National Optical Astronomy Observatory

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National Solar Observatory

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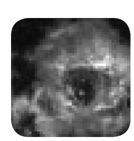

From the Editor:

It has been said many times that change is difficult.

Managing change effectively may be even more challenging — witness the wide variety of strong opinions expressed in the wake of Daniel S. Goldin's recent departure as NASA administrator, after a record tenure marked by near-constant change.

The subtext of many stories in this *NOAO Newsletter* is change: a modified role for NOAO in facilitating the national astronomical system, a larger vision of scale in the design and development of scientific instrumentation, the transition of both Gemini telescopes from commissioning to routine operations, and new modes of observing for small telescopes at CTIO.

I hope that these articles make it plain to see that NOAO is changing to address the realities and ambitions of the US community. Any of the authors would be pleased to provide more details or answer follow-up questions. As always, your opinions are welcome.

And let us be among the first to wish you a healthy and productive year in 2002, with plenty of positive change for all.

-- Doug Isbell

On the Cover

Images from the most recent Project ASTRO-Tucson workshop show attendees sketching, writing, and painting in their Moon journals, and conducting an exercise on demonstrating the phases of the Moon. See page 34.

Notable Quotes

"*Modern cosmology is in the midst of a revolution. New instruments are producing the first detailed data about the distant universe.*

The resulting origin story will be the first ever based on scientific evidence and created by a collaboration of people from different religions and races all around the world, all of whose contributions are subjected to the same standards of verifiability. The new picture of reality excludes no one and treats all humans as equal.

The revolution in scientific cosmology today may open the door to a believable picture of the larger reality in which our world, our lives, and all our cultures are embedded."

-- Nancy Ellen Abrams and Joel R. Primack of the Physics Department at the University of California, Santa Cruz, writing in the 7 September 2001 issue of SCIENCE magazine. Spouses Abrams and Primack co-teach a course on cosmology and culture at UCSC.

Have you seen an interesting comment in the news or heard one during a NOAO-related meeting or workshop? *Please share them with the Newsletter Editor, editor@noao.edu.*

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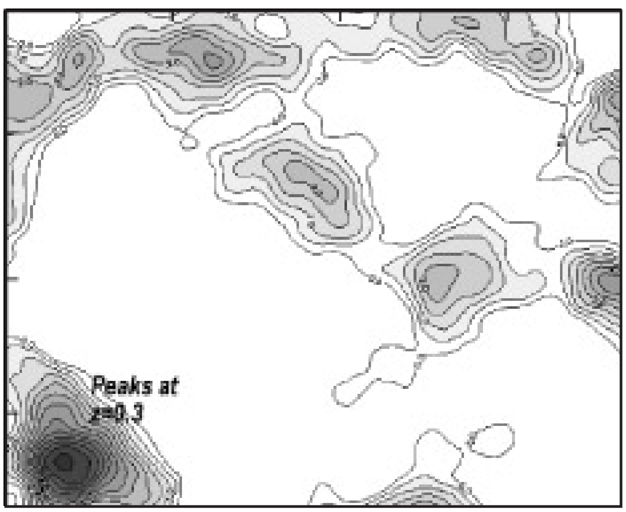
Through a Gravitational Lens, Darkly

Based on a contribution solicited from Tony Tyson (Bell Labs)

David Wittman, Tony Tyson and Vera Margoniner (Bell Labs), J. Cohen (Caltech), and I. Dell'Antonio (Brown) used their technique of 3-D mass tomography to discover a cluster of galaxies solely from its lensing of background galaxies. Their raw material was a multi-color imaging survey conducted with the Big Throughput Camera on the CTIO 4-m telescope. By combining shear measurements of faint galaxies with photometric redshifts, Wittman and collaborators found evidence for a strong mass concentration at a redshift of ~0.3. Spectroscopy conducted at the Keck Observatory confirmed that they had detected the potential of a rich galaxy cluster at that redshift.

Ninety-five percent of the mass-energy of the Universe is in some non-baryonic form. Statistical studies aimed at understanding dark mass-energy should ideally be not biased for baryons. Until now, however, one still had to rely on detection of radiation from baryons associated with concentrations of dark matter. Even 2-D projected mass mapping via weak gravitational lensing, a technique that Tyson and others have developed over the past decade, has relied on spectroscopy for the distance to mass concentrations (clusters of galaxies). The new breakthrough is based on distance estimates for the background-lensed galaxies, based on colors provided by 4-band imaging.



The figure above shows the massive concentration of dark matter discovered via the weak lens shear of thousands of background galaxies imaged with the Big Throughput Camera on the CTIO 4-m telescope. This field is one degree on a diagonal. Wittman and collaborators first place the background galaxies into redshift bins, based on the color-z estimates. Higher redshift galaxies are sheared more strongly by the foreground mass than lower-z galaxies. Using the 2-D location of this mass on the sky, and fitting the shear of the background galaxies to a series of model redshifts for the mass, a best fit at z=0.3 was found. They then confirmed this redshift via spectroscopy of some cluster galaxies using the Keck 10-m telescope. The precision for this shear-derived redshift is more than sufficient for studies of the 3-D distribution of mass in the Universe.

The first application of 3-D mass tomography will be in one of NOAO's survey programs. The Deep Lens Survey (DLS), which will eventually cover 28 square degrees, is nearly half finished (see *http://dls.bell-labs.com*). A deep multi-wavelength imaging survey of millions of distant galaxies in the BVRz bands, these data will enable a multitude of astronomical probes. The DLS made its first public data release this past August in the form of calibrated photometric catalogs, FITS images, and JPEG color images. This first look at the 3-D mass distribution will enable a unique probe of dark energy. The nature of dark energy, which now appears to dominate the mass-energy of the Universe, is a challenge to our understanding of physics. Estimates of its expected density based on current physics are at least 50 orders of magnitude too large. The DLS will shed light on dark energy: a Universe dominated by diffuse energy (rather than mass) grows mass structures via gravity more slowly. The DLS weak lens data is our first opportunity to directly probe whether the Universe is dominated by a cosmological constant or by Quintessence.

Wholesale application of 3-D mass tomography is a central goal of the Large-area Synoptic Survey Telescope (*http://lssto.org)*. The LSST will be a powerful probe of dark energy because it measures a number of properties that depend on different combinations of angular distance and structure growth. Measuring a range of properties of cosmic shear and cluster abundance, the LSST will provide several independent constraints on the dark-energy density and the equation-of-state to a precision of a few percent.

With an 8.5-m primary mirror and a 2-Gigapixel camera, the LSST will image the entire visible sky several times per month, enabling a variety of unique planetary, stellar, and cosmological investigations. A time-tagged imaging database of several petabytes will result.

The Biggest KBO Found So Far

Based on a contribution solicited from L.H. Wasserman (Lowell)

L.H. Wasserman (Lowell) and Jim Elliot (MIT/Lowell) used the Mosaic CCD camera at the CTIO Blanco 4-m telescope to discover what may be the largest Kuiper Belt Object (KBO) found so far. The size of the new object, 2001 KX76, can be estimated only by assuming an albedo, but conservatively it appears to have a diameter of slightly under 1,300 km, which would make it larger than both Ceres, the largest main-belt asteroid, and Charon, Pluto's moon.

2001 KX76 was discovered on May 22 in the course of the Deep Ecliptic Survey (DES, PI: Robert Millis/Lowell), a NASA-funded program that uses NOAO's KPNO and CTIO 4-m telescopes to characterize the Kuiper Belt. The DES will run for three years and aims to discover and determine accurate orbits for roughly 500 KBOs. A large collection of KBOs with accurate orbits is necessary to understand the dynamical structure of the Kuiper Belt. It also provides a rich sample of objects that can be used for physical studies by large (6-m or bigger) telescopes or HST.

Wasserman, Elliot, and other DES team members who searched the Mosaic observations for moving objects found 2001 KX76 to be unusually bright for a KBO at the time of its discovery, although an absolute magnitude (which for solar system objects is the brightness of an object 1 AU from both the Sun and Earth) would have to await the determination of an accurate orbit.

The observed arc defined by the discovery observations was too short to yield a meaningful orbit, and the USNO A2.0 catalog, which the DES team uses for its astrometric reference net, is known to have poor photometric accuracy. That, combined with the use of a non-standard VR filter, results in apparent magnitudes at discovery that can have errors of a few tenths of a magnitude.

Fortunately, Elliot had a follow-up observing run on the 6.5-m Magellan telescope at Las Campanas and was able to reobserve this object on June 9 and 12. Wasserman also obtained observations of this object at the Lowell 1.8-m telescope on June 19-20, yielding a 28-day observational arc; accurate photometry was also obtained.

For an object with this short an observational arc, one usually first determines its Vaisala orbit, i.e., an orbit that assumes the object's radial velocity is zero — that is, the object is at perihelion or aphelion. Logically, objects are normally discovered at perihelion, where they are brighter. However, the aphelic solution gave RMS residuals of about 0.1″, while the perihelic gave RMS residuals of 0.6″. If the aphelic solution was the correct one, this was clearly the brightest KBO yet discovered. If the perihelic solution was correct, the object was an unusually bright KBO, but not the brightest known.

Brian Marsden (IAU) decided that the perihelic orbit was more likely to be correct and published it in MPEC 2001-M59. Further observations of this object eventually resulted in an orbit that was accurate enough to find the object in earlier data, eventually extending the arc back to 1982 and resulting in this object being assigned a number. While it is clear that neither the perihelic nor the aphelic orbit was exactly correct, the object-Sun and object-Earth distances derived from the aphelic orbit were essentially correct.

The orbit is now well defined, and 2001 KX76 is, indeed, the intrinsically brightest KBO currently known. If one assumes an albedo of 0.07, the albedo of 2000 Varuna — the only KBO with a measured albedo — 2001 KX76 exceeds the diameter of Ceres.

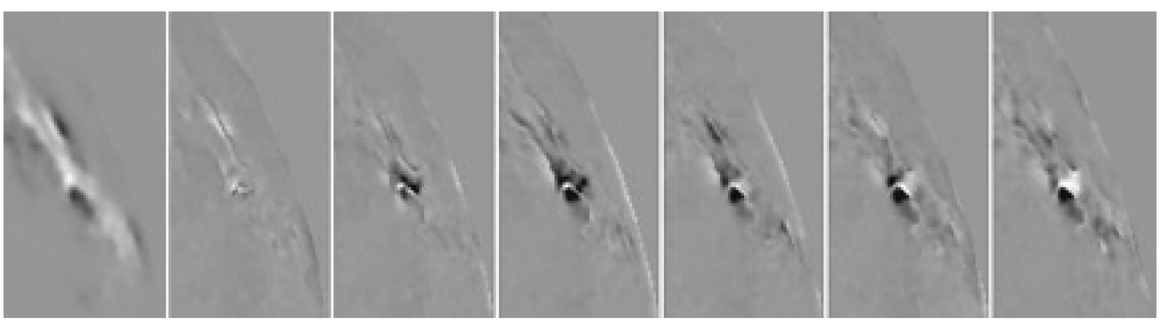
Clear and Consistent Observations of Magnetic Field Changes with Flares

Jack Harvey (NSO)

For more than a half-century, it has been suspected that solar flares, the most energetic and violent explosions in the solar system, are driven by changes in the solar magnetic field. As measurement techniques have improved since the late 1950s, there have been numerous reports of observations of magnetic field changes associated with flares. The reports had been inconsistent and confusing, and a clear picture of the nature of flare-associated magnetic fields had not emerged. The advent of several independent observing systems, which can measure the magnetic field at high cadence with adequate spatial resolution and sensitivity, has provided a breakthrough. The key has been simultaneous observations by different instruments that all show the same results.

At NSO, the new capability is magnetic field images of the full solar disk produced once per minute by the instruments of the recently upgraded GONG+ network. J. Harvey has studied some of these magnetograms, which first became available in limited numbers in May 2000. A. Kosovichev has studied similar magnetogram sequences produced by the MDI instrument on board the SOHO spacecraft, and T. Spirock has examined magnetograms made at Big Bear Solar Observatory.

A particularly good example of changes is associated with the most powerful X-ray flare observed during the present solar cycle on 2 April 2001, in an active region situated near the northwest solar limb. The central part of this large active region contained sunspots and magnetic fields that showed large shears along the photosphere. This part was the locus of the flare. According to the GONG+ magnetograms, the apparent strength of the line-of-sight component of the magnetic field decreased on both sides of the so-called neutral line suddenly at the start of the flare. Later in the flare and afterward, the strength on one side of the neutral line gradually increased to a level exceeding the original values. Without information about the full vector magnetic field, these changes cannot be unambiguously interpreted, but observations of many flares at different disk locations should allow construction of a consistent physical model.

