NOAO/NSO Newsletter

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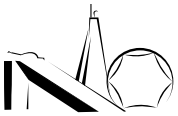


NOAO @ the 209th AAS Meeting

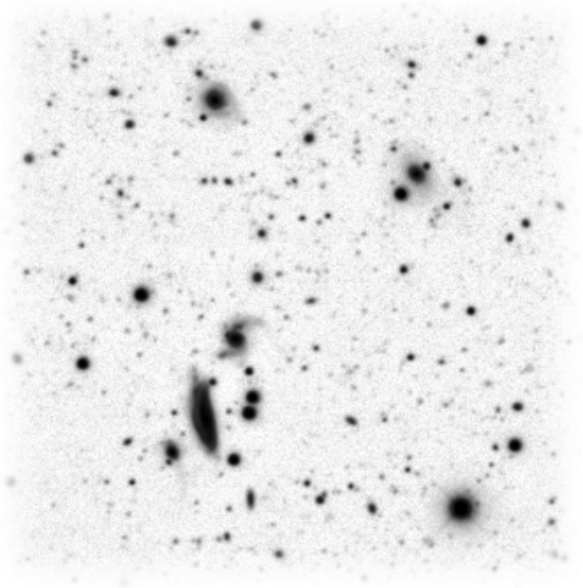
Be sure to visit the NOAO and Gemini Science Center exhibit booths at the American Astronomical Society meeting in Seattle from 6–10 January 2007.

We would like to request your active participation in both the NSF town hall meeting, and an additional special session led by NSF on implementing the Senior Review, scheduled for early afternoon on Sunday, January 6. Possible topics of discussion include the university role in building future instruments for NOAO telescopes and the rationale for, and location of, more small telescopes in the national observatory system.

The NOAO exhibit booth will feature posters and handouts on the Dark Energy Camera (also the subject of a special session), the WIYN One-Degree Imager, the latest observing opportunities with the SOAR 4.1-meter telescope in Chile, and more.

An adjacent booth will feature staff members from the NOAO Gemini Science Center, who will be available to answer questions about how to apply for observing time on the Gemini telescopes and how to take best advantage of the latest capabilities of Gemini instruments. Information on the Gemini Science 2007 meeting in Brazil will also be available.

A special session on Tuesday, January 9, will highlight "Science from the NOAO Deep Wide-Field Survey Boötes Field." A session on Wednesday, January 10, will discuss "Ground-Based Mid-Infrared Astronomy in the Spitzer Era," including research results and a speaker from Gemini Observatory.



On the Cover

Deep Imaging of NGC 7635

This wide-field image of the Bubble Nebula (NGC 7635) in the constellation Cassiopeia was taken with the Mayall 4-meter telescope and Mosaic imager at Kitt Peak National Observatory. The image contains optical evidence of a supernova remnant (SNR) recently discovered at radio wavelengths by the Canada Galactic Plane Survey. The magenta-colored wisps to the lower center-right are filaments of the SNR.

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

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Probing the Outer Limits of Dwarf Galaxies

Steve Majewski, Ricardo Muñoz and Jeffrey Carlin (University of Virginia)

The hierarchical formation of structure in the Universe on all size scales, as demonstrated by high-resolution numerical simulations of Cold Dark Matter (CDM), has shown good success in matching the observed properties of the largest structures, such as galaxy clusters. However, challenges still remain when trying to reconcile these models with the observed properties of galaxies.

The Milky Way with its satellite system of galaxies is a particularly useful laboratory for testing specific predictions of the CDM models, because very strong, detailed structural and dynamical constraints can be obtained in unparalleled regimes of low surface brightness and acceleration. The Milky Way's satellite galaxies include the smallest systems to show signs of dark matter content and possibly constitute visible CDM "subhalos." These dwarf spheroidals (dSphs) are thus important targets for testing the ΛCDM paradigm.

In this context, over the last decade, students at the University of Virginia have been taking advantage of wide-angle instruments at NOAO—the twin Mosaic and Hydra instruments—to explore Milky Way dSphs over large areas. The primary goal of this work is to establish the structure and dynamics of these systems over the largest possible dimensions, to set constraints on their dark matter content and distribution, and to look for possible evidence of tidal disruption along the paradigm of the well-known Sagittarius system. The results of this program continue to be reported in a series of papers, "Exploring Halo Substructure with Giant Stars."

The key strategy employed to probe to effective surfaces brightnesses as low as 31.5 mag arcsec^{-2} is reliance on large-area imaging—most typically with the NOAO Mosaic imagers—through combinations of filters with specific sensitivity to stellar surface gravity. This approach allows effective identification of the brightest stars in dSphs (giants and horizontal branch stars) from the overwhelming foreground of Milky Way dwarf-star contaminants. The resulting rather pure samples of dwarf galaxy stars allow for reliable mapping of satellite structure and dynamics to their tidal boundary and, we believe, well beyond.

Two recent papers in the series (Papers VI and IX, Majewski et al. 2005, *AJ*, 130, 2677: and Muñoz et al. 2006, *ApJ*, 649, 201 respectively) have proven the existence of stars associated with the Carina dSph to the full limit of our 11 deg^2 area Blanco+Mosaic mapping, equivalent to a Carina radius of 3 kpc (figure 1). The most widely separated Carina-associated stars show an asymmetrical distribution,

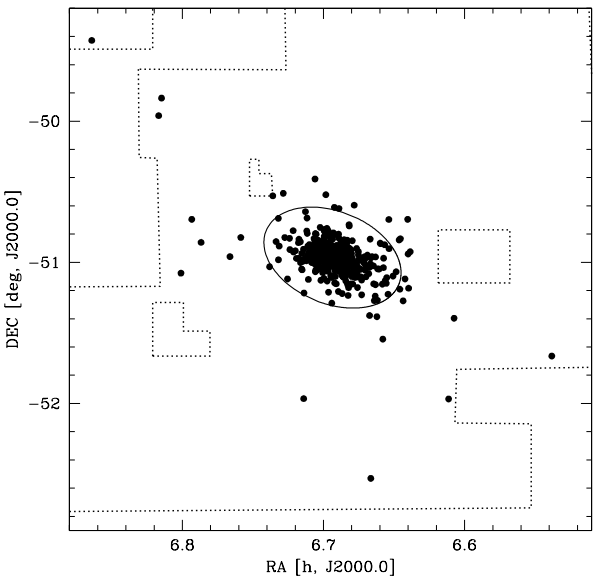


Figure 1. The distribution of bona fide Carina radial velocity (RV) members on the sky are found to be distributed asymmetrically, in a manner suggestive of tidal tails. The area covered by our photometric and spectroscopic survey is marked by dotted lines. The nominal King limiting radius of Carina is delineated by the ellipse. The photometric survey was done using the Mosaic imager mounted on the Blanco 4-meter telescope and covers roughly 11 deg^2, the largest photometric survey of Carina to date.

suggesting organization into nascent tidal tails. These stars, in turn, provide the most complete mapping of dSph dynamics yet measured.

Carina, like other dSphs we have studied in this way (Sculptor, Westfall et al. 2006, *AJ*, 131, 375; Ursa Minor and Draco, Muñoz et al. 2005, *ApJL*, 631, L137; Leo I, Sohn et al. 2006, *ApJ*, submitted, astro-ph/0608151, and Sgr, Majewski et al. in preparation), demonstrates a rather flat velocity dispersion with radius (figure 2a). These structural and dynamical properties can be successfully modeled by mass-follows-light, N-body simulations of a Carina dSph having the nominally inferred central M/L ~40 (in solar units), but moving on very radial (e.g., 105:15 kpc) orbits with tidal shocking that induces tidal disruption to produce the extended distribution of stars (Muñoz et al., in preparation). Alternatively, if all of these stars were bound within an extended Carina dark matter halo, it would have a minimum M/L exceeding 6,300. The extent to which these outer Carina stars can be consistent with a dark matter halo of the nominal NFW shape will be explored in Strigari et al (2006, in preparation).

continued

Probing the Outer Limits of Dwarf Galaxies continued

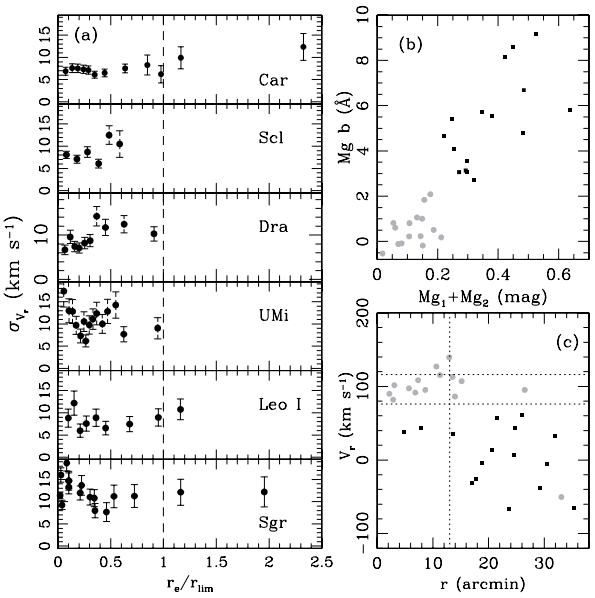


Figure 2. (a) Velocity dispersion versus angular separation for dSphs studied by the Virginia group. The radii have been normalized to the nominal King limiting radius fit to the cores of each dSph. Apart from some fluctuations, the dispersion profiles of all dSphs remain more or less flat to the King radius and, when measured, well beyond. These profiles can be explained either by very extended dark matter halos, or, as in the case of Sgr shown, by the presence of tidal debris at large radii. (b) Mg_1+Mg_2 versus Mg b instrumental Lick indices for stars lying along the dSph giant branch in the Boötes field. These indices, when applied to giant stars of similar temperature, are useful to discriminate stars most likely to be metal poor (circles) from those more metal rich (squares). As seen in panel (c), the radial velocities for the most metal-poor stars in the Boötes field cluster to a common velocity and centralized position from the Boötes center. The dotted vertical line marks the half-light radius of the dSph, while the dotted horizontal lines delimit a 3σ RV spread.

Another Milky Way satellite explored using the WIYN Hydra spectrograph (Muñoz et al. 2006, *ApJ*, 650, L51)—the recently discovered Boötes dSph (Belokurov et al. 2006, *ApJ*, 647, L111)—also reveals some surprises. Boötes is one of the faintest known dSph galaxies, and the new spectra show it to be the most metal-poor known, with [Fe/H] ~ -2.5 (figure 2b). Even the most conservative evaluation of the velocity dispersion of its stars (figure 2c) implies a total Boötes mass that makes it among the darkest-known objects in the Local Group (*M/L* ~ 600)—*if* it is in virial equilibrium. However, among the dSphs, Boötes also shows the most distorted morphology, and this suggests that the dSph may have suffered severe tidal shocking. Thus Boötes reinvigorates the classical debate over whether both tidal and CDM effects can significantly influence the velocity dispersions of dSphs.

Yet another very extended satellite structure was serendipitously discovered as a foreground curtain of stars in the direction of the Carina dSph These stars were traced back to the Large Magellanic Cloud (LMC), some 22 kpc away (Paper IX). If bound to the LMC, these Carina-foreground stars imply that the LMC has a minimum mass of 3.1×10^{10} (in solar units) and radius of 23 degrees (22 kpc), or roughly twice its previously known extent. Alternatively, these stars may represent the first evidence for unbound stellar tidal debris from the LMC (though these stars lie orthogonally positioned to the HI Magellanic Stream). A new wide-angle survey of the extended density profile of the LMC is now underway by David Nidever and his Virginia collaborators using the same photometric techniques, aided by the Mosaic imager and Hydra spectrograph on the Blanco telescope.

Our exploration of the structure and kinematics of Milky Way satellite galaxies has revealed the presence of rather extended luminous structures surrounding most of them. The true nature of these stellar populations, while not completely resolved, now at least lies among more starkly contrasted possibilities: either Milky Way satellite galaxies have *enormously* extended dark matter halos and total *M/L* reaching into the 10,000s, or tidal disruption—similar to that seen in the Sgr dSph system—is a common phenomenon among them.

Our favored interpretation is that the tidally disrupting Sgr dSph is not unique: not only are the cores of other Milky Way dSphs now found to resemble Sgr in every measurable way, but models of dwarfs—CDM-dominated at more modest levels consistent with their *central M/L* ratios (e.g., Sohn et al. 2006)—can successfully account for our observations at all radii.

The Suns of M67

Mark Giampapa

The WIYN 3.5-meter telescope with the Hydra multi-object spectrograph has been used over several seasons on Kitt Peak by my collaborators Jeff Hall (Lowell Observatory), Richard Radick (Air Force Research Laboratory, Sac Peak), Sallie Baliunas (Smithsonian Astrophysical Observatory), and myself to complete a long-term study of the Sun-like stars in the open cluster M67. These results were compared with data obtained by Bill Livingston (NSO) in his multi-decadal program of Ca II H and K observations of the Sun-as-a-star, using the McMath-Pierce solar telescope. The M67 open cluster has approximately the same age and metallicity as the Sun. Thus, the many "suns of M67" form a homogeneous population to compare with the range of activity seen on our own Sun. In this way, we can gain insight into the potential range of variation that our Sun can exhibit.

The main results of the M67 study are illustrated in figures 1 and 2. Figure 1 shows the distribution of an index related to the total core strength of the Ca II H and K lines ("HK index") for both the M67 solar-type stars and the Sun. We find that the stellar distribution in our HK index is broader than that for the solar cycle. Approximately 17% of the M67 Sun-like stars exhibit average HK indices that are less than solar minimum. About 7%–12% are characterized by relatively high activity in excess of solar maximum values, while 72%–80% of the solar analogs exhibit Ca II H+K strengths within the range of the modern solar cycle. The ranges given reflect uncertainties in the most representative value of the maximum in the HK index to adopt for the solar cycle variations observed during the period 1976–2004. Thus, ~20%–30% of the M67 homogeneous sample of Sun-like stars have mean chromospheric H+K strengths that are outside the range of the contemporary solar cycle. This could mean that the Sun might have excursions beyond the contemporary range of the cycle about the same fraction of the time. Figure 2 shows seasonal means, over six years of observations, for some M67 stars that are practically photometric "twins" of the Sun, along with the data for the Sun itself.

The Sun-like stars may be showing tantalizing hints of cycle-like variations, though at higher relative amplitudes compared to the Sun. The results of this work recently appeared in the 01 November 2006 volume of *The Astrophysical Journal*. We hope to follow up this study with further high-precision observations of these analogs of our Sun.

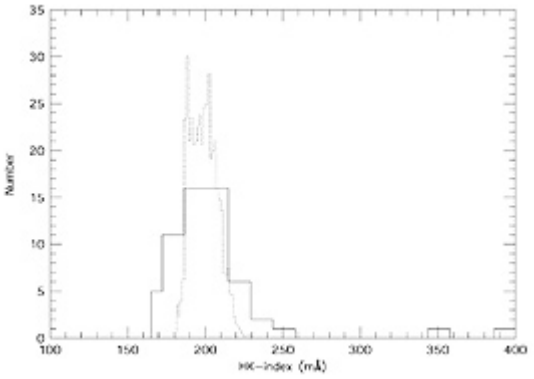


Figure.1. The distribution of the HK index for the M67 solar-type stars (solid) and for the contemporary Sun (dashed). The HK index is an indicator of the chromospheric emission present in the deep cores of the Ca II H and K lines.

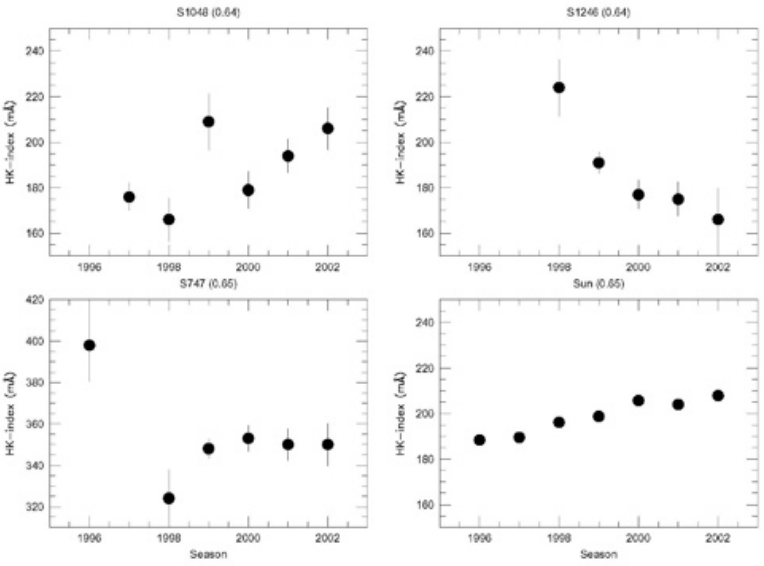


Figure 2. The seasonal variation of the mean HK index—indicative of the level of chromospheric activity present—in solar analogs in M67. The seasonal variation of the Sun-as-a-star is also shown (lower right panel).

