented their work with a great enthusiasm to the CTIO, Gemini, and Las Campanas scientific staff and visitors in a two-day mini-symposium held in La Serena in March. The outcome of their projects will also be presented in the poster session of the upcoming winter meeting of the American Astronomical Society, which will be held in Austin, Texas. Everyone is encouraged to visit the posters and discuss the students' experience in La Serena.

Although we will all miss them, we wish them the best of luck in their endeavors in astronomy. We are confident that they will have brilliant careers and we are looking forward to their future accomplishments

More information about the 2007 REU program can be found at *www.ctio.noao.edu/REU/ctioreu_2007/REU2007.html*.

Stephanie Golmon and Daniel Harsono in the CTIO 1-meter control room

Outreach Activities With the Tohono O'odham

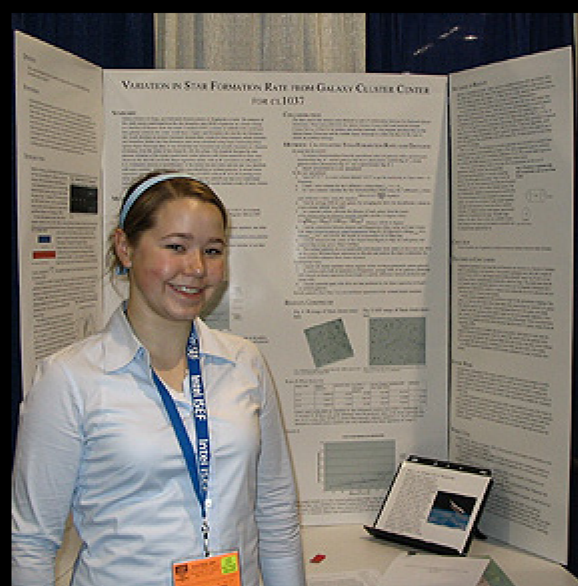
NOAO public affairs staff members Katy Garmany, Rob Sparks and Doug Isbell presented a star party on April 11 to the local children at the new recreation center at Meneger's Dam (Al Jek), located in the far southwest corner of the Tohono O'odham reservation. NOAO was invited by the director of the new center, Roger Antone. Before dark, the kids learned how to use a star wheel, and they made a model of the solar system. The group then visited Kitt Peak National Observatory for an evening of tours and further telescope viewing on May 25.

On April 5, the entire Ha:san Middle School (serving Native American students in Tucson, primarily those from the Tohono O'odham Nation) attended the Nightly Observing Program at Kitt Peak. They were particularly excited by the sight of Saturn in a telescope. Student Deidre Hendricks was proud to tell everyone that her grandfather, Herman Ramon, works at Kitt Peak.

INTEL Science Fair Prize Winner

Emily Petroff won the second place Bok award at the INTEL International Science & Engineering Fair for her project "Variation in Star Formation Rate from Galaxy Cluster Center for c11037." The INTEL fair was held in Albuquerque, New Mexico, from May 13-19.

NOAO Goldberg Fellow Greg Rudnick was Emily's mentor on this project, which used data from the Spitzer Space Telescope. Emily's teacher is Rosa Hemphill from Oregon Episcopal School in Portland, who participated in the NOAO Teacher Leaders in Research Based Science Education (TLRBSE) program a few years ago. Last year, Hemphill was chosen as a participant in the Spitzer-RBSE Research Program for Teachers conducted by the NOAO educational outreach group and the Spitzer Science Center.



NOAO Takes On Leadership Roles for the International Year of Astronomy 2009

Staff members from the NOAO Office of Public Affairs and Educational Outreach (PAEO) have taken on several leadership roles in planning programs and activities connected to the upcoming International Year of Astronomy 2009. This worldwide public celebration of 400 years of observing through telescopes since the age of Galileo has been endorsed by the International Astronomical Union (IAU) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO).

