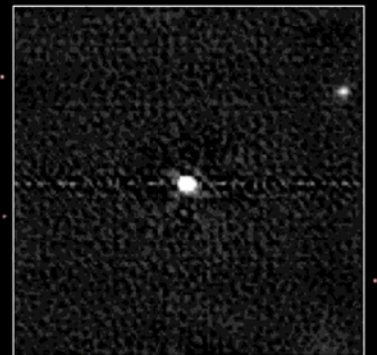


# NOAO/NSO

NEWSLETTER Issue 101, March 2010



NATIONAL OPTICAL ASTRONOMY OBSERVATORY | NATIONAL SOLAR OBSERVATORY  
CERRO TOLDOLO • KITT PEAK • NOAO SYSTEM SCIENCE CENTER • SACRAMENTO PEAK  
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UNDER A COOPERATIVE AGREEMENT WITH THE NATIONAL SCIENCE FOUNDATION



# NOAO/NSO Newsletter

NATIONAL OPTICAL ASTRONOMY OBSERVATORY/NATIONAL SOLAR OBSERVATORY

ISSUE 101 – MARCH 2010

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## On the Cover

This month's cover presents an artist's view of the newly discovered planet Kepler-7b orbiting its host star while an unassociated, faint red star is viewed in the far distance. The planet orbits a star that has a surface temperature close to that of our sun, but which has a considerably larger mass ( $1.3 M_{\odot}$ ) and radius ( $1.8 R_{\odot}$ ). The transiting planet was discovered by the NASA Kepler mission and has a close orbit with a period of  $\sim 5$  days. Being only half as massive as Jupiter, but with a radius 50% larger, Kepler-7b has an unusually low density. The insert image shows a speckle image of the system obtained with the WIYN telescope, one of the observational follow-up programs being performed at Kitt Peak as a part of the Kepler mission. See the related story "Kitt Peak Observations Provide Solid Ground for Kepler" on page 2. (Image credit: Pete Marenfeld/NOAO/AURA.)

## Our New Format

With the first issue of the *NOAO/NSO Newsletter* in 2010, we will begin producing only two issues a year for publication in March and September. This is in response to various observatory committee suggestions, as we explained in this column in the December issue.

Additionally, we are changing the section organization to make the *Newsletter* more useful and informative. One result of this change is that our section editors now are called program editors. In previous issues, the section content followed the organizational structure of NOAO. The new sections, described below, are subject-oriented.

**Science Highlights**—This will remain much the same as it has been—a place for highlighting scientific accomplishments in astronomy/astrophysics. We welcome Tod Lauer as the new editor for this section, and thank George Jacoby for his service.

**System Science Capabilities**—This will include articles about the telescopes and instruments under development and plans for enhancing the US ground-based optical/infrared system of telescopes. These articles will pertain to the facilities provided

to the US astronomical community by the Cerro Tololo Inter-American Observatory, Kitt Peak National Observatory, Gemini Observatory, SMARTS and SOAR consortiums, Telescope System Instrumentation Program, and ReSTAR.

**System Observing: Instruments & Telescopes**—This section contains everything readers will need to know to propose for observing time with the above mentioned facilities.

**NOAO Operations & Staff Highlights**—This begins with the NOAO director's article and includes articles about the operations/management of and the people involved with the National Observatory.

**NSO Happenings**—This begins with the NSO director's article and includes all NSO-related articles that are not in "Science Highlights" and cover topics about NSO telescopes and instruments, the operations/management of, and the people involved in NSO.

We continue to encourage our readers to view the *Newsletter* online ([www.noao.edu/noao/noaonews.html](http://www.noao.edu/noao/noaonews.html)). We send out an electronic notification when the *Newsletter* is posted online, generally several weeks before hard copies reach all our readers.



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# Kitt Peak Observations Provide Solid Ground for Kepler

Steve B. Howell

NOAO Astronomer Steve B. Howell, a member of the Kepler Science team, is using telescopes on Kitt Peak to help evaluate planet candidates discovered by Kepler. The Kepler mission has a follow-up team of approximately a dozen science team members (and their postdocs and students), which uses nearly an equal number of 1- to 3-m-class telescopes, funneling the best candidates to the Hobby-Eberly and Keck telescopes for planet mass information. The work at Kitt Peak is a vital part of this effort.

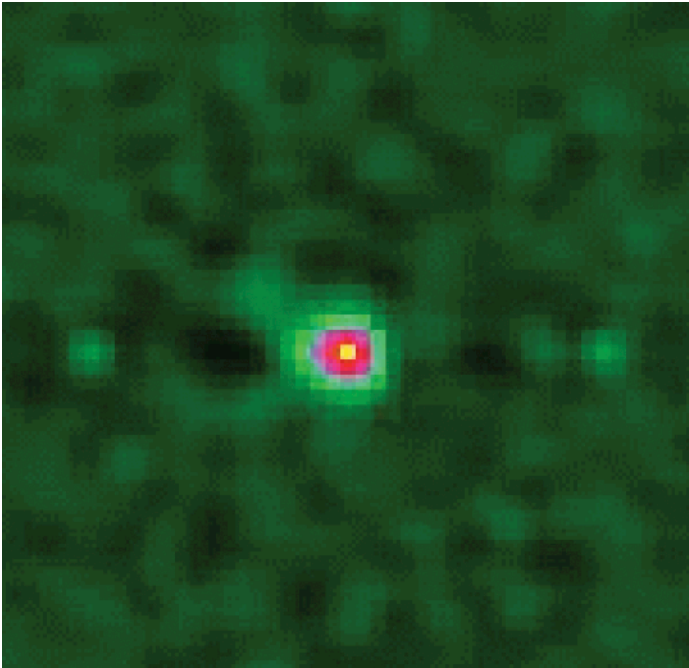


Figure 1: A 1-arcsec-square reconstructed speckle image of a 13<sup>th</sup> magnitude star with its very close (0.13 arcsec) faint companion star (upper left). This companion, likely here to be physically associated with the star, could be a brown dwarf in an ~55 AU orbit. The speckle observations ruled out the “transiting-planet” hypothesis for this star. (Image credit: S. Howell.)

The goal of the NASA Kepler mission (launched in March 2009) is the discovery of Earth-like planets orbiting in the habitable zone of their host stars. Kepler continuously collects photometric information with  $2 \times 10^{-5}$  relative errors for over 100,000 stars every 30 minutes, and every 60 seconds for a smaller set. These data are cast as light curves and searched for exo-planet transit-like events. However, simply spotting an event is not proof that a planetary transit has caused it. Seeing multiple transit events helps, but for complete confirmation that a real planet has been detected, a number of follow-up steps, including ground-based observations, are needed to rule out alternative explanations.

The follow-up program (Gautier et al. 2010arXiv1001.0352G) is well orchestrated, with the Kitt Peak 2-m and 4-m telescopes as well as WIYN playing major roles. Howell and collaborators Elliott Horch (Southern Connecticut State University) and William Sherry (NOAO/NSO) are using the 3.5-m WIYN telescope to obtain speckle images of Kepler exo-planet candidates. The Kepler point spread function is quite large, so observations with higher angular resolution can uncover close variable-star companions

that have blended with the Kepler observations of the star. The cover image and Figure 1 show two different examples of Kepler follow-up speckle-imaging reconstructions made from the WIYN observations.

The speckle instrument recently underwent a significant upgrade to allow simultaneous two-color “electron-multiplier” CCD observations. Speckle images are used as a part of the weeding out process for the largest class of false positives: background eclipsing binary stars and/or a true close companion. The cover illustration shows a reconstructed speckle image and an artist’s concept of the newly-discovered, very-low-density exo-planet Kepler-7b. In this case, the faint red close (1.3 arcsec) companion is not physically associated with the planet host star but a distant background source; however, it is not the cause of the transit-like event (See Latham et al. 2010arXiv1001.0190L). In contrast, the properties of the companion to the star shown in Figure 1 suggest that it caused a false impression of a planetary transit.

Howell is using two other Kitt Peak telescopes as part of the Kepler mission. Spectrographs on the 2-m and 4-m are being used to perform initial reconnaissance spectroscopy for exo-planet candidates to help confirm (or deny) the Kepler mission information gleaned from its own light curves. Some transit-like events are due to (grazing) eclipses, and some of these binaries are easily picked out from the initial spectroscopy. Information on spectral type, luminosity class, stellar activity, and rotation are obtained as well. The spectrographs are also being called into service to provide additional information on specific interesting candidates and to obtain orbital velocities to support eclipsing binary follow-up for systems that show a transit-like event from a third body.

The Kepler mission has performed well to date, with Jupiter-size planets now being “easy” (Figure 2) to detect. However, harder work awaits the science team as they push the limits of their light curves and ground-based work toward the mission goal—other Earths. These smaller planets will require far more intense ground-based follow-up observations. The Kitt Peak telescopes will continue to be a strong part of the Kepler mission.

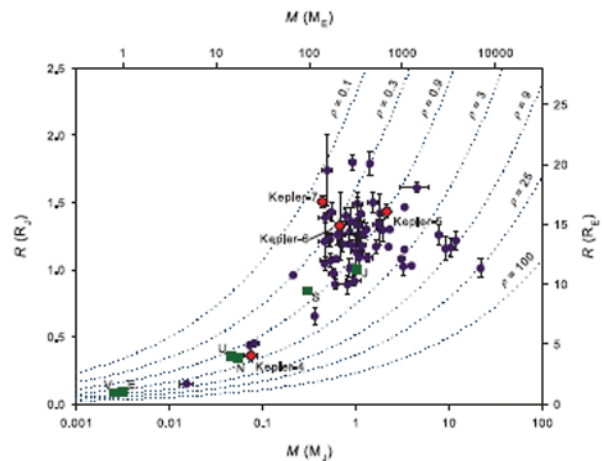


Figure 2: (From Latham et al. 2010). A mass-radius diagram for known transiting exo-planets. The Kepler mission’s recent discoveries (Kepler 4b, 5b, 6b, and 7b) are shown (red diamonds). (Reproduced by permission of the AAS.)



# Early Results from the NEWFIRM Medium-Band Survey

Pieter van Dokkum

The NEWFIRM Medium Band Survey (NMBS) is an NOAO Survey program (PI: Pieter van Dokkum, Yale University) on the Mayall 4-m telescope with the NEWFIRM wide-field infrared imager. The program uses a set of five custom, medium-bandwidth, near-infrared filters to obtain well-sampled spectral energy distributions from 1.0–1.8  $\mu\text{m}$ . This enhanced sampling greatly improves photometric redshift estimates of galaxies at  $z > 1$ , where the Balmer and 4000-Å breaks shift outside of the optical window. It also provides accurate measurements of the rest-frame colors of galaxies and of their environment.

All observations for the program have been completed. The survey comprised a total of 75 nights, with 45 nights provided by the NOAO Survey program and 30 nights provided through a time trade with Yale University. Van Dokkum and his team obtained deep imaging in  $J_1, J_2, J_3, H_1, H_2,$  and  $K$  in two  $28' \times 28'$  fields (parts of the COSMOS field and AEGIS fields). About two-thirds of the data have been reduced, by graduate student Kate Whitaker at Yale. The NMBS team expects to release the first data products in late summer of this year. Below are some early highlights from the survey.

*A clear bimodality in galaxy colors from  $z = 0$  to  $z = 2$ :* The accurate redshifts and colors of the NMBS enabled the identification of a distinct “red sequence” of galaxies with low star-formation rates all the way to  $z = 2$  (see Figure 1). It is a puzzle why some massive galaxies at  $z = 2$  form stars at a prodigious rate, while in others, star formation seems to have ceased almost completely.

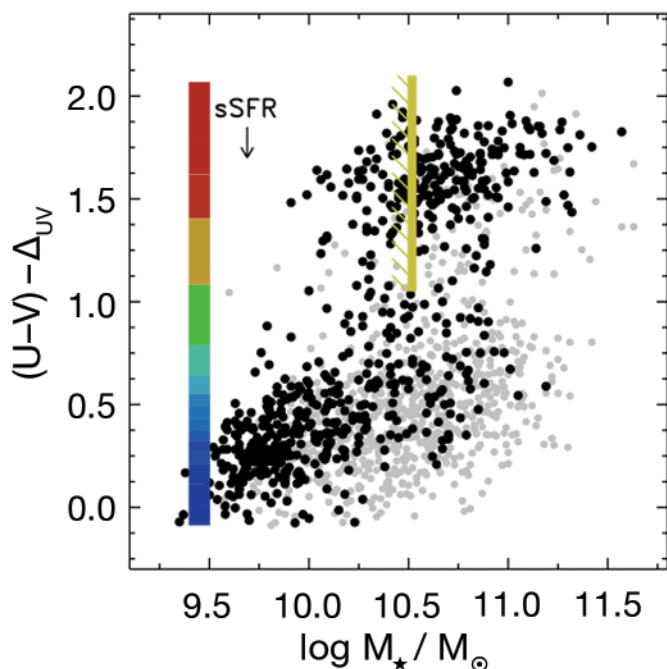


Figure 1: The dust-corrected color-mass relation at  $z = 2$  (Brammer et al. 2009). The yellow vertical line indicates the completeness limit for red galaxies. Note the clear bimodality in the galaxy colors, with quiescent galaxies being well separated from star-forming galaxies. (Reproduced by permission of the AAS.)

*Discovery of very old galaxies at high redshift:* A related problem is determining the ages of galaxies on the red sequence. The NMBS data show that galaxies have a wide range of ages, and that in addition to post-starburst galaxies, a population of redder, presumably older galaxies exists at  $z = 2$ . This confirms previous studies based on painstakingly obtained near-infrared spectroscopy of small samples.

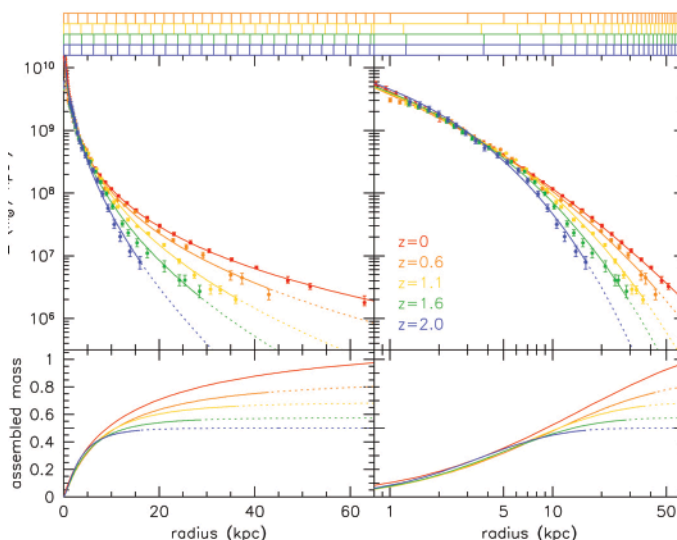


Figure 2: Evolution of the radial surface density profiles of massive galaxies, determined from stacking NMBS galaxies in different redshift bins (van Dokkum et al. 2010). The profiles are nearly invariant with redshift in the inner parts, but evolve strongly at large radii. (Reproduced by permission of the AAS.)

*Growth of galaxies since  $z = 2$ :* The NMBS gives accurate redshifts and stellar masses for thousands of galaxies at high redshift, allowing determination of the mass evolution of galaxies at a fixed number density. Massive galaxies grow by a factor of  $\sim 2$  in mass since  $z = 2$ , consistent with an extrapolation of earlier results at  $0 < z < 1$ . By stacking the NEWFIRM images, the NMBS team determined that this mass growth is driven by the rapid build-up of the outer envelope of galaxies (see Figure 2), perhaps due to widespread merging activity.

Van Dokkum and his team are working on a variety of other papers and projects, such as the determination of evolution of the mass function, the properties of very massive galaxies at high redshift, the star formation history of galaxies, and various follow-up programs. They are also in the planning stages of NMBS-II, a wide-field extension of the NMBS that was recently approved by the NOAO Survey Time Allocation Committee. NMBS-II will image 4 square degrees with NMBS filters from CTIO in 2010 and 2011 to pin down the evolution of “monster” galaxies (those having masses of  $\sim 5 \times 10^{11} M_\odot$ ) from  $z \sim 3$  to the present.

## References:

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# The NOAO Outer Limits Survey: Stellar Populations in the Extremities of the Magellanic Clouds

Abhijit Saha & The OLS Team

**A**bi Saha and his “Outer Limits” team have used the Mosaic camera on the CTIO 4-m telescope to probe the extreme outer regions of the Large Magellanic Cloud (LMC). With Mosaic, they are able to identify main sequence stars belonging to the LMC at large distances from its center. The use of main sequence stars provides a much richer probe of the structure, countering the extreme paucity of the giants in the same fields, which are more traditionally used as tracers. The Outer Limits results show that the LMC is disk-dominated at large radii, giving a complete trace of the LMC disk over 10 scale lengths. The existence of a disk at such large radii may suggest that the LMC has not repeatedly passed close to the Galaxy.

The most metal poor and plausibly the oldest stars in our Galaxy are distributed in a halo that extends beyond 25 kpc. Their spatial distribution, chemical composition, and kinematics provide clues about the Milky Way’s early history, as well as its continued interaction with neighboring galaxies. The Large and Small Magellanic Clouds (SMC) are the nearest galaxies with ongoing star formation. How far out from their centers can we still identify stars that belong to them? Are the clouds disk- or halo-dominated? How old are they? Do they reveal tidal structure due to interaction with our Galaxy, or share a common halo? What do the kinematics of such outlying stars say about the dark matter distribution? Do they shed any light on the origin of the Magellanic Stream seen in HI?

Direct detection of spatially extended structure in the LMC/SMC is difficult, because of the clouds’ considerable extent on the sky, and because the LMC bar and disk are relatively face on. There is a rich legacy from past studies that probe the extent of these galaxies. Van der Marel (2001), for example, mapped the stellar extent of the LMC using RGB and AGB star count densities from the Deep Near Infrared Survey (DENIS) and 2-Micron All-Sky Survey (2MASS) out to an angular distance of about 8 degrees, beyond which the surface density of RGB and AGB stars fall below detectable levels. Within that distance, van der Marel was able to use these probes to derive the disk inclination on the sky, the intrinsic elongation of the LMC disk, and a disk scale length of about 1.3 kpc. In the SMC the RGB, AGB, and clump stars can be used out to an angular distance of about 3 degrees.

There are currently several ongoing studies to push the detection of RGB stars associated with the Clouds to larger angular distances from their centers. In contrast, Saha and his team have carried out a deep imaging survey in five passbands (Washington C, M, DDO51, and Landolt R and I) using the Mosaic camera on the Blanco 4-m telescope at CTIO in selected fields around the LMC/SMC complex, primarily directed at identifying stars on the main sequence (MS) below the oldest turn-off, while also including the ability to identify giants. Not only are MS stars nearly two orders of magnitude more numerous than giants, but they also provide a representation of the parent population that is unbiased by age and metallicity. Further, the morphology of the color-magnitude diagrams in the above chosen bands yields useful handles on age and metallicity, which are additional characteristics of the stellar populations in the extremities of these galaxies that are important clues about the

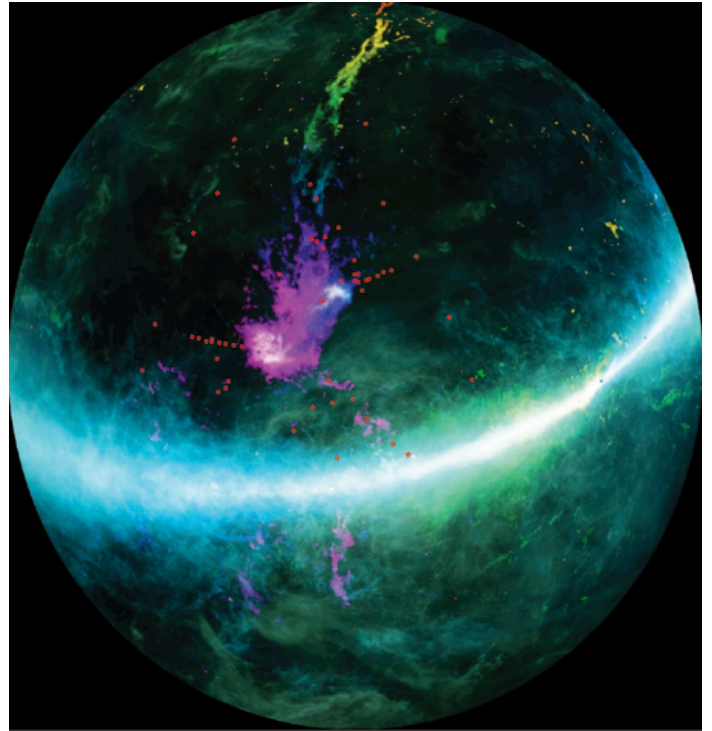


Figure 1: The extended region of sky surrounding the Magellanic Clouds, as seen in neutral hydrogen emission from the Galactic All Sky Survey (see [www.atnf.csiro.au/research/GASS/](http://www.atnf.csiro.au/research/GASS/)). The Galactic plane, the location of the LMC and SMC, and both “leading” and “trailing” arms of the Magellanic Stream are clearly visible. The positions of the fields studied in this survey are shown by the over-plotted symbols. (Image credit: S. Janowiecki.)

origin of the galaxies themselves. Thus the survey is crafted to reveal the early history of the LMC and SMC and their interactions with each other and with the Milky Way.

Complete spatial coverage to the desired depth around the LMC/SMC/Magellanic Stream complex would involve about 2000 square degrees, which is observationally prohibitive with current instrumentation: a thirty-night program on the Blanco with Mosaic-2 provides only a 1% fill factor. Thus, Saha and his team strategically selected representative fields in six regions:

1. Looking away from the LMC in a direction least complicated by the SMC. This is along north from the LMC from 7 to 20 degrees from the LMC center. This is supplemented by a similar radial cut along the north-west direction.
2. Almost due north from the SMC, along the Magellanic stream.
3. Toward the Galactic plane from the LMC along the “leading arm” of the Magellanic Stream.