NOAO and the NSF Senior Review

Jeremy Mould & Todd Boroson

The report of the Senior Review commissioned by the NSF astronomy division was released on November 3, following months of anticipation (see *www.nsf.gov/mps/ast/ast_senior_review.jsp*). The goal of the review was to evaluate the scientific effectiveness of all NSF astronomy facilities, and to provide recommendations that could free up as much as $30 million per year through selective closures or facility restructuring. We understand that this was a very difficult undertaking, and that every recommendation to downsize or eliminate something inevitably has real pain associated with it.

From the perspective of NOAO and our community, we find the report very encouraging. At the highest level, it provides a resounding endorsement of NOAO's role as an effective national organization, as laid out by the most recent decadal survey: NOAO must manage the development of the ground-based optical/infrared (O/IR) system of facilities, and provide effective access to it. It must represent the community and provide leadership in the design, construction, and operation of the largest and most expensive facilities. And it must provide a significant portion of the capabilities available to the broad community through state-of-the-art telescopes and renewed instrumentation, built in collaboration with universities.

All of these roles are described in the decadal survey, and they are all elements of the recommendations in the Senior Review report. These are exactly the precepts that have guided NOAO's program plan over the past six years.

One goal of the review was to designate resources that could be reprogrammed to address a problem of unprecedented magnitude at the NSF astronomy division: how to fund the pre-construction design and development—and the post-construction operation—of an ambitious set of decadal survey initiatives. The approach taken in our submission to the Senior Review panel was to point out that NOAO was already committing to these new initiatives (GSMT, LSST, NVO) roughly the fraction of facility funding (approximately 25 percent) that the Senior Review was trying to find program-wide at NSF. These funds have contributed noticeably to the scientific and technical leadership in these projects, as well as to community participation in them—just as recommended in the decadal survey.

Whether this approach was enough to satisfy the Senior Review is difficult to say, based on their report. A management review was recommended for each major NSF facility. In the recommendations for NOAO, it is suggested that the Major Instrumentation Program and Data Products Program, as well as administrative and scientific staff, are areas to review. No evidence of inefficiency or identification of activities that they are willing to eliminate was provided. We are confident that any significant cuts in these areas would not allow us to maintain the level of support that the community demands.

The other area of potential change is the nature of NOAO's participation in the decadal survey initiatives, particularly the Large Synoptic Survey Telescope (LSST) and the Giant Segmented Mirror Telescope (GSMT). The sense of the Senior Review recommendation is that our investments in these projects should be guided by realistic expectations regarding the funding schedule for their expensive construction phases.

It appears we have hit it just right for LSST, with current work aimed at submitting a proposal to NSF's Major Research Equipment Facility Construction (MREFC) funding process in early 2007, allowing this facility to get in line for funding behind the Advanced Technology Solar Telescope. A more complex problem is presented by the GSMT, due to the emergence of two extremely large telescope projects: the Thirty Meter Telescope (TMT) and the Giant Magellan Telescope (GMT). NOAO must position itself to represent and advocate community participation in either of these projects. The lengthy design and development phases of these projects demands significant early participation as the only way to ensure community access to the resulting observing time.

The subsequent article in this Newsletter, written by AURA President William Smith, presents a more detailed look at the

continued

Kitt Peak National Observatory (Credit: P. Marenfeld and NOAO/AURA/NSF)

NOAO and the NSF Review continued

Cerro Tololo Inter-American Observatory (Credit: M. Urzúa Zuñiga/Gemini Observatory)

evolution of public participation in the GSMT project. These ideas were endorsed by Wayne Van Citters, NSF astronomy division director, during his meeting with the NOAO staff on November 13.

One clear focus of the report is the ongoing productivity of the original observatories of NOAO: Kitt Peak National Observatory and Cerro Tololo Inter-American Observatory. We certainly welcome the acknowledgement that these facilities are important to the community, and that the capabilities they provide are critical elements of the O/IR system. In our role as stewards of the system, NOAO gratefully accepts the offer to upgrade and improve the existing facilities through possible one-time reinvestments. We are developing lists of candidate improvements for these observatories, and will work with the community to gather and prioritize more ideas.

Finally, in the last section of the report, the Senior Review report calls for a new high-level commission to manage US O/IR astronomy. Having immersed ourselves deeply in the development of the "ground-based O/IR system," we believe that this dynamic combination of public and private facilities is best guided through the creation of mechanisms through which all participants can see their diverse interests served, rather than through a top-down structure.

Although acceptance of the system perspective has been slow, it has been steady, marked by accomplishments such as our stewardship of the Telescope System Instrumentation Program (TSIP) and the well-attended "Third System Workshop on the Ground-Based O/IR System: Developing an Instrumentation Strategy" in mid-November (organized and hosted by NOAO), which provide compelling evidence that this approach is succeeding.

Overall, we find the Senior Review report very supportive of the current NOAO program plan. We look forward to working with NSF astronomy division staff and the O/IR community to develop an implementation plan that reinforces NOAO's goal of continuing as the effective national organization envisioned by the decadal survey.

The Senior Review and the NOAO Mission

William S. Smith, Jr. (AURA)

As the president of the Association of Universities for Research in Astronomy (AURA), which manages NOAO under a cooperative agreement with the NSF, I would like to convey a few thoughts about the implications of the Senior Review for the NOAO mission and its relationship to the decadal survey of 2000, which has guided us over the past several years.

Although the Senior Review was basically an exercise in examining scientific priorities, and the budget balance within the NSF astronomy division, a great deal of attention was focused on the mission of the national observatory. Despite some of the cost and budget issues, which were a necessary part of the discussion, it is very evident that NOAO is seen as more important than ever.

In every possible place, the Senior Review encourages NOAO to take a leadership position:
- In playing an enabling role in developing the "System."
- In combining its capabilities with those of the university community to address instrumentation needs.
- And, most importantly in sustaining the astronomical community, by making sure there is access to telescopes of all apertures. Our access today is one to ten meters.

continued

The Senior Review and the NOAO Mission continued

In the future there will no doubt be 20-,30- or 50-meter telescopes and NOAO will need to bridge this gap.

There is nothing in the Senior Review suggesting that the vision of the decadal survey is misguided or unachievable. The Giant Segmented Mirror Telescope (GSMT) and Large Synoptic Survey Telescope (LSST) are still seen as some of the most compelling science machines of the future. There is no question that NOAO has dedicated itself to achieving this vision and has fulfilled every expectation in doing so.

The Senior Review has taken a broader view in judging the overall pace that we should expect in achieving these goals, and the balance that should be maintained in the community in the interim. There is no question that the community will depend on NOAO for observing opportunities at Cerro Tololo and Kitt Peak, access to Gemini, and access to independent telescopes. They have called attention to this reality and this is a good thing for all of us. NOAO's role will be to ensure a healthy system today, while working with the community to ensure that the system evolves to enable the entire US community to plan and carry out front-line research with tomorrow's telescopes.

The Senior Review spent a considerable effort looking at the landscape for the GSMT. They observed that coordinating the design and technology development for major projects like the GSMT, expediting their passage through the various phases of the NSF approval process, and ultimately preparing for their operations and science phases, requires leadership and planning at a level unprecedented in the NSF. The NSF has approached AURA to discuss the most productive means of carrying out this process, in a manner that best serves US astronomy while capitalizing on the basic purpose of the national observatory.

NSF has asked that NOAO act as the "Program Manager" for the GSMT technology development effort at a national level, in a manner similar to NASA's major field centers. There is much to be done to restructure and re-tool for this new approach, and AURA and NSF are working together with the two existing GSMT projects to lay out a clear path.

We do not want to squander any of the good work that has been done so far, and it is critical that we continue the activities such as identifying and working toward the establishment of new observing sites in Chile.

Some of the specific things we have discussed involve:
- Assuring that national needs are understood, and that the Thirty Meter Telescope and Giant Magellan Telescope subscribe to them as a requirement for federal participation in an eventual public-private partnership for the construction and operation of either telescope.
- Performing independent evaluations of technical progress by both projects.
- Providing a strong, respected and consistent point of contact for international partnership interests.
- Finally, assuring community support for the GSMT as a national priority and for a healthy scientific enterprise in the GSMT era. This may become the real focus of the "system" as we develop it.

AURA, NOAO, and the community should find much to be encouraged about in the Senior Review.

The SOAR and Gemini South telescopes on Cerro Pachón (Credit: M. Urzúa Zuñiga/Gemini Observatory)

The NOAO Gemini Science Center and the Senior Review

Todd Boroson & Verne V. Smith

The report of the National Science Foundation's Senior Review is very positive regarding the role of the NOAO Gemini Science Center (NGSC) in managing US user community access to the two Gemini telescopes. The report also contains discussions and recommendations concerning the Gemini Observatory.

Items discussed in the review include current and future Gemini operations, as well as plans for future Gemini instrumentation. As the "gateway" for US access to Gemini observing time, NGSC would like to highlight a couple of points in the report to bring them to the attention of the user community.

The Senior Review calls on NOAO to pursue the goals of the last decadal survey and to provide US community access to a strategic set of optical/infrared (O/IR) telescopes of all apertures, up through the twin 8-meter Gemini telescopes—of which the United States (via NSF) is a 50 percent financial shareholder. There is a strong, clear call in the review report for continued access by the US community to the Gemini telescopes and their broad range of instrument capabilities, as well as to do everything possible to maximize science return from this valuable resource.

One of the major tasks of NGSC is to inclusively engage and educate the entire national community about current Gemini issues, observing opportunities, and science results. NGSC is also a strong advocate for the US community within the Gemini partnership. In addition, NGSC will continue to publicize Gemini activities and opportunities via the *NOAO/NSO Newsletter*, the NGSC Web pages, AAS Meetings, and other means. We pledge to redouble our efforts along these lines in the months ahead, as the user community considers the suggestions put forth by the Senior Review.

The Senior Review notes that the current operating agreement for the Gemini Observatory will expire in 2012, and the future operating agreement beyond this date will be negotiated beginning in 2010. One facet of observatory operations that may enter into these negotiations, also called for in the Senior Review, is a cost/performance analysis relative to other large optical telescopes. Such a cost/performance review is positive, and should be encouraged and welcomed by the partnership. It is crucial, however, that such a review be informed by a full understanding of the structure of the Gemini budget. For example, the Senior Review report overstates the cost of a Full-Time Equivalent employee by at least 30 percent.

In addition, we believe that one key part of such a review is a concise breakdown of all observatory operations, for all of the observatories considered in the comparative analysis. Each distinct operational cost should be called out in detail, so that these data can then be used in direct comparisons among similar expenses. Such a review will lead to a clarified understanding of the various price tags associated with the operation of 8–10-meter-class telescopes, and how different operational models may impact total observatory budgets.

Gemini is a unique facility and a major resource, as the only full-sky coverage 8-meter-class observatory that is also capable of 100-percent queue observing with a large suite of instruments. This capability of carrying out 100-percent queue mode with multiple instruments has evolved in direct response to user demand since the commencement of Gemini operations.

Gemini's mid-infrared capabilities are unmatched anywhere (see related article in this *Newsletter*). The observatory is currently engaged in deploying adaptive optics systems at both sites, as well as in pursuing a powerful program for procurement of a number of very capable new instruments. As such, access to Gemini is a major component within the US community's integrated system of ground-based O/IR telescopes. Understanding how to optimize Gemini operations, and planning for its future place in the system, are key issues for discussion in the coming months. NGSC will work hard to provide the US community with the information it needs to help plan this future.

We welcome your comments or questions via email (*vsmith@noao.edu*) or phone (56-51-205397).

Tribute to Hugo E. Schwarz

Alistair Walker

Hugo Schwarz, an astronomer at NOAO South, died tragically in a motorcycle accident on 20 October 2006. Hugo was integral to all the activities at the observatory, and his loss leaves an enormous gap that will be very difficult to fill.

Hugo arrived at CTIO in 2000, following several years as Officer-in-Charge of the Nordic Optical Telescope on La Palma, Canary Islands, where his energetic leadership and hands-on style were responsible for transforming it into one of the best-performing moderate-aperture telescopes in the world. Prior to that, Hugo worked in Chile at ESO La Silla, so his familiarity and deep understanding of Chilean life and culture made his transition back to La Serena and CTIO relatively seamless.

The SOAR 4.1-meter telescope was under construction at the time of his arrival, and Hugo's talents made him the perfect choice for deep involvement with this telescope as it transitioned from construction through commissioning to operations. Formally, he was the CTIO scientist assigned to SOAR, but he was much more, acting as Steve Heathcote's indispensable righthand-man through the whole difficult commissioning period. Hugo led the installation of site testing equipment on the Cerro Pachón site for the LSST, as well as being in charge of the all-sky camera project (see photo), which produced instruments now in use for site testing related to the Thirty Meter Telescope, Giant Magellan Telescope and the Large Synoptic Survey Telescope, as well as observing tool use for most of the international observatories in Chile.

Hugo was also passionate about protection of dark skies near observatory sites, and worked tirelessly with Pedro Sanhueza and Malcolm Smith to ensure the long-term viability of the Chilean observatories. He had just become the president of Commission 50 of the International Astronomical Union, "Protection of Existing and Potential Observing sites." Despite all this activity, Hugo found time to keep up a strong research program on the late stages of stellar evolution, particularly planetary nebulae, with many collaborators and much student involvement.

Hugo didn't neglect educational outreach either. This was his final activity for CTIO - late on Friday afternoon, Hugo came into my office after giving a talk to a visiting group of students from the University of Talca, joking that he had been presented with a pen in a smart polished wooden box, very much nicer than the one that had been given to Malcolm Smith! This is so typically Hugo—he gave cheerfully and unstintingly, and was very, very effective in all he did. We shall miss him terribly. Our hearts go out to Hugo's wife Claudia and her children Maria Josefina and Diego, and to his children by his first marriage, Tamar and Jouke.

Mid-Infrared Astronomy at the Gemini Observatory: Capabilities and Recent Scientific Highlights

Adwin Boogert

The International Gemini Observatory twin 8-meter telescopes, located in Hawaii and Chile, provide the US community with access to the most sensitive mid-infrared (7–26 micron) instruments on the planet. Gemini telescope optics have been coated with silver to enhance their mid-IR reflectively and reduce their emissivity to a few-percent level. Near diffraction-limited images are commonly seen at both sites in the N- and Q-band windows: 0.4 arcsec at 10 microns and 0.6 arcsec at 20 microns.

Although surpassed in sensitivity by satellite missions, Gemini's mid-IR instruments are at least an order of magnitude higher in spatial and spectral resolution, and offer unrivaled detailed complementary and follow-up observations of the brighter mid-IR emitting objects in the sky. Gemini's flexible queue-based observing mode guarantees that observations are done during the dry, cirrus-free conditions required by many mid-IR programs.

Gemini's mid-IR facility instrumentation suite consists of the Thermal Region Camera and Spectrograph (T-ReCS) on Cerro Pachón, and the mid-infrared imager and echelle spectrograph Michelle on Mauna Kea. The Texas Echelle Spectrograph, TEXES, was available in the 2006B semester as a guest instrument. Watch the call for proposals for future TEXES observing opportunities. Both Michelle and T-ReCS offer imaging and low- and medium- resolution (R=100–1,000) spectroscopy in the atmospheric windows between about 7 and 25 microns.

The echelle modes of Michelle and TEXES extend the available spectral resolving power to values as high as 100,000, and Michelle's newly commissioned imaging polarimetry mode provides a capability unique to 8-meter class telescopes. T-ReCS and Michelle have been at the telescope for about 2.5 years, and a steady stream of studies that attack a wide range of astrophysical problems is being published.

Debris Disks

The high spatial and spectral resolution of Michelle and T-ReCS make these instruments ideally suited for studies of debris disks. Tedesco et al. (2005, *Nature*, 433, 133) resolved the edge-on debris disk around the A5V star β Pictoris. Imaging photometry in five filters between 8 and 25 microns revealed a clump of dust at 50 AU from the star that is warmer than its surroundings. This dust is likely composed of small grains produced by collisions between planetesimals.

Based on 10-micron spectroscopy with Michelle, a similar conclusion was drawn for the solar-type star BD +20 307 by Song et al. (2005, *Nature*, 436, 363). Spectral signatures of small crystalline silicate grains were observed in the prominent 10-micron emission band, and most likely result from collisions within an asteroid belt 10,000 times more massive than the asteroid belt in our solar system.

