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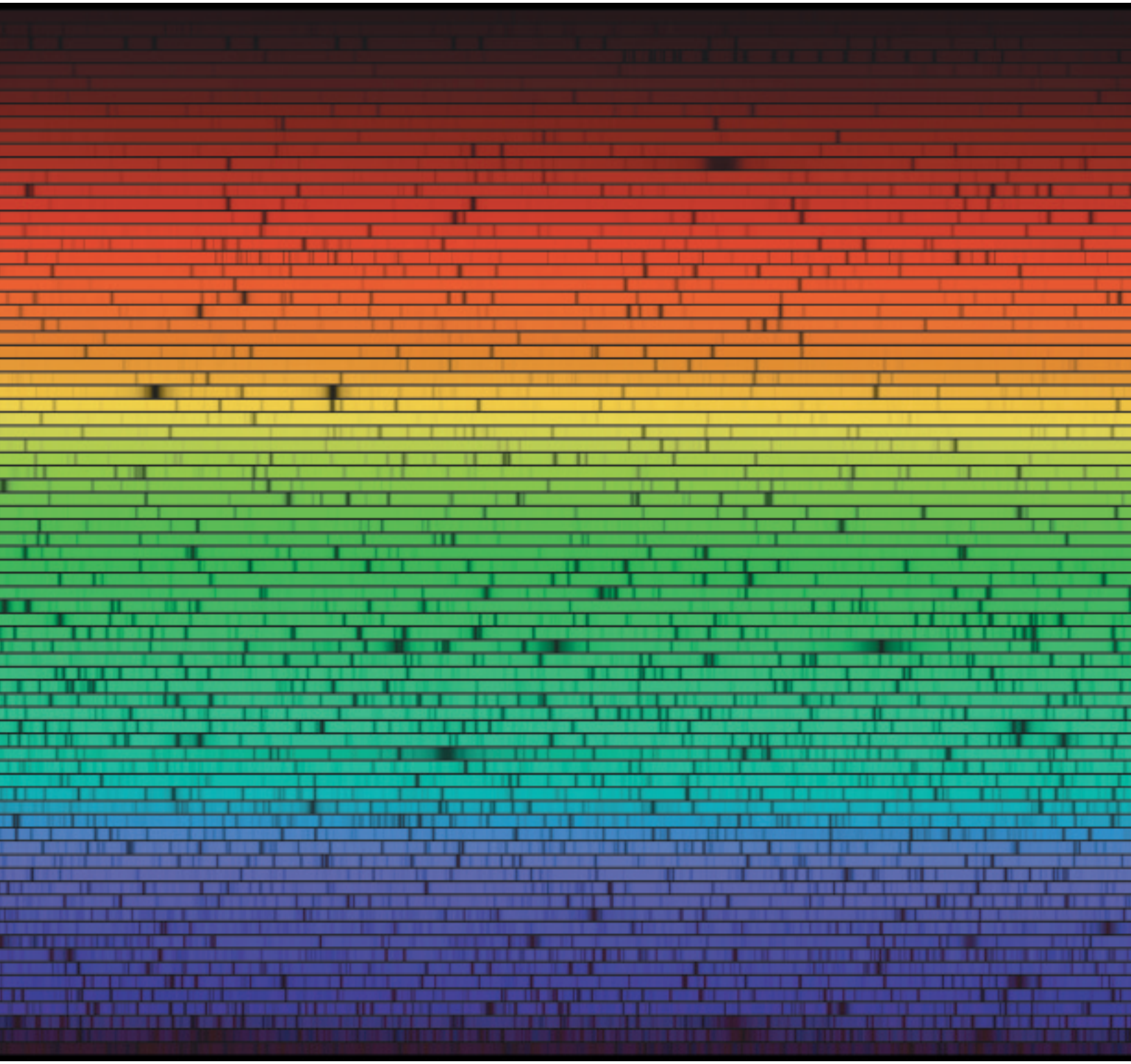
Newsletter 64 December 2000



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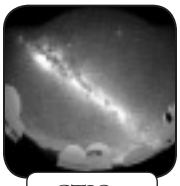
USGP

Gemini Sharpens the Galactic Center

Gemini "Demonstration Science" observations of the Galactic Center are now available, three months after they were obtained with Hokupa'a/QUIRC. Nearly diffraction-limited near-IR images of the central arcminute of the Galactic Center give an unprecedented combination of sharpness and field of view to provide a clearer understanding of the complex relation between the stellar population and the extreme density found in the nucleus of our galaxy. [Page 3]


CTIO

SOAR Continues to First Light in 2002

SOAR passed a minor milestone with the completion of the building structure and siding. A temporary roof will be installed before the arrival of the dome in March 2001 so that electrical and HVAC systems can be installed. [Page 13]


KPNO

WIYN Improves Performance

Observers report an increase in the fraction of 0.5″ to 0.7″ images after an airbag tertiary mirror support system was installed and an improved pointing model came into use. Image sizes of 0.4″ were consistently seen in 5 min exposures during one night of NOAO time and 0.26″ exposures noted with the Yale speckle camera. [Page 17]


NSO

ATST to Design and Development

The Advanced Technology Solar Telescope (ATST), a 4-m, off-axis reflecting telescope with adaptive optics and thermal control, has entered the design and development phase. The science objective of ATST is to study magnetic fields in the plasma structures on the Sun with the intent of understanding the mechanisms responsible for solar variability. [Page 24]

On the Cover

A Digital High-Resolution Solar Spectrum in an Old Way

A high-resolution digital spectrum of the Sun is displayed to mimic an echelle spectrogram. Nigel Sharp (NOAO/KPNO) colorized the digital atlas observed with the Fourier Transform Spectrometer at the McMath-Pierce Solar Facility on Kitt Peak by Robert L. Kurucz, Ingemar Furenlid, James Brault, and Larry Testerman (*National Solar Observatory Atlas No. 1*, June 1984) and sliced it into orders like those produced by an echelle.

This image and a colorized version of a spectrum of Arcturus are available in the NOAO Image Gallery (*http://www.noao.edu/image_gallery*).

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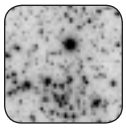


Gemini Gives the Galactic Center a Sharp Look

Robert Blum (CTIO)

An international team of astronomers led by François Rigaut (Gemini) has used adaptive optics imaging with the Gemini North 8-m telescope to obtain nearly diffraction-limited near-IR images of the central arcminute of the Galactic Center. These images were obtained as part of the early "Demonstration Science" project and have now been released by the Gemini Observatory for use by any interested astronomer.

The goal of the Galactic Center demonstration project was to provide a better understanding of the complex interplay between the stellar population and the extreme environment at the core of the Milky Way, which includes a two million solar mass black hole. Besides providing a view of the Galactic Center that is unprecedented in sharpness and field of view, the data provide an opportunity for Gemini partner country scientists to explore how to best obtain, reduce, and analyze near-infrared images using an adaptive optics (AO) system.