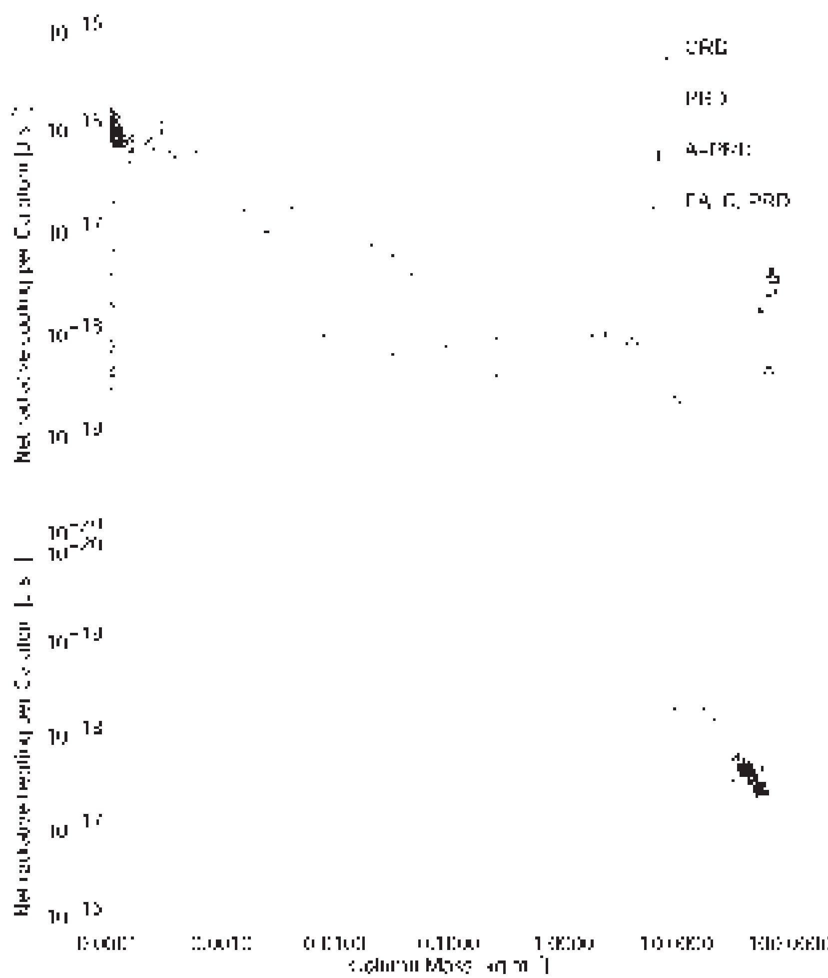


Sasha Kosovichev called attention to changes in GONG+ observations of the X20 flare of 2 April 2001 in NOAA 9393, and Jack Harvey prepared this figure to show the temporal evolution. The left panel is the line-of-sight component of the magnetic field near the northeast limb, averaged over 30 minutes prior to the flare (2100-2129 UT). The next six panels show the difference between the absolute value of the signal averaged over subsequent 10-minute periods and the 30-minute pre-flare average. White represents increasing line-of-sight signal strength; black represents decreasing line-of-sight signal strength. The panels are averaged from left to right over 2130-39 (preflare), 2140-49 (rising phase), 2150-59 (maximum), 2200-09 and 2210-2219 (declining phase), and 2250-59 (post flare). The changes shown are a combination of seeing effects, change in perspective as the Sun rotates, line profile changes associated with the maximum phase of the flare, normal evolution of the active region field, and real field changes associated with the flare. The later panels are coincident with a strongly sheared sunspot. It is not clear if the flare field changes are in strength, direction or position, or some combination of the three.

The Effect of Coherent Scattering on Radiative Losses in the Solar Ca II K Line

Han Uitenbroek (NSO)

Despite decades of observations and theoretical calculations, we still lack a clear understanding of the nature of chromospheric emission in the Sun and other stars. Current theoretical models range from traditional one-dimensional, semi-empirical models, which require a continuously present chromospheric temperature rise on top of a 4,400 K temperature minimum, to radiation-hydrodynamic models, which derive their chromospheric emission from intermittent shock dissipation. Despite their large differences, the two types of models are very similar in the sense that each has severe problems when confronted with detailed spectroscopic observations. For instance, the traditional hydrostatic models cannot explain the presence of 3,700 K gas, as indicated by the deep absorption line cores of the CO molecule observed near the solar limb, while radiation-hydrodynamic models often predict intensity variations with much larger amplitude than is observed.



The figure compares the time-averaged net radiative losses in the Ca II K line for CRD (triangles), angle-averaged PRD (diamonds), and angle-dependent PRD (squares) for the chromospheric dynamics model. Top of the atmosphere is to the left, bottom to the right. Coherent scattering reduces radiative losses in the K line by a factor of two to three in the middle of the atmosphere. Even though time-averaged chromospheric emission from the dynamic model and the traditional hydrostatic model are very similar, the radiative losses in the latter (crosses) are very different on average.

Even though the average amount of chromospheric emission from both types of models is very similar, their average temperature structure, and corresponding chromospheric energy budget, are very different. Where the traditional model requires a continuous temperature rise from

continued

Coherent Scattering continued

the temperature minimum outward to produce the observed amount of chromospheric emission, the dynamic model shows an average temperature which gradually declines until a sharp transition appears to the hot corona, far above the location of the chromosphere in the traditional models. The manner in which each model's energy budget is determined is also different. In semi-empirical models the temperature stratification is adjusted so that the calculated spectrum matches the observed spectrum over a wide array of observables. In the dynamic models, only the mechanical input flux at the bottom can be varied; the rest follows from the physical laws implemented in the simulation. The temperature structure, in particular, is a direct result of the running balance between mechanical and radiative sinks and sources.

In the chromosphere, shock wave dissipation is balanced by radiative losses in strong lines of hydrogen and resonance lines of high abundance metals, with highest losses coming from the K line of singly ionized calcium. Even in state-of-the-art simulations (Carlsson & Stein 1997, ApJ 481, 500), the radiative losses in these lines are calculated with the assumption of complete frequency redistribution (CRD), which neglects the substantial effects of coherent scattering in these strong lines, mainly to reduce the computational problem to manageable proportions.

However, with the advent of an efficient yet accurate technique to take account of coherent scattering (so-called partial frequency redistribution, or PRD, Uitenbroek 2001, ApJ 557, 389), it is now possible to evaluate the effect of coherent scattering on the radiative losses in the K line even in dynamic models, which require the use of angle-dependent PRD, a more involved form of redistribution which also accounts for coherency in the angle of scattering. The figure on page 6 shows that coherent scattering leads to radiative energy losses in the K line that are considerably different from the CRD case, and should be taken into account for realistic estimates of these losses.

Director's Office

A Major Focus On Instrumentation

Jeremy Mould

It is easy to find hard evidence for the increasing scale of the enterprise involved in building state-of-the-art astronomical instrumentation, from the scientific impact of the Two-Degree Field Spectrograph (e.g., *astro-ph*/0109152) and the beautiful spectra from Keck's HIRES and ESO's UVES, to the promise of the Gemini Near-InfraRed Spectrograph and Magellan's IMACS.

The next generation of instruments discussed in the context of the VLT (see *www.eso.org/gen-fac/meetings/vltinstr2001/*) presages a continuation of this trend (e.g., *astro-ph*/0108130 & 0108106). The *GSMT Greenbook*, due out soon from the NOAO-Gemini New Initiatives Office, goes a step further in this direction.

In recognition of this trend, we have integrated NOAO's instrumentation resources going into the new fiscal year, through a new Major Instrumentation Program that merges NOAO's related efforts in Arizona and Chile.

As the name implies, the program is devoted to instruments of the scale required for 8-meter class telescopes. Working together at both sites with communications channels that are now well-matched, thanks to Gemini-driven improvements, NOAO can muster a program capable of simultaneously carrying out two concept studies, plus detailed design of an additional instrument and fabrication of another. The Major Instrumentation Program represents some 18 percent of the overall resources of the Observatory. We intend to recruit a talented leader for this program, which is a great opportunity for the right person. The new Head of Instrumentation will be an Associate Director of NOAO.

This move "upmarket" also creates opportunities in the area of 4-meter telescope instrumentation. NOAO is now looking to university groups for innovative instruments for its 4-meter telescopes. Science programs will accompany those instruments. We look forward to hearing from interested partners in these developments, both at Kitt Peak and Cerro Tololo.

Telescope System Instrumentation Program

After much discussion by US astronomy's top advisory groups, the Announcement of Opportunity for the first year of the Telescope System Instrumentation Program is almost ready to be rolled out.

According to the National Research Council's Decadal Survey, *Astronomy & Astrophysics in the New Millennium*, "US ground-based optical and infrared facilities …should…be viewed by the National Science Foundation (NSF) and the astronomical community as a single integrated system drawing on both federal and nonfederal funding sources."

The highest priority "moderate initiative" was the Telescope System Instrumentation Program (TSIP). This was envisioned by the Panel on Optical and Infrared Astronomy from the Ground as a $5 million per year program that would have several positive effects on the emerging new paradigm of the "system." The O/IR panel report describes TSIP as having three goals:

1) "… guid[ing] the evolution of the telescope system so that it becomes more powerful and more diverse; it would do this by, for example, favoring instruments with unique capabilities and those that would be particularly effective in reaching…scientific goals…,"
2) "achieving greater public access to these facilities,"
3) "encouraging and leveraging the contribution of institutions that contribute nonfederal funds to the US astronomy enterprise."

TSIP would accomplish these goals by funding the development of instruments for the private observatories, in exchange for telescope time on those facilities. This observing time would be made available to the community in amounts corresponding to half the value of the instrument funding provided.

Development of the system though TSIP was underlined again as a vital new initiative by the recent report by the Committee on the Management of Research in Astronomy & Astrophysics, chaired by Norm Augustine.

Under its cooperative agreement, NOAO plans to work with NSF to make this program a success in the coming year. Look for updates on the NOAO Web site at *www.noao.edu/system/tsip/*.

The Five-Year NOAO Fellowship: A Research Opportunity to Shape the Future

NOAO will award two or more five-year post-doctoral fellowships to recent Ph.D.s of outstanding promise to conduct ambitious, long-term research programs using the International Gemini Observatory, Kitt Peak National Observatory, or Cerro Tololo Inter-American Observatory.

Fellows may reside at either NOAO (Tucson, AZ) or CTIO (La Serena, Chile) headquarters, with support during the final year of the fellowship for residence at a participating US astronomical research department.

NOAO fellows will also participate in NOAO programs to define the next generation facilities, including the Giant Segmented Mirror Telescope, the Large Synoptic Survey Telescope, the National Virtual Observatory, facility-class instrumentation, or design and operation of large astronomical surveys.

The deadline for applications is 2 January 2002. For further information, see *www.noao.edu/hr/*.

Congratulations to Richard Green for being named a Fellow of the American Association for the Advancement of Science. Richard will be awarded this honor in Boston on 16 February 2002, at the annual meeting of the AAAS.

U S G P

US GEMINI PROGRAM

Status of the Gemini Telescopes

Bob Schommer

During the past several months, there has been significant progress in the commissioning of the two initial facility instruments at Gemini North. The optical imager and multi-object spectrograph (GMOS) underwent very successful system verification (SV) runs in August and September. Imaging, long-slit, and MOS modes have all been commissioned, and the IFU mode should be commissioned in October and November. Queue science observations should start in mid-November. More detailed information and sample images and spectra are available at *www.gemini.edu/sciops/instruments/gmos/gmosHotNews.html*.

The facility IR imager and grism spectrograph, NIRI, has had its steering mirror mechanism replaced, and the measured flexure is in the sub-pixel range over the relevant orientation parameters. SV tests were scheduled to be performed in mid-November. If the SV is successful, the first 2001B queue observations with NIRI were to be started in late November. See *www.gemini.edu/sciops/instruments/niri/NIRIHotNews.html* for the latest updates.

At Gemini South, a serious problem arose when FLAMINGOS was damaged in shipment to Chile. A major optical element was broken, and other damage had occurred inside the dewar. Fortunately, CTIO was in the process of constructing ISPI, a clone of the FLAMINGOS dewar, for the Blanco telescope, and was able to provide the crucial replacement lens almost immediately. The HgCdTe detector had to have a bond wire repaired, which required a quick trip back to the factory in the US. These repairs limited the amount of time that FLAMINGOS could be used, but science-imaging observations began in early October.

The mid-IR imager and spectrograph, OSCIR, was shipped to Cerro Pachón in August, and the first engineering runs on Gemini South occurred in late September. The instrument went on the telescope using the same mounting hardware as on Gemini North, and chopping and guiding worked using the same electronic and software interfaces as on the northern telescope. Nearly diffraction-limited stellar images were obtained almost immediately, although poor weather limited the amount of on-sky testing that could be attempted. Several issues still remain, including improvements in the chopping efficiency and the use of the autofocus servo loop using the peripheral wavefront sensor. See *www.gemini.edu/sciops/instruments/oscir/oscirHotNews.html* for details. These remaining issues required additional engineering in November; science queue observations were scheduled to begin during the last week of November and run through mid-December.

In summary, it has been a busy and productive several months, and in early October both telescopes were taking science data for the first time ever.

US Gemini Hokupa'a Mini-Queue Run, 20-21 June 2001

Steve Ridgway (NOAO) and Laird Close (Steward Observatory)

For three semesters, the US Gemini Program has operated a mini-queue for Hokupa'a in an attempt to optimize access and throughput with the limited time available. We were invited to serve as the on-site observers for the second queue run in June 2001. One of us (LC) had a half-night assigned in the queue, and hence a personal stake in the run's outcome.

Owing to perfect conditions and excellent support, we had a very good run. After finishing the second night, but before leaving the mountain, we sent e-mails to several people. Summarized below are excerpts from those messages, which we hope capture the experience and also highlight some of the factors involved in queue observing and astronomy with Hokupa'a.

continued

Hokupa'a continued

For one program, we obtained the observations requested, choosing to use K′ for compatibility with other queue observations. The images showed resolved structure with good signal to noise, but cried out for color information. Because another scheduled program proved to be impossible to carry out and we had extra time, we made an on-the-spot judgment that the best use of the telescope at that moment was in extending this program by acquiring H and J images. Each of the images shows interesting extended structure with morphological and color information. It was very exciting for us to see the images come out of the quick look.