Orion Nebula

Although Gemini's maximum chop throw of 15 arcsec can significantly complicate mapping emission on large scales, an 11.7-micron mosaic of the inner 2 arcmin of the Orion nebula was obtained by applying special mapping and reduction techniques (Smith et al., 2005, *AJ*, 130, 1763; figure 1). The image contains nearly 100 distinct point sources, highlighting the extreme complexity of this crowded star-forming region. One of the many inferences that can be drawn from this data set is that the numerous stars detected at 11.7 microns possess 1- to 2-million year old dust disks, smaller than the approximate size of Pluto's orbit, as they lack extended structure in T-ReCS and HST images.

continued

	Michelle	**T-ReCS**
location	Hawaii	Chile
wavelength coverage	7–25 microns	7–25 microns
imaging FOV	32 × 24 arcsec	29 × 22 arcsec
imaging pixel size	0.10 arcsec	0.09 arcsec
imaging polarimetry	Yes	No
spectral resolving power	200–30,000	100–1,000
spectral pixel size	0.18 arcsec	0.09 arcsec
slit widths	0.18–1.44 arcsec	0.26–1.30 arcsec

Mid-IR Astronomy at the Gemini Observatory continued

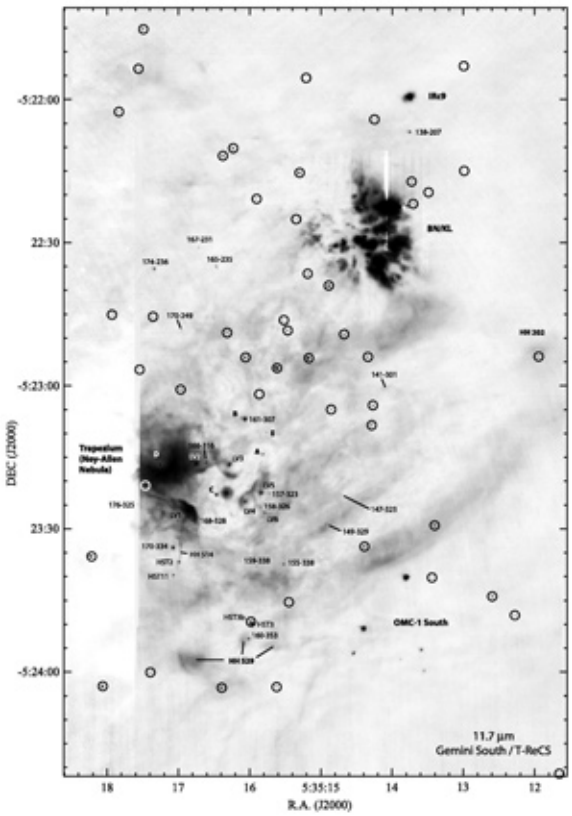


Figure 1: Image mosaic at 11.7 microns of the Orion Nebula made with T-ReCS on Gemini South. In these high spatial resolution images, proplyds seen in HST images are identified, as well as a few other major features of the Orion Nebula. Faint and unresolved (non-proplyd) infrared stars, likely surrounded by solar system-sized dust disks, are circled (from Smith et al. 2005, with permission).

Supernovae

Investigations of the production and properties of dust in relatively nearby supernovae give an indirect glimpse of what may be the dominant source of dust and metals in the early universe. Following a Spitzer Space Telescope detection of infrared (IR) emission from the region of the nearby galaxy NGC 6946 containing the remnant of supernova 2002hh, Barlow et al. (2005, *ApJ,* 627, L113) used Michelle to isolate the supernova remnant from neighboring emission sources. With data uncontaminated by emission from the surrounding objects, the team could construct the spectral energy distribution of the supernova remnant itself, estimate the mass of gas and dust in the remnant, and determine that the most likely source of the dust was an episode of mass loss from the central star before the supernova occurred.

T-ReCS has been used to carry out a similar, detailed investigation of supernova 1987A. In figure 2, one image from a time series shows a clumpy ring of dust excited by the supernova blast wave (Bouchet et al., 2006, *ApJ*, 650, 212 and 2004 *ApJ*, 611, 394).

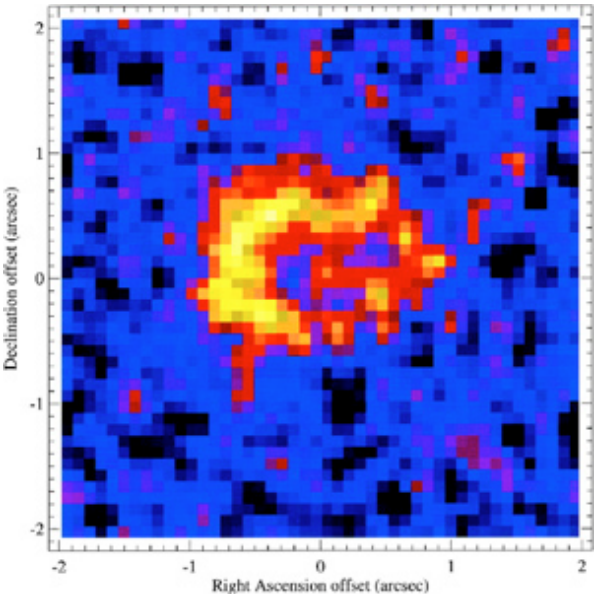


Figure 2. This T-ReCS observation of supernova 1987A in the N-band filter at day 6067 shows silicate dust lighting up as the blast wave hits the progenitor circumstellar envelope (Bouchet et al., 2004) . The central 0.32-mJy point source corresponds to dust in the ejecta of the supernova, and is detected in 23 minutes of on-source integration time. See Bouchet et al. (2006) for 11.7- and 18.3-micron images at day 6552.

Active Galactic Nuclei (AGN)

The high spatial resolution of Michelle and T-ReCS has also provided insight into the nature of the inner regions of AGN (figure 3). Copious amounts of 10- and 20-micron emission are observed toward these sources, as is predicted by the unified model of AGN in which a toroidal cloud of dusty gas partly obscures the central supermassive black hole. The torus has not been resolved in even the closest of these galaxies and mid-IR size limits significantly constrain theoretical models of the torus.

AGN often exhibit considerable mid-IR emission not directly associated with the torus itself. A case in point is the Seyfert galaxy NGC 1068, in which only 30 percent of the emission in a 1.2-arcsec-diameter aperture comes from the central point source. The extended mid-IR emission from NGC 1068, and from other galaxies in studies by Roche et al. (2006,

continued

Mid-IR Astronomy at the Gemini Observatory continued

MNRAS, 367, 1689; arXiv: *astroph*/0610583), was mapped by spatially resolved spectroscopy using both Michelle and T-ReCS. The profile and depth of the 9.7-micron silicate absorption feature in several galaxies is observed to vary on very small scales, along with the shape of the continuum and the flux in fine structure lines. This is consistent with the presence of an inclined layer of dust obscuring both the unresolved torus and its extended ionization cones. The detection of emission features from aromatic hydrocarbons on sub-arcsec scales in the Circinus galaxy, tracing near-nuclear star-forming regions, further demonstrates a level of complexity that can best be addressed using high spatial resolution observations.

The 7–25 micron imaging and medium- and high-spectral resolution capabilities of Michelle, T-ReCS and TEXES, as well as Michelle's newly commissioned imaging polarimetry mode, have opened up poorly charted regions of discovery space in the mid-IR. For more technical information on Gemini's suite of mid-IR instrumentation, please consult *www.gemini.edu*. Follow the 'MIR Resources' link for a wealth of information dedicated specifically to observing in the mid-IR. The NOAO Gemini Science Center provides Gemini support for the US astronomical community (*www.noao.edu/usgp/*).

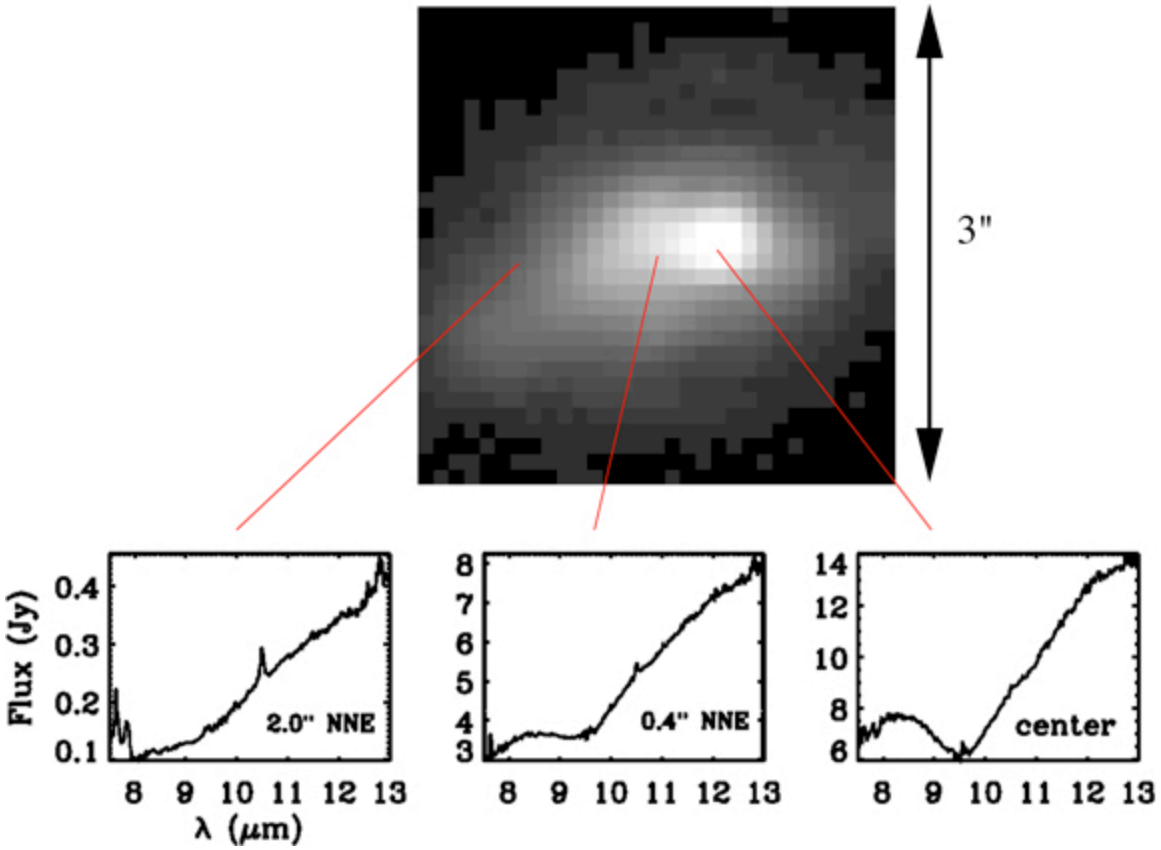


Figure 3: This 11.7-micron image from Michelle of the nucleus of the Seyfert 2 galaxy NGC 1068 shows a bright compact nucleus and extended material at 0.4-arcsec spatial resolution (Mason et al., 2006, ApJ, 640, 612). In low-resolution Michelle spectra, the depth of the 9.7-micron silicate absorption band and the 10.5-micron [S IV] emission line vary considerably on sub-arcsec scales. The Spitzer point spread function covers the entire area shown here.

Gemini Near-infrared Integral Field Spectrometer

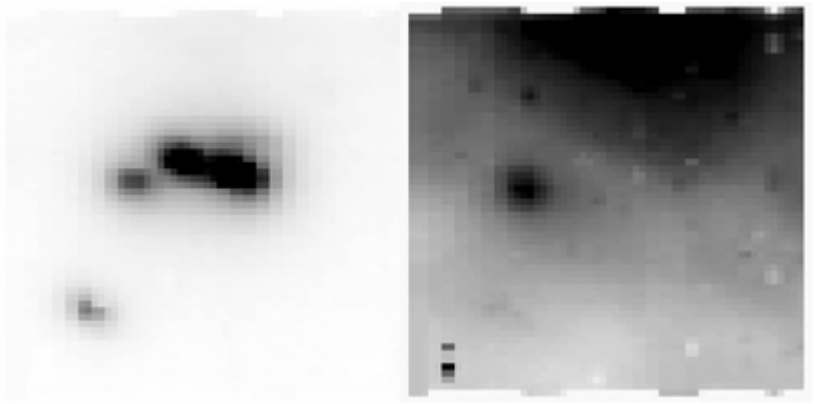
Robert Blum & Peter McGregor (Australian National University)

The Gemini Near-infrared Integral Field Spectrometer (NIFS) went into general science operations during semester 2006B at Gemini North. NIFS is currently waiting final commissioning with the facility laser guide star system, also scheduled for semester 2006B.

The near diffraction limited pixel scale (0.1 arcsec by 0.043 arcsec) of NIFS is a good match to the delivered image quality at Gemini North when used in tandem with the facility adaptive optics module, Altair. NIFS is now routinely used with Altair in its natural guide star (NGS) mode.

An example of a NIFS/NGS observation is shown in the figure below, where NIFS and Altair were used in July 2006 to image this 3-arcsec field toward a Galactic ultra-compact HII region. A continuum region centered at 2.17 microns (left panel) was extracted from the NIFS K-band data cube (which has a spectral resolution of ~5,300). This continuum was then subtracted from the Brackett gamma spectra in the data cube to produce a Brackett gamma map of the region (right panel). The map reveals a compact emission source near the corresponding continuum object and strong extended emission to the north (top) of the frame.

The Gemini IRAF (v1.9) NIFS package was used to extract these maps and to build the data cube from which they were extracted. This release of NIFS data reduction tools marks a major milestone, providing NIFS users with a baseline set of tools that enable the construction of fully calibrated data cubes. The package includes basic data cube display tools, as well as the ability to extract one-dimensional spectra in user-defined apertures selected on the two-dimensional spatial image.



NIFS images of the ultracompact HII region G45.45+0.06 (north is up, east left). The left panel shows the continuum near 2.17 microns, while the right panel is a continuum-subtracted Brackett gamma map. These spectral regions were extracted from the NIFS K-band data cube (R=5,300). The angular resolution along pixel rows is 0.1 arcsec (each independent pixel is represented by two image pixels), while the resolution along the columns is 0.043 arcsec per pixel.

Gemini Science 2007 Conference Update

Katia Cunha & Verne V. Smith

The second conference on Gemini science results will be held 11–13 June 2007, at the Mabu Thermas and Resorts in Foz do Iguaçú, Brazil. A Gemini Users meeting will take place at the same venue on June 14.

The primary purposes of this conference are:

- To highlight Gemini science results.
- To promote the capabilities of the Gemini telescopes and instruments to the community.
- To enhance scientific collaboration within the community.
- To define new science avenues.
- To increase acquaintances among Gemini users.

The format of the meeting will include 20-minute oral presentations focusing on scientific results from the Gemini North and Gemini South telescopes, as well as poster sessions. The one-day Gemini Users session will include presentations on future Gemini instrumentation and software development, as well as ample time for general discussion.

Further meeting details can be found at *www.lna.br/~gsm2007/*. There is no registration fee for the conference, and registration is now open. Watch for updates on the conference Web site as plans for the meeting progress.

Gemini Data Reduction Working Group

Tom Matheson

The mission of the Gemini Observatory is not only to deliver high-quality data from its many world-class instruments, but also to provide the tools to process that data into meaningful scientific results. The development of the Gemini-IRAF package is one major (and ongoing) example of this effort. Gemini recently hired a Project Scientist for Dataflow System & Products, and has constituted the Gemini Data Reduction Working Group (GDRWG) to oversee an expansion of the entire process.

The GDRWG is an offshoot of the Gemini Science Committee that will advise the Gemini director on issues relating to tools and methods used to process the data produced by the observatory. This includes providing tools for current users, as well as ensuring that the observatory can monitor data quality and that future users of the Gemini Science Archive will be able explore the data fruitfully.

The first meeting of the GDRWG was held in Hilo, Hawai'i, from 11–12 October 2006, to lay out preliminary plans and goals. As this will be an ongoing effort, in my role as the chair of the GDRWG, I welcome comments or questions about the process and our plans (*matheson@noao.edu*).

The Gemini Data Reduction Working Group at Gemini Headquarters in Hilo, Hawai'i, 12 October 2006.

The Gemini-Subaru Time Exchange Program

Verne V. Smith

The NOAO Gemini Science Center (NGSC) would like to remind US astronomers of the Gemini-Subaru time exchange program, begun in semester 2006B. This agreement exchanges service observing time at Subaru for queue observing time at Gemini. The Subaru instruments currently available to the Gemini community are Suprime-Cam (wide-field optical imaging) and MOIRCS (near-infrared imaging and multi-object spectroscopy). In exchange, the Subaru community has access to queue mode observing on GMOS (both North and South) and NIFS.

This agreement will likely be continued in semester 2007B. Announcements regarding this Subaru exchange program are posted on the Gemini Web site call for proposals link (*www.gemini.edu*), and on the NGSC Web site (*www.noao.edu/usgp*). US proposals for semester 2007B should be submitted with NOAO proposals by the December 2007 NOAO deadline. For 2007A, the agreement allowed a total of 50 hours of Subaru service observing. Gemini recommended a minimum request of five hours, with larger programs encouraged. Potential applicants should note that there were some special rules for 2007A proposals. For instance, proposals had to be submitted using the Phase I Tool (PIT) with "Subaru" selected as partner.