*continued*

## The NOAO Outer Limits Survey continued

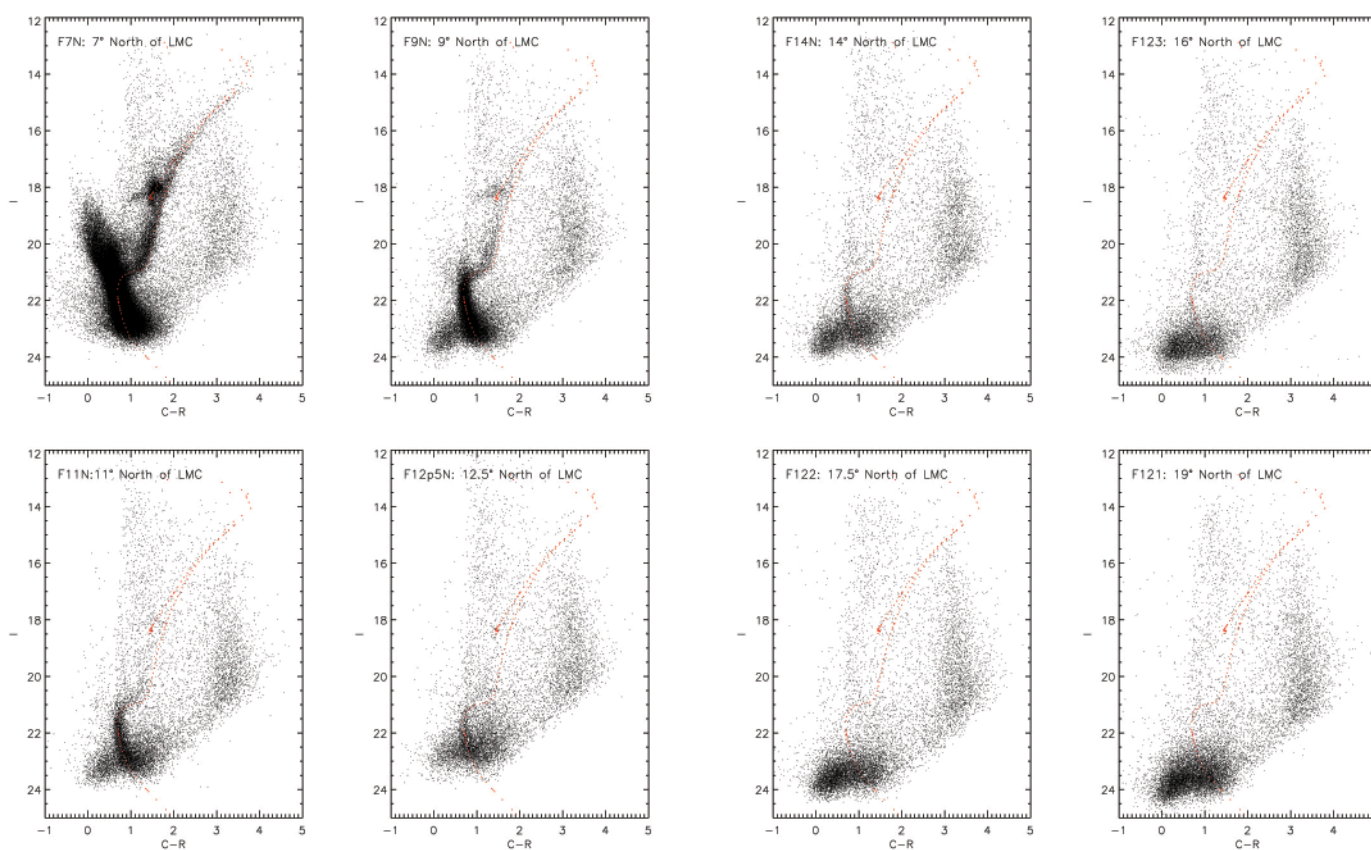


Figure 2a

Figure 2b

Figure 2a: The color-magnitude diagrams in C-R vs. I are shown for fields progressively more distant (from 7 to 12.5 degrees) along a line due north from the center of the LMC. All objects whose profiles are consistent with those of a stellar point spread function are shown. The majority of objects fainter than  $I = 22.5$  and with colors ranging from  $0 < C-R < 1.5$ , especially noticeable in the more distant fields, are background galaxies unresolved in the seeing limited images. The isochrone (Marigo et al. 2008) for  $z = 0.002$  and  $\log t = 9.9$  (~8 Gyr) is over-plotted using a distance modulus of 18.5 on all the panels. Figure 2b: Same as for Figure 2a, but for fields 14 to 19 degrees from the LMC center.

4. Westward from the SMC, orthogonal to the Stream, which is also an area opposite from the LMC and least affected by it.
5. Several control fields 30 to 40 degrees away from the Clouds, spanning a range of Galactic latitudes that bracket the levels of foreground contamination in the target fields. This is necessary to make good models to account for contamination.
6. In a direction looking back along the LMC's trajectory, based on the proper motion studies by Kallivayalil et al. (2006) and by Piatek et al. (2008).

A panoramic view of this part of sky as seen in neutral hydrogen is shown in Figure 1, with the various field locations over-plotted.

The observations were concluded in December. The photometry has better than 2% systematic accuracy. The first results from the analysis of the data products are in hand: a particularly salient example is described below.

Figure 2a shows the color-magnitude diagrams (CMD) (C-R vs. I) for fields running north from the LMC (region 1 above), from 7 through 12.5 degrees from the LMC center. Figure 2b continues out even farther, from

14 through 19 degrees from the LMC center. These fields also happen to lie at a constant Galactic latitude of about -34 degrees.

A smooth progression in the features of the CMD is apparent. Going from the 7- through 9- to 11-degree fields, there is not only a decline in the total number of stars present, but also a steady erosion of the younger stars relative to the older ones, as seen from the sharp decline in the number of blue MS stars (above the oldest turn-off). At distances of 11 degrees, the younger stars are all essentially gone. The overall decline in the number of all stars also causes the RGB to vanish against the backdrop of foreground stars from the Galaxy: while it is clearly delineated in the 7-degree field and still quite visible 9 degrees out, it is not discernible on its own in the 11-degree field. In contrast, the MS clearly continues to stand out prominently, and remains visible even 16 degrees out, beyond which it too is no longer present. This is the expected validation of one of the basic precepts of this survey: that of reaching the MS stars below the oldest turn-off, and using them as tracers of extended structure. The MS stars carry us out about twice as far as the RGB- and AGB-based study by van der Marel.

The procedure is to define regions on these CMDs that delineate the MS stars below the oldest turn-off, and also the locus of the RGB as seen in

*continued*





## The NOAO Outer Limits Survey continued

the 7-degree field. The number of stars in these two regions in each of these eight CMDs is then counted. The 17.5-degree and 19-degree fields, where no MS feature is visible, as control fields that represent the Galactic foreground and general background object densities provide corrections to the raw counts in the other six fields to derive the contribution from the stars that are associated with the LMC. The inferred number of giants (per Mosaic-2 field of about 0.33 square degrees) is consistent with zero at distances of 11 degrees and beyond. In contrast, Figure 3 shows the log of the inferred surface density of MS stars associated with the LMC against the projected distance from the LMC center. The excellent fit (shown as the line in Figure 3) to an exponential decline in surface density over the entire range where MS stars are associated with the LMC argues strongly that these stars lie on a disk, with a scale length of 1.35 degrees on the sky. De-projecting on to the plane of the disk following the geometric parameters derived by van der Marel (2001) yields a disk scale length of about 1.3 kpc, which is in stunning agreement with the value he derived for the inner disk using giant stars! Attempts to reconcile these star counts with a spheroidal halo run into various problems, which will be discussed in a forthcoming paper.

The conclusion that the detectable stellar outer limit of the LMC is disk dominated is interesting on several fronts. Observationally, optical detection of a disk well past 10 scale lengths is unprecedented. The MS star density near the extremities produces a surface brightness as faint as 34 mags per square arcsec. That such ordered structure persists so far out from the LMC while in the tidal field of the Galaxy suggests that the LMC could not have repeatedly passed close to the Galaxy, although formal conclusion on this must await dynamic modeling.

These examples underscore the unique opportunity that the LMC/SMC complex provides for studying the outer extremities of galaxies, even though these particular examples may be peculiar.

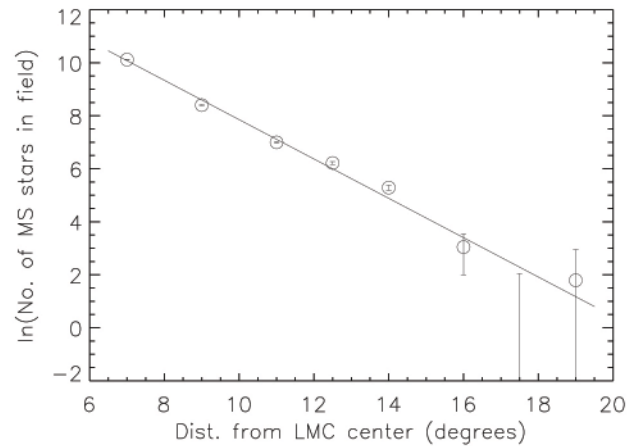


Figure 3: The run of the log of surface density of MS and old turn-off stars in a predefined region of the CMD with LMC-centric distance as projected on the sky along a direction due north from the LMC center. The line shown is a fit to the inner six points, which implies an exponential decrease in the surface density of these stars with distance, with a scale length of about 1.3 degrees on the sky.

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## Evidence that Temporal Changes in Solar Subsurface Helicity Precede Active Region Flaring

Rudi Komm (NSO), Frank Hill (NSO), Alysha Reinard (University of Colorado/CIRES) & Justin Henthorn (Ohio State University)

As our society becomes more technologically advanced, “space weather” (the fluctuating effect of the Sun on the heliosphere and the Earth) is an increasing concern. Solar flares and coronal mass ejections (CMEs) affect satellite function, high-frequency communication, power grids, and many applications that use the Global Positioning Satellite system (e.g., deep-sea drilling and precision farming). Because of our increasing reliance on technology that is susceptible to space weather effects, it is vital that we improve our understanding of solar flares and increase our ability to forecast when a flare will occur and how large it will be. Highly twisted magnetic fields are very likely responsible for strong eruptive phenomena such as flares and CMEs. While several parameters based on surface magnetic field measurements have been evaluated as potential flare-forecasting criteria, so far none have been found to offer much improvement over predictions based on chance alone.

We studied the relationship between twisted velocity fields below the surface of the Sun and flare production. The velocity can be measured indirectly with local helioseismology using the “ring diagram” technique. In this method, localized regions are probed rather than the entire Sun, making it possible to map the horizontal flows in the immediately subsurface, outer convection zone as a function of heliographic latitude, longitude, depth, and time. This technique has led to detailed maps of the horizontal flows, with continuous coverage since August 2001 using data from the NSO Global Oscillation Network Group (GONG) program. The 100-plus 27-day-long Carrington rotations that have been collected so far cover the maximum of solar activity and the descending phase of Solar Cycle 23, as well as the current extended and deep minimum of solar activity. While the flow maps themselves are a rich source of information about the solar convection zone, their value is enhanced by

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## Temporal Changes in Solar Subsurface Helicity continued

the computation of fluid dynamics descriptors, such as the divergence and the vorticity of the flows. Vertical velocities are determined using the divergence of the horizontal flows, assuming incompressibility and zero surface velocity. The kinetic helicity density is then the scalar product of the velocity and vorticity vector.

Previous work showed that if an active region had both high subsurface vorticity and a strong surface magnetic field, it would also have a very high probability of producing several strong flares. In addition, the helicity of one of the 2003 “Halloween” flare regions (AR10486) had very large values that shrank to essentially zero at the time when an X10 flare occurred. This suggested that the temporal behavior of the subsurface helicity might be useful as a flare predictor. We investigated more than 1000 active regions to determine if this behavior is typical or if AR10486 was unusual.

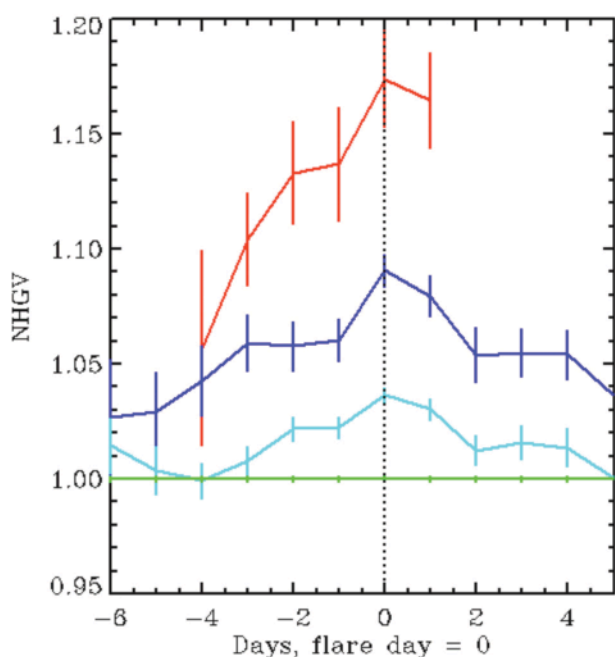


Figure 1: The temporal variation of the Normalized Helicity Gradient Variance (NHGV) for active regions associated with X-class flares (red), M-class flares (blue), and C-class flares (cyan). Shown in green is an average value for active regions that do not flare. (Image credit: Alysha Reinard, University of Colorado/CIRES.)

We designed a parameter, the Normalized Helicity Gradient Variance (NHGV), to capture the large, but shrinking, spread of helicity values, the overall range of helicity values, and the depth variation of the helicity. Figure 1 shows the average NHGV versus time leading up to a flare that occurs on day zero for X-, M-, and C-class flares normalized by the values for quiet, non-flaring active regions. This normalization produces a value of one for quiet regions. It is immediately apparent that the parameter is able to identify C-, M-, and X-class flare-producing active regions since the NHGV increases with increasing flare class and all of these values are higher than the quiet region data. The NHGV rises in the days before the flare occurs, peaking on the day of the flare. A statistically significant jump in NHGV is seen two days before C- and X-class flares and three days before M-class flares. While this result is based on average data, it indicates the potential ability to use this data to predict when a flare will occur, how large it will be, and from which active region it will arise.

The results suggest that a buildup of energy caused by twisting velocity fields is taking place below the surface of the Sun, leading to the following physical scenario: turbulent flows gradually twist field lines below the photosphere, thus using rotational kinetic energy to push magnetic field lines into an unstable configuration below the active region. This configuration propagates upward into the solar atmosphere, and, if the subsurface helicity becomes strong enough, the magnetic field is twisted to the point where the repulsion of like polarity is overcome, resulting in explosive reconnection in the form of a flare. This simple scenario then suggests that large, decreasing values in the rotational kinetic energy, i.e., helicity, precede flaring activity. While numerical simulations to study the twist of magnetic flux tubes resulting from the kinetic helicity of turbulent flows have been done, it is quite clear that detailed magnetohydrodynamic simulations are needed to fully understand the physical mechanism and to further guide predictive techniques based on subsurface vorticity measurements. Figure 2 shows an artistic conceptual image of the physical scenario.

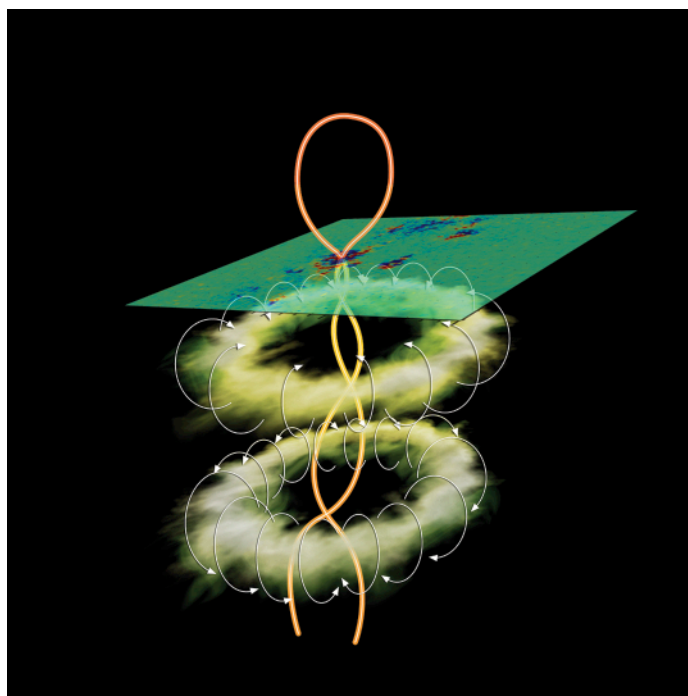


Figure 2: Conceptual drawing of the physical mechanism causing flares. The surface of the Sun is shown in green, with the surface magnetic field of AR10486 in red and blue. Below the surface, the flows form a double “smoke ring” pattern with opposite senses of rotation within the ring. The magnetic field flux tube, shown as an orange curve, is twisted by the flows in the rings to the point where the repulsion of like polarity is overcome, resulting in explosive reconnection in the form of a flare. (Image credit: P. Marnfeldt/NOAO.)

Using the discriminant statistical technique, we found that the combination of the temporal evolution of NHGV and the surface magnetic field strength provides a flare vs. no-flare forecast within one day of a flare with a Heidke skill score of 0.333. The Heidke skill score indicates whether a prediction result is better than could be expected by chance, and its value measures how much better the prediction is compared to chance. A perfect predictor has a Heidke skill score of one, a predictor that does no better than chance has a Heidke skill score of zero, and predictors that do worse than chance have negative Heidke skill scores. Our Heidke skill


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## Temporal Changes in Solar Subsurface Helicity continued

scores range from 0.25 to 0.38. For comparison, using various combinations of surface vector magnetic-field measurements to predict flares produces Heidke skill scores that range from 0.07 to 0.15.

Thus, the temporal variation of subsurface helicity is a good indicator of when a flare will occur, how strong it will be, and in which active region it

will occur. We are currently developing improvements to the analysis and starting to work with the National Oceanic and Atmospheric Administration Space Weather Prediction Center in Boulder to develop an operational tool for forecasting flare activity. A complete discussion on this topic has been accepted for publication in the *Astrophysical Journal (Letters)*. 

# McMath-Pierce Observations of the Lunar Impact Plume from the LCROSS Mission

R.M. Killen (NASA Goddard Space Flight Center), A.E. Potter (NSO), D. Hurley (Johns Hopkins University Applied Physics Laboratory, Maryland), C. Plymate (NSO) & S. Naidu (University of Maryland)

The purpose of the Lunar Crater Observing and Sensing Satellite (LCROSS) mission was to determine if appreciable amounts of water are condensed in the permanently shadowed craters that are found in lunar polar regions. The permanently shadowed regions are obviously inaccessible to direct observations that might reveal the presence of water ice. So, in order to loft some of the shadowed material from the crater floor into sunlight where it could be analyzed spectroscopically, a Centaur (rocket) upper stage was crashed into the permanently shadowed crater Cabeus. The impact plume was predicted to rise into sunlight, where a small follower satellite and ground-based telescopes could observe its properties.

We planned to observe sodium emission, water vapor, and polarization effects in the impact plume. The McMath-Pierce main telescope was used with the stellar spectrograph to observe sodium emission and water vapor, and the McMath-Pierce East Auxiliary telescope was used to image the impact plume in orthogonal polarizations.

The Centaur upper stage impacted the crater floor of Cabeus at 11:31:19 UT on 9 October 2009. The small, shepherding spacecraft followed, making spectroscopic measurements of the Centaur impact plume, and itself impacting at 11:35:35.05 UT. Recent reports are that water was detected in the plume.

In common with all other ground-based observers, we did not detect the impact plume in visible light images from the East Auxiliary telescope, so we did not obtain any information about the polarization properties of the plume.

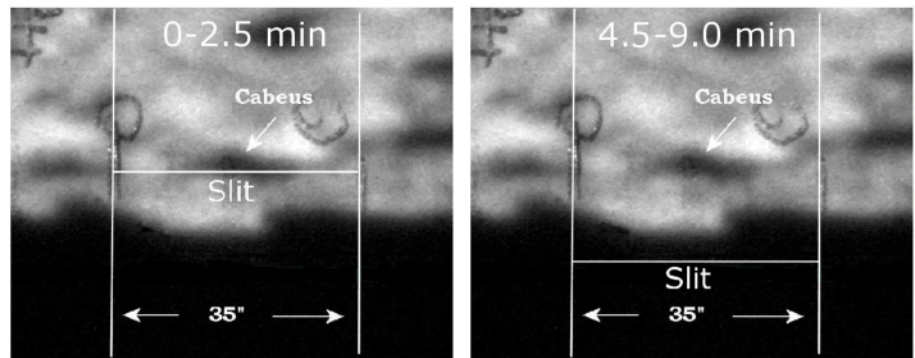


Figure 1: Guide camera image of the limb of the Moon at Cabeus. The positions of the slit immediately after the Centaur impact (left), and then 4.5 min later (right) are marked. (Image credit: Andrew Potter/NSO.)

The spectra observed with the stellar spectrograph covered the two sodium D-lines, and included a number of terrestrial water lines. We could not see any change in the water lines, so we did not obtain any information about water in the impact plume. However, we did detect emission from the sodium D-lines. The remainder of this report is concerned with our observations of the sodium emission.

Figure 1 shows the configurations of the spectrograph slit for the stellar spectrograph measurements. The first two measurements were made with the slit across the crater shadow (left image), expecting to get spectra of the initial impact cloud there. The slit was then moved off the limb (right image), where two more measurements were made to get spectra of the more diffuse cloud expected as the impact cloud dissipated.

Spectra taken before the event were used to subtract out the background, so as to get spectra

of the sodium D<sub>2</sub> emission alone. Immediately following the last impact event measurement, the lunar equatorial limb was measured to provide an intensity calibration from the known reflectivity of the lunar limb. The sodium emission intensities in kiloRayleighs resulting from the calibration were converted to atom column densities, using the g-value appropriate for the sodium D<sub>2</sub>-line at 1 AU (0.53 photons/atom/sec). Results are shown in Figure 2, where sodium atom column densities are plotted against distance on the Moon.


Results from the observation covering the first 90 sec after the impact are shown in the left panel of Figure 2. There is a sharply defined peak at the approximate location of Cabeus, rising to a maximum of about  $3 \times 10^{11}$  atoms/cm<sup>2</sup> column. A sodium peak is still detected in the second 90-sec interval, but it has fallen to a level of about  $0.5 \times 10^{11}$  atoms/cm<sup>2</sup> column. At 270 sec (4.5 min) after impact, the slit was

*continued*



## McMath-Pierce Observations continued

moved off the lunar limb, as shown in Figure 1. The resulting off-limb column density profiles are shown in the right panel of Figure 2. For the observation covering the period 4.5–6.5 min after impact, a sodium peak still is seen, but it has broadened beyond the field of view of the spectrograph, with a maximum of about  $0.8 \times 10^{11}$  atoms/cm<sup>2</sup> column. The final observation for the period 7.0–9.0 min showed a broad weak sodium emission, with a maximum of about  $0.2 \times 10^{11}$  atoms/cm<sup>2</sup> column.

One of us (Hurley) developed a model of the sodium plume, assuming a release temperature of 1000 K and scalable by the mass of sodium released. Two configurations were analyzed: in one, the sodium cloud expanded isotropically; in the other, it was directed at a 45° angle to the surface. The latter model seems to be more consistent with the observations, not unreasonably, considering that the Centaur upper stage struck the surface at an extremely oblique angle. Results from the model are shown in Figure 3. The left panel shows the sodium column density averaged over the first 90 sec after impact. In the immediate vicinity of the impact, the predicted width of the emission is roughly similar to the observed width. However, predicted column densities assuming 1 kg of sodium released are in the range of  $10^{12}$  atoms/cm<sup>2</sup> column, three or more times larger than the observed values in the  $3 \times 10^{11}$  atoms/cm<sup>2</sup> column range. We suggest that the difference might be due to shadowing of the sodium plume, resulting in an underestimate of sodium from our sunlight scattering measurements, or possibly the slit was slightly misaligned with the plume. There is better agreement between the off-limb observations and the model predictions, with sodium densities in the same range, and a width of the plume that appears to be similar. From this, we conclude that the impact released a mass of sodium of the order of 1 kg at a temperature on the order of 1000 K. 