We attempted to carry out another program of gravitational lens galaxy observations; the conditions were good, and we were hopeful of success. Unfortunately, when we acquired the wavefront reference star, we found that it was a close binary with 1.4 arcsec separation. The magnitude difference was just large enough to make detection of the duplicity difficult from survey plates; there may have been no likely way to avoid this trap. We found no alternate reference stars.

Since the Hokupa'a wavefront sensor field of view is also about 1.4 arcsec, the wavefront control servo was unstable in a complex way. After a series of tests, we concluded that Hokupa'a as currently configured could not carry out this observation. We were obliged to move on to the other queue programs, which were able to make good use of the excellent conditions. This is an example of the way that a queue is expected to optimize telescope use, but that is hardly any consolation for this PI. We appreciated the obvious eagerness of this PI to get results and regret that it didn't work out. We hope another candidate source can be found for a future proposal.

For a program on M31 and M32, the date scheduled was very poor. We went to the sources as they approached air mass 2.4, and finding that conditions were inadequate, tried again at lower air mass. We were unsuccessful at closing the loop on M31. This had been tried unsuccessfully before with Hokupa'a, but never under such good conditions. It appears that the extent of the nucleus is too large for the wavefront sensor.

We reviewed the options and decided that the most useful observation we could make was to observe M32 at J and K. Since we were profiting from good seeing, there was a fair chance of success. We carried out a series of dither steps and sky measurements until the sky level began to rise rapidly. Unfortunately the data set is not large — there was a very short slot between the source rising and twilight. However, both K′ and J skies were also obtained.

For the final program attempted, we decided to concentrate on obtaining long integrations, with fairly large and somewhat randomized dithering, after examining the fields from quick-look reductions. We did not go off-source for sky frames, as it was clear that the sky obtained from the dither sequences would be far better than sky offset in time. This decision, plus a higher observing efficiency than assumed in the proposal, enabled us to obtain much longer integrations than requested. We expect that this will pay off for the PI, as the independent image groups show numerous "objects" in the field at low significance, which will be better studied in the 3-4 times longer integration totals.

We considered acquiring a photometric standard, which we hoped could also serve as a PSF reference. Since the PSF depends on the guide star brightness, it would have been necessary to find a standard that was nearby and of similar brightness as the QSO's. We did not find any such standards and judged that under the conditions, the results from 2MASS photometry of the QSO's would probably do as well. We hope that this decision will not be detrimental.

Since the sources were not far apart on the sky, we alternated sources so that, at some level, each can be used as a seeing reference for the other. Guided by the alternation time and efficiency, we changed sources every 30 minutes. This was perhaps longer than optimum, but it did appear that seeing was fairly stable through the night. The RX source was very exciting for us. With adaptive optics (AO) and two hours integration, this may be the deepest IR image of its type. The field contains additional blobs within 10 arcsec in interesting geometries, which led us to possibly wild speculation about the relation of the sources.

In summary, five proposals were scheduled for June 20-21. The total time requested was about two nights vs. the scheduled 1.5 nights. The "assigned" observations probably could not have been obtained entirely in 1.5 nights, even if they were optimally distributed. However, one program was impossible, and only minimal progress could be made on another. So there was plenty of time for the remaining three programs. For these, results were either as requested or significantly more than requested.

Although called a "mini" queue, this program is really a version of service observing. We had no assigned backup program for poor conditions and no

continued

Hokupa'a continued

flexibility in scheduling in order to wait for the most suitable conditions. The observers all requested 50 percent conditions (but most really required 20 percent conditions). In pre-run discussions, all PIs said they would accept whatever they could get, although for three of the programs observing under 50 percent conditions would have been unproductive.

We were uncertain as to how much personal judgment we were expected to exercise. In pre-run discussions with the PI's, we recommended (negotiated) changes to the observing plans, to accommodate the realities of the Hokupa'a system and our experience with diffraction-limited observing. By the time we arrived at Hilo, we felt a strong personal commitment to the specific programs. We are confident that we got the best results globally, although each PI could conceivably object that his program wasn't carried out exactly as he might have done it.

A very impressive Gemini and Hokupa'a team supported the work at the telescope. Olivier Guyon, Dan Potter, and Mark Kocevski of U. Hawaii supported Hokupa'a. Francois Rigaut provided AO science support from Gemini. John Hamilton was the science support associate. All of these people worked with us all night. Also, while Hokupa'a operated perfectly for our run, it was not functional on the engineering night of June 19, and all the above plus a day crew worked to find and fix the problem.

Gemini is the only facility in the world that can record 0.1 arcsec images with a 15.5 magnitude guide star, and this run took outstanding advantage of that capability. We hope the community and the TACs fully appreciate this opportunity and continue to make the best possible use of it.

2002A Proposal Statistics

USGP Staff

NOAO received 113 proposals for time on the Gemini telescopes in Semester 2002A. Nights requested were 141.4 for Gemini North and 80 for Gemini South, with oversubscription factors of 4.5 and 3.2 respectively. The most popular instruments were GMOS and NIRI on Gemini North, and Phoenix and T-ReCS on Gemini South. For 2002A, proposers had the option of using either the NOAO proposal form or the Gemini Observatory Phase I Tool (PIT). We received 11 proposals submitted with the PIT.

US Gemini proposals were scheduled to be reviewed by the NOAO TAC in early November, and accepted proposals immediately forwarded to the International Gemini Observatory for review by IGO's International TAC in mid-December. The Gemini schedules will be posted around December 21, following e-mail notification to investigators.

We anticipate that the next call for proposals for time on the Gemini North and Gemini South telescopes in Semester 2002B will occur in late February.

Interested observers should keep a close watch on the NOAO Web site at that time for announcements regarding proposal deadlines and the instruments to be available on each telescope. Proposals for Semester 2002B will be due on 1 April 2002.

NOAO Instruments at Gemini South

Ken Hinkle and Nigel Sharp

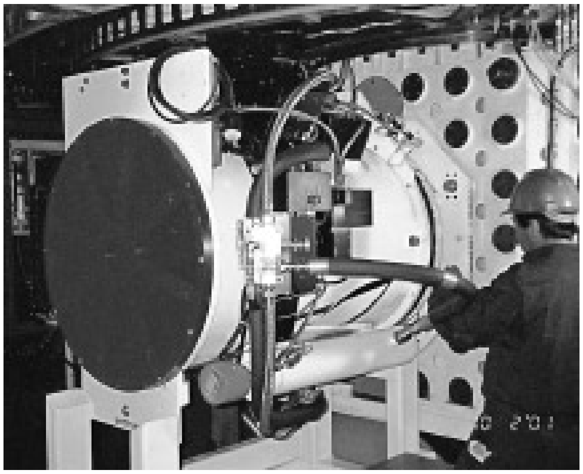
Phoenix

Phoenix arrived at Gemini South on Monday, September 10, having left the NOAO loading dock in Tucson only four days before. On September 24, a team from NOAO arrived at Cerro Pachón to uncrate Phoenix and the Phoenix-to-Gemini mounting equipment. Tests showed that Phoenix had made the trip without incident, and by the end of the week Phoenix was functioning as well in the lab at Gemini South as it had in Tucson.

Phoenix was fitted to the telescope to check the mechanical coupling unit and to check the electrical and compressed helium connections. Plans call for mounting Phoenix on the telescope for the 2002A semester in mid- to late-November. There will be a commissioning run shortly before Christmas and a demonstration science run near the start of the 2002A semester.

continued

Instruments at Gemini continued



Gustavo Alarcón of Gemini South is shown attaching Phoenix to the Gemini telescope instrument mounting surface for a test fit in September 2001.

Abu

NOAO's Abu infrared imager was installed on Gemini South in May 2001 for image quality tests during commissioning (*NOAO Newsletter* No. 67). Abu is maintenance free, using no cryogens and requiring no routine servicing, and so it has been left in place and used intermittently for observing ever since. Occasional unplanned power outages on Cerro Pachón are no problem: once the closed cycle cooler compressors restart, Abu cools back to operational temperature with no human intervention within a few hours. The worst cases have required only cycling a few power switches to ensure the correct hardware and computer boot-up sequence, all of which can be handled from the control room. Because of this convenience and a desire to continue using the excellent pixel scale of Abu for imaging tests, the Abu control system has been kept intact at Gemini South. A separate control system for Phoenix has been built from spares and hardware provided by CTIO, enabling Abu and Phoenix to run independently and separately.

The Abu dewar includes filters for the standard J, H, and K pass-bands, as well as an L′ 3.82-micron filter, and narrow band filters for H_2 (2.12 microns), Brackett γ (2.17 microns), and Brackett α (4.05 microns). Each of these filters has been used on Gemini South. Abu has seen the sky for at least part of twenty nights or more over the past few months, with excellent results on a wide variety of astronomical objects now being evaluated by staff members of the Gemini Observatory and NOAO.

US Gemini Instrumentation Program Update

Taft Armandroff and Mark Trueblood

Much activity is underway in the US on instrumentation for Gemini, both at NOAO and in the broader US community. This article gives a status update as of early October.

T-ReCS

T-ReCS, the Thermal Region Camera and Spectrograph, is a mid-infrared imager and spectrograph for the Gemini South telescope, under construction at the University of Florida by Charlie Telesco and his team. T-ReCS has been completely assembled. Its mechanisms have been operated successfully at cryogenic operating temperature and under software control. The science detector, a Raytheon 320 × 240-pixel Si:As BIB array, has imaged successfully and has revealed good optical performance. The team is in the midst of system testing and optimization, which will culminate in T-ReCS's Pre-Ship Acceptance Test. T-ReCS is planned to be offered as a facility instrument on Gemini South in late semester 2002A.

GNIRS

The Gemini Near-InfraRed Spectrograph is a long-slit spectrograph for the Gemini South telescope that will operate from 1 to 5 microns and will offer two plate scales and a range of dispersions. The project is being carried out at NOAO in Tucson under the leadership of Jay Elias (Project Scientist) and Neil Gaughan (Project Manager). Optical bench fabrication is complete, and the benches and key mechanisms were assembled for a fit check before painting. Mechanism assembly and testing is underway. GNIRS subsystem integration and testing have begun. Integration of the subsystems into the instrument was scheduled to begin in November. Over-

continued

Program Update continued

all, 80 percent of the work to delivery has been completed. The team expects to begin warm imaging tests in January, with GNIRS delivery expected in the fall of 2002.

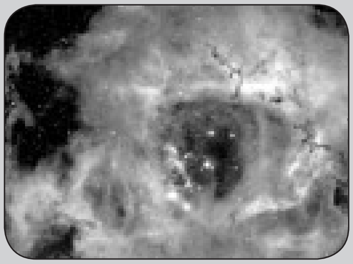
NICI

The Near Infrared Coronagraphic Imager (NICI) will provide a 1-5 micron dual-beam coronagraphic imaging capability on the Gemini South telescope. NICI is being built by Mauna Kea InfraRed (MKIR) in Hilo, under the leadership of Doug Toomey. The NICI team has made significant progress in the areas of optical design, mechanical design, electronics design, systems engineering, and software design. In particular, the optical layout of the instrument and the opto-mechanical error budget are complete. All mechanisms and mechanical subassemblies are in preliminary form in the three-dimensional design model. The NICI Preliminary Design Review is scheduled for March 2002.

Phoenix

Phoenix, NOAO's high-resolution near-infrared spectrograph, has been delivered to Gemini South. For more information, see the article "NOAO Instruments at Gemini South" in this section.

The GNIRS Optical Bench fit check, with team members (from left to right) Al Davis, Randy Bennett, Dick Joyce, Gary Muller, and Jay Elias.



Observational Programs

NOAO Survey Proposals Due March 15, Letters of Intent Due January 31

Tod Lauer

Three years ago, NOAO initiated the first annual call for Survey Proposals for large programs to be carried out at its CTIO and KPNO facilities. Such programs allow the identification of complete, well-defined samples of objects that can yield both conclusions based on statistical analysis of the survey data itself, and also provide important subsets for more detailed observations with larger telescopes. In the past three years, 52 Survey Proposals were received, and 13 were accepted.

The accepted programs are:

Deep Imaging Survey of Nearby Star-Forming Clouds (PI Bally, U. Colorado)

The Evolution of Galaxy Clustering at $1<z<2$ (PI Elston, U. Florida)

ChaMPlane: Measuring the Faint X-ray Binary and Stellar X-ray Content of the Galaxy (PI Grindlay, CfA)

In Search of Nearby Stars: A Parallax Program at CTIO (PI Henry, JHU)

A Fundamental Plane: Peculiar Velocity Survey of Rich Clusters within 200 h^{-1} *Mpc* (PI Hudson, U. Waterloo)

The NOAO Deep Wide-Field Survey (PIs Jannuzi and Dey, NOAO)

Toward a Complete Near-Infrared Spectroscopic and Imaging Survey of Giant Molecular Clouds (PI Lada, U. Florida)

The Resolved Stellar Content of Local Group Galaxies Currently Forming Stars (PI Massey, Lowell)

Star Formation in HI Selected Galaxies (PI Meurer, JHU)

Deep Ecliptic Survey (PI Millis, Lowell)

Southern Standard Stars for the u′g′r′i′z′ System (PIs Smith, U. Michigan; and Tucker, FNAL)

A Next Generation Microlensing Survey of the LMC (PI Stubbs, U. Washington)

Deep Lens Survey (PIs Tyson and Wittman, Lucent; and Dell'Antonio, NOAO)

Proposals for the next round of the NOAO Survey Program are due 15 March 2002. Investigators interested in applying for time under the Survey Program **MUST** submit by 31 January 2002 a letter of intent (by e-mail to *surveys@noao.edu*) describing the broad scientific goals of the program, the membership of the survey team, the telescopes and instruments to be requested, the approximate amount of time that will be requested, and the duration of the proposed survey. Up to 20 percent of the total telescope time at CTIO and KPNO may be awarded through the Survey Program, including time allocated in the earlier rounds to continuing programs.