The Galactic Center Demonstration Science team completed successful runs in July and August 2000 using the University of Hawaii Hokupa'a adaptive optics system and the QUIRC near-infrared imager on the Gemini North 8-m telescope. This team, which included members from all the International Gemini Project partner countries, obtained H- (1.65 μm) and K-band (2.2 μm) images of eleven different fields around the Galactic Center (the FOV of QUIRC is 20 arcsec).

A mosaic of four QUIRC images in the central few parsecs of the Galaxy (north is up, east is left). The concentration of bright stars to the lower right of the image is the nuclear cluster of the Galaxy. Many of the images obtained at K have 0.1 arcsec FWHM or better, some approaching the diffraction limit of 0.08 arcseconds.

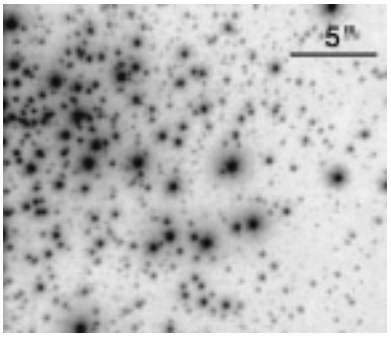
The Demonstration Science team also obtained a series of narrow band images in the 2.3 μm CO band-head (prominent in late-type stars) and several epochs of data on the central cluster and the massive star cluster

Gemini Galactic Center continued

"the Arches," located some 30 parsec in projection from the Galactic Center.

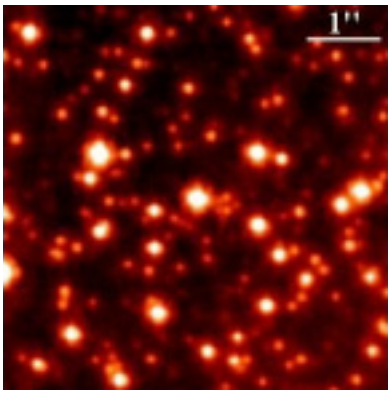
Science topics that will be addressed with the data set include star formation history in the Galactic Center, the distribution of late-type stars and dynamical evolution in the nuclear cluster, variability of the IR counterpart to the radio source SgrA* (commonly thought to be associated with the central black hole), and investigations of the stellar content of the SgrA* stellar cluster (for example, Ghez et al. 1998, *ApJ*, **509**, 678), to name just a few.

More details and information on how to obtain the data may be found on the Gemini Web pages (*http://www.gemini.edu/galactic.html*) and the USGP Web pages (*http://www.noao.edu/usgp*).

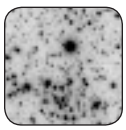


(Above) Using adaptive optics on the Gemini North telescope, the sharpness of star fields in the Galactic Center region come to resemble the visual appearance of commonly imaged fields of stars in the solar neighborhood. But with one critical difference: the density of stars in this detail of the Gemini Galactic Center mosaic is some 300,000 times the stellar density in our region of the Galaxy.

A close-up of the NW region shows a clear view of the bow shock created by a stellar object (IRS 8) as it slams into a streamer of gas, which is itself falling into the central parsec.



The Gemini Demonstration Science release of Galactic Center observations includes the sharpest image ever taken of the Arches Cluster, one of the largest clusters of stars in our galaxy, which is located about 100 light-years from the Galactic Center. This cluster is poorly understood because of the intervening 25,000 light-years of obscuring dust that completely blocks visible light. The lifetime of such a cluster must be very short, due to the intense tidal forces from the nucleus of our galaxy.



Heavy Metal and the Early Galaxy

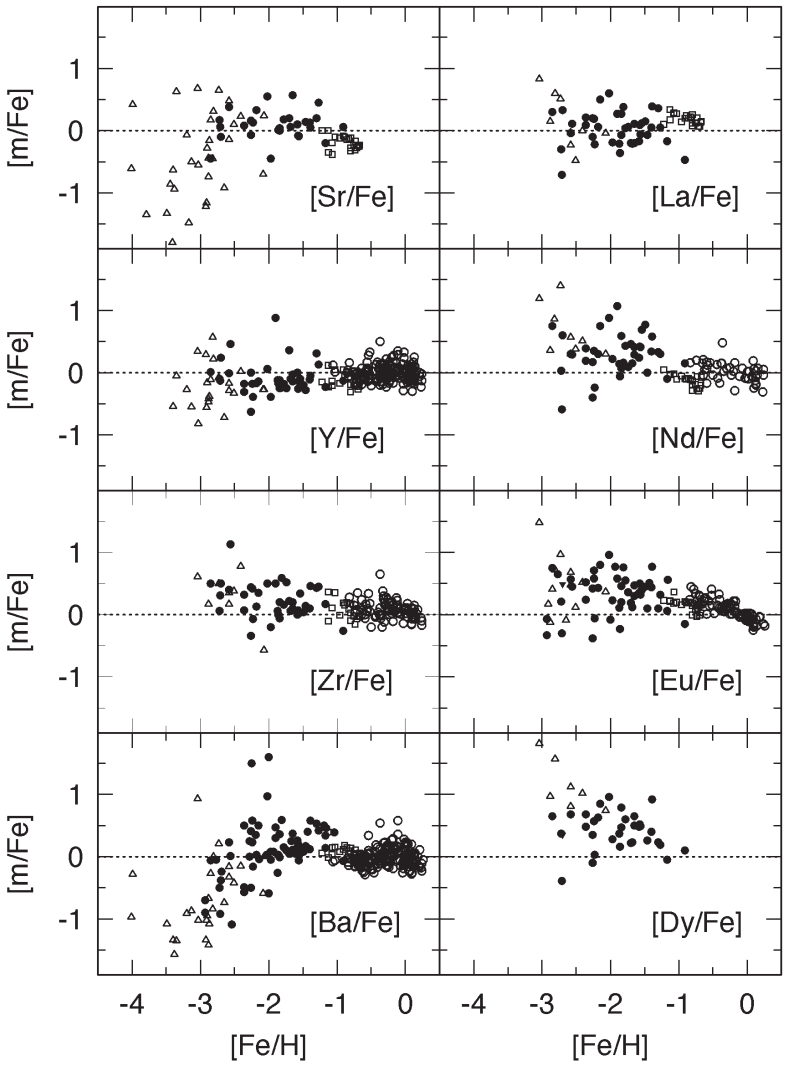
Based on a Solicited Contribution from Caty Pilachowski (NOAO)

New abundances for neutron-capture elements in a large sample of metal-poor giants have been determined by Debra Burris (Oklahoma City Community College) in collaboration with Caty Pilachowski and Taft Armandroff (NOAO), John Cowan (Oklahoma), Chris Sneden (Texas), and Henry Roe (Berkeley). These new abundances, in combination with data from the literature, form a comprehensive picture of the production of elements in the early Galaxy, particularly of the role of supernovae with 1-3 $M_{\odot}$ progenitors in the precursors to the oldest stars we see today.