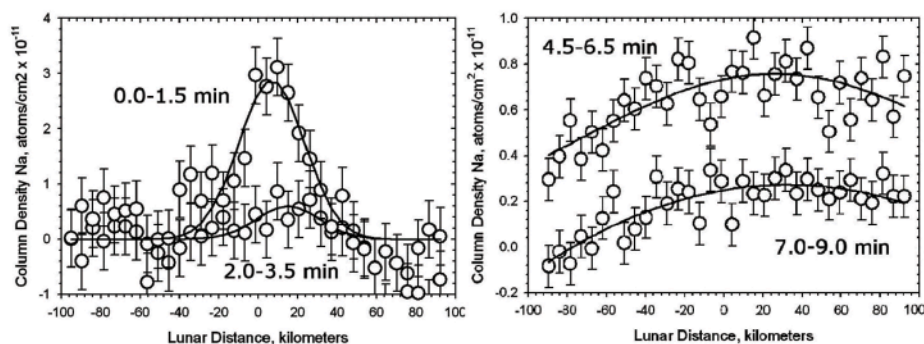


Figure 2: Sodium column density profiles across the LCROSS impact plume. The left image is for the slit placed directly on the crater Cabeus, and the right image is for the slit placed about 10 arcsec off the limb. (Image credit: Andrew Potter/NSO.)

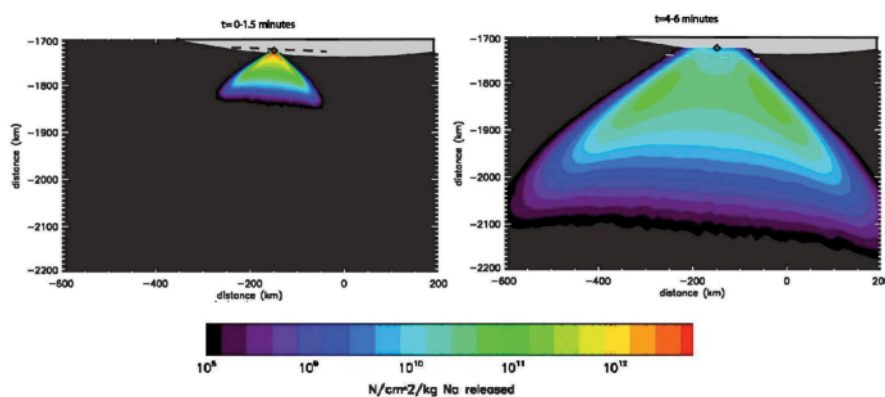


Figure 3: Model predictions of the distribution of sodium following the Centaur impact. The left panel shows sodium column density averaged over the first 1.5 min, corresponding to the first observation period. Peak sodium levels at the crater were in the range  $10^{12}$ – $10^{13}$  atoms/cm<sup>2</sup> column at the crater, and the width was about 50 km. The right panel shows the averaged density over the 4- to 6-min period corresponding to the first off-limb observation period. Peak sodium levels were in the range  $10^{10}$ – $10^{11}$  atoms/cm<sup>2</sup> column, and the width close to the limb was about 200 km. (Image credit: D. Hurley, Johns Hopkins University Applied Physics Laboratory, Maryland.)

## Creating a Roadmap for the Ground-Based O/IR System

Todd Boroson

Over the past decade, the community has come to accept the idea, espoused by the 2000 decadal survey, that the total suite of US ground-based optical/infrared (O/IR) facilities may be viewed as a system. This perspective acknowledges that we move forward as a single community, inclusive of those who have preferred access to some facilities and those who do not, and that it is the entirety of the resources available to our community rather than any single facility that makes us competitive internationally. Of course, having a lot of glass is nice, but the system concept goes further. It suggests that choices can be made that optimize, or at least improve, the entire thing.

What choices should be made? In what ways could the system be made better? The answers depend on at least two sets of constraints. First, it would be helpful to understand what the community wants: what new capabilities are desired, what types of access need to be enhanced or enlarged. Second, how can we encourage strategic choices that benefit the system? Some of the resources that will be used to improve the system will come from federal sources with the goal of benefiting the entire community,

and decisions involving these should consider the leverage that private investment provides. Some of the resources will come from private sources, and these must be encouraged to consider choices that have global benefit to the entire system beyond the local benefit to a given facility or subset of the community.

I am not a political scientist (though I often feel like I play one on TV), but my take on this is that we need a “roadmap” for the evolution of the system; one that shows and justifies where we want to go, how we might best get there, and what choices should be made along the way. This roadmap must be developed with broad community involvement, because it needs broad community endorsement to be effective. It needs to be dynamic because all the constraints are always changing. And its development and implementation need to be shepherded by a group with a degree of institutional memory and a degree of improvisation.

And so, this is an announcement of an activity that will proceed from where the Renewing Small Telescopes for Astronomical Research (ReSTAR) and Access to Large Telescopes

for Astronomical Instruction and Research (ALTAIR) committees ended. We now have a lot of the input data. We have a good idea what those segments of the community want, and we have seen the difficulty of getting broad community buy-in to federal investment in an extremely large telescope. The challenge is to integrate the desires of these (and other) segments into a viable plan for the entire system that can be implemented with the combination of federal and non-federal resources that we, the entire community, will have access to.

With the approval and interest of NSF/AST, we are initiating a System Roadmap Committee. As with ReSTAR and ALTAIR, we will try to populate this committee with people who can think broadly about how to solve these very difficult problems and who have a good understanding of the issues and difficulties that have prevented much progress in this integration before. The task will include soliciting a lot of community input. Watch for information on our Web site about the roadmap and its development and for opportunities to provide input: through our electronic newsletter, *Currents*; to online polls; and at AAS and other meetings.

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## Dark Energy Camera Update

Alistair Walker & Timothy Abbott

The Dark Energy Camera (DECam) is a new camera being built by the Dark Energy Survey (DES) Consortium for the Blanco telescope prime focus. The DES Consortium consists of over 130 scientists from 12 institutions in the US, Spain, Brazil, and the UK, with Fermilab as the lead institution. In exchange for building DECam, the Consortium has been allocated 525 nights over five years to carry out a 5000-sq deg *grizY* imaging survey of the Southern Galactic Cap. The survey data will become public after 12 months, and high-level data products (e.g., catalogs) will be published mid-survey and after its completion. The project is funded by the US Department of Energy and NSF; the funding agencies of the UK, Spain, and Brazil; and contributions from the Consortium institutions. It is expected that

DECam will be commissioned on the Blanco telescope in late 2011.

DECam will be a facility-class instrument fully integrated into the telescope system and standard CTIO operations and offered for use to the community for small and large programs. DECam will be delivered with a *Community Pipeline*, which will deliver raw and processed images into the NOAO Archive, operated by the NOAO Science Data Management group. The camera will have a focal plane of 62 2K × 4K CCDs plus 12 2K × 2K focus and guide CCDs, all of which use the Lawrence Berkeley National Laboratory (LBNL) fully-depleted design. The full focal plane (1040 MB) can be read out in 17 seconds, a data rate approximately 60 times greater than that of the Mosaic-2 Imager.

We are now in the construction and test phase, and so far all the news is good! The five elements of the new prime focus corrector are being polished and figured at Société Européenne de Systèmes Optiques (SESO) in France, and are due for delivery to Consortium member University College London. There, the Optical Sciences Group will mount and align the elements in the instrument barrel before careful packing and shipping to Chile. The many steps of CCD fabrication are being carried out under the direction of LBNL at several vendors in Canada and the US. After the wafers are diced, the CCDs are sent to Fermilab for packaging, testing, and grading. We have just passed the milestone of packaging enough science-grade 2K × 4K detectors to populate the entire focal plane, and we will continue production until

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## Dark Energy Camera Update continued



Figure 1: The DECam shutter. At 600 mm clear diameter this is the largest “Bonn shutter” ([www.astro.uni-bonn.de/~ccd/shutters/](http://www.astro.uni-bonn.de/~ccd/shutters/)) yet made. (Image credit: Argelander-Institut für Astronomie.)

June to ensure there are plenty of spares. Many mechanical parts—the hexapod, the barrel, the new cage assembly, the imager dewar—are being fabricated, as is a large telescope simulator onto which the whole instrument, less the optical elements, will be mounted for testing, starting in March 2010.

In parallel, development work on the CCD controller electronics has moved into the production phase. The CCD controllers are based on the NOAO MONSOON system design, with boards significantly modified for higher density, given the constrained environment in the prime focus cage. The Telescope Simulator tests will occupy most of the year and will culminate in a full systems test of the Imager, fully populated with high-quality engineering-grade CCDs, the production CCD electronics, and the data acquisition system. Important among these tests will be ascertaining that the system for installing and dismantling the  $f/8$  mirror works safely and efficiently—because we no longer will be doing cage flips—with a permanently mounted  $f/8$  mirror. The Telescope Simulator Tests will also be an opportunity to test the DECam system software and to send real camera data as opposed to simulated data via the NOAO Data Transport System, the DES data management system, albeit by a circuitous route.

As reported by T. Abbott in earlier newsletters (“Blanco TCS Upgrade,” September 2008, p. 32

and “Blanco Shutdown 2009,” September 2009, p. 25), we are also improving the Blanco telescope: with a new Telescope Control System, a definitive repair of the primary mirror radial supports, and attention also is being paid to the environmental control system. The coudé lab area in the Blanco dome is being converted into a large clean room and instrument support area.

By January 2011, all DECam parts with the exception of the Imager and Optical Corrector will be shipped to CTIO, and the Imager and the fully assembled corrector will arrive in the following two months. In addition, the penultimate data challenge (DC6) will have been completed. Upon arrival, DECam will be assembled and tested, and then soon after the arrival of the optics and the imager, the entire instrument will be fully ready for installation. In parallel, the DES and Community pipelines will undergo their penultimate acceptance tests prior to the start of on-sky commissioning. Precise details are still being worked out, but we anticipate that on-sky commissioning of the full DECam system will begin in October 2011.

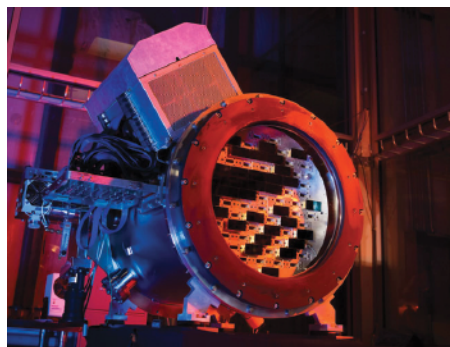



Figure 2: The multi-CCD test vessel, a full-size prototype of the DECam Imager, is shown at Fermilab. The focal plane is partially populated with engineering-grade CCDs. (Image credit: Fermilab)

More information can be found at [www.ctio.noao.edu/decam](http://www.ctio.noao.edu/decam). We will be putting a lot more content at this address over the next few months. Also, see the DES project site at [www.darkenergysurvey.org](http://www.darkenergysurvey.org). DECam and DES are always prominent at American Astronomical Society (AAS) meetings, both in posters and at the NOAO booth. There will be a strong presence at the June Society of Photo-optical Instrumentation Engineers meeting in San Diego. We plan on holding a DECam parallel meeting at the 2011 January 2011AAS meeting in Seattle and a workshop devoted to DECam science later in 2011. For feedback on any of the above, and for more information, please do not hesitate to write to the authors. 

## NSF Funds Improved Instruments for the Mayall Telescope

Buell T. Jannuzi & David Sprayberry

We depend on modern instruments to keep our telescopes capable of producing first-rate science. The most recent new instrument used at the Mayall 4-m telescope has been the modern, NEWFIRM wide-field infrared imager, producing many exciting results over its past two years of use. We are fortunate that the stream of updated and new instruments for the Mayall will continue thanks to supplemental funding being provided by the NSF in response to NOAO’s Renewing Small Telescopes for Astronomical Research proposal. Mosaic-1 will be upgraded during 2010 with new CCDs and a modern controller (see the accompanying article in this issue) through a collaboration of NOAO System Instrumentation program and KPNO staff. A new multi-object optical spectrograph for the Mayall (see “KOSMOS—a New Spectroscopic Capability for the Mayall” in this issue) will be built as a collaboration among The Ohio State University, the NOAO System Instrumentation program, and KPNO. We are very appreciative to the NSF and our collaborators for the opportunity to provide these improved capabilities to our community.





# Kitt Peak Mosaic Upgrade— an Imager for a New Decade of Science

Dave Sawyer, Steve B. Howell & Heidi Schweiker

A project to upgrade the KPNO Mosaic-1 Imager is underway due to the assistance of supplemental funding from the NSF in support of NOAO's Renewing Small Telescopes for Astronomical Research (ReSTAR) proposal ([www.noao.edu/system/restart/](http://www.noao.edu/system/restart/)). The Mosaic-1 upgrade is being led by Project Scientist Steve Howell and Project Engineer Dave Sawyer and carried out collaboratively by staff from the NOAO System Instrumentation program and KPNO. The upgrade will focus on replacement of the now outdated Arcon CCD controllers. New CCD detectors, new controllers, and new software for improved performance, reliability, and serviceability of the instrument are all aspects of the upgrade project. New CCDs are on order and are scheduled to arrive in early April 2010. A review of the project plans and design was held 20 January 2010. A final design review will occur in late March 2010.

The impact to observing with the Mosaic-1 Imager is being minimized as much as possible by scheduling the majority of the upgrade work during the summer months and our annual shutdown during the monsoon season. Mosaic-1 will be taken out of service in mid-June 2010 and sent to Tucson for about three months for the installation of the new detectors and controllers, implementation of new software, and system integration and testing. The upgraded instrument is scheduled to return to Kitt Peak 1 October 2010 to start a commissioning phase that is expected to be completed October 29. Shared risk observing for visiting observers is to be scheduled during the remainder of the 2010B observing semester. Unfortunately, commissioning of the upgraded Mosaic-1 on the WIYN 0.9-m telescope likely will need to wait until a future semester, although we are still studying schedules that would allow us to have an initial technical and engineering run on the WIYN 0.9-m with the new version of the instrument during January 2011. The Mosaic-1 Imager will not be available for science programs at the WIYN 0.9-m telescope during 2010B.

The new detectors will be  $2K \times 4K$  pixel format devices fabricated by e2v Technologies and will be arranged in an  $8K \times 8K$  array that is nearly identical to the existing focal plane (Figure 1). The detector format was chosen to minimize the impact on science images, such as changes in the field of view and gaps between detectors, but current Mosaic-1 users will see subtle changes in the data after the upgrade. The new detectors will have reduced readout noise, higher frequency operation for reduced readout times, and better quantum efficiency. These improvements in detector performance will reduce both exposure times and readout times, thus, the science data volume is expected to increase significantly. The e2v detectors offer many coating options, and after soliciting comments from Mosaic users, our review panel, and the KP Users Committee, a two-layer coating was selected (Figure 2). The coating was selected because it provides a more uniform exposure depth across the UVBRI band passes, which is beneficial for surveys, and provides a flatter overall response curve, which is generally easier to standardize. The improved blue response of the two-layer coating will also be more complementary to other wide-field imagers to be available through NOAO, such as the Dark Energy Camera.

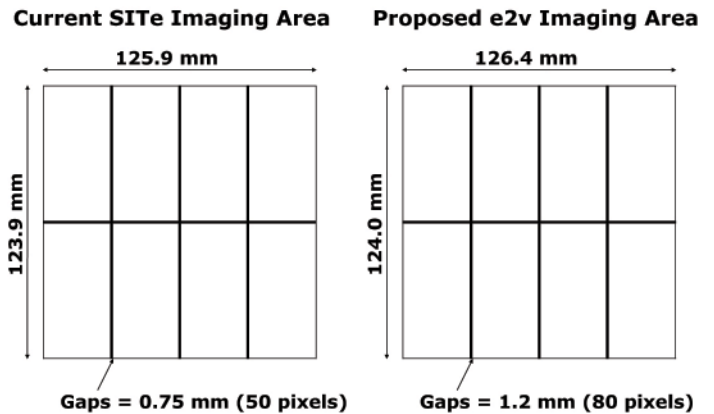


Figure 1: Comparison of imaging area between the current and new Mosaic focal plane arrays.

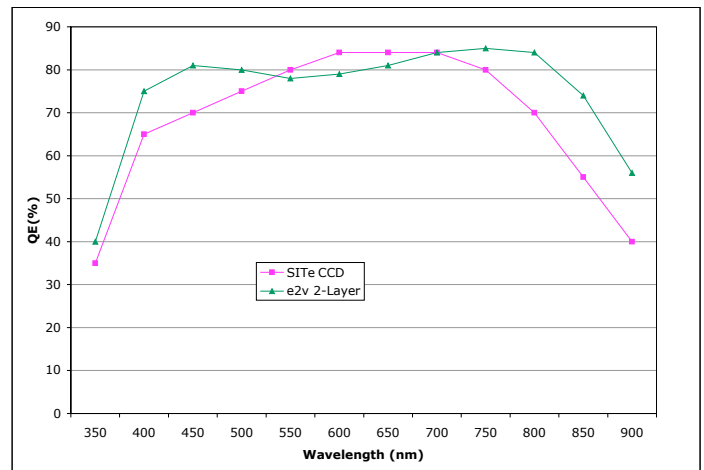


Figure 2: Plot showing the quantum efficiency of the e2v CCD with a two-layer anti-reflection coating relative to the existing SITe CCDs in Mosaic-1.

As part of the upgrade, the aging Arcon CCD controllers will be replaced. Many components used in the Arcon controllers are no longer available, and spare parts have been depleted, which makes the controllers very difficult to support. In addition, there has been an increase in failures due to the aging components that has adversely affected the reliability and efficiency of the instrument. The controllers will be replaced with modern MONSOON TORRENT controllers. TORRENT is the next-generation MONSOON controller, which is currently in development and expected to reach production readiness in May 2010. TORRENT shares a lot of technology with the previous MONSOON "Orange" controllers in order to reduce development risk, while components have been updated to improve parts availability and power consumption.


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## Kitt Peak Mosaic Upgrade continued

The user interface and user software will also have to be changed as part of the upgrade project. Currently Mosaic-1 is run with an IRAF Control Environment (ICE) Arcon package as well as a few independent graphical user interfaces that control specific features of the instrument/telescope combination. Given the success of the NEWFIRM wide-field infrared imager's user interface and control system (NEWFIRM Observation Control System, NOCS), we plan to adapt it for the new Mosaic-1 user interface. There are many advantages with choosing NOCS, but the primary reason is that it has had two years of use at the Mayall telescope and users and support personnel now have valuable experience using this system. This has allowed the software to be debugged and optimized.

NOCS also has been well-documented by the NOCS team. Currently, NOCS includes 90% of the functionality required to operate the new Mosaic-1 instrument. The new user interface will contain all of the current functionality as well as some improvements, such as the ability to try it at home prior to your run and to make and use observing scripts.

If you have questions regarding the upgrade, please contact the project scientist at [howell@noao.edu](mailto:howell@noao.edu). Questions regarding the scheduling of shared-risk programs should be directed to KPNO Director Buell Jannuzi ([bjannuzi@noao.edu](mailto:bjannuzi@noao.edu)). For more information on the Mosaic-1 upgrade project see [www.noao.edu/ets/mosaic](http://www.noao.edu/ets/mosaic). 

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## KOSMOS—a New Spectroscopic Capability for the Mayall

Jay Elias

One of the strongest recommendations of the Renewing Small Telescopes for Astronomical Research (ReSTAR) committee report (see report and implementation plan at [www.noao.edu/system/restar/](http://www.noao.edu/system/restar/)) was that the spectroscopic capabilities on the NOAO 4-m telescopes be upgraded. The initial ReSTAR funding received over the past summer has allowed NOAO to start work, in conjunction with The Ohio State University (OSU), on a project to adapt the design of the Ohio State Multi-Object Spectrograph (OSMOS) for use on the Mayall telescope.

OSMOS is a multi-object, visible-wavelength spectrograph designed for use on the 2.4-m Hiltner telescope at MDM ([www.astronomy.ohio-state.edu/~martini/osmos/](http://www.astronomy.ohio-state.edu/~martini/osmos/)). It has a field of view of approximately 20 arcmin with 0.3-arcsec pixels and is useful over a wavelength range of 350–1000 nm. It is nearing final assembly at OSU and is expected to be commissioned in the spring of this year.

The Kitt Peak Ohio State Multi-Object Spectrograph (KOSMOS) is the adaptation for the KPNO Mayall telescope. KOSMOS should in principle have a similar pixel scale but a smaller field of view (approximately 12 arcmin). This allows the bulk of the OSMOS mechanical design to be retained, as the only major design modification is the faster camera required to produce a similar pixel scale on the larger telescope. The ini-

tial design effort is concentrated on verifying that a faster camera, in fact, can be designed and built without compromising instrument throughput, wavelength coverage, and image quality. Further details on KOSMOS are available at [www.noao.edu/ets/kosmos/](http://www.noao.edu/ets/kosmos/) (or click through from the “Instrumentation” link on the NOAO Astronomers home page). The KOSMOS design should also work for the CTIO Blanco telescope; if funding were to become available in a timely fashion, a copy of KOSMOS would be built for CTIO.

The effort on KOSMOS is divided between OSU and NOAO. OSU (principal investigator: Paul Martini) is leading the design work on the spectrograph itself, while NOAO will be responsible for the detector and controller. NOAO will provide much of the mechanical fabrication and be responsible for ensuring that the telescope will work efficiently with KOSMOS. Scientific direction and program management are done jointly by both institutions.

The KOSMOS design phase will lead to a design review, tentatively scheduled for early June of this year. The modified design will be presented at the review, along with detailed cost and schedule estimates for construction of the instrument. Our expectation is that the instrument will be delivered to the Mayall telescope around the third quarter of 2011.

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## Upgrades of the CTIO 1.5-M Telescope Fiber Echelle

Andrei Tokovinin (CTIO) & Debra Fischer (Yale University)

The fiber echelle spectrometer at the CTIO 1.5-m telescope has become a popular instrument among NOAO and Small and Moderate Aperture Research Telescope Systems users. One large, ongoing observing program is the search for terrestrial planets around Alpha Centauri A and B. Data obtained in 2009 yield a single-measurement precision of 3 m/s. This precision is achieved by modeling tiny shifts in the stellar lines—with a precision of 0.0008 pixels—relative to iodine absorption lines (Figure 1).

