>>>NOAO/NSO Newsletter

NATIONAL OPTICAL ASTRONOMY OBSERVATORY/NATIONAL SOLAR OBSERVATORY
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Science Highlights

Director's Office

NOAO Gemini Science Center

Observational Programs

Science Data Management

Cerro Tololo Inter-American Observatory

Kitt Peak National Observatory

National Solar Observatory

Education & Public Outreach

Publication Notes

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

focus on>>>

Recent Staff Announcements at NOAO

NOAO Diversity Advocates: NOAO is pleased with recent staff promotions into areas that will continue to strengthen our ties to the astronomical and public communities. In January, Drs. Katy Garmany and Dara Norman were appointed as Advocates for Diversity at NOAO. Their role as advocates is part of an AURA initiative to establish advocates at all of the AURA centers. In the near term, Katy and Dara will work with the NOAO director's office on staff recruitment, retention, and work climate of individuals from underrepresented groups. Longer-term goals include working on broadening participation in the NOAO science enterprise among individuals, groups, and geographic regions which have been underrepresented or not involved in NOAO programs in the past. This activity is part of a larger AURA plan to respond to the recent report from the NSF entitled "Broadening Participation at the National Science Foundation: A Framework for Action." The NSF report is available on the NSF Web site at: *www.nsf.gov/od/broadeningparticipation/bp.jsp*

AURA Head of Mission in Chile: AURA announced on January 21 that CTIO Director Chris Smith will be the new Head of Mission for AURA facilities in Chile including CTIO, Gemini, and SOAR. Quoting from the AURA announcement: "The Head of Mission is the primary representative in Chile for AURA and all units operating or wishing to operate on it's [sic] property. These units include National Optical Astronomy Observatory (Cerro Tololo Inter-American Observatory), Gemini South, and Southern Observatory for Astronomical Research and such other observatory operations functioning under the auspices of AURA in Chile. He will also be responsible for all diplomatic matters and the point of contact with all Chilean governmental authorities, the Union and Chilean institutions." At the same time that we congratulate Chris on this appointment, we thank out-going Head of Mission Dick Malow for all his efforts in supporting AURA's missions in Chile and specifically his work on behalf of NOAO and CTIO.

Education and Public Outreach: NOAO is very pleased that Dr. Stephen Pompea has agreed to head the newly re-organized program for Education and Public Outreach. Besides being an outstanding scientist, Steve is an expert in the field of science education and has led a number of successful education and outreach projects while at NOAO. This year, Steve is heading a major effort as the principal investigator of the US International Year of Astronomy (IYA) grant from NSF. A centerpiece of the IYA effort (*www.noao.edu/iya-noao.php*) is a high-quality, low-cost telescope, designed by Steve and collaborators, to bring the wonders discovered by Galileo to the widest possible audience.

Science Data Management: The NOAO Data Products Program (DPP) was recently reorganized (see the December 2008 *Newsletter*) into the Science Data Management (SDM) Program. In addition to her previous role as Program Manager, Betty Stobie has taken on the role of Interim Head of Program for SDM. NOAO has appointed CTIO astronomer Chris Miller as the SDM Program Scientist. Chris arrived at CTIO in 2004 and has been working on the NOAO NVO portal, a Web-based tool to access NOAO and related science data sets. Chris and Betty will be developing and implementing a new program plan for NOAO's data capture, science pipeline, and software tools team. We are confident Betty, Chris, and their group will meet the challenges and opportunities that lie ahead for SDM.

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On the Cover

Technologies to resolve and measure the Sun's magnetic fields and how they control the solar atmosphere will be brought together in the planned 4-meter Advanced Technology Solar Telescope (ATST). Its optical system has an unobstructed view that minimizes scattered light, alleviates thermal issues, and can probe the relatively unexplored infrared region, as well as observe both solar disk and corona. A high-order adaptive optics system—several times more powerful than that of any now in use for solar physics—will make ATST possible. Self-induced seeing effects are controlled by features such as a dome, shaped and louvered to smooth airflow around it, and an air handling system to direct flows from ceiling to floor to control dust and turbulence.

ATST will provide unprecedented views of solar magnetic structure and activity. Solving this "dark energy" problem of solar physics lies beyond the capabilities of current solar telescopes. These answers will become the key to understanding solar variability and its direct impact on Earth. ATST will use the Sun as a stellar laboratory in our astrophysical backyard where crucial properties of magnetic plasma can be observed and understood, and models can be tested and refined.

Image credit: LeEllen Phelps, NSO/AURA/NSF

>>>SCIENCE HIGHLIGHTS
NOAO/NSO

Introduction

NOAO is actively developing a broader "System" of telescope access to satisfy observers' needs for a diverse set of facilities and capabilities. The science highlights chosen for this *Newsletter* issue illustrate that kind of diversity:

- Søren Meibom's article on measuring stellar ages was made possible by a unique service observing opportunity at the WIYN 0.9-meter telescope, combined with spectroscopy from the WIYN 3.5-meter telescope;
- Howard Bond's work uses such diverse facilities as an amateur 12-inch telescope, the SMARTS Consortium 1.3-meter and 1.5-meter telescopes, and the Hubble Space Telescope;
- David Yong needed the Phoenix infrared spectrograph, originally deployed at the NOAO 4-meter telescopes, but now at Gemini;
- Laura Magrini's study was enabled through the Telescope System Instrumentation Program access to the MMT; and
- Todd Boroson's and Tod Lauer's analysis demonstrates the power of digging through large data sets from the Sloan Digital Sky Survey, representing a forward look to the kind of algorithms that will become common in the era of much larger data sets such as those that will be produced by the Large Synoptic Survey Telescope.

– George Jacoby

Stellar Ages from Stellar Rotation

Søren Meibom (Harvard-Smithsonian Center for Astrophysics)

Introduction

As part of the WIYN Open Cluster Study (WOCS), my collaborators R. Mathieu (University of Wisconsin), K. Stassun (Vanderbilt University), and I have obtained extensive time-series radial-velocity observations and highly precise time-series photometric observations of late-type stars in the 150 Myr and 200 Myr open clusters M35 (NGC 2168) and M34 (NGC 1039). When combined, these data sets allow us to distinguish cluster membership and binarity in the clusters, and to derive rotation periods. The collection of the survey data was made possible with generous telescope time allocations through NOAO and University of Wisconsin–Madison; the photometric program relied heavily on queue-scheduled observations taken by a long list of WIYN 0.9-m telescope observers (the author gives a big thank you to them all).

Our objective was to learn about the rotational evolution of single stars and stars in close binaries, and how this evolution depends on the stellar mass in clusters with different ages. Stellar rotation, and its dependence on stellar age and mass (color), has recently come to the fore as a distance-independent indicator of age ("gyrochronology;" Barnes 2003a, 2007). However, our ability to determine stellar ages from measurements of stellar rotation hinges on how well we can measure the dependence of rotation on age for stars of different masses. For that purpose, rotation periods for stars in open clusters are essential.

Knowing stellar ages is fundamental to understanding the time-evolution of astronomical phenomena related to stars and their companions. Accordingly, over the past decades much work has been focused on identifying the properties of a star that best reveal its age. For coeval populations of stars in clusters, the most reliable ages are determined by fitting model isochrones to single cluster members in the color-magnitude diagram. However, for the vast majority of stars not in clusters (e.g., unevolved, late-type field stars), ages determined using the isochrone method are highly uncertain because the primary age indicators are nearly constant throughout their main-sequence lifetimes, and because their distances and thus luminosities are poorly known. Therefore, finding a distance-independent property of individual stars that can act as a reliable determinant of their ages is extremely valuable.

Stellar rotation has been demonstrated to be a promising and distance-independent indicator of age (Skumanich 1972; Kawaler 1989; Barnes 2003a, 2007). Skumanich (1972) first established stellar rotation as an astronomical clock by relating the average projected rotation velocity in young open clusters to their ages. The Skumanich relation is limited in mass to early G dwarfs and suffers from the ambiguity of the v-sin(i) data. Furthermore, for ages beyond that of the Hyades cluster (625 Myr), the Skumanich relationship is constrained only by a single G2 dwarf—the Sun.

Modern photometric time-series surveys in young, open clusters can provide precisely measured stellar rotation periods (free of the sin(i) ambiguity) for F, G, K, and M dwarfs. Based on such new data and emerging empirical relationships between stellar rotation, color, and age, a method was proposed by Barnes (2003a) to derive ages for late-type dwarfs from observations of their colors and rotation periods alone. (See Barnes 2003a for a description of the method of gyrochronology.)

The Key Role of Open Clusters

Open clusters are coeval populations of stars with a range of masses and well-determined ages, and, therefore, fulfill a critically important role in calibrating the relations between stellar age, rotation, and color. Indeed, open

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Stellar Ages from Stellar Rotation continued

clusters can define a surface in the three-dimensional space of stellar rotation period, color, and age, from which the latter can be determined from measurements of the former two (see figure 1 to the right).

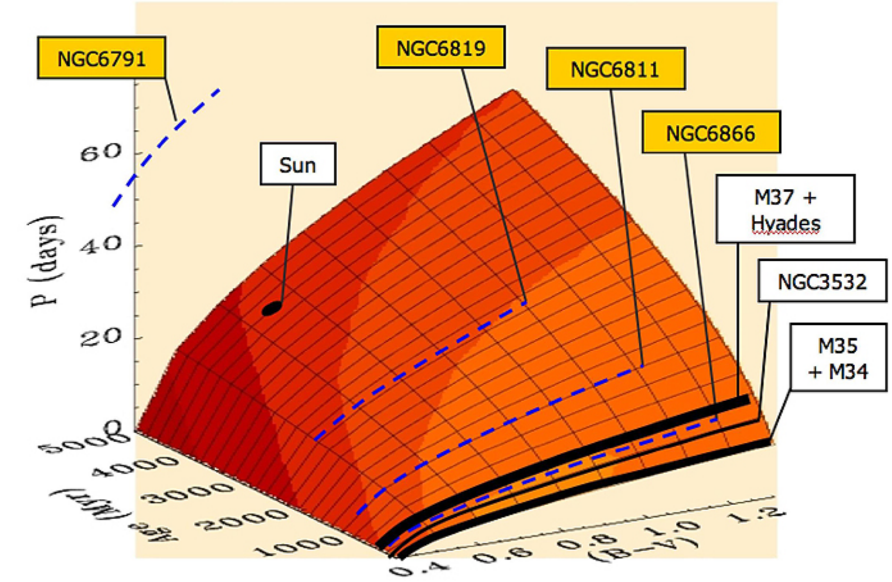

Figure 1: A schematic of the (presumed) empirical surface in the three-dimensional parameter space of stellar age (Myr), color (mass), and rotation period. The surface is currently defined only by stars in young open clusters (black solid lines) and by the Sun (black dot). The dashed blue lines mark the ages and approximate color ranges of FGK dwarfs in the four open clusters within the Kepler field.

This inherent quality of open clusters can only be fully exploited if precise stellar rotation periods (free of the sin(i) ambiguity) are measured for cluster members. Accordingly, the time baseline and frequency of time-series photometric observations must be long enough and high enough, respectively, to avoid a bias against detecting periods of more slowly rotating stars, and to avoid detection of false rotation periods due to aliases and a strong "window-function" in the data. Furthermore, measured rotation periods must be considered in combination with cluster membership and multiplicity data. Removing non-members and stars in close binaries affected by tidal synchronization improves the definition of the relationship between rotation period and color at the age of the cluster. Also, identification of single cluster members improves cluster age determinations from isochrone fitting. Our new results for the open clusters M35 and M34 shown in figure 2 reflect the powerful combination of decade-long, time-series spectroscopy for cluster membership and time-series photometry over five months for stellar rotation periods.

The Color-Period Diagram

Figure 2 shows the rotational periods for members in M35 and M34 plotted against their de-reddened (B-V) colors. The coeval stars fall along two well-defined sequences representing two different rotational states. One sequence displays a clear correlation between rotation period and color, and forms a diagonal band of stars whose periods are increasing with increasing color index (decreasing mass). The second sequence consists of rapidly rotating stars and shows little mass dependence. A small subset of stars is distributed between the two sequences. The distribution of stars in the color-period diagrams suggests that the rotational evolution is slow where we see the sequences and fast in the gap between them. Other areas of the color-period plane are either unlikely or "forbidden."

The Dependence of Stellar Rotation Period on Color

For our purpose of determining the dependence of stellar rotation on stellar color, we can focus on the diagonal sequence of more slowly rotating stars in figure 2. We can do so because surveys for stellar rotation in the older clusters M37 (550 Myr) and the Hyades (625 Myr) show that F, G, and K dwarfs spin down over a few hundred million years and converge onto this sequence.

Barnes (2003a, 2007) refers to the diagonal sequence as the Interface (I) sequence and proposes a function to represent it. From the method of gyrochronology, the functional dependence between stellar color and rotation period will directly affect the derived ages and will, if not accurately determined, introduce a systematic error. It is therefore important to constrain and test the color-rotation relation for stars on the I sequence as new data of sufficiently high quality become available. In Meibom et al. (2009), we fit the function suggested by Barnes (2007) to the I sequence stars in M35, leaving all coefficients as free parameters. We get nearly the same

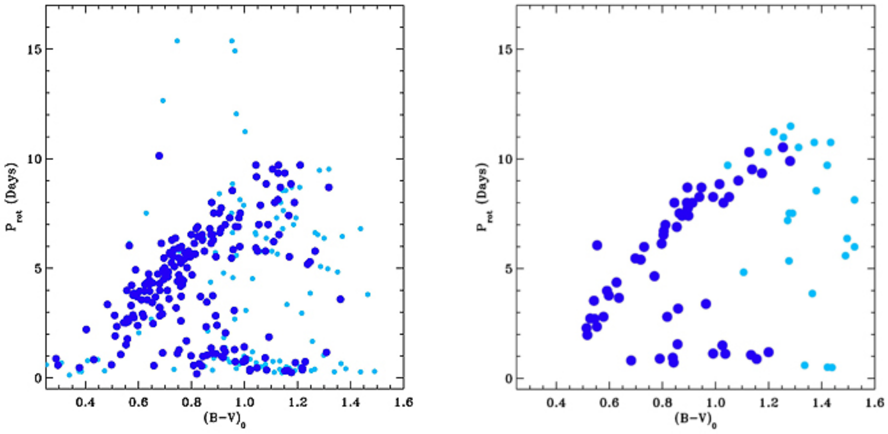

Figure 2: The distribution of stellar rotation periods with (B-V) color index for 310 members of the open cluster M35 (left) and 79 members of the open cluster M34 (right). Dark blue (black) plotting symbols are used for radial-velocity members and light blue (grey) for photometric members.

continued

Stellar Ages from Stellar Rotation continued

coefficients, but by leaving the translational term free, we find a value of 0.47, which corresponds to the approximate (B-V) color for F-type stars at the transition from a radiative to a convective envelope. This transition is also associated with the onset of effective magnetic-wind breaking (Schatzman 1962) and is known as the break in the Kraft curve (Kraft 1967). The value of 0.47 suggests that for M35 the high-mass end of the I sequence begins at the break in the Kraft curve. The I sequence in M34 is particularly well-defined and will be used to further constrain the dependence between rotation and color in a forthcoming paper (Meibom et al. 2009, in preparation).

The Dependence of Stellar Rotation Period on Age

With well-defined color-rotation relations (I sequences) for clusters of different ages, we are able to constrain the dependence of stellar rotation on age for stars of different masses. By comparing the rotation periods for F-, G-, and K-type I-sequence dwarfs at different ages, we can make a direct test of the Skumanich relationship for early G dwarfs and for dwarfs of higher and lower masses.

When this test is applied to G and K dwarfs on the I sequences in M35 and the Hyades, the Skumanich time-dependence can be shown to account for the evolution in rotation periods of G dwarfs in these clusters. However, the time-dependence for spin-down of K dwarfs is slower than the Skumanich relation (Meibom 2009). In a more in-depth analysis, preliminary results of a comparison of the mean rotation periods of late-F, G, early-K, and late-K I-sequence dwarfs in M35, M34, NGC 3532 (Barnes 2003a; 300 Myr), M37, and the Hyades, show that age is consistent with Skumanich spin-down for the late-F and G dwarfs, but the K dwarfs spin down significantly slower (Meibom et al. 2009, in preparation).

The Kepler Mission—A Special Opportunity

At the present time, the Hyades represents the oldest coeval population of stars with measured rotation periods. Measurements of rotation periods for older, late-type dwarfs are needed to properly constrain the dependence of stellar rotation on age and mass, and to calibrate the technique of gyrochronology. Figure 1 shows a schematic of the surface in the three-dimensional space of rotation, color, and age. At the present time, this surface is defined solely by color-period data in young clusters and for the Sun. The solid black curves represent the ages and color-ranges of FGK dwarfs in M35, M34, NGC 3532, M37, and the Hyades. The color and age of the Sun is marked as a solid dot. The figure demonstrates clearly the need for observations of stellar rotation periods beyond the age of the Hyades.

The lack of periods for older stars (with the exception of the Sun) reflects the challenging task of measuring from the ground the photometric variability for slowly rotating stars with ages of 1 Gyr or more. However, the Kepler space telescope (scheduled for a 2009 launch) will provide photometric measurements with a precision, cadence, and duration sufficient to measure stellar rotation periods from brightness modulations for stars that are even older than the Sun. Four open clusters are located within the Kepler target region: NGC 6866 (0.5 Gyr), NGC 6811 (1 Gyr), NGC 6819 (2.5 Gyr), and NGC 6791 (~10 Gyr). With Kepler, we have a unique opportunity to extend the age-rotation-color relationships beyond the age of the Hyades and the Sun. ⓃⓁ

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Luminous Transients in Nearby Galaxies

Howard E. Bond, Luigi R. Bedin, Alceste Z. Bonanos (STScI),
Roberta M. Humphreys (University of Minnesota), Berto Monard (Bronberg Observatory),
Jose L. Prieto (Ohio State University) & Frederick M. Walter (Stony Brook University)

The outbursts of classical novae (CNe) and supernovae (SNe) have been known to astronomers for decades. More recently, stellar eruptions with luminosities intermediate between CNe and SNe and outburst time scales of a few months are being discovered in increasing numbers. This is the result of surveys for transients by professional and amateur observers that are reaching greater depths and sky coverage. These new types of outbursts are posing new challenges to our understanding of late stages of stellar evolution.

The term "supernova impostors" was introduced by Van Dyk et al. (2000) following the outburst of SN 1997bs. Although superficially resembling a narrow-lined Type IIn SN in spectrum and light curve, the SN 1997bs event reached an absolute magnitude at maximum more than 3 mag fainter than a typical core-collapse SN. Van Dyk et al. argued that SN 1997bs was instead a "superoutburst" of a massive, luminous blue variable (LBV), analogous to those experienced historically by the Galactic objects P Cygni and eta Carinae.

The recent outburst of SN 2008S, which had a SN IIn spectrum but only reached an absolute magnitude of -14, has been discussed by Thompson et al. (2008) and Smith et al. (2008). Remarkably, Prieto et al. (2008) used archival Spitzer images to show that the progenitor of SN 2008S was a luminous infrared star, deeply enshrouded in circumstellar dust, and thus dissimilar to the LBVs P Cyg and eta Car.

V838 Monocerotis (V838 Mon) belongs to an apparently separate class of transients also lying in the CN-SN gap. Its 2002 eruption, discovered by an amateur, illuminated a spectacular light echo (Bond et al. 2003) that yielded a geometric distance to the star (Sparks et al. 2008). Unlike a CN, V838 Mon became progressively redder during

continued

Luminous Transients in Nearby Galaxies continued

its outburst. Its light curve was very different from that of a SN, CN, or LBV eruption, showing a series of four maxima separated by about a month each. It has been proposed that the outburst of V838 Mon was due to a stellar merger or collision. Possible extragalactic analogs of V838 Mon include the 1988 outburst of a luminous red object in the Andromeda galaxy—denoted the M31 red variable, or "M31 RV" (Bond & Siegel 2006)—and a luminous red transient in the Virgo galaxy M85 in 2006 (Kulkarni et al. 2007).

We describe observations of a new, luminous transient discovered in May 2008 in the nearby Southern Hemisphere galaxy NGC 300. Our results serve to illustrate the broad wavelength coverage now available to ground- and space-based observatories, the contributions of amateur astronomers, and the power of the quick response and synoptic capabilities of the telescopes in the Small and Medium Aperture Research Telescope System (SMARTS) at NOAO's Cerro Tololo Inter-American Observatory (CTIO).

The NGC 300 optical transient (NGC 300 OT) was discovered by the amateur member of our team, Berto Monard, during his SN search program at his private 0.3-m observatory in South Africa. NGC 300 is a spiral galaxy in the Sculptor Group, lying just outside the Local Group at a distance of 1.9 Mpc. A normal SN in this galaxy would peak brighter than 10th mag. At discovery, however, the NGC 300 OT was only at 14.3 mag.

Because of our interest in luminous transients, we immediately began a program of photometric and spectroscopic monitoring of the NGC 300 OT, using the 1.3-m and 1.5-m telescopes at CTIO operated by the SMARTS consortium (*www.astro.yale.edu/smarts*).

The Chilean service observers employed by SMARTS can respond very quickly to target-of-opportunity requests. Thus, within a day of its announcement on the Central Bureau for Astronomical Telegrams (CBAT) Unconfirmed Observations Page, we obtained the first spectrum (Bond et al. 2008) of the NGC 300 OT, shown at the top of figure 1. This remarkable spectrum exhibits strong emission at Hα, Hβ, and the Ca II triplet at 8542-8498-8662 Å. Most surprisingly, it has strong emission at the unusual forbidden [Ca II] doublet at 7291-7323 Å. These are superposed on an F-type supergiant absorption spectrum. Overall, the low-excitation spectrum is indicative of an optically thick wind or envelope, slowly expanding away from the site of the outburst. We continued the spectroscopic monitoring throughout 2008; by August, as shown in figure 1, the continuum had faded but the emission lines continued to be strong.

Since the spectrum of the NGC 300 OT was somewhat similar to that of V838 Mon at a comparable stage in its outburst, we also began a program of photometric monitoring, in anticipation of detecting periodic spikes like those of V838 Mon. These observations are being done with the SMARTS 1.3-m telescope and its ANDICAM camera, which obtains simultaneous optical and near-infrared (IR) images using CCD and IR detectors. Figure 2 shows the light curve up to the present. As it turned out, the light curve of the NGC 300 OT did not show any spikes, but instead declined smoothly, superficially resembling a SN but at a considerably lower luminosity. The rise to maximum was not well covered, but was clearly more rapid than the subsequent decline. The NGC 300 OT has become steadily redder as it fades.