A more detailed description of the Survey Program requirements and guidelines is available at *www.noao.edu/gateway/surveys/*. Proposals must be initiated using the NOAO Web proposal form at *www.noao.edu/noaoprop/noaoprop.html*, which will be available approximately 15 February 2002.

Proposal Process Update

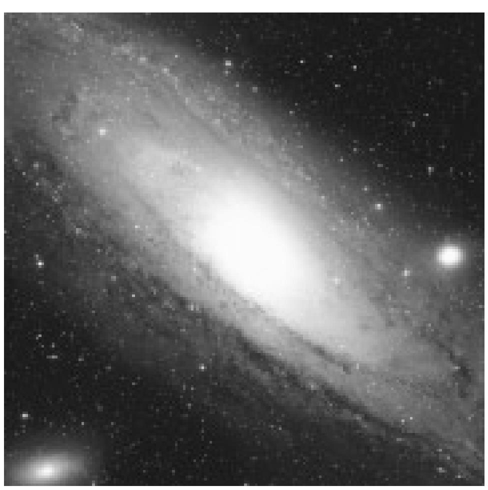
Dave Bell

NOAO received 334 observing proposals for telescope time during the 2002A semester, plus an additional 11 proposals on behalf of the Chilean National TAC for time at CTIO. Of those sent to the NOAO TAC, 138 proposals requested time at KPNO, 113 proposals requested time with the Gemini telescopes, 105 requested time at CTIO, seven requested public-access time at MMT, and three proposals requested public-access observations with the Hobby-Eberly Telescope. Thesis projects accounted for 23 percent of those received, or 77 proposals, and 11 proposals requested long-term status. Detailed time-request statistics will be published in the following edition of this newsletter.

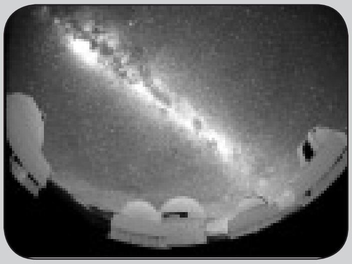
In addition to these new programs, nine continuing survey programs and six continuing long-term programs are to be scheduled in 2002A. Similarly, four continuing SIRTF legacy programs and two Chandra legacy programs were awarded time at NOAO-coordinated facilities in 2002A. Some HET and MMT programs that were previously awarded time at these facilities are also being carried forward.

As of this writing, the proposals are being reviewed by members of the NOAO TAC. After their deliberations, the KPNO and CTIO schedules will be completed by early December, and e-mail notifications will be sent promptly to principal investigators. Investigators who have submitted HET and MMT requests will also be notified at this time. Investigators who have requested time at Gemini will be notified in late December, after the meeting of the Gemini International TAC and final approval by the Gemini Director. Mailed information packets will follow the e-mail notifications by about two weeks.

Looking ahead to 2002B, Web materials for most facilities should go online around February 15, with Gemini-related materials following in early March. The March issue of this newsletter will contain updated instrument and proposal information. The deadline for submitting regular proposals will be Monday, 1 April 2002. Survey letters of intent will be due January 31 (by e-mail to *surveys@noao.edu*), with proposals due March 15.



This detailed image of the Andromeda Galaxy was taken by NOAO Outreach Astronomer Travis Rector at the National Science Foundation's 0.9-meter telescope on Kitt Peak, using the NOAO Mosaic CCD camera. It is one of three images taken by Rector that are being turned into posters to be sold at the Kitt Peak Visitor Center. Although Rector has departed NOAO for a Jansky fellowship at NRAO, he will remain involved with taking data for NOAO educational outreach programs.



CTIO OPERATIONS

Adaptive Optics for SOAR

Andrei Tokovinin

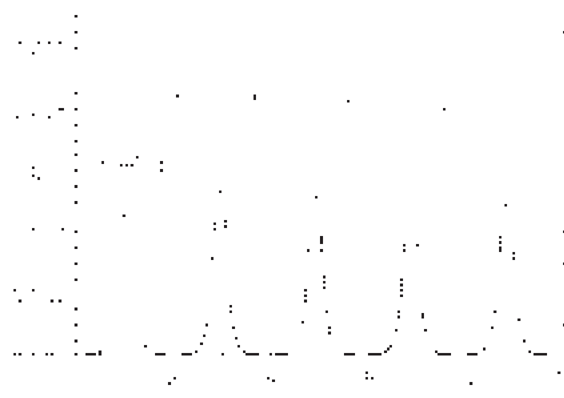
Most modern large telescopes are now being equipped with adaptive optics (AO) systems. Next door to SOAR, Gemini South is planning two systems: a near-infrared coronographic imager and an ambitious multi-conjugate AO system with several sodium laser guide stars (LGSs). One of the 8-meter VLT telescopes at ESO will soon have a working AO system, NAOS, and, for a while, will have exclusive capabilities on the Southern sky.

In this picture of modern ground-based astronomy, the 4.2-meter SOAR telescope has its specific niche, namely projects that require large amounts of observing time and concentrate on the optical range, including near-ultraviolet (UV). The initial goal is to achieve the best seeing-limited resolution with tip/tilt compensation. We propose to go further in this direction to design an AO system operating in the visible range. No such systems are currently planned for other large telescopes.

It is well-known that turbulence compensation in the visible presents a serious technological challenge. Instead of attempting full correction, we aim at partial compensation, but in a large field of view. The idea is to compensate only for low turbulent layers up to a not-very-high order (60-70 actuators, or sub-aperture size of 0.5 meter). Rayleigh LGSs have the natural property of being insensitive to high-altitude turbulence. By locating a LGS deliberately at a low altitude of 10 kilometers, uniform seeing correction can be achieved in a few arcminute field. The laser will work in the near-UV range (350 nm) invisible to human eyes, and with no harm to aircraft pilots and satellites. Laser technology is mature, and these solid-state lasers are ~10 times cheaper than sodium lasers.

Expected improvement in the resolution reaches a factor of two: under good seeing conditions, a FWHM of 0.25 arcsec can be obtained even at 500-nm wavelength. Sky coverage with a LGS will be virtually complete. Three faint natural stars at the periphery of the field will be selected for tip/tilt compensation. Such a performance gives an edge in all deep-imaging projects, especially in the crowded fields (star clusters, nearby galaxies). Calibration of the Point-Spread-Function (PSF), which always plagued AO-assisted science, will be much less of a problem because there will be plenty of stellar calibrators in each image.

The diffraction limit in the R band is around 0.04 arcsec — even better than at 8-meter telescopes in the infrared. Can it actually be achieved with AO? The simulations show that with 0.5-meter size sub-apertures, the diffraction-limited core will be prominent in the PSF, especially under good seeing. However, the size of the fully compensated field will be limited by atmospheric anisoplanatism to less than 10 arcsec. Moreover, the field must be centered on a bright natural guide star that is needed to measure wave fronts in real time. These two conditions are very restrictive, but still enable a large scope of unique scientific projects. Studies of the surroundings of bright stars include young objects with disks and jets, stellar ejecta (Be stars, planetary nebulae, novae), extended atmospheres of supergiants, and detection of low-mass companions. This kind of science almost always calls for spatially resolved spectroscopy, which will be provided by the SOAR IFU spectrometer. The combination of an IFU with diffraction-limited resolution in the visible seems to offer unique and compelling capabilities to SOAR.



Stacked Point-Spread-Functions (PSFs) on-axis and at increasing distances from the guide star for tip/tilt compensation (full line) and for seeing-improved AO (dotted line). The uncorrected seeing-limited PSF is plotted first. Case of good seeing: r_0(500 nm)=20 cm, wavelength 670 nm.

continued

Adaptive Optics continued

The scientific return on a high-resolution AO will *critically* depend on the limiting magnitude of the guide star. With a state-of-the-art wavefront sensor, we shall be able to reach a limit of R=12*m* under good seeing. The actual experience of the PUEO system at CFHT seems to confirm this estimate; with sub-apertures twice as large, they can use guide stars down to 15*m*.

The concept of the SOAR AO system combines two operational modes in a single instrument. A high-resolution mode with natural guide stars will be implemented first. Then the system will be upgraded with a Rayleigh LGS, to be operated in seeing-improvement mode. There will be a flexibility between these two modes. If a natural guide star is too faint for full compensation, still some very useful resolution gain will be obtained in the partial-compensation regime. On the other hand, if there is no bright star, and a maximum resolution is needed for a particular faint target, a LGS can be placed at a higher altitude, thus trading field for resolution. We see this versatility as a key to efficient operation.

The AO module will be designed as an independent instrument and will occupy one of the output ports of SOAR. It will be relatively small, owing to the use of a small electrostatic deformable mirror (DM) like the one to be used in the AO system for the 1.5-meter NSO telescope. Beyond the DM, a selectable diachronic will send part of the compensated beam to the wavefront sensor, while the remaining wavelengths will be passed to the scientific instruments. The AO module can feed up to three instruments attached to its sides. One of these will be a 2K CCD imager, built as a part of the AO project. With a new red-optimized CCD, it will complement the regular UV-optimized SOAR optical imager, offering a superb detectivity in the V, R, I, z bands. The finest image scale of 15 milli-arsec per pixel will enable diffraction-limited sampling, while a coarser scale will be used in seeing-improved mode.

The second instrument, the IFU spectrometer, is being built by the Brazilian SOAR partners. It will be easy to attach its small input fiber bundle to the AO module, which will provide it with the appropriately scaled image. The field will be limited by the number of fibers. The third output of the AO module will be left vacant for future instruments. The AO system will fully support the SOAR operation model. It will be installed permanently and can be activated in the queue-scheduled mode (e.g., to take advantage of the best seeing).

The full width at half maximum (FWHM) of the seeing-limited PSF (upper full line). When the finite outer scale of turbulence is taken into account, there is less image motion, and seeing-limited resolution is expected to be better for a given r_0 (lower full line). At the same time, the gain from tip/tilt compensation is less. Upper dashed line shows the predicted on-axis resolution for tip/tilt compensation. Other lines are for the seeing-improved AO mode (with a Rayleigh LGS at 10 km) and for the high-resolution AO mode with a bright natural guide star.

During 2002, we will refine the conceptual design of this system and prepare a fully costed proposal. In parallel, some prototyping will be done in order to characterize the DM and to assist with other aspects of the design. The goal is for first light in 2004, with the LGS upgrade the following year.

More information about this project is available at *www.ctio.noao.edu/˜atokovin/soar*. For those who are not familiar with AO, an on-line tutorial is available at *www.ctio.noao.edu/˜atokovin/tutorial*.

SOAR Telescope Mount Passes Final Exam with Flying Colors

Victor Krabbendam & Steve Heathcote

Final acceptance testing of the SOAR telescope mount was completed in early October at the Mexia, TX plant of contractor VertexRSI. These trials indicate that the system is performing better than anticipated and will meet all of SOAR's stringent requirements. The first resonance mode of the mount was measured at 8 Hz, a value consistent with the target of nearly 12 Hz when the mount is located on its bedrock foundation on Cerro Pachón instead of the less resilient Texas mud. The system is capable of blind pointing to less than 1 arcsec, while tracking jitter is less than 0.08 arcsec RMS, based on encoder readings. While a final performance evaluation must await installation at the SOAR site and tests with a star, these internal measures give us high confidence.

The SOAR mount has several unique features, which allow it to achieve this exact performance. The azimuth bearing is a 3.6-meter diameter rolling-element bearing that has both a large race for vertical support and a smaller race for lateral restraint. Four motors operating through helical gearboxes set up as counter-torqued pairs provide smooth accurate azimuth motion. The elevation axis also operates on roller bearings and is driven by a pair of torque motors mounted directly to the elevation axis. The control system, developed by VertexRSI's Precision Controls Division, has now demonstrated the ability to control the mount through the very high dynamic range necessary to both track with <0.1 arcsec RMS jitter and slew at 2 degrees per second. The telescope carries up to nine hot instruments for a total instrument payload of 7.4 metric tons.

The final acceptance test was the last milestone of the design and build contract before shipping the hardware to Chile. The telescope mount is now being disassembled, painted, and readied for shipping. It is expected to arrive onsite in late January 2002. With this hurdle successfully passed, SOAR comes one step closer to first light, currently anticipated in October 2002.

The SOAR telescope mount during final acceptance testing at VertexRSI. The cylinder in the foreground is a mass simulator for one of the two Nasmyth instrument clusters, while simulators for the Folded Cassegrain instruments are shown attached to the elevation ring. The large platform to the right will hold an IFU-fed, bench-mounted spectrograph, while the smaller one to the left carries the electronics racks that control the telescope and its various subsystems.

Small Telescope Opportunities at CTIO – Part II

Alistair Walker (CTIO) and Charles Bailyn (Yale)

In the previous *NOAO Newsletter*, we floated the idea of running the small telescopes at CTIO via a collaboration of partners, building on the experience of the YALO consortium, which has been operating successfully at CTIO for the past three years.