The spectra were acquired with the KPNO 4-m echelle and coudé feed spectrographs. Abundances of eight n-capture elements (Sr, Y, Zr, Ba, La, Nd, Eu, Dy) in 43 stars were derived from blue echelle spectra and red coudé spectra, and the abundance of Ba only was derived from the red spectra for an additional 27 stars.

The oldest metal-poor halo stars are Galactic fossils that provide clues to the conditions and populations of stars that existed early in the Galaxy's history. The chemical compositions of these halo stars are due to only a few, perhaps one, earlier generations of stars. Metal-poor stars provide an opportunity to observe neutron-capture elements (Z>30) produced in the unseen precursors to Population II, and through their abundances, to deduce characteristics of the first Galactic stellar population.

continued



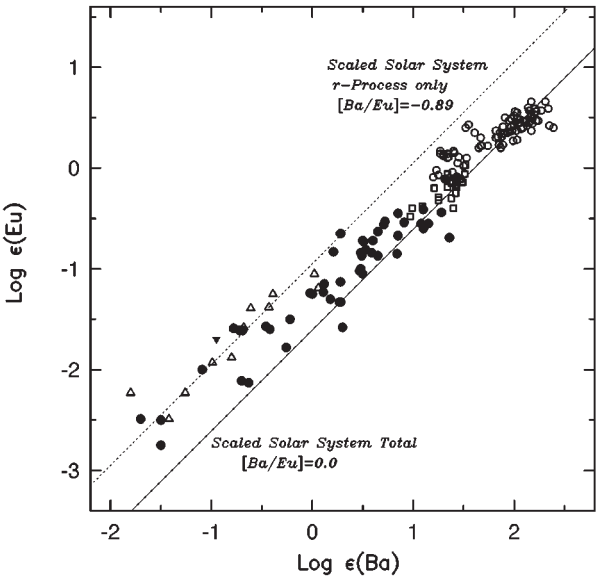
[Sr/Fe], [Y/Fe], [Zr/Fe], [Ba/Fe], [La/Fe], [Nd/Fe], [Eu/Fe] and [Dy/Fe] as a function of metallicity. Filled circles are from the research described here; triangles represent upper limits for Eu and Dy. Other symbols represent abundances taken from the literature.

The Early Galaxy continued

The neutron-capture elements are produced through both slow (s-) and rapid (r-) neutron-capture processes that are believed to occur at different sites. The r-process requires a high neutron flux level (with many neutron captures over a timescale of a fraction of a second) thought to occur in supernova explosions, while the s-process, which requires a lower neutron flux (with a typical neutron-capture taking many years), is generally thought to occur during the double-shell burning phase of low- (1–3 $M_\odot$) and intermediate-mass (4–7 $M_\odot$) asymptotic giant branch (AGB) stars. However, for the most metal-poor stars, many observational and theoretical studies have demonstrated that the observed abundances of neutron-capture elements in metal-poor stars are consistent with production via the r-process only, without contributions from the main s-process.

Overall, the abundances of the neutron-capture elements in metal-poor stars show clear evidence for a large star-to-star dispersion in the heavy element-to-iron ratios. This condition must have arisen from individual nucleosynthetic events in rapidly evolving halo progenitors that injected newly manufactured neutron-capture elements into an inhomogeneous early Galactic halo interstellar medium. The new data also confirm that at metallicities [Fe/H] < -2.4, the abundance pattern of the heavy (Z ≥ 56) neutron-capture elements in most giants is well matched to a scaled Solar System r-process nucleosynthesis pattern.

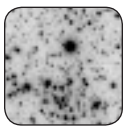
The onset of the main r-process can be seen at [Fe/H] ~ -2.9; this onset is consistent with the suggestion that low-mass Type II supernovae are responsible for the r-process. Contributions from the s-process can first be seen in some stars with metallicities as low as [Fe/H] ~ -2.75, and are present in most stars with metallicities [Fe/H] > -2.3. The appearance of s-process contributions as metallicity increases presumably reflects the longer stellar evolutionary timescale of the (low-mass) s-process nucleosynthesis sites.



The abundance of Ba vs. Eu, where ε is the number of atoms on a logarithmic scale where the abundance of H is 12. The dotted line indicates the Solar System r-process abundance ratio and the solid line indicates the total Solar System abundance ratio of Ba/Eu. For metal-poor stars, the Ba/Eu abundance ratio matches the observed solar system r-process-only ratio, while for more metal-rich stars that contain the nucleosynthesis products of double-shell burning, the ratio shifts to match the solar system total ratio. (The symbols are as in the first figure.)

The lighter neutron-capture elements (Sr-Y-Zr) are enhanced relative to the heavier r-process element abundances. Their production cannot be attributed solely to any combination of the Solar System r- and main s-processes, but requires a mixture of material from the r-process and from an additional neutron-capture process that can operate at early Galactic time. This additional process could be the weak s-process in massive (~25 $M_\odot$) stars, or perhaps a second r-process site, i.e., different from the site that produces the heavier (Z ≥ 56) neutron-capture elements.

Finally, the excess of heavy elements at intermediate metallicities confirms the delay in Fe production by Type Ia supernovae relative to the production of neutron-capture elements in Type II supernovae. Type Ia's are thought to arise from stars of lower mass than the Type II's, and this delay reflects the evolutionary timescales involved.



Extrasolar Planets Are Not Out of Line

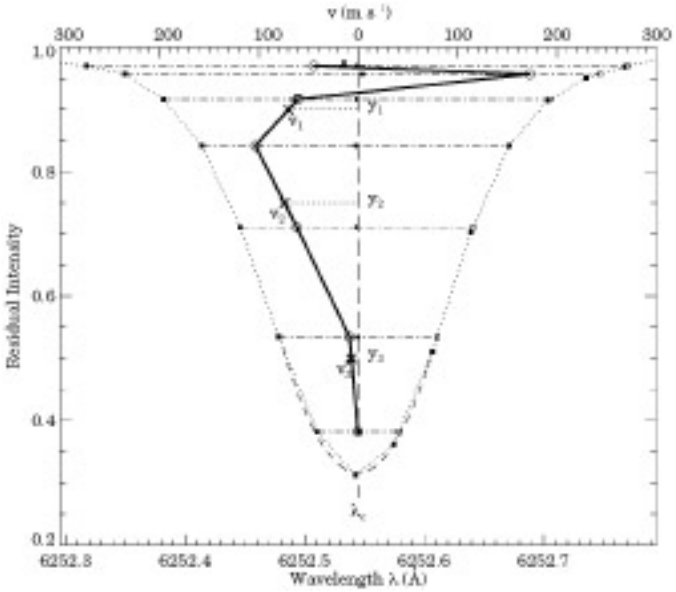
Mark Giampapa (NSO)

Former NSO REU student Matthew Povich (Harvard) has published an analysis of high-resolution synoptic spectra of ten F- and G-type stars, seven of which exhibit periodic radial velocity variations due to the presence of one or more extrasolar planets. Povich and his advisors and collaborators—Mark Giampapa (NSO), Jeff Valenti (STScI), Trudy Tilleman (NSO), Sam Barden (NOAO), Drake Deming (NASA/GSFC), Bill Livingston (NSO), and Caty Pilachowski (NOAO)—searched for subtle periodic variations in photospheric line asymmetry as characterized by line bisectors.