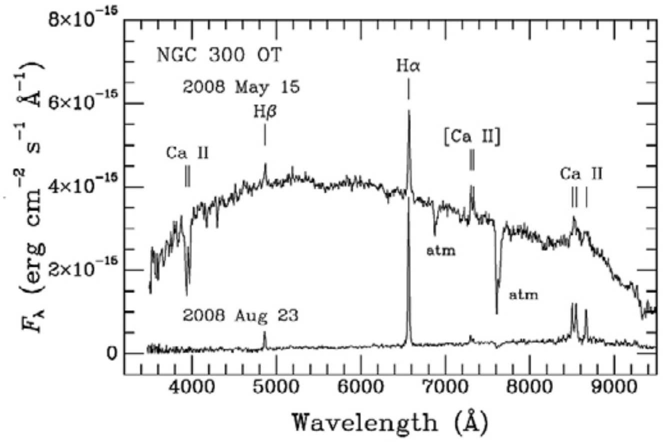

Figure 1: Low-resolution SMARTS 1.5-m spectra of the NGC 300 OT on 15 May and 23 August 2008. In the May observation, note strong emission lines of H, Ca II, and [Ca II] superposed on an F-type absorption spectrum. By August, the continuum had faded dramatically and the spectrum was dominated by emission lines.

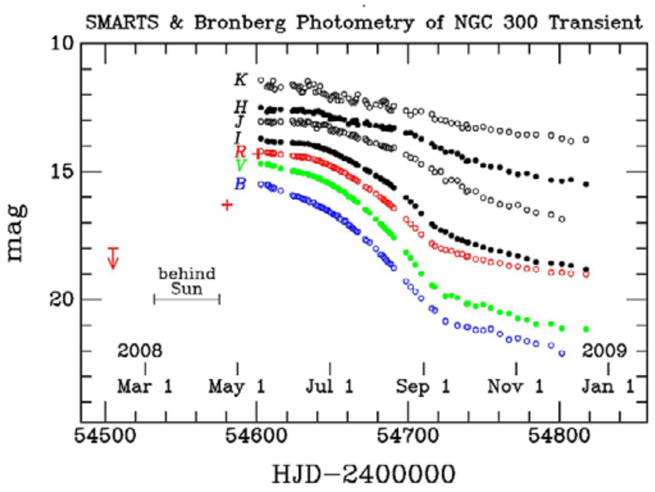

Figure 2: BVRIJHK light curve of the NGC 300 OT. SMARTS 1.3-m telescope data are shown as open and filled circles. Monard's Bronberg 0.3-m discovery observations and a pre-discovery detection are shown as crosses, and the downward arrow on the left shows Monard's upper limit in February 2008.

There are deep archival Hubble Space Telescope (HST) images of NGC 300, taken before the outburst. The HST images reveal an extremely rich field of resolved stars at the OT site, lying in a spiral arm of NGC 300. In order to localize the OT with high astrometric precision, we obtained new HST images of the outburst site with the WFPC2 camera in June 2008. To our surprise, there is no progenitor object detected in the archival HST images to a limit of V magnitude 28.5.

However, a luminous star *is* present at the OT location in archival Spitzer images obtained in 2003 and 2007, as first reported by Prieto (2008). This source is detected throughout the mid-IR, from 3.6 to 24 microns, with a black-body fit giving a temperature of 350 K, an enormous radius of 300 AU, and a luminosity of 5.5 x 10^4 $L_\odot$.

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Luminous Transients in Nearby Galaxies continued

These observations are consistent with the progenitor being an evolved supergiant of about 10–15 $M_{\odot}$, heavily enshrouded in a surrounding dust shell that blocked the optical light and reprocessed it to the mid-IR. This optically hidden star then underwent a sudden outburst that evaporated most of the surrounding dust. The exact nature of the outburst, however, remains unknown: it may have been some type of as-yet unexplained failed SN, a photospheric eruption of an uncertain origin, or, as suggested by Berger et al. (2009), a violent binary interaction.

This new type of stellar eruption may not be uncommon, as illustrated by two very similar events (SN 2008S and NGC 300) occurring in the same year. The forthcoming synoptic surveys, including Pan-STARRS and LSST, are likely to reveal many new examples.

Details of our observations are given in Bond et al. (2009).

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Chemical Abundances in the Tidally Disrupted Globular Cluster NGC 6712

David Yong (ANU), Jorge Meléndez (Centro de Astrofísica de Universidade do Porto),
Katia Cunha (NOAO), Amanda Karakas, John Norris (ANU) & Verne Smith (NOAO)

Globular clusters are the oldest Galactic objects for which reliable ages can be obtained and have long been regarded to be the first bound systems to have formed in the protogalactic era. As such, they have witnessed the subsequent formation and evolution of our Galaxy. However, were globular clusters innocent bystanders to the chaotic hierarchical assembly of our Galaxy, or were they active, albeit presumably minor, participants? After all, some contend that all field stars were born in clusters.

Spectacular tidal tails associated with the globular clusters Palomar 5 and NGC 5466 have been revealed by the Sloan Digital Sky Survey. Therefore, these tidally disrupted clusters are currently contributing stars to the disk and halo. For both clusters, additional evidence for tidal stripping comes from their flat mass functions, which reveal significant depletions of low-mass stars presumably stripped by the Galactic tidal field.

Detailed chemical abundances place strong constraints upon the fraction of field stars that may have been born in globular clusters and/or the types of globular clusters that may populate the disk and halo. Every well-studied Galactic globular cluster, including Palomar 5 (Smith et al. 2002), has large star-to-star abundance variations for the light elements from C to Al. Within a given cluster, the abundances of C and O are low when N is high, O and Na are anticorrelated, as are Mg and Al. While hydrogen burning at high temperatures can explain these abundance patterns, the source of the nucleosynthesis and the nature of the pollution mechanism remain unknown. Nevertheless, these abundance patterns have yet to be found in field stars. The discovery of a tidally disrupted globular cluster in which there are no light element abundance variations would open the possibility that clusters could have played a considerable role in building up our Galaxy.

NGC 6712 is the only globular cluster whose mass function actually decreases with decreasing mass (Paresce & De Marchi 2000). With an orbit penetrating deep into the bulge, tidal forces have stripped away a substantial fraction of low-mass stars. Due to the high reddening, chemical abundances for this cluster are best obtained at near infrared wavelengths. In this study, we obtained high-resolution H-band and K-band spectra using the Phoenix spectrograph on Gemini-South (see figure 1). From these spectra, we measured the relative abundances of C, N, O, F, Na, and Fe (Yong et al. 2008).

We assume that observing cluster giants is equivalent to observing giants in the tidal tails, thus, we can probe the compositions of tidally stripped stars. Even within our small sample of seven bright giant stars, we found large abundance variations for C, N, O, F, and Na (see figure 2). Such patterns are not found in field stars, therefore, clusters like NGC 6712 and Palomar 5 cannot provide many field stars, and/

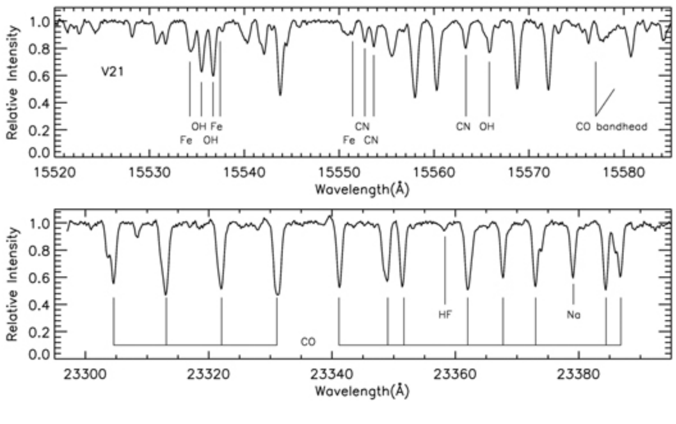

Figure 1: Spectra of NGC 6712 V21 for the two wavelength regions. Lines used in the abundance analysis are indicated.

continued

Chemical Abundances in NGC 6712 continued

or field stars do not form in environments with chemical enrichment histories like those of NGC 6712 and Palomar 5.

NGC 6712 is only the second cluster in which F has been observed in more than two stars and both clusters show F abundance variations, which may be produced in AGB stars with masses > 5 $M_{\odot}$ (Smith et al. 2005). The fluorine abundances in globular clusters are considerably lower than in field and bulge stars at the same metallicity (see figure 3), which highlights additional chemical differences between the field and cluster environment. In the context of trying to identify the source of the light element abundance variations, our study has reinforced the importance of accounting for F (this element shows the largest abundance variation amplitude of all elements measured in this cluster).

Finally, the chemical abundances measured in this cluster offer the intriguing prospect of allowing us to estimate its initial mass, and therefore, the fraction of mass lost through tidal stripping. Carretta (2006) found a correlation between the amplitude of the abundance variations and the absolute magnitude. Based on the abundance amplitudes, we tentatively confirm the calculations by Takahashi & Portegies Zwart (2000), which indicate that NGC 6712 was once one of the most massive clusters to have formed in our Galaxy.

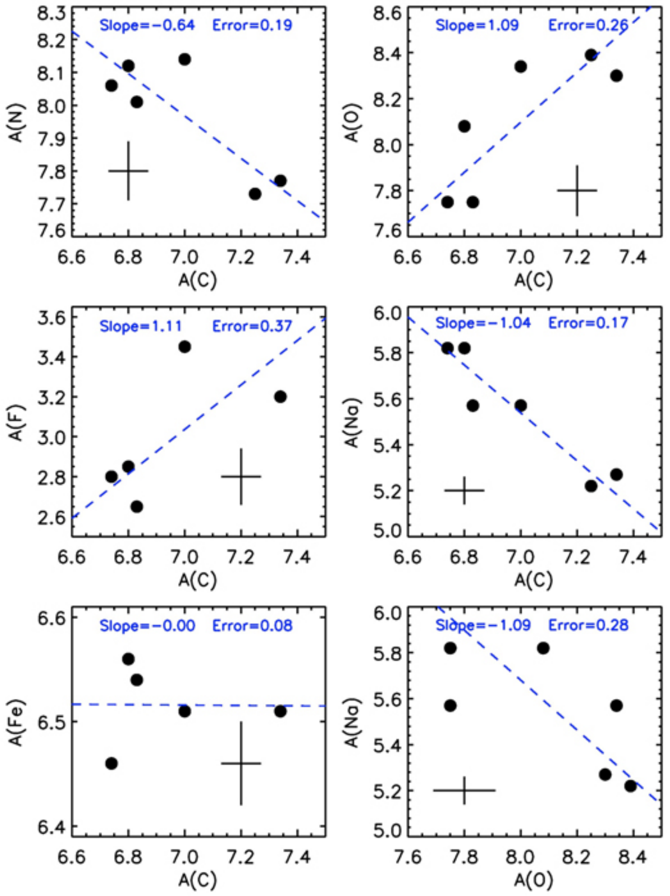

Figure 2: Elemental abundances A(X) vs. A(C) as well as A(Na) vs. A(O) (bottom right panel). A representative error bar is shown. The dashed line is the linear least-squares fit to the data (slope and associated error are included).

Of great interest would be the chemical analysis of additional globular clusters that show evidence for tidal disruption to search for a cluster in which there are no light element abundance variations. Equally important would be to expand the search for field stars that exhibit the "globular cluster light element abundance patterns." These endeavors will enhance our understanding of the formation and evolution of our Galaxy.

I wish to thank my long-time collaborators David Lambert and Frank Grundahl.

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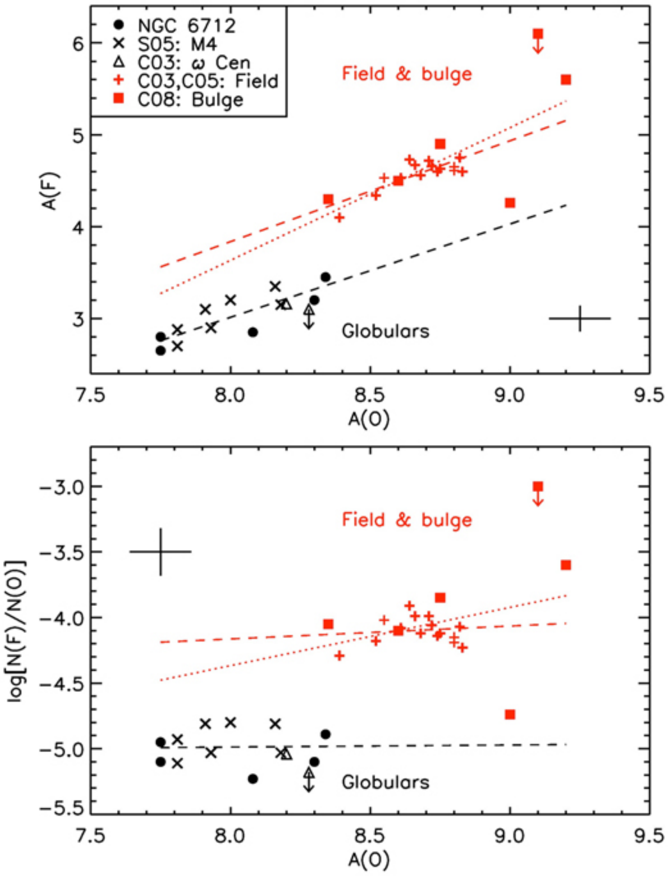

Figure 3: A(F) vs. A(O) (top) and log[N(F)/N(O)] vs. A(O) (bottom). NGC 6712 (black circles), M4 (black crosses: Smith et al. 2005), ω Cen (black triangles: Cunha et al. 2003), bulge stars (red squares: Cunha et al. 2008), and field stars (red plus signs: Cunha et al. 2003; Cunha & Smith 2005) are shown. A representative error bar is shown. The red and black dashed lines are the linear least-squares fits to the field & bulge and globular cluster data, respectively (excluding upper limits). The dotted red line is the fit to the field & bulge data excluding the upper limits and the bulge star with A(O) = 9.0.

The Planetary Nebula View of M33:
A Deep Spectroscopic Study with Hectospec

Laura Magrini (INAF), Letizia Stanghellini (NOAO) & Eva Villaver (STScI)

M33 (NGC 598) is a spiral galaxy whose closeness (840 kpc, Freedman et al. 1991), optical size (53' × 83', Holmberg 1958), and inclination (i = 53°) allow detailed studies of its stellar populations and ionized nebulae.

Planetary Nebulae (PNe) and HII regions represent two very different formation ages, and the comparison of these two populations provides insight to the chemical evolution of the host galaxy. Planetary nebulae are the final ejecta of evolved low- and intermediate-mass stars (LIMS) with masses between 1 and 8 $M_\odot$, which must have formed between 3×10^7 yr and 10 Gyr ago (Maraston 2005), while HII regions belong to a very young population.

During their evolution, LIMS do not modify the composition of the several elements that derive from the nucleosynthesis of Type II supernovae, such as oxygen, neon, argon, and sulfur—the so-called α-elements. Nucleosynthetic activity involving α-elements has been observed only in the lowest metallicity environments (Leisy and Dennefeld 2006; Magrini et al. 2005; Kniazev et al. 2008); evolutionary models confirm that at the metallicity of M33 one does not expect LIMS either to produce or destroy the α-elements (Marigo 2001). Thus, the observation of α-elements in PNe allows a measurement of the original metallicity of the interstellar cloud that gave birth to the LIMS.

On the other hand, the helium, nitrogen, and carbon abundances that we measure in PNe do not correspond to those at the time of the progenitor's formation, because these elements are synthesized in LIMS as well as in massive stars. These elements provide information about LIMS evolution as a function of their initial mass and metallicity, and, for a given metallicity, help to constrain the PN progenitor mass and age. The advantage of M33 compared to the Galaxy as a target for metallicity studies is that PNe in M33 have well-determined galactocentric distances, whose relative errors are <5%, much smaller than the large uncertainties of Galactic PNe distances (Stanghellini et al. 2008). In addition, the small inclination and the low reddening of M33 allow us to investigate the PNe population (and other stellar populations) across the whole radial range.

One of the most discussed issues in this field is the rate of evolution of the metallicity gradient in disk galaxies with time. Chemical evolution models predict different temporal behaviors of the metallicity gradient, depending on the assumptions one makes for gas inflow and outflow rates, and the star and cloud formation efficiencies. Observations are needed to constrain these assumptions, but so far they have been insufficient, especially for the old populations of PNe. Comparing different sets of results for the young and old stellar populations, such as HII regions and old stars, is also delicate, because the techniques of observing and analyzing nebulae and stars are very different, each with its own collection of uncertainties.

The motivation for our observations is to study the chemical and physical properties of a large number of PNe and HII regions in M33, using the same observational procedures, the same data reduction and analysis techniques, and identical abundance determination methods, to avoid the biases due to the stellar versus nebular analysis. The aim was to derive abundances of the α-elements for as many PNe and HII regions as possible, and to study the variation of the metallicity gradients and the average abundances in M33 as compared with the Galaxy and other galaxies.

In semester 2007B, we observed ~150 ionized nebulae in M33 in multi-object spectroscopic mode with the MMT Hectospec fiber-fed spectrograph (Fabricant et al. 2005), with a 270 mm^{-1} grating at a dispersion of 1.2 Å pixel^{-1}. The instrument deploys 300 fibers over a field of view 1° in diameter; the fiber diameter is 1″ (4 pc using a distance of 840 kpc to M33). The 102 PNe were selected from the catalog by Ciardullo et al. (2004), and include four PNe at large galactocentric radii. We obtained spectra of 102 PNe and 48 HII regions with spectral coverage from ~3600 to 9100 Å. The total exposure time was 4 hr, split into 8 sub-exposures of 1800 s each, taken on the nights of 13 October 2007 and 12 November 2007. The spectra were reduced and flux calibrated using the Hectospec package. The observed line fluxes, measured with the SPLOT package, were corrected for the effect of the interstellar extinction using the extinction law of Mathis (1990).

We used the extinction-corrected intensities to obtain the electron densities and temperatures of each PN with the commonly used diagnostic ratios: [S II] $\lambda\lambda$6716,6731 for the density, and [O III]λ4363/(λ5007 + λ4959) and [N II]λ5755/(λ6548 +λ6584) for the temperature. With the latter formulae we derive the electron temperatures of 34 PNe directly from our spectra; for the remaining PNe, we used the correlation between I(He II λ4686)/I(Hβ) and T_e([O III]), representing the effect of the central stars heating of the medium-high excitation nebulae. The ionic abundances were computed using the *nebular* analysis package in IRAF/STSDAS (Shaw & Dufour 1994). The elemental abundances were then determined by applying the ionization correction factors (ICFs) following the prescriptions by Kingsburgh & Barlow (1994) for the case where only optical lines are available.

Most of the PNe observed in M33 belong to its disk, while two PNe belong to the halo population (Ciardullo et al. 2004). We do not include the halo PNe in the following discussion. From the plot of N/O versus He/H, we found that there are 19 Type I PNe by Dopita's (1991) definition. Most PNe in our sample are non-Type I, implying a population mainly composed of PNe from old progenitors, with $M < 3M_\odot$, and ages > 0.3 Gyr.

We found a tight relationship between O/H and Ne/H in the M33 PNe (figure 1), thus broadly excluding modification of both elements during the lifetime of the progenitors, and validating the assumption that oxygen is a good tracer of the galaxy primordial metallicity. We also found that, generally speaking, the average elemental abundances of the α-elements in the M33 disk PNe are very similar to those of the Large Magellanic Cloud.

continued

Planetary Nebula View of M33 continued

In this preliminary paper we only present our PNe abundances; in order to assess the chemical evolution of M33, we used HII region observations from the literature (Rosolowsky & Simon 2008; Magrini et al. 2007a). The comparison between M33 PNe and HII region average abundances indicates a negligible global enrichment of the M33 disk from the epoch of the formation of the PNe progenitors to the present time.

The abundances of the α-elements were then used to compute the metallicity gradient of M33 by deriving the radial metallicity gradients of those elements that are not modified during the lifetime of LIMS—oxygen, neon, and sulfur. The element with the most reliable abundance, oxygen, has a slope of -0.031±0.013 dex kpc^{-1} through the disk of M33 (figure 2). Within the errors, this slope is in agreement with the same gradient derived from the cumulative sample of HII regions described above, 0.032±0.009 dex kpc^{-1}. Because the metallicity gradients of PNe and HII regions are practically indistinguishable from each other, and the mean abundances of the PNe and HII regions are very close, we conclude that the chemical enrichment in M33 from the time of the formation of the PN progenitors to the present time has been almost negligible.

A comparison of our results with chemical evolutionary models was done under the simplifying assumption that the age of all PNe is ~5 Gyr. The class of models that assume a halo collapse phase for the formation of the disk, such as Mollà et al. (1997), produce a PN gradient -0.025 dex kpc^{-1} steeper than the one for HII regions. Models assuming two infall episodes for the formations of the disk (first the thick disk, then the thin disk), such as Chiappini et al. (2001), predict PN gradients flatter that those of HII regions by about +0.03 dex kpc^{-1}. Finally, models assuming a slow formation of the disk from the intergalactic medium (Magrini et al. 2007b) predict a PN gradient -0.015 dex kpc^{-1} steeper than the one at the present time.

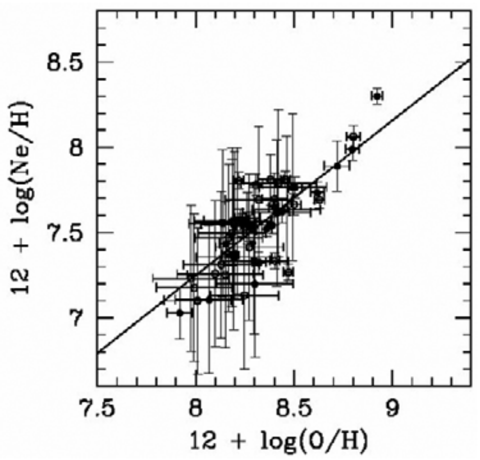

Figure 1: The relationship between oxygen and neon abundances. Filled circles refer to Type I PNe and empty circles to non-Type I PNe, following the definition of Dopita (1991). The continuous line is the weighted least-squares fit to the complete sample of PNe.

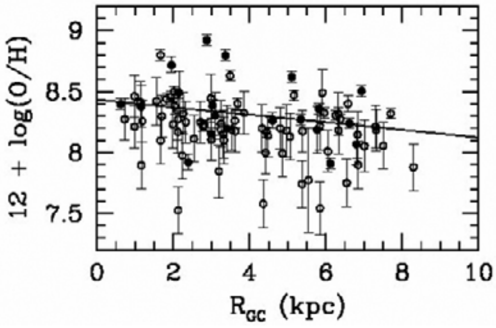

Figure 2: The radial gradient of oxygen abundance. Symbols are as in figure 1. The continuous line is the weighted least-squares fit to the complete sample of disk PNe.

Our observations argue strongly that, within the errors, the slope of the metallicity gradients had small variations during the last several Gyr. Thus, our results exclude formation models of the disk of M33 that require rapid collapse scenarios and processes that produce changes in the metallicity gradients during the last Gyr. Rather, an extremely slow accretion from the intergalactic medium is favored for the formation of the M33 disk. Further, more detailed modeling is needed to confirm the formation scenarios of this disk galaxy. More details on this project can be found in Magrini et al (2008).