In January 2010, the new CCD controller (MONSOON Orange) and data-acquisition software (ArcView) were commissioned. This system replaces the old Arcon system that was shared by the echelle and the lower resolution R-C Spec. The read noise in the new controller is slightly higher, 7 electrons compared to 3.4 electrons for the Arcon controller. However, the new echelle controller results in a time savings of more than 30 minutes each night that was formerly

*continued*



### Upgrades of the CTIO 1.5-M Telescope Fiber Echelle continued

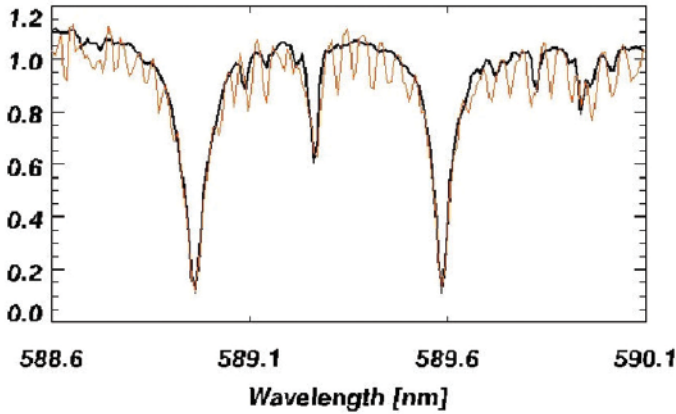


Figure 1: Continuum-normalized spectrum of the Na-D lines for  $\alpha$  Cen A obtained with (red) and without (black) the iodine cell. (Image credit: Debra Fischer, Yale.)

spent swapping instruments for queue-scheduled observations. In addition, the readout time with the new controller is faster by a factor of two to four. This improves the duty cycle and efficiency of the 1.5-m telescope by about 10%. The new data-acquisition system also offers some convenient new features.

Work is under way to build the new echelle spectrometer, New Echelle CTIO High Resolution Spectrometer, CHIRON, with funding from the NSF Major Research Instrumentation program. CHIRON will have a significantly improved overall efficiency (15% peak efficiency, compared to 1–2% with the current echelle spectrometer) and spectral resolution ( $R = 80,000$ ), which is a factor of two

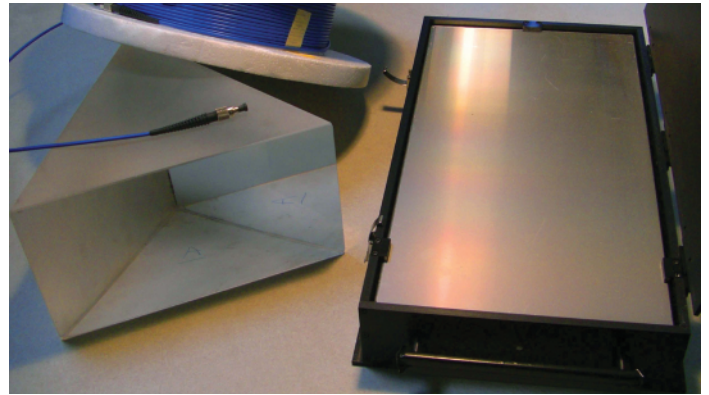


Figure 2: CHIRON will use the existing large echelle grating of  $375 \times 200$  mm and a big glass prism as a cross-disperser. The image also shows the new fiber cable with increased transmission. (Image credit: Andrei Tokovinin.)

improvement. The high resolution will be achieved with an image slicer that provides an effective “slit” of  $3 \times 30$  pixels on the detector. A 4K 15- $\mu$ -pixel CCD from e2v will replace the current 2K 24- $\mu$  detector. The fixed spectral format will provide complete wavelength coverage from 420 nm to 880 nm without gaps. The spectrometer will be housed in a hermetic and thermo-stabilized enclosure in the coude room, and the existing fiber feed will be re-used.

The optics and detector for CHIRON have been secured (Figure 2), and the mechanical design is under way. Instrument integration should start in August and commissioning is planned for December 2010.

## Developing a SOAR Laser Guide Star System—an Update on the SAM Project

Brooke Gregory & Nicole van der Blik

As reported in the September 2009 *Newsletter*, the SOAR Adaptive Module (SAM) saw first light 6 August 2009 in its Natural Guide Star mode. Since then, all effort has been devoted to realizing its role in a Laser Guide Star (LGS) system. This requires extensions to the functionality of the module itself, e.g., a range-gated wavefront sensor built to handle the return signal from the laser guide star and x-y stages carrying the natural tip-tilt guide star sensors. As of late January 2010, these extensions were completed or were nearing completion. Other advances in the Module include an atmospheric dispersion compensator and completion of the dedicated SAM Imager (SAMI).

The laser projection system consists of the commercial laser (procured and extensively tested last year), a “laser box” with controls and diagnostics, and, critically, the launch telescope (including a simple, beam transfer mirror). The laser box and telescope mechanics have received extensive design work and some fabrication has begun. The launch telescope mirror is being fabricated, in Russia, and we have recently received a photograph of the mirror blank (Figure 1).

The operation of the modified Module will be completely tested in LGS mode in the lab, starting immediately. By the middle of this year,

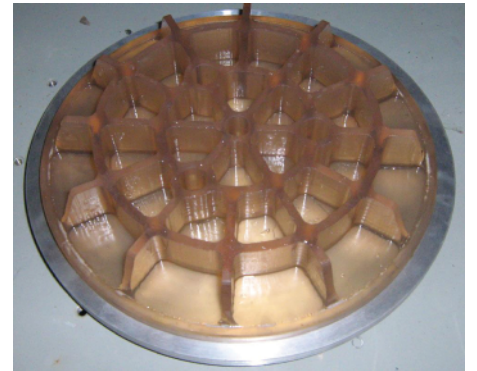


Figure 1: The light-weighted M1 blank produced by the laboratory of S. Potanin. (Image credit: S. Potanin.)

at the end of that process, we expect to install the laser projector on the telescope, and subsequently, we will mount the Module back on the telescope to test the operation of the laser projector on the sky in the complete system. At that point, scientific commissioning will begin.



# SIFS—the SOAR Integral Field Spectrograph

Sean Points (CTIO), Steve Heathcote, Luciano Fraga (SOAR) & Bruno Castilho (LNA)



The SIFS team after the off-telescope integration: (left to right) Flávio Ribeiro, Bruno Castilho, Steve Heathcote, Marcio Arruda, Luciano Fraga, Tina Armond, and Sergio Scarano, Jr. (Image credit: Luciano Fraga, SOAR.)

The Southern Astrophysical Research (SOAR) Integral Field Spectrograph (SIFS) was delivered to SOAR 10 December 2009. The Brazilian instrument team (Bruno Castilho, Flávio Ribeiro and Márcio Arruda) from Laboratório Nacional de Astrofísica Brasil (LNA) was helped by the SOAR technical and science staff to remove the 1.2 tons of equipment (including test and handling material) from the boxes and to assemble the spectrograph. The instrument consists of three subsystems: fore-optics, fiber cable, and bench spectrograph. All parts were tested on the telescope for mechanical assembly and to make final adjustments in the fiber cable path. All in all, the instrument arrived in great shape, and the off-telescope integration engineering of SIFS was completed 18 December 2009.

Once the opto-mechanics were assembled, the team worked on the electronics and software, solving most of the problems as they came up. The team then performed a first-order optical alignment and prepared the spectrograph for the second engineering run/integration test. Just before the end of January, the fully functional spectrograph was located in the SOAR instrument receiving area in anticipation of this second integration test, which took place at the end of January.

In this second integration period, the team completed the optical alignment, installed the spectrograph at the telescope, and began integration of the instrument control software with the SOAR telescope control system. When this software integration is completed, SIFS will be ready for the on-sky commissioning to take place in February/March.

We would like to congratulate the current and former SIFS development team members for the accomplishment.



## SMARTS Update: Small Telescopes Going Strong!

John Subasavage

The small telescopes at CTIO continue to operate smoothly under the management of the Small and Medium Aperture Research Telescope System (SMARTS) consortium. During the past year, there have been a number of changes to the administrative structure of SMARTS as well as to onsite operations. Unlike previous years in which the consortium's involvement was evaluated and renewed every three years, SMARTS is now on a quasi-permanent, one-year renewable schedule. This schema allows for more accurate projections of operational costs and currency fluctuations, and minimizes the potential for a shortfall of funding prior to the renewal period. It also allows private partners whose scientific or financial horizons are shorter than three years to join the consortium.

On site, the echelle spectrograph on the 1.5-m telescope has received significant upgrades to enhance performance (see accompanying article “Upgrades of the CTIO 1.5-M Telescope Fiber Echelle”) and provide additional capabilities for users. In addition, the first CTIO/SMARTS Postdoctoral Fellow (this author) arrived at CTIO in late 2009 (see also September 2009 *Newsletter*, p. 26), a position jointly funded by SMARTS and CTIO to provide improved scientific support and on-site management for the small telescopes. Operations have become more efficient as on-the-spot scientific insight is coupled with the engineering and mechanical expertise already in place. Also, communications between the US-based SMARTS management and local staff on the mountain have been streamlined to better and more quickly address problems as they are encountered. There are a number of lingering inconveniences that have surfaced in recent years at the small telescopes, to which the observers have largely adapted, but which are in need of correction. With a specific individual delegated to keep track of situations and continue to push toward resolutions, more progress is likely.

It is encouraging to note that the oversubscription rate for 2010A for the 1.5-m telescope (3.0 for NOAO users) is at its highest since SMARTS began. Demand for the 1.3-m and 0.9-m telescopes remains strong as well. These statistics show that the small telescopes continue to provide the astronomical community with important resources for cutting-edge science. The consortium is always interested in forming new partnerships, particularly using less-oversubscribed telescopes such as the 1.0-m telescope. The current cost structure is \$1,100 per night for user time and \$1,650 per night for a service observer to perform the observations. Interested parties should contact Charles Bailyn ([charles.bailyn@yale.edu](mailto:charles.bailyn@yale.edu)) for more information.

For more information and a list of the consortium members, see [www.astro.yale.edu/smarts](http://www.astro.yale.edu/smarts).



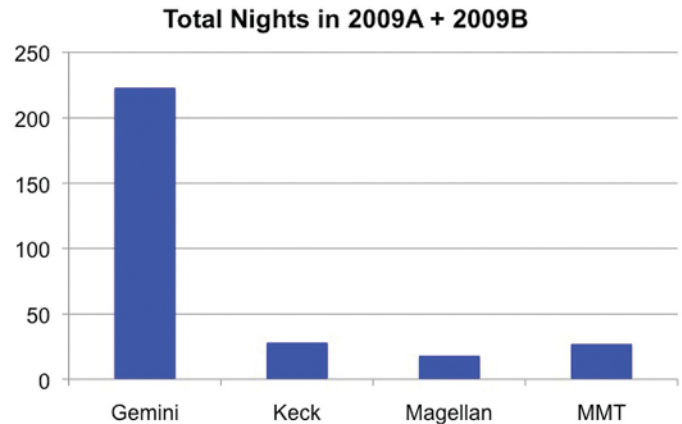
# Future Observational Capabilities and Instruments for Gemini: Viewpoints from the US and Partner User Communities

Timothy C. Beers (Michigan State University; Chair, Gemini Science Committee) & Verne V. Smith

The Access to Large Telescopes for Astronomical Instruction and Research (ALTAIR) committee (organized by NAO) polled the US community in 2008 concerning their usage of and future aspirations for instrumentation on 6.5- to 10-m-class telescopes. Their final report was issued in March 2009 ([www.noao.edu/system/altair/files/ALTAIR\\_Report\\_Final.pdf](http://www.noao.edu/system/altair/files/ALTAIR_Report_Final.pdf)). Some 600 users responded to the Web-based survey on telescope usage, thus the ALTAIR report represents a significant source of data with which to gauge US user desires regarding access to and instrumentation for large-aperture telescopes.

Open-access observing time on the two Gemini 8.2-m telescopes represents the single largest portion of 6.5- to 10-m aperture time available to US users, as can be seen in the accompanying figure in which the total number of open-access nights for 2009 are plotted for each of the large telescopes: Gemini (North and South combined), Keck (I and II combined), Magellan (Baade and Clay combined), and the MMT. Gemini nights are thus a significant asset in terms of aperture size combined with the amount of time. One important question in the ALTAIR survey asked users to identify the most important capabilities they needed on large telescopes in the long term. This was question 14b, which asked, "What instrument capabilities will be important for your research in the longer term?" There were 27 general observational capabilities listed after this question, and users were asked to rank this list in order of importance. Because the US nights on Gemini contain, by far, the greatest amount of available large-telescope time, it is of interest to see how well capabilities on Gemini map into these community desires, as well as to see what capabilities might be the most logical to develop and deploy in the future.

As the Gemini Observatory is an international partnership, the Gemini Science Committee (GSC), which is a Gemini committee, was tasked by the Gemini Board to obtain information from the non-US partners that paralleled some of the data obtained by ALTAIR from the US community. In particular, one of the questions was the same as the one mentioned above. In the case of the GSC survey, which was conducted during December 2009, some 202 responses were collected from the other Gemini



Total number of open-access nights for 2009A + 2009B by telescope.

partners: Canada, Australia, Brazil, Argentina, Chile, and the University of Hawai'i. The UK responses were not included in the results presented here, as future capabilities will only arrive after 2012, when the UK almost certainly will no longer be a partner (see accompanying article in this issue, "The November 2009 Gemini Board Meeting and the Status of the UK in the Gemini Partnership"). The top-10 ranked responses from the US community for desired observational capabilities are tabulated below, along with the ranking from the other Gemini partners. These rankings were based on weighted sums of the number of respondents who ranked each capability as one of their first, second, or third choices. After each capability, in the last column, the Gemini instrument that currently fills a particular "capability niche" is noted. The blanks indicate capabilities that are not currently available on the Gemini telescopes, but are highly ranked as important.

At least two points can be taken away from the table below: (1) The correlation between ranked capabilities from the US community and the other partner communities is excellent, with strong agreement among

US Ranking	Non-US Ranking	Capability	Current Gemini Instrument?
1	1	Optical/Multi-object spec. (R < 15,000)	GMOS
2	2	Optical/Wide-field imaging	
3	4	Optical/Single-object spec. (R > 15,000)	
4	3	Optical/Multi-object spec. (R > 15,000)	
5	12	Optical/Single-object spec. (R < 15,000)	GMOS
6	9	Near-IR/Single-object spec. (R > 15,000)	
7	5	Near-IR/Multi-object spec. (R < 15,000)	FLAMINGOS-2 (F2)
8	7	Near-IR/Diffraction-limited imaging	NIRI, MCAO/GSAOI & F2
9	14	Near-IR/Single-object spec. (R < 15,000)	GNIRS, F2, NIRI
10	8	Optical/IFU imaging & spec.	GMOS


continued



## Future Observational Capabilities and Instruments for Gemini continued

the most desired capabilities on 8.2-m telescopes; (2) There are obvious, highly-ranked “capability gaps” that can be filled by so-called workhorse instruments that could be built on relatively short timescales with moderate budgets. It should be noted that neither Gemini telescope is presently configured for wide-field imaging; hence, this capability (which ranked second in both surveys) will need to be filled by creative time swaps with large-aperture telescopes that do have this capability. The GSC has encouraged the Gemini Board to seek commitments from the

NSF and Gemini partners to begin design and construction of instruments capable of filling the missing capabilities—such as Optical/Single-object spec. ( $R > 15,000$ ), Optical/Multi-object spec. ( $R > 15,000$ ), or Near-IR/Single-object spec. ( $R > 15,000$ ) as soon as possible.

Interested members of our user community who have comments or questions about this article should not hesitate to contact the authors ([beers@pa.msu.edu](mailto:beers@pa.msu.edu); [vsmith@noao.edu](mailto:vsmith@noao.edu)). 

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# The November 2009 Gemini Board Meeting and the Status of the UK in the Gemini Partnership

Verne V. Smith

The Gemini Board held its most recent semi-annual meeting 11–13 November 2009. One action item concerned an “Assessment Point” for the International Gemini Agreement. At this Assessment Point, all of the parties within the Gemini Agreement (US, UK, Canada, Australia, Brazil, and Argentina) were to state their intentions to remain or withdraw from the partnership after the current agreement expires 31 December 2012. At the Board meeting, all parties except the UK stated their intentions to remain in the partnership after the end of 2012. The position of the UK at the Board meeting was that it had not completed its process of review, but that it was almost certain not to continue in the partnership post 2012.

Not long after the November Board meeting, the UK Science and Technology Facilities Council (STFC) posted a report 16 December 2009 titled “Science Programme Prioritisation 2010–2015.” Within this

report, the STFC noted that “the programme includes the managed withdrawal from a number of projects and programmes including the Gemini telescopes, the NLS, and UKIRT.” This report can be found at [www.scitech.ac.uk/PMC/Prel/STFC/CouncilNews161209.aspx](http://www.scitech.ac.uk/PMC/Prel/STFC/CouncilNews161209.aspx).

As part of the assessment process, the Board, in keeping with the International Gemini Agreement, established another Assessment Point to occur no later than 19 March 2010, at which time the parties will restate their intention to continue or withdraw, with the UK making its final position clear.

Interested members of our user community should keep an eye on the NOAO/NSSC Web site ([www.noao.edu/nssc/](http://www.noao.edu/nssc/)) for recent developments. If you have any questions or comments about this issue, do not hesitate to contact me ([vsmith@noao.edu](mailto:vsmith@noao.edu)).



## 2010B Observing Proposals Due 31 March 2010

Dave Bell

Standard proposals for NOAO-coordinated observing time for semester 2010B (August 2010–January 2011) are **due by the evening of Wednesday, 31 March 2010, midnight MST**.

The facilities available this semester include the Gemini North and South telescopes, Cerro Tololo Inter-American Observatory (including SOAR), Kitt Peak National Observatory, and community-access time with the 10-m Keck I and Keck II telescopes at the W. M. Keck Observatory, the 6.5-m Baade and Clay telescopes at Las Campanas Observatory, the 6.5-m MMT telescope, and the 200-in (5-m) Hale Telescope at Palomar Observatory.

Proposal materials and information are available on our Web page ([www.noao.edu/noaoprop/](http://www.noao.edu/noaoprop/)). There are four options for submission:

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

**File upload**—A customized LaTeX file may be downloaded from the Web proposal form after certain required fields have been completed. “Essay” sections can then be edited locally and the proposal submitted by uploading files through a Web page at [www.noao.edu/noaoprop/submit/](http://www.noao.edu/noaoprop/submit/).

**Email submissions**—A customized LaTeX file may be downloaded from the Web proposal

form after certain required fields have been completed. “Essay” sections can then be edited locally and the proposal submitted by email. Please carefully follow the instructions in the LaTeX template for submitting proposals and figures. Please use file upload instead of email if possible.

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

Note that proposals for Gemini time may also be submitted using the standard NOAO form, and that proposals that request time on Gemini plus other telescopes **MUST** use the standard NOAO form. PIT-submitted proposals will be converted for printing at NOAO and are subject to the same page limits as other NOAO proposals. To ensure a smooth translation, please see the guidelines at [www.noao.edu/noaoprop/help/pit.html](http://www.noao.edu/noaoprop/help/pit.html).

Help with proposal preparation and submission is available via the addresses below:

Web proposal materials and information	<a href="http://www.noao.edu/noaoprop/">www.noao.edu/noaoprop/</a>
Request help for proposal preparation	<a href="mailto:noaoprop-help@noao.edu">noaoprop-help@noao.edu</a>
Address for thesis and visitor instrument letters, as well as consent letters for use of PI instruments on the MMT	<a href="mailto:noaoprop-letter@noao.edu">noaoprop-letter@noao.edu</a>
Address for submitting LaTeX proposals by email	<a href="mailto:noaoprop-submit@noao.edu">noaoprop-submit@noao.edu</a>
Gemini-related questions about operations or instruments	<a href="mailto:gemini-help@noao.edu">gemini-help@noao.edu</a> <a href="http://www.noao.edu/ngsc/noaosupport.html">www.noao.edu/ngsc/noaosupport.html</a>
CTIO-specific questions related to an observing run	<a href="mailto:ctio@noao.edu">ctio@noao.edu</a>
KPNO-specific questions related to an observing run	<a href="mailto:kpno@noao.edu">kpno@noao.edu</a>
Keck-specific questions related to an observing run	<a href="mailto:keck@noao.edu">keck@noao.edu</a>
MMT-specific questions related to an observing run	<a href="mailto:mmt@noao.edu">mmt@noao.edu</a>
Magellan-specific questions related to an observing run	<a href="mailto:magellan@noao.edu">magellan@noao.edu</a>
Hale-specific questions related to an observing run	<a href="mailto:hale@noao.edu">hale@noao.edu</a>



## 2010A TAC Results Available Online

Information regarding NOAO 2010A observing time requests, including Time Allocation Committee (TAC) membership, telescope and instrument request statistics, and a list of accepted programs can be found online at [www.noao.edu/gateway/tac/](http://www.noao.edu/gateway/tac/).



# System-Wide Observing Opportunities for Semester 2010B: Gemini, Keck, Magellan, MMT, and Hale

Verne V. Smith & Dave Bell

Semester 2010B runs from 1 August 2010 to 31 January 2011, and the NOAO System Science Center (NSSC) encourages the US community to propose for observing time using all of the ground-based open-access system-wide facilities available during this semester. This article summarizes observing opportunities on telescopes other than those from KPNO, CTIO, WIYN, and SOAR.

## The Gemini Telescopes

The US user community has about 50 nights per telescope per semester on the Gemini North and Gemini South telescopes, which represents the largest piece of open-access observing time on 8-m-class telescopes. The Gemini Observatory provides unique opportunities in observational and operational capabilities, such as the ability to support both classically- and queue-scheduled programs.

In an effort to increase interactions between US users and the Gemini staff, as well as observing directly with the telescopes and instruments, **NOAO strongly encourages US proposers to consider classical programs, which can be as short as 1 night, on the Gemini telescopes. NOAO will cover the travel cost to observe at Gemini for up to two observers for classical programs.**

US Gemini observing proposals are submitted to and evaluated by the NOAO Time Allocation Committee (TAC). The formal Gemini “Call for Proposals” for 2010B will be released in early-March 2010 (close to the publication date of this *Newsletter* issue), with a US proposal deadline of Wednesday, 31 March 2010. As this article is prepared well before the release of the Call for Proposals, the following list of instruments and capabilities are only our expectations of what will be offered in semester 2010B. Please watch the NSSC Web page ([www.noao.edu/nssc](http://www.noao.edu/nssc)) for the Gemini Call for Proposals, which will list clearly and in detail the instruments and capabilities that will be offered.