Direct questions about the Subaru exchange program to Verne Smith (*vsmith@noao.edu*).

NGSC Instrumentation Program Update

Verne Smith & Mark Trueblood

The mission of the NGSC Instrumentation Program is to provide innovative and capable instrumentation for the Gemini telescopes in support of frontline science programs. This article gives a status report on Gemini developments in the US since the June 2006 *NOAO/NSO Newsletter*.

NICI

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

The NICI Pre-ship Acceptance Test was held the week of September 18–22. Additional testing of thermal emissivity and other items was held the following week, and the instrument was declared ready to ship to the Gemini Hilo Base Facility (HBF).

NICI was lifted onto the Subaru BSIT truck and transported to the Gemini HBF on October 18 (figure 1). The instrument was unloaded and inspected by MKIR and Gemini personnel, including Gemini Observatory Director Doug Simons (figure 2). NICI will undergo flexure testing on the Gemini Flexure Test Facility, following additional inspection and minor reconfiguration.

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

Figure 1. NICI is lowered by crane onto the Subaru BSIT truck at MKIR's Hilo, HI, facility.

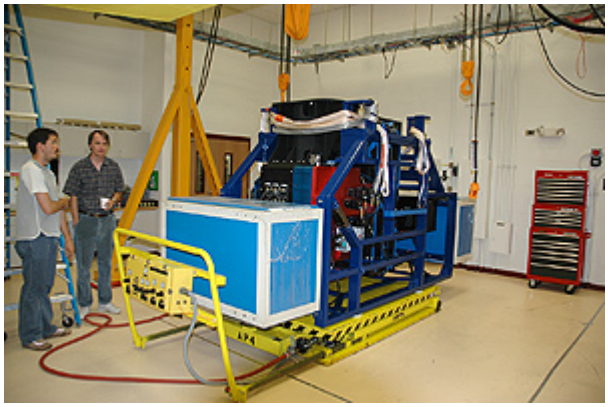


Figure 2. Gemini Observatory Director Doug Simons (right) inspects the new NICI instrument on a Gemini standard instrument air pallet in the Gemini Hilo Base Facility instrument bay, where it will undergo flexure testing.

FLAMINGOS-2

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

The FLAMINGOS-2 Team is continuing with the integration and testing phase of the project. The University of Florida team now expects the R~3,000 grism to be delivered by the end of 2006, meeting or exceeding its design throughput. Current work is focused on issues of image quality, reliability, and flexure. Once these factors are addressed, work will turn to preparation for the Pre-ship Acceptance Test.

As of October, the University of Florida team reports that 94 percent of work toward FLAMINGOS-2 final acceptance by Gemini is complete.

2007A Proposal Process Update

Dave Bell

NOAO received 446 observing proposals requesting telescope time during the 2007A observing semester. These included 210 proposals for Gemini, 110 for KPNO, 83 for CTIO, 40 for Keck, nine for MMT, seven for Magellan, and seven for HET. Thesis projects accounted for 25 percent (113 proposals) of those received, with 13 proposals requesting long-term status. Time-request statistics by telescope and instrument appear in the tables that follow. Subscription rate statistics will be published in the March 2007 edition of the *NOAO-NSO Newsletter.*

As of this writing, proposals are being reviewed by members of the NOAO Time Allocation Committee (see the following listing). We expect all telescope schedules to be completed by 14 December 2006, and plan to notify principal investigators of the status of their requests at that time. Mailed information packets will follow the email notifications by about two weeks.

Looking ahead to 2007B, Web information and forms will be available online around March 1. The March 2007 *Newsletter* will contain updated instrument and proposal information.

SINGG Data Released Via NOAO Science Archive

Gerhardt Meurer (Johns Hopkins University)

The Survey of Ionization in Neutral Gas Galaxies (SINGG) is pleased to announce the availability of calibrated H-alpha and R-band imaging data through the NOAO Science Archive (NSA).

SINGG is an NOAO survey program designed to enable star formation studies in a sample of galaxies selected by neutral gas content. We have so far imaged over 300 galaxies selected from the HI Parkes All Sky Survey (HIPASS) only on the basis of HI properties. The targets have radial velocities covering 200 < V < 13,000 kilometers per second (weighted towards the lowest velocities), and thus predominantly sample the local universe.

The SINGG sample includes many well-known bright southern spirals, as well as dwarf irregular, blue compact dwarfs, and interacting systems. These have been imaged using a narrowband filter chosen to isolate the H-alpha line, as well as a broad R-band filter. SINGG Release One (SR1) data products available through the NSA include images in the narrowband, R band, and net H-alpha of 93 targets observed over four photometric observing runs (18 nights) in 2000 and 2001 with the CTIO 1.5-meter telescope. Each target contains at least one—and up to four—spatially extended H-alpha emission line galaxies, resulting in H-alpha detections in 111 galaxies. More information on SR1, as well as tabulated measurements of the data, can be found in Meurer et al. (2006, ApJS, 165, 307).

An example of the data available is shown in the figure of HIPASS J1337-29, also known as NGC 5236 or M83. The SINGG data can be obtained from the NSA, at the

continued

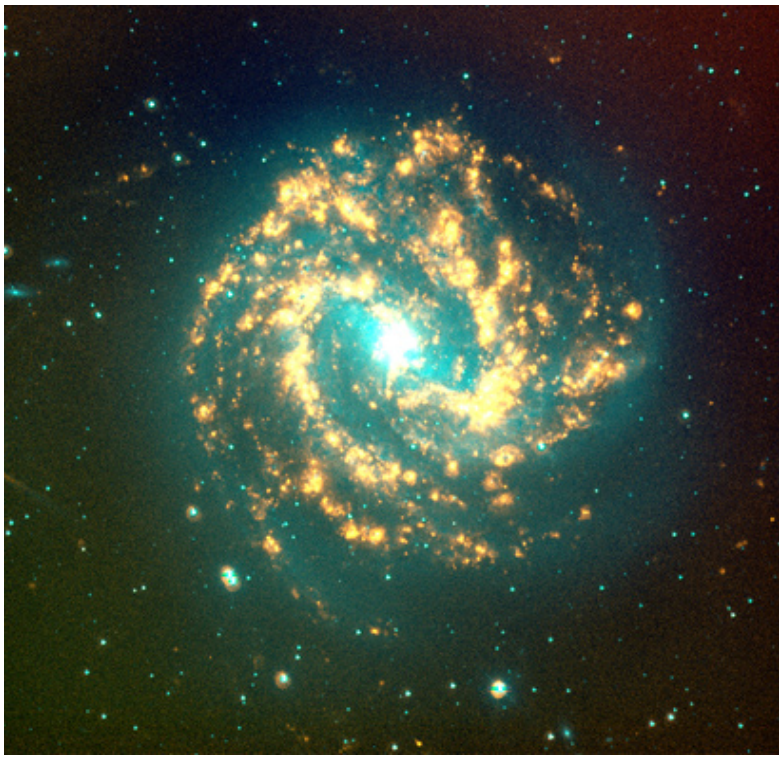


*Figure. SINGG image of M83 from data obtained with the CTIO 1.5-meter telescope. The image is 14.3 arcmin on a side, or 18.6 kiloparsecs, for an assumed distance of 4.5 megaparsecs. The color version of this image (*www.noao.edu/image_gallery/html/im1007.html*) shows net H-alpha in red, the R-band continuum in blue, and the narrowband image before continuum subtraction in green. This results in H-alpha emission having a red-orange glow with the HII regions having a yellow core, while foreground stars and the galaxy continuum have a cyan color.*

SINGG Data Released continued

Web site *archive.noao.edu/nsa/,* by selecting the survey "Star Formation in HI Selected Galaxies".

The selection can be further narrowed using the Web interface. SR1 data are also available through the NASA/IPAC Extragalactic Database and the SINGG team Web page *sungg.pha.jhu.edu/.* There you will find three-color images of the fields at various stretches and binning factors, as well as images showing the measurement apertures used by Meurer et al. (2006).

The SINGG team is now working on producing data products from all of its CTIO observations. We thus anticipate a second release (SR2) of data products within a year, for a total of about 300 targets.

NOAO Survey Proposal Deadline Postponed by Six Months

Tod R. Lauer

The NOAO Extremely Wide-Field Infrared Imager (NEWFIRM) should be a powerful and exceptional instrument for surveys—but not just yet!

Current plans call for NEWFIRM to be commissioned at the KPNO Mayall 4-meter telescope during the spring of 2007. Ordinarily we would also issue a call for new NOAO survey programs in the first part of 2007 as well. However, we have decided to delay the call for new NOAO survey programs for six months given the strong interest in using NEWFIRM for surveys, combined with the fact that we will have no on-sky verification of NEWFIRM performance prior to a proposal deadline that would allow new surveys to begin in 2007B.

We anticipate that a call for new survey programs will be released in June 2007, with 15 September 2007 as the probable deadline. A key element of the evaluation of survey proposals will be assessing whether the proposing teams have a realistic plan for survey and data management. NEWFIRM is likely to present new challenges in data reduction, so successful proposals must demonstrate a path to producing interesting and timely science, as well as archivable data products, with this new instrument.

2007A Time Allocation Committee Members

Extragalactic (30–31 October 2006)

Dave De Young, Chair, NOAO
Tod Lauer, Chair, NOAO
Lisa Storrie-Lombardi, Chair, Spitzer Sci. Ctr.
John Blakeslee, Washington State University
Alison Coil, University of Arizona, Steward
Megan Donahue, Michigan State University
John Feldmeier, Youngstown State University
Andy Fruchter, STScI
Mauro Giavalisco, STScI
Michael Gregg, Lawrence Livermore Nat'l Lab
Robert Knop, Vanderbilt University
Mark Lacy, Spitzer Science Center
Tom Matheson, NOAO
Casey Papovich, University of Arizona, Steward
Alice Shapley, Princeton University
Adam Stanford, University of California, Davis
Alan Stockton, University of Hawaii
Donna Weistrop, UNLV

Solar System (1 November 2006)

Caitlin Griffith, Chair, University of Arizona, LPL
Anita Cochran, McDonald Observatory
Drake Deming, NASA GSFC
Matthew Holman, Harvard-Smithsonian CfA
Renu Malhotra, University of Arizona, LPL
David Trilling, University of Arizona, Steward

Galactic (2–3 November 2006)

Letizia Stanghellini, Chair, NOAO
Todd Boroson, Chair, NOAO
Sidney Wolff, Chair, NOAO
Andrew Cole, University of Minnesota
Don Garnett, University of Arizona, Steward
Tom Harrison, New Mexico State University
Inese Ivans, Carnegie Observatories
Chris Johns-Krull, Rice University
Jennifer Johnson, Ohio State University
Steve Kawaler, Iowa State University
Kevin Luhman, Pennsylvania State University
Ciska Markwick-Kemper, Univ. of Manchester
Mario Mateo, STScI
John Monnier, University of Michigan
Randy Phelps, California State Sacramento
Bart Pritzl, Macalester College
Nathan Smith, University of California, Berkeley
Eva Villaver, STScI

2007A Instrument Request Statistic by Telescope Standard Proposals

Kitt Peak National Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
KP-4m		**67**	**73**	**288.2**	**115**	**40**	**3.9**
	ECH	7	8	31	0	0	3.9
	FLMN	12	13	52	0	0	4
	IRMOS	1	1	6	0	0	6
	MARS	6	6	19	11	58	3.2
	MOSA	23	24	95.2	76	80	4
	RCSP	18	20	83	26	31	4.2
	SQIID	1	1	2	2	100	2
WIYN		**30**	**34**	**100.3**	**45**	**45**	**2.9**
	DSPK	5	5	21	0	0	4.2
	HYDR	10	13	32.5	13	40	2.5
	MIMO	7	7	18.8	18	96	2.7
	OPTIC	3	3	7	7	100	2.3
	SPSPK	5	5	17	7	41	3.4
	WTTM	1	1	4	0	0	4
KP-2.1m		**17**	**22**	**147.2**	**22**	**15**	**6.7**
	CFIM	3	3	20	13	65	6.7
	ET	3	6	41	0	0	6.8
	FLMN	2	2	27	0	0	13.5
	GCAM	4	5	23	9	39	4.6
	SQIID	3	3	15.2	0	0	5.1
	VIS	2	3	21	0	0	7
KP-0.9m		**2**	**2**	**14**	**7**	**50**	**7**
	MOSA	2	2	14	7	50	7

Gemini

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
GEM-N		**134**	**186**	**186.2**	**78**	**42**	**1**
	GMOSN	71	98	104.1	76.9	74	1.1
	Michelle	19	24	13.2	0.3	2	0.6
	NIFS	11	13	17.5	0.8	5	1.3
	NIRI	45	51	51.4	0	0	1
Subaru Exchange		**15**	**16**	**15.1**	**7.1**	**47**	**0.9**
	MOIRCS	10	10	9.6	1.7	17	1
	SuprimeCam	6	6	5.5	5.5	100	0.9
GEM-S		**80**	**93**	**111.9**	**14.5**	**13**	**1.2**
	GMOSS	25	29	23.6	11.9	51	0.8
	GNIRS	26	30	36.5	0	0	1.2
	Phoenix	11	11	30.7	0	0	2.8
	TReCS	17	18	16.6	2.5	15	0.9
	bHROS	5	5	4.5	0	0	0.9

Cerro Tololo InterAmerican Observatory

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
CT-4m		42	45	167.7	40	24	3.7
	HYDRA	14	16	70	9	13	4.4
	ISPI	6	6	27	0	0	4.5
	MOSAIC	13	13	36.7	21	57	2.8
	RCSP	10	10	34	10	29	3.4
SOAR		16	20	43.6	14	32	2.2
	OSIRIS	9	9	27.5	6	22	3.1
	SOI	9	11	16.1	8	50	1.5
CT-1.5m		9	10	34.6	0.4	1	3.5
	CPAPIR	2	2	7.1	0	0	3.5
	CSPEC	7	8	27.5	0.4	1	3.4
CT-1.3m		7	12	38.6	9	23	3.2
	ANDI	7	12	38.6	9	23	3.2
CT 1.0m		6	8	60	25	42	7.5
	CFIM	6	8	60	25	42	7.5
CT-0.9m		7	12	34.4	11	32	2.9
	CFIM	7	12	34.4	11	32	2.9

Community Access

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Keck-I		**21**	**21**	**33**	**10.5**	**32**	**1.6**
	HIRES	10	10	15.5	1.5	10	1.6
	IF	2	2	2	0	0	1
	LRIS	9	9	15.5	9	58	1.7
Keck-II		**22**	**22**	**31**	**8**	**26**	**1.4**
	DEIMOS	3	3	3	2	67	1
	ESI	3	3	5	3	60	1.7
	IF	2	2	2	0	0	1
	NIRC2-LGS	1	1	1	1	100	1
	NIRSPAO-LGS	1	1	0.5	0	0	0.5
	NIRSPAO-NGS	1	1	1	0	0	1
	NIRSPEC	10	10	17.5	2	11	1.8
	OSIRIS-LGS	1	1	1	0	0	1

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
HET		**7**	**7**	**13.2**	**0**	**0**	**1.9**
	HRS	6	6	9.2	0	0	1.5
	LRS	1	1	4	0	0	4

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Magellan-I		**1**	**1**	**3**	**0**	**0**	**3**
	IMACS	1	1	3	0	0	3
Magellan-II		**6**	**6**	**11**	**0**	**0**	**1.8**
	LDSS3	1	1	2	0	0	2
	MIKE	5	5	9	0	0	1.8

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
MMT		**9**	**9**	**22**	**12**	**55**	**2.4**
	BCHAN	4	4	9	5	56	2.2
	Hectochelle	3	3	6	0	0	2
	Hectospec	2	2	7	7	100	3.5

CTIO Partnerships: Present and Future

Alistair Walker

New Operations Partnerships

Cerro Tololo Inter-American Observatory (CTIO) has been engaged in forming operations partnerships for the Blanco 4-meter telescope, similar in nature to those at Kitt Peak National Observatory (KPNO), which were described in the September 2006 *NOAO/NSO Newsletter*. The partnership opportunity announcement in 2005 pointed out that the decreasing availability of NSF funds for the operation of CTIO and KPNO facilities presented a chance for university astronomy departments to form creative partnerships with NOAO.

In return for sharing the responsibility for continued operation of the telescopes, our partners enjoy the continued benefits of wide-field, large-aperture optical/infrared astronomy from excellent scientific sites. To optimize the scientific return to the partners, there is additional scope within the partnership concept for exchanges of time within the set of telescopes operated by NOAO. The AURA Observatories Council and the NOAO Users Committee recommended that the amount of observing time available for partnerships on the Blanco telescope should not exceed 10 percent. This percentage was chosen to maintain time available for NOAO users to not less than 50 percent in the era beyond 2010, when the Dark Energy Survey will be using 30 percent of Blanco time. The remaining 10 percent goes to Chile.