In principle, periodic variations in line asymmetry observed at lower spectral resolutions could mimic the radial velocity signature of a low-mass companion (see figure). No significant evidence of such behavior was found in the data. No correlation was seen between bisector velocity displacement and the known orbital phase of planets around the program stars. Simulations of a periodic signal with noise levels that mimic the measurement errors suggest that bisector variations with amplitudes greater than about 20 m s^{-1} can be excluded. These results support the conclusion that extrasolar planets best explain the observed periodic variations in radial velocity.

The observations were obtained from 1998 March to 1999 February using the NSO 1.52-m McMath-Pierce solar telescope facility on Kitt Peak and the solar-stellar spectrograph, to achieve a resolving power of 1.2×10^5. The synoptic data were obtained by Trudy Tilleman with support from a grant to the NSO/NOAO from the NASA Origins of Solar Systems Program.

The paper, "Limits on Line Bisector Variability for Stars with Extrasolar Planets," has been accepted for publication in the *Astronomical Journal*. In the meantime, Matt Povich, following his graduation from Harvard, has joined the Peace Corps for a two-year assignment in Tanzania as a secondary education physics teacher. Matt hopes, in his words, "to help some African students discover the joys and wonder of the pursuit of science." We all wish Matt the best of success in this very worthwhile endeavor!



Subtle periodic line profile asymmetry, which is revealed by the spectral line bisector technique, was not found to be correlated with the known orbital motion of planets around ten F- and G-type stars. These results support the conclusion that periodic variations in radial velocity in these stars are due to extrasolar planets. The bisector points (filled circles) are the midpoints of the line segments drawn parallel to the wavelength scale of the spectrum. The equivalent velocity scale is magnified at top to reveal the relatively small amplitude of the periodic variation in photospheric line asymmetry (solid, dark line with open circles).

Director's Office

The First Workshop on the Ground-Based O/IR System

Todd Boroson

NOAO sponsored the First Workshop on the Ground-Based O/IR System at the Radisson Resort in Scottsdale, Arizona, on October 27–28. Approximately 50 invited participants plus an additional 30 who responded to a community-wide announcement met for two days. This workshop was the first public opportunity to discuss the recommendation of the McKee-Taylor Decadal Survey that the publicly- and privately-funded facilities be viewed as a single system, and to explore ideas about how the system might evolve, based on community scientific aspirations.

The workshop organizing committee met the day after the workshop to begin formulating a report. When it is completed, the report will be disseminated through the workshop Web site (http://www.noao.edu/gateway/oir_workshop), which also gives the agenda, list of participants, and relevant background information, as well as at the January 2001 AAS meeting in San Diego.

The workshop included three sets of presentations—on context for the system, elements of the system, and science talks on six broad areas. The context talks considered the current state of the O/IR system, the international landscape, and the synergy between ground- and space-based facilities. The talks on elements of the system covered the major facilities as well as ideas about the roles of smaller telescopes, advances in instrumentation, software, adaptive optics, interferometry, and observing modes. The science talks laid the groundwork for breakout groups, which were charged to identify the relationships between the important scientific programs of the next decade and the available or planned capabilities. A final discussion summarized the workshop.

Among the points that seemed likely to emerge as recommendations of the workshop are the following:

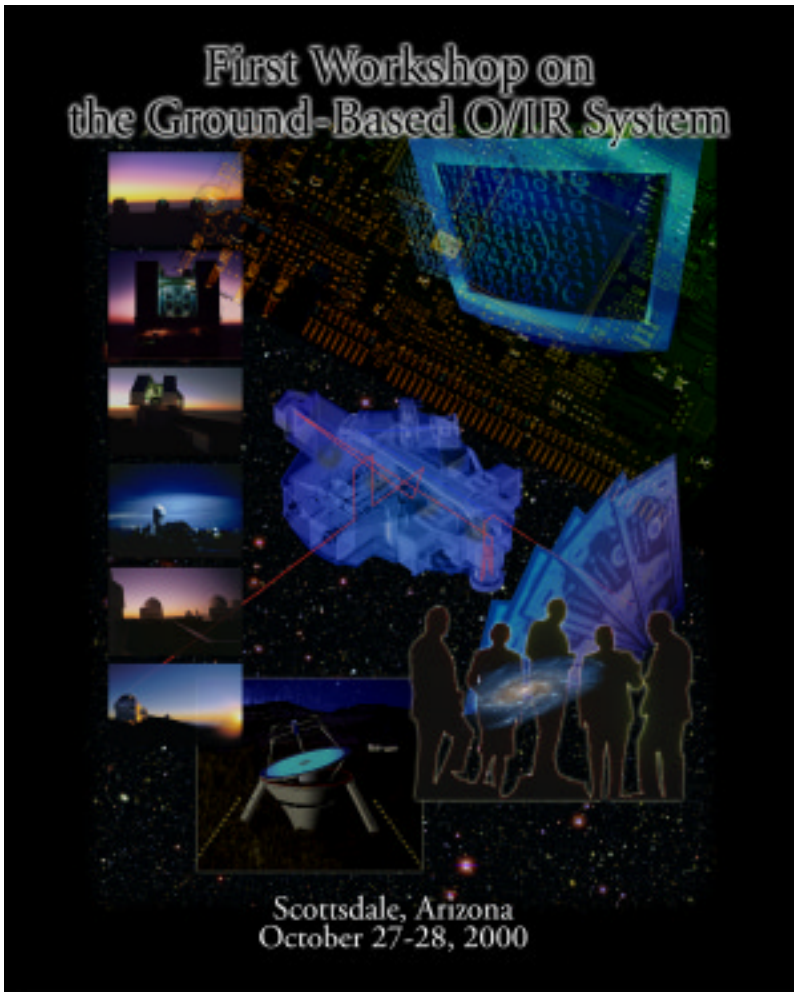
- A strong case was made for enhancing community capabilities in the areas of wide-field imaging at both near-IR and optical wavelengths. In the science areas of star formation and galaxy evolution, it was recognized that imaging surveys using instruments that will be designed around the upcoming generation of 4K × 4K IR arrays will define samples for detailed study with 8–10 m and even larger telescopes. In the optical, the community appears ready for the next step from 8K × 8K CCD mosaics to the LSST—with a three degree field and the consequent ability to survey the entire sky in a few nights. Much of the enthusiasm for this capability was driven by the anticipation of opening up the time domain, which caught the imagination of a number of the science groups.
- Wide field optical (and near-IR) multi-object spectroscopy was also identified as a priority. Groups interested in galaxy evolution and large-scale structure saw a need for the ability to collect spectra of very large samples of objects. Densities of hundreds to thousands of targets per square degree provide a goal for such next-generation instruments.
- There was substantial and increasing acknowledgement of the role that archived data might play in the future. There was overall agreement that more effort must be made to archive and provide access to large, uniform data sets, and that the utility of archiving smaller "PI" observations should be explored. It was recognized that this is limited by the way