NSSC anticipates the following instruments and modes on Gemini telescopes in 2010B:

### Gemini North:

- NIFS: Near-Infrared Integral Field Spectrometer.
- NIRI: Near Infrared Imager and spectrograph with both imaging and grism spectroscopy modes.
- ALTAIR adaptive optics (AO) system in natural guide star (NGS) mode, as well as in laser guide star (LGS) mode. ALTAIR can be used with NIRI imaging and spectroscopy and with NIFS integral field unit (IFU) imaging and spectroscopy, as well as NIFS IFU spectral coronagraphy.
- Michelle: mid-infrared (7–26  $\mu$ ) imager and spectrometer, which includes an imaging polarimetry mode.
- GMOS-North: Gemini Multi-Object Spectrograph and imager. Science modes are multi-object spectroscopy (MOS), long-slit spectroscopy, IFU spectroscopy, and imaging. Nod-and-Shuffle mode is also available.
- All of the above instruments and modes are offered for both queue and

classical observing, except for LGS, which is available as queue only. **It is important to note that classical runs are now offered to programs that are one night or longer and consist of integer nights.**

- Details on use of the LGS system can be found at [www.gemini.edu/sciops/observing-with-gemini](http://www.gemini.edu/sciops/observing-with-gemini) (see “Announcements for Next Semester 2010B”), but a few points are emphasized here. Target elevations must be >40 degrees and proposers must request good weather conditions (Cloud Cover = 50%, or better, and Image Quality = 70%, or better, in the parlance of Gemini observing conditions). Proposals should specify “Laser guide star” in the Resources section of the Observing Proposal. Because of the need for good weather, LGS programs must be ranked in Bands 1 or 2 to be scheduled on the telescope.
- Time trades will allow community access to:
  - Keck 1: up to 5 nights (HIRES only)
  - Subaru: up to 10 nights (all instruments offered).

### Gemini South:

- T-ReCS: Thermal-Region Camera Spectrograph mid-infrared (2–26  $\mu$ ) imager and spectrograph.
- GMOS-South: Gemini Multi-Object Spectrograph and imager. Science modes are MOS, long-slit spectroscopy, IFU spectroscopy and imaging. Nod-and-Shuffle mode is also available.
- Phoenix: the NOAO high-resolution infrared spectrograph (1–5  $\mu$ ) is expected to be available during 2010B, although the likely appearance of the multi-conjugate adaptive optics system CANOPUS on the telescope may impact the scheduling of Phoenix. Users should keep an eye on either the Gemini Web site ([www.gemini.edu](http://www.gemini.edu)) or the NSSC site ([www.noao.edu/nssc](http://www.noao.edu/nssc)) for the most up-to-date information about Phoenix.
- NICI: Near-Infrared Coronagraphic Imager. NICI is available for general user proposals, although its use is restricted to good seeing conditions.
- All modes for GMOS-South, T-ReCS, NICI, and Phoenix, are offered for both queue and classical observing. **As with Gemini North, classical runs are now offered to programs with a length of at least one or more integer nights.**

Detailed information on all of the above instruments and their respective capabilities is available at [www.gemini.edu/sciops/instruments/instrumentIndex.html](http://www.gemini.edu/sciops/instruments/instrumentIndex.html).

We remind the US community that Gemini proposals can be submitted jointly with collaborators from other Gemini partners. An observing team requests time from each relevant partner. Please note that all multi-partner proposals must be submitted using the Gemini Phase I Tool (PIT).

Note that queue-proposers have the option to fill in a so-called “Band 3” box, in which they can optimize their program execution if it is scheduled on the telescope in Band 3. Historically, it has been found that somewhat smaller than average queue programs have a higher probability of completion if they are in Band 3, as well as if they use weather conditions

*continued*



## System-Wide Observing Opportunities for Semester 2010B continued

whose occurrences are more probable. Users might want to think about this option when they are preparing their proposals.

Efficient operation of the Gemini queue requires that it be populated with programs that can effectively use the full range of observing conditions. Gemini proposers and users have become increasingly experienced at specifying the conditions required to carry out their observations using the on-line Gemini Integration Time Calculators for each instrument. NSSC reminds you that a program has a higher probability of being awarded time and of being executed if ideal observing conditions are not requested. **The two conditions that are in greatest demand are excellent image quality and no cloud cover. We understand the natural high demand for these excellent conditions, but wish to remind proposers that programs that make use of less than ideal conditions are also needed for the queue.**

NOAO accepts Gemini proposals via either the standard NOAO Web proposal form or the Gemini PIT software. We note to proposers who plan to use the PIT that NOAO offers a tool that allows you to view how your PIT proposal will print out for the NOAO TAC (please see [www.noao.edu/noaoprop/help/pit.html](http://www.noao.edu/noaoprop/help/pit.html)).

### TSIP Open-Access Time on Keck, Magellan, and MMT

As a result of awards made through the National Science Foundation's Telescope System Instrumentation Program (TSIP), telescope time is available to the general astronomical community at the following facilities in 2010B:

#### W. M. Keck Observatory

- Keck I & II: A total of 12 nights of classically scheduled observing time will be available with the 10-m telescopes (Keck I and Keck II) at the W. M. Keck Observatory on Mauna Kea. All facility instruments and modes are available. For the latest details, see [www.noao.edu/gateway/keck/](http://www.noao.edu/gateway/keck/).

#### Las Campanas Observatory

- Magellan I & II: A total of seven nights will be available for classically scheduled observing programs with the 6.5-m Magellan I (Baade) and Magellan II (Clay) telescopes at Las Campanas Observatory. For updated information on available instrumentation and proposal instructions, see [www.noao.edu/gateway/magellan/](http://www.noao.edu/gateway/magellan/).

#### MMT Observatory

- 6.5-m telescope: Twelve nights of classically-scheduled observing time are expected to be available with the 6.5-m telescope of the MMT Observatory. Previous requests have disproportionately used our allocation of dark and grey time, so bright-time proposals are particularly encouraged. For further information, see [www.noao.edu/gateway/mmt/](http://www.noao.edu/gateway/mmt/).


#### ReSTAR Observing Time on the Hale Telescope

Funding for the Renewing Small Telescopes for Astronomical Research (ReSTAR) proposal has been provided by the NSF for FY 2010, and one part of this award has been to procure 23 nights per year, over the next three years, on the 200-in (5-m) Hale Telescope at Palomar Observatory. The 2010B allocation is as follows:

#### Palomar Observatory

- 200-in Hale Telescope: Twelve nights of classically-scheduled observing time will be available with the 200-in (5-m) Hale Telescope at Palomar Observatory. For more information, see [www.noao.edu/gateway/hale/](http://www.noao.edu/gateway/hale/).

The list of instruments that we expect to be available in 2010B can be found in the tables following this article. As always, investigators are encouraged to check the NOAO Web site for any last-minute changes before starting a proposal.

Feel free to contact us ([vsmith@noao.edu](mailto:vsmith@noao.edu) or [dbell@noao.edu](mailto:dbell@noao.edu)) if you have any questions about proposing for US observing time. 



## WIYN and Mayall Telescope Proposers: Take Note

**WIYN 3-5-m:** Availability of the WIYN 3.5-m telescope for science observations in 2010B is being evaluated due to the anticipated arrival sometime in the fall of the One Degree Imager (ODI) for installation and commissioning. Prior to preparing your proposal for observing time on the WIYN 3.5-m telescope, please check for updates at: [www.wiyn.org/ODI/about/ODIstatus.html](http://www.wiyn.org/ODI/about/ODIstatus.html).

**Mosaic-1 on Mayall:** The Mosaic-1 upgrade schedule calls for the instrument to return to the Mayall 4-m in early October 2010 for commissioning on the telescope. The lunar dark periods in August, September, and early October, therefore, are available for spectroscopic programs requiring dark time, but not for programs needing Mosaic. We intend to offer the upgraded Mosaic-1 for limited shared-risk observing in the latter half of semester 2010B.

**Mosaic-1 on WIYN:** The Mosaic-1 imager at the WIYN 0.9-m telescope will **not** be available for science programs during 2010B.

**WHIRC:** The WHIRC Web pages have been updated. Scheduled observers or those proposing to use these instruments should refer to the updated pages, particularly the "Hot News" pages, which report current developments or information ([www.noao.edu/kpno/manuals/whirc/hotnews.html](http://www.noao.edu/kpno/manuals/whirc/hotnews.html)).

**FLAMINGOS:** The FLAMINGOS Web pages for have been updated. Scheduled observers or those proposing to use these instruments should refer to the updated pages, particularly the "Hot News" pages, which report current developments or information ([www.noao.edu/kpno/manuals/flmn/hotnews.html](http://www.noao.edu/kpno/manuals/flmn/hotnews.html)).





# KPNO Instruments Available for 2010B

Spectroscopy	Detector	Resolution	Slit Length	Multi-object
<b>Mayall 4-m</b>				
R-C CCD Spectrograph	T2KB/LB1A/F3KB CCD	300–5000	5.4'	single/multi
MARS Spectrograph	LB CCD (1980×800)	300–1500	5.4'	single/multi
Echelle Spectrograph	T2KB/F3KB CCD	18,000–65,000	2.0'	
FLAMINGOS [1]	HgCdTe (2048×2048, 0.9–2.5mm)	1000–1900	10.3'	single/multi
IRMOS [2]	HgCdTe (1024×1024, 0.9–2.5mm)	300/1000/3000	3.4'	single/multi
<b>WIYN 3.5-m [3] (IMPORTANT - Check Web for Update)</b>				
Hydra + Bench Spectrograph [4]	STA1 CCD	700–22,000	NA	~85 fibers
SparsePak [5]	STA1 CCD	700–22,000	IFU	~82 fibers
<b>2.1-m</b>				
GoldCam CCD Spectrograph	F3KA CCD	300–4500	5.2'	
FLAMINGOS [1]	HgCdTe (2048×2048, 0.9–2.5mm)	1000–1900	20.0'	

Imaging	Detector	Spectral Range	Scale ("/pixel)	Field
<b>Mayall 4-m</b>				
CCD Mosaic-Upgraded [6] (Reduced Availability)	8K×8K	3500–9700Å	0.26	35.4'
SQIID	InSb (3-512×512 illuminated)	JHK <sub>s</sub>	0.39	3.3'
FLAMINGOS[1]	HgCdTe (2048×2048)	JHK	0.32	10.3'
<b>WIYN 3.5-m [3] (IMPORTANT - Check Web for Update)</b>				
Mini-Mosaic [7]	4K×4K CCD	3300–9700Å	0.14	9.3'
OPTIC [7]	4K×4K CCD	3500–10,000Å	0.14	9.3'
WHIRC [8]	VIRGO HgCdTe (2048×2048)	0.9–2.5µm	0.10	3.3'
<b>2.1-m</b>				
CCD Imager [9]	T2KB CCD	3300–9700Å	0.305	10.4'
SQIID	InSb (3-512×512 illuminated)	JHK <sub>s</sub>	0.68	5.8'
FLAMINGOS [1]	HgCdTe (2048×2048)	JHK	0.61	20.0'
<b>WIYN 0.9-m [10] (No Availability 2010B)</b>				

[1] FLAMINGOS Spectral Resolution given assuming 2-pixel slit. Not all slits cover full field; check instrument manual. FLAMINGOS was built by the late Richard Elston and his collaborators at the University of Florida. Dr. Steve Eikenberry is currently the PI of the instrument.

[2] IRMOS, built by Dr. John MacKenty and collaborators. Availability will depend on proposal demand and block scheduling constraints.

[3] As we go to press, the availability of the WIYN 3.5-m for science observations during 2010B is being evaluated due to the anticipated arrival of the One Degree Imager (ODI) for installation and commissioning sometime in the fall. Please check the Web page [www.wiyn.org/ODI/about/ODIstatus.html](http://www.wiyn.org/ODI/about/ODIstatus.html) for updates prior to preparing your proposal for WIYN 3.5-m observing time. Please also feel free to contact [kpno@noao.edu](mailto:kpno@noao.edu) with questions.

[4] The Bench Spectrograph has recently been upgraded. A new CCD (STA 1), a new collimator, and two new Volume Phase Holographic (VPH) gratings (740 l/mm and 3300 l/mm) are now available for use. Dispersion and wavelength range remain essentially the same in the upgraded system. Observers should access the Hydra manual at <ftp://ftp.noao.edu/kpno/hydra/hydrawynmanual.pdf> to help plan observations.

[5] Integral Field Unit, 80"×80" field, 5" fibers, graduated spacing. Observers should view [www.wiyn.org/instrument/bench\\_upgrade.html](http://www.wiyn.org/instrument/bench_upgrade.html) for details on changes in throughput and instrumental resolution, as well as new options such as binning and gain choices, to help plan observations.

[6] The Mosaic-1 camera will be upgraded during 2010 with new e2v CCDs and MONSOON-based controllers. The improved instrument is currently scheduled to be recommissioned at the Mayall 4-m during September and October of 2010. We intend to offer shared risk observing with the upgraded instrument in the latter half of the 2010B observing semester. The instrument will not be available for science programs at the WIYN 0.9-m during 2010B.

[7] As we go to press, the availability of the OPTIC Camera from University of Hawai'i is unknown for the 2010B observing semester. OPTIC has been available in the past through an agreement with Dr. John Tonry of the University of Hawai'i. Please see footnote [3] above for additional information regarding WIYN 3.5-m science proposals.

[8] WHIRC was built by Dr. Margaret Meixner (STScI) and collaborators. The availability of this instrument for science observations during 2010B is subject to the same uncertainty, at press time, affecting all WIYN 3.5-m science proposals. Please see footnote [3] above. Observers contemplating use with WTTM correction should consult with Dick Joyce or Lori Allen for details.

[9] While T2KB is the default CCD for CFIM, use of F3KB may be justified for some applications and may be specifically requested; scale 0.19"/pix, 9.7'×3.2' field. If T2KB is unavailable, CFIM may be offered with T2KA (scale 0.305"/pix, 10.4' field) or with F3KB to best match proposal requirements. [www.noao.edu/kpno/ccdchar/ccdchar.html](http://www.noao.edu/kpno/ccdchar/ccdchar.html)

[10] The planned upgrade of Mosaic-1 (see footnote [6]) will prevent the use of Mosaic-1 or the upgraded instrument at the WIYN 0.9-m for semester 2010B. No proposals will be accepted for NOAO time on the WIYN 0.9-m during 2010B.



# CTIO Instruments Available for 2010B

Spectroscopy	Detector	Resolution	Slit
<b>CTIO BLANCO 4-m</b>			
Hydra + Fiber Spectrograph	SiTe 2K×4K CCD, 3300–11,000Å	700–18,000, 45000	138 fibers, 2" aperture
R-C Spectrograph [1]	Loral 3K×1K CCD, 3100–11,000Å	300–5000	5.5'
<b>SOAR 4.2-m</b>			
OSIRIS IR Imaging Spectrograph [2]	HgCdTe 1K×1K, JHK windows	1200, 1200, 3000	3.2', 0.5', 1.2'
Goodman Spectrograph [1,3]	Fairchild 4K×4K CCD, 3100–8500Å	1400, 2800, 6000	5.0'
<b>CTIO/SMARTS 1.5-m [4]</b>			
Cass Spectrograph	Loral 1200×800 CCD, 3100–11,000Å	<1300	7.7'
Fiber echelle spectrograph	SiTe 2K×2K CCD, 4020–7300Å	20,000–42,000	2.4" fiber
Imaging	Detector	Scale ("/pixel)	Field
<b>CTIO BLANCO 4-m</b>			
Mosaic II Imager	8K×8K CCD Mosaic	0.27	36'
NEWFIRM [5]	InSb (mosaic, 4-2K×2K, 1–2.3µm)	0.4	28.0'
ISPI IR Imager [6]	HgCdTe (2K×2K 1.0–2.4µm)	0.3	10.25'
<b>SOAR 4.2-m</b>			
SOAR Optical Imager (SOI)	E2V 4K×4K Mosaic	0.08	5.25'
OSIRIS IR Imaging Spectrograph	HgCdTe 1K×1K	0.33, 0.14	3.2', 1.3'
Spartan IR Imager [7]	HgCdTe (mosaic 4-2K×2K)	0.068, 0.041	5.2', 3.1'
Goodman Spectrograph [3]	Fairchild 4K×4K CCD	0.15	7.2' diameter
<b>CTIO/SMARTS 1.3-m [8]</b>			
ANDICAM Optical/IR Camera	Fairchild 2K×2K CCD	0.17	5.8'
	HgCdTe 1K×1K IR	0.11	2.0'
<b>CTIO/SMARTS 1.0-m [9]</b>			
Direct Imaging	Fairchild 4K×4K CCD	0.29	20'
<b>CTIO/SMARTS 0.9-m [10]</b>			
Direct Imaging	SiTe 2K×2K CCD	0.4	13.6'

[1] The R-C Spectrograph will ONLY be scheduled in the case of extremely heavy spectroscopic demand that cannot be served by the SOAR+Goodman spectrograph. In general, the R-C Spectrograph should be out-performed by the Goodman Spectrograph on SOAR. A comparison guide is available. We will attempt to schedule highly ranked requests for R-C Spectrograph runs on the SOAR/Goodman. Proposals requesting R-C Spec should indicate why Goodman cannot fulfill their needs.

[2] The spectral resolutions and slit lengths for the OSIRIS imaging spectrograph correspond to its low-resolution, cross-dispersed, and high-resolution modes, respectively. In the cross-dispersed mode, one is able to obtain low-resolution spectra at JHK simultaneously.

[3] The Goodman Spectrograph is available in single-slit mode. Imaging mode is also available, but only with U, B, V, and R filters.

[4] Service observing only. Note that, due to severe scheduling constraints in 2011A, long term proposals for 2010B that extend into 2011A will not be accepted. However, existing long term proposals will be allowed to continue in 2011A.

[5] Please see [www.noao.edu/ets/newfirm/](http://www.noao.edu/ets/newfirm/) for more information. Permanently installed filters include J, H, and K<sub>s</sub>. In addition to these three broad band filters, two narrowband filters, 2.12µ H<sub>2</sub>, 2.17µ Br-γ and five intermediate band filters for the J & H band (provided by P. van Dokkum, Yale U.) will be installed for 2010B. Please see NEWFIRM Web pages for information and updates on filters and their availability/schedulability.

[6] ISPI should be out-performed by NEWFIRM. In exceptional cases, for example for programs already started with ISPI, and for which instrument characteristics should be identical for all observations, ISPI MAY be scheduled depending on block scheduling constraints. Proposals requesting ISPI should indicate if and why NEWFIRM or SPARTAN cannot fulfill their needs. It is fine to request ISPI if available, but NEWFIRM as a second choice.

[7] We expect Spartan to be in regular science operation in the low resolution mode. The high resolution mode is commissioned, but has seen very little use. Spartan should be preferred to OSIRIS for most imaging applications.

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

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

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



# Gemini Instruments Expected to be Available for 2010B

GEMINI NORTH	Detector	Spectral Range	Scale ("/pixel)	Field
NIRI	1024×1024 Aladdin Array	1–5μm R~500–1600	0.022, 0.050, 0.116	22.5", 51", 119"
NIRI + Altair (AO- Natural or Laser)	1024×1024 Aladdin Array	1–2.5μm + L Band R~500–1600	0.022	22.5"
GMOS-N	3×2048×4608 CCDs	0.36–1.0μm R~670–4400	0.072	5.5' 5" IFU
Michelle	320×240 Si:As IBC	8–26μm R~100–30,000	0.10 img, 0.20 spec	32"×24" 43" slit length
NIFS	2048×2048 HAWAII-2RG	1–2.5μm R~5000	0.04×0.10	3"×3"
NIFS + Altair (AO- Natural or Laser)	2048×2048 HAWAII-2RG	1–2.5μm R~5000	0.04×0.10	3"×3"
GEMINI SOUTH	Detector	Spectral Range	Scale ("/pixel)	Field
Phoenix	512×1024 Aladdin Array	1–5μm R<70,000	0.085	14" slit length
GMOS-S	3×2048×4608 CCDs	0.36–1.0μm R~670–4400	0.072	5.5' 5" IFU
T-ReCS	320×240 Si:As IBC	8–26μm R~100, 1000	0.09	28"×21"
NICI	1024×1024 (2 det.) Aladdin III InSb	0.9–5.5μm Narrowband Filters	0.018	18.4"×18.4"
EXCHANGE	Detector	Spectral Range	Scale ("/pixel)	Field
HIRES (Keck)	3×2048×4096 MIT-LL	0.35–1.0μm R~30,000–80,000	0.12	70" slit
MOIRCS (Subaru)	2×2048×2048 HAWAII-2	0.9–2.5μm R~500–3000	0.117	4'×7'
Suprime-Cam (Subaru)	10×2048×4096 CCDs	0.36–1.0μm	0.2	34'×27'
HDS (Subaru)	2×2048×4096 CCDs	0.3–1.0μm R~90,000	0.138	60" slit
FOCAS (Subaru)	2×2048×4096 CCDs	0.33–1.0μm R~250–7500	0.104	6' (circular)
COMICS (Subaru)	6×320×240 Si:As	8–25μm R~250, 2500, 8500	0.13	42"×32"
IRCS (Subaru)	1024×1024 InSb	1–5μm R~100–20,000	0.02, 0.05	21"×21", 54"×54"
IRCS+AO188 (Subaru)	1024×1024 InSb	1–5μm R~100–20,000	0.01, 0.02, 0.05	12"×12", 21"×21", 54"×54"





## Keck Instruments Available for 2010B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
<b>Keck-I</b>					
HIRESb/r (optical echelle)	3x MM-LL 2K×4K	R~30k–80k	0.35–1.0 $\mu$ m	0.19	70" slit
LRIS (img/lslit/mslit)	Tek 2K×4K, 2×E2V 2K×4K	R~300–5000	0.31–1.0 $\mu$ m	0.22	6'×8'
<b>Keck-II</b>					
ESI (optical echelle)	MIT-LL 2048×4096	R~1000–6000	0.39–1.1 $\mu$ m	0.15	2'×8'
ESli (optical echelle, IFU)	MIT-LL 2048×4096	R~1000–6000	0.39–1.1 $\mu$ m	0.15	2'×8'
NIRSPEC (near-IR echelle)	1024×1024 InSb	R~2000, 25,000	1–5 $\mu$ m	0.18 (slitcam)	46"
NIRSPA0 (NIRSPEC w/AO)	1024×1024 InSb	R~2000, 25,000	1–5 $\mu$ m	0.18 (slitcam)	46"
NIRC2 (near-IR AO img)	1024×1024 InSb	R~5000	1–5 $\mu$ m	0.01–0.04	10"–40"
OSIRIS (near-IR AO img/spec)	2048×2048 HAWAII2	R~3900	0.9–2.5 $\mu$ m	0.02–0.1	0.32"–6.4"
DEIMOS (img/lslit/mslit)	8192×8192 mosaic	R~1200–10,000	0.41–1.1 $\mu$ m	0.12	16.7'×5'

### Interferometer

IF (See <http://nexsci.caltech.edu/software/KISupport/>)

## MMT Instruments Available for 2010B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
BCHAN (spec, blue-channel)	Loral 3072×1024	R~800–11,000	0.32–0.8 $\mu$ m	0.3	150" slit
RCHAN (spec, red-channel)	Loral 1200×800	R~300–4000	0.5–1.0 $\mu$ m	0.3	150" slit
MIRAC3-BLINC (mid-IR img, PI inst)	128×128 Si:As BIB		2–25 $\mu$ m	0.14, 0.28	18.2', 36"
Hectospec (300-fiber MOS, PI)	2 2048×4608	R~1000–2000	0.38–1.1 $\mu$ m	R~1K	60'
Hectochelle (240-fiber MOS, PI)	2 2048×4608	R~34,000	0.38–1.1 $\mu$ m	R~32K	60'
SPOL (img/spec polarimeter, PI)	Loral 1200×800	R~300–2000	0.38–0.9 $\mu$ m	0.2	20"
ARIES (near-IR imager, PI)	1024×1024 HgCdTe		1.1–2.5 $\mu$ m	0.04, 0.02	20", 40"
SWIRC (wide n-IR imager, PI)	2048×2048 HAWAII-2		1.0–1.6 $\mu$ m	0.15	5'
CLIO (thermal-IR AI camera, PI)	320×256 InSb		H,K,L,M	0.05	16"×13"
MAESTRO (optical echelle, PI)	4096×4096	R~28,000	0.32–1.0 $\mu$ m	0.15	
PISCES (wide n-IR imager, PI)	1024×1024 HgCdTe		1–2.5 $\mu$ m	0.18	3.1'

## Magellan Instruments Available for 2010B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
<b>Magellan I (Baade)</b>					
PANIC (IR imager)	1024×1024 Hawaii		1–2.5 $\mu$ m	0.125	2'
IMACS (img/lslit/mslit)	8192×8192	R~2100–28,000	0.34–1.1 $\mu$ m	0.11, 0.2	15.5', 27.2'
<b>Magellan II (Clay)</b>					
MIKE (echelle)	2K×4K	R~22,000	0.32–1.0 $\mu$ m	0.12–0.13	5" slit
MIKE Fibers (echelle)	2K×4K	R~16,000	0.32–1.0 $\mu$ m	0.12–0.13	20'–23', 256 fibers
MagE (echellete)	1024×2048 E2V	R~4100	0.31–1.0 $\mu$ m	0.3	10" slit

## Hale Instruments Available for 2010B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
Double Spectrograph/Polarimeter	1024×1024 red, 2048×4096 blue	R~1000–10,000	0.3–1.0 $\mu$ m	0.4–0.6	128" long, 8"×15" multi
TripleSpec	1024×2048	R~2500–2700	1.0–2.4 $\mu$ m	0.37	30" slit



# New NOAO Survey Programs Selected

Tod R. Lauer

Three new NOAO survey programs have been initiated, with observations beginning in the first semester of 2010. Eighteen proposals were submitted in response to an announcement of opportunity for new survey programs.