In mid-February 2007, NOAO Associate Director for PAEO Douglas Isbell was asked by Kevin Marvel of the American Astronomical Society to take over as co-chair of the US International Year of Astronomy (IYA) 2009 Program Committee, along with co-chair Susana Deustua, the AAS director of education. (A parallel development committee chaired by Peter Stockman of Space Telescope Science Institute has been constituted by the AAS to help raise funds to support the best IYA 2009 program ideas.) Isbell and Deustua also serve on the top-level IYA 2009 working group at the IAU.

Within just a few weeks, a new US program outline was prepared and then presented by Isbell, Deusuta and Rick Fienberg (editor-in-chief of *Sky & Telescope* magazine and a member of the program committee) at a major IYA 2009 planning meeting in Garching, Germany, at the headquarters of the European Southern Observatory. This presentation was well received, and helped generate several international task groups.

The newly stated goal for the US program for IYA 2009 is simple but ambitious: "To offer an engaging astronomy experience to every person in the country, and build new partnerships to sustain public interest."

US programs will be aligned around six major themes:

- Looking Through a Telescope – star parties, observatory open houses, binocular experiences…
- Dark Skies Are a Universal Resource – GLOBE at Night 2009, public health and economic issues….
- Astronomy in Arts, Entertainment & Storytelling – documentaries, TV specials, public events, lectures, Native American traditions…
- Research Experience for Students, Teachers, and Citizen-Scientists
- Telescope Building & Optics Challenges – a new cheap telescope kit, Hands On Optics activities, contests, internships…
- Sharing the Universe Through New Technology – programs at science centers and planetaria, blogging, podcasting, social networking…

Each US theme will be supported by 2-3 working groups of 6-8 people each (professional and amateur). These working groups are being formed now, toward the next US IYA 2009 organizational meeting in late May.

Stephen Pompea, director of science education and an astronomer at NOAO, is chairing the US IYA 2009 working group on telescope building and optics challenges. Connie Walker, a senior science education specialist and astronomer at NOAO, is chairing the dark skies group, which will focus largely on expansion of the highly successful GLOBE at Night 2006 and 2007 campaigns that she organized.