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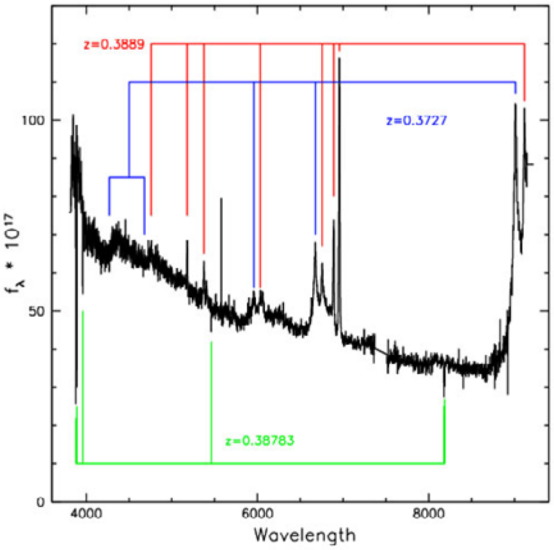
A Candidate Sub-Parsec Supermassive Binary Black Hole System

Todd A. Boroson & Tod R. Lauer (NOAO)

A dramatic impact of the large survey archives now available, in particular, the Sloan Digital Sky Survey (SDSS), is that they have forced us to think about new ways to study large data sets. We need new techniques to learn what information is contained in a large set of observations, and we need new techniques to tease out the relationships that lead us to a physical understanding or to test our ideas. Large sets of spectra represent a particularly difficult problem, because different researchers will be interested in different kinds of information.

We have been applying an approach based on the Karhunen-Löeve Transform, or principal components analysis, to the spectra of the low-redshift, quasi-stellar objects (QSOs) in the SDSS archive to characterize the information contained in this data set. Our approach is based on the prescription of Connolly and Szalay (1999), who foresaw the capability of this technique to improve signal-to-noise ratios and fill in missing data in large, complex data sets. The procedure emphasizes the information in features that occur commonly in the ensemble of spectra and deemphasizes that which is in rare features, including noise. One of the consequences of this analysis is the identification of outliers, objects that are not well fit by the basis that describes the sample as a whole.

Having processed the 17,500 spectra of QSOs with $z < 0.7$ in the SDSS archive, we discovered a spectrum that seemed unique to us: a QSO with two broad-line systems. The spectrum of SDSS J153636.22+044127.0 (J1536+0441) is shown in the figure. This QSO has a *g* magnitude of 17.24 and 2MASS JHK magnitudes of 15.46, 14.85, and 14.10. It was detected by the Röntgen Satellite (ROSAT), but is not found in either the Faint Images of the Radio Sky at Twenty-cm (FIRST) or the NRAO VLA Sky Survey (NVSS) radio survey catalogs. Its appearance is stellar in the SDSS images.



The observed spectrum from the SDSS archive of the QSO SDSS J153636.22+044127.0. The three redshift systems discussed in the text are indicated with most of the identified features marked. The strong unmarked emission feature is an artifact from poor subtraction of the night sky line at λ5577.

The spectrum of J1536+0441 shows two broad-line emission systems and one system of narrow absorption lines. The highest redshift system, the r-system at $z = 0.3889$, shows broad Balmer lines (Hα, Hβ, and Hγ) and the usual narrow lines ([O II], [O III], [Ne III], [Ne V]) seen in low-redshift QSO spectra. The lowest redshift system, the b-system at $z = 0.3727$, shows broad Balmer lines (Hα through Hδ) and broad Fe II emission, seen most strongly around 3000 Å in the rest frame. The identification of the ultraviolet Fe II emission in the b-system is confirmed by cross-correlating the spectrum with a composite QSO spectrum (Vanden Berk et al. 2001). A strong, narrow absorption-line system, the a-system, is also present, including the Mg II doublet (λλ 2796, 2803), the Mg I λ2852 line, the Ca II K line, and the Na D doublet. The redshift of this system is 0.38783, which, in the QSO rest frame, is 240 km s^{-1} less than that of the r-system and 3300 km s^{-1} greater than that of the b-system.

The b-system is a very unusual system in that it shows no narrow or forbidden-line emission. The [O III] 5007 line, typically the strongest such line, would fall just off the blue edge of the r-system [O III] 4959 line, a region that is otherwise quite clean. A conservative upper limit on the equivalent width of a line at this position is about 0.5 Å. This is about 2% of the measured strength of the r-system [O III] 5007 line. While there are a few QSOs known with no detectable [O III] lines, they are exclusively infrared-luminous objects that have extremely strong optical Fe II emission.

The interpretation of this object as a bound system of two black holes allows us to estimate the orbital parameters. The measured widths of the Hβ lines are 2400 km s^{-1} for the b-system and 6000 km s^{-1} for the r-system. We apportion the luminosity at 5100 Å to the two black holes by assuming that the fraction attributable to each is proportional to its mass. This gives $10^{7.3}$ solar masses for the b-system black hole and $10^{8.9}$ solar masses for the r-system black hole. Alternatively, dividing the flux into equal halves would produce values of $10^{8.0}$ and $10^{8.8}$ for the two systems. If we then assume that we are observing this system at a random inclination and a random phase, we derive a separation of about 0.1 pc and an orbital period of about 100 years. Upper limits can be estimated from the assumption that we are seeing the system edge-on at a time when the relative velocity vector is in the line of sight. In that case, the separation is about 0.3 pc and the period is about 500 years.

Of course, it is possible that the spectrum is the result of two objects that appear by chance in the same line of sight. We estimate the probability of this by integrating the SDSS QSO luminosity function (Richards et al. 2006) over a volume corresponding to a one-arcsecond radius circle and a depth that would put the object at a given redshift to within 10,000 km s^{-1}. This probability is 1.8×10^{-7}, which, when multiplied by the 17,500 objects in our sample, results in the expectation of 0.003 such objects. Although this is not negligible, we note the additional point of the unusual nature of the b-system spectrum as an argument that this is a single object with two black holes.

Future observations will determine the nature of this object. Better spectroscopy will allow better characterization of the two systems and perhaps detect associated starlight. High spatial resolution imaging may reveal the morphology of the host galaxy. Spectroscopic monitoring is critical, because our model predicts changes in the relative velocities as large as 150 km s^{-1} in a single year. A paper on this object is in press in *Nature*.

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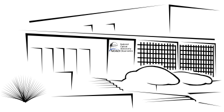

Looking to the Future

David Silva

Strategy informs tactics. If you do not know where you want to go, you will not get anywhere or be ready to take advantage of unexpected opportunities. In the last *Newsletter*, I wrote about how current strategic priorities are driving our short-term budget decisions.

But, what about the future? How does NOAO merge strategic guidelines from the NSF Senior Review with community ambitions for science capabilities over the next decade across a broad range of telescope apertures? Certainly, the decadal survey (Astro2010) is interested in an answer from NOAO. To help sharpen our answer, AURA has convened a community-based committee chaired by Tim Beers (Michigan State). The Future of NOAO (Future) committee charge and a list of committee members are available at: *www.noao.edu/system/future09*.

The first face-to-face meeting was held in Long Beach immediately after the January American Astronomical Society meeting. Prior to the meeting, Beers asked everyone to provide their top five NOAO and/or System priorities for the first five years and the next five years, commencing essentially in 2010. Based on these initial thoughts and two days of vigorous discussion, the committee is working on a white paper that begins by stating their view of why a strong national observatory is essential for US optical/infrared (O/IR) astronomy and what NOAO needs to do over the next decade to fulfill that vision. Topics include implementation of recommendations from the Renewing Small Telescopes for Astronomical Research and Access to Large Telescopes for Astronomical Instruction and Research committees about future relationships between NOAO and Gemini, the role of NOAO in the LSST and GSMT observatories, and concepts for a more coherent strategic roadmap for data management for the ground-based O/IR System.

The Future committee plans to release their draft white paper to the community-at-large in early March with a request for prioritization and feedback via a Web-based survey form. Based on community feedback, the committee will produce a final white paper by early May. This schedule is aggressive but necessary to fit within constraints posed by the broader Astro2010 input process.

I am excited by how the Future of NOAO white paper is shaping up and the enthusiastic vision it conveys. I believe you will be too.

Budget Update

David Silva

Stimulus is the word in Washington. Stimulus funding may present an unexpected opportunity to strengthen NOAO. Here's how.

It appears that Congress will send between one and two billion dollars to the NSF. That money will have to be handed out fast to energize the US economy. NSF is looking for "shovel-ready" projects, especially projects that improve university-related research infrastructure and help catch up on deferred maintenance.

So that we are ready when NSF wants input, NOAO is preparing lists of candidate projects now. On the bricks-and-mortar side, we have compiled a list of deferred maintenance projects that contains everything from basic building maintenance on Cerro Tololo to a new water treatment plant on Kitt Peak to significant building improvements in Tucson and La Serena. Individual projects cost from thousands to millions of dollars.

On the science capability side, NOAO has obvious needs and wants, starting with complete funding of our Renewing Small Telescopes for Astronomical Research implementation proposal. That alone would lead to new spectrographs for the Mayall and Blanco 4-meter telescopes, access to the Palomar 5-meter telescope, and design studies for an echelle spectrograph for the Discovery Channel Telescope as well as 2-meter telescopes to add to the Las Cumbres Observatory Global Telescope network. We would also like a clone of the NEWFIRM wide-field infrared imager and expanded funding of the Telescope System Instrumentation Program to expand public access at the independent observatories.

To be honest, it is difficult to know what will really happen. NOAO may get no stimulus money; it may get millions. But, like the lottery, if you do not play, you cannot win. And unlike the lottery, I believe our chances of at least partial success are actually pretty good.

To close on a cautionary note: stimulus money will not solve our FY09 base budget problems discussed in the last *Newsletter*. NOAO may get a significant amount of short-term project money and still be constrained in staff size. For now, we need to stay conservative with staff size issues in particular. Fortunately, much of the possible work related to stimulus money can be contracted to bricks-and-mortar service providers, short-term technical staff, or university labs.

New Look for NOAO Home Page

Robert Blum

On January 1, NOAO released its new home page at *www.noao.edu/*. The new look, shown below, is designed for NOAO users and the general public to quickly locate the information they need. For starters, the old home page information has been split into two pages. The initial page is oriented now more to topics and information appropriate to a general audience. Clicking the prominently displayed button labeled "Astronomers" takes the astronomer to the second, similarly-styled, Astronomer home page. Here, the main links have been expanded to include resources US astronomers need to write proposals, reduce and find data, contact or identify NOAO staff, and navigate the US ground-based optical/infrared System.

A bar of items "below the fold" is routinely updated and shows current events, new projects, and important reports from our advisory committees. We encourage our users to check out the new pages and give us feedback; use the new "Contact Us" link, or send comments directly to Mark Newhouse (*newhouse@noao.edu*) and Bob Blum (*rblum@noao.edu*).

NOAO at the IYA2009 Opening Ceremonies NOAO astronomer and U.S. IYA Project Director Stephen Pompea shows off the "Galileoscope" student telescope kit at IYA opening ceremonies at UNESCO Headquarters in Paris. More about NOAO and IYA2009...

Clear Skies Over Kitt Peak is a monthly radio show produced by NOAO for the Tohono O'odham Nation, to provide the latest news from Kitt Peak National Observatory and the world of Astronomy.

Join us as Kitt Peak National Observatory celebrates 50 years of astronomy!

The National Optical Astronomy Observatory is proud to be a US National Node in the International Year of Astronomy 2009

NOAO is the national center for ground-based nighttime astronomy in the United States and is operated by the **Association of Universities for Research in Astronomy** (AURA), under cooperative agreement with the **National Science Foundation.** If you would like information about solar astronomy, visit the **National Solar Observatory.** If you would like information about radio astronomy, visit the **National Radio Astronomy Observatory.**

Frank Kelley Edmondson August 1, 1912—December 8, 2008 Professor Edmondson was one of the major players in the creation of the Association of Universities for Research in Astronomy (AURA) and the National Observatory. More...

Spartan Camera Arrives at SOAR.

NOAO Users Committee documents posted:

2008 Charge
2008 Report
2008 NOAO Response

LSST E-News, Issue 4. Highlights include primary and secondary mirrors fabrication, construction permits in Chile, acquisition of the 1.2-m Calypso telescope on Kitt Peak

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Screen shots of the new NOAO home page (left) and Astronomer home page (right). A focused set of main links on the right side center of both pages is designed to get information to users quickly. For example, all science capabilities from current to future telescopes and instruments are accessed through the "Science Capabilities" link.

Classical and Queue Observing Opportunities with the Gemini Telescopes for Semester 2009B

Verne V. Smith

Semester 2009B runs from 1 August 2009 to 31 January 2010, and the NOAO Gemini Science Center (NGSC) encourages the US community to propose for Gemini observing time during this semester. 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.**

US Gemini observing proposals are submitted to and evaluated by the NOAO Time Allocation Committee (TAC). The formal Gemini Call for Proposals for 2009B will be released in late-February 2009 (before you receive this *Newsletter* issue), with a US proposal deadline of Tuesday, 31 March 2009. 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 2009B. Please watch the NGSC Web page (*www.noao.edu/usgp*) for the Gemini Call for Proposals, which will list clearly and in detail the instruments and capabilities that will be offered.

NGSC anticipates the following instruments and modes on Gemini telescopes in 2009B:

Gemini North:

- Near-Infrared Integral-Field Spectrograph (NIFS).
- Near-Infrared Imager (NIRI) 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 microns) imager and spectrometer, which includes an imaging polarimetry mode.
- Gemini Multi-Object Spectrograph (GMOS-North) and imager. Science modes are multi-object spectroscopy (MOS), long-slit spectroscopy, and 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.** The offer of one-night classical runs opens up the possibility of many more Gemini programs being eligible for classical observing, if the program principal investigator (PI) wants to use this mode.
- Details on use of the laser guide star (LGS) system can be found at *www.gemini.edu/sciops/ObsProcess/ObsProcIndex.html*, 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 the high-resolution echelle spectrograph, HIRES, on Keck, as well as to the Suprime-Cam wide-field imager and the infrared imager and spectrograph (MOIRCS) on Subaru.
- Gemini Near-Infrared Spectrograph (GNIRS). The repair and refurbishment of GNIRS continues in Hilo, and it is planned that sometime during 2009B the spectrograph will be deployed on Gemini North to undergo commissioning on this telescope. It will not be available as a general-user instrument in the 2009B Call for Proposals; however, its commissioning on Gemini North may affect the telescope schedule.

Gemini South:

- Thermal-Region Camera Spectrograph (T-ReCS) mid-infrared (2–26 microns) imager and spectrograph.
- Gemini Multi-Object Spectrograph (GMOS-South) and imager. Science modes are multi-object spectroscopy (MOS), long-slit spectroscopy, and IFU spectroscopy and imaging. Nod-and-shuffle mode is also available.
- Phoenix, the NOAO high-resolution infrared spectrograph (1–5 microns), is expected to be available during 2009B.
- Near-Infrared Coronagraphic Imager (NICI). With the continuing NICI Science Campaign taking place during this semester, NICI is available for general-user proposals.
- All modes for GMOS-South, T-ReCS, Phoenix, and NICI 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*.

The percentage of telescope time devoted to science program observations in 2009B is expected to be greater than 85 percent at Gemini North and greater than 75 percent at Gemini South.

continued

Classical and Queue Observing Opportunities with Gemini continued

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. Multi-partner proposals are encouraged because they access a large fraction of the available Gemini time, thus enabling larger programs that are likely to have substantial scientific impact. 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 that are more likely to occur. Users might want to think about this option when they prepare 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 online Gemini Integration Time Calculators for each instrument. NGSC 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.

There is continuing need for proposals that can be run under the poorest conditions. To help fully populate the queue, a Poor Weather category for proposals has been established. Poor weather programs may be submitted for any facility instrument; for these proposals, neither the PI nor the partner country will be charged for any time used. For additional information, see the link at: *www.gemini.edu/sciops/ObsProcess/ObsProcCfP_background.html*.

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 one to view how the PIT proposal will print out for the NOAO TAC (*www.noao.edu/noaoprop/help/pit.html*).

Feel free to contact me (*vsmith@noao.edu*) if you have any questions about proposing for US Gemini observing time.

Understanding Observing Constraints at Gemini

Tom Matheson

One of the advantages of queue scheduling at Gemini is that principal investigators (PIs) can specify the observing conditions under which their observations will be obtained, be it excellent seeing, the darkest skies, or the driest atmosphere. The time for the best conditions fills up rapidly. Programs that can take advantage of less-than-ideal conditions are likely to obtain data. Programs in Band 3 typically need to relax their observing constraints. Understanding the nature of the constraints is crucial to planning a successful program.

Gemini has four observing constraints under the control of the PI during the proposal process: image quality (IQ), cloud cover (CC), water vapor (WV), and sky background (SB). Some of these constraints are correlated, so not all combinations are possible. In addition, some constraints are not relevant for certain wavelength regimes. The percentiles used to define the range of conditions within each constraint are based on long-term records at each site (or extrapolations from other sites in Chile, in the case of Gemini South). Revisions to these distributions may be made as a result of observations made by Gemini itself. For complete details, please see the Gemini Web page concerning observation constraints. All the tables in this article are derived from that Web page (*www.gemini.edu/node/10781*).

Image quality is mainly a reflection of atmospheric seeing, but includes other factors such as wind shake. Table 1 lists the values in each IQ bin for various wavelength regimes when using the wavefront sensor typically operated for that regime (see the complete table on the Gemini Web site: *www.gemini.edu/node/10781#ImageQuality*). The numbers in the table are the 50% encircled energy diameter in arcseconds (this corresponds to full width at half maximum [FWHM] for a Gaussian profile). For the IQ ANY bin, the values represent typical measurements during poor conditions, but selection of ANY means that any level of image quality is acceptable, including worse than the numbers in the table. Note that the values in the table are for observations at zenith. If a target is observed at a larger airmass, delivered IQ may be lower. The IQ is usually determined from acquisition images.

Table 1: FWHM as a function of image quality and wavelength

Wavelength	IQ = 20	IQ = 70	IQ = 85	IQ = ANY
V (0.5μ)	0.45	0.80	1.10	1.90
I (0.9μ)	0.45	0.80	1.10	1.70
J (1.2μ)	0.40	0.60	0.85	1.55
K (2.2μ)	0.35	0.55	0.80	1.40
L (3.4μ)	0.35	0.50	0.75	1.25
N (11.7μ)	0.31–0.34	0.37	0.45	0.75
Q (18.3μ)	0.49–0.54	0.49–0.54	0.49–0.54	0.85

continued

Understanding Observing Constraints at Gemini continued

Cloud cover is an estimate of the sky transparency. The values in table 2 represent the extinction in magnitudes for each CC bin. This is an average; patchy clouds could result in higher extinctions for some observations. Evaluation on any given night is more subjective, being based on the estimate of the observer at the telescope. For wavelength regimes above 3 microns (μ), observing is not possible for CC 90 and greater. For observations below 3 μ, CC ANY is possible, but unlikely to produce useful results. Note that even at CC 50, careful use of standard stars is still recommended for photometric accuracy when observing in the mid-infrared (IR) range (8–25 μ).

Table 2: Extinction in magnitudes as a function of cloud cover

Wavelength	CC = 50	CC = 70	CC = 90	CC = ANY
0.4–2.5μ	0	0.3	2	3+
3–25μ	0	0.3	NA	NA

Water vapor is a measure of the precipitable water column. At Gemini North, this is determined from the Caltech Sub-millimeter Observatory 220 gigaHertz optical depth; at Gemini South, it is estimated from the sky background in T-ReCS *N*- and *Q*-band images. Table 3a lists values for the precipitable water for Gemini North; table 3b has similar data for Gemini South. For optical observations, water vapor is not a major concern, so WV should be ANY. In the near- and mid-IR, the effects of water vapor are strongly dependent on wavelength. Please see the model spectra on the Gemini Web site for details: *www.gemini.edu/node/10781?q=node/10789*.

Table 3a: Precipitable water as a function of water vapor at Gemini North

Wavelength	WV = 20	WV = 50	WV = 80	WV = ANY
0.4–1.0μ	NA	NA	NA	NA
1.0–2.5μ	1.0mm	>1.0mm	>1.0mm	>1.0mm
3–25μ	1.0mm	1.6mm	3.0mm	>3.0mm

Table 3b: Precipitable water as a function of water vapor at Gemini South

Wavelength	WV = 20	WV = 50	WV = 80	WV = ANY
0.4–1.0μ	NA	NA	NA	NA
1.0–2.5μ	2.3mm	>2.3mm	>2.3mm	>2.3mm
3–25μ	2.3mm	4.3mm	7.6mm	>7.6mm

The sky background is an indicator of the brightness of the night sky. At optical wavelengths, this is dominated by moonlight, but there are other factors. Table 4 lists the *V*-band magnitude per square arcsecond (μ_V) for each SB constraint. Note that the sky color also changes with the degree of illumination. For the near-IR, the background is mainly OH emission, with some thermal emission at longer wavelengths (*K*-band). Typical brightnesses in magnitudes per square arcsecond of the night sky in near-IR bands are 16.0 in *J*, 13.9 in *H*, and 13.5 in *K*. At longer IR wavelengths, the WV and CC constraints dominate the background. In practice, the SB constraint for all IR observations (>1.0 μ) should be ANY. As with IQ, these values for SB are determined at zenith. Brighter backgrounds may occur at larger airmass.

Table 4: *V*-band magnitude per square arcsecond as a function of sky background

Wavelength	SB = 20	SB = 50	SB = 80	SB = ANY
0.4–1.0μ	$\mu_V > 21.3$	$\mu_V > 20.7$	$\mu_V > 19.5$	$\mu_V > 18.0$
1.0–25μ	NA	NA	NA	NA

An additional observing constraint is the elevation of the telescope. This restriction is not allowed during the proposal (Phase I) process, but can be implemented in Phase II. The Observing Conditions section of the Phase II contains a pull-down menu for elevation constraints, either by hour angle or airmass. Hour angle constraints can also help for observing near the parallactic angle. Use of this constraint requires the approval of the head of science operations of the appropriate telescope. Instructions are on the Gemini observing constraints Web page (*www.gemini.edu/node/10781*).

If you have further questions, please consult the Gemini Web pages or contact NGSC directly.

Classical Observing at Cerro Pachón

Ken Hinkle

Gemini programs requiring one or more integer nights of telescope time can be either classically or queue scheduled. While many Gemini observers prefer queue, observers can reap a number of benefits by being at the telescope. For instance, the observer can make real-time decisions and implement optimizing strategies. Being at the telescope allows observers insight into the operation of the instrument. This results in more efficient observing and optimal reduction techniques. Many observers also note a sense of ownership and responsibility for the data that results from doing their own observing.

Recently I was at Cerro Pachón as a co-investigator on a Phoenix run. The run took place in the Chilean summer. The short nights were countered by nearly perfect observing conditions. As has now become commonplace, the Gemini South telescope performed flawlessly. The delivered image quality each night was better than 0.4 arcseconds.

While the telescope and instrument performed very much as for my run a year before, there were noteworthy operational changes. Observers now stay at Cerro Pachón. There is a new dormitory located about a mile drive from the summit (photo). If you are familiar with the summit, the new dormitory is located next to the 20-units building. However, the dining room remains near the summit. Cars are provided for the observers to drive between the dining room, dormitory, and telescope. The new dormitory at Cerro Pachón is a significant improvement in observer convenience and safety. Previously, observers stayed at Cerro Tololo, which is a nearly 30-minute drive away.

The new dormitory for Gemini users at Cerro Pachón.

Another change is the shuttle (carryall) service between La Serena and Cerro Pachón. At the time of my visit, there was a shuttle three times a day. Observers should consult the Gemini Web site for details (see Instructions for Gemini South Visitors at *www.gemini.edu/sciops/observing-with-gemini?q=node/10993*).