NOAO surveys are observing proposals that require the generation of a large, coherent data set in order to address their scientific research goals. Surveys may run for up to three years and can receive larger blocks of time than are usually awarded in the standard observing-time allocation process. In return for the large allocation of resources, the survey teams are required to deliver their reduced survey data products to the NOAO Science Archive (NSA) for follow-on investigations by other interested astronomers. A key part of the evaluation of the survey proposals is understanding the likelihood that interesting follow-on investigations can be done with the data products that will not be conducted as part of the primary scientific goals of the survey team itself.

Overall, the Survey Telescope Allocation Committee graded the proposals in three categories, with the final grades comprising a weighted sum of 50% for quality of the primary scientific goals, 25% for the archival research value of the data products, and 25% for the credibility of the survey management plan.

Pieter van Dokkum (Yale) and 14 co-investigators will be conducting "The NEWFIRM Medium Band Survey II: Hunting Monster Galaxies." This survey requested 32 nights of NEWFIRM imaging at the CTIO 4-m

telescope to study the early evolution of the most massive galaxies in the Universe. The goal is to use a large field survey to increase the number of massive galaxies known at  $z > 2$  by over an order of magnitude. The program will use a set of medium-band filters to obtain accurate photometric redshifts of the galaxies, in turn, measuring their luminosity function, stellar ages, and AGN and dust content. The survey should also find rare AGN and proto galaxy-clusters.

Ronald Probst (NOAO) and six co-investigators will use 11 NEWFIRM nights at the CTIO 4-m telescope to conduct "A Deep H<sub>2</sub> Imaging Survey of Star Forming Regions in the Magellanic Clouds." Imaging of selected molecular clouds in both the Large Magellanic Cloud and Small Magellanic Cloud will be done in a narrowband filter, isolating the 2.122 mm line of molecular Hydrogen (a K<sub>s</sub> filter will be used for background subtraction). The specific goal is to characterize gas at 1000° K, which represents a temperature scale intermediate between the fully ionized and fully molecular interstellar medium of the star forming regions.

The third survey selected is "A Unified FLAMINGOS-2 GOODS Survey," led by Mark Dickinson (NOAO) and Anthony Gonzalez (Florida) with 20 co-investigators. This program will use FLAMINGOS-2 over 23 nights at Gemini South to obtain near-infrared spectra of ~100 galaxies in the GOODS South field. The goal is to study the physical properties of star-forming galaxies and AGN during the peak cosmological era of star formation.

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## Third Quarter 2010 NSO Proposal Deadline

The NSO/Sac Peak Telescope Allocation Committee

The current deadline for submitting observing proposals to the National Solar Observatory is 15 May 2010 for the third quarter of 2010.

Information is available from the NSO Telescope Allocation Committee at:  
P.O. Box 62, Sunspot, NM 88349, for Sacramento Peak facilities ([sp@nso.edu](mailto:sp@nso.edu)) or  
P.O. Box 26732, Tucson, AZ 85726, for Kitt Peak facilities ([nsokp@nso.edu](mailto:nsokp@nso.edu)).

Instructions may be found at [www.nso.edu/general/observe/](http://www.nso.edu/general/observe/).

A Web-based observing-request form is at [www2.nso.edu/cgi-bin/nsoforms/obsreq/obsreq.cgi](http://www2.nso.edu/cgi-bin/nsoforms/obsreq/obsreq.cgi).

Users' Manuals for the SP facilities are available at [nsosp.nso.edu/dst/](http://nsosp.nso.edu/dst/).

Users' Manuals for the KP facilities are available at [nsokp.nso.edu/](http://nsokp.nso.edu/).

An observing-run evaluation form can be obtained at [ftp://ftp.nso.edu/observing\\_templates/evaluation.form.txt](ftp://ftp.nso.edu/observing_templates/evaluation.form.txt).

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

## Director's News

David Silva

### The View from Cerro Tololo

As I was standing on Cerro Tololo with the AURA Board recently, we were surrounded by an impressive view of the vitality and creativity within the US Optical/Infrared (O/IR) System. Our view also celebrated a long-term collaboration with the Republic of Chile, the host country for these great facilities.

Below us, we could see the Panchromatic Robotic Optical Monitoring and Polarimetry Telescopes (PROMPT) array of 6 × 0.41-m telescopes operated remotely from the University of North Carolina for rapid, multiband gamma-ray burst follow-up observations. Right next door, the new Las Cumbres Observatory Global Telescope Network (LCOGTN) site was under construction. Soon, three 1-m and six 0.4-m telescopes will be installed, the first of five such clusters distributed around the world for near-continuous observations over 24 hours. The Wisconsin H-Alpha Mapper (WHAM) was also close by, after a five-year stay on Kitt Peak. Behind us were the small-aperture telescopes operated by the Small and Moderate Aperture Research Telescope System (SMARTS)-II group as well as the Michigan Curtis Schmidt. All of these facilities leverage existing infrastructure on Cerro Tololo to deploy and operate low-cost observational experiments.

Towering over the SMARTS telescopes was the Blanco 4-m telescope, where renovation and renewal work on various sub-systems has been underway for several years in preparation for the arrival of the NEWFIRM wide-field (0.2-deg) infrared imager from Kitt Peak and the Dark Energy Camera (DECam), a 3-deg optical imager from Fermilab. NEWFIRM will be on-sky shortly, an event anticipated by the high user demand during the 2010A proposal cycle. DECam should be available for science observations in late 2011. NOAO has also proposed to fund university-based groups to build new optical and near-IR, medium resolution spectrographs for the Blanco, but NSF has not yet allocated funding.

Off to the south, both the Southern Astrophysical Research (SOAR) 4.1-m and Gemini South 8.2-m telescopes stood out on Cerro Pachón. After a relatively slow start, SOAR is reaching operational maturity with a strong instrumentation suite. Later in 2010, a ground-layer adaptive optics system with a high spatial resolution imager (both built by NOAO) will become available for science observations. Meanwhile, the Near-Infrared Coronagraphic Imager (NICI) planet-finding campaign is underway at Gemini South at the same time the multi-object, near-IR spectrometer FLAMINGOS-2 is being commissioned. In 2011, the Gemini Multi-Conjugate Adaptive Optics System (GeMS) should be deployed as well as the Gemini Planet Imager (GPI). And of course, we look forward to the Large Synoptic Survey Telescope (LSST) on Cerro Pachón by mid-decade if the Astro2010 decadal survey provides a favorable recommendation.

To the north, the mind's eye could see the Magellan 6.5-m telescopes with the Inamori-Magellan Areal Camera and Spectrograph (IMACS) and Magellan Inamori Kyocera Echelle (MIKE) instruments so popular during open-access time provided by the Telescope System Instrumentation Program. These excellent telescopes have many other interesting instruments and a strong user community. And if you really squinted, you could see an outline of the Giant Magellan Telescope enclosure ris-

ing above Cerro Las Campanas, a hint of the arrival of this exciting new facility late in the decade.

Over decades, funding for this rich constellation of capabilities has come including a diverse range of sources, from private individuals; the Ford and Carnegie Foundations; the Smithsonian Institution; the National Science Foundation; governmental agencies in Argentina, Australia, Brazil, Canada, and the United Kingdom; and, not least of all, private and public universities in the United States.

Thanks to the generosity of these institutions, agencies, and individuals, the US and international communities can look forward to years of astronomical research excellence and exploration from the mountains near La Serena.

¡Cielos claros! Clear skies!

### Vista Sidney Wolff

As you drive on the AURA road towards Cerro Tololo and Cerro Pachón, you eventually reach a junction with a beautiful view of the Cerro Pachón summit ridge. On 1 February 2010, a new overlook at this junction was dedicated to Dr. Sidney C. Wolff. The dedication ceremony was attended by the AURA Board as well as Dr. William Smith, president of AURA, and various Gemini and NOAO personnel. After a few brief remarks by Dr. W. Smith and Dr. Katy Pilachowski (AURA Board vice-chair), Dr. R. Christopher Smith (associate director for NOAO South) unveiled a plaque titled "Vista Sidney Wolff" that reads:

*This beautiful view is dedicated in honor of Dr. Sidney C. Wolff, whose vision and leadership as Director of NOAO, Director of Gemini, and President of the SOAR Board and LSST Corporation were critically important in the establishment of the facilities you see here on Cerro Pachón.*



Left to right: Chris Smith, Sidney Wolff, David Silva, and Bill Smith.  
(Image credit: Enrique Figueroa.)

Congratulations Sidney! And thank you for all your work to make these facilities a reality for the entire international community that uses them.





# Ongoing Celebrations of Our 50<sup>th</sup> Anniversary

Elizabeth Alvarez, John Glaspey & Buell T. Jannuzi

We began celebrating our 50<sup>th</sup> Anniversary in March 2008 fifty years after the National Science Foundation announced that Kitt Peak, located in the Schuk Toak District on the land of the Tohono O'odham Nation, was the top choice for the site of the new National Astronomy Observatory. We will continue celebrating through March 2010, fifty years after the dedication of the Observatory. Throughout these two years, which included the International Year of Astronomy, we have held a number of events to reach various audiences. We'd like to highlight some of the most recent and herald some yet to come.



Figure 1: Artists from the IAAA in front of the Kitt Peak National Observatory Visitor Center. Front row, left to right: Michelle Rouch, Bill Hartmann, Kara Szathmáry. Back row, left to right: Jon Ramer, Tim Malles, April Faires, Betsy Smith, John W. Clark. (Image credit: Kara Szathmáry.)

In October 2009, we invited a group of artists from the International Association of Astronomical Artists (IAAA) to Kitt Peak to spend a week at the observatory and create artwork in celebration of the contributions of our National Observatory. The visit, one of the recommendations of a 50<sup>th</sup> anniversary art/culture subcommittee chaired by Pat Eliason (NSO), was a resounding success. Eight accomplished astronomical artists (from Arizona, California, Florida, New Hampshire, and Quebec, Canada) visited Kitt Peak; eagerly absorbed the science,

technology, and culture; and shared their perspectives with our communities. Outreach included interaction and collaboration with art students from the Tohono O'odham Nation during a day of painting at the Nation's Cultural Center and Museum. The week culminated in an art show entitled "Visions of the Cosmos" in which over 60 pieces, including 32 created during the week on Kitt Peak, were on display. With the University of Arizona (UA) Lunar and Planetary Laboratory (LPL) launching their own 50<sup>th</sup> anniversary celebrations in 2010, we were delighted when they offered their building on the university campus as the venue for the art show so we could open it to, not just our own employees and the local astronomy community, but also the UA and broader Tucson communities. Special thanks for the success of the week's numerous inter-organizational collaborations go to Kara Szathmáry (IAAA lead coordinator); Michelle Rouch and Bill Hartmann (local IAAA artists); Allison Francisco and colleagues at the Tohono O'odham Nation Museum and Cultural Center; Mary Guerrieri and colleagues at the UA LPL; NovaSpace Galleries; and Aletha Kalish and staff, docents, and astronomers at NOAO, NSO, and the Kitt Peak tenant observatories.



Figure 2: Kitt Peak view with panels painted by each of the eight visiting artists. (Image credit: Dan Eklund.)

In November 2009, we enjoyed a reunion of NOAO/NSO employees across the decades. Some photos taken at the event were shown on pages 44–45 of the December 2009 *Newsletter* ([www.noao.edu/noao/noaonews/dec09/pdf/NL100\\_Celebratory.pdf](http://www.noao.edu/noao/noaonews/dec09/pdf/NL100_Celebratory.pdf)), and we have created a Web site with more of the photos at [www.noao.edu/kpno/history/Reunion/](http://www.noao.edu/kpno/history/Reunion/). Another Web page includes the photos that were shown to attendees during the Tucson get together to refresh memories: [www.noao.edu/kpno/history/reunion\\_slideshow/](http://www.noao.edu/kpno/history/reunion_slideshow/). In all, there



Figure 3: Community art show in celebration of the 50<sup>th</sup> anniversaries of our National Astronomy Observatory and the University of Arizona Lunar and Planetary Laboratory. (Image credit: Dan Eklund.)

were over forty alumni, half of whom joined a visit to Kitt Peak during the reunion. Roughly sixty staff and spouses came to a luncheon to meet and reminisce with the former colleagues.

In March 2010, we will culminate our anniversary celebrations. Among the activities that month, will be two special science symposia with a joint day of celebration. "From First Light to Newborn Stars" happens March 14–17, followed by "The Eventful Universe" March 17–20. On March 17, both symposia will meet jointly for talks by our distinguished invited speakers (Vera Rubin, Nick Suntzeff, Heather Morrison, Charlie Lada, Douglas Rabin, and Alan Dressler) to celebrate the 50<sup>th</sup> anniversary of the National Observatory.

"From First Light to Newborn Stars" will focus on the physics of star formation in galaxies, including the Milky Way, nearby galaxies, and galaxies at high-*z*. The meeting format will include both plenary session talks on major topics of interest to both galactic and extragalactic researchers, as well as plenty of time for in-depth discussion of both theory and observation within smaller groups. Major themes include star formation on galactic scales, star formation in extreme environments, and star formation in low-metallicity conditions. Some time will be

*continued*




## Ongoing Celebrations of Our 50th Anniversary continued

devoted to discussion of future capabilities and their requirements for advancing our understanding of star formation.

“The Eventful Universe” explores the time-axis in observational phenomena. Topics will cover the extragalactic: detection of gamma-ray bursts and supernovae in distant galaxies, vari-

able AGN; the galactic: variable stars, novae, cataclysmic events; and the solar system: the detection of near-earth asteroids and Kuiper Belt objects. A common theme will be understanding the best observational strategies for detecting, characterizing, and following up on all transient events. The meeting format will include several breakout sessions to promote

discussion and exploration of individual classes of objects or detection methodologies.

To register for either symposium and/or the celebratory joint day, go to [www.noao.edu/kp50/symposia.html](http://www.noao.edu/kp50/symposia.html). 

## A Survey of the NOAO Survey Program

Tod R. Lauer

For the last decade, NOAO has offered an annual opportunity to propose observational survey programs. Over the first part of this year, NOAO intends to conduct an external review of the survey program to gauge its effectiveness and to identify ways in which it can be improved.

“Surveys” are investigations needing large allocations of telescope time beyond what can typically be awarded on a per-semester basis by the standard telescope allocation process to solve a critical scientific program. Survey programs typically focus on imaging large areas of the sky or obtaining large spectroscopic samples in a uniform way. The programs may span up to three years. Overall, 25% of the telescope time available through NOAO (excluding community time on private facilities through the Telescope System Instrumentation Program) is available for survey programs.

A key part of the survey programs is producing reduced data products that can be used by other members of the community to do frontier science beyond that conducted by the survey teams themselves. In return for large allocations of telescope time, the survey teams are required to make these products available to the NOAO Science Archive on a timely basis.

A list of the surveys selected over the length of the program can be found at [www.noao.edu/gateway/surveys/programs.html](http://www.noao.edu/gateway/surveys/programs.html). Over the duration of the program, many of these surveys have had large scientific impact, both through

the science conducted by the original survey team, and by those doing follow-up work on the data products. Because the overall allocation to the survey programs is large, NOAO has decided that it should be reviewed to understand how well it is working and to understand ways in which it can be made more effective, particularly to those in the community benefitting from the use of the data products. NOAO thus intends to convene an external committee to review the survey program with the following topics in mind:

- Examine the original purpose and expectations of the survey program and the original recommendations for implementation.
- Determine how well NOAO has developed and implemented a set of procedures that are consistent with those recommendations.
- Quantify the overall success of the program.
- Identify the ways in which the program falls short of the original expectations.
- Understand what has changed: either aspects of the program where reality has shown the limitations of the approaches taken, or evolution of community aspirations, or NOAO capabilities that could be addressed better.
- Recommend specific changes for the program.

The goal is to produce a report by June 2010 that allows the survey program to be reconfigured as needed in advance of the next call for survey proposals. Comments from the community on the effectiveness of the NOAO survey program are welcome at: [survey\\_review@noao.edu](mailto:survey_review@noao.edu)



## Change Planned to FITS Format in the NOAO Archive

Rob Seaman

Observers and users of observatory data products should be advised of a change to the Flexible Image Transport System (FITS) format for data stored in the NOAO Archive. Starting February 1 with the 2010A observing semester, all newly archived raw and pipeline-reduced FITS data files will be stored in the “tile-compressed” **fpack** (for “packed FITS”) format. While the various data formats currently used by observatory instruments will not change on the telescope computers, data fetched from the NOAO archive will be provided in this new format.

This change will save about 19% of the storage and network transport costs for 16-bit integer images currently compressed with the venerable **gzip**, while 32-bit integer and floating point data will benefit by a much greater factor.

Additional details are available in the accompanying article, “What Is FITS Tile Compression?” As is described in that article, tile-compressed files can be uncompressed into normal FITS files using the **funpack** command available with either the IRAF FITSUTIL package or the CFITSIO package from NASA Goddard Space Flight Center.



# What Is FITS Tile Compression?

Rob Seaman

As announced in the accompanying notice, the NOAO Archive will be using a new flavor of the Flexible Image Transport System (FITS) format. Tile-compressed FITS is a way to represent compressed data within FITS itself, not through the use of some external compression program like gzip. This is similar to how the JPEG, GIF, and PNG image-format standards contain built-in compression algorithms.

Tile-compression, a FITS standard since 2001, has numerous benefits. Images are encoded as binary tables, and many standard FITS tools can be used. For instance, image headers remain fully readable. Access is very rapid because each rectangular tile (default is one image line) can be accessed individually without having to uncompress any other pixels.

Multiple image compression algorithms allow each class of data to benefit from a tailored choice (both lossless and lossy options are supported). For most astronomical data, the lossless Rice algorithm appears to be the best trade-off between speed and compression factor. In fact, Rice is both significantly faster than gzip and produces higher compression ratios, thus smaller files.

Numerical compression algorithms like Rice have highly beneficial features such as compressing 16-bit and 32-bit pixels of the same data into the same absolute size. This is critical for efficiently representing data (as from 18-bit analog-to-digital converters) that fall between these short and long integer sizes.

Support for on-the-fly tile-compression is built into the widely used CFITSIO library and is available for numerous computer platforms via the standalone *fpack* and *funpack* tools ([heasarc.nasa.gov/fitsio/fpack](http://heasarc.nasa.gov/fitsio/fpack)). *Fpack* (for “packed FITS”) and the inverse tool, *funpack* (for “unpacked FITS”), will pack and unpack several popular image formats, such as single FITS images as well as FITS Multi-Extension Format

(MEF) files, gzipped FITS files, and IRAF images directly into tile-compressed FITS. The FITSUTIL package provides support for IRAF users (see [iraf.noao.edu/extern.html](http://iraf.noao.edu/extern.html)).

Compression is intimately related to the noise within an image. W. D. Pence (NASA/Goddard Space Flight Center), R. L. White (Space Telescope Science Institute), and I covered this in a recent paper, “Lossless Astronomical Image Compression and the Effects of Noise” (PASP v121, n878, 414). *Fpack* is a tool for properly managing that noise.

In particular, *fpack* supports noise-sensitive scaling of floating-point data to achieve high compression ratios while preserving the scientific content of data. Similar sigma-scaling benefits have been widely discussed recently, for example, for the Joint Dark Energy Mission ([arxiv.org/pdf/0910.4571](http://arxiv.org/pdf/0910.4571)) and by the Astrometry.net project ([arxiv.org/pdf/0910.2375](http://arxiv.org/pdf/0910.2375)). The remarkable results from the Kepler Mission rely on noise-scaled data ([arxiv.org/pdf/1001.0216](http://arxiv.org/pdf/1001.0216), section 3.2). To this, *fpack* adds the beneficial feature of subtractive dithering ([www.adass2009.jp/poster/files/PenceWilliam.pdf](http://www.adass2009.jp/poster/files/PenceWilliam.pdf)).

This has been a dense article even with several features and references omitted (e.g., a truly gripping discussion of integrated FITS checksum support). Hopefully, some of my personal excitement over the galvanizing opportunities facing astronomical data compression has been conveyed. This is a transformative technology that will be a key to meeting the aggressive data handling requirements for near-future projects relying on rapid-readout, gigapixel cameras such as those for the Dark Energy Survey, the WIYN One Degree Imager, and the Large Synoptic Survey Telescope. The soul of data compression is not the static storage of data, but rather the dynamic optimization of throughput throughout the observatory data flow and the US Ground-Based Optical/Infrared System of telescopes.