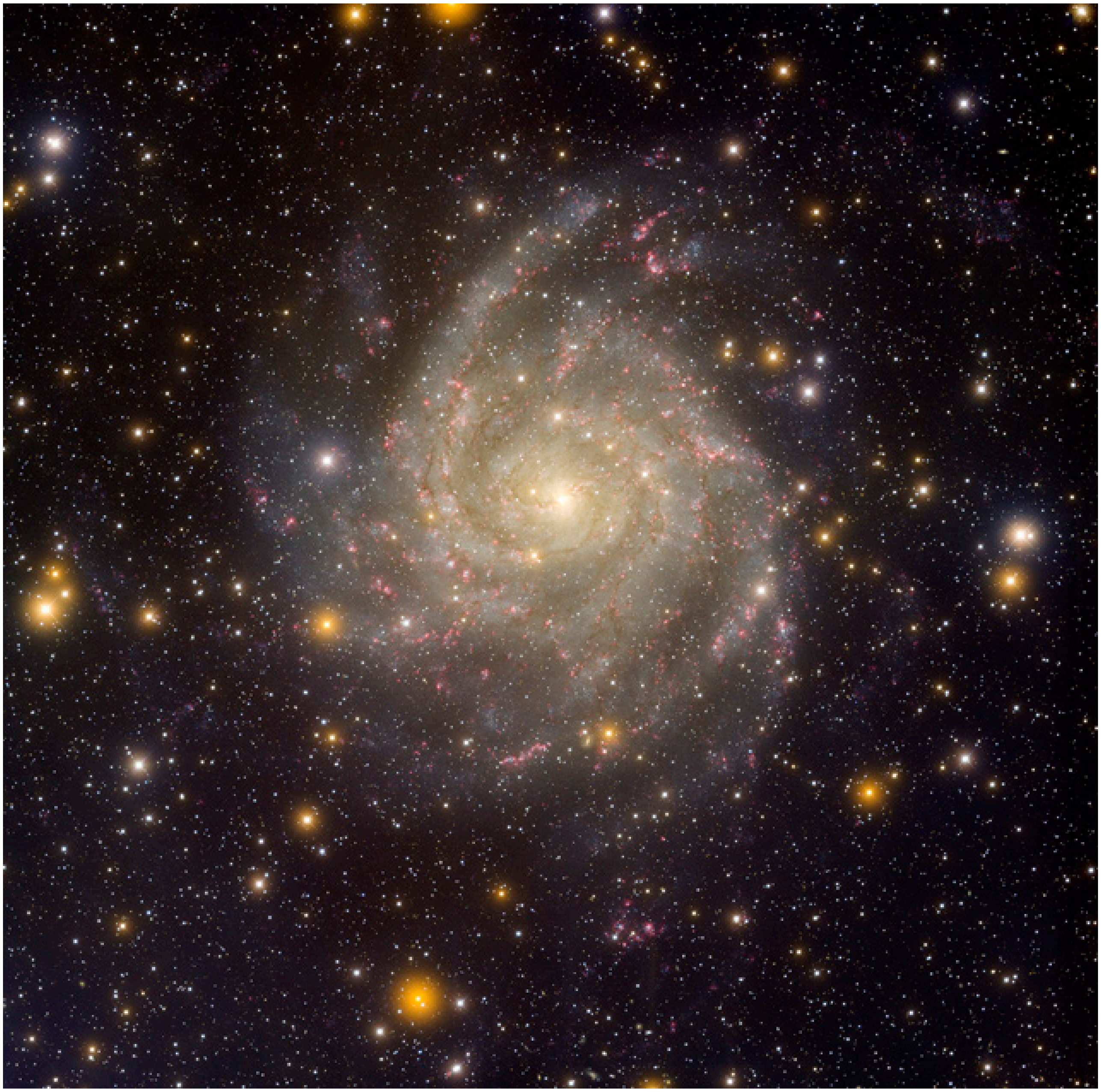
More details about the US IYA 2009 program will be discussed at the annual meeting of the Astronomical Society of the Pacific in Chicago in early September, followed by a second US IYA 2009 planning meeting tentatively scheduled from September 7-8.

Another key meeting will be the Communicating Astronomy to the Public 2007 meeting in Athens, Greece, from October 8-11. This meeting is the third in a series under IAU sponsorship that begin in 2003 in Washington, DC. For more on this meeting, see *www.communicatingastronomy.org/cap2007/*.

The main Web site for IYA 2009 is *www.astronomy2009.org*. One venue for organizing and publicizing US events will be a MySpace page – check it out at *www.myspace.com/2009yearofastronomy*.

Contact Doug Isbell (*disbell@noao.edu*) to express an interest in getting involved or adding program ideas!

Galaxy Image Shows Value of Dark Skies



This beautiful image of spiral galaxy IC 342 that takes advantage of the dark night sky at Kitt Peak National Observatory was released in Washington, DC, on February 21 during the opening day of "The Night: Why Dark Hours Are So Important," a two-day symposium hosted at the Carnegie Institution.

IC 342 is located 11 million light-years from Earth in the constellation Camelopardalis, "the giraffe." From our perspective on Earth, this galaxy is viewed through much of the stars and interstellar dust and gas within our own galaxy, the Milky Way. This means that much of the star light from IC 342 is diminished before it reaches us.

"Without all of the interstellar gas and dust between us and IC 342, it would be one of the brightest galaxies in our night skies and a favorite target for backyard astronomers," said astronomer Travis Rector of the University of Alaska Anchorage. "Being able to produce an image like this, through all that obscuring gas and dust, demands dark night skies like those still found in Arizona at Kitt Peak, which are crucial for making observations of this depth and sensitivity."

The image, obtained in late 2006, was taken using the 64-megapixel Mosaic-1 digital imager on the Mayall 4-meter telescope.

Credit: T.A. Rector/University of Alaska Anchorage, H. Schweiker and NOAO/AURA/NSF