Yale University organized a workshop, held at the American Museum of Natural History on October 5-6 , to explore the political, technical, financial, and scientific context of such a collaboration. Participants developed a tentative plan for matching science to telescopes and instruments, and discussed the possibilities for obtaining the required funding.

Although there are a number of issues that need to be resolved, no “showstoppers” were identified. The strawman plan has four telescopes (1.5-meter, 1.3-meter, 1.0-meter, 0.9-meter) with CCD and IR imaging, and possibly spectroscopic capabilities. The queue-scheduled synoptic program presently run on the 1.0-meter, using ANDICAM, would move to the 1.3-meter.

Participants agreed to meet again in January-February 2002 with a view to having an agreement in place by mid-2002. The new operational mode would start in the 2003A semester.

This is not too far away, and serious planning needs to begin almost immediately. Thus, we would like to hear from any other prospective participants. Note that in the proposed consortium, which we are calling SMARTS (Small and Medium Aperture Research Telescopes System), NOAO will retain a significant fraction of time for its users, so the people we would like to hear from are those with some combination of a large scientific project, financial support, or an instrument. Please contact Charles Bailyn at *bailyn@astro.yale.edu*.

Security at CTIO

Malcolm G. Smith

It was suggested that I write an “off the wall” article for this newsletter, but I did not expect security to be the topic. As usual, the highly cooperative spirit of everyone at the observatory has come to the fore during this uncertain time following the terrorist attacks on New York and Washington. Our employees and visitors can be proud of the calm, cooperative, and mutually supportive spirit that has prevailed throughout.

A sign of the times is that on Thursday, October 11, just a month after the attack, our receptionist, Kadur Flores, detected a suspicious brown envelope among the regular mail. This was just hours before news of the “anthrax envelopes” in the US made people around the world suddenly aware of the importance of handling mail with great care. However, a few days earlier, two suspicious packages had been detected at the US Embassy in Santiago. One was reported to be a hoax, the other a genuine letter bomb, which was handled without any injuries. Because of that event, the observatory was on high alert, and Kadur (along with others handling mail and packages) had been given a copy of the US Embassy’s advice for the handling of such mail.

It is a tremendous credit to Kadur that he followed these procedures coolly, and alerted AURA’s safety personnel. They in turn called the police, who called in three different special units. The district attorney for La Serena arrived to take charge of the response by the authorities. The envelope was opened within a sealed, evacuated container, and we were told a few minutes later that the envelope contained a white powder and a one-word note in phonetic Spanish — “Jihad.” The container and the envelope were sent to Santiago for analysis. There was initial relief as the feared explosive was apparently just a harmless white powder, but then concern mounted as more envelopes with white powder started appearing in various parts of the US that same day. Finally, the phone call from Santiago came through. The substance was “calcium carbonate – plaster of paris – and no explosive or otherwise harmful trace elements were found by the people at the Institute of Public Health in Santiago.” Similar statements were reported by the media.

continued

Security at CTIO continued

No one seemed to notice that plaster of paris is hemihydrated calcium sulphate, but never mind. Furthermore, it took a week before we had sufficiently conclusive statements from the authorities to rule out the presence of anthrax; these statements were made on television and obtained from the Web.

AURA and the US Embassy are still awaiting the promised official reports on the incidents from the Chilean authorities. As it happened, our envelope was the first of 11 such envelopes delivered during the following week to different destinations in Chile. We also do not know who played this lousy trick, so we have taken a wide variety of low-profile measures to further tighten security.

Conference on Light Pollution and RFI

Malcolm G. Smith

An international conference on controlling light pollution and Radio Frequency Interference (RFI) worldwide will be held in La Serena on 5-7 March 2002. A recent paper by Cinzano, Falchi, and Elvidge (see *arxiv.org/abs/astro-ph/0108052*) points out that "Assuming average eye functionality, about one-fifth of the World population, more than two thirds of the US population and more than one half of the EU population, have already lost naked-eye visibility of the Milky Way."

In the past it was common for people in the "advanced, first-world countries," with their "deeper understanding" of science and how it applies to the natural world, to express a degree of amusement at the reaction of "ignorant, primitive cultures" during solar eclipses. However, during a recent earthquake in California, the lights went out in one of the big cities, and residents were scared because they could see a "new, silver band of light, associated with the earthquake, that cut the sky in two." This was in the United States, at the end of the 20th century.

In some ways, CTIO acts as the "canary in the mine" for the world's population. While Roger Smith successfully made a movie from CTIO of the setting Zodiacal light, thus demonstrating the spectacular nature of the very dark skies over Northern Chile, we also have nasty pictures of CTIO and of Gemini clearly showing the lights of La Serena and Coquimbo on the Western horizon. Pedro Sanhueza, the new head of Chile's Office for the Protection of the Skies of Northern Chile (see *www.opcc.cl*), has reported the clarity with which he has seen from Cerro Paranal the lights of Antofagasta to the North and the La Escondida mine to the East Northeast.

A reporter once asked me, "Why bother to control the lighting? You astronomers just need to move to more remote places." The Atacama Desert of Northern Chile is pretty remote. Nevertheless, the atlas created by Cinzano et al. (see *www.lightpollution.it/dmsp*) shows colored in dark gray about half of the most cloud-free area of Northern Chile, around the latitudes of Paranal. Cinzano et al. comment in their paper: "In order to show how far the light pollution propagates from sources, we colored in dark gray areas where the artificial sky brightness is greater than 1% of the reference natural brightness (i.e., greater than 8.61 10^5 V-band ph/cm2/s/sr or 2.5 μcd/m2). In these areas the night sky can be considered unpolluted at the zenith, but at lower elevations pollution might not be negligible, and uncontrolled growth of light pollution will endanger even the zenith sky." Cinzano does add a caveat on the measurement uncertainties at this level.

Although it is important to remember that the 11-year solar cycle produces natural variations as high as 0.6 magnitude, the challenges to IAU Commission 50's new working group on "Controlling Light Pollution" are nevertheless immense (see *www.ctio.noao.edu/light_pollution/iau50/*). In addition to stimulating educational, legislative, engineering and enforcement efforts, the group has been supporting the publication of Web-based information and the holding of conferences, such as this next one in La Serena. The International Dark-Sky Association (see *www.darksky.org/ida/index.html*) in Tucson has been a crucial leader and partner in this effort.

For the latest information on the conference, invited talks, and details of how to participate, please visit *www.opcc.cl/congreso_internacional/ingles.htm*.

Staff Comings and Goings

Malcolm G. Smith

Comings…

Alan Whiting arrived in Chile early October to start his three-year postdoctoral appointment at CTIO. He obtained his Ph.D. at the University of Cambridge (UK) in 1997. Alan is a US Naval Reserve Officer, and his last employment was as a Senior Instructor at the Physics Department of the US Naval Academy.

Alan's main research interest is local-volume cosmology. He plans to construct a complete and accurate picture of the dynamics of the local volume, including the amount and distribution of dark matter as well as luminous matter.

Alan will gradually assume responsibility for NSF's Research Experience for Undergraduates Program (REU), filling the vacancy left by Donald Hoard. During early 2002 (the REU program runs in the Southern summer), he will share this work with Nicole van der Bliek and Chris Smith. Next year he will take over as Director of the REU and associated PIA programs in Chile.

…and goings

Roger Smith arrived from Australia to work at CTIO in March 1983. He started as an assistant engineer under a two-year contract to help construct an array controller for the (then) new infrared arrays. Roger was promoted to Engineering Project Manager last year and now leaves us to join the instrumentation group at Caltech/Palomar.

During his 18 years in Chile, Roger came to be much respected as a versatile and productive electronic engineer. He produced the CCD controllers (Arcons) and tweaked the very best performance out of the CCDs for a generation of cameras at NOAO, culminating in the Mosaic project and his all-sky CCD cameras. He is one of the finest engineers I have seen in tracking down and reducing noise in detectors; this ability had already come to the fore at the AAT, prior to his move to Chile.

Roger did much besides helping CTIO/NOAO retain a state-of-the art detector/controller capability for more than a decade. He was the highly proactive, AURA representative on the Board of Directors of the International School in La Serena and has labored to try to increase the school's interest in higher-quality science education. In working with the AURA and La Serena community, he and his wife Margy proved to be a marvelous team. Margy arrived with Roger back in 1983, shortly after their wedding. They were at CTIO for more than 18 years, and their children, Alexandra, Russell, and Tasman, have been part of the Tololo family all of their lives.

Stefanie Wachter was hired at CTIO as a postdoctoral fellow in 1998. A couple of years later she applied for and was awarded a tenure-track staff position at CTIO against a particularly strong field of internal and external applicants.

Stefanie applied her research background in cataclysmic variables to great effect at Cerro Tololo. She led the application to synoptic astronomy of more flexible service-observing scheduling on the 0.9-meter and YALO 1-meter telescopes. Indeed, a characteristic of Stefanie's evolving contribution to the life of the Observatory is her strong commitment not only to her own research, but also to various kinds of related service and administrative work. An example of this development is her recent support of the commissioning of both the Gemini North and Gemini South 8-meter telescopes.

Donald Hoard worked at CTIO in various postdoctoral positions since arriving here in 1998. Within a very short time it was clear that he was an ideal candidate for the position of Director of the NSF's REU Program at CTIO. We had decided not to fill the position the year before, because the field of applicants was not of the quality demanded by the program. We preferred to halt the program rather than relinquish our commitment to excellence. Thanks to Donald, we were able to restart the program. Donald has demonstrated an excellent mixture of quiet maturity and leadership, while taking full advantage of the excellent working environment at CTIO to motivate the students to get involved in project work and international opportunities associated with the program. Since Donald's arrival, all of the participating students have presented their work at AAS meetings. The NSF is delighted with the quality of the REU program at CTIO.

Donald also obtained a NASA grant to work with Dr. Doug Geisler of the Universidad de Concepción on data reduction and analysis of globular-cluster systems observed with HST. This is consistent with Donald's willingness to explore ways to use the spectral and time domains to their fullest extent from space and from the ground when tackling astrophysical problems. This trend towards increasing the breadth of his work seems particularly promising. Last year Donald qualified directly for

continued

Staff Comings and Goings continued

one of the CTIO postdoctoral positions.

Both Donald and Stefanie are now working in the Astronomy Department of the University of Washington, Seattle. They will both move soon to take up positions with the SIRTF Science Center in Pasadena. Although Stefanie has left CTIO to take up a position in the US, she will continue to work with the Yale-AURA-Lisbon-Ohio (YALO) consortium on the operation of smaller telescopes on CTIO for synoptic astrophysics.

Donald, Stefanie, and their two cats started their journey back to the US on Tuesday, September 11th. The terrorist attacks in New York and Washington stranded them (and at least two other visitors to AURA-O/CTIO) in Santiago for several days. They finally took off from Santiago on Friday night, September 14th, and after a variety of other adventures arrived safely in Seattle on Sunday.

Other Happenings at CTIO

The International Astronomical Observatories in Chile will hold a **workshop on "Galactic Star Formation Across the Stellar Mass Spectrum"** in La Serena from 10-15 March 2002. The aim of this workshop is to join together the most recent observational and theoretical results of Galactic star formation into a coherent picture of how stars form as a function of mass. Registration for the workshop will soon be available at *www.ctio.noao.edu/workshop2002*.

Confirmed speakers for the workshop are Diego Mardones (U. Chile), Richard Larson (Yale), Alan Boss (Carnegie Inst. Wash.), Susana Lizano (UNAM), Leonardo Testi (Arcetri Obs.), Ed Churwell (U. Wisconsin-Madison), John Bally (U. Colorado), and Paul Ho (Harvard/CfA).

In addition to CTIO's Research Experiences for Undergraduates (REU) program, we occasionally host undergraduates during other times of the year who work with staff scientists on a variety of projects. This semester, **Jessica LaVine from Union College**, Schenectady, NY has been working with Dr. Chris Smith to develop an **on-line catalog of supernova remnants in the Large Magellanic Cloud**. Smith and LaVine plan to use this catalog to study the global properties of the remnants in this nearby galaxy.

As part of a three-year course for optical engineers at the **Ecole Supérieure d'Optique** in Paris, students spend four to six months of their final year working on a project in industry or, more recently, an observatory. **Student Sandrine Thomas interned at CTIO** from May through October, studying the seeing and primary mirror figure control at the 4-meter and 1.5-meter telescopes. In particular, she worked with Maxime Boccas and Hugo Schwarz **to build and test a small version of the well-known ESO Differential Image Motion Monitor**, which they dubbed the BabyDIMM. For more information, see *www.ctio.noao.edu/students/internships*.

K P N O
Operations

Final Phase of Mayall Telescope Image Quality Improvements

Chuck Claver and Richard Green for the KPNO 4-meter DIQ Team and Engineering Staff

The elements of thermal management and active optical control of the Mayall telescope retrofit have reached the final stage of integration into an effective system. Technical efforts for the year included re-aluminizing the primary mirror, with subsequent recollimation of the system led by Chuck Claver. Chuck was able to verify good physical alignment between the optical axis of the primary and the physical center of the prime focus corrector. New look-up tables for the 4-meter Active Primary Support (4mAPS) system were constructed for prime focus and f/8. During verification of the new look-up tables, Chuck found that the RMS wavefront errors across the sky were less than 275 nm.

During the year, the precision of the encoding and control of the new f/8 secondary drive mechanism was increased to meet the demanding specifications of integration with 4mAPS. Full integration was achieved during summer shutdown. This allows for correction of the comatic terms in the wavefront errors. During integration tests, the activation of coma correction brought the residual wavefront errors down to approximately 200 nm RMS, and often below.