Helpful Hint: Gemini HelpDesk

The Gemini HelpDesk provides a pull-down menu with various topics to direct your question to the proper people. This ensures a faster and better response to your inquiry. A misdirected question can result in delays. One of the more common misdirections is to select an instrument as the topic when actually the problem is related to the data reduction software. If your question involves IRAF or Gemini IRAF (such as installation problems or some failure to run), then choose those topics rather than the instrument used to obtain your data.

NICI—AO Imaging Capability at Gemini South

Ken Hinkle

NGSC expects that the Near-Infrared Coronagraphic Imager (NICI) will be offered at Gemini South in 2009B. NICI is an adaptive optics (AO) dual-channel camera with a coronagraph that is optimized to search for and image large Jovian-type planets around nearby stars. NICI can also be used without the coronagraph as a natural guide star AO imager. The detector is a 1024 × 1024 ALADDIN InSb array with 18 mas/pixel yielding a field of view of 18 × 18 arcseconds. A variety of broadband and narrowband filters are available including J, H, K, and Ks. The field of view and pixel scale are similar to those of the Hokupa'a/QUIRK system used at Gemini North until 2003. AO imaging is a new feature at Gemini South.

Joint Subaru/Gemini Science Conference in May 2009

Katia Cunha

The Subaru and Gemini Observatories will jointly host a science meeting in Kyoto, Japan, from 18–21 May 2009. The main goals of the meeting are to promote a mutual understanding of the Gemini and Subaru communities as well as to highlight the international nature of modern astronomy. Registration is now open, and a preliminary program for the meeting is available at: *www.kusastro.kyoto-u.ac.jp/kyoto2009/schedule.html*. The deadlines are 31 March 2009 for early registration and 24 April 2009 for late registration. A Gemini Users Meeting will be held on May 22 at the same venue.

NGSC Instrumentation Program Update

Verne V. Smith & Mark Trueblood

This article gives a status update on Gemini instrumentation being developed under the oversight of the NGSC, with progress since the December 2008 *NOAO/NSO Newsletter*.

FLAMINGOS-2

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

After the August 2008 Pre-ship Acceptance Test (AT), the University of Florida team worked long hours to prepare FLAMINGOS-2 for a second Pre-ship AT held in Gainesville, December 15–18. Changes since the first AT include applying labels to electrical connectors and dual-language warning placards to the instrument exterior, routing cables and hoses in a neat and orderly manner, and delivering required documentation electronically.

Many items not tested at the August 2008 AT were tested in December, with 41 items passing in this AT. As of this writing, some items are still pending resolution and analysis, while others have been deferred to the Final Acceptance Test on the telescope, or to Commissioning. Following the test, the Gemini Observatory produced a Punch List of items to be completed in a future test (probably in March 2009) before the instrument is shipped to Cerro Pachón.

The group of participants in the Flamingos-2 Pre-ship Acceptance Test includes Primary Investigator Steve Eikenberry and members of the University of Florida scientific and engineering staffs; Gemini Instrument Scientist Percy Gomez and members of the Gemini scientific and engineering staffs; and Chris Packham and Nancy Levenson, members of the Gemini Science Committee, who acted as observers. Photo by Mark Trueblood/NOAO/NGSC.

2009B Observing Proposals Due 31 March 2009

Dave Bell

Standard proposals for NOAO-coordinated observing time for semester 2009B (August 2009–January 2010) are **due by Tuesday evening, 31 March 2009, 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 Keck, Magellan, and MMT.

Proposal materials and information are available on our Web page (*www.noao.edu/noaoprop/*). There are three options for submission:

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

Email submissions—As in previous semesters, a customized LaTeX file may be downloaded from the Web proposal form, after certain required fields have been completed. "Essay" sections can then be edited locally and the proposal submitted by email. Please carefully follow the instructions in the LaTeX template for submitting proposals and figures.

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

Note that proposals for Gemini time may also be submitted using the standard NOAO form, and that proposals requesting 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*.

The addresses below are available to help with proposal preparation and submission:

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

Community Access Time Available in 2009B with Keck, Magellan, and MMT

Dave Bell

As a result of awards made through the National Science Foundation's Telescope System Instrumentation Program (TSIP) and a similar earlier program, telescope time is available to the general astronomical community at the following facilities in 2009B:

Keck Telescopes
A total of fourteen nights of classically scheduled observing time will be available with the 10-meter telescopes at the W. M. Keck Observatory on Mauna Kea. All facility instruments and modes are available. For the latest details, see *www.noao.edu/gateway/keck/*.

Magellan Telescopes
A total of ten nights will be available for classically scheduled observing programs with the 6.5-meter Baade and Clay telescopes at Las Campanas Observatory. For updated information on available instrumentation and proposal instructions, see *www.noao.edu/gateway/magellan/*.

MMT Observatory
Fifteen nights of classically scheduled observing time will be available with the 6.5-meter 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/*.

A list of instruments that we expect to be available in 2009B can be found at the end of this section. As always, investigators are encouraged to check the NOAO Web site for any last-minute changes before starting a proposal.

A New NOAO Survey Program

Tod R. Lauer

A new NOAO survey program has been initiated, with observations beginning in semester 2009B. Eleven proposals were submitted in response to the 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 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.

The Survey TAC grades 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.

The survey selected for 2009B is, "*The Carnegie Spitzer IMACS Survey,*" Prinicipal Investigator Daniel Kelson (OCIW). This survey will use NEWFIRM at both the KPNO and CTIO 4-meter telescopes in conjunction with low-resolution optical spectroscopy obtained with the Magellan IMACS instrument to probe the evolution of galaxies and large-scale structure from $z < 1.5$ to the present. The survey sample is selected from a large 3.6-micron Spitzer survey covering 15 square degrees in three fields. The selection criterion allows close tracking of the stellar mass of galaxies over the redshift interval being probed. The survey yields ~500,00 galaxies with $m_{AB} < 21.0$ at 3.6 microns. NEWFIRM will provide J, H, and K_S photometry, which is critical to fill in the spectral energy distribution of the galaxies between the optical bandpass of the IMACS low-resolution spectroscopy and the Spitzer photometry.

Evolution of the NOAO Time Allocation Process (Everything You Always Wanted to Know about the TAC)

Letizia Stanghellini

The NOAO time allocation process is a system-based process for allocating telescope time on facilities available to the US community through NOAO. Proposals are submitted to the NOAO Telescope Allocation Committee (TAC), based on science, and requesting as many telescopes and instruments as required for the successful completion of the science goals. In the last few years, the capabilities accessible through the NOAO TAC have greatly expanded, and we now offer a suite of 18 telescopes, including several 8-meter-class telescopes, providing more than 50 instruments and observing modes. This large selection of observing modes and capabilities allows proposers to choose the best match between science and observations, and it lets the NOAO TAC select the most meritorious science from the proposed programs.

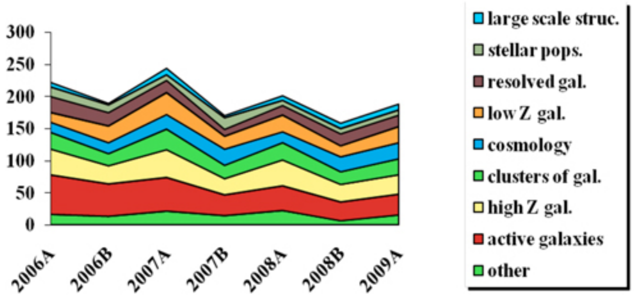


Figure 1a: Proposals submitted by science category (extragalactic astronomy).

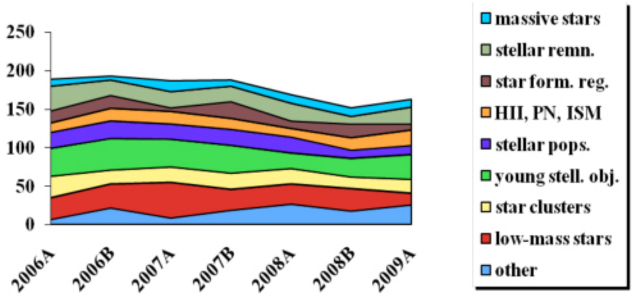


Figure 1b: Proposals submitted by science category (Galactic astronomy and resolved stellar populations).

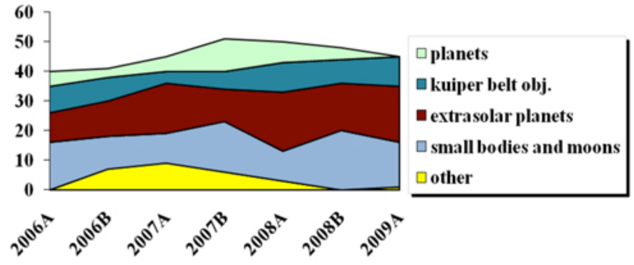


Figure 1c: Proposals submitted by science category (solar systems).

In each of the past three years, NOAO has received approximately 1000 proposals. In order to monitor the proposal selection, we ask the proposing teams to choose a science category from among a list of nine extragalactic, ten Galactic and resolved stellar populations, and five solar systems ones. The science categories are used primarily to match the proposal to the reviewers. Semester after semester, we receive approximately the same mix of science topics, as seen in figures 1a–1c. The spread across the categories is the basis for panel recruitment, and the constancy of that spread reassures us that the five-semester tenure in the NOAO TAC is a good match to the expectations. There are notable exceptions of course—see the recent rise of extrasolar planet proposals in figure 1c—that are taken into account each semester by adjusting the panel recruitment accordingly.

The proposal pressure, measured as nights requested over the nights available, depends mainly on aperture size. Figure 2 shows the proposal pressure in 2009A, which was typical for telescopes offered through the NOAO TAC. The high subscription rate of Kitt Peak's Mayall 4-meter (KP-4m) telescope, due to the recent deployment of the NEWFIRM wide-field infrared imager, demonstrates that new capabilities increase demand. The low oversubscription of the Magellan telescopes likely is due to small number statistics.

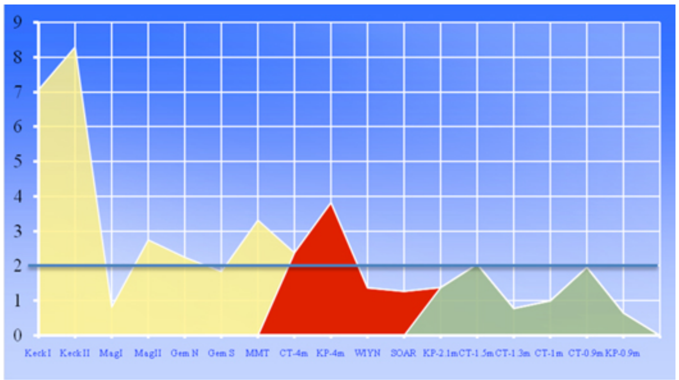


Figure 2: NOAO proposal pressure in 2009A. The horizontal line indicates the 2:1 oversubscription.

Each semester we hold a panel review for proposal selection. There are seven subject panels (three Galactic, three extragalactic, and one solar systems) whose members are carefully selected within the North American—United States, Canada, and Mexico—astronomical community. We make good use of the expected mix of subjects, as seen in figure 1, and we endeavor to represent the astronomical community within each panel, tracking seniority, diversity, and technical expertise. In 2006, AURA held an ad-hoc review panel to discuss how proposals, in particular those requesting the Gemini telescopes, were handled by NOAO. The outcome of the review was very favorable to the NOAO TAC. The panel recommended that reviewers be chosen who have broad scientific expertise, and that panel chairs be chosen preferen-

continued

Evolution of the NOAO Time Allocation Process continued

tially from the broad community rather than from NOAO. NOAO responded to these recommendations from the review panel, and now we routinely have five or six of the seven panel chairs from outside the NOAO staff each semester.

Proposal assignment is based on scientific expertise, but there are other criteria that should be applied as well. In particular, personal conflicts-of-interest are cleared before proposal assignment. Secondarily, all proposals requesting each of the public-access times to the external telescopes (MMT, Keck, and Magellan) go to a single panel of the appropriate discipline (Galactic, extragalactic, or, obviously, the only solar systems panel) so the resulting rank list is sizeable. Gemini proposals are split roughly evenly across panels and, together with the other 8-meter-class telescope proposals, are discussed with special attention within each panel, as recommended by the AURA review.

Panel members have typically three and a half weeks to read and grade proposals. During this time, each panelist is encouraged to disclose all conflicts with proposals he or she is reviewing, including conflicting proposals submitted to the same TAC. We are always available during this interim to reassign proposals and act in the best interests of the proposed science. Each proposal is assigned to a Lead Reviewer, but it is read by all panel members (five in each panel) and graded by all. Preliminary grades are not used to triage proposals, because our TAC reviews all submitted proposals. Most fall semesters we also hold a Survey TAC, which now functions as a regular TAC panel, with the difference that its membership is based on the Letters of Intents to avoid conflicts and select the best science match. We plan to introduce the option of applying for Gemini time in Survey programs, as recommended by the AURA review.

The TAC meetings are held at Tucson NOAO headquarters. The collegial atmosphere of the NOAO patio and nearby restaurants is very conducive to the TAC deliberations, where astronomers can see their friends and colleagues informally at breaks and lunches. While the feedback that I get from the panels is very positive about the logistics and spirit of the TAC, we are working at capacity, and an external site might be the choice to compact the schedule and workload for the support team. A science and policy orientation is held before each panel group meets—our current schedule groups the three Galactic, the three extragalactic, and the solar systems panels on different dates—and includes a question and answer session and brief presentations from the KPNO, CTIO, and NGSC directors, which are focused on the novel observing modes and instruments.

The actual panel review is a complex process with the very simple goal of realizing the best science possible given the current set of proposals and capabilities. In order to focus on their many charges and duties, panel chairs are exempted from discussing and grading proposals, which is different from many other TACs. Although the large number of telescopes and instruments offered by NOAO can increase TAC entropy, the benefit of undistracted, knowledgeable chairs has proved an ideal solution for the NOAO TAC. Parallel Galactic (and extragalactic) panels typically deal with slightly different areas of astronomy, according to the member expertise. For example, Galactic subjects are subdivided into (1) star forming regions, young stellar objects, and massive stars; (2) star clusters, stellar populations, and abundances; and (3) stellar remnants, low-mass stars, and chemical evolution. Each panel has enough scientific breadth to deal with other panel subjects for the occasional personal conflict. These subdivisions foster excellent science discussions in all panels. The solar systems panel gets too few proposals to be split successfully into multiple panels; in this case, we make sure that the panelists can deal with the occasional personal conflict of other members. Chairs of parallel panels meet privately on the second TAC day to resolve intra-panel issues, such as the occasional panel chair conflict (a parallel chair would sit on the panel of the conflicted chair to bring the panel consensus to the Merging TAC).

At the end of the panel review, we hold the Merging TAC where the scientific program recommendation to the NOAO director is finalized. I chair the Merging TAC; the other Merging TAC members are the panel chairs, including the Survey panel chair, and the KPNO and CTIO directors who participate to clarify scheduling issues. A separate merging TAC is held to build the Gemini schedule, and is chaired by NOAO Gemini Science Center Director Verne Smith. During the merging TACs, the merged ranked lists of proposals are discussed and adjusted if needed. Proposals requesting more than one telescope (see figure 3) are discussed to make sure they either get all the requests, or that there is sufficient scientific potential in partial allocation. Multi-telescope proposals are more than 10 percent of the total proposals. We try to allocate the full requests by the proposers, if the TAC ranks the proposal highly, and cut nights only in exceptional circumstances. The Merging TAC also finalizes the long-term recommendations; long-term status is approved exclusively when scientifically justified. The final product of each merging TAC is a suite of ranked lists, one for each telescope, to be reviewed and approved by the NOAO director before they are given to the schedulers. Schedulers of all telescopes offered strive to follow TAC recommendations.

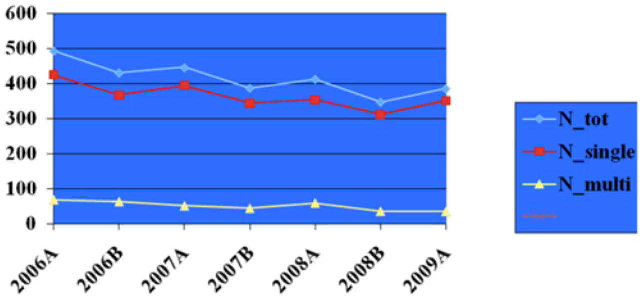


Figure 3: Number of single- or multi-telescope proposals.

Figures 4a and 4b show the proposal size for programs requesting small-aperture (<5 meters) and large-aperture (>5 meters) telescopes, respectively, in the past few semesters, including survey programs. For small apertures, most of the science programs consist of medium-size observing runs (three to six nights), while most large-aperture programs are very short, with almost no large-telescope programs scheduled for more than five nights. This is not a science selection effect, as similar plots on proposed science would look very similar. Instead, this is due to sociological effects (the perception that large-telescope time is very hard to get) and also to the fact that no survey programs so far have been implemented to observe with Gemini and the other large telescopes. We would like to remind proposers that while the nights with Keck and other Telescope System Instrumentation Program telescopes are very oversubscribed, the relatively large allotment of public US Gemini time allows larger programs to be suc-

continued

Evolution of the NOAO Time Allocation Process continued

cessful, and teams are encouraged to submit larger programs for these telescopes when justified by the science goals.

The NOAO TAC provides critical feedback to all proposers (the "comments"). The contents of these comments are drafted by the lead reviewer, discussed during the panel review, checked again by the panel chair to make sure that they captured the panel discussion, and checked finally once again after all schedules have been completed. Proposers should be aware that past comments are available to panel members on resubmitted proposals, and proposals that incorporate answers to previous TAC comments are typically well received. We endeavor to produce the best and fairest comments for all proposals and to have all proposals reviewed fairly and competently. My personal experience with managing the TAC is that the level of scientific discussion is very high, but occasionally the comments have not risen to the same level. New steps have been taken to improve the comments even further.

While managing about a thousand proposals a year, we only receive one or two complaints over the approved scientific program. Of course, as a primary investigator, I totally understand that sometimes the TAC might seem like a black box, which produces an unsatisfactory outcome (when our great proposals are denied time!). For all our colleagues who have felt that way, I warmly suggest you take a look at the oversubscription rates, and also that you each volunteer for the NOAO TAC, or talk to your colleagues that are or have recently been NOAO TAC members (TAC membership is published every semester in this *Newsletter*). Once you sit on the TAC, you will better understand its workings and, hopefully, feel more confident about the fairness of its outcome.

Once the TAC process is complete, another complex set of activities begin: scheduling the highest ranked proposals. This scheduling process will be described in the next issue of the *NOAO/NSO Newsletter*.

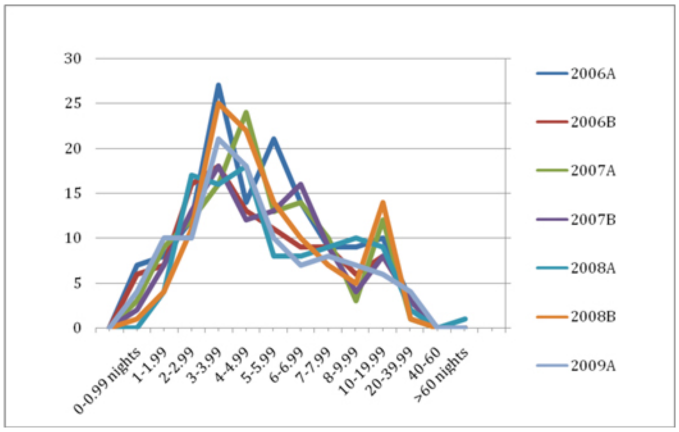


Figure 4a: Size of scheduled programs, small apertures.

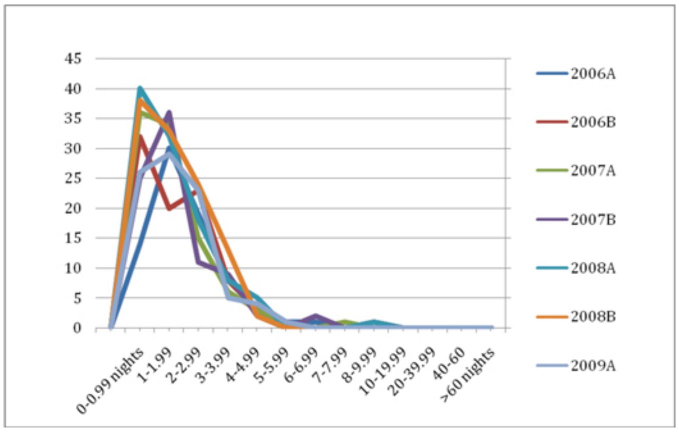


Figure 4b: Size of scheduled programs, large apertures.

Observing Request Statistics for 2009A Standard Proposals

	No. of Requests	Nights Requested	Average Request	Nights Allocated	DD Nights (*)	Nights Previously Allocated	Nights Scheduled for New Programs	Oversubscription for New Programs
GEMINI								
GEM-N	122	124.24	1.02	53.48	0.8	0	53.48	2.32
GEM-S	65	82.52	1.27	44.7	0	0	44.7	1.85
CTIO								
CT-4m	48	174	3.62	68	0	6	62	2.81
SOAR	21	53.39	2.54	49	0	3	46	1.16
CT-1.5m	13	65.5	5.04	24.4	0	5	19.4	3.38
CT-1.3m	11	25.6	2.33	20.5	0	6	14.5	1.77
CT-1.0m	10	42	4.2	81	0	0	81	0.52
CT-0.9m	19	74.55	3.92	29.3	0	5	24.3	3.07
KPNO								
KP-4m	54	198.5	3.68	47.5	0	4.5	43	4.62
WIYN	24	76.5	3.19	40	0	0	40	1.91
KP-2.1m	33	174.5	5.29	117	0	0	117	1.49
KP-0.9m	3	13	4.33	10	0	0	10	1.3
Keck, Magellan, MMT								
Keck-I	34	49.5	1.46	8	0	0	8	6.19
Keck-II	31	44.5	1.44	7	0	1.5	5.5	8.09
Magellan-I	3	3.3	1.1	3	0	0	3	1.1
Magellan-II	6	11	1.83	4	0	0	4	2.75
MMT	15	36.5	2.43	10.5	0	0	10.5	3.48

*Nights allocated by NOAO Director

CTIO Instruments Available for 2009B

Spectroscopy	**Detector**	**Resolution**	**Slit**
CTIO BLANCO 4-m			
Hydra + Fiber Spectrograph	SITe 2K×4K CCD, 3300-11,000Å	700-18,000, 45,000	138 fibers, 2" aperture
R-C Spectrograph [1]	Loral 3K×1K CCD, 3100-11,000Å	300-5000	5.5'
SOAR 4.2-m [2]			
OSIRIS IR Imaging Spectrograph [3]	HgCdTe 1K×1K, JHK windows	1200, 1200, 3000	3.2', 0.5', 1.2'
Goodman Spectrograph [1,4]	Fairchild 4K×4K CCD, 3100-8500Å	1400, 2800, 6000	5.0'
CTIO/SMARTS 1.5-m [5]			
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**
CTIO BLANCO 4-m			
Mosaic II Imager	8K×8K CCD Mosaic	0.27	36'
ISPI IR Imager	HgCdTe (2K×2K 1.0-2.4mm)	0.3	10.25'
SOAR 4.2-m [2]			
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'
Goodman Spectrograph [4]	Fairchild 4K×4K CCD	0.15	7.2' diameter
CTIO/SMARTS 1.3-m2 [7]			
ANDICAM Optical/IR Camera	Fairchild 2K×2K CCD	0.17	5.8'
	HgCdTe 1K×1K IR	0.11	2.0'
CTIO/SMARTS 1.0m [8]			
Direct Imaging	Fairchild 4K×4K CCD	0.29	20'
CTIO/SMARTS 0.9-m [9]			
Direct Imaging	SITe 2K×2K CCD	0.4	13.6'

[1] The R-C Spectrograph should be out-performed by the Goodman Spectrograph on SOAR, in general. A comparison guide is available.