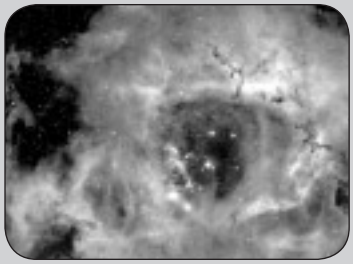
continued

O/IR System continued

instruments are designed and used, and there was a call to consider the needs of archiving with some priority in the design of future instruments.

- Workshop participants recognized that software plays an increasingly important role in our research, both through its importance in the effective operation of complex instruments and through its application to archival research. The general sense was that software efforts are underappreciated and underfunded. Several groups proposed projects that would require substantial software efforts, including a complete census of AGN by the black holes group. This project would depend on the National Virtual Observatory to provide access to federated archives covering many wavelength bands.
- Follow-up, "intervention-type" observing modes were identified as necessary for studies in several areas, ranging from investigations of lensed supernovae by the cosmology group, to a census of trans-Neptunian objects and Earth-crossing asteroids by the solar system group.
- There was recognition of the fact that many of the projects proposed required many types of capabilities spread over a number of different observatories—some even combining space-based and ground-based capabilities. Each of these observatories has different constraints on access and different means of reviewing proposals. The idea of finding ways to provide access to multiple facilities through a single science proposal was supported.





Observational Programs

Round 3: NOAO Survey Proposals Due March 15

Todd Boroson

Two 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 both yield conclusions based on statistical analysis of the survey data itself and also provide important subsets for more detailed observations with larger telescopes. In the first two rounds, 38 Survey Proposals were received and ten were accepted. Proposals for the third round of the NOAO Survey Program are due 15 March 2001, with a letter of intent to be received by 31 January 2001.

The accepted programs are:

- *Deep Imaging Survey of Nearby Star-Forming Clouds* (PI Bally, Colorado)
- *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, 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, Florida)
- *The Resolved Stellar Content of Local Group Galaxies Currently Forming Stars* (PI Massey, Lowell Obs.)
- *Star Formation in HI Selected Galaxies* (PI Meurer, JHU)
- *Southern Standard Stars for the u′g′r′i′z′ System* (PIs Smith, Michigan, and Tucker, FNAL)
- *Deep Lens Survey* (PIs Tyson and Wittman, Lucent, and Dell'Antonio, NOAO)

Further details concerning these approved Survey Programs, including telescopes used and links to individual project Web sites, can be found on the NOAO Web site at *http://www.noao.edu/gateway/surveys/programs.html*.

Proposals for the third round of the NOAO Survey Program are due 15 March 2001. Investigators interested in applying for time under the Survey Program *must* submit by 31 January 2001 a letter of intent to propose a survey program (by e-mail to *surveys@noao.edu*). The letter of intent must describe 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% of the total telescope time at CTIO and KPNO may be awarded through the Survey Program, including that allocated in the first two rounds.

A more detailed description of the Survey Program requirements and guidelines is available at *http://www.noao.edu/gateway/surveys/*. Proposals must be initiated using the NOAO Web proposal form (*http://www.noao.edu/noaoprop/noaoprop.html*), which will be available approximately 15 February 2001.

Looking Ahead to 2001B

Todd Boroson

The spring proposal round for observations in Semester 2001B (August 1, 2001 – January 31, 2002) will be here soon, with the usual due date of 31 March 2001 (15 March 2001 for survey programs, 31 January 2001 for survey letters of intent). Proposal materials should be available around February 15 at *http://www.noao.edu/noaoprop/*.

Possibly included in the 2001B round would be the first opportunity for observations with Gemini South. If a "Call for Proposals" occurs, information should be available on NOAO's Gemini gateway page (*http://www.noao.edu/gateway/gemini*) in early March. While the instrumentation to be available during the first semester of operations at Gemini South is still under discussion, the instrument list is likely to include FLAMINGOS, OSCIR, and PHOENIX. At Gemini North NIRI, GMOS, and Hokupa'a are expected to be available.

Observing time at the Hobby-Eberly telescope and on the 6.5-m telescope of the MMT Observatory is also expected to be available through the NSF's Public Access Program for new programs in 2001B.

NOAO Facilities Popular with SIRTF Legacy Investigators

Caty Pilachowski

The SIRTF Science Center, in collaboration with NOAO, offered SIRTF Legacy Program investigators the opportunity to apply for observing time on NOAO facilities as part of their Legacy science proposals. More than half of the SIRTF Legacy proposers did just that, requesting NOAO observing time to enhance the scientific value of their proposed SIRTF observations. Once the SIRTF Legacy TAC has met, approved programs will be reviewed by NOAO, and then, if possible, scheduled during 2001 and 2002. Up to 10% of telescope time on facilities at CTIO and KPNO is available to approved SIRTF Legacy programs.

Proposal Update for 2001A

Caty Pilachowski

NOAO received 345 observing proposals for telescope time during the 2001A semester, plus an additional 15 proposals on behalf of the Chilean National TAC for time at CTIO. Fifty-eight percent of proposals were submitted using the NOAO Web form, with the remainder arriving by e-mail using the LaTeX template. Thesis proposals accounted for 25% of all proposals received, or 86 proposals. Of the proposals received, 163 requested time at Kitt Peak, 118 requested time at CTIO, 77 requested time at Gemini North, and 8 requested time at the Hobby-Eberly telescope. Thirteen proposals requested long-term status.

In addition to these new programs, an additional 17 programs continue into 2001A as long-term or survey programs at CTIO and KPNO. Some HET and MMT programs are also being carried forward because of slow starts at both of those new facilities.

As of this writing, the proposals are in the hands of the NOAO TAC. The results of their deliberations for the KPNO, CTIO, and HET requests should be announced by e-mail to investigators in early December, followed by formal letters in mid-December. Notification to Gemini investigators must await final approval of the Gemini Director. Investigators who requested time on Gemini should hear the outcome by e-mail in mid-December, with formal letters following a week or so after that.