While this improvement may not be apparent under relatively poor seeing (e.g., 1 arcsec), it is distinctly noticeable when the seeing is good (e.g., 0.8 arcsec or better). This effectively lowers the floor in terms of image quality that the 4-meter Mayall can now deliver. The 4mAPS look-up table for f/8, including the coma terms, has been constructed. Implementation now depends only on some minor software modifications and verification of the form of correction as a function of telescope position.

Progress was also made during summer shutdown on installation of a wavefront camera that will allow the 4mAPS zero point to be set at the start of every night, as is the standard procedure at WIYN, and facilitate the acquisition of wavefront data needed for construction of the look-up tables. In addition, we are exploring the possibility of using the wavefront camera off the optical axis to continuously monitor the wavefront. This would provide both true closed-loop operation of 4mAPS rather than relying on look-up tables and a means to lock the telescope focus to the science instrument. The guider/adapter was modified to include the x-y stage on which the camera will be mounted. Completion of the project will occur in FY02, with installation of custom optics and the camera itself.

The combination of mirror cooling during the day and air extraction over the primary at night makes a measurable difference in sampled wavefronts. We are planning to further enhance the air extraction system with the addition of four exhaust fans around the primary mirror cell. These fans will pull air from around the outer periphery of the primary, using the plenum installed during our early mirror cooling tests. These improvements will further enhance our ability to mitigate thermal effects when the massive heat capacity of the 4-meter primary prevents us from tracking rapid changes in ambient conditions.

Remaining improvements are anticipated to be largely operational, with tighter control of the primary mirror-front surface achieved through better control of the cooling set point and the temperature of the building glycol coolant. Experiments will be undertaken to optimize the rate of guider correction as a function of conditions.

This multi-year project is starting to pay off. Test images during summer shutdown showed 0.65 arcsec FWHM at Cassegrain, and one of the first scheduled Mosaic observers reported extended periods of comparable quality in R and in B at the prime focus. Our goal now is to improve on the consistency of operations so that we achieve this kind of performance more routinely at the Mayall.

Update on the Performance of MARS

Arjun Dey, Sam Barden, Roger Lynds, Rich Reed, Charles Harmer,
Bill Ditsler, Dave Dryden, Nigel Sharp, Bob Marshall, Dave Mills, and Rob Seaman

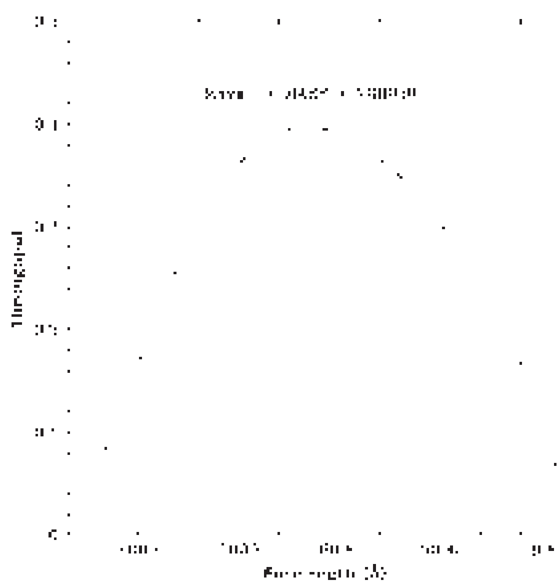
MARS, previously known as CryoCam, performed well on its first engineering run on the Mayall telescope on September 7-10. The measured total system throughput (see figure at right) matched our predictions and confirms MARS as one of the highest throughput systems for low-resolution red spectroscopy currently available.

As described in previous *NOAO Newsletter* articles, the high red sensitivity is due to a combination of the LBNL CCD, the LLNL over-coated silver coating on the Schmidt primary, and the implementation of a new volume-phase holographic (VPH) grism. The figure on page 26 shows a comparison of the MARS system throughputs using three different grisms: the VPH VG8050-450 grism, the old GR730 (λ_{cen}=8010Å, 300l/mm), and GR780-1 (λ_{cen}=9700Å, 300l/mm) grisms. The VPH grism outperforms the other two grisms over most of the wavelength range.

We have also implemented some improvements to the nod-and-shuffle observing mode. The overhead associated with each nod has been reduced from 15 seconds to less than 5 seconds, and the setup at the telescope has been simplified. With the current overheads, a 30-min nod-and-shuffle exposure on target, subdivided into 30-second integrations, now takes a little less than 63 min (2 sec CCD prep time + 30 min on object + 30 min on sky + [20 nods × 5 sec/nod] + 55 sec CCD read time).

During our tests, we found that the particle event rate on the MARS CCD was nearly four times higher than that measured using the LBNL CCD in other dewars. This was traced to the field flattener lens, which is located only 1.5 mm from the surface of the CCD. This commercially purchased BK7 element was tested at LBNL and found to produce beta radiation due to the presence of ^{40}K in the glass. We plan to replace this lens with a non-radioactive element and are currently investigating different glasses with the help of our friends at LBNL. We are also investigating whether significant improvements can be made to the image quality by replacing the old doublet collimator with a triplet.

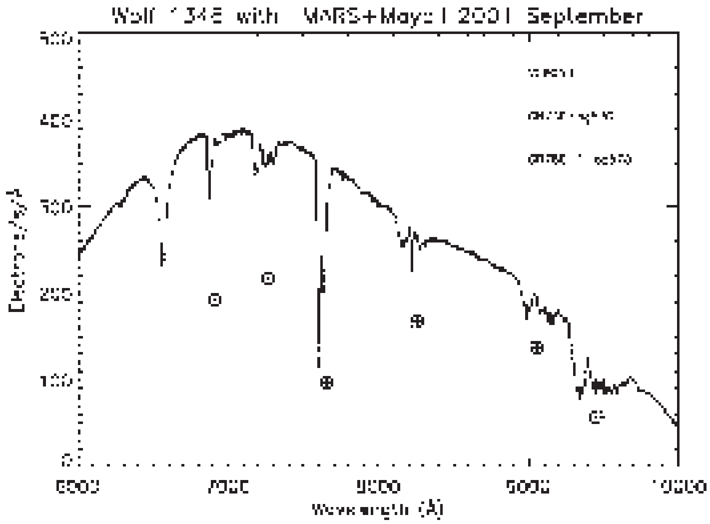
Testing of MARS will continue through the current semester, and updates will be posted at *www.noao.edu/kpno/mars/mars.html*. An exposure time calculator for MARS is currently available at *www.noao.edu/gateway/spectime/kp4mmars.html*.



Measured total system throughput of MARS with the VG8050 grism on the Mayall 4-meter telescope referred to an air mass of 1.0

continued

Update Performance continued



Comparison of MARS observations of the spectrophotometric standard star Wolf 1346 using three different grisms: the VPH grism VG8050 (undeviated central wavelength = 8050Å; ruling = 450lines/mm), and the old grisms GR730 (8010Å, 300l/mm) and GR780-1 (9700Å, 300l/mm)

WIYN News

Abi Saha

The instrument adaptor system (IAS) on the Nasmyth focus used for imaging on the 3.5-meter WIYN telescope has been modified to accommodate two instruments simultaneously. A new slide mechanism can be deployed to insert a pick-off mirror in the beam to feed a second instrument mounted alongside the centrally mounted one. Primarily, this is in anticipation of the tip/tilt imager, which we expect to commission early in 2002. The tip/tilt camera will be mounted along with the regular mini-mosaic (MIMO) imager. Observers will be able to switch from one to the other in the course of only a few minutes, as dictated by observing conditions and their experiment. This, of course, is in addition to the option of switching to the HYDRA port.

The IAS continues to provide observing functionality as before, such as guiding, focus tracking, and acquisition of images for wavefront analysis. The comparison lamp illumination used with DENSPAK at this port is now provided through a fiber feed, with the lamps now physically located below the observing floor. We are working to restore illumination levels to be comparable to what we had before the new layout of the IAS.

The airbag support mechanism for the tertiary mirror has been tuned, and this appears to have produced noticeable improvement in image quality. FWHM seeing of 0.7 arcsec and better are commonplace. Guided exposures of ~1000s in V and R with FWHM as small as ~0.35 arcsec have been obtained occasionally. The Shack-Hartmann focus probe is in regular use and reliably predicts the smallest noticeable focus changes that can now be corrected, even during the course of an exposure.

There appears to be some mysterious deterioration in the aluminization of the secondary mirror — there are growing spots that have lower reflectivity. At this time, the effects are hardly noticeable. In particular, pupil rotation, as a result of correcting the field rotation in this alt-az telescope, produces no significant changes in the flat-field at the 0.2 percent level.

The cause of this malady is unknown, but the remedy — re-aluminizing the mirror — will be applied this November. Some adroit adjustments of the observing schedule (thanks to gracious concessions by Indiana University observers) have been made to accommodate the nights that will be lost.

We have begun making tests with an IR imager for the first time at WIYN. The University of Illinois NIRIM camera provided by Margaret Meixner was used on a two-night run in early September. Seeing with FWHM of about 0.3 arcsec was obtained in J and H bands. An image of NGC 7027 is available on the Web at *www.noao.edu/wiyn/nirim_test.html*.

The initial implementation will be for university users and the instrument PI. NOAO hopes to use this camera as one of the detectors for the WIYN Tip/Tilt Module, to realize the higher gains in image quality that are achievable in the near-IR via fast guiding.

National Solar Observatory

From the NSO Director's Office

Steve Keil

Projects continued to dominate the NSO landscape during the past quarter, even as observing pressures increased due to the advent of solar adaptive optics (AO) and its ability to achieve diffraction- limited imaging.

The first Advanced Technology Solar Telescope (ATST) site survey tower was erected at Sacramento Peak near the Dunn Solar Telescope (DST). The Solar Dual Image Motion Monitor (S-DIMM) and Shadow Band Array (ShaBaR) are mounted on the tower, and calibration measurements are underway. Seeing measurements will be compared with the AO system wavefront sensor at the DST. (See Frank Hill's article, for details on progress of the site survey.) A first draft of the Science Requirements document for the ATST was completed and can be found at *www.nso.edu/ATST.* We invite your comments on the science requirements and site survey.

Christopher "Kit" Richards (right) receives a 2001 AURA Technology and Innovation Award from Steve Keil.

I'm pleased to announce that Jim Oschmann has accepted the job of Project Manager for the ATST. Jim was selected after an exhaustive search from a field of very qualified applicants. He brings a wealth of experience in optical science and systems engineering and management, which includes his role as Project Manager for the construction phase of the Gemini Telescopes. He officially starts his position with NSO in February 2002, but over the next few months will spend about 20 percent of his time organizing the ATST Project. Jim will be based in Tucson, but will make frequent trips to Sunspot and to our ATST partner institutions.

GONG has completed the replacement of its 256 × 256 rectangular-pixel cameras with 1024 × 1024 square-pixel cameras (GONG+), and has started an era of continuous high-resolution helioseismology and magnetograms. SOLIS has awarded a contract to the Rockwell Science Center for delivery of cameras for the Vector Spectromagnetograph by the first of the year; this will allow us to deploy SOLIS during 2002. NSO and HAO have entered into an agreement to upgrade the Advanced Stokes Polarimeter so that vector magnetic fields can be measured at the diffraction-limited image scale delivered by AO at the Dunn Solar Telescope.

A workshop on "Prominence Research: Observations and Models" organized by Sara Martin (Helio Research) and Jack Zirker (NSO) was held at NSO/Sac Peak on October 11-13. This is an annual gathering of a core working group (PROM) that studies prominences; other scientists engaged in prominence research also participate by invitation. This year's workshop concentrated on relating observations to theoretical models, and the implications for prominence eruptions and their observational signatures. Knowledge of the 3-D topology of magnetic fields and plasma motions in and around filaments — prominences at the limb — is crucial for understanding the physics of prominences and mechanisms of their eruption.

Once again, NSO was fortunate this summer to host a group of talented college students to participate in research projects under the sponsorship of the NSF Research Experiences for Undergraduates (REU) Program and NSO's graduate student Summer Research Assistantship (SRA) Program. NSO also hosted three high school teachers, two at Sac Peak and one in Tucson, as part of the 2001 NSF Research Experiences for Teachers (RET) Program. Project descriptions for the eight undergraduates (four in Tucson and four at Sac Peak), four graduate students, and RET interns are available at *www.sunspot.noao.edu/PR/eo_programs.html*.

With the availability of AO at the Dunn Solar Telescope, NSO has experienced a sharp rise in proposals to investigate fundamental processes in the solar atmosphere.

In recognition of his strong contributions to the NSO Solar Adaptive Optics Project, Christopher "Kit" Richards received a 2001 AURA Technology and Innovation Award. Kit's contribution to the AO project cannot be over emphasized. As the lead engineer, he was responsible for design and implementation of the wavefront sensor hardware and software. The wavefront sensor is the key component of the AO system. Its development required innovative thinking and outstanding engineering skills.

continued

Director's Office continued

Kit not only designed and built key components of the AO system, but also played a key role in integrating and testing the system. He also was in charge of installing and operating the NSO low-order AO system at the German Vacuum Tower Telescope on the Canary Islands. This successful campaign so far has produced several publications and has resulted in international recognition of NSO's capabilities in building and operating state-of-the-art astronomical instrumentation. Kit's dedication and hard work have made this possible and have opened up a whole new regime of solar physics.