[2] There will be a 2-month SOAR shutdown in Oct-Nov for mirror realuminization. The science fraction for the remainder of the semester will be no less than 70%.

[3] 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.

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

[5] Service observing only. The Fiber Echelle is a new capability, see the NOAO Proposals Web pages and this *Newsletter* for more information.

[6] Some modes of the Spartan IR imager may be available. Please consult the NOAO Proposals Web pages for the latest information.

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

[8] 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 telescope. In this case, there will be a corresponding increase in the scheduled time. No specialty filters, no region of interest.

[9] 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 2009B

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	2×1024×1024 Aladdin III InSb	0.8-5.5μm Narrowband Filters	0.018	18.4" × 18.4"

EXCHANGE	Detector	Spectral Range	Scale ("/pixel)	Field
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'
HIRES (Keck)	3×2048×4096 MIT-LL	0.35-1.0μm R~30,000-80,000	0.12	70" slit

*Please refer to the NOAO Proposal Web pages in March 2009 for confirmation of available instruments.

KPNO Instruments Available for 2009B

Spectroscopy	**Detector**	**Resolution**	**Slit Length**	**Multi-object**
Mayall 4-meter				
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, 0.9-2.5µm)	1000-1900	10.3'	single/multi
IRMOS[2]	HgCdTe (1024×1024, 0.9-2.5µm)	300/1000/3000	3.4'	single/multi
WIYN 3.5-meter[3]				
Hydra + Bench Spectrograph[9]	STA1 CCD	700-22,000	NA	~85 fibers
SparsePak[4]	STA1 CCD	700-22,000	IFU	~82 fibers
2.1-meter				
GoldCam CCD Spectrograph	F3KA CCD	300-4500	5.2'	
FLAMINGOS[1]	HgCdTe (2048×2048, 0.9-2.5µm)	1000-1900	20.0'	
Exoplanet Tracker (ET)[5]	CCD (4K×4K, 5000-5640 Å)	See Note	Fiber (2.5")	

Imaging	**Detector**	**Spectral Range**	**Scale**	**Field**
Mayall 4-meter				
CCD MOSAIC-1	8K×8K	3500-9700 Å	0.26	35.4'
NEWFIRM[6]	InSb (mosaic, 4-2048×2048)	1-2.3µm	0.4	28.0'
SQIID	InSb (3-256×256 illuminated)	JHKs	0.39	3.3'
FLAMINGOS [1]	HgCdTe (2048×2048)	JHK	0.32	10.3'
WIYN 3.5-meter				
Mini-Mosaic[7]	4K×4K CCD	3300-9700 Å	0.14	9.3'
OPTIC[7]	4K×4K CCD	3500-10,000 Å	0.14	9.3'
WHIRC[8]	VIRGO HgCdTe (2048×2048)	0.9-2.5µm	0.10	3.3'
2.1-meter				
CCD Imager[10]	T2KB CCD	3300-9700 Å	0.305	10.4'
SQIID	InSb (3-256×256 illuminated)	JHKs	0.68	5.8'
FLAMINGOS[1]	HgCdTe (2048×2048)	JHK	0.61	20.0'
WIYN 0.9-meter				
CCD MOSAIC-1	8K×8K	3500-9700 Å	0.43	59'

[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] A new Volume Phase Holographic (VPH) grating, 740 l/mm, is now available for use. Please contact Di Harmer for information.

[4] Integral Field Unit, 80"×80" field, 5" fibers, graduated spacing.

[5] Exoplanet Tracker (ET) is an instrument provided by Dr. Jian Ge of the University of Florida and his colleagues. It enables very high precision measurements of radial velocities for suitably bright enough targets. Details regarding this instrument are available via our instrument Web pages. It is capable of providing Doppler precision of 4.4 m/s in 2 minutes for a V = 3.5 mag. G8V star.

[6] Please see *www.noao.edu/ets/newfirm/* for more information. Permanently installed filters include J, H, and Ks. Please see NEWFIRM Web pages for update on availability/schedulability of other filters.

[7] OPTIC Camera from University of Hawai΄i is anticipated to be available from Aug. through late Oct. through an agreement with Dr. John Tonry (U of Hawai΄i). This instrument may be assigned to those that request to use Mini-Mosaic, if this substitution still meets proposed imaging needs and making such an assignment would further observatory support constraints. Fast guiding mode of operation of OPTIC is now a supported mode for NOAO users of the instrument.

[8] WHIRC, built by Dr. Margaret Meixner (STScI) and collaborators, will be available for use during 2009B (no WTTM). It will be available for shared-risk use with the WTTM module.

[9] STA1 is the offered Bench CCD. A 3300 l/mm VPH grating will be available in shared-risk mode. Following a successful commissioning, the new collimator is in use. Observers should plan for the same dispersion and wavelength range, but with a factor of ~2 increase in throughput. Depending on the configuration, there may be up to a 20% reduction in the instrumental resolution. Observers are encouraged to view *www.wiyn.org/instrument/bench_upgrade.html* for further details to help plan observations.

[10] 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.*

Keck Instruments Available for 2009B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
Keck-I					
HIRESb/r (optical echelle)	3x MM-LL 2K×4K	30k-80k	0.35-1.0μm	0.19	70" slit
NIRC (near-IR img/spec)	256×256 InSb	60-120	1-5μm	0.15	38"
LRIS (img/lslit/mslit)	Tek 2K×4K, 2×E2V 2K×4K	300-5000	0.31-1.0μm	0.22	6×8'
Keck-II					
ESI (optical echelle)	MIT-LL 2048×4096	1000-6000	0.39-1.1μm	0.15	2×8'
NIRSPEC (near-IR echelle)	1024×1024 InSb	2000, 25,000	1-5μm	0.18 (slitcam)	46"
NIRSPAO (NIRSPEC w/AO)	1024×1024 InSb	2000, 25,000	1-5μm	0.18 (slitcam)	46"
NIRC2 (near-IR AO img)	1024×1024 InSb	5000	1-5μm	0.01-0.04	10-40"
OSIRIS (near-IR AO img/spec)	2048×2048 HAWAII2	3900	0.9-2.5μm	0.02-0.1	0.32-6.4"
DEIMOS (img/lslit/mslit)	8192×8192 mosaic	1200-10,000	0.41-1.1μm	0.12	16.7×5'
Interferometer					
IF (See *msc.caltech.edu/software/KISupport/*)					

MMT Instruments Available for 2009B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
BCHAN (spec, blue-channel)	Loral 3072×1024 CCD	800-11,000	0.32-0.8μm	0.3	150" slit
RCHAN (spec, red-channel)	Loral 1200×800 CCD	300-4000	0.5-1.0μm	0.3	150" slit
MIRAC3 (mid-IR img, PI inst)	128×128 Si:As BIB array		2-25μm	0.14, 0.28	18.2, 36"
Hectospec (300-fiber MOS, PI)	2 2048×4608 CCDs	1000-2000	0.38-1.1μm	R ~1K	60'
Hectochelle (240-fiber MOS, PI)	2 2048×4608 CCDs	34,000	0.38-1.1μm	R ~32K	60'
SPOL (img/spec polarimeter, PI)	Loral 1200×800 CCD	300-2000	0.38-0.9μm	0.2	20"
ARIES (near-IR imager, PI)	1024×1024 HgCdTe		1.1-2.5μm	0.04, 0.02	20", 40"
SWIRC (wide n-IR imager, PI)	2048×2048 HAWAII-2		1.0-1.6μm	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	28,000	0.32-1.0μm	0.15	

Magellan Instruments Available for 2009B

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
Magellan I (Baade)					
PANIC (IR imager)	1024×1024 Hawaii		1-2.5μm	0.125	2'
IMACS (img/lslit/mslit)	8192×8192 CCD	2100-28,000	0.34-1.1μm	0.11, 0.2	15.5', 27.2'
MagIC (optical imager)	2048×2048 CCD		BVRI, u’g’r’i’z’	0.07	2.36'
Magellan II (Clay)					
LDSS3 (mslit spec/img)	4096×4096 CCD	200-1700	0.4-0.8μm	0.19	8.25' circ.
MIKE (echelle)	2K×4K CCD	22,000	0.32-1.0μm	0.12-0.13	5" slit
MIKE Fibers (echelle)	2K×4K CCD	16,000	0.32-1.0μm	0.12-0.13	20-23', 256 fibers
MagE (echellete)	1024×2048 E2V	4100	0.31-1.0μm	0.3	10" slit

Changes to the Data Products Program

Elizabeth Stobie, Chris Miller & Barbara Fraps

The mandate for the Data Products Program has changed, necessitating a more appropriate program name. The program is now called Science Data Management (SDM). This reflects the short-term mandate (18–24 months) by NOAO management to meet the immediate data management needs of NOAO and its community. These needs include the management of data from current NOAO and near-term facilities. For the next 24 months (starting 1 January 2009), the directive for SDM provided by the NOAO director is defined to be:

Data Management Systems Operations
- Raw data capture and storage for all current NOAO instruments
- Wide-field imager data processing for NOAO 4-meter telescopes (Mayall and Blanco)
- Operation of the existing NOAO Archive for raw and reduced data retrieval—in preparation for the Dark Energy Camera (DECam)

Data Management Systems Development
- System and archive development for DECam
- Support for the Dark Energy Survey Community Pipeline

Science Data Processing
- Legacy IRAF support including release and platform support
- Applications support for DECam

Science User Support
- Data Handbook updates, data dictionaries, and a NEWFIRM cookbook
- Help desk management

Elizabeth (Betty) Stobie, interim head of program and program manager, and Chris Miller, program scientist spent many hours in January preparing a new program plan for SDM to be approved by NOAO Director David Silva. The new program plan takes into consideration the directives noted above in light of a severely reduced budget and a no-new-hires environment. SDM staff have been assigned to project teams and are creating detailed definitions for the projects to be completed within this fiscal year. Within the new scope, the staff of the SDM program are highly committed to meet the data management needs of NOAO and its community. We will keep you posted on our accomplishments as the year and our projects progress.

Santa Cruz, California • April 26-April 30, 2009

The VOEvent Working Group of the International Virtual Observatory Alliance announces the workshop, Hot-wiring the Transient Universe 2. A strong interdisciplinary agenda will engage all aspects of technology, experimental design and information infrastructure for pursuing time domain science associated with astronomical transient events. A primary focus will include the announcement of transients and their rapid follow-up using robotic and human directed telescopes, as well as the acquisition and scientific curation of archival time series data. Published proceedings will capture a panoramic snapshot of the state of the art of real-time astronomy.

Astronomical transients occur at a scale from the local solar system to Galactic to cosmological. Transients arrive via electromagnetic radiation, gravitational waves, neutrinos and other particles. Discoveries are made via spacecraft and by ground-based surveys, through automatic pipelines and the Virtual Observatory, with robotic telescopes and by the human eye. Meeting the challenges of the time domain demands this new empirical framework for carrying out the art and science of astronomy.

Organizing Committee
Rob Seaman, National Optical Astronomy Observatory
Steve Allen, UCO/Lick Observatory
Alasdair Allan, University of Exeter
Scott Barthelmy, NASA Goddard Space Flight Center
Joshua Bloom, University of California, Berkeley
Robert Denny, DC3-Dreams
Matthew Graham, California Institute of Technology
Norman Gray, Universities of Leicester and Glasgow
Frederic Hessman, Georg-August-Universität Göttingen
Roy Williams, California Institute of Technology

Registration, hotels and information:
http://www.cacr.caltech.edu/hotwired2

The VOEvent Working Group of the International Virtual Observatory Alliance announces Hot-wiring the Transient Universe 2, a time domain astronomy workshop (see above). This is a sequel to the highly successful 2007 "Hotwired" workshop.

For registration, hotels, and workshop information, see the Web site at: *www.cacr.caltech.edu/hotwired2*.

The workshop engages all aspects of technology, experimental design, and information infrastructure for pursuing science related to astronomical transient events and time varying phenomena. A primary focus includes the announcement of celestial alerts and their rapid follow-up using robotic and human-directed telescopes, as well as the acquisition and scientific curation of archival time-series data. VOEvent-related technologies provide the framework for efficiently connecting new giant surveys, such as the Dark Energy Survey, to follow-up facilities in NOAO's emerging US System of telescopes.

>>>CTIO
CERRO TOLOLO INTER-AMERICAN OBSERVATORY

Filling out the SOAR Instrument Complement

Steve Heathcote & Chris Smith

The year 2009 will be a seminal year for SOAR. As one of the two southern 4-meter-class telescopes available to the US community through NOAO (NOAO has 30% time), SOAR plays a critical role in providing community access to the rich scientific opportunities in the skies of the Southern Hemisphere.

In semester 2009A, the fraction of time on SOAR scheduled for science has increased to 80% (from 60% in 2008B), significantly increasing the number of nights available at this telescope through NOAO.

The remaining engineering time is being used for instrument commissioning, with completion of work on the fourth of SOAR's first-generation instruments anticipated during 2009. This initial instrument suite provides work-horse capabilities for optical imaging (SOI), optical spectroscopy (Goodman High Throughput Spectrograph), infrared (IR) spectroscopy (OSIRIS), and IR imaging (currently OSIRIS, very soon Spartan IR Camera). During 2009-2010, the SOAR instrument suite will be expanded with two instruments, augmenting both spatial resolution (with adaptive optics (AO)) and spectral resolution.

To help the community prepare proposals for the 2009B semester, and plan science programs for future proposals, we briefly present below the current and planned instrumentation at SOAR.

Current Instrumentation

SOI: The SOAR Optical Imager, built at CTIO, has been in regular use since 2004, initially for commissioning and subsequently for science activities. It routinely delivers images comparable to, or better than, the prevailing seeing, while the blue optimized optics provide excellent transmission, even down to the atmospheric cutoff.

OSIRIS: The Ohio State Infrared Imager and Spectrometer, fitted with a 1K × 1K Rockwell HgCdTe array purchased by CTIO, was moved to SOAR after several years of use on the Blanco 4.0-meter and CTIO 1.5-meter telescopes, becoming available for science on SOAR in the 2005B semester. It provides both an imaging and a modest-resolution, near-infrared spectroscopic capability (up to $R = 3000$).

Goodman HTS: The Goodman High Throughput Spectrograph, built at the University of North Carolina, supports low- to medium-resolution ($R \sim 1400$–6000) spectroscopy, achieving high throughput in the 320–800 nanometer region through the use of Volume Phase Holographic gratings and an all-transmissive optical design. The imaging and single-slit spectroscopic modes came into regular science operation for the 2008B semester. Work to implement its multi-slit capabilities will proceed during 2009.

Spartan IRC: The Sparten Infrared Camera was designed and built by Michigan State University. This 4K × 4K near-IR imager saw first light in November 2008 and is currently undergoing commissioning. It produces outstanding J, H, and K broadband images exploiting SOAR's excellent image quality. Science verification testing, with community involvement, will be carried out during 2009B, and regular science use starting with the 2010A semester. (Related article in this section.)

Future Instrumentation

SAM: The SOAR Adaptive Module is designed to enhance the telescope-delivered image quality by correcting the turbulence in the first 5–10 kilometers of atmosphere, halving the image size during appropriate atmospheric conditions, expected to occur about half the time. SAM will incorporate an ultraviolet (UV) laser guide star (LGS) working in Rayleigh backscatter mode, with laser pulses and shutter timings coordinated to select the altitude of the reflection used for the wavefront correction. It is expected that commissioning of the SAM in natural guide star mode will begin in the 2009B semester. Full availability, including use of the (LGS) is expected by the end of 2010. (Related article in this section.)

SIFS: The Brazilian-built SOAR Integral Field Unit Spectrograph is entering its final phases of assembly and testing, and it is expected to be delivered to SOAR in early 2010. SIFS employs a 1300-element microlens array coupled to a fiber-optic bundle to dissect a small patch in the SOAR focal plane, feeding the light to a bench-mounted spectrograph. SIFS will produce moderate dispersion ($R \sim 1000$–$30{,}000$) spatially resolved optical spectra. Initially, SIFS will be mounted on a direct port producing seeing-limited spectral images. However, it is expected to achieve its maximum potential when mounted on SAM, allowing it to exploit the AO-corrected images delivered by the LGS.

STELES: The SOAR Telescope Echelle Spectrograph is a beam-fed, high-resolution spectrograph, optimized for work at blue/UV wavelengths. The design work on this second-generation instrument is well advanced, and fabrication work is slated to begin once SIFS is completed.

BTFI: The Brazilian Tunable Filter Imager employs a novel tunable filter based on Volume-Phase Holographic gratings to perform low-resolution spectral imaging, as well as a more conventional Fabry-Perot etalon for higher spectral resolution. Although BTFI can be used stand-alone, using natural seeing images, it will primarily be used in conjunction with SAM to produce AO-corrected spectral images. BTFI is being developed and funded entirely by Brazil for the use of its own community. However, if demand is sufficient, it is our intention to negotiate with Brazil concerning access for the NOAO community, once BTFI has been successfully commissioned.

Spartan Commissioning

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

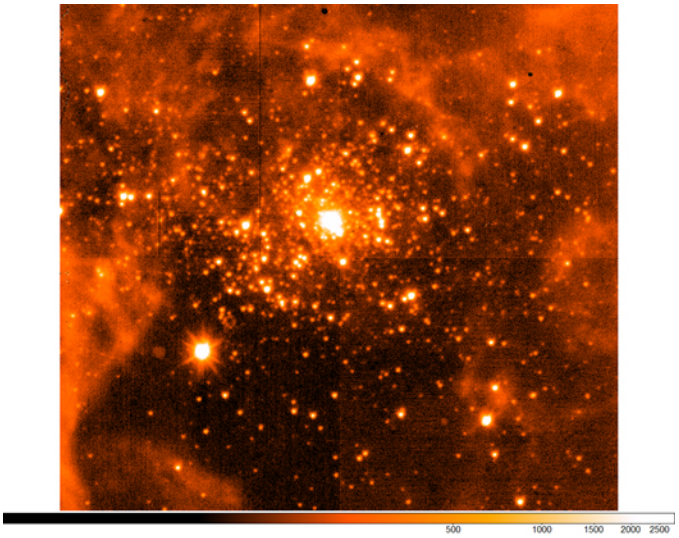
The Spartan Infrared Camera had a successful first light on the Southern Astrophysical Research (SOAR) 4.1-meter telescope in mid-November.

Built at Michigan State University under the direction of Ed Loh, Spartan has two plate scales, 43 milliarcseconds per pixel with a 3 × 3-arcminute field and 68 milliarcseconds per pixel with a 5 × 5-arcminute field, with a spectral range of 0.9–2.5 microns.

Following delivery to SOAR in early October, the instrument underwent a series of laboratory tests to ensure its health on arrival, before mounting it on the telescope to prepare for its first use. The instrument is now in the process of being commissioned, with three engineering runs carried out to date. These have focused mainly on characterizing the detectors and exploring the on-sky performance of the imaging optics and tip-tilt guider. The accompanying figure shows an image of the 30 Doradus nebula taken during the second of these runs and attests to the good progress being made. Commissioning activity will continue during the remainder of this (2009A) semester.

Spartan has a focal plane consisting of four "HAWAII2" 2048 × 2048-pixel HgCdTe detectors. Currently, two of these are Engineering grade, but they will be replaced with new Science grade arrays when those are delivered in the next few months. At the same time, the present compliment of broadband Y, J, H, and K filters will be supplemented with a set of narrowband filters (purchased by Cassio Leandro Barbosa of UNIVAP, Brazil) recently received in Chile.

Spartan has not yet been characterized to allow it to be offered through the regular 2009B call for proposals, especially given the upcoming detector and filter upgrades. However, we anticipate inviting the NOAO community to participate in Science Verification Testing during that semester through a special call for proposals (stay tuned for further information in the NOAO e-newsletter *Currents*!). In addition, during the scheduling process, we will evaluate successful imaging proposals for the Ohio State Infrared Imager and Spectrometer (OSIRIS) and will offer Spartan as an alternative if, at that time, it appears to be better matched to the science program.



Spartan Infrared Camera image of R136, the massive star cluster at the center of the 30 Doradus nebula in the Large Magellanic Cloud. Thousands of stars, crowded together in the recently-formed central cluster, illuminate the surrounding remnants of the giant molecular gas cloud from which they formed. This K-band (2.2-micron wavelength) image was taken on Spartan's second commissioning run on the SOAR telescope. The area shown is 150 arcseconds across and is only 1/4 of Spartan's full field of view. Picture credits: E. Loh & J. Baldwin, MSU

The 2009 CTIO REU/PIA Program

Ryan Campbell

Monday, 12 January 2009 was the start of CTIO's 14th Research Experiences for Undergraduates (REU) and Practica de Investigación en Astronomía (PIA) program. During this 10-week program, six US students and two Chilean students spend the Chilean summer working and living at the CTIO compound in La Serena. And, not only do 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: Tracy Becker (Lehigh University), Will Flanagan (University of Colorado-Boulder), Danielle Nielsen (Colby College), Jordan Mirocha (Drake University), Ben Moore (Xavier University of Louisiana), and Shannon Dealman (Clemson University). The PIA

continued

The 2009 REU and PIA students and CTIO REU Director Ryan Campbell. From left to right: Will Flanagan, Jacqueline Seron, Ryan Campbell, Shannon Dealman, Marcela Espinoza, Danielle Nielsen, Ben Moore, Tracy Becker, and Jordan Mirocha.

The 2009 CTIO REU/PIA Program continued

students for 2009 are Jacqueline Seron (Universidad de Concepción) and Marcela Espinoza (Universidad de La Serena).