We are very pleased to announce that the University of Illinois and Yonsei University, South Korea, are the new CTIO operations partners. Partnership proposals from these groups were reviewed externally and approved by the NSF. The partnerships—13 nights per year for Illinois and 15 for Yonsei—begin in semester 2006B and continue for three years. Illinois will be using its Blanco time to study star formation in the Magellanic Clouds and to survey galaxy clusters as part of a multi-wavelength campaign. A minor fraction of the Illinois time will be used in exchange for KPNO Mayall 4-meter telescope time to study quasars in the northern sky. Astronomers at Yonsei University have long been involved in the international collaborations that use CTIO facilities, and we hope this tradition will be expanded further by this new opportunity. Yonsei will use its observing time for research and educational programs for 10 Ph.D. astronomers and 15 graduate students, primarily on globular clusters and early-type galaxies near and far.

SMARTS Partnership

The second round of the Small & Moderate Aperture Research Telescope System consortium (see *www.astro.yale.edu/smarts* and *www.ctio.noao.edu/telescopes/smarts.html*), known as SMARTS II, has almost completed its first year of operations of the small telescopes at CTIO. This partnership carried on immediately after the wind-up of a very successful three years of operations of SMARTS I.

The consortium has ten members plus NOAO/CTIO, each of whom brings either telescopes, instruments, funding, or a combination, to the table. NOAO retains ~25 percent of the observing time on this system of four telescopes—the 1.5-meter with optical spectrograph or wide-field infrared imager; the 1.3-meter with dual IR/CCD imager optimized for synoptic programs; and the 1.0-meter and 0.9-meter telescopes, each with CCD imagers—that are operated in a variety of modes: queue, service, and classical. Observing time for these facilities can be applied for via the usual NOAO observing proposal process.

There are distinct advantages to becoming a SMARTS consortium member. An astronomer or group of astronomers in a university department can obtain a substantial amount of observing time on reliable, well-instrumented telescopes at a superb observing site for an investment of ~$50K/yr, or approximately $1,000 per night for a classically scheduled night, and a little more for nights in which a service observer takes the data.

The growing list of SMARTS publications, found by following the above Web addresses, is testimony to the success of this consortium in carrying out a wide variety of programs. SMARTS has capacity to accommodate a few more partners willing to sign up for a semester or longer; those interested should contact the SMARTS Principal Scientist, Charles Bailyn (*bailyn@astro.yale.edu*).

DECam Instrumentation Partnership

The Dark Energy Camera (DECam) has been described several times in the *NOAO/NSO Newsletter,* most recently in the September 2006 edition, where Tim Abbott reported that the camera had a successful design review (equivalent to Conceptual Design Review) in July 2006 at Fermilab National Accelerator

continued

CTIO Partnerships continued

Laboratory. The partnership consortium is building the camera and delivering a data management system (see *www.darkenergysurvey.org/*), in exchange for 30 percent of the Blanco observing time for five years in order to carry out the Dark Energy Survey, a multi-band imaging survey covering 5,000 square-degrees of the south galactic cap. After a 12-month proprietary period, the survey data will be available to all.

DECam is expected to be delivered in 2010, and it will be a facility instrument available to all users. Data will be pipelined into the NOAO Science Archive, and we intend that the instrument will be just as easy to use as smaller-format cameras, despite the formidable quantity of data that will be possible: a single readout should take less than 20 seconds while delivering a 500-gigapixel raw image.

Important design decisions are being made right now. Since the requirements of the general user may be different from those of the consortium members carrying out the Dark Energy Survey, we have created a document titled "Community Needs for the Dark Energy Camera and Data Management System," which community members are encouraged to read and comment upon. The document can be downloaded from *www.noao.edu/dir/usercom/2006/DECam-Community-Use-v2.pdf* .

A splinter meeting at the January 2007 AAS meeting in Seattle, titled "CTIO Blanco Telescope Dark Energy Camera," will provide an opportunity to hear more about DECam and to provide input into its design. There will also be various posters that discuss DECam and the Dark Energy Survey at NOAO's exhibit booth at the meeting.

Simon Schuler - New Goldberg Fellow at CTIO

Simon Schuler began his Leo Goldberg Fellowship position at CTIO in October. The NOAO Goldberg Fellowship is a five-year post-doctoral position aimed at supporting young astronomers of outstanding promise to carry out research at NOAO North or South over the first four years, followed by research and teaching at a university in the fifth year (see *www.noao.edu/goldberg/*). The fellowships provide a context for designing and executing challenging long-term research programs, as well as preparation for university careers. Fellowship namesake Leo Goldberg was an outstanding US astronomer who was instrumental in setting up the national observatory in the mid-1950s, and served as Kitt Peak director from 1971–77.

Simon graduated with a Bachelor of Science (cum laude) from the University of Miami in 2001, followed with a master's degree at the University of Nevada. His PhD was awarded in 2006 by Clemson University for a project titled "Chemical Abundances of Solar-Type Dwarfs in Open Clusters," under advisor Jeremy King. Simon is interested in chemical and stellar evolution of our galaxy, as derived from high-resolution spectroscopy of various stellar populations, and he is expert in the analysis of high-dispersion stellar spectra. He has observed with most of the world's largest telescopes equipped with suitable facilities for this work. Welcome, Simon!

Exoplanet Tracker at the 2.1-meter Telescope

Steve B. Howell

The Exoplanet Tracker (ET) was built by the University of Florida under the guidance of Principal Investigator Jian Ge. This instrument allows measurement of extremely high-precision radial velocities for solar-type stars. Designed to search for extra-solar planets (exoplanets) in orbits about stars similar to the Sun, ET has been used successfully at the Kitt Peak 2.1-meter telescope by the Florida group for the past two years.

Beyond discovering the first exoplanet to be found from Kitt Peak (*news.ufl.edu/2006/01/11/new-planet/*), ET has confirmed the existence of known exoplanets and provided additional measurements of others. ET was made available to the general NOAO community starting in semester 2006B. Three NOAO proposals for ET were submitted, one from the University of Florida and two from the NOAO user community.

The NOAO user programs include a search for exoplanets in a sample of high-metallicity K stars and a program using ET for a new type of application unrelated to exoplanets.

Observations from September during the first 2006B run with ET are fully reduced and show promising results for all three programs. Individual radial velocity measurement uncertainties are near four to 10 miliseconds for stars in the magnitude range of V=3 to 12. A second run of ten days occurred in October, with far better weather, and those observations are nearly reduced at the time of this writing. The velocity precision and absolute stability of ET over time will be rigorously tested during the 2006B observing runs, but so far we see no indication of any problems in this area.

New proposals have been submitted for semester 2007A, and will be reviewed in the coming weeks. If you have an interest in using ET, furthur information is available at *www.noao.edu/noaoprop/help/etmemo.html*. Please contact me to answer any remaining questions (*showell@noao.edu*).

NEWFIRM Progresses on Technical and Scientific Planning Fronts

Ron Probst (NEWFIRM Project Scientist)

The NOAO Extremely Wide-Field Infrared Imager (NEWFIRM) has made significant progress toward first light since our last *NOAO/NSO Newsletter* report in March 2006.

We received the last two large aspheric lenses from the vendor, and have verified end-to-end optical alignment of the Optical Support Structure with warm bench testing. This was a significant milestone, achieved through a "build-to-print" philosophy, coupled with tight tolerancing and careful measurement during parts fabrication and optical system integration.

The detector foundry run has produced enough devices to fill the focal plane, and the array mosaic is assembled and has been brought coplanar. At the time of this writing in late October, the instrument is beginning its third cold cycle, once more on the NOAO Flexure Test Rig. This is the first cold-test cycle with a fully illuminated and populated focal plane, and a complete set of array electronics. There is much to do as we work toward first light, now scheduled for late January 2007.

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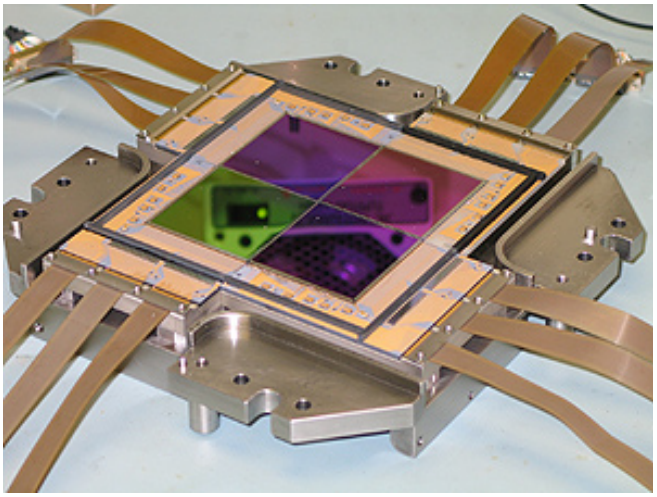

Figure 1. Focal plane mosaic populated by four arrays. Color differences are due to slight run-to-run variations in the infrared anti-reflection coating, and do not impact infrared performance.

NEWFIRM Progress continued

Planning of Science Verification observations during the commissioning period has moved into high gear, with the process remaining as described in the September 2005 *Newsletter*. Science-driven operations will be used to pursue subtle performance issues, to optimize operational protocols, and to finalize reduction pipelines. Science ideas have germinated into projects, science teams are being assembled, and planning has begun for carrying the projects rapidly from the telescope to archived, publicly accessible, imaging data products.

We expect commissioning to transition from a focus on engineering tests to primarily Science Verification in several runs over the course of Semester 2007A. More information on this phase can be found at *www.noao.edu/ets/newfirm/sv.htm*.

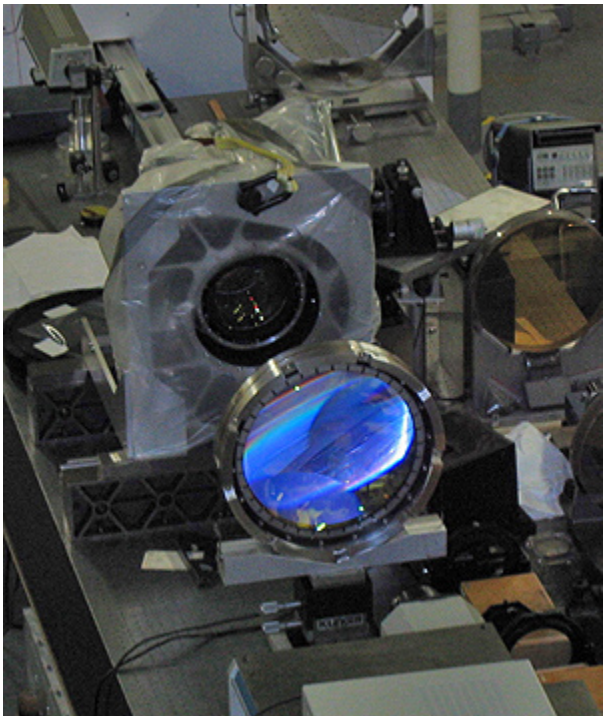

Figure 2. NEWFIRM's Optical Support Structure set up for double-pass, interferometric null testing in the NOAO Optical Shop. The large aspheric field lens, prominent in the photo, also serves as the dewar entrance window.

QUOTA Sees First Light!

Daniel Harbeck (University of Wisconsin-Madison) & George Jacoby (WIYN Observatory)

The WIYN consortium is building the One-Degree Imager (ODI) for its 3.5-meter telescope at Kitt Peak. We have reported on the progress of the ODI project in the *NOAO/NSO Newsletter* on several occasions (March 2005, March 2006, June 2006). We are now pleased to announce that the QUad Orthogonal Transfer Array (QUOTA), the prototype camera for the One-Degree Imager, saw star light for the first time during the October 2006 Testing & Engineering (T&E) run at the WIYN 3.5-meter telescope. The current configuration of this prototype features two thinned Orthogonal Transfer Array (OTA) CCD detectors, with two (disconnected) thick devices that serve to baffle the focal plane.

The QUOTA first-light campaign represents a number of important "firsts." This was the first time we tested detectors from the STA ODI Lot-2 foundry run, and the first time that OTA CCDs have been operated in an array configuration. This was also the first time that the NOAO MONSOON controller was used outside of a laboratory. QUOTA's first light is so far not only a milestone for ODI, but also for all projects incorporating the MONSOON controller concept. Last but not least, the October run was the first time the

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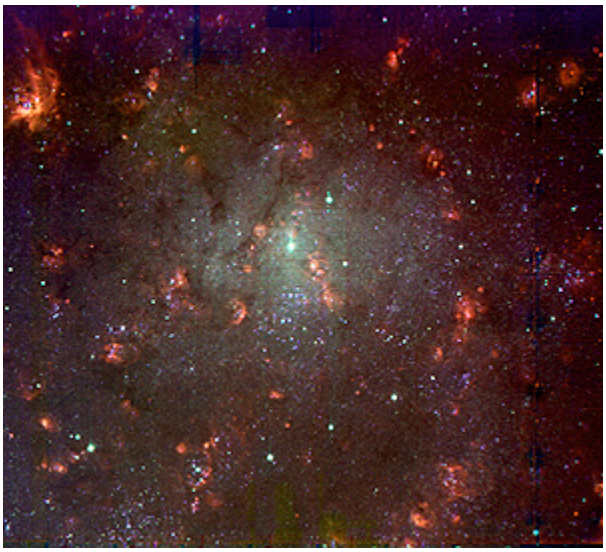


Figure 1. An image of M33 taken by QUOTA during its first-light campaign (October 8–11). The picture is a composite of 20-minute exposures taken in the SDSS r'-band, the U-band and in H-alpha

QUOTA See First Light! continued

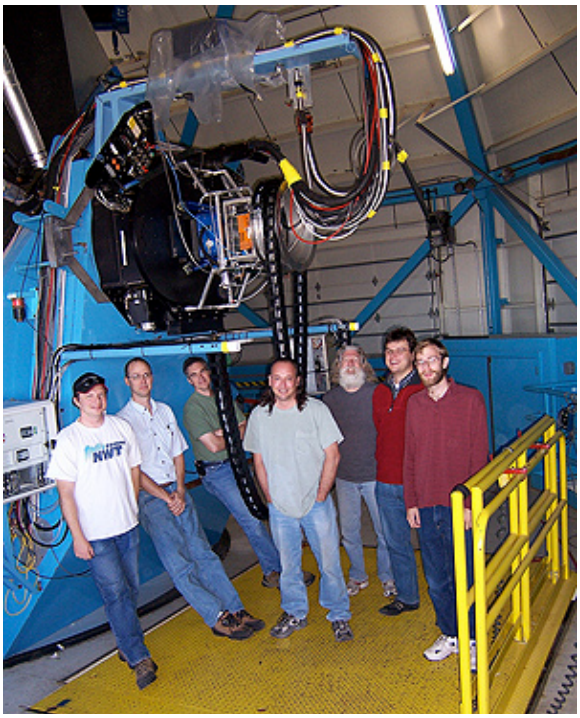


Figure 2. The QUOTA first-light team in front of the instrument. Most noticeable is the large cable wrap behind the camera and the MONSOON controller.

whole QUOTA system was fully integrated, including the Bonn shutter, the ACE filter wheel, and the MONSOON user interface.

Installing the instrument at the telescope was a very smooth process, with minor obstacles easily resolved with a bit of machine work. Firing up the control software was similarly straightforward, requiring only some debugging on the first (cloudy) night. Over the three remaining nights, QUOTA was a very stable system—possibly more stable than some other facility instruments.

Since QUOTA was working so reliably, we were able to obtain on-sky images under excellent conditions. The seeing was never above 0.8 arcsec with QUOTA's excellent sampling (0.11-arcsec pixels), and we typically obtained images with seeing of order 0.6 arcsec. The best image was 0.45 arcsec. Some examples are shown in the figures: The globular cluster M2 (the I-band image is shown here), the planetary nebula M76 (in H–alpha), and the spiral galaxy M33 (processed by Brian Brondel of Indiana University and Peter Marenfeld). Additional observations—of standard stars in particular—are under reduction.

The detectors and the optics are very well-behaved: the images flat-field very well with no measurable cross-talk between the detectors or cells, indicating a level at least 10 times better than Mosaic or MiniMo—note that each OTA CCD consists of 64 independent CCDs, and the controller has 16 independent data channels!

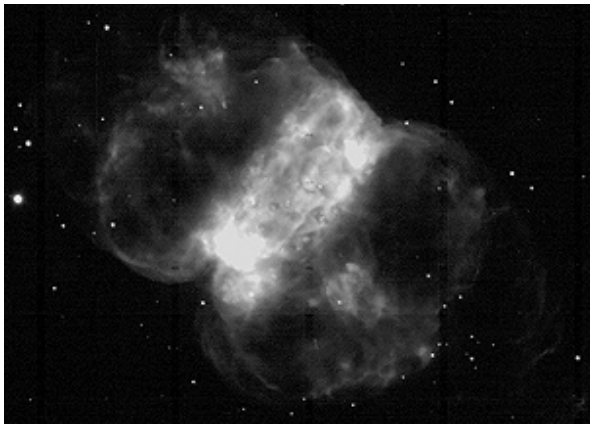


Figure 3. Three 60-second exposures from QUOTA are combined in the I-band image of the globular cluster M2. The seeing in this image was 0.56 arcsec.