Application of solar AO to large-aperture telescopes promises to reveal the mechanisms leading to atmospheric heating, solar activity and variability, and to understanding the magnetic field-plasma interactions that determine stellar atmospheric structure. Kit continues to be the key engineering staff member on the AO project. In fact, he is absolutely essential to the high-order AO project led by Thomas Rimmele, which is funded by the NSF MRI program and carried out in collaboration with several partners. Overall, Kit Richards has become an exceptionally valuable asset to NSO and the solar community.

ATST Site Survey Status

Frank Hill

The Advanced Technology Solar Telescope (ATST) site survey has made considerable progress since the last report in the June 2001 *NOAO Newsletter*. The seeing monitor development is now essentially finished. This instrument consists of a solar differential image motion monitor (S-DIMM) and a scintillometer array. Several problems with the scintillometer electronics and optics have been identified and rectified. Haosheng Lin, of the University of Hawaii's Institute for Astronomy, has agreed to develop and build the sky brightness monitor and water vapor instrument.

The site survey passed a major milestone in September with the installation of the first test stand at Sac Peak. The test stand is six meters high, and was fabricated by CVE in High Rolls, NM. A total of six of these structures will be built.

The sites that will be fully tested with the complete installation of test stand, seeing monitor, and sky brightness monitor are Sacramento Peak; Big Bear, CA; Haleakala, HI; and La Palma in the Canary Islands. Two additional sites remain to be selected for full testing; candidates in Northern Chile and additional lakes in the Southwest US are currently being considered. A scintillometer array will be placed at Mauna Kea to perform a short limited test. The test stand at Big Bear will be installed as soon as the building permit is obtained, while we expect that the instruments on Haleakala and La Palma will be installed in early 2002.

The site survey working group membership has been revised. The current membership is Jacques Beckers (NSO), Peter Brandt (Kiepenheuer Institute), Carsten Denker (BBSO/NJIT), Jeff Kuhn (U. of Hawaii/IFA), Kim Streander (HAO), M. Collados-Vera (Instituto de Astrofisica de Canarias), and F. Hill (NSO).

The ATST site survey test stand installed at Sac Peak. The seeing monitor is mounted on the top of the tower, covered by a protective canvas bag (left) along with a weather station (right). Steve Hegwer, project manager of the site survey, stands at the base of the tower.

SOLIS

Jack Harvey

The SOLIS mounting, an equatorial with two independent declination axes, is undergoing software testing and alignment after successful tuning of 1,200 foot-pound, direct-drive torque motors used on all three axes. A freak windstorm destroyed a fabric cover used to protect the mounting at its temporary location at the GONG prototype site. The 15-ton mounting was not damaged, and a replacement cover has been installed.

Assembly and testing of the SOLIS instruments continues. The Vector Spectromagnetograph (VSM) is presently located in a basement lab where wiring and coolant plumbing have been completed. An opto-mechanical alignment plan has been developed that will allow removal of optics that might require future maintenance without the need for a major disassembly. Required alignment aids were built.

The major delay in completing the VSM is a failure to deliver by our original CCD camera vendor. Regular visits to the vendor of replacement cameras confirm good progress toward an expected end-of-year delivery, and the data acquisition system has been reprogrammed to accommodate the new cameras.

Polarization modulators were assembled and tested, and while crosstalk is somewhat larger than predicted by theory, calibration procedures will deal with that. After a series of comparison tests, choices of initial reduction codes for vector magnetograms were made, and their implementation is in progress.

The Full Disk Patrol (FDP) housing is in another basement lab where it is being fitted with optics cells, mechanical mechanisms, and electronic components. The 1083-nm filter oven was tested for temperature stability using a new commercial temperature controller, and found to meet specifications easily. By the time this article appears, the filter should be tuned, and preliminary intensity and Doppler images should be available.

There is still some concern about the two CCD cameras used by the FDP. Testing showed that they both work with a commercial frame grabber, but only one works properly with our data acquisition system. This camera runs hot and has significant cosmetic defects, while the other one is well-behaved (using the commercial frame grabber). Construction of the tunable 380-680 nm narrow-band filter is proceeding in small steps, since each stage of the filter contains slightly irregularly sized calcite pieces salvaged from an early filter. Another impediment to rapid construction and assembly of this filter is the odd shape of the liquid crystal variable retarders.

The Integrated Sunlight Spectrometer (ISS) is producing integrated sunlight spectra in the same basement lab that houses the VSM. Final hardware control software is in use via a nice operator's GUI, and the observation scheduler allows observation sequences to be created and run (except that a real time clock is not available in final form as yet). The ISS is being used to develop flat-field and other calibration procedures in preparation for its first science-grade observations.

For accurate Doppler shift measurements, it is necessary to know the pattern of atmospheric extinction across the solar disk, since this affects how solar rotation averages out in a spatial integration. This knowledge is obtained by an extinction monitor, which produces four solar disk images at different wavelengths to accompany ISS spectra. This system is again under development after a hiatus for other activities.

NSO Proposal Submission Deadline for Spring (April-June) 2002 Quarter:
15 February 2002
Observing Time Request Forms available at *www.nso.noao.edu/*

Dedicated Astrometric Capability for Near-Earth Objects

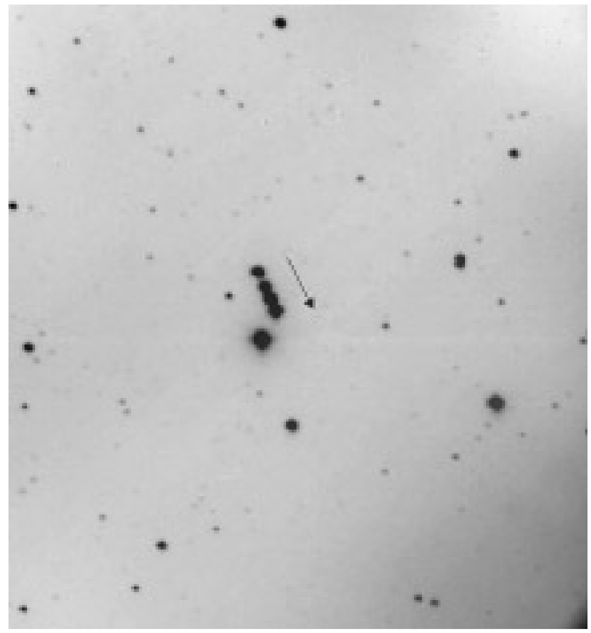
Andrew Potter

NASA supports five teams for the study of Near-Earth Objects (NEOs). The efforts of the search teams are focused on discovery, with a lesser emphasis on follow-up measurements to verify orbit accuracy. It is well-known that small errors in the initial orbit determination will propagate and grow with time, so that unless the orbits of these objects are periodically checked and improved, it is possible that they may be lost, or at least predictions of their future position may be incorrect. This could lead to an incorrect assessment of the hazard in the case of an Earth-crossing asteroid.

The objective of this effort is to provide a full-time, dedicated astrometric capability available to the NEO discovery program. The rate of discovery likely will increase in the future, and experience has shown us that immediate follow-up of initial discoveries is needed to provide accurate orbital data. At the present time, there is insufficient astrometric capability to handle the expected increase in discovery rate.

The NSO McMath-Pierce Solar Te1escope facility at Kitt Peak includes two 0.8-meter auxiliary telescopes of excellent quality. One of these – the McMath-Pierce East Auxiliary Telescope – is available to the NEO follow-up program for nighttime astrometric observations. The drive and tracking mechanisms were badly worn on this telescope, and repair was required. This work has been completed, and the telescope is now fully operational under computer control. Development of the auxiliary optics and detector system needed for astrometric measurements began this past summer.

The AP8 CCD Camera from Apogee Instruments was chosen for the detector. This is a back-illuminated 1024 × 1024 CCD with 24-micron pixels having a peak quantum efficiency of about 80 percent. A field of view of about 5 arcmin is required to ensure that there would be sufficient stars in the field of view for accurate astrometry. To accomplish this, a lens system was designed to increase the image scale of the telescope to the required size. The prototype optical system was set up vertically on a rotating optical bench, which was driven at the sidereal rate to compensate for image rotation as the telescope tracked the sky.



This composite image shows the 10.4-magnitude asteroid 14 Irene as it moves across the sky. It is a combination of four one-minute exposures spaced about 20 minutes apart. The motion of the asteroid is clearly evident.

During this past summer, the prototype system was tested by observing a number of asteroids and NEOs. NSO REU student Danielle Kalitan was involved with this effort as part of her undergraduate project. An example of the kind of data that were obtained is shown in the figure, which displays a composite of four exposures of the asteroid 14 Irene. Performance of the prototype system was generally satisfactory, although several areas that need improvement were evident. Based on these results, an operational system has been designed and is expected to be brought on-line early next year.

GONG
Global Oscillation Network Group

GONG

John Leibacher

The Global Oscillation Network Group (GONG) project is a community-based activity which operates a six-site helioseismic observing network to do the basic data reduction and provide the data and software tools to the community, and to coordinate analysis of the rich data set that is resulting. GONG data is available to any qualified investigator. Information on the status of the project, the scientific investigations, as well as access to the data, is available on our Web site at *www.gong.noao.edu*.

El Teide, the last station on the GONG+ deployment schedule, was installed at the beginning of the last quarter, marking the complete transition to GONG+ network operations. Since then, the last of the GONG Classic data tapes has arrived at the DMAC, and the analysis team is working on the transitional period. Soon GONG+ data will fill the pipeline, providing a test-bed for algorithm development and analysis, and setting the stage for the full GONG++ analyses. The first installment of the GONG++ computing hardware has arrived, and we are busy starting on its entry into service. Also, we have had a number of new personnel join the Tucson team.

Network Operations and the GONG+ Deployment

The third quarter of 2001 brought the completion of the GONG+ installations. The last installation at Teide went smoothly, and we continue to learn about the GONG+ system's operations in the field. In particular, we found that the GONG+ system was vulnerable to certain variations in the AC power. By adding more capacitance to the camera power supply, such line variations can be tolerated. It is planned that all sites will be provided with the modified version of the supply.

We took advantage of already planned travel to the Silver Jubilee celebration of the founding of the Udaipur Solar Observatory to install the new equipment there, where it is enjoying the beautiful, post-monsoonal skies. Congratulations to our partners at Udaipur for their first 25 years, and best wishes for the exciting future upon which they have embarked.

An intermittent problem with one of the four channels of the Big Bear camera appeared as soon as the Tucson team left. Fortunately, the data was not significantly impacted, and the faulty camera was replaced in July.

A problem at Mauna Loa arose at the beginning of July, which involved errors in the timing system caused by motion of the camera rotator. Many attempts were made at tracking it down, and software changes were made to minimize loss of data. It was not until a team was dispatched that the problem was harnessed by supplementing the grounding of the camera rotator housing.

Data Management and Analysis

During the past quarter, the DMAC produced month-long (36-day) velocity, time series, and power spectra for GONG months 57, 58, 59, and 60 (ending on 4 April 2001), with respective fill factors of 0.92, 0.93, 0.86, and 0.77, and tables of mode frequencies, which were computed from the power spectra using the three-month-long time series centered at GONG months 55, 56, and 57.

The DMAC continued upgrading and testing systems and applications for the routine reduction of GONG+ data and began computing the alignment of images from Classic GONG and GONG+.

Kerri Donaldson Hanna joined the DMAC GONGsters. Welcome aboard!

Data Algorithm Developments (and Some Science)

Cliff Toner continues to develop methods of measuring the periodic irregularities in the camera rotator gear train using the Ronchi ruling installed in the filter wheel. Using the Ronchi measurement, Cliff is able to measure the angle with errors of only a few thousandths of a degree. See top figure on page 32.

Simon Kras and Rudi Komm have now installed the multi-taper package in the GONG pipeline. After initial testing to verify correct operation, this package will be in routine use as soon as GONG+ data completely fills the pipeline. The improvement in the number of frequencies that we are able to extract is quite impressive. See figure at the bottom of page 32.

Rachel Howe is working on the leakage matrix calculation for low-degree m-leaks. Once we have an accurate computation, Simon Kras will modify Peakfind II to incorporate this information in the fitting.

continued

GONG continued

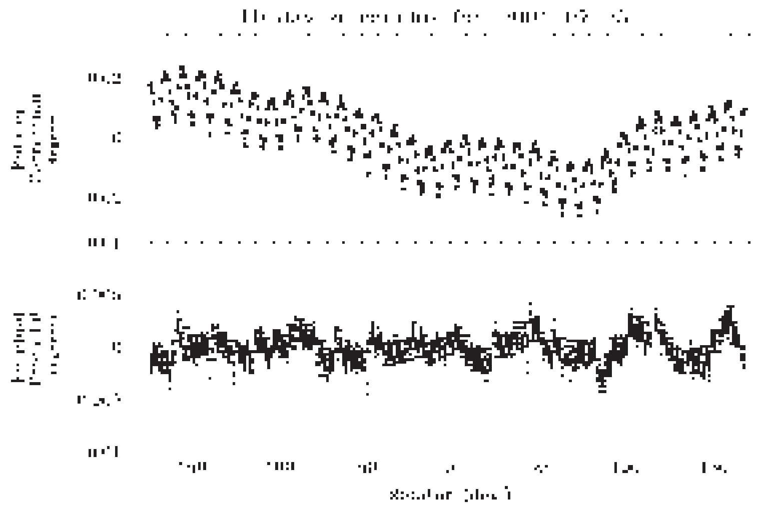
Richard Clark and Jeff Sudol have recently joined the team. Richard is working on bad image rejection and image merging, while Jeff is devising a scheme to characterize any optical distortions in the GONG+ images.