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## KPNO Projects Funded by the American Reinvestment and Recovery Act of 2009

John Dunlop & Buell T. Jannuzi

NOAO has received funding through the American Reinvestment and Recovery Act of 2009 (ARRA) to address key infrastructure repair and operational projects over the next few years. In Arizona, a new staff engineer was recently hired to focus on the various Arizona-based projects and ensure their completion by coordinating with the involved design engineering firms, contractors, and staff. Three of these projects will directly benefit operations on Kitt Peak.

The major infrastructure project focus will be to renovate the mountain's water processing and distribution system, which serves all users on Kitt


Peak. The existing system, part of the original construction on Kitt Peak, has been providing all treatment, processing, and distribution of potable water to the buildings since the early 1960s. Many of the primary system components need to be modified or replaced to maintain compliance with revised or expanded Environmental Protection Agency (EPA) drinking water regulations and to ensure the delivery of potable water to all users. An environmental engineering firm is being hired to identify and design system changes in compliance with EPA requirements and to prepare construction documentation for work to be performed by outside contractors.

*continued*



### KPNO Projects Funded by the ARRA of 2009 continued

ARRA funding also is enabling the replacement of the existing handicapped wheelchair lift, which provides access to one of the Kitt Peak Visitor Center's public telescopes per the Americans with Disabilities Act (ADA). This telescope is heavily used in our popular nightly observing program for the public, and the new elevator will ensure that all individuals, independent of mobility issues, are able to take advantage of these programs. The original lift is over 10 years and is prone to serious breakdowns. A contract has been signed to replace it with a new unit that incorporates updated lifting mechanisms to restore safe access. The new lift is projected to be installed by the end of the second quarter of FY10.

The third Kitt Peak project will focus on providing a mountain facility where we can repair and maintain the large modern instruments used on the telescopes. We will report progress on all three of these projects in future *Newsletters*. 



Water piping plant. (Image credit: Mike Hawes.)

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## CTIO Summer Student Programs for 2010

Ryan Campbell

Summer in the Southern Hemisphere has started and so have the CTIO Summer Student Programs. We have six US students participating in CTIO Research Experiences for Undergraduates (REU) and two Chilean students participating in *Prácticas de Investigación en Astronomía* (PIA). For the first time, CTIO also is hosting one US student participating in Graduate Opportunities for Fisk Astronomy and Astrophysics Research (GO-FAAR), which is funded by the NSF Partnerships in Astronomy & Astrophysics Research and Education program.

GO-FAAR is a collaborative effort between Fisk and Vanderbilt Universities. The aim of this program is to bridge the gap between undergraduate and graduate studies in astronomy and astrophysics and, in this way, substantially broaden the participation of underrepresented minorities in these fields. NOAO, NSO, and other sites are offering external locations to conduct scientific internships for the GO-FAAR students.

During the 10-week CTIO Summer Student Programs, the US and Chilean students work and live at the CTIO compound in La Serena. The students work on research projects with CTIO, SOAR, and Gemini staff. They also have the chance to visit Cerro Tololo, Cerro Pachón, and

Cerro Paranal, observe at Cerro Tololo, attend seminars, and sample the social and cultural life of the CTIO compound and Chile. This year the REU students are: Mason Carney (University of Maine), Katy Accetta (Youngstown State University), Li-Wei Hung (Ohio State University), Connor Sayres (University of Washington), Melodie Kao (Massachusetts Institute of Technology), and Ameer Salois (University of Arkansas). The PIA students for 2010 are Eduardo Bañados (Católica Universidad) and Yasna Ordenes (Universidad de La Serena). The GO-FAAR participant is Mark Bryant from Southern University and A&M College; he is the first GO-FAAR student to come to NOAO.

We wish them an enjoyable stay in La Serena.

Mentors for the students are an integral part of the program. As such, Ryan Campbell, the REU/PIA director, would like to thank the staff of CTIO: Roberto De Propriis, Sean Points, John Subasavage, Craig Harrison, Malcolm Smith, and Andrea Kunder; and Gemini's Peter Pessev, who, in addition to Ryan, are the mentors for this year's CTIO Summer Student Program.





# NOAO at the 2010 Winter AAS Meeting

Ken Hinkle & Katia Cunha

The NOAO booth at the winter American Astronomical Society (AAS) meeting in Washington, DC, had several displays: the panorama of “NOAO: Past, Present, and Future”; “NOAO and The System: Enabling Your Science”; and “Wide-Field Imaging at NOAO: Meeting Community Need.” The NOAO presence at the AAS is one of the opportunities we have to meet and talk with you—our users and potential users. Many NOAO scientific staff members were present at the booth, and this year we were joined by a number of staff from Fermilab. The Fermilab team was spearheaded by Tom Carter, who is currently on sabbatical from the College of DuPage, and included Fermilab Director John Peoples. Fermilab is leading the international collaboration on the Dark Energy Camera for the Blanco 4-m telescope, one of the NOAO telescopes in the Southern Hemisphere.

NOAO also hosted two town hall meetings. The first one, the NOAO Town Hall, held 5 January 2010, was well attended by the community. NOAO Director David Silva presented an overview of the organization and long-range plans for developing the US Optical/Infrared (O/IR) System of capabilities. Questions and answers followed.

The second NOAO-hosted meeting was a US Gemini Town Hall on 6 January 2010. Gemini Director Doug Simons and Gemini Associate Directors Eric Tollestrup and Dennis Crabtree gave presentations.

NOAO System Science Center (NSSC) Director Verne Smith also presented results from a survey conducted by the Gemini Science Committee, along with the survey from the US Access to Large Telescopes for Astronomical Instruction and Research committee, which focused on community-desired observational capabilities and instruments that could be deployed at Gemini within the next three to five years. An open discussion followed, which involved all aspects related to Gemini, its operations, and its relation to the US community.

Staff at the AAS booth also included the NOAO Education and Public Outreach team. They set up a Galileoscope at the booth and ran a raffle for one, which was presented to the winner, Ed Chambers (Northwestern University), by Steve Pompea at the NOAO Town Hall on Tuesday.

For Gemini users, NSSC again offered help with Phase II preparation. The timing of the winter AAS meeting coincides with the due date for Phase II submissions. It is much easier for the principal investigator to work one-on-one with NSSC staff at the AAS meeting than via email. We urge Gemini users to find time during future AAS meetings to take advantage of this quick and relatively painless way of preparing Phase II submissions. This also gives us the opportunity to get feedback from you. The AAS meetings are one of our few chances for face-to-face interactions.



From upper left, clockwise: John Peoples (Fermilab) helps at the NOAO booth; Anil Seth (Harvard-Smithsonian Center for Astrophysics [CfA], Knut Olsen (NOAO), and Andrea Dupree (CfA) work on preparing or helping to prepare Gemini Phase IIs; Nicole van der Blik (CTIO) assists Louis Strolger (Western Kentucky University); Ed Chambers (Northwestern University) is congratulated by Steve Pompea (NOAO) on winning the Galileoscope raffle; Susana Deustua (Space Telescope Science Institute), Rachel Ivie (American Institute of Physics), Karly Pitman (Planetary Science Institute), and Pat Knezek (WIYN) discuss the first survey of astronomy graduates.





# First Fire, Now Snow and Ice

John Dunlop & Buell T. Jannuzi

After successfully dealing with the challenges of last summer's wildfire, nature threw some winter challenges to our wonderful staff. Kitt Peak bore the brunt of a major snowstorm that dipped down into Southern Arizona, January 20-23. Low temperatures and extreme winds created problems in numerous areas around the mountain site and damaged the dome and support building of the WIYN 3.5-m telescope by blowing off several exterior panels. Sustained winds of over 80 mph were incurred for several days, with many hours of even higher winds, and the low temperatures resulted in ice coatings almost an inch thick on buildings and domes. Wind gusts exceeding 150 mph possibly caused the worst of the damage. Panels (~15' x 9.5') from the western side of the WIYN ground-level base building and dome shutter were blown off. Charles Corson initiated efforts to protect instruments and the telescope. By the afternoon of January 22, WIYN Observatory, KPNO, and NOAO-Tucson staff were working effectively to secure the

WIYN dome, installing tarps and plywood to protect the interior. This combination of repairs, made in the wind and snow (see photos), now provide temporary protection from the weather until a longer-term repair effort can be implemented. As this *Newsletter* issue went to press, normal science operations had resumed. Planning for more permanent repairs has begun.

Damage from wind, rain, snow, and ice was not limited to WIYN. Doors were damaged, water intruded into building interiors, trees were downed, and electrical power was lost to the west ridge, the Mayall 4-m telescope, and the facilities of Steward Observatory. Power eventually was restored, and staff worked to clean up and secure other damaged areas.

We greatly appreciate that throughout the storm and subsequent clean-up efforts safety was everyone's top concern.



Storm damage and temporary repairs to WIYN 3.5-m telescope dome and support building. (Image credit: John Dunlop.)

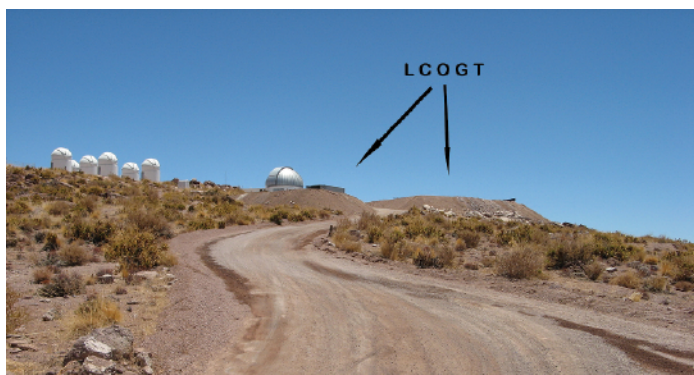
# Las Cumbres Observatory Global Telescope Network Work Begins at Cerro Tololo

Enrique Figueroa & Nicole van der Blik

On 26 October 2009, we started the site preparation for construction of the Cerro Tololo complement of the Las Cumbres Observatory Global Telescope Network (LCOGTN) by creating two platforms (top image). These platforms will house three 1-m telescopes and three clusters of two 0.4-m telescopes each.

The telescope foundation process, started 12 January 2010 (bottom image), is expected to be completed by the end of February. The prefab enclosure is coming from LCOGTN and is expected to arrive during mid-March.

For more information on the LCOGTN, go to: [lcogt.net/](http://lcogt.net/).



Las Cumbres Observatory Global Telescope Network construction work at Cerro Tololo has started. (Image credit: N. van der Blik.)

# A Classical Observing Run Photo Journal from Gemini North

Karen Kwitter (Williams College)

Emma Lehman is a senior astrophysics major at Williams College in Massachusetts. In October 2009, she traveled to the Gemini North telescope on Mauna Kea for a classical run with Karen Kwitter and her collaborators, Dick Henry and Bruce Balick. The group spent three nights observing planetary nebulae in the Andromeda Galaxy (M31) using GMOS. Emma is analyzing these spectra for her honors thesis. During her trip, Emma kept a journal chronicling her time in Hawai'i and her experience observing on Mauna Kea (and running the observing!).

*Day 3: (the night of) Saturday, October 24*

*... We left for the summit at about 5 p.m., and the trip up was at once breathtaking and terrifying. The views were astounding, but the road was so rough that I was convinced we were going to bounce off the road and tumble down the mountain at any moment. ...*

You can read the full journal at:  
[www.williams.edu/home/focus/star\\_journal](http://www.williams.edu/home/focus/star_journal).



Emma Lehman in the Gemini North control room, with Karen Kwitter connected by video from the Hilo Base Facility. (Image credit: Bruce Balick, University of Washington.)





## High Demand for NEWFIRM at the Blanco 4-Meter Telescope in 2010A!

Bringing the NEWFIRM wide-field infrared imager to CTIO for several semesters has generated a great deal of interest and exciting science ideas. So much so, that there were a large number of highly ranked NEWFIRM proposals for semester 2010A; most of them requested at least four nights and several requested more than an entire week. This high demand for NEWFIRM and the fact that it only is available for users starting at the beginning of May caused the last three months of semester 2010A to be dominated with NEWFIRM observing runs.

Filling in the nights between the NEWFIRM blocks turned out to be straightforward, as there were also a significant number of highly ranked Mosaic runs. As a result, it may seem that the second half of semester 2010A was heavily block-scheduled, when in fact, this arrangement was a result of the high demand and high ranking for NEWFIRM and Mosaic, respectively.

We are very pleased with the response to the availability of wide-field imaging capabilities at the Blanco 4-m telescope. It is clear that the community is excited about using NEWFIRM in the Southern Hemisphere, and we look forward to bringing more excitement next year with the installation of DECam at CTIO!

## Former Kitt Peak Director Geoff Burbidge Passes Away

Stephen M. Pompea



Image credit: NOAO Image Gallery.

Dr. Geoffrey Burbidge, former director of Kitt Peak National Observatory (1978 to 1984) and astronomer at the University of California, San Diego, passed away 26 January 2010 in San Diego. He was 84 years old.

Burbidge was born in England in the Cotswolds in the small town of Chipping Norton, midway between Oxford and Stratford-on-Avon. When his father, a builder, found out that his son was good in mathematics, he wanted him to be an accountant. However, Burbidge studied physics at the University of Bristol and received his PhD in theoretical physics at University College London in 1951.

Burbidge is most famous for his work with his wife Margaret Burbidge, William Fowler, and Fred Hoyle that showed how all of the elements except the very lightest ones are produced by nuclear reactions inside stars. In 1957, they produced the seminal paper "Synthesis of the Elements in the Stars," which showed that all of the elements from carbon to uranium could be produced by nuclear processes in stars. Fowler received the Nobel Prize in Physics in 1983 for work in this area. Burbidge also made key contributions to radio astronomy and the nature of quasars and active galactic nuclei. While director of Kitt Peak National Observatory, Burbidge focused the observatory on the need to offer significant observing time to the community. This is seen today in the current NOAO mission to offer significant amounts of peer-reviewed observing time to the US astronomy community.

Some of his many awards include the American Astronomical Society Warner Prize, the Royal Astronomical Society's Gold Medal, and the Catherine Wolfe Bruce Gold Medal in 1999 from the Astronomical Society of the Pacific (ASP). Burbidge was president of the ASP from 1974 to 1976. He was a professor of physics and founding member of the department at the University of California San Diego, from 1963 until 2002, except for the six-year period when he served as director of the Kitt Peak National Observatory.

## New KPNO Observing Assistant

Mike Merrill

KPNO welcomed Jenny Power as a new Observing Assistant in October 2009. Following her initial training on the Mayall 4-m telescope, she has expanded her skills at WIYN. Jenny attended Queen's University at Kingston, Ontario, where she received her Masters of Science degree. Jenny joins the telescope operations team of Karen Butler, Krissy Reetz, Dave Summers, George Will, and Doug Williams at the summit of Kitt Peak.



## Director's Corner

Steve Keil

### Transition

The National Solar Observatory (NSO) is entering a transitional phase. For the past decade, NSO has concentrated on the Design and Development phase of the Advanced Technology Solar Telescope (ATST), bringing Synoptic Optical Long-term Investigations of the Sun (SOLIS) instrumentation and data processing online, establishing new high-resolution helioseismology and magnetic field measurement capabilities for Global Observation Network Group (GONG), bringing state-of-the-art instruments and operating systems to the Dunn Solar Telescope (DST), and increasing the IR capabilities of the McMath-Pierce Solar Facility (McMP). Near the end of 2009, NSF reached a Record of Decision to proceed with the ATST on Haleakalā and completed the transfer of the first increment of construction funds to NSO in January.

With the ATST construction phase now underway, challenges to NSO, in addition to building the ATST, during the next several years include reorganizing its base programs to permit the transition of personnel to ATST construction tasks while continuing our strong observing support and synoptic data collection and distribution for the solar community. NSO is in the process of developing the organizational structure it will need when ATST becomes operational. This includes establishing a presence on Maui for telescope operations and finding a suitable home for combining the current NSO staffs located in Sunspot, New Mexico and Tucson, Arizona. NSO also will continue its pursuit of increased diversity and educational outreach.

Because of these challenges and to achieve some economies, NSO is reorganizing parts of its management structure to accommodate immediate needs during the transition to ATST construction and to begin an evolution toward the structure we anticipate having when ATST becomes operational. Other considerations driving the new organization include ramping up support for SOLIS, streamlining the operation and finding partial external support for GONG to meet the recommendation of the Senior Review, and the plan for NSO to take on some of the ATST Work Packages, including the polarization modulation and calibration unit,

the coudé room benches and optical layout, camera systems and detectors, one of the first-light instruments, and the wavefront correction package. Many of the technical and scientific staff members who have supported instrumentation and operations at the Dunn Solar Telescope (DST) will transfer to ATST, creating a need to reorganize the Sacramento Peak staff.

During this transitional period, NSO needs to continue its strong support of the solar community while using current assets to develop ATST instruments, to test ATST operational concepts, and to train personnel on the use of simultaneous, multi-instrument programs and handling and processing the high output of data expected with ATST. Precursors of several of the ATST instruments now exist at the DST and are supported for users. These include the Interferometric Bidimensional Spectrometer (IBIS: a narrowband tunable filter similar to the ATST Visible Tunable Filter), the Facility Infrared Spectropolarimeter (FIRS: an infrared [IR] spectropolarimeter similar to the ATST Near-IR Spectro-Polarimeter), the Spectropolarimeter for Infrared and Optical Regions (SPINOR: a forerunner of the Visible Spectropolarimeter on ATST), Rapid Oscillations in the Solar Atmosphere (ROSA) with its high-speed cameras, a high-speed speckle system, and the Diffraction Limited Stokes Polarimeter, all of which are fed by adaptive optics. While supporting users on these instruments, which can be used simultaneously in various combinations, NSO will gain the expertise needed to operate the multi-instrument configurations planned for ATST and to handle the large data sets that they will generate. NSO is also experimenting with service mode operations for our high-resolution observations, something that we have done for many years with our synoptic programs. At the McMP, NSO now has IR capabilities with the NSO Array Camera that goes out to 5 microns as well as thermal IR capabilities out to 20 microns.

ATST construction is taking off. NSO has released several requests for proposal for major ATST subsystems including the mirror blank, telescope mount assembly, enclosure, support building, and other subsystems. Several new

personnel have been added to the ATST construction team as we ramp up our construction activities. We are working closely with the University of Hawai'i to obtain a conservation district use permit for construction.

### Other News

NSO and New Jersey Institute of Technology (NJIT) jointly developed an adaptive optics system for use at the 64-cm telescope at Big Bear Solar Observatory (BBSO). With the replacement of the 64-cm with the 1.6-m New Solar Telescope, the current Adaptive Optics (AO) system is insufficient to fully correct the telescope. Thus NSO and NJIT have entered into a program to upgrade their current 97-actuator system to 349 actuators. The current NSO and BBSO AO systems and the development of the new BBSO system serve as stepping stones for the much larger 4-m ATST, which requires a 1300-actuator system. The DST systems are serving as test beds for the development of the ATST AO system. For example, the project is testing reconstruction algorithms needed for the ATST AO, where the pupil on the deformable mirror will rotate with respect to the wavefront sensor.

NSO has completed the replacement of the original SOLIS Rockwell cameras with Sarnoff units. The Sarnoff cameras are faster and are a much better match to the original Vector Spectromagnetograph specifications. Our tests show that we are now getting a much better signal-to-noise ratio with subsequent improvements in the magnetograms. We also replaced the data acquisition system and data processing software to match the new camera characteristics. The spectra are much sharper due to a thinner sensor later in the detector (so, less charge diffusion). We are also planning a modulator change to replace degrading optics and to enable the first-ever synoptic chromospheric vector magnetograms. The guider for the Full-Disk Patrol (FDP) is under construction and should be installed in the lab in early March. The FDP will begin observations in the downtown laboratory during the April–May time frame, and the FDP data will be ingested and processed by the Synoptic Data Center.





# Advanced Technology Solar Telescope (ATST) Is “Go”

The ATST Staff

The NSF awarded a \$298 million cooperative support agreement to AURA Inc. on 1 January 2010 to build the 4-m Advanced Technology Solar Telescope (ATST). “I want to congratulate everyone who has helped make this happen,” said Dr. Stephen L. Keil, director of the National Solar Observatory and AURA’s principal investigator for ATST. “It should be an exciting next several years as we bring ATST to reality.”

ATST will be the largest and most capable solar telescope—no comparable facility exists or is planned. ATST will be the world’s flagship facility for the study of magnetic phenomena in the solar atmosphere and will be the first large, ground-based, open-access solar telescope in the United States in more than 40 years. “This is an exciting opportunity for the National Solar Observatory to lead the community,” said Dr. William Smith, president of AURA. “We look forward to achieving a first-rate, cutting-edge facility.”

ATST will be built atop Haleakalā, Maui, Hawai’i, which was selected after considering 72 sites and then narrowing those down to six for thorough on-site testing. Of those, only the Haleakalā site met all of the ATST requirements: the least atmospheric blurring, the most annual hours of low sky brightness, the lowest dust levels, and the smallest temperature extremes. The site is next to the existing Mees Solar Observatory, which is owned and operated by the University of Hawai’i Institute for Astronomy, a principal partner in the project.

ATST passed an NSF-sponsored Final Design Review 18–21 May 2009 in Tucson. Then, the National Science Board at its August 5–6 meeting “authorized the NSF Director, at his discretion, to make an award” to AURA to build ATST. The final step came December 3 when Dr. Arden Bement, NSF director, signed the Final Environmental Impact Statement Record of Decision (ROD), completing the Federal compliance process for construction at the “Preferred Mees Site” at Haleakalā.

Understanding the role of magnetic fields in the outer regions of the Sun is crucial to understanding the solar dynamo, solar variability, and solar activity, including flares and mass ejections, which can significantly affect life on Earth. ATST research will investigate solar variability and the conditions responsible for solar flares, coronal mass ejections, and other activities that can impact terrestrial communications and power systems, disrupt satellite communications, and endanger astronauts and air travelers.

The ATST 4-m primary mirror will feed an advanced array of instruments designed to study the Sun in light ranging from the near ultraviolet (350 nm) into the far infrared (28  $\mu\text{m}$ ). High-order adaptive optics, pioneered by the NSO and its partners at the NSO Dunn Solar Telescope at Sunspot, New Mexico, will correct blurring of solar images caused by Earth’s atmosphere and thus allow ATST to observe features in the solar atmosphere with unprecedented sharpness, down to structures tens of kilometers in size.

A unique aspect of the ATST design is that it will observe both on the bright solar disk and in the ultra-faint corona. ATST will accurately measure magnetic fields in the ultra-faint corona, which is only a few parts in a million as bright as the solar disk.

The award is effective 1 January 2010 and “[c]ontingent upon the availability of funding and the progress of the project [and] for a not-to-exceed amount of \$297,928,000 for a period of 96 months.” Of that, \$146 million is to become available immediately through the American Recovery and Reinvestment Act of 2009 and the balance through the NSF Major Research Equipment and Facilities Construction account. Construction is to start in 2010 and operations in 2017, and the funding covers the telescope and four commissioning or “first light” instruments.