The current OTA CCD detectors from our Lot 2 foundry run are not performing at the desired level yet. Pronounced amplifier glow and high power consumption (three watts per device) require special attention, and are being addressed in the next detector design revision. Upgrades to the cooling system, and eventually to the revised design for Lot 3 devices, will address these problems. We have also upgraded the system's power supply to meet the demand of the detectors for upcoming on-sky testing.

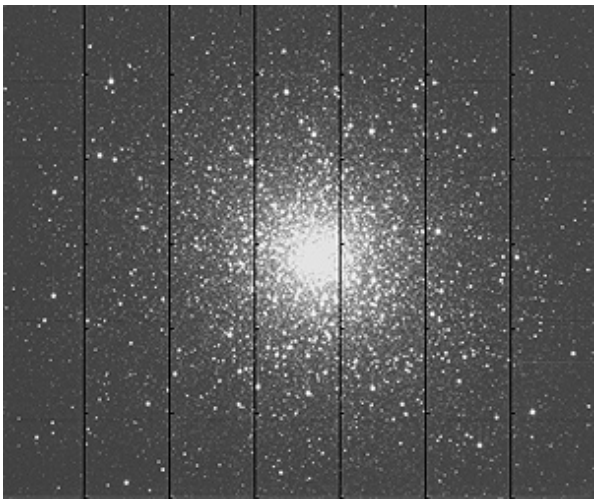


Figure 4. The planetary nebula M76 observed by QUOTA in H-alpha. The seeing during this exposure was 0.6 arcsec.

QUOTA See First Light! continued

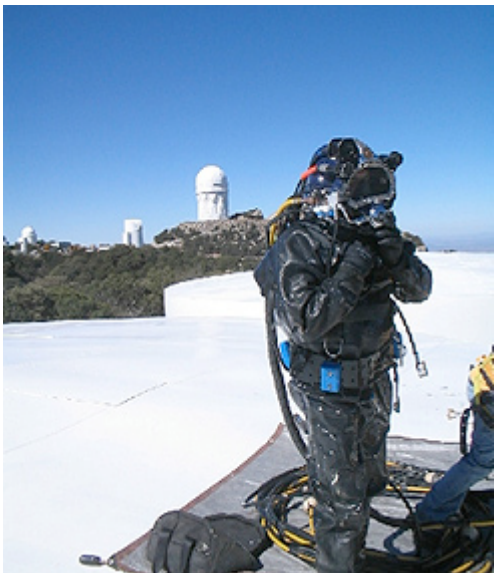
We now look forward to the next T&E run in December. We are focused on implementing the functionalities specific to the OTA detectors: reading out video streams of up to 32 guide stars, and, eventually, the application of tip/tilt corrections during the science integration to compensate for image motion by the atmosphere and telescope.

This relatively smooth installation, and subsequent reliable operation, is the product of an intense effort by many very dedicated individuals from across the WIYN consortium. They all deserve a lot of credit! A list of names, along with a gallery of QUOTA pictures, can be seen at: *www.wiyn.org/ODI/odi_news.htm*.

Diving on Kitt Peak

John Dunlop

A hard-hat diver was an unusual sight on Kitt Peak recently, climbing on top of and inside the main mountain water storage tanks. The interior of the storage tanks need to be inspected and repaired on a periodic basis, as part of water system maintenance.



The tanks were drained and the interiors inspected, repaired, and repainted over 20 years ago. Since that time, however, drought conditions have prevented us from taking the tanks out of service to do it again. Water is a precious commodity on Kitt Peak so a specialized contractor from Oregon was hired to provide a hard-hat diver to inspect the interior of the full tanks and perform any needed repairs.

The divers were decontaminated before they entered the tanks, where they proceeded to remove a small amount of sediment from the tank floor and inspect the interior surfaces. Some minor repairs were required and completed to assure the integrity of the tank. A video review of the interior was provided. While the tanks were found to be in excellent shape overall, coating repairs will be needed on the interior ceiling of one tank in the near future.

Observer Support Update

Michael Merrill

Karen Butler joined the KPNO/WIYN Observing Support Team as a full-time Observing Assistant in August. Currently still in training, Karen can be spotted operating the Mayall 4-meter, the WIYN 3.5-meter, or briefing incoming observers on use of the 2.1-meter telescope.

Karen brings diverse experience to KPNO, including tours with the Hertzberg Institute for Astrophysics and Gemini South. Karen replaces Gene McDougall, who has transitioned to a position as an engineering physicist with the WIYN Observatory. Gene is now involved with a variety of projects, including the new imagers, QUOTA and ODI. Gene will continue to help KPNO maintain the optical alignment of all our telescopes.

Congratulations to both Karen and Gene on their new positions. KPNO is very proud to have such talented individuals as part of the team operating and improving our telescope facilities.

Kitt Peak Energy Cost Saving Efforts

John Dunlop

The Kitt Peak facilities staff is always working to reduce the overall cost of mountain operations. Craftsperson Randy Feriend and the entire facilities staff have been working to modify piping, install energy efficient equipment and lighting, and optimize chiller operations to help reduce energy usage to below FY01 levels. In addition, Kitt Peak Engineering design efforts have enabled high-energy consumption devices such as air compressors to be downsized, resulting in reduced run times. The overall FY06 mountain usage has been reduced to 11 percent below FY01 levels and the Mayall 4-meter telescope usage has been reduced to 27 percent below the FY01 level (see table below). Unfortunately, a recent rate increase of 51 percent by the local supplier from $0.059 to $0.089 per hour will impact cost savings, but the reduction in energy usage should help to offset and control increasing supplier costs.

General Mountain Electric Usage

FY	Annual KW	Annual $ Cost
01	1,910,020	210,767
02	1,845,934	173,528
03	1,860,724	170,374
04	1,889,020	160,308
05	1,890,310	163,062
06	1,692,340	157,429

Mayall 4-meter Telescope Electric Usage

FY	Annual KW	Annual $ Cost
01	600,727	66,524
02	594,468	55,883
03	595,950	54,705
04	600,110	51,354
05	543,049	48,009
06	438,149	41,651

SELECTED RESOLUTIONS APPROVED BY THE WIYN BOARD OF DIRECTORS

20 October 2006— Madison, WI

Congratulations on First Light for QUOTA

The WIYN Board congratulates the QUOTA/ODI team, the Monsoon project team, and the WIYN Observatory on a very successful "first light" commissioning run of the QUOTA imager. We recognize the significant accomplishment represented by this completed milestone on the path toward deploying the One-Degree Imager. We also note with pleasure the mature level of project management that has kept ODI on schedule and budget through a successful CDR (optics) and PDR.

Congratulations to Bench Spectrograph UpgradeTeam

The WIYN Board congratulates the extended Bench Spectrograph upgrade team for its significant progress over the past year. Equipped with a promising and thoroughly reviewed redesign for the bench, the project seems well positioned to achieve deployment of the upgraded Bench Spectrograph in 2007. The improved Bench Spectrograph will enhance the spectroscopic capabilities of the WIYN Observatory.

Recognition of Continued High Level of Performance of Observatory Operations

The WIYN Board notes the continued high level of operational performance of the WIYN Observatory while simultaneously working to provide major new instruments for the future. We applaud the extraordinary efforts of the entire staff of the WIYN Observatory, and the support, engineering, and facilities staffs of Kitt Peak National Observatory in successfully maintaining the outstanding quality of the WIYN 3.5-meter telescope operations.

From the Director's Office

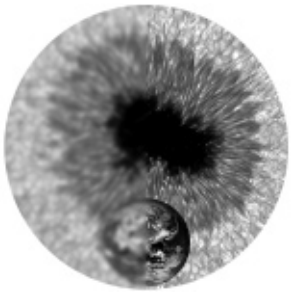
Steve Keil

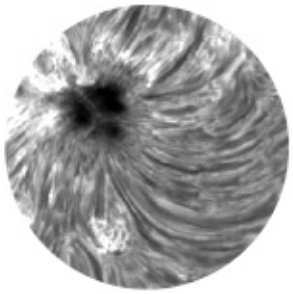
NSO Response to the Senior Review

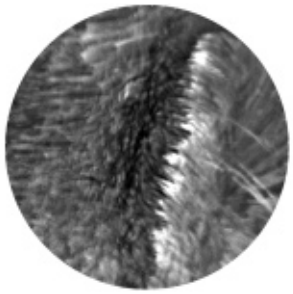
The report of the Senior Review commissioned by the National Science Foundation's Division of Astronomical Sciences (NSF/AST) was released publicly on November 3 (see *www.nsf.gov/mps/ast/ast_senior_review.jsp*). The report is a set of recommendations that will be vetted by the national observatories and the scientific community as NSF develops an implementation plan.

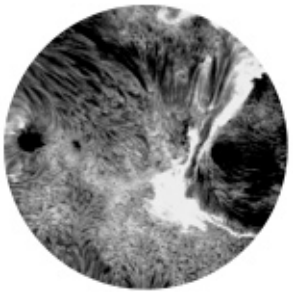
The National Solar Observatory is pleased that the Senior Review report substantially affirms its long-range planning. We are ready to work with the NSF on the implementation of these recommendations, while ensuring that the solar research community—including students—can continue their advanced work, enabled by the unique NSO facilities, until the Advanced Technology Solar Telescope (ATST) is ready to conduct science.

The Senior Review report is strongly supportive of the solar community's desire to build the ATST as the next major national solar facility to replace our aging telescopes and advance high-resolution and coronal science to the next level of scientific discovery, while revolutionizing our understanding of the interactions between the highly ionized solar plasma and the magnetic field. The report also supports NSO plans to expand SOLIS into a three-station network through international partnerships, as recommended in the decadal survey.









With strong NSF support, NSO and the solar community have devoted considerable effort to designing the ATST to meet the scientific challenges of understanding the complete spectrum of solar magnetism, along with the activities it creates that impact humankind. The Senior Review supports our plan that ATST proceed to construction in 2009, with completion in 2014, followed by other large projects such as GSMT, LSST, and the Square Kilometer Array as soon as feasible. NSO has done its homework for ATST, and as demonstrated at the NSF-sponsored Preliminary Design Review in November, we have done it extremely well.

The Senior Review report recognizes the efficiency of the NSO operational model, calling for the maintenance of current NSO staffing levels into the ATST era, and for the start of transitioning positions to ATST as soon as possible. This is reflected in NSO's long-range planning, and the report commends NSO for acknowledging the need to give up still-productive solar facilities in order to free resources for the ATST project.

The Sun is the most significant astronomical object that we study, given the direct relevance of its output to Earth's environment, our economy, and the defense of our nation. It is of utmost importance that the NSO and NSF work together to ensure that advanced research and solar monitoring, supported by NSO facilities, continue without interruption until the ATST is built. Thus we will work closely with the NSF to ensure a smooth transition between existing programs and those of the ATST era.

While for the most part the Senior Review report endorses the NSO long-range plan, there are some significant differences between its recommendations to NSF/AST and those called for by our community-driven plan. The Senior Review recommends that we find alternate funding sources for GONG, or plan for its closure, one year after the commissioning of the oscillation experiment on NASA's Solar Dynamics Observatory (SDO). We are concerned that implementation of this recommendation removes a cornerstone of the NSO program, which is based upon the comprehensive study of the Sun from its core to its hot corona.

If closed on this schedule, the new high-resolution upgrade of GONG, which has enabled local helioseismology, would not complete its data collection over one solar activity cycle, nor would the new science to come from the continuous high-sensitivity magnetograms be exploited. The GONG science community has produced several compelling arguments as to why a ground-based oscillations experiment needs to continue. These points will be

continued

From the Director's Office continued

discussed with the NSF. NSO will also explore alternate funding sources to reduce the cost of GONG operations to NSF. Additionally, the NSO long-range plan calls for a phased merging of GONG and SOLIS operations into a single, efficient NSO synoptic program providing the data required to put ATST and space experiments into the context of long-term variations in solar activity.

The recommendation for GONG is similar to that for Arecibo and the VLBA. The Senior Review Committee recognized the superb science that GONG has produced, and proposed an orderly shutdown for the facility that would allow a transition to a new helioseismology experiment (Solar Dynamics Observatory), as well as the establishment of a GONG legacy database. Specifically, GONG should be closed only if a majority of its operations cost cannot be found from external agencies or partner countries. The recommendation allows for one year of overlap of GONG and SDO operations in order to perform cross-calibration of the instruments.

The report also recommends tying the ramp down of NSO's major telescope facilities to the beginning of ATST construction. NSO has planned to phase out operations at Kitt Peak and Sac Peak facilities, with final closure tied to the commissioning of ATST. This ensures that the US solar community has continuous access to state-of-the-art instrumentation supporting their research, and that the community has the necessary facilities to develop ATST technology (e.g., multi-conjugate adaptive optics, advanced multi-line polarimetry, infrared and thermal infrared instrumentation), and to develop the techniques (such as interpretation of advanced polarimetry measurements) needed to fully exploit ATST. These facilities are also vital to continued training and development of the next generation of solar scientists and instrumentalists, who will be necessary to achieve the scientific goals of the ATST.

NSO plans ensure a smooth transition of personnel to ATST operations, without creating large near-term funding spikes, having already transferred considerable resources to ATST development. All current instrument programs at the Dunn and McMath-Pierce Solar Telescopes were approved on the basis of their contribution to ATST technology development and, when these are completed in the next year or two, no further instrumentation specific to existing telescopes will be developed. We will continue to work with NSF to effect this transition in the most logical fashion, without leaving a major gap in US observing capability, and in the training of the next generation of solar physicists where NSO plays a key role.

There is also a recommendation for NSO to expedite plans for the consolidation of its scientific and technical staffs. The location of a new headquarters for NSO remains to be determined. The process that is being discussed between NSF/AST, NSO, and AURA will include a request for proposals from interested institutions followed by a thorough consideration of proposed sites. The decision to unify NSO operations is of course dependent on the timescale for ATST construction funding, which has not yet been approved

The shutdown of NSO facilities on Kitt Peak and Sacramento Peak is part of the long-range plan put forward by NSO as we transition into the era of the ATST. The divestment of the facilities and the establishment of a new home for NSO will be a complex process entailing a search for organizations that may be interested in assuming ownership of existing facilities, possible demolition, environmental mitigation, and negotiation with potential new 'landlords' for the NSO headquarters. The Senior Review recommendation reflects their understanding of these complexities and encourages an early start for the preparations. The details of the transition from the existing facilities to the new one will be part of the NSF/AST implementation plan, and NSO will work closely with NSF/AST in shaping that plan.

We look forward to working with the National Science Foundation and the scientific community on the responsible implementation of the Senior Review recommendations for the National Solar Observatory. The Sun is an astronomical object of profound importance to our lives, and it is therefore vital to the nation that we continue to provide advanced capabilities for the investigation of our nearest star.

ATST Preliminary Design Review

During the first week of November, NSF held a four-day Preliminary Design Review (PDR) of the ATST, assessing its readiness to move into the construction funding approval stage. The review panel, selected by NSF, was extremely impressed with the quality of the work presented. The ATST team is to be congratulated for their dedicated and excellent efforts that form the basis for the current ATST design and plans.

Under the very capable leadership of Project Manager Jeremy Wagner, the PDR presentations established the readiness of the project to begin construction as soon as funding is secured. The team displayed great technical competence and professionalism, and were able to address all of the issues raised by the committee to its satisfaction. The team should be proud of their accomplishments, which have provided the solar community and NSF with the material to forge ahead with the realization of the ATST. It became clear to everyone at the review that ATST will be a facility with unique capabilities that should revolutionize solar astronomy.