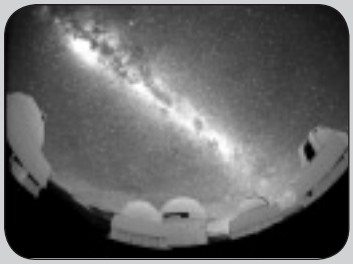
2001A Observing Requests Statistics

February 2001–July 2001

CTIO Telescopes	4-m	1.5-m	YALO	0.9-m	SCHM
No. of requests	96	41	11	19	6
No. of nights requested	302	185	39.5	127	50
Nights available	140	150	23	160	80
Nights previously committed	12	33	0.46	31	0
Nights available for new programs	128	117	22.5	129	80
Oversubscription	2.35	1.58	1.76	0.98	0.63
Average request	3.15	4.51	3.59	6.68	8.33

KPNO Telescopes	4-m	WIYN	2.1-m
No. of requests	108	38	55
No. of nights requested	334.3	92.8	265.2
Nights available	145	60	160
Nights previously committed	26	13	51
Nights available for new programs	119	47	109
Oversubscription	2.81	1.97	2.43
Average request	3.10	2.90	4.82

Other Telescopes	GEM-N	HET
No. of requests	77	7
No. of nights requested	122	9.75
Nights available	34	5
Nights previously committed	0	3
Nights available for new programs	34	2
Oversubscription	3.59	4.88
Average request	1.58	1.39



CTIO
OPERATIONS

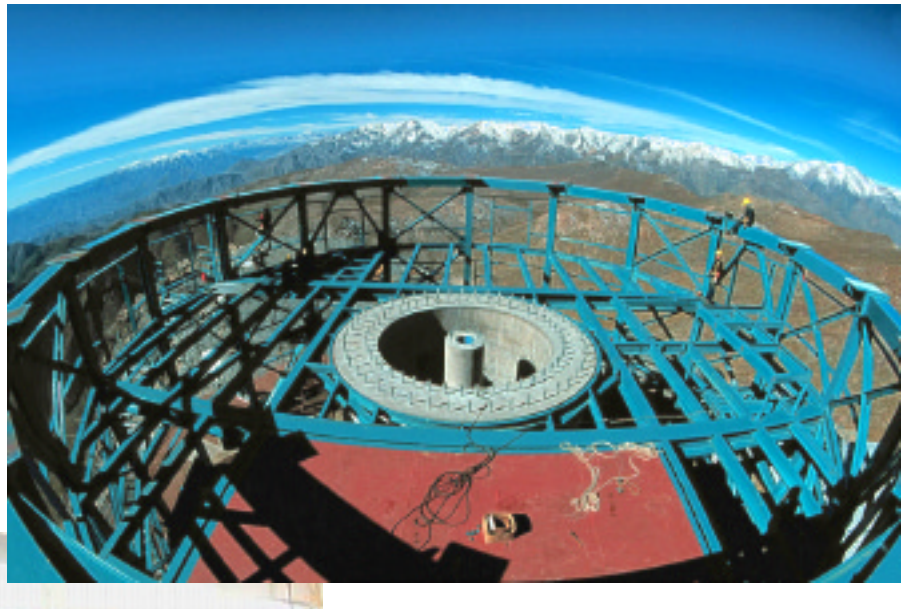
SOAR Update

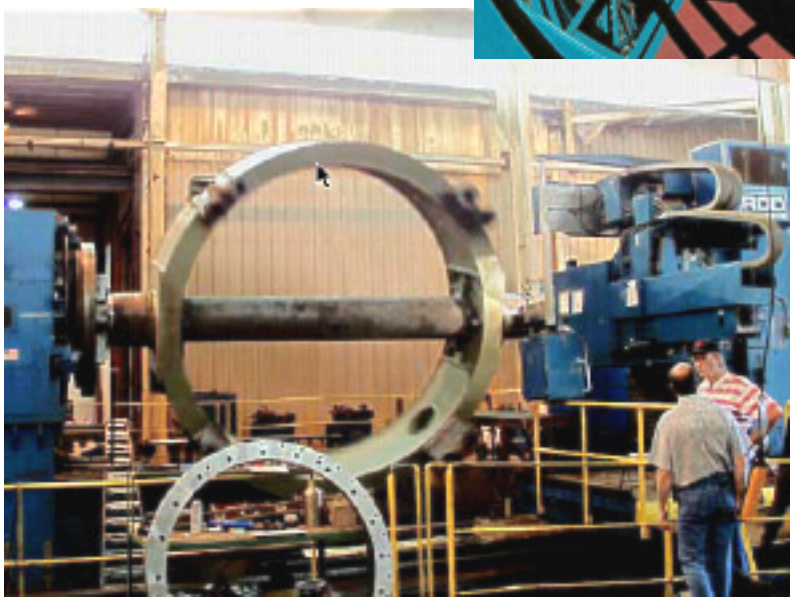
Steve Heathcote

SOAR continues to make excellent progress to its first light in June 2002.

Assembly of the structural steel skeleton of the SOAR facility building was completed in late September and the process of cladding this with metal siding is now all but finished.

The next task will be to add a circus tent-like temporary roof that will allow interior work, such as the installation of the heating and ventilation system (HVAC) and electrical equipment, to proceed prior to the arrival of the dome in March 2001.





Meanwhile, fabrication of major components of the mount such as the elevation ring, seen here being machined at the facility of G&G Machine in Alabama, has continued on schedule.

CTIO Instruments and Telescopes—An Update

Alistair Walker

CTIO's Web page showing the planned availability of CTIO telescopes and instruments over the next few years has been updated. Find the latest news through the link from the CTIO home page or directly at http://www.ctio.noao.edu/telescopes/TheFuture/crystal_ball.html.

As previously stated, we are very conscious of the need to preserve access to stable instrumentation, particularly for survey and other long-term programs already underway. However, anyone who is contemplating initiating a long-term project on any of our telescopes is encouraged to consult with us well in advance of applying for telescope time.

The main changes involve the smaller telescopes. The YALO partners plan to meet in March 2001 to discuss the future of the consortium. The baseline plan is to continue the YALO operation on the 1.0-m through 2003, and *not* to move the operation to the 1.5-m when the present agreement expires at the end of 2001.

The 1.5-m will eventually only be offered with CCD imaging and spectroscopy. ASCAP will last be offered in 2001B, and IR astronomy will move to SOAR (with OSIRIS, and later the MSI IR Imager) and to the Blanco with ISPI. A few technical details still need to be resolved with the OSIRIS move to SOAR; the plan assumes that satisfactory solutions can be found.

The Blanco complement remains as before. The IFU spectrograph is due for its first engineering run in November 2000. Thereafter, we will review the optical spectroscopy instrument suite in the light of its achieved performance.