## SOLIS/VSM Update

Kim Streander & The SOLIS Team

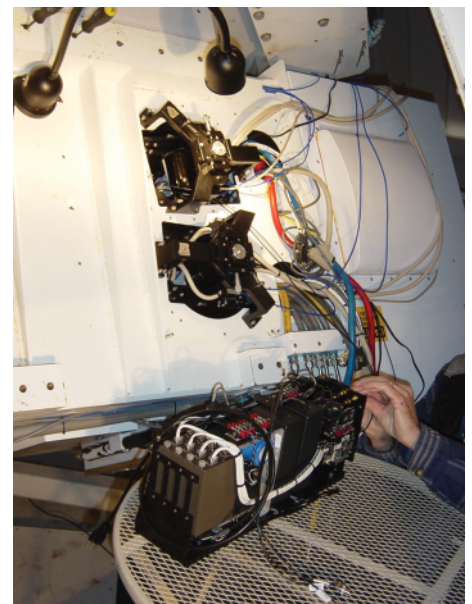
### New Cameras

Synoptic Optical Long-term Investigations of the Sun (SOLIS) recently had its Rockwell cameras replaced with Sarnoff cameras over a three-week period that started 1 December 2009 (see Figure 1).

The spectra with the new cameras are considerably sharper than those with the Rockwell cameras, as the Sarnoff sensor layer is one tenth the thickness of the Rockwell with less chance for charge diffusion before the image is read out. In addition, the Sarnoff pixels are 1.0 arcsec in

size as compared to the Rockwell’s 1.125 arc-sec. The magnetogram from 9 January 2010 is the sharpest one ever obtained with the Vector Spectromagnetograph (VSM) even though the observers had almost no feedback in focusing the telescope at the time (see Figure 2). As a result of these improvements, it is possible to

Figure 1: Newly installed Sarnoff cameras being tested and aligned using a remotely located Data Acquisition System that was later installed within the electronics bay of the Vector Spectromagnetograph (VSM). (Image credit: Neill Mills.)



*continued*

## SOLIS/VSM Development Update continued

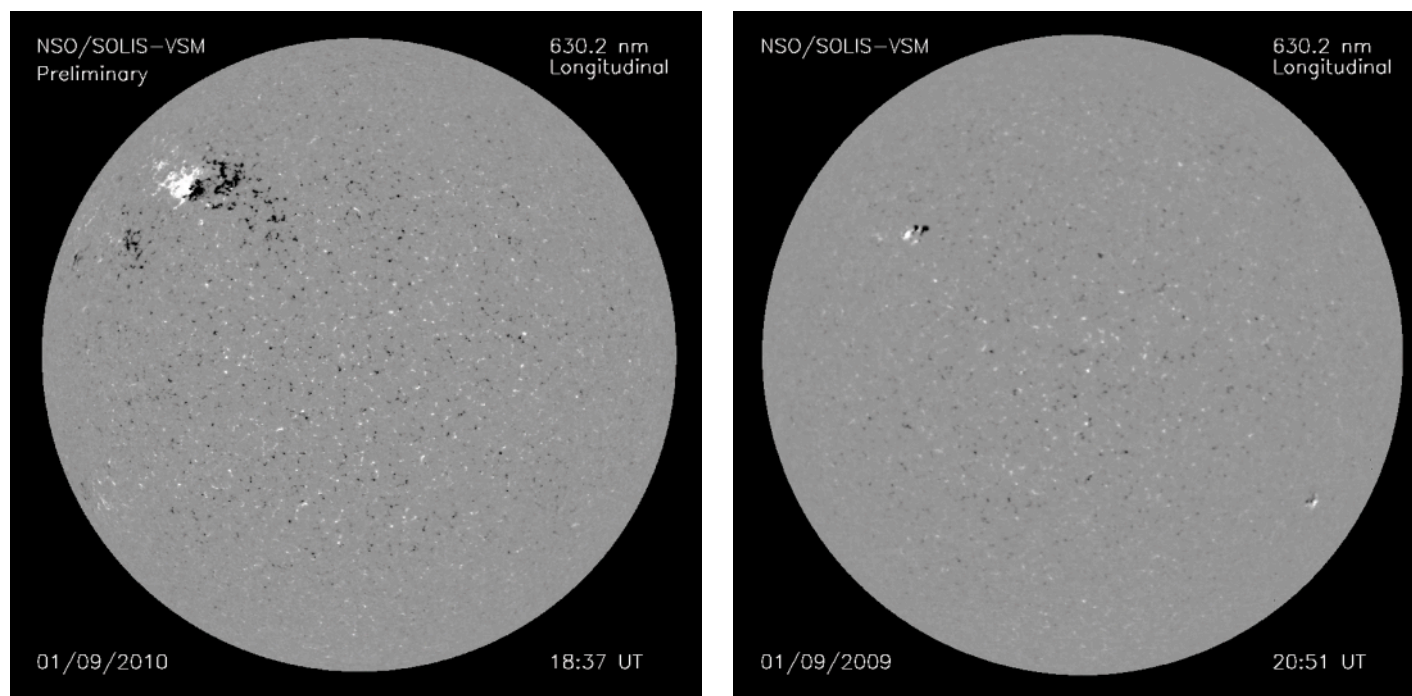


Figure 2: Comparison of the 6302 Å line data taken one year apart. Note the increased number of small solar features detected with the Sarnoff cameras, image 9 January 2010 (left). (Image credit: The Solis Team.)

see the Zeeman splitting of the 6302.5 Å line in sunspot umbrae directly (i.e., the sigma components are separated). This suggests a new algorithm that will allow the field strength to be determined in umbrae as Bill Livingston does with the 15648 Å line and the McMath-Pierce spectrograph.


The VSM is currently operational; however, full resumption of data processing has been delayed due to differences between the Rockwell and Sarnoff camera formats. All data products are expected to be back on the Web prior to the launch of the Solar Dynamics Observatory.

### Synoptic Charts

A useful way to display solar magnetic field observations is with a “synoptic chart,” a term borrowed from meteorology. Synchronic charts attempt to show the entire solar surface at a given instant of time. Diachronic charts show the entire surface built from pole-to-pole strips along the central meridian as a function of time, usually one Carrington solar rotation of about 27.3 days; Figure 3 is an example. This chart was constructed from observations made in late 2003 using the SOLIS VSM at a time when there was a lot more solar activity than at present.

Synoptic charts are not new. But this one (and a nearly full set covering 2003 to the present) is

different and unique because it shows measurements of the magnetic field in the solar chromosphere rather than the much more common photospheric magnetic field measurements. The SOLIS VSM is the only facility producing such chromospheric charts. Synoptic measurements are used as the boundary conditions for estimates of the magnetic field above the surface of the sun. These estimates are the basis for predicting space weather near earth several days in advance. Improving predictions is an

important goal of solar research. The advantage of using chromospheric measurements is that the magnetic field is less likely to depart from the physical assumptions used to extrapolate the magnetic field outward from the sun. These newly-constructed charts offer a new tool to help understand and predict space weather. They are available from the “Latest Synoptic Maps” link on the SOLIS Web site ([solis.nso.edu/](http://solis.nso.edu/)). 

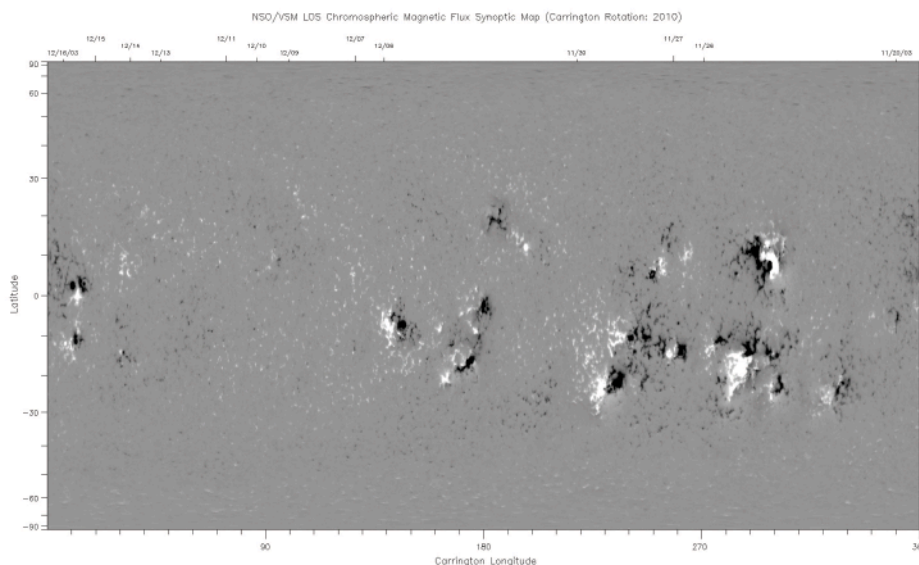


Figure 3: Chromospheric Magnetic Field Synoptic Chart from the SOLIS/VSM. (Image credit: John Britanik, NSO)



# The Global Oscillation Network Group (GONG++)

Frank Hill & The GONG++ Team

## AFWA H $\alpha$ Project

The ten production filters from Daystar were delivered to us in November for the Air Force Weather Agency (AFWA)/GONG project to develop a full-time Hydrogen alpha (H $\alpha$ ) system as part of GONG, and it has been determined that they all have excellent wavelength bandpass characteristics. However, the image quality of the filters is not as good as our sample filter from last spring. Daystar has identified an internal waveplate as the component that is degrading the image quality of our filters, and they are working on improving the flatness of the waveplate with thermal and vacuum methods. If this solution is inadequate, we will obtain custom optical corrector plates from Light Machinery, the company that manufactured the original GONG interferometers. In the meantime, we have identified the best three filters in terms of their image quality, and we have completed the assembly of three production units incorporating these components and the recently completed mechanical assemblies. The completed sets will soon be installed in our Tucson engineering site for burn-in and certification.

Since Daystar cannot provide a schedule for the return of the filters yet, we may need to revise our schedule for the deployment of the systems to the GONG sites. One strategy is to initially deploy the three systems containing the best filters and to set up a three-site network to begin supplying data to AFWA in the May–June 2010 time frame. In that scenario, the remaining three instruments will be deployed as soon as possible after either Daystar provides three more acceptable filters or we acquire corrector plates.

The initial three sites remain to be chosen. Our practice has been to deploy new development hardware to the closest and most accessible site at Big Bear Solar Observatory, California. In that case, in order to provide coverage that is evenly distributed throughout 24 hours, we would next deploy to Teide, Spain and Learmonth, Australia. However, bandwidth issues still prevent us from acquiring real-time data from Learmonth. In place of Learmonth, we would most likely install one of the initial systems at Mauna Loa, Hawai'i, which would not result in an optimal network, leaving an uncovered gap of about two hours

around 4–6 Universal Time (UT) in the spring and fall. However, the continued operation of the AFWA/Solar Electro-Optical Network site at Learmonth would help fill in the gap until the GONG deployment can be completed.

All of the computer systems for the project have been delivered and are undergoing initial burn-in acceptance tests. A set of new blocking filters for the camera has been procured to eliminate an unwanted reflection that was recently noticed.

Work on the transfer of the data to AFWA has begun. John Bolding, our lead in this area, has been conferring with staff at both Offutt and Kirtland Air Force Bases to set up the transfer systems. We continue to routinely transfer the data from the GONG engineering site to the headquarters, where it is processed and stored. The image geometry correction appears to be doing a good job with the current images. A movie of the flare of 2 January 2010 can be downloaded from the GONG Web page at [gong.nso.edu](http://gong.nso.edu).

## Magnetic Field Data

The set of four near-real-time images (ten-minute average and standard deviation of the magnetic field, average intensity and synoptic map weights) developed at the request of the Air Force Research Laboratory (AFRL) is now in routine production. Work continues on the development of a new pole-filling algorithm to improve the field extrapolation such that small coronal holes are correctly modeled. Near-real-time magnetograms are available at [gong2.nso.edu/dailyimages/](http://gong2.nso.edu/dailyimages/) and synoptic maps and field extrapolations can be found at [gong.nso.edu/data/magmap/](http://gong.nso.edu/data/magmap/).

## Solar Oscillation Data

The  $p$ -mode pipeline processing software wrappers have been overhauled to incorporate a higher level of automation. The latest frequencies and time series for GONG month 143 (centered on 9 June 2009) are now available. Ring-diagram processing is complete through 23 June 2009. The GONG data archives may be accessed at: [gong.nso.edu/data/](http://gong.nso.edu/data/).

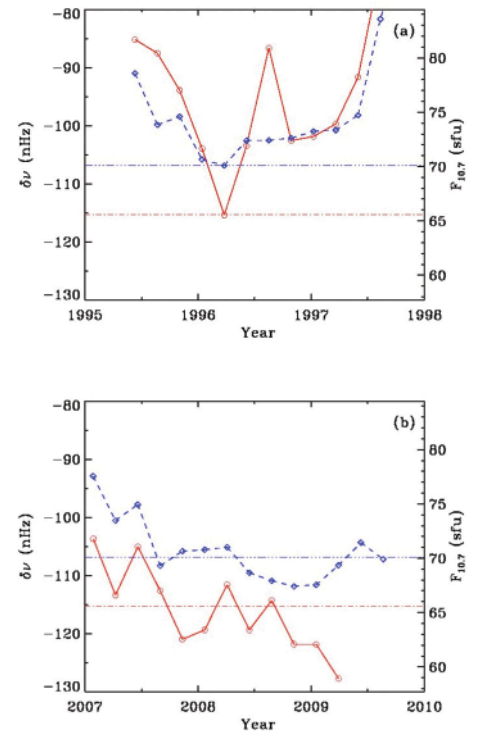


Figure 1: Temporal evolution of GONG frequency shifts (circles) calculated from 72-day time series during the (a) previous cycle (22–23) and (b) current (cycle 23–24) minima of the solar cycle. The diamonds represent the linearly scaled 10.7-cm radio flux ( $F_{10.7}$ ). The symbols have been joined by a line to visualize the solar cycle. The dash-dot and dash-dot-dot-dot lines in both panels of the figure display the minimum value in activity and frequency shifts between the cycle 22–23, respectively. Both  $F_{10.7}$  and frequency are lower this minimum relative to the last; the decrease in mean frequencies and activity are of the order of 11% and 4%. Thus, during the extended minimum phase, the changes in oscillation frequencies are greater as compared to the solar surface activity. This implies that the magnetic variations that cause the frequencies to change are yet to reach the solar surface. (Image credit: Sushant Tripathy.)

## Science Highlight

Sushant Tripathy, Kiran Jain, and John Leibacher have been studying the temporal evolution of the intermediate-degree frequencies during the current peculiar minimum of solar activity. This has been motivated by the recent announcement that the minimum occurred in late 2007 as reported from the analysis of low-degree frequencies from the Global Oscil-

*continued*



## GONG++ continued

lations at Low Frequencies instrument on the Solar and Heliospheric Observatory. Using GONG and Michelson Doppler Imager (MDI) intermediate-degree data, Tripathy et al. find a seismic minimum in MDI data in July–August 2008, but no seismic minimum as of March 2009 in GONG data. In fact, both the GONG and MDI frequencies show a surprising anti-correlation between frequencies and the 10.7-cm radio flux during this minimum, in contrast to the behavior during the previous minimum in 1996–1997. The GONG case is shown in Figure 1. This is another indication that the current minimum is unusual.

### Operations

We are finding anomalous features in the *p*-mode spectra from several of the sites in the form of high temporal frequency streaks at many spatial frequencies. The artifact was first discovered at Mauna Loa, where some of the magnetograms contained artifacts and one of the camera power supply voltages appeared to be unusually noisy. When a spare power supply was installed, the voltage in question was less noisy, and the anomalous features disappeared. Thinking that the solution was at hand, a comparably low-noise power supply was sent from Tucson and installed at Mauna Loa, where the voltage again appeared noisy and the features reappeared. To add a further complication, the original high-noise supply was returned from Mauna Loa and found to have no problems at Tucson. Currently, the low-noise supply is in use at Mauna Loa, and verification that the features are gone is in progress. Big Bear is the only other site with a low-noise supply, and its acoustic spectrum also looks good. The remaining network sites all have anomalous features and higher levels of noise on the supply voltage. So far, swapping the supplies at these sites has not reduced the power supply noise. We have produced spectra from Cerro Tololo since the swaps, and the features are still present there. Several ideas about how to address this problem are being pursued.

### Program News

The first Vector Magnetogram Comparisons Group meeting was held in Tucson, October 27–29. There were 22 participants, includ-

ing 10 from outside NSO. Comparisons were made among data sets from Hinode, Synoptic Optical Long-term Investigations of the Sun, Facility Infrared Spectropolarimeter, and MDI. The major conclusion was that the inversion software used to derive the magnetic field parameters from the data needs substantial improvement.

GONG is participating in a proposed European effort to develop a training program for helio- and asteroseismology known as Helio- and Asteroseismology Training Network (HASTRAN), led by Thierry Appourchaux (Institut d’Astrophysique Spatiale, Orsay). This proposal would provide a number of early-career researchers an opportunity to visit Tucson to learn about the methods of helioseismology.



Figure 2: Pat Eliason (right) passes on the “glue of management” to her successor, George Luis. (Image credit: Olga Burtseva.)

Members of GONG could be involved in the Stellar Observations Network Group (SONG) project, which will build eight telescopes to monitor stellar oscillations and carry out research in asteroseismology. We expect to receive notification soon of the decision on a US SONG proposal that was submitted to the NSF in response to the Major Research Instrumentation-R2 opportunity.

The Solar Dynamics Observatory (SDO) was launched February 1. This is very exciting, as many of the next big advances in helioseismology will come from this mission. We hosted a

Local Helioseismology Comparison (LoHCo) group meeting in Tucson in February.

An unfortunate encounter with an automobile while riding his bicycle home from work on November 24 has left Alan Brockman, our main contact at Learmonth, Australia, in a hospital in Perth. Al was struck by a car driven by a co-worker at Learmonth and suffered substantial injuries. We wish him a speedy recovery and hope that he will return to the job soon. For now, John Kennewell has graciously agreed to return to Learmonth to fill in for Al.

After 12 years, Pat Eliason left the position of GONG Program Manager to undertake the supervision of the Advanced Technology Solar Telescope support building and telescope pier construction. Pat has been a key person in the success of GONG. Her management skills in an ever-changing environment have resulted in the smooth operation of the complex GONG system. She successfully managed the development and deployment of the higher-resolution GONG cameras in 2001 and the upgraded polarization modulators in 2006. More recently, she guided the H $\alpha$  instrument development through to a successful Prototype Design Review. In addition to these major accomplishments, she shepherded GONG from a developmental to an operational structure, oversaw the migration of the data processing system from the Sun/Solaris architecture to a Linux-based environment, participated in every major decision affecting GONG, and smoothly managed the day-to-day functions of the system. She has been very important to the program, and we will greatly miss her advice and counsel.

George Luis stepped into the role of GONG Program Manager on November 1. George had been the senior engineer for GONG for several years, and has intimate knowledge of the instrument and operations of the network. George will be an excellent Program Manager, and he will continue the tradition of excellence in GONG. In turn, Dave Dryden was appointed as the leader of the GONG engineering team.

We had a celebration on November 4 to honor Pat’s contributions and to wish her all of the best (Figure 2). ☼





# Old Wisdom and New Insight

Kevin Reardon, Alexandra Tritschler & Han Uitenbroek

The solar chromosphere has been an important area of study at Sacramento Peak since the founding of the observatory. In the 1960s and 1970s, key research in the field was carried out using the Evans Solar Facility and later the Dunn Solar Telescope (DST). Important discoveries such as the three-minute oscillations of the chromosphere, umbral flashes above sunspots, and the characteristics of solar spicules were made there.

So, it was especially appropriate that a meeting dedicated to this topic was held in Sunspot, New Mexico 1–4 September 2009. The meeting, the 25<sup>th</sup> in the Sac Peak Summer Workshop series, was entitled “Chromospheric Structure and Dynamics: Old Wisdom and New Insight.” With more than 70 attendees from 15 countries, this was one of the larger workshops ever hosted by NSO at Sunspot. Drawing these attendees were talks and discussions about an area in solar physics rapidly attracting renewed interest. The chromosphere of the solar atmosphere plays a key role as the interface between the photosphere and corona, essentially controlling the propagation of matter and energy upward to form the corona and solar wind.

The focus of the meeting was on the physical processes that govern the formation and behavior of the chromosphere on small scales. Sessions covered the chromosphere above both quiet and active regions, prominences, and the measurement of chromospheric magnetic fields. A final session covered the connection between the chromosphere and corona. Notable in all of these was the strong connection between observational advances and the development of increasingly realistic numerical simulations. Combined, these two approaches hold much promise for untangling the physics in this highly structured region of the atmosphere.

During the meeting, review talks were given by Phil Judge, Tom Ayres, Rob Rutten, Judy Karpen, Javier Trujillo Bueno, Hardi Peter, and Franz Kneer. Ample time was left following these speakers, as well as the other 35 talks,



Attendees of the 25<sup>th</sup> NSO/Sac Peak Summer Workshop “Chromospheric Structure and Dynamics: Old Wisdom and New Insight.” (Image credit: David Dooling, NSO.)

to allow for lively discussion. Jacques Beckers, one of the NSO scientists involved in much of the groundbreaking research in the field in the 1960s and 1970s, gave a wrap-up talk at the conclusion of the workshop.

As studies of the solar chromosphere enter an exciting new period of discovery, NSO looks to continuing to play a key role in the field. “What’s interesting,” says Dr. Stephen Keil, NSO director, “is that, while we are using the same telescopes as before, we are still able to perform cutting-edge science in this field because of the upgraded suite of modern instruments.” The DST, outfitted with a high-order adaptive optics (AO) system, has a cutting-edge suite of instruments for chromospheric studies, including the Interferometric Bidimensional Spectrum (IBIS), the Spectropolarimeter for Infrared and Optical Regions (SPINOR), the Facility Infrared Spectropolarimeter (FIRS), and the Rapid Oscillations in the Solar Atmosphere (ROSA),

while the Evans coronagraph hosts the ProMag spectropolarimeter. All of these instruments now provide information on the fine details of the solar atmosphere with high spectral and temporal resolution, essential for understanding the complex dynamics of the chromosphere. The workshop organizers were Alexandra Tritschler (NSO), Kevin Reardon (Istituto Nazionale di Astrofisica), and Han Uitenbroek (NSO). The local NSO staff, including Donell Long, Rebecca Coleman, Jackie Diehl, Ramona Elrod, and Lou Ann Gregory, among many others, all contributed to making everything run smoothly. Financial support for the meeting was provided by NSO, the NSF Division of Astronomical Sciences, the NASA Heliospheric Physics Division, and the European Space Agency. With a portion of this funding, travel support was provided for 15 doctoral students or postdocs to attend the meeting.