SOLIS

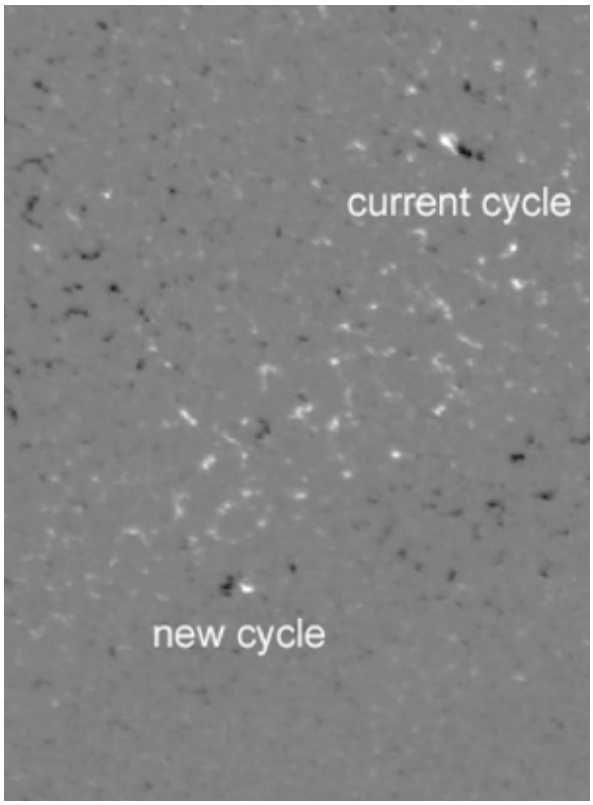
Carl Henney & the SOLIS Team

SOLIS data showing evidence of the emerging solar cycle, and a subsequent NSO press release, caught the notice of three "science watch" news agencies, and a local news station (see the accompanying figure and *solis.nso.edu/news/Cycle24.html* for details). A journalist with the BBC contacted Project Scientist Jack Harvey, while he was attending the IAU meeting in Prague, to discuss the characteristics of Cycle 24 and its ramifications for space weather and communications. Highlights from this interview were included in BBC's weekly "Science in Action" broadcast. Information from the press release also appeared in *Space Daily* and *Space Ref: Science News as It Happens*. A few additional high-latitude "new cycle" regions have been observed since the press release.

Program Scientist Carl Henney and NSO postdoc Nour-Eddine Raouafi attended the Second Ambiguity-Resolution Workshop from October 4–6 in Boulder, CO. An important goal of the workshop was to define a merit function to rate which algorithms are best suited for any given user's requirements. Currently, the algorithm developed by Manolis Georgoulis has emerged as the clear choice for a large dataset such as that of the SOLIS Vector Spectromagnetograph (VSM), with accuracy, stability, and automated functionality. A sample set of active regions observed by the VSM and disambiguated using the Georgoulis algorithm is available via the SOLIS Web site (*solis.nso.edu*).

SOLIS data processing aides Jessica Goodman, Nathan Hadder, and Alex Toussaint have made good progress with various VSM-related projects. Jessica has completed processing level-2 photospheric (630.25 nanometer) longitudinal-magnetogram data. This data set has greater magnetic sensitivity—especially within sunspot umbrae—and will replace the currently available (630.15 nm) magnetograms within the year. Nathan has continued upgrades to the SOLIS database and browser interface to VSM data. Nathan also completed implementation of Jack Harvey's new 854.2-nm processing code. The new code is currently being tested for pipeline processing. Alex has made great progress compressing VSM Stokes profile data using Hermite polynomials. Detailed analysis between the observed and fitted profiles will continue through the fall.

New feed optics were installed for the Integrated Sunlight Spectrometer (ISS) to reduce the image size illuminating the fiber that connects to the ISS. A smaller-diameter quartz fiber was installed at the SOLIS tower after the ISS moved to Kitt Peak. With the new feed optics, the ISS is no longer undersampling the solar disk. The pointing of the feed optics was adjusted during installation to co-align with the pointing of the VSM. Software and two frame-grabber boards were purchased to read out the two Full Disk Patrol (FDP) cameras. This change allows for the rapid and simultaneous display of the cameras, required for optical alignment of the visible and infrared paths needed to affix the beamsplitters to the instrument.



This equator-to-south pole subsection of a SOLIS/VSM magnetogram from 23 July 2006 shows the location and polarity of magnetic fields as light and dark patches. White indicates polarity rising out of the solar surface and black indicates polarity into the surface. An eruption of the new cycle is labeled in the lower, high-latitude part of the image. A current cycle low-latitude eruption is labeled at the top. Notice the reversed east-west orientation of the eruptions. Magnetic patterns in the northern hemisphere will be reversed, i.e., black-white near the equator for the current cycle, and white-black near the poles for the new cycle.

ATST Science Team Meets on Maui

The ATST Team

The Science Working Group (SWG) for the Advanced Technology Solar Telescope (ATST) held its first-ever meeting on Maui from October 17–19. The meeting in Kihei marked a clear shift in the group's focus from the design of the ATST to the definition of detailed science needs and science cases.

"The second day's session of science presentations was particularly interesting and useful for gauging the current state-of-the-art in solar physics research," said SWG Chairman Thomas Berger (Lockheed Martin Solar and Astrophysics Laboratory).

The SWG was organized around status updates and reviews of major focal plane instrument designs on Tuesday, science discussions on Wednesday, and a final half-day meeting summary and assignment of action items on Thursday. Special guests included Mark Hoffman of Maui Community College, and native elder and teacher Verna Nahulu.

Wednesday's session was targeted at detailing the science topics in which ATST will excel. SWG members were invited to prepare short reviews of science topics of their own choosing at the forefront of solar physics, followed by an outline of how the ATST instrument complement will be used to improve our knowledge of this topic. The reviews included basic instrument "observing programs" describing how solar physicists would like to see the ATST instrument array used when it comes on line, and the science data products they would find useful.

The SWG then held a brainstorming session on research areas where our knowledge of the Sun is lacking, and how the ATST might fill these gaps. Group members asked:

- What are the main questions that remain unanswered?
- How will the unique capabilities of the ATST address these questions?
- What specific measurements should ATST make?
- What ground- or space-based instruments should be used with the ATST?

The Thursday session ended with selection of four cases to be developed as clear and concise "ATST Science Programs."

"We need to be able to explain clearly to the larger science community the ways that the ATST will be able to address specific important science questions that have relevance to the larger astrophysics and space physics community," Berger said. "These ATST Science Programs will be important aspects of the project as it progresses through the various review and approval stages."

continued

Members of the ATST Science Working Group, project team, and guests, in front of an uncharacteristically cloudy Haleakalā.

ATST Science Team Meets on Maui continued

The four Science Requirements Document (SRD) programs and associated team leaders are:

- *Sunspot magnetoconvection* (SRD 3.1.7), Tom Berger (Lockheed Martin Solar and Astrophysics Laboratory).
- *Chromospheric dynamics* (SRD 3.2.2, 3.2.3), Gianna Cauzzi (Observatorio de Astrofisico di Arcetri, Italy).
- *Coronal magnetic topology* (SRD 3.2.5, 3.2.7), Haoshing Lin (University of Hawaii).
- *Dynamics of flares and coronal mass ejections* (SRD 3.2.4, 3.3.2), Hugh Hudson (University of California at Berkeley).

The teams will prepare detailed, realistic Observing Plans for each program and show how one or more of the four first-generation ATST instruments will make specific observations in support of each. The finished plans will include the wavelengths, fields-of-view, temporal cadence, data products, and coordinated observing requirements for each topic. Each SWG member will contribute to at least one Observing Plan, with a completion deadline of February 2007, in time for reviews by the Space Studies Board or National Science Board.

SWG members were also asked to review the SRDs and Instrument SRDs for currency, relevancy, and completeness of the science presentation. The finalized SRD is to contain only cutting-edge science: several topics have either been significantly advanced, or have revealed new issues since the original case was made.

"In some sense the SRD is a 'historical document' already," Berger noted. "The engineers have nearly finalized the design of the telescope facility, and it is not intended that any updates or changes that we make to the SRD will result in changes to the telescope design."

In contrast, updates to the Instrument SRD science motivations are expected to impact designs to some degree. The issue of observing cadence came up repeatedly in the SWG meeting. Many of the Instrument SRDs now have maximum cadence requirements of 30 seconds or even minutes. Some presentations—especially for studying the chromosphere at high resolution—demonstrated that cadence values on the order of seconds are required to do discovery science below 0.1-arcsec resolution. Instrument designers may have to rethink mechanisms and camera requirements significantly when multi-wavelength requirements are added.

ATST – Refinement of Enclosure Design

The ATST Team

Design elements of the ATST enclosure have been refined in recent months to incorporate recommendations from the Systems Design Reviews conducted in early 2006.

In response to a recommendation for further analysis of the co-rotational requirements of the enclosure and telescope, it was found that, with minor modifications to the enclosure, non-co-rotating operations are possible. A key component of the enclosure modifications is a custom carousel bridge crane, installed on double girders and set at an angle to clear the telescope in any position. The crane, along with a flange feature that allows the primary shutter to be split in two, and leave a large opening in the top of the carousel, will be very useful during construction of the telescope mount.

Exploration of weatherproofing considerations resulted in the adoption of an 'exoskeleton' arrangement for the carousel. As shown in figure 1, the weather-tight insulated skin is installed on the inside of the structure. The plate coil panels used for maintaining the carousel surface temperatures are mounted directly to the structure without

continued

Figure 1. The model of ATST, produced on a 3-D printer by Solid Concepts, illustrates the 'exoskeleton' configuration for the carousel structure, skin, and plate coil.

ATST — Refinement of Enclosure Design continued

skin penetrations that would require detailed sealing. It is expected that this arrangement will eliminate an ongoing maintenance concern once ATST is in operation.

Tailoring the enclosure and associated thermal systems to the particular climatic and terrain conditions of the Haleakalā site has resulted in identification of a number of cost reduction strategies. The optimized thermal system includes a combination of important contributions: a white concrete apron surrounding the enclosure, which produces smaller loads; a slight change in carousel geometry, reducing exposure to insolation; a better understanding of site conditions, reducing the need for thermal treatment; and a less-expensive style of plate coil.

The project has initiated contracts with industry to review the enclosure designs and to provide independent cost estimates. Two different vendors are reviewing the technical challenges of providing the cable wrap needed to transfer the water-glycol solution across the azimuth axis for the carousel plate coil cooling system.

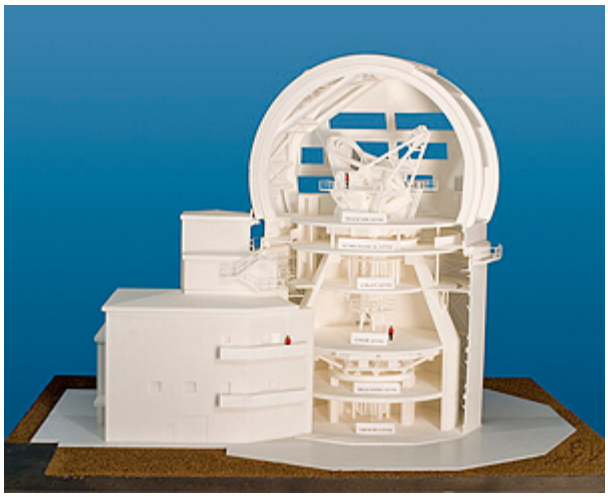


Figure 2. Full view of the ATST model produced by Solid Concepts.

Summer in Tucson from an REU Perspective

Rachel MacDonald

"Tucson? I thought you hated hot weather!"

This was the reaction I got when I told people how I was spending my summer, but I was undeterred. I was going to participate in the National Solar Observatory's summer 2006 Research Experiences for Undergraduates (REU) program, in Tucson, AZ.

I learned about REU programs in the spring of my first year at the University of Washington, but missed the application deadlines. After hearing about just-completed summer experiences from fellow astronomy majors during the next fall quarter, I started researching REU programs. I already had one program on my list—the National Solar Observatory, whose poster I had seen on a bulletin board. I was fascinated from the start, because I had never heard of solar observatories until then. The thought that there were entire institutions dedicated to the study of the Sun was marvelous.

I was accepted to two REU programs. I felt quite proud of that accomplishment, considering the number of students that apply for these spots every year. The first was a private observatory on the East Coast (where I have never been), and sounded interesting, but the second was the National Solar Observatory. Decision made without hesitation!

Rachel MacDonald adjusting the NSO Array Camera at the McMath-Pierce Solar Telescope

I left Seattle on a cool, rainy Monday morning, and arrived in Tucson on a hot, dry Monday afternoon. I was the last of the REU students to arrive, and I was worried at first that I would find it hard to get to know people. I had also read

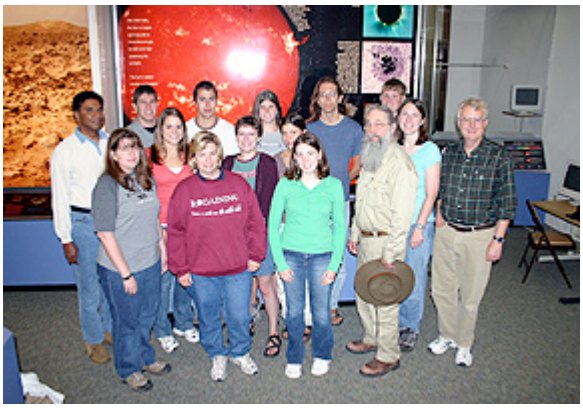
continued

Summer in Tucson from an REU Perspective continued

about other students' summer experiences that mention psychology or personalities. I need not have worried. I have never worked with such a group of nice, easy-going people as I did this summer. There were 11 of us working in a large room for most of 11 weeks—four NSO students and seven KPNO students. As far as I know, there were no conflicts, and no major personality issues. We all just got along. We told stories, laughed together, talked about our projects, helped each other with computer problems, hung out when not at work, and commiserated about the hot, hot weather. I'm looking forward to seeing everyone again at the American Astronomical Society (AAS) meeting in January, and I hope that we all stay in contact in the years to come.

My project this summer was to look through data taken at the Kitt Peak Vacuum Telescope (KPVT), and find trends in the intensity of the umbra of sunspots (specifically, to see if there were trends tied to the solar cycle). I looked at about 3,000 sunspots from 12 years of data and found that sunspots vary in phase with the solar cycle, getting darker from sunspot minimum to sunspot maximum, and getting brighter from maximum back to minimum. My work on the KPVT data links the previously contradicting results, which came from observations during different times of the solar cycle. This is exciting work that will result in my co-authoring a paper with my advisor, Dr. Matthew Penn.

The whole summer experience was wonderful and fascinating. I learned about sunspots and the solar magnetic cycle. I also learned the programming language IDL, and how many times you can run a program and still not find all the bugs. I've read papers, and then later met their authors walking through the hallways at work—a little intimidating at first, but enlightening. I have also discovered how difficult it is to study the Sun during monsoon season in Arizona. More importantly, however, I've discovered that I love solar astronomy.



Participants in the NSO 2006 Research Experiences for Undergraduates (REU), Research Experiences for Teachers (RET), and Summer Research Assistantship (SRA) programs. From left (back row): K. S. Balasubramaniam (NSO-Sunspot REU Site Director), David Waters (RET), Brian Harker (NSO PhD candidate), Susanna Kohler (REU), Matt Rocklin (Undergrad SRA), Tom Schad (REU). Middle row, from left: Mary Reiman (Grad SRA), Elizabeth Keil (REU), Rachel MacDonald (REU), Tiffany Hayes (REU), Dan Seeley (RET), Stephen L. Keil (NSO Director). Front row, from left: Charlene Olsen (RET), Stephanie De Wet (REU). Missing from photo: Dalfra Lynn Fleming (RET). See http://eo.nso.edu/ for full list of 2006 students, teachers, and advisors, and project descriptions.

I feel incredibly fortunate to have been chosen to participate in this program. I cannot recommend it strongly enough to other students. One of the reasons I wanted to do an REU was to see if I would like the day-to-day work of an astronomer. I have discovered that not only do I like it, I can't wait to start doing it myself as an independent scientist. For now, as an undergraduate, I'm thinking ahead to next summer. I hear Hawaii has a good solar program . . .

International Research Experience for (Graduate) Students (IRES)

IRES
INTERNATIONAL RESEARCH EXPERIENCE FOR STUDENTS

NSO/GONG announces a summer 2007 research program for US graduate students sponsored by the NSF Office of International Science and Engineering (OISE). The eight-week program will take place in Bangalore, India under the auspices of the Indian Institute of Astrophysics (IIA). The goal of the program is to expose potential researchers to an international setting at an early stage in their careers. See *eo.nso.edu/ires/* for additional information and application materials.

GONG++

Frank Hill & the GONG Team

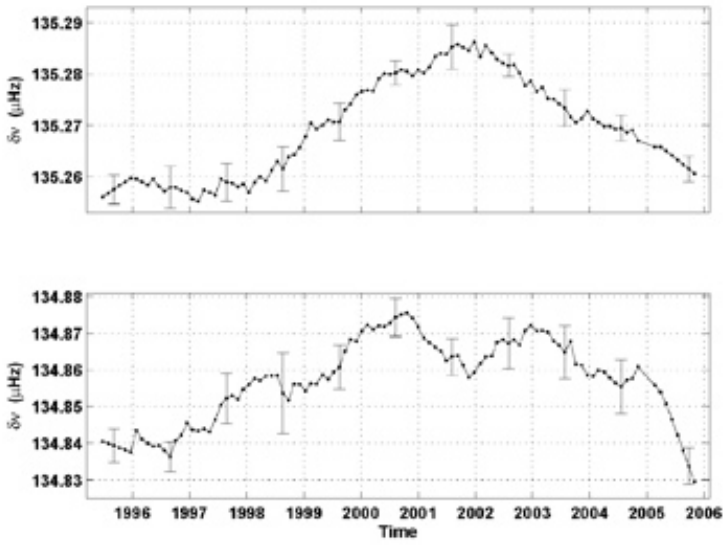
GONG celebrated its eleventh birthday, spanning half the nominal length of a solar "Hale" activity cycle. Long-term and stable helioseismic measurements of subsurface structures and flows have become a major component of our exploration of activity-related variations in the Sun, and the solar physics community is eager to see how the upcoming solar maximum develops, especially in light of the wide variation in predictions of its amplitude.