As always, feedback from the user community is most welcome and forms an important input as we strive to optimize the facilities we offer.

1.5-meter telescope at Cerro Tololo Inter-American Observatory.

Was Your Night at CTIO Photometric?

Nick Suntzeff

Since the opening of CTIO, mountain operations have kept records of the night-time observing conditions. We have placed these pages on the Web at *http://www.ctio.noao.edu/diroff/phot/sky_conditions.html*. You can consult these statistics to see if your night was photometric.

These pages contain the nightly observer reports from CTIO. Every telescope reports the sky conditions over the four quarters of each night. The sky is reported on a scale from 0 (clear) to 8 (totally overcast). The information from all the telescopes is then averaged by TelOps, and a final sky report is given.

For instance, a report of 0-0-0-0 means the whole night was photometric. A report of 8-5-5-0 means that the first quarter of the night was totally cloudy, the next two quarters were partly cloudy, and the final quarter appeared to be clear. Seasoned photometrists would tell you that if a good part of the night was cloudy, the whole night probably should be considered suspect.

Mosaic II Maturing

Knut Olsen and Chris Smith

Mosaic II has now been in use for one and a half semesters, with many happy users going away with gigabytes of data. For the latest updates, keep an eye on the Mosaic II support page, available through links from CTIO's home page or directly at http://www.ctio.noao.edu/mosaic/. We are continually trying to improve the Mosaic experience and are pleased to report on the following enhancements to the system:

- Sixteen channel readout: Perhaps the most significant change that users will be seeing next semester (2001A) will be the upgrade from eight channel to sixteen channel readout. This upgrade will bring the readout time down from 160 sec to 100 sec. In performing the upgrade, Roger Smith has also managed to improve the full-well capacity of several of the CCDs. Only a few software issues remain before release of 16 channel mode to the general user community.
- Several new filters have been purchased. The chipped V filter has been replaced, a full SDSS g′r′i′z′ filter set has been purchased, as have two new narrowband filters, one centered 80 Å to the red of Hα and the other on the [OIII] emission line. Users are welcome to bring their own filters if the CTIO set doesn't fill their needs; the dimensions should be 146 × 146 mm square and no more than 12 mm thick.
- The filter information written into image headers now contains a unique identifier in addition to a short description of the filter. This system was implemented in order to avoid confusion for duplicate filters or filters with similar names.
- The data storage and analysis machine at the CTIO 4-m has been given two new 70-Gigabyte disks and upgraded to 1 Gigabyte of memory. Since readout time limits the data volume per night to ~20 Gb, the increased disk space will be able to store all of the data from a typical run, including space for reductions. The increased memory will increase data handling speed during periods of heavy usage.
- Following periodic maintenance of the camera and detectors, we generally compute new cross-talk coefficients. The name of the latest cross-talk calibration file now contains a date stamp to indicate the dates over which the file should be used; as before, the name of the appropriate cross-talk file is written into the header. Users can copy this file at the telescope or, soon, through the NOAO Mosaic Web page.
- The external IRAF Mosaic reduction package *mscred* version 4.1 is available. Version 4.1 contains a number of new useful tasks. Among them are *mscgetcatalog*, which downloads stellar positions from the USNO-A2 catalog given the RA and DEC in the image header; *mscfindgain*, which allows easy calculation of gain and read noise in Mosaic images; and *xtcoeff*, which allows computation of cross-talk coefficients given an appropriate image. The *mscred* package, along with release notes, can be obtained from *ftp://iraf.noao.edu/iraf/extern/mscredV4.0/*.
- If fast readout is very important, users can choose to bin by up to 4 × 4 pixels. Switching between binning modes takes only a few seconds. The command *snap*, which is usually used to set up on fields and to zero point the telescope at the start of the night, incorporates 4 × 4 binning.
- For those rare users who really don't want a 36′ × 36′ field of view and 135 megabyte images, Mosaic II now supports region-of-interest readout mode. The region of interest is limited to a strip of lines of variable height centered on the Mosaic; the number of columns cannot be controlled. ROI readout mode is still tagged with the 25-second overhead at the beginning of every exposure.

Guest House Changes

Elaine Mac-Auliffe

The AURA-O Council of Directors, at their meeting on 30 September 2000, endorsed changes in the functional mode of the Santiago Guest House to make it a cost-efficient operation. The following changes will be effective starting 1 November 2000:

- Meals will no longer be provided in-house, except for breakfast.
- Breakfast will be provided on a routine basis and included in the cost of the room.
- The rate will increase to US $50 per night. This rate is for single or double occupancy; a surcharge of US $10 will be added for each extra person (in excess of two) occupying the same room. No extra charge will be made for children aged five and under sharing their parents' room.

Day room rate remains at US $20.

Guests can opt to eat out at nearby restaurants or order from restaurants with home delivery service. We remind guests that meal preparation in the kitchen is not permitted.

Cerro Tololo is featured in a set of stamps issued by the US Postal Service to celebrate the accomplishments of American space exploration. The next time you need a stamp to send an international letter, consider using one of these special issue stamps.

How to Contact CTIO

The Web	http://www.noao.edu/ctio
Questions	ctio@noao.edu
E-mail a Staff Member	first initial+last name@noao.edu

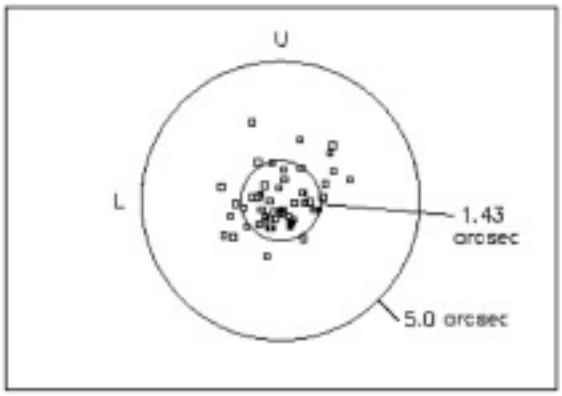
KPNO
Operations

WIYN—Still Getting Better!

Charles Corson, Dave Sawyer, and George Jacoby

The December 1999 and March 2000 *NOAO Newsletter* reported improvements in the performance of the WIYN telescope and noted that further work was in progress. We report here on some new results.

- The tertiary mirror support was designed to be supported by an airbag system, but the original design never worked. Instead, the tertiary was supported on hard points and the dominant optical errors were removed via the active optics support system of the primary, leaving high-order aberrations in the optics and some instability with position. We installed a new airbag system during the August shutdown and noted immediate reductions in wavefront errors of about ~15%.
- Though a statistical analysis of the delivered image quality (DIQ) is not yet available, observers report an increase in the frequency of 0.5 to 0.7″ images (in 5 to 20 minute exposures) since September. We will report current seeing statistics in a future newsletter.
- An autofocus Shack-Hartmann device has been put into routine operation to track the telescope focus errors with normal guide stars. During a recent run, the focus sensor maintained the telescope focus in 0.7″ seeing for over three hours.