Mentors for the students are an integral part of the program. As such, Ryan Campbell, the new REU/PIA director, would like to thank this year's participating mentors: Tim Abbott, Roberto De Propris, Jayadev Rajagopal, Susan Ridgway, and Nicole van der Bliek from CTIO; Luciano Fraga and Steve Heathcote from SOAR; and Bryan Miller, Gelys Trancho, and Bernadette Rodgers from Gemini. NL

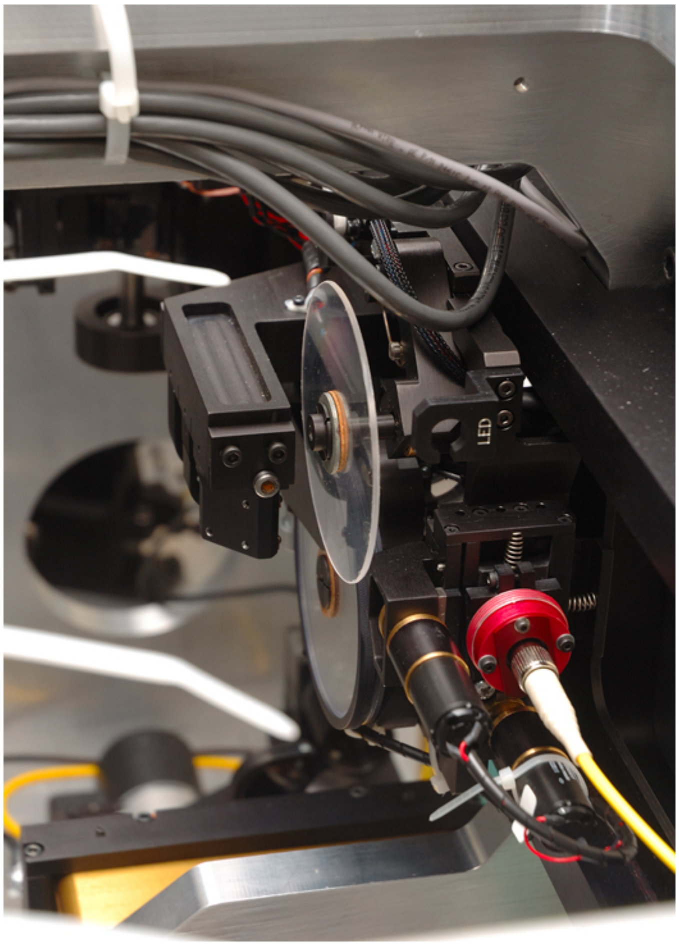
First Integration, Alignment & Testing of Complete SOAR Adaptive Module

The SAM Team

As reported in the December 2008 *NOAO/NSO Newsletter*, integration, alignment, and testing of the SOAR Adaptive Module (SAM) was taking place during the second half of 2008. On the evening of Thursday, December 18, integration and alignment of the last subsystem, the built-in turbulence simulator (TurSim), was completed (see figure, below). TurSim was mounted into the SAM Main Module in its designed location and at nominal focusing position of its dovetail rail (see figure, right). Image and pupil were almost aligned and in correct location in Z, the focus position. The next morning, December 19, the TurSim electronics were connected, the engineering graphical user interface was set up, and we were able to control all of the TurSim functions. Note that there are seven motors plus light sources to control in TurSim alone.

That same afternoon, we were able to close the loop on turbulence generated by TurSim. The loop is robust and the closed-loop image at the SAM Imager focal plane is clearly corrected to the near-diffraction limit as measured by Wavescope.

TurSim mounted into the SAM Main Module (left), and Optical Engineer Roberto Tighe working on the integration and alignment of TurSim.



Congratulations to the whole SAM team, especially everyone from the design, drafting, instrument shop, electronics, and optics groups for making this happen.

Meanwhile, the instrument has been taken completely apart. After making some modifications to the main module, the instrument will be anodized and painted before being reassembled. The achievements of late 2008 put SAM well on track for first light at the telescope later this year.

WIYN's One Degree Imager: About a Year to the Start of Commissioning

Daniel Harbeck (University of Wisconsin Madison/WIYN), Pierre Martin (WIYN) & George Jacoby (NOAO)

The One Degree Imager (ODI) is the future flagship instrument of the WIYN Observatory (see June and December 2006 issues of the *NOAO/NSO Newsletter* for previous updates on ODI). This innovative instrument will use an 8 × 8 array of Orthogonal Transfer Array (OTA) CCD detectors to sample a one-degree field of view with about one billion pixels. Additional electronic tip/tilt image motion correction is expected to improve the median image quality by 0.1 minute in the r' band (see accompanying box on OTA devices for details). ODI will be *the* wide-field, high-resolution imager in the US. The project has made substantial progress during the last few years. Installation of ODI at WIYN is scheduled for early 2010, with science commissioning following later in the year. ODI might be offered for shared-risk science operations as early as the end of semester 2010B. *(Disclaimer: Because all projects can suffer delays, do not base your entire career on dates presented in this article.)*

Figure 1: Instrument maker, Ron Harris, standing behind the aluminum Atmospheric Dispersion Compensator (ADC) housing. Three triangular shaped outrigger blocks will bolt to the housing to form the main structural component to which filter mechanisms and axles, ADC cells, and Dewar will mount. When completed, the housing will weigh 170 pounds with overall dimensions of 37 inches across the flats by 6.26 inches thick.

Status of ODI

The ODI project has made significant progress in all aspects of the instrument since the last *NOAO/NSO Newsletter* article two years ago. The design of the instrument is finalized, and all major system reviews have been successfully completed. (Separate design reviews were held for the Instrument Support Package, Dewar and focal plane assembly, and the software.) At NOAO, machinists and instrument builders have spent the past year working on ODI's backbone, the instrument support package (ISP) (see figure 1). All of the large aluminum and steel parts of the instrument have now been manufactured.

Almost all major component procurement items have been contracted: the optics are being manufactured by Société Européenne de Systèmes Optiques (SESO, France). ODI's optical system consists of a two-element field corrector (two Fused Silica lenses) and an atmospheric dispersion compensator (four wedges: two made from Fused Silica and two from flint glass PBL6Y) (figure 2). Parts of the optics are ready for shipment as of this writing. A California firm, Infinite Optics, will treat the optics with high-performance, broadband anti-reflection coatings.

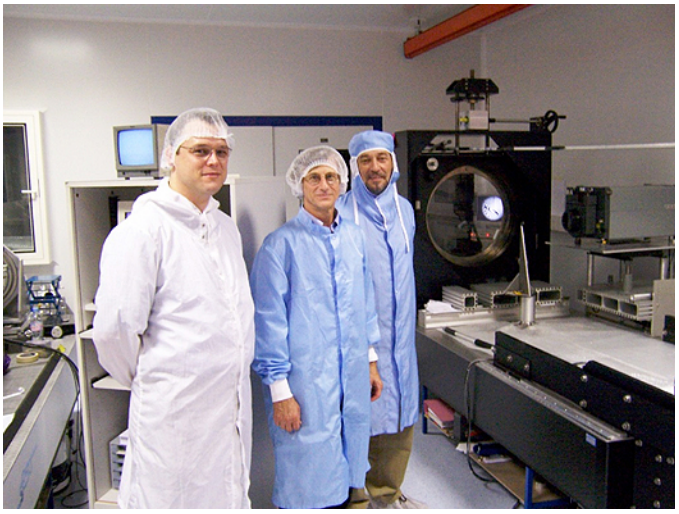


Figure 2: Dan Blanco, George Jacoby, and Daniel Harbeck (from right) visited the optical vendor SESO at Aix-en-Provence during the 2008 SPIE meeting. A wedge for the atmospheric dispersion compensator is mounted in an interferometer (right) to verify its flatness. All optics are anticipated to be delivered by March 2009.

Semiconductor Technology Associates finalized the design of the OTA CCD detectors, and production at the wafer level has been successful at DALSA Corporation. The detectors will be thinned and packaged by Imaging Technology Laboratory (ITL) at the University of Arizona. ITL will also fully characterize the detectors and mount them within the specified flatness requirement onto a custom-made Silicon Carbide focal base plate (Coorstek).

The detector array will be driven by a Stargrasp controller system, purchased from the Institute of Astronomy at University of Hawai´i. The Stargrasp CCD controller was developed to drive OTA detectors for the Panoramic Survey Telescope & Rapid Response System (Pan-STARRS) imagers, and has successfully demonstrated OTA-correction on sky

continued

WIYN's One Degree Imager continued

with the PS1 camera. Substantial work towards the instrument control software design has been done at WIYN. The University of Bonn is under contract to deliver the large mechanical shutter for ODI.

The last major purchase for ODI, the filters, was started in December when we placed the order for SDSS g', r', and i' filters from Barr Associates. In the upcoming month, we will work on the specifications for the remaining four filters: z', U, H-alpha, and O [III].

We are now ramping up for assembly, integration, and testing of ODI during this year with an anticipated start of installation at the telescope in the first quarter of 2010. The next two major milestones in 2009 are the testing of the ODI instrument support package and optics *on the telescope* during the summer shutdown of operations, and the delivery in the fall of the focal plane plate with all detectors mounted.

The WIYN of Change

ODI will be by far the most complex and expensive instrument that WIYN has seen so far, and its integration at WIYN will certainly have an impact on operations. Most foreseeable, there will be a change in the port allocation. WIYN has two major ports in use, the two Nasmyth ports. Hydra, the multi-object spectrograph, currently occupies one of these ports. The other (named the "WIYN" port) hosts the Instrument Adaptor System (IAS) to which all other instruments are currently mounted (i.e., SparsePak, MiniMo, OPTIC, WHIRC, and visitor instruments). ODI will be permanently mounted at this "WIYN" port. The current Hydra port will then be shared between Hydra and the IAS in about two month-long time blocks. Whenever the IAS is mounted, sensitive parts of Hydra will ride on a cradle on the telescope fork. When Hydra is mounted, the IAS will be completely removed from the telescope.

ODI might lead WIYN to develop new, efficient observing modes. For example, we currently are investigating operating ODI in a queue mode, which would improve quality of data and calibration products, but could also *ensure* the success of the highest ranked projects (compared to betting on good weather). Similarly, diverse options are being explored to offer data reduction pipelines and support thereof to ODI users. The WIYN Board has authorized the hire of two dedicated scientists to support the study of the development of a data pipeline system and a queue observing mode for ODI.

What Are OTAs and How Can They Help Us?

Orthogonal Transfer Array CCD detectors (OTAs) were developed by Lincoln Labs and John Tonry in order to provide a detector that could assist in the process of maximizing the delivered image of every science exposure (e.g., Tonry et al. 2002, SPIE, 4836, 206). Each OTA device consists of an 8 × 8 array of CCD cells that can operate as an almost independent detector.

For ODI, each of these cells will cover approximately one square arcminute on the sky. The pixel structure in these CCD cells allows the charge to be moved up/down and left/right during integration, not just during the read-out of the array. Even better, the behavior of each cell can be controlled largely independently. While some cells of a detector might integrate light like a normal CCD, others can be repeatedly read out at video frequencies (about 20 Hertz). The basic proposed operating mode for OTA detectors is that cells with bright stars (about 12–14th magnitude) are read out in video mode, and the image motion as sensed by these stars would be used to shift the charge in the integrating cells to compensate for that image degradation. Thus, OTA detectors are the electronic equivalent of a tip/tilt mirror system. The following operating modes are envisioned for ODI:

Static imaging: ODI is used as a conventional, large CCD imager. Guide stars can be used for telescope guiding.

Coherent correction: A single correction for unwanted image motion is determined for and applied over the entire field of view. This correction is derived from the correlated motion of guide stars in the corners, correcting for telescope guide errors and windshake. We expect this to be the workhorse mode of ODI for its low overhead needs.

A variation of this mode would shape the point-spread function into squares, allowing high-precision photometry. (See related article, "What are Orthogonal Transfer CCDs Good for Anyway?")

Local correction: Image motion is corrected locally based on the nearest guide star's motion signal. In addition to the correlated motion, effects of atmospheric turbulence could be corrected. This mode will provide the best possible image quality at the cost of increased data reduction efforts and observing overhead.

Shutterless photometry: Guide stars are science targets, and their video stream is used to derive shutterless photometry at rates from 0.1 to 20 Hertz.

Non-sidereal tracking: The guide stars are used to derive a telescope-tracking signal for non-sidereal guiding (solar system science).

If the concept of OTA detectors in a wide-field imager sounds familiar, you might be reminded of Pan-STARRS. Their cameras will utilize the same detector concept, and there is a close collaboration between the ODI team and the Pan-STARRS camera team in the detector and camera development effort (see *pan-starrs.ifa.hawaii.edu/public/* for more information on Pan-STARRS).

WIYN's One Degree Imager continued

ODI in the System

ODI will be a significant addition to the US System and will give us a unique wide-field imaging capability in the Northern Hemisphere. However, ODI will not be the only wide-field imager in the world. In fact, over the next ten years there is an entire ecosystem of optical, wide-field imaging capability developing (or already extant).

So where is ODI's niche in this highly competitive environment?

First, ODI offers open access to wide-field imaging for individual proposers: ODI is not dedicated for a single survey, but was conceived as an instrument supporting more numerous programs. Together, the Dark Energy Camera (DECam) and ODI will provide comprehensive wide-field imaging access in both hemispheres to the US community. ODI will be permanently mounted at one of the WIYN's Nasmyth ports. A paradigm in ODI's planning was not to compromise on image quality. The optical design, which includes an atmospheric dispersion compensator, and the use of OTA detectors underline this effort. ODI's key contribution to the US System will be wide-field, high-resolution optical imaging. The WIYN/ODI system should have good sensitivity in the blue optical bands (>45 percent in the U-band), which might fill a gap in available capabilities. WIYN's slow f/6.3 beam enables the use of narrowband filters, allowing programs not possible with many of the other wide-field imagers. ODI will hold up to nine filters simultaneously. Filter replacements will be possible on the timescale of a few hours. Filters for ODI will be very expensive, and, at least initially, the total number of available filters will be small and can be accommodated in the instrument.

From a national perspective, there is also a strategic value of ODI and DECam to pave the way toward efficient use of LSST. Valuable lessons will be learned about the acquisition, handling, and reduction of large data volumes. Even smaller programs done with Gigapixel cameras will most likely require data reduction strategies that rely on distributed computing; there is a need for a new generation of data reduction frameworks.

ODI is partly supported through NSF Telescope System Instrumentation Program (TSIP) funds. As a part of the TSIP agreement, Yale is planning survey projects that will involve the community—90 nights are already committed to these programs, and this total may increase. For further information, please contact Charles Bailyn (*charles.bailyn@yale.edu*).

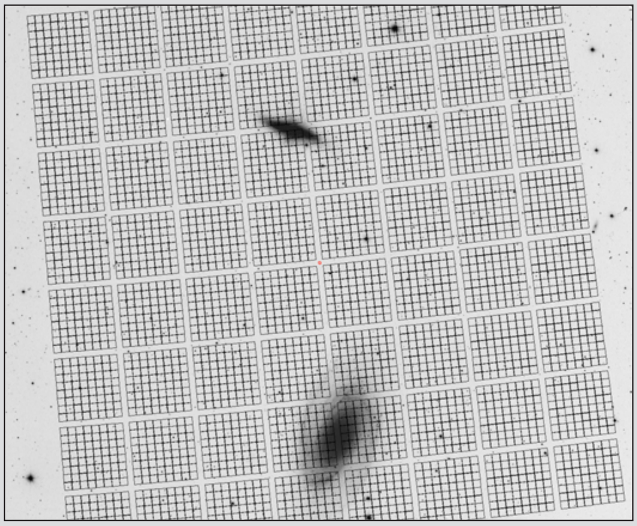


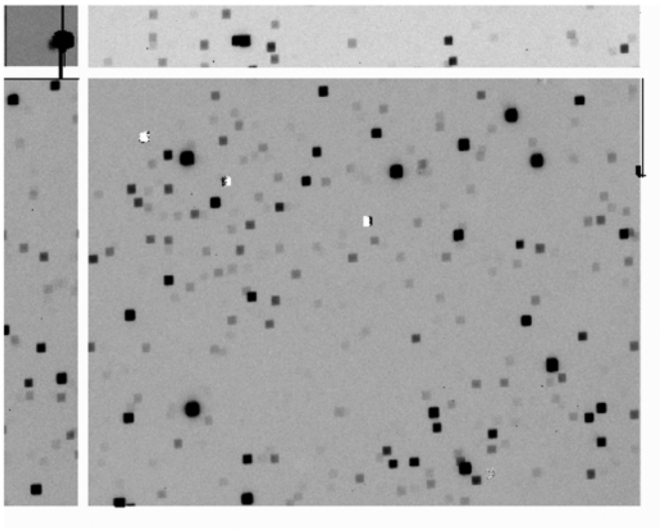
Figure 3: Predicted footprint of ODI illustrated at the M81/M82 group. Each of the 64 detectors is divided into a grid of 64 almost-independent CCD cells. The gaps between the cells are of order of 3 arcseconds, and the gaps between the detectors are about 45 arcseconds.

What are Orthogonal Transfer CCDs Good for Anyway?

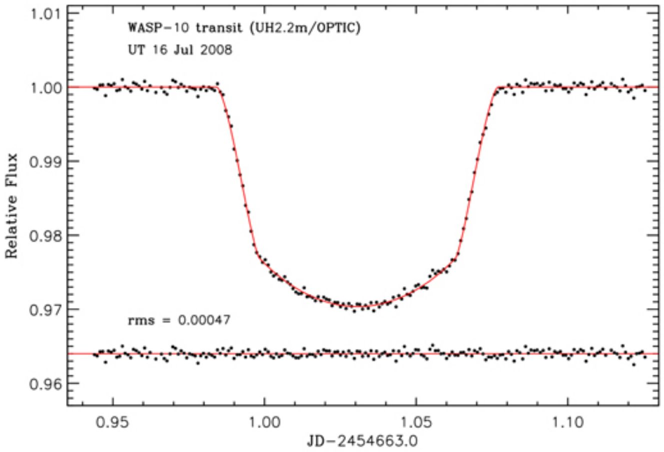
Steve Howell

Kitt Peak National Observatory is home to the first general-use orthogonal transfer CCD (OTCCD) camera. The Orthogonal Parallel Transfer Imaging Camera (OPTIC) has been in service at the WIYN Observatory for over five years now, spending nearly half the time on Kitt Peak and half the time on Mauna Kea at the University of Hawaiʻi 88-inch telescope. OPTIC was built by John Tonry (University of Hawaiʻi) and makes use of the new OTCCDs developed by Tonry in collaboration with Massachusetts Institute of Technology Lincoln Labs. Originally developed as a means to provide low-order tip/tilt corrections through the use of one or more bright guide stars, OTCCDs have been used for a number of other purposes. Their performance as tip/tilt imagers equals that of low-order mechanical systems, albeit easier to set up and use. There are no moving parts—the collected electrons are merely moved during integration to follow the atmosphere.

One of the most promising uses of OTCCDs, as demonstrated by OPTIC both at WIYN and at the University of Hawaiʻi 88-inch telescope, is for the collection of ultra-high-precision, high-speed photometry. Since OTCCDs have the ability to move the collected charge during an active exposure, Howell et al. (2003, PASP, 115, 1340) put this idea to work in the form of purposely forming square stars in the image (see below).



The idea was to collect as many photons as possible without saturation as well as form a very stable point spread function. All stars in the image are formed into the same shape, and extracting differential photometry of the stars of interest leads to the elimination of almost all systematic and atmospheric effects, producing the highest ground-based photometric precision routinely obtainable. A striking example of such work is the light curve of the transiting exo-planet WASP-10 obtained by Johnson et al. (2008, *adsabs.harvard.edu/abs/2008arXiv0812.0029J*). The graph below shows the transit light curve and the amazing precision obtained, rms = 0.00047 magnitude.



So why are we showing off OTCCDs? Well, if you have not heard, the WIYN Observatory is about one year away from beginning the commissioning of a one-degree imaging camera that will contain OTCCDs as the detectors. Imagine the potential of the One Degree Imager if such high-precision, time-series photometry could be gathered all at once over a one-degree field of view. Open clusters and planet searches come to mind right away, but many additional scientific projects will be enabled as well.

Further information on OTCCDs at WIYN can be found in the December 2008 *Newsletter* article "QUOTA—A Prototype Camera for the WIYN One Degree Imager" and in this issue's "WIYN's One Degree Imager: About a Year to the Start of Commissioning."

The Birth of Our National Observatory

Elizabeth Alvarez del Castillo & Buell T. Jannuzi

The golden anniversary of the birth of Kitt Peak National Observatory (KPNO) celebrates the realization of a landmark concept that led not just to KPNO, but also to the National Solar Observatory, Cerro Tololo Inter-American Observatory (CTIO), and access to a system of international and non-federally funded facilities (e.g., Gemini, Keck, Magellan, MMT). These pictures remind us that with the birth of our national observatory, we celebrate a system open to all astronomers based on the merit of their scientific proposals.

Our national observatory helped change our understanding of the universe, advanced telescope and instrument operations and design, and trained a large fraction of our community. As we celebrate our successes of the past 50 years and our plans for the future, we invite you to visit our 50th anniversary Web page at: *www.noao.edu/kp50/*.

(Top to bottom, left to right)
Construction of the McMath-Pierce telescope on Kitt Peak began in March 1960. First light was 1 November 1962. Credit: NSO/AURA/NSF.

The McMath-Pierce telescope on Kitt Peak is still the largest solar telescope in the world. Credit: NSO/AURA/NSF.

The slip-form pier for KPNO's Mayall 4-meter telescope during construction, seen at night when it was about 45 feet high. Credit: D. Crawford and NOAO/AURA/NSF.

The Mayall 4-meter telescope (13 June 2003) on Kitt Peak. Credit: NOAO/AURA/NSF.

This AURA-European Southern Observatory group on horseback at the saddle between Cerro Tololo and Cerro Morado in Chile represents the beginnings of Cerro Tololo Inter-American Observatory. Left to right: Ch. Fehrenbach, O. Heckmann, Sr. Marchetti, J.H. Oort, N.U. Mayall, F.K. Edmondson and A.B. Muller (10 June 1963). Credit: NOAO/AURA/NSF.

The silvered dome of CTIO's Blanco 4-meter telescope rises 13 stories above Cerro Tololo in Chile. Image taken in 2007. Credit: T. Abbott and NOAO/AURA/NSF.

Director's Corner

Steve Keil

Solar Physics and the Decadal Survey
The decadal survey (Astro2010) is now in full swing with an open meeting at the American Astronomical Society Long Beach meeting. Unfortunately, many solar astronomers (including me) usually do not attend this winter meeting, opting to attend the American Geophysical Union conference instead. Thus, if solar science is to find its way into the survey, it is imperative that we find avenues to do so. The first such avenue is the call for white papers by the survey committee at: *www7.nationalacademies.org/bpa/Astro2010_Request_for_Input.html*.

We would like to encourage you individually or in groups to submit white papers on what you believe are hot topics in solar physics. These papers are supposed to be sent to the appropriate Science Frontier Panel(s) at: *www7.nationalacademies.org/bpa/Astro2010_Science_Frontier_Panels.html*. The panels follow:

1. The Cosmology and Fundamental Physics (CFP) Panel
2. The Planetary Systems and Star Formation (PSF) Panel
3. The Stars and Stellar Evolution (SSE) Panel (Solar Physics is in here?)
4. The Galactic Neighborhood (GAN) Panel
5. The Galaxies across Cosmic Time (GCT) Panel

It is not completely clear where the various aspects of solar physics fit in to the panel structure. There are certainly aspects that are fundamental physics, others concerning what the Sun tells us about astrophysical and laboratory processes, and the Sun as driver of phenomena in the Solar System, including space weather. According to Roger Blandford, Astro2010 chair:

"*…the intent [of the white papers] is to help the Science Frontier Panels develop an exciting and scientifically compelling program organized around key questions and areas where we expect future discoveries to be made.*"

He goes on to say:

"Please address your submissions to specific panels and focus on the scientific opportunities. Do try to collaborate with your colleagues. It is the quality of the science, not the number of submissions that is of relevance here and you should aspire to make simple and clear statements that will help the panels and the survey committees write their reports."