The past quarter of GONG activity was filled primarily with a number of international meetings, the continued development of the data processing pipeline for magnetograms in preparation for the STEREO launch, and progress on the construction of the "hot spare" instrument. We had a scare in October from the earthquake in Hawaii, but were fortunate not to suffer any damage at the Mauna Loa site.

Science Highlights

GONG scientific staff contributed 21 papers at the recent helio- and astero-seismology meeting ("GONG 2006") in Sheffield (United Kingdom), held in conjunction with the SOHO helioseismology instruments and the new European Union network HELAS. Staff also attended the IAU General Assembly in Prague (where we had a Joint Discussion on helio- and asteroseismology); the Second International Symposium on Space Climate in Sinaia (Romania); the HELAS Local Helioseismology workshop in Nice (France); and the Solar Orbiter meeting in Athens. In November, GONG staff participated in a Local Helioseismology Comparison (LoHCo) group meeting in Boulder, CO.

Shukur Kholikov has found that an autocorrelation analysis of the low-degree time series can provide a very sensitive measurement of the "large separation," the frequency difference between modes with the same degree but different radial order. This has revealed that the large separation varies with the level of solar activity, indicating that the depth of the upper reflection point of the modes depends on the activity. The method can also be used for time-series analysis in asteroseismology, opening a new window on the physical changes associated with stellar activity (see the accompanying figure for details).



The "large separation" of low-degree solar modes as a function of time (upper panel: ℓ = 0, lower panel: ℓ = 1). The large separation, δν, is the difference in frequency for modes with the same spherical harmonic degree (ℓ) but consecutive radial order (n). The large separation is a measure of the time for an acoustic wave to travel between its upper and lower reflection points in the internal solar temperature gradient. Variations in the large separation thus arise either from changes in the density scale height, which affects the depth of the upper turning point, or from variations in the internal sound speed. The variations are correlated with the solar activity level, indicating that the presence of activity raises the average internal sound speed and reduces the solar acoustic radius. The large separations shown here are computed from the autocorrelation of the time series, and have a precision that is a factor of 50 better than what can be achieved from the individual mode frequencies estimated from the power spectrum. This technique should be useful for asteroseismic studies of stellar activity.

Network Operations & Engineering

The months of July and August offered a welcome respite from site maintenance visits, following the magnetograph modulator upgrades and the Learmonth shelter swap during the previous quarter. There was considerable activity at the Tucson site, where spare items were repaired, upgraded, tested and certified for use in the network stations. The turret returned from Learmonth, after the shelter swap was overhauled and installed at the Tucson instrument. Troubleshooting and repair of failed electronics cards progressed significantly during the summer months, and has restocked the supply of usable spares. Testing and burn-in of the new waveplate amplifiers has continued, with installation imminent at some of the

continued

GONG++ continued

network sites. Cameras and camera power supplies are regularly under test. Adapting the real-time system to work with LTO tape drives has been successful, but this has not yet been tested with the Tucson instrument. All of this work allows for the resumption of preventative maintenance trips during the fall.

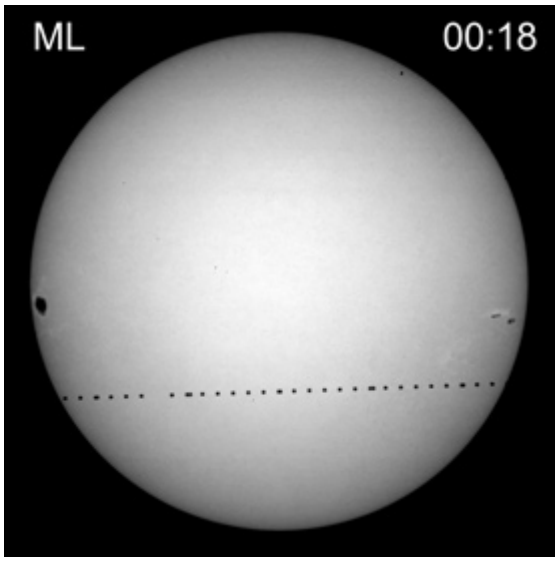
The only site visit that occurred this quarter was a preventive maintenance (PM) trip to Mauna Loa. Because the weather did not cooperate during the original installation of the upgraded modulator, and the original alignment had to be completed without sunlight, the follow-up visit to adjust and realign the modulator was useful. Data from Mauna Loa will be checked to verify proper modulator alignment. A few days before the trip began, the CCD temperature stabilization failed on the camera, and a replacement camera was added to the preventive maintenance packing list. In the end, the on-site camera was repaired in the field and the routine PM was completed on schedule.

The shelter for GONG's Hot Spare system has been completed, with work now proceeding on the system components. The optical table support system has been completed and the table is ready for installation. The camera rotator and light feed (turret) assemblies are all nearing completion. Wiring of the power supply chassis has begun, with wiring of other chassis and the equipment rack to follow.

Data Processing, Software Development & Analysis

As of this writing, the realtime magnetogram pipeline is nearing completion. Remapped magnetograms, site-day diagnostic synoptic maps, and network-wide Carrington rotation synoptic maps are now available online.

These real-time magnetogram data products have been provided to the STEREO science team as well, supporting the mission's coronal science. STEREO was successfully launched on 25 October 2006, and the GONG synoptic maps can be found at *gong.nso.edu/data/magmap/*. Full-disk magnetograms, delivered every twenty minutes in near real time, can be found at *gong.nso.edu/Daily_Images/*.



The team prepared a live Web page for the Mercury transit on November 8 (*gong.nso.edu/mercury_transit06/latest_site_images.html*). For almost any transit event, at least one GONG station is able to view the complete transit, while another two sites will see it at sunrise or sunset. Unlike past transits tracked by GONG, this transit was visible from Australia, Hawaii (see image), California, and Chile, which meant that staff were able to monitor the live Web page updates during regular daytime hours.

Progress is being made in the migration of the Data Storage and Distribution System (DSDS) to Oracle 10 on the Linux platform. We can anticipate that a new DSDS GUI will be deployed before the end of the year. The GONG Web server was recently migrated from "solarch" (Sun Solaris) to "fargo" (Linux), and as a result, we are noticing a dramatic improvement in the overall performance of the Web site. The GONG Classic (1995-2001) calibrated image catalog is being migrated from eight millimeter tape to LTO media. This will preserve the data for posterity, and enable science analysis of previously unavailable meta-data stored in the FITS image header. The calibration module of the global *p*-mode pipeline, VMBICAL, is nearly ready to be migrated to Linux for routine processing, which should help reduce the backlog (currently at 452 site days).

Processing to date includes month-long (36-day) velocity time series and power spectra for GONG Month 108 (centered at 09 December 2005), with a fill factor of 0.87. 108-day Mode Frequency Tables are available for Month 107 and Ring Diagrams are available through Month 108. Last month, the DSDS distributed 183 Gigabytes in response to six data requests.

Staff News

We are pleased to announce that Tamara Rogers, a long-term visitor with GONG, recently accepted a faculty position with the University of Arizona Lunar and Planetary Laboratory. Tami has been working on theoretical numerical simulations of solar internal gravity modes, and will be searching for these modes in GONG data.

Creative Thinking Saves Teacher-Student Observing at Kitt Peak

Katy Garmany

It is every astronomer's nightmare: you arrive at the telescope to find it's down with mechanical problems that can't be resolved until the day after your observing run ends. This was the situation faced in September by a high school teacher and three of his students.

John Blackwell, a past participant in the Astronomy Research Based Science Education (A-RBSE) program conducted by the NOAO educational outreach group, had successfully guided three of his students from Phillips Exeter Academy, Exeter, NH, through a modified time allocation process designed to offer ongoing observing opportunities at Kitt Peak for students and their teachers. This special observing program is available to successful participants in the A-RBSE program, now entering its 11th year at NOAO.

Blackwell and his students had been granted two nights of NOAO time on the WIYN 0.9-meter telescope to observe an eclipsing binary, with assistance from Katy Garmany. However, the telescope was still suffering the after-effects of a severe lightening strike earlier this summer, and the group arrived to find it out of commission.

Figure 1. Teacher John Blackwell and his three students watch the spectrum of their star appear at the coudé feed.

Figure 2. Students Meridith Mead, Olivia Claudio and Sean Leahy filling the dewar at the WIYN 0.9-meter telescope.

Some brainstorming in the dining hall that evening and a rapid response from Kitt Peak Director Buell Jannuzi resulted in the group receiving permission to use the coudé feed at the 2.1-meter telescope to observe the binary they had hoped to follow photometrically. Not only did they get to take spectra at the coudé feed (figure 1), they had the opportunity to fill dewars at TWO telescopes (figure 2)!

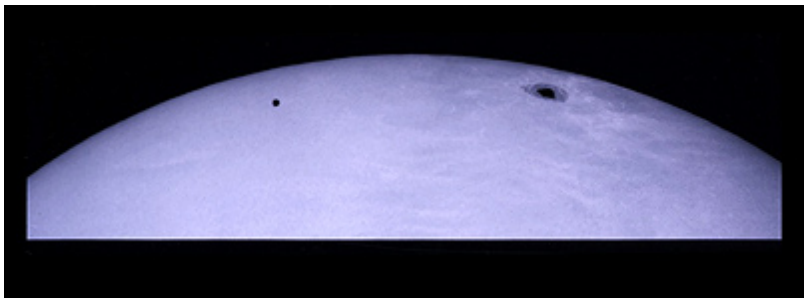
Results from this observing run will be reported in a future issue of the online *RBSE Journal (www.noao.edu/outreach/tlrbse/journal.html).*

Visit to Santa Rosa

NOAO outreach staff traveled to Santa Rosa Boarding School on the Tohono O'odham Nation on October 17 to a conduct a star party for students and local residents. While rain clouds dampened the telescope viewing, the 75 attendees asked many questions about the latest astronomical discoveries, and took advantage of the time to discuss local issues related to Kitt Peak. Student Serena Brown (photo) was the winner of a drawing for a pair of binoculars donated by Kitt Peak Visitor Center.

Mercury Transit Webcast and Science Observations

The transit of the Sun by planet Mercury on 8 November 2006 was Webcast around the world by the Exploratorium science museum of San Francisco, using a 16-inch public outreach telescope at Kitt Peak National Observatory located near the WIYN 3.5-meter telescope.



Meanwhile, observations at the National Solar Observatory (NSO) McMath-Pierce Solar Telescope at Kitt Peak, and others at the NSO Sac Peak facility, were conducted to study the atmosphere of Mercury during the transit. The objective of the transit observation at the McMath-Pierce led by Andrew Potter (NSO) was to map Mercury's sodium exosphere by measuring absorption of sunlight by sodium vapor surrounding the planet. The transit gives a rare opportunity to measure the dawn and dusk terminators of the planet simultaneously.

"The day of the transit was ideal, with no clouds and good seeing," Potter reported. The adaptive optics system functioned well. We measured approximately 1,000 spectra, stepping across the planet in half-arcsecond steps, with the slit oriented first north-south, and then east-west. Preliminary analysis of the spectra show sodium absorption above the planetary disk, extending 2-3 arcseconds outside of the disk. Clearly, the adaptive optics capability made the observation possible."

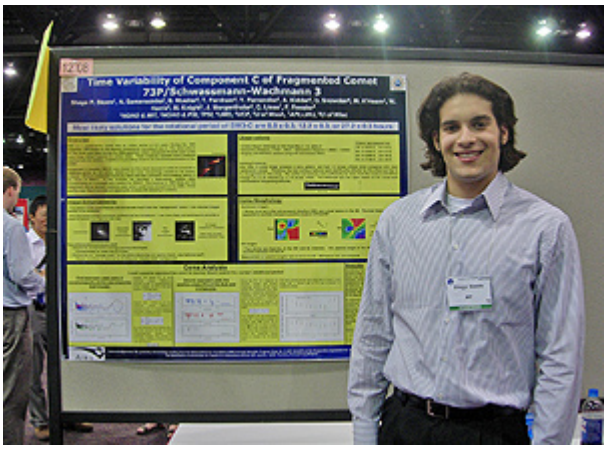
Observations of the transit at the NSO Sac Peak facility utilized the IBIS instrument, a scanning Fabry-Perot interferometer, to capture images of Mercury's shadow surrounded by sodium absorption.

The image above shows the transit about 10 minutes after first contact, as well as a large sunspot just rotating into view. It was taken by Bill Livingston (NSO) using the west auxiliary feed of the McMath-Pierce.

My Kitt Peak REU 2006 Experience

Shaye Storm (Massachusetts Institute of Technology)

The Research Experience for Undergraduates (REU) program at Kitt Peak National Observatory provides an incredible opportunity for aspiring young scientists to learn about astronomy while make themselves known in the scientific community.



I participated as an REU student this past summer, working with Nalin Samarasinha of NOAO and Beatrice Mueller of the Planetary Science Institute to constrain the rotational period of periodic comet 73P/Schwassmann-Wachmann 3-C (SW3-C). For ten weeks, I worked primarily out of the NOAO headquarters, while taking time off for touring major astronomy facilities in the Southwest, observing at Kitt Peak, attending weekly lunch seminars on a range of astronomy topics, and exploring Arizona with the other REU students. Partaking in the following winter meeting of the American Astronomical Society (AAS) is an additional beneficial experience provided by the Kitt Peak program.

Gaining proficiency at presenting results to the astronomy community is just as important for students as the research itself. Although I will be attending the AAS meeting in January, my project on SW3, my personal astronomy interests, and my graduate school plans created a desire to attend the fall meeting of the AAS Division of Planetary Sciences (DPS) as well. The KPNO REU program and my university, MIT, were kind enough to fund this trip to Pasadena, CA, to attend my first professional research conference.

continued

My Kitt Peak REU 2006 Experience continued

The main goal for my two full days at DPS was to meet as many people as possible to discuss graduate school and future research opportunities. Nalin, Beatrice, and my MIT professors were eager to introduce me to their colleagues. I had the great opportunity to talk casually with many professors and students about their departments and personal research. Questions on the top of my list pertained to observatory access, the number of active observers in the department, and the overall happiness of the graduate students. Having them ask me questions also allowed me to leave the meeting with a better definition of what I was looking for in graduate school.

I also had the goal of successfully presenting my REU research on SW3 and hearing what other teams had discovered about the comet. The SW3 poster session was on the first afternoon of the conference. The week before flying out, I made sure to go over my talk in front of my friends in order to brush up on the finer details that I had forgotten.

The relaxed atmosphere of the poster session was facilitated by the refreshments and popcorn served around the hall. I stood near my poster and entertained visitors stopping by to take a look. A few people asked questions that I could not answer, since I lacked deep overall cometary science knowledge, but I felt as if I properly presented my findings to everyone who was interested.

I also enjoyed listening to discussions of the SW3 poster next to mine: the team had similar goals, but used very different techniques. Not only was I able to compare results with them, but I also learned the basics of radar imaging and how it can be used to constrain physical and rotational parameters of small bodies.

The secondary goal of keeping up with my MIT course work while at the meeting was mildly successful. I found myself doing some last-minute work on the floor of LAX before my flight back to Boston, but falling a few days behind was well worth the amazing opportunity.

As an undergraduate interested in pursuing a career in astronomy, I feel that the only things that can confirm my interest are doing research and presenting at meetings while still at the undergraduate level. The firsthand experiences given to me by the summer KPNO REU program and the fall DPS meeting have made me firm in my next step of attending a top graduate school in astronomy.

Students Needed for 2007 REU Program at Kitt Peak

Kenneth Mighell

Each summer, a group of talented college students come to Tucson to participate in astronomical research at Kitt Peak National Observatory (KPNO) under the sponsorship of the National Science Foundation's Research Experiences for Undergraduates (REU) Program.

Like the parallel program at Cerro Tololo, the KPNO REU program provides an exceptional opportunity for undergraduates considering a career in science to engage in substantive research activities with scientists working in the forefront of contemporary astrophysics.

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

As part of their internship experience, all six of our 2006 REU participants will present posters describing their astronomical research projects at the January 2007 American Astronomical Society meeting in Seattle.

We anticipate being able to support six REU positions during the summer of 2007. Student participants must be citizens or permanent residents of the United States to meet NSF requirements.

The KPNO REU positions are full-time for 10–12 weeks between June and September, with a preferred starting date of early June. The salary is $570 per week, with additional funds provided to cover travel to and from Tucson.

Further information about the KPNO REU 2007 program, including the online application form, can be found at www.noao.edu/kpno/reu. Completed applications (including official transcripts, and at least two letters of recommendation) must be submitted to KPNO no later than 29 January 2007.