Caroline Barban is proceeding with the comparison of spectra obtained in velocity and intensity. She has successfully fitted the peaks in both spectra and is studying the differences.

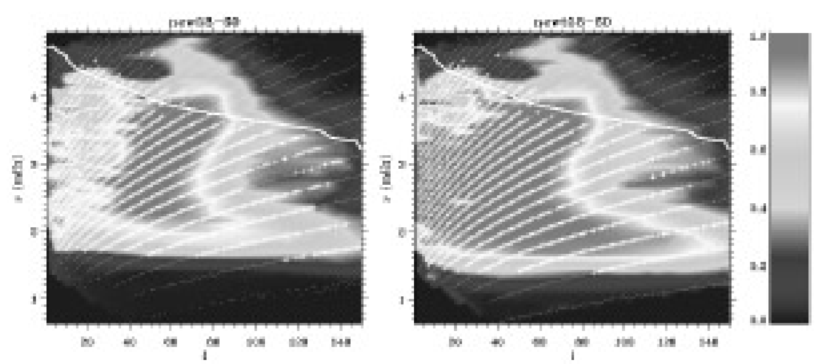
Mike Thompson, Sushant Tripathy, and Markus Roth visited the Tucson office to work with project staff. Mike gained familiarity with the GONG+ images, Sushant demonstrated that frequency changes associated with magnetic field variations can be seen in 18-day long time series, and Markus improved his model of the effect of large-scale flows on the frequencies.

With the advent of GONG+ data, we must deal with the transition phase in the data stream. We are studying several options: simply butting the two streams together, blending them, or inserting a gap. It looks like we'll do it all three ways in order to evaluate which will become the "official" GONG data product.

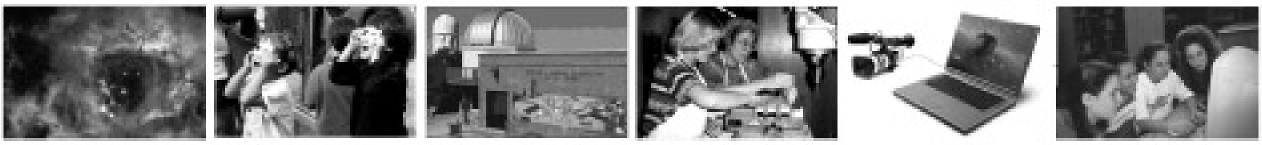
We are also working on improvements to the GONG magnetogram calibration, which will facilitate the use of this exciting new product. The availability of full-disk magnetograms, one per minute around the clock with 2.5 arcsec pixels, should open up some exciting new lines of research into magnetic field evolution. We are also developing methods to return some of this data from the sites soon after it is obtained.



Using images of the Ronchi grating we are able to measure periodic rotation errors introduced by irregularities in the camera rotator gear train. The top panel shows the difference between the measured angle of the camera rotator as deduced from the Ronchi images and the assumed position as returned by the gear encoders (dots) for the El Teide instrument. The solid line is a model fit which is constrained to use only those periods expected from the rotator gears. The bottom panel shows the difference between the measurements and the fitted model. Estimated errors are on the order of two to three thousandths of a degree.



Multi-taper spectral analysis significantly increases the number of frequency measurements that GONG is able to extract from its data. Seen here are the results for a typical 108-day time series (GONG Months 58-60), with the traditional approach on the left and the multi-taper results on the right. Dots indicate multiplets where some modes were fitted, while crosses indicate that the mode coverage was high enough to fit the multiplet. The colors indicate the fraction of all ($2\ell+1$) modes per multiplet that are fitted, and the thick solid line indicates the boundary of the region where ℓ leakage makes fitting difficult. The multi-taper method leads to more modes and multiplets at low frequencies and at low ℓ values. Overall, the number of good fits increases by about 28 percent, and the number of multiplets increases by about 14 percent, while introducing no bias in the frequencies.



Public Affairs & Educational Outreach

Gemini Outreach Expands in Sync With Scientific Output

Peter Michaud

Two years ago, the Gemini Observatory's Public Information and Outreach Office began an ambitious, multi-faceted effort to expand the reach of its impact in cultivating popular appreciation for astronomy and better public understanding of science.

This planned five-year ramp-up will significantly expand the outreach resources available to the entire Gemini partnership. A vibrant PIO liaison network is emerging, with representatives from each partner country helping to establish a true multinational outreach effort.

The US Gemini Program has been a pathfinder in this process. Late last year, Doug Isbell of NOAO Public Affairs began serving actively as the official US representative to the Gemini PIO network, and the immediate impact of this partnership has been profound. Doug has worked closely with the Gemini PIO Office in many areas, including the planning, production and distribution of press releases; conference coordination; and the production of media resources that will be useful for the entire Gemini partnership.

As 2001 comes to a close, nearly all of the Gemini partners have identified PIO liaison network representatives, with most of them having visited the Gemini headquarters in Hawaii and toured the Gemini North facility. In 2002, the first full PIO liaison network meeting will be held, bringing together all of the partners for two to three days to share ideas, discuss common needs and issues, and determine how the Gemini PIO office can best grow to serve the partnership.

Visitors to Gemini Observatory Headquarters in Hilo, HI, view the portable StarLab planetarium that travels to area schools to share Gemini's findings with students and the public. The planetarium, which can accommodate 30 people at a time, is equipped with slide and video projectors capable of displaying all the stars visible from the Northern or Southern Hemispheres.

Other elements beyond this core liaison network are emerging, and some have begun in earnest. Several new staff members have been hired to expand day-to-day activity in the Gemini offices, including local outreach positions in both Hilo and La Serena, a graphic artist, and a part-time administrative assistant. The hiring of a full-time press officer is also planned in the next phase of the expansion, which will complete the in-house staff.

The programmatic elements of the Gemini PIO expansion are quite diverse, ranging from local outreach programming in Gemini host communities to the development of a variety of media resources such as animations, video clips, and new images.

One of the Gemini PIO initiatives that has shown tremendous potential in the prototype stage is the Gemini Observatory Virtual Tour. The Virtual Tour is being produced as a multi-platform interactive CD-ROM that will provide users with a complete Gemini "experience." In the tour, users can visit everything from a virtual (QuickTime VR®) "walk-around" of the observatory to a simulated observing scenario where the user goes through all of the key steps involved in obtaining astronomical data, based upon real Gemini data sets. Currently the tour is installed at six prototype test sites and is available upon special request to interested users. Once testing and production is complete in 2003, the tour will be distributed widely to the public, museums and schools, and then adapted for the Web.

With the arrival of a graphic artist on the Gemini PIO staff, the development of "pretty pictures" and graphical materials such as brochures, posters, and

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Gemini Outreach continued

conference displays will reach a new level. Already, a new Gemini brochure is near completion (in both English and Spanish), and new exhibit display materials are being produced. In the past, an adaptable Gemini conference display has been used extensively by the partnership at local open houses and in the US at AAS conferences and educational meetings, such as the National Science Teachers Association.

The Gemini PIO network will evolve in sync with Gemini North and South, by taking advantage of their most recent accomplishments through on-going input from project officials and scientific users, and by gathering feedback from educators, the media, and the public.

Watching over the shoulders of the initial telescope users, we have just begun to glimpse what Gemini is capable of scientifically. It is clear that our success in the PIO effort will be limited only by our imagination, creativity, and innovation.

A Gemini visitor uses the prototype Gemini Virtual Tour at one of the six locations where it is currently undergoing evaluation and testing. The CD-ROM "tour" is expected to be ready for distribution in 2003.

Educational Outreach Update

Suzanne Jacoby

NOAO's Public Affairs and Educational Outreach (PAEO) office received notice in August that its proposal to the NSF/MPS Internship in Public Science Education Program was successful, providing $100,000 over the next three years to work with local teachers on developing improved activities and materials for classroom visits to Kitt Peak. A second goal of the program is to develop online and hardcopy classroom materials to make use of NOAO science discoveries in the K-12 classroom.

NOAO Outreach Astronomer Travis Rector has accepted a Jansky Fellowship and moved on to the VLA in Socorro, NM. For the past three years, Travis has been responsible for the scientific research areas of the NOAO Research Based Science Education (RBSE) program for middle and high school teachers. Travis will still be connected to RBSE, sharing data from observing runs, facilitating parts of the online course, and participating in the summer workshop. Travis has left his mark at NOAO, in both the scientific integrity of the RBSE program and the many beautiful images now gracing our Web pages, posters, and PAEO products. We wish him well in his new adventures and look forward to ongoing collaborations.

Our Teacher Leaders in Research Based Science Education (TLRBSE) program has recruited applicants for the first year of a Distance Learning program, which prepares participants for a two-week summer institute held at NOAO/Tucson/Kitt Peak and NSO/Sac Peak. Astronomer mentors will be needed for each of the participants, and we'll be actively recruiting for these volunteer positions at the January AAS meeting. You can learn more about this program at *www.noao.edu/outreach/tlrbse/*.

We're also preparing for a strong showing as an exhibitor at the National Science Teachers Association meeting to be held in San Diego in March 2002.

Project ASTRO continues strong into its sixth year at NOAO Tucson, having formed more than 250 ongoing partnerships between astronomers and teachers to bring hands-on activities into science classrooms. The fall 2001 workshop was held in September, and included a group trip to Kitt Peak, as well as lectures from noted planetary scientist

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Educational Outreach continued

and space artist William K. Hartmann, and comet hunter and author David Levy. On the Kitt Peak trip, workshop participants sketched the rising Moon, modeled phases of the moon in the unique environment of the Mayall 4-meter pier, and viewed wonders of the night sky with telescopes, binoculars, and the naked eye.

Workshop presenters Joni Chancer and Gina Rester-Zodrow, authors of *Moon Journals: Writing, Art and Inquiry through Focused Nature Study*, extended the concepts from the their book into the area of authentic scientific inquiry. This is done by having teachers work in collaboration with astronomers to guide students through a month of lunar observations and exploration of investigative questions using art, writing, scientific investigation, and Project ASTRO activities.

Four activities from the Astronomy Society of the Pacific's publication, *Universe at Your Fingertips*, were included in the workshop. Astronomers and teachers learned together how to help students investigate the size and scale of the solar system, the formation of craters, the phases of the Moon, and radar-mapping techniques.

Plans are underway for the 2002 Project ASTRO workshop. For information, visit the Project ASTRO Web site at *www.noao.edu/education/astrotucson.html*.

The 2001 and 2002 REU Programs at the Kitt Peak National Observatory

Kenneth Mighell

Every summer KPNO is fortunate to welcome a group of talented college students to Tucson to participate in astronomical research under the sponsorship of the National Science Foundation's Research Experiences for Undergraduates (REU) Program. The 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 a KPNO staff member on specific aspects of major on-going research projects. As part of their research activities, REU students gain experience with KPNO's telescopes and develop expertise in astronomical data reduction and analysis.

During the summer of 2001, eight students participated in the KPNO REU Program and worked on a diverse range of topics. They also took part in a weekly lecture series, observing runs using telescopes on Kitt Peak, and a "field trip" to both NRAO's VLA and NSO's Sacramento Peak Observatory.

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Summer 2001 saw eight undergraduates in Tucson as participants in the KPNO REU Program. Two undergraduates joined them from the NASA-funded URPA Program. Shown are (left to right), Nelvin Thomas (U. Virgin Islands/URPA), Daneil Wik (Ohio U.), Heather Jacobson (U. of Texas), Melissa Miller (Macalester College), Sarah Robinson (Rochester Institute of Technology), Matthew Grabelsky (Rice), Elana Klein (Brandeis), Vincent Davis (Elizabeth City State U./URPA), John Pina (U. of Arizona), and Valerie Mikles (Johns Hopkins).

REU Programs continued

At the end of the summer, the students shared their results with the Tucson astronomical community by giving oral presentations describing their research. Most of these students will be attending the January 2002 AAS meeting in Washington, DC, as part of the REU Program (thanks to the NSF), and we encourage you to stop by their poster sessions and attend their talks.

We anticipate being able to support six REU positions during the summer of 2002. As required by the NSF, student participants must be citizens or permanent residents of the United States. The positions are full-time for 10 to 12 weeks between May and September, with a preferred starting date of early June. A salary of $375 per week and funds to cover travel to and from Tucson are provided.

Completed applications (including basic applicant information, official transcripts, and letters of recommendation) must be submitted to KPNO no later than 15 January 2002. Additional information and application forms are available at *www.noao.edu/kpno/reu*.

IN BRIEF

NOAO and the University of Arizona teamed up to issue a joint press release on September 28 regarding observations of Comet Borrelly from Kitt Peak in support of the NASA-JPL Deep Space 1 spacecraft flyby. This news garnered a page one story in the Tucson section of the *Arizona Daily Star,* and coverage on Space.com and in the December *Sky & Telescope*.

PAEO Web Designer Mark Newhouse recently completed work with the GONG group on a musical educational outreach activity titled "Solar Music: Using Helioseismology to See Inside Our Sun." Based on an exercise that solar astronomer Frank Hill put together for scientists visiting elementary school classrooms, the unit includes hands-on activities for students as well as teachers. The unit is available for download as a PDF file at *www.noao.edu/education/ighelio/Solar_Music.pdf.*

Charles Bailyn of Yale University conducted a creative live tour of the WIYN 3.5-meter and 0.9-meter telescopes on Kitt Peak on the Research Channel on October 15, which was broadcast back to classrooms on the Yale campus via a satellite news truck. A simultaneous streaming Webcast received more than 6,000 hits.