The astronomical object most relevant to humanity and life on earth is the Sun. Some of the many reasons for the intense, continuing interest in observing the Sun follow:

The Sun is the nearest and most readily studied astronomical object. Many physical processes that form the foundations of our current understanding of the universe are most accurately observed on the Sun. The Sun is a unique plasma physics laboratory. Its magnetic field configurations and environment provide conditions unattainable in terrestrial laboratories and are close enough to study with precision. The Sun presents us with many important unsolved mysteries and unexplored domains that challenge science.

The Sun sustains life on Earth; it controls our environment and impacts our technological civilization. Understanding and predicting the influences of the Sun on the Earth's climate and on space weather in the near-Earth environment is a major challenge for science. Understanding the Sun and Sun-Earth connection is crucial for understanding planetary systems (solar and extra-solar) in general.

Over the last few decades a remarkable change has taken place in solar physics. The increasing power of numerical simulations, both in hardware performance and through development of new techniques, has transformed the field from a more phenomenological science, describing the appearance of the wide variety of magnetic phenomena, to a solid physical science that investigates their nature and connections between them. At the same time, the advent of adaptive optics on ground-based solar telescopes and high-resolution space-based missions has opened new observational windows that let us examine fundamental processes. These new assets, while greatly enhancing our ability to probe solar phenomena such as magnetoconvection, magnetic field stability throughout the solar atmosphere, and structure and evolution below the surface of the Sun among many others, have also raised many new questions that require new capabilities. For example, nowhere in the Universe is there a better place than the Sun to explore and understand how magnetism directs astrophysical and planetary change. It is crucial that we get these new questions in front of the Decadal Panel, which in turn helps build community support for our projects.

As stated in the call for the white papers, the output of each panel will include a short list of central questions to be answered and a single general area where there is unusual discovery potential. Thus, authors should focus their white papers on the detailed presentation of fundamental and important science opportunities, rather than on broad or general studies. White papers will be of most use to the panels if they identify directly specific, critical questions and opportunities as well as the potential measurements and/or theoretical advances that will address them. Although the white papers are not supposed to dwell on a particular project, when describing the type of measurements needed, it would certainly make sense to link those measurements to a facility such as the Advanced Technology Solar Telescope.

As a community, we need to make this case to the Astro2010 committee, so I strongly urge members of the solar community to submit white papers to the survey.

Changes
It is with regret that we announce that Dr. Aimee Norton has resigned from the NSO to join the faculty of James Cook University in Towns-

continued

Director's Corner continued

ville, Australia, as a lecturer in astrophysics. Aimee served the NSO and the community in the especially valuable role of SOLIS Program Scientist, where she assumed primary responsibility for producing the principal data product of the SOLIS facility—the VSM full disk vector magnetograms. In addition to her invaluable service to the SOLIS program, Aimee carried out an active research program using all the major NSO facilities. Her "aimee-able" nature and keen intellect will be sorely missed by the NSO. However, we can look forward to the new students who will enter the field of solar physics under her mentorship in her new position at James Cook. We wish Aimee and her family all the best in their new lives down under.

ATST Update

The ATST Team

The Advanced Technology Solar Telescope (ATST) passed a series of design reviews in late October and early November 2008, setting the stage for a Final Design Review with the National Science Foundation (NSF) in March 2009. The Enclosure Control System and Mount Control System Design Reviews were held October 29. Next were three Systems Design Reviews (SDRs): Site and Science & Operations Building, November 4; Enclosure, November 5; and Telescope Mount Assembly (TMA), November 6. The NSF review—expected in late March—is intended to identify all risks and define budgets. Team managers also developed a white paper for the NSF describing the project's budget requirements in light of the potential funding available for FY 2009 and also a possible FY 2010 construction start scenario.

While the SDR committees identified several areas where additional work is needed by the team, they generally gave the ATST team high marks. "The review committee is overall very impressed at the level of detail, analysis, and the progress of the ATST project team," wrote the Enclosure SDR review team. "The subsystems are well defined and the overall contracting approach is sound." On the question of whether safety is adequately addressed, the committee concluded, "Definitely. The ATST Project has demonstrated that safety is a pervasive institutional value."

The TMA review committee concluded that, "The documentation presented is to a very high standard and as such places the project in a good position for progressing towards contract placement. There are however a number of areas that still require some work to be fully complete and clear. Sorting out these areas now will make life considerably easier during contract by reducing uncertainty and closing potential loopholes in both the specification and the Interface Control Documents (ICD)'s."

"Both collectively in the SDR meetings and in individual talks with the committee members throughout the week, I heard nothing but praise and words of approval for the ATST team and the work that we've done," said Lead Mechanical Systems Engineer Mark Warner.

"The committee treated us well," noted Systems Engineer Ron Hubbard, "while also giving us lists of improvements that we should make to the details of our document packages, and offering a couple of important suggestions for alternatives to our contracting strategy."

SOLIS

Aimee Norton, Kim Streander & The SOLIS Team

The Solar Optical Long-term Investigations of the Sun (SOLIS) team has made significant progress toward the release of science-grade vector magnetic-field data. In particular, successful fringe-removal algorithms were developed to clean up the spectra because application of conventional fringe-fitting and removal methods resulted in full-disk images that still contained "streaking." Therefore, an improved approach to the fringe removal was employed that uses the observed polarization data itself, rather than the data from the flat-field observations, to fit the fringes. The fringe-removal code was then translated from the format in which it

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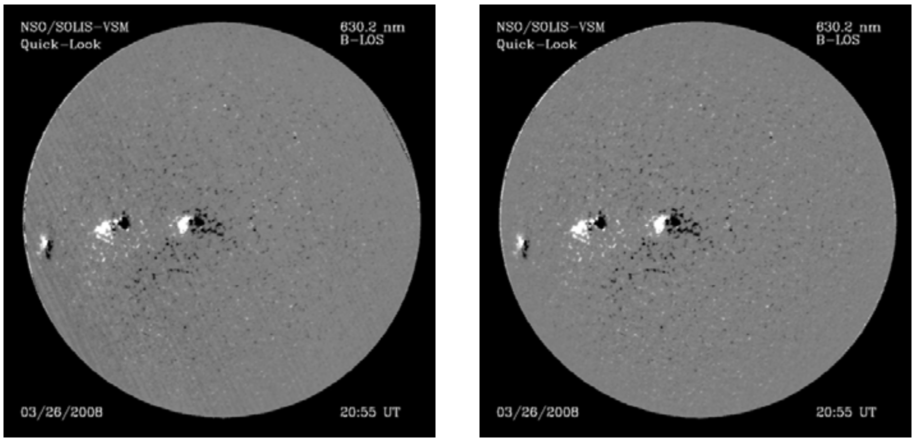


Figure 1: Sample data showing the effect of polarization fringes before (left) and after (right) removal.

SOLIS continued

was written (suitable for diagnostic efforts) to a streamlined code that operates efficiently within the routine processing platform. The first vector quick-look images processed in the pipeline using this code were made available via the NSO SOLIS Web page on 30 December 2008. For an example of Vector Spectromagnetograph (VSM) images before and after fringe removal, see figure 1.

Now that the polarization fringes can be removed with confidence, the SOLIS team members have turned their attention to the testing of the inversion codes to ensure that accurate results are obtained when inversions are performed on full-disk data. An example of the observed vector data, Stokes profiles I, Q, U, and V, and the resulting fits provided by the Milne-Eddington (ME) inversion code can be seen in figure 2.

The conversion of the ME inversion code from a small field-of-view application into a full-disk, large field-of-view application has

continued

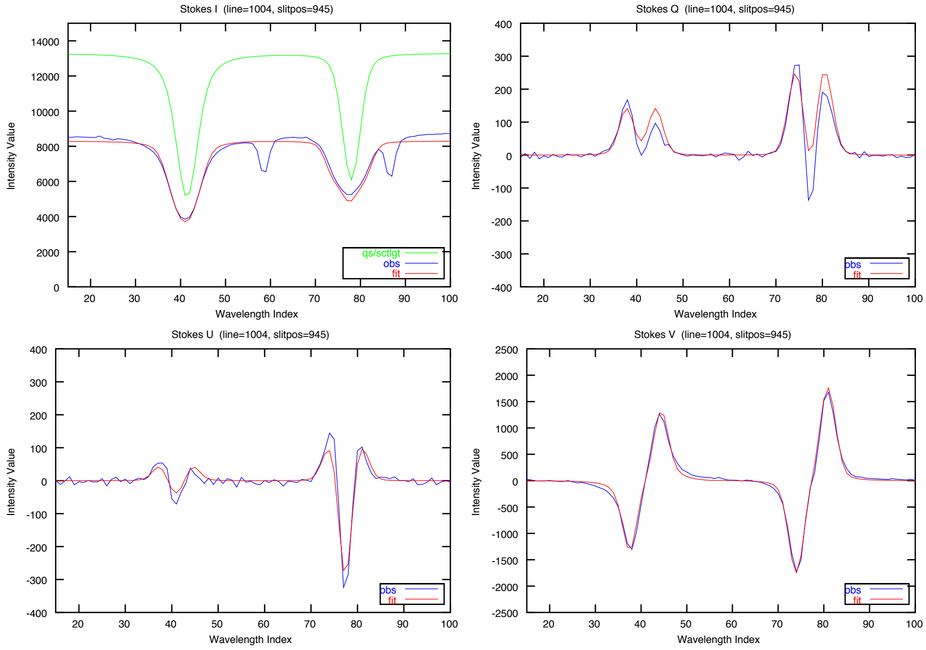


Figure 2: Example of the observed solar Stokes I, Q, U, and V profiles and the fits to these profiles as produced with the current ME inversion code model.

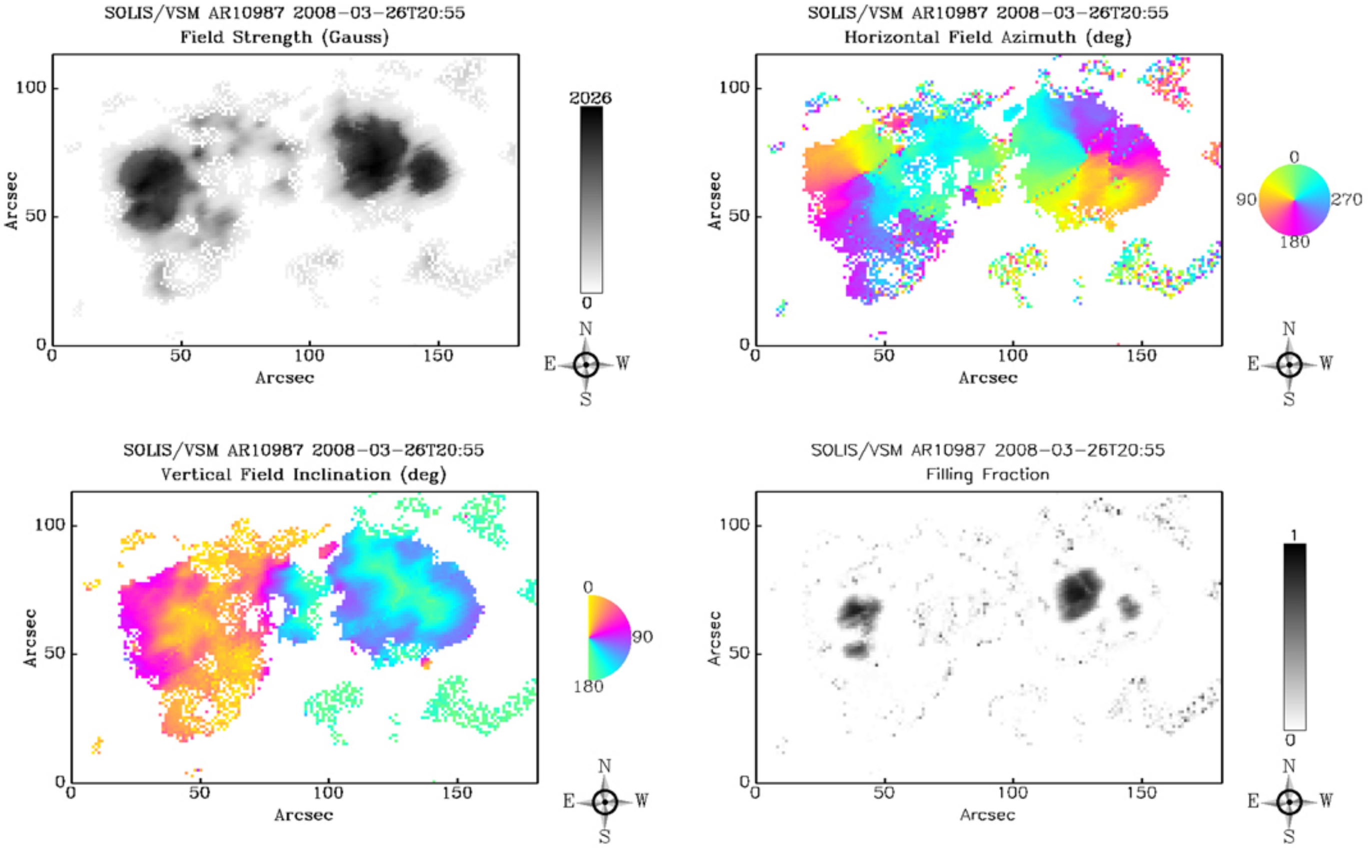


Figure 3: Parameters of a sunspot region as observed by SOLIS VSM near disk-center on 26 March 2008. Magnetic field strength, inclination, azimuth and filling fraction are plotted.

SOLIS continued

been challenging. The inversion of spectropolarimetric data has been traditionally performed for small fields of view on the Sun, and attempts to invert data over the full disk thus necessitated changes in the existing code. In particular, codes for determining quiet-Sun profiles were developed and then optimized to decrease processing time. Quiet-Sun values were put into a table-lookup in order to increase the computational speed by a factor of 15,000. Analysis shows the optimal table size to be around 1000 micron entries (about 0.5 megabytes in memory). In addition, smear-fitting code was developed to determine the best value to use for smearing in the quiet-Sun code for a best fit with the data. Preliminary results from the ME inversion are shown in figure 3 for a selected active region; the sunspot region near disk-center on 26 March 2008 is shown with magnetic field strength, azimuth, inclination, and filling fraction.

In addition to progress made on VSM data processing, the Integrated Sunlight Spectrometer (ISS) data calibration method was compared to that of the McMath-Pierce Solar Telescope when analyzing data taken simultaneously with both instruments. It was determined that if the 2-point ISS calibration method were applied to the McMath-Pierce data set, then there is virtually exact agreement between the K-line parameters, see figure 4.

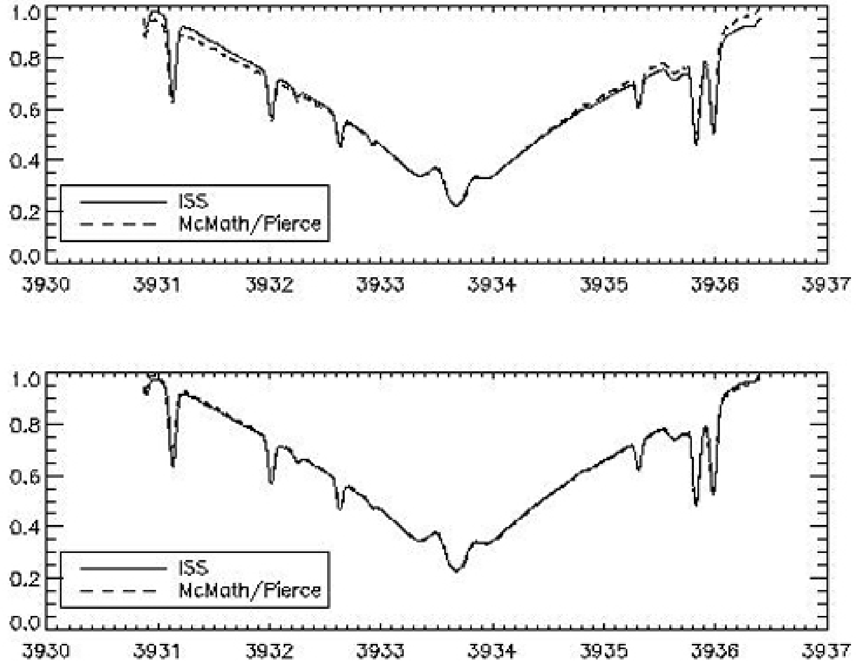


Figure 4: Calcium-K intensity is plotted as a function of wavelength in Angstroms. The upper image shows a comparison of K-line intensity as observed with the SOLIS ISS instrument and the McMath-Pierce main spectrograph before implementing a 2-point calibration method to the McMath-Pierce data. The lower image shows a comparison after the new calibration method is applied.

GONG++

Frank Hill & The GONG++ Team

Introduction

The Global Oscillation Network Group (GONG++) Team is gearing up with the start of the new year. The US Air Force Weather Agency (AFWA) funds for the new H-alpha observing system arrived, and we have begun its development. Scientific advances continue to emerge from the data stream, including one-minute merged magnetograms. Additionally, the third year of our educational program in India is underway.

Science Highlights

Rudi Komm has recently found a signature of emerging magnetic flux in the GONG++ subsurface flow maps. Figure 1 shows the average vertical velocity as a function of depth for 801 active regions classified in a variety of ways. The solid line shows the vertical velocity averaged over all of the regions and all of the observations. The filled squares show the vertical velocity for regions with emerging flux—the 25 percent of regions with the highest increase in flux. Similarly, the filled circles are for regions with decaying flux—the 25 percent with the greatest decrease in flux. The open squares are for the remaining 50 percent of the regions. The plot shows that emerging flux is associated with strong upflows in the deeper layers (10–15 megameters), and weaker downflows near the surface. The decaying flux shows the opposite: stronger downflows near the surface, and weak upflows at deeper depths. This is the first unambiguous indication of a subsurface effect arising from an emerging magnetic field.

Program

The US Air Force Weather Agency (AFWA) has provided funds for adding H-alpha observing capability to the GONG instrument. During the last quarter, Jack Harvey and Neill Mills have come up with an optical and mechanical conceptual design, which is shown in figure 2. Major hardware components for the project have been selected,

continued

GONG++ continued

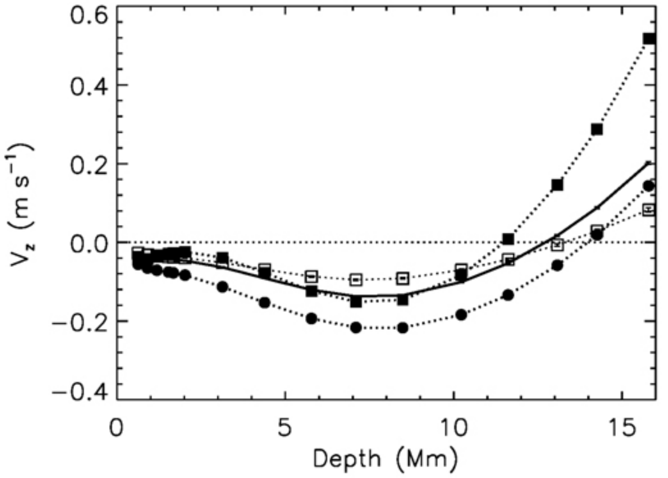


Figure 1: The average vertical velocity as a function of depth for 801 active regions classified in a variety of ways. The solid line shows the vertical velocity averaged over all regions and all observations. The filled squares show the vertical velocity for regions with emerging flux—the 25 percent of regions with the highest increase in flux. Similarly, the filled circles are for regions with decaying flux—the 25 percent with the greatest decrease in flux. The open squares are for the remaining 50 percent of the regions. The plot shows that emerging flux is associated with strong upflows in the deeper layers (10–15 megameters), and weaker downflows near the surface. The decaying flux shows the opposite: stronger downflows near the surface, and weak upflows at deeper depths. Error bars are smaller than the plotting symbols. This is the first unambiguous indication of a subsurface effect arising from an emerging magnetic field.

and now that funds have arrived at the NSO, sample lenses have been ordered. The loan of a camera (with an accompanying H-alpha filter) has been arranged for proof-of-concept evaluation and testing. We will acquire some data to use in the software development, which will be a major part of the observing system. Thanks to the design work and background research already done by Jack, Neill, and George Luis, we should be able to move forward expeditiously.

Network Operations & Engineering

The last quarter of 2008 continued to bring additional problems with Global Positioning System (GPS) receivers. After resolving the problems with the Mauna Loa unit and spare, new software for monitoring the GPS status was installed around the network. However, this revealed that the Big Bear receiver was compromised although working well enough that no data was being lost, the Udaipur spare GPS unit was not usable, and the Learmonth receiver indicated that it was not registering the full complement of satellites. Currently, a functional spare is in transit to Udaipur, and another unit is being readied in Tucson for shipment to Learmonth. Mauna Loa and Big Bear are still without spares, but a working unit can be sent quickly from Tucson if required. We have acquired additional units, but they are not compatible with the current real-time software. Work is underway to modify and test new code that will allow us to employ these newer units.

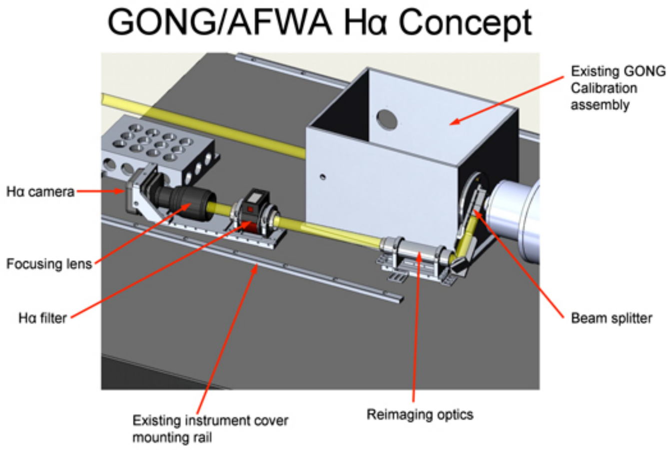


Figure 2: A rendering of the first design of the AFWA-sponsored H-alpha observing system. This system will provide full-disk solar images (2048 × 2048 pixels) at a wavelength of 6563 Angstroms with a 20-second cadence around the GONG++ Network. The data will be returned to Tucson within one minute of acquisition, and ingested into the Air Force Space Weather system at Offutt AFB to provide flare alerts.

The light-feed turret oscillation at Mauna Loa, which appeared to be fixed after the last preventative maintenance visit there, has reappeared, and we now suspect that it could be a result of the colder winter conditions. As it happens, the Tucson instrument is exhibiting similar behavior and is giving us the opportunity to investigate and understand the problem and, we hope, formulate a solution.

Data Operations and Software Development & Analysis

The new Data Management and Analysis Center (DMAC) Magnetogram pipeline will be placed in service within a few weeks. From the fully calibrated GONG site magnetograms, we will generate one-minute cadence network-merged magnetograms and Carrington rotation duration synoptic maps. Similar products are already available as quick-look images, but this is our first formal venture into routine, fully calibrated magnetogram products. The DMAC is also finalizing the Solaris-to-Linux port and testing methods to expedite the site image calibration process.