Open-loop tracking and target acquisition have been significantly improved at WIYN with an improved pointing model. The residual pointing error scatter diagram from TPOINT shows an all-sky rms error of only 1.43″ (59 random sky points).

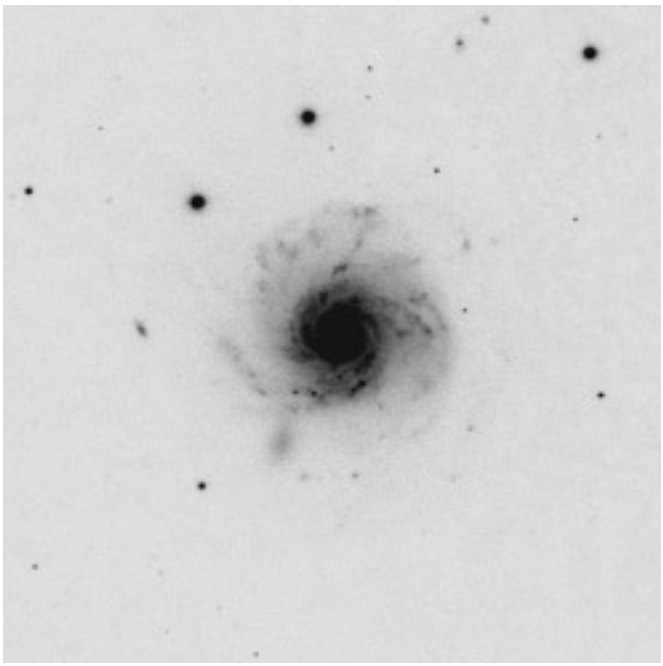


Image sizes of 0.36″ FWHM are seen in this 225-second I-band exposure of NGC 7620, a nearly face-on Sc-type spiral galaxy, which was observed with Mini-Mosaic by M. Bershady (Wisconsin) and colleagues as part of a program supported through NOAO time to study galaxy disk distortions. A companion 225-second R-band exposure taken during the same observing run in 2000 October showed 0.40″ images.

continued

WIYN continued

- Telescope pointing also affects the DIQ via tracking errors, a particular problem for altitude-azimuth telescopes. Pointing was improved significantly at WIYN by using an improved model for tilt in the azimuth axis. The all-sky pointing error was reduced from ~5″ to ~1.5″. The improved open-loop tracking was evident when Elliott Horch and William Van Altena (Yale) noted 0.26″ images with their speckle camera for 0.5-sec exposures at 6475Å.

While it is too soon to assess how much better the images at WIYN are now, predictions suggest that the median DIQ will drop about 0.1″, to below 0.7″. Can the image quality be further improved? The answer is probably yes. We are aware of several major heat sources on the telescope that are degrading the dome seeing. A project scheduled for the coming year is aimed specifically at removing unnecessary heat.

Other major improvements planned at WIYN during the coming year include:

- Hydra upgrade to speed up positioner by more than a factor of 2. Setup times should decrease from 25 minutes to 10 minutes.

- Development of the Cassegrain (f/13.5) port to allow three instruments to be always "live" at the flip of the tertiary mirror.

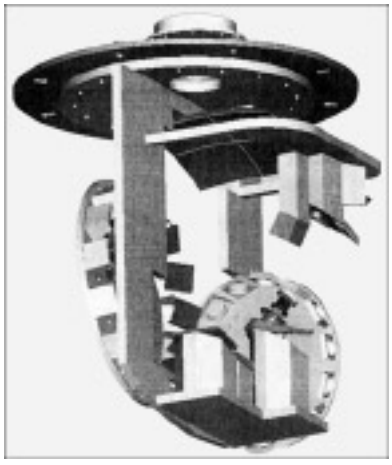
An IR Multi-Object Spectrometer for KPNO

Bruce Bohannan, Richard Green, and John W. MacKenty

STScI , Goddard Space Flight Center (GSFC), and KPNO have begun a collaboration to build an infrared multi-object spectrometer using micro-mirror arrays. IRMOS, the InfraRed Multi-Object Spectrometer, will be a pathfinder instrument for the Next Generation Space Telescope (NGST) and will offer resolutions ranging from 300 to 3000 in the 1- to 2.5-µm bands. Now nearing the end of its design phase, IRMOS will be deployed on Kitt Peak in 2002.

The innovative aspect of IRMOS is the demonstration of micro-mirror arrays (MMA), micromechanical electrical systems also known as digital mirror devices (DMD). IRMOS will use a commercial Texas Instruments DMD with 16-µm square aluminum mirrors in an 848×600 array. The common application of these devices in video projectors leads to a critical feature—that they must be free of defects, which makes them excellent as a programmable spectrograph "slit." The array will be used in reflection, where each mirror is individually addressed to synthesize entrance slits of almost any shape required. Electrostatic actuation latches mirrors into *on* or *off* states, where they can be held essentially

continued



IRMOS is an infrared multi-object spectrometer proposed by John Mac Kenty (STScI) as a facility instrument for Kitt Peak.

IRMOS continued

indefinitely (whereas the array is refreshed at 1 kHz in projection displays). Slits in a variety of sizes in multiples of 0.20″ (at the Mayall 4-m) and numbering from a few to more than a hundred can be tailored to targets in less than a minute.

A 1- to 5-μm multi-object spectrometer was selected as one of three science instruments proposed for NGST. Prototypical science programs required spectroscopy at 0.1″ spatial resolution over "as large a field of view as possible," a reflection of the relatively low space density of "interesting" objects. The design field-of-view of the NGST-MOS is 4.1′ × 2.7′. Micro-mirror arrays are the perfect device for achieving multi-object spectroscopy in a space environment, where aperture masks and fiber systems are not viable. For NGST, MMAs with array sizes of 1K square are required. GSFC is now developing prototype devices to identify technology challenges and to limit design phase space.

John MacKenty (STScI) is the principal investigator for IRMOS. Personnel at STScI are undertaking the design of optics, software, and electronics. GSFC is responsible for instrument design, fabrication, and system integration. KPNO is providing design support, telescope time, science operations support, and a Rockwell HgCdTe 1024-square detector.

Please contact John MacKenty (*mackenty@stsci.edu*) for more information.

Protecting the Dark Skies around Kitt Peak

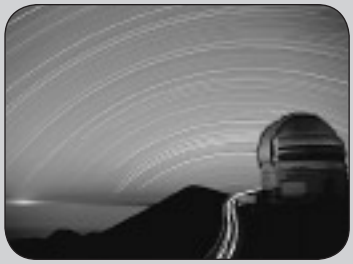
John Glaspey and Richard Green

Kitt Peak