Processing to date includes time series, frequencies, merged velocity, and rings through GONG Month 135 (centered at 080807), with a fill factor of 0.773. Last quarter, the GONG Data Archive distributed 1500 gigabytes of data. All GONG data products can be obtained at: *gong.nso.edu/data*. NL

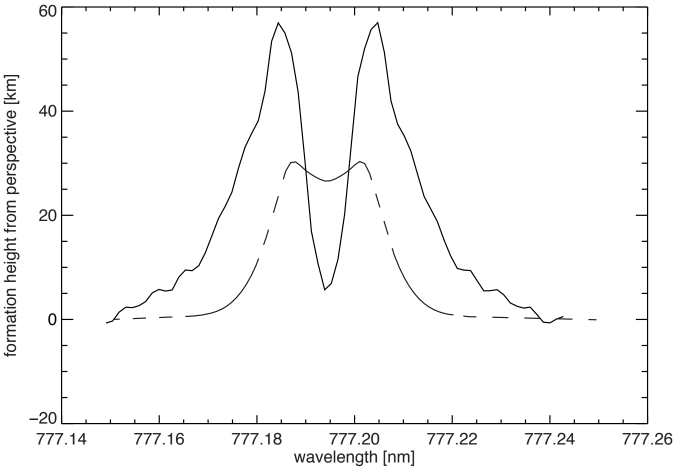
Estimation of O I Line Formation Heights from Perspective Shift Measurements

Han Uitenbroek (NSO/Sacramento Peak), Marianne Faurobert &
Claude Aime (Université de Nice Sophia Antipolis, Nice, France)

If the current rate of decline in its abundance continues, the Sun is estimated to run out of oxygen soon (the "solar oxygen crisis," see Ayres 2008, ApJ, 686, 731). This slightly unconventional interpretation of the data notwithstanding, the problem remains that recent oxygen abundance determinations have resulted in values that are uncomfortably low. These values are in serious conflict with what is considered a well-established, standard solar model determined from helioseismology (Basu & Antia 2008, Phys. Rep., 457, 217), and they no longer match meteoritic values, while results were previously in a consistent range for both cases.

Traditionally, the abundance of an element is determined by fitting the equivalent widths of its spectral lines calculated from a one-dimensional hydrostatic atmospheric model to observed values. This fitting procedure involves a free parameter for line broadening, namely the microturbulence, which, like the abundance, has to be determined from the line fit (increasing the uncertainty in the latter). Only recently has it become possible to employ more sophisticated and realistic three-dimensional atmospheric models taken from hydrodynamic solar convection simulations. These models no longer require the fudge of microturbulence because the convective motions in the simulation account naturally for Doppler broadening over the thermal values. Use of these models caused the solar oxygen abundance to be revised downwards by a factor of almost two (Asplund et al. 2004, A&A, 417, 751). Even though the simulations have no direct free parameters, their realism possibly is impaired still by the choice of physics that can be implemented, and the numerical resolution that can be achieved. These field limitations (and the fact that the three-dimensional oxygen abundance determination is well below values established in other fields) suggest that further tests are required to validate the simulations.

Ideally, observational tests should be as independent of circumstances, instrument, and theoretical model as possible. The good agreement of the precise, convection-induced shape of spatially- and temporally-averaged spectral line profiles between observations and simulations is one example that has been used to argue the realism of the latter. Here we present a different test. It is based on a measurement of the small perspective shift that occurs when two images at different wavelengths in a spectral line, sampling different heights in the atmosphere, are viewed toward the solar limb. The shift is determined from the slope of the phase as a function of spatial frequency in the Fourier transform of the correlation between the two images, and it is therefore independent of telescope resolution and seeing conditions. To ensure perfect instrumental alignment between images at different wavelengths, the images were constructed by sampling slit spectra along the dispersion direction while the slit was positioned away from disk center, oriented in the direction of the offset towards the limb.



The perspective shift of images taken at different wavelengths through the O I 777.19 nanometers line, relative to the continuum image. Observation (black curve) at a relative radius of R = 0.5 in the N-S direction, simulation (dashed) at the equivalent viewing angle.

On 5 July 2008, we used the horizontal spectrograph at the NSO/Dunn Solar Tower to take slit spectra of the O I triplet at 777 nanometers at several positions on the disk with radial positions of R = 0, ±0.5 in the solar N-S direction, scanning the slit in the E-W direction. Dark- and gain-correction images were constructed at all wavelengths through the three spectral lines. The phase of the Fourier transform of the correlation function between images at successive wavelengths is indicative of their relative perspective shift in the solar N-S direction. This perspective shift can be directly compared with that obtained from simulations. We calculated the emergent spectra in the three oxygen lines from several snapshots of a magneto-hydrodynamic simulation of solar convection at the equivalent viewing angles, and determined the apparent perspective shift of images at different wavelengths through the lines in the same way as in the observations. A comparison of the perspective shift between images through the 777.19 nanometer line determined from observations (solid black) and simulation (dashed curve), respectively, is shown above. It is clear that there are significant differences between the two curves. In particular, in the wings of the line, the formation height of intensities at wavelengths towards the core of the line seems to increase much faster in the real Sun than in the simulated one. This suggests that the density stratification with height falls off much slower in the former than in the latter, and, therefore, seriously questions the appropriateness of the simulations for abundance simulations.

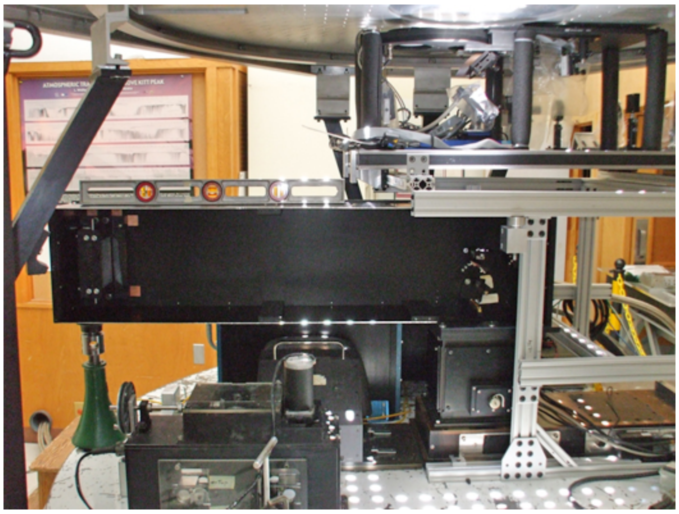
An Integral Field Unit for the McMath-Pierce Solar Telescope

Kim Streander

A state-of-the-art, image slicer Integral Field Unit (IFU) has been developed for the NSO/McMath-Pierce Solar Telescope (McMP). The work has been a joint effort between California State University Northridge, Utrecht University, and the National Solar Observatory.

The IFU samples a small, adaptive-optics-corrected field of view simultaneously for three-dimensional (3-D) spectroscopy and polarimetry. It consists of 19 effective slices that correspond to a field of view of 7 × 6.3 arcseconds. The IFU will create a 155–arcsecond-long slit for an existing spectrograph for diffraction-limited 3-D spectroscopy. The 3-D instrument is being used for high-spatial and high-temporal resolution solar imaging, which is crucial for the magnetic field and spectroscopic studies of two-dimensional solar fine structures.

In December 2008, Dr. Deqing Ren (California State University Northridge) performed verification tests at the McMP, see figure. The instrument was then returned to Califortnia in order to apply a gold coating to the mirror and make minor adjustments to the alignment mechanism. The instrument will return in April/May of 2009 to be commissioned as a user instrument.



IFU (large black box) during verification testing. Note the universal mounting platform with adaptive optics that is used in conjunction with the IFU.

Second Quarter Deadline for NSO Observing Proposals

The current deadline for submitting observing proposals to the National Solar Observatory is February 15 for the second quarter of 2009. Information is available from the NSO Telescope Allocation Committee at:

P.O. Box 62, Sunspot, NM 88349
for Sacramento Peak facilities
(*sp@nso.edu*), or

P.O. Box 26732, Tucson, AZ 85726
for Kitt Peak facilities
(*nsokp@nso.edu*).

Instructions may be found at *www.nso.edu/general/observe/*. A Web-based, observing-request form is available at *www2.nso.edu/cgi-bin/nsoforms/obsreq/obsreq.cgi*. Users' manuals are available at *nsosp.nso.edu/dst/* for the Sac Peak facilities and *nsokp.nso.edu/* for the Kitt Peak facilities. An observing run evaluation form can be obtained at: *ftp.nso.edu/observing_templates/evaluation.form.txt*.

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

The Sunspot Solar System Model

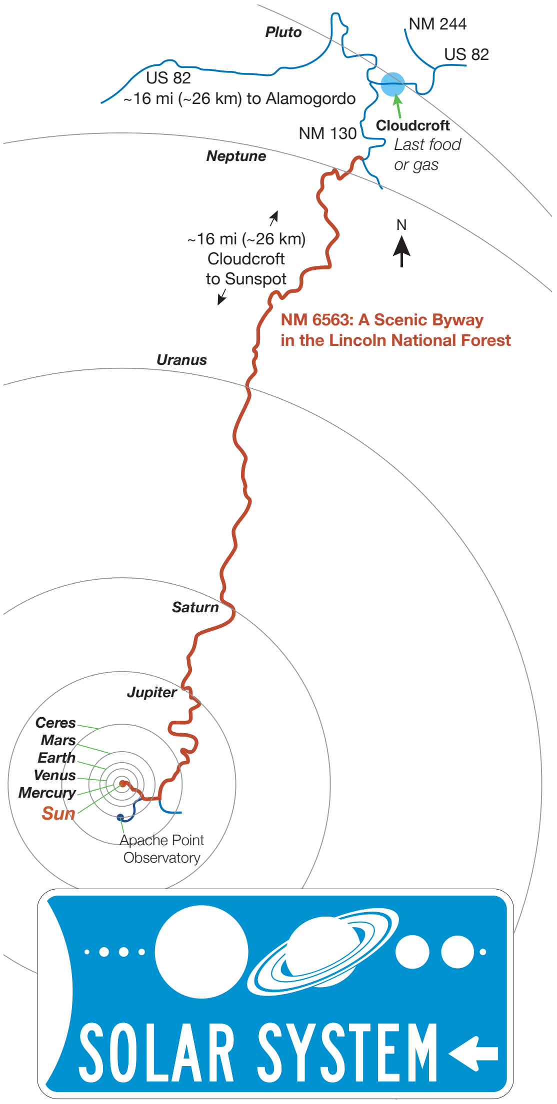
Dave Dooling

The National Solar Observatory (NSO) will bring the Sun and planets down to Earth with the quarter-billion-scale Sunspot Solar System Model centered at Sunspot, New Mexico, and extending outward. It will be funded by a $75,000 grant from the New Mexico Tourism Department as part of capital outlay funding sponsored by State Senator Vernon Asbill of Carlsbad, NM. As part of its contribution to the International Year of Astronomy 2009, the model will draw more tourists and students to Sunspot to learn about the importance of studying and understanding solar activity and the NSO's role in it.

The model uses the popular community solar system concept where astronomical societies, universities, and museums place models of the planets on a path leading from a museum or other feature and tailored to that area's geography. In like manner, this model places the Sun at the Sunspot Astronomy and Visitors Center and uses an existing corridor, the Sunspot Scenic Byway, NM 6563, with signs indicating the orbits of the planets to draw visitors inward. The 1:250-million scale model was set by having Neptune pass through the New Mexico Museum of Space History in Alamogordo. Pluto's orbit is eccentric enough that it transits Cloudcroft, a tourist destination that visitors must pass en route to Sunspot, and recreational attractions along NM 6563.

Because NM 6563 is a two-lane mountain road, only minimalist signs will be placed on it for driver safety. Explanatory markers will be placed at existing turnouts. Podcasts will narrate the journey inward. Neptune inward to the asteroid (or minor planet) Ceres will be on NM 6563—the only known state highway numbered for an astrophysical phenomenon (H-alpha light is 6563 Angstroms)—and the inner planets will be on Solar Physics Drive as you enter the observatory grounds.

In the Visitors Center, guests will encounter models of the Sun and planets and new graphics. The planets will be represented by white plastic spheres, ranging from 1/8-inch Ceres to 22-inch Jupiter (with textured 39-inch rings!). Earth is a mere 2 inches in diameter. An 18-foot-wide graphic will represent the Sun with overlays of features as seen through NSO telescopes. The models will not be painted because of the cost and complexity. This allows Sunspot to invite blind and visually impaired visitors to touch them and feel the relative sizes of the Sun and planets. In addition, markers on the walking tour of Sunspot will indicate the relative diameters of giant stars. An 18-foot, cold-air balloon model of the Sun also will be developed for special events at Sunspot and area schools.



Map depicts the Sunspot Solar System Model as it reaches from Sunspot up to Cloudcroft and Alamogordo. The route will be indicated by graphic identifier signs like the inset, which show a traditional (familiar) view of the Solar System.

The Visitor Center will have four new graphics panels to complete the model. *Our Sun from the Inside Out* will depict the solar interior, the complexity of activity at and near its surface, and its reach to the heliopause. The lower section will introduce NSO's various telescopes. *Sizing Up Your Solar System* will present images of the planets at the correct scale of the model (and with reasonably correct colors). *The Goldilocks Star* will place the Sun into the context of other stars. Finally, *A Map of the Universe* will guide visitors from the surface of Earth to the edge of the Big Bang. It is based on the map developed by John Gott and Mario Juric of Princeton University.

Expanding the model across the state will be *Water in the Desert* markers planned for state parks with small star party observatories, and other locales. On the model's scale, most of New Mexico lies between the Kuiper Belt and inner Oort Cloud. The region is populated with icy bodies holding several times the total volume of water on Earth. Finding them though, is like finding water in the desert.

A planned expansion of the model features a second set of planet models surrounding an 18-foot radome in Planet Plaza outside the Sunspot Astronomy and Visitors Center. The model also includes educational activities being developed for middle and high school students.

For additional information, contact Dave Dooling at 575-434-7015 or *dooling@nso.edu*.

International Year of Astronomy Commences

Steve Pompea

The US International Year of Astronomy 2009 (IYA2009) program has been in the planning for almost two years with a team of over 150 astronomy education enthusiasts across the nation working on key areas of astronomy education. IYA2009 is viewed as a grass-roots "full-court press" to reach millions of people in the US with an engaging astronomy experience. IYA2009 began with special events at the American Astronomical Society (AAS) meeting in Long Beach, including participation of the Cincinnati Observatory, one of the oldest public observatories in the country.

The Long Beach AAS meeting featured workshops on "Teaching with the Galileoscope," and "Dark Skies Awareness." It also had invited talks on all aspects of IYA2009, an evening ceremony featuring a ribbon cutting on Second Life, an astronomical sing-along, and a premiere of the PBS documentary "Four Hundred Years of the Telescope."

The US Project office was established several months ago by a grant to the AAS from the National Science Foundation (Principal Investigator Kevin Marvel). That office has funded a half-time coordination effort by IYA2009 Project Director Stephen Pompea (NOAO), work by Project Manager Andrea Schweitzer (Little Thompson Observatory), and program dissemination work by the Astronomical Society of the Pacific. The individual programs and events have been largely self-supporting, as befits a grass-roots effort.

Key NOAO-led projects for IYA2009 include the following:

- Dark Skies Awareness (where both the US and International Cornerstone projects are led by Connie Walker) *www.darkskiesawareness.org*

- Galileoscope project, to provide high-quality refracting telescope kits and educational materials to hundreds of thousands of students (Steve Pompea, Telescope Kits Working Group Chair, with Richard Feinberg, International Galileoscope Chair, and Doug Arion, Carthage College)

The worldwide opening ceremonies were held at the United Nations Educational, Scientific and Cultural Organization (UNESCO) office in Paris, January 15–16. The US was well represented by AAS President John Huchra, IAU Executive Committee Working Group on IYA2009 members Mary Kay Hemenway (University of Texas, Austin) and Doug Isbell (also US Single Point of Contact), IYA2009 Cultural Astronomy Working Group Chair Jarita Holbrook (University of Arizona), Denise Smith and Leslie Lowes (NASA), and IYA2009 Project Director Steve Pompea (NOAO). Also in Paris was US IYA2009 national spokesperson and Franklin Institute astronomer Derrick Pitts. Derrick discussed with the many delegates how museums and planetaria worldwide can work together more effectively to promote astronomy education, as well as some of the lessons learned in Philadelphia on conducting large urban star parties.

Steve Pompea shows IAU President Cesarsky how easy the Galileoscope is to assemble. Credit: D. Isbell.

Brazilian delegate Kepler de Oliveira and Kevin Govender of South African Astronomical Observatory are shown the Galileoscope by US IYA2009 representative Derrick Pitts. Credit: D. Isbell.

Many delegates were shown the assembly of the Galileoscope telescope kit by Pompea, including IAU President Catherine Cesarsky. Since it was cloudy most of the time, the Galileoscope was available for viewing the Eiffel Tower from the front sidewalk of the UNESCO building. Views from the upper floor cafeteria provided engaging views of Paris and of the Observatoire de Paris-Meudon on the outskirts. See *www.galileoscope.org* for more details on the project and for information on how to obtain Galileoscopes.

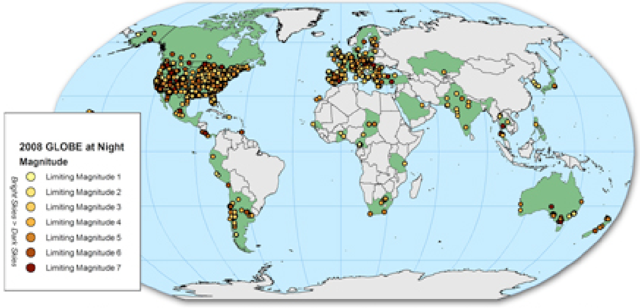
GLOBE at Night: Dark Skies for Everyone

Connie Walker

GLOBE at Night is a fun, international citizen-science event that encourages everyone—students, educators, dark sky advocates and the general public—to measure the darkness of their local skies and contribute their observations online to a world map. The program is a centerpiece of the Dark Skies Awareness Global Cornerstone Project for the International Year of Astronomy (IYA) in 2009. Its goal is to raise public awareness of the impact of artificial lighting on local environments by getting people involved. Data collection and online reporting is simple and user-friendly.

Led by the educational outreach staffs at the National Optical Astronomy Observatory and the University Corporation for Atmospheric Research (UCAR) GLOBE Program, the fourth GLOBE at Night campaign will take place 16–28 March 2009. Partners in the program include the International Dark-Sky Association, the Astronomical Society of the Pacific, the Association of Science and Technology Centers, the Astronomical League, and Astronomers Without Borders.

Over the past three years, tens of thousands of citizen-scientists around the world have contributed measurements of their local sky brightness to a growing global database in two ways: simple unaided-eye observations toward the constellation Orion and quantitative digital measurements through a handheld, well-calibrated, sky-brightness meter.



Shown above are 6,800 observations from the 2008 event.
Help us exceed these numbers in 2009!

For the first method, citizen-scientists take data on light pollution levels by comparing what they see toward Orion, with star maps showing different stellar brightness limits. The basic idea is to look for the faintest stars and match them to one of seven star maps of progressively fainter limiting magnitudes.

For the second method, digital sky-brightness meters are used for more precise measurements. The low-cost, digital Sky Quality Meter (SQM), manufactured by Unihedron, can make a highly repeatable, direct measurement of integrated sky brightness. The newly available second-generation meter (SQM-L) being used this year by several GLOBE at Night sites has a cone-shaped field of view that is three times more narrow than the previous model. This specifically aids its use in city environments, where surrounding lights or buildings may affect the readings. Reporting is done online.

To learn the five easy steps to participate in either type of GLOBE at Night program and to obtain important information on light pollution, stellar magnitudes, the mythology of Orion, how to find Orion, how to obtain your latitude and longitude, and how to use an SQM, see *www.globe.gov/globeatnight/*. All information needed to participate is on the GLOBE at Night Web site, along with downloadable activity guides. All observations will be available online via Google Earth and as downloadable datasets.

Utilizing its partners' international networks, GLOBE at Night is able to engage people from around the world. From 2006–2008, GLOBE at Night successfully conducted two-week campaigns each spring, during which a total of 20,000 observations were submitted online from 100 countries. Within a few weeks after submission, a world map showing the results is available. These measurements can be compared with data from previous years of GLOBE at Night, as well as with satellite data and population density data. Data from multiple locations in one city or region are especially interesting, and can be used as the basis of a class project or science fair experiment, or even to inform the development of public policy.

More measurements made each year and over the next few years will allow for more in-depth analysis. Additional measurements within a city will provide maps of higher resolution. Comparisons between years would allow people to monitor changes. Monitoring our environment this way provides multiple benefits. It helps us as citizen-scientists to identify and preserve dark sky oases in cities or catch a quickly developing area and influence people to make smart choices in lighting. It could allow us to track the habitats of animals endangered by over-lighting. If more and more people took a few minutes during the March 2009 campaign to measure sky brightness either toward Orion with the unaided-eye or toward zenith with a Sky Quality Meter (or both!), their measurements could make a world of difference.

For more information, visit the GLOBE at Night Web site at: *www.globe.gov/globeatnight/*.

Happy star-hunting!

Astronomy Camp Is Coming to Kitt Peak

Katy Garmany

For almost 20 years, Dr. Don McCarthy, Steward Observatory, has run a summer Astronomy Camp on Mt. Lemmon for teenagers. This year the Camp will be moving to Kitt Peak National Observatory to take advantage of additional educational facilities and a lower elevation. Kitt Peak is looking forward to hosting three groups in June. These groups include a week-long Beginning Camp, designed to demonstrate that science and engineering is fun. There is also a week-long Advanced Camp for the more devoted astronomy enthusiasts.


Astronomy Campers from 2008 visiting Kitt Peak National Observatory.

At Camp, students of all ages explore "the heavens" with large telescopes and experience the joys of scientific inquiry. In this immersion experience, Campers become real astronomers, watching the night sky, operating research-class telescopes, keeping nighttime hours, interacting with leading scientists, interpreting their own observations, investigating their own questions and curiosities, and, most importantly, having fun doing so. These Camps emphasize a hands-on learning approach, and activities are driven by student involvement and interest. A prior background in astronomy is not required. During the long June days, students also will hike, experiment with liquid nitrogen cannons, and make friends from all over the country.

Many former Campers return as mentors and Camp counselors, and some are now professional astronomers. Familiar names include Ben Oppenheimer who received his Ph.D. in astronomy from Steward Observatory in 2008, Caitlin Casey who received a Goldwater Scholarship in 2006, and Rob Simcoe who is a postdoctoral Fellow in astronomy at MIT. Even more Campers have gone on to careers in a variety of fields, including teaching, medicine, and classical music.

This year, special effort is being devoted to recruiting Tohono O'odham students who would like to attend the Beginning Camp. In the past, students from the Tohono O'odham Nation have attended on Mt. Lemmon, including the daughter of the current chairman of the Nation. This year, with the Camp being held on Kitt Peak, several scholarships are being offered for teenagers from the Nation.

The Web site for the Camp, *www.astronomycamp.org*, includes information on the telescopes and instruments that will be used, names of many past Campers, and an online application form for any teenagers interested in this year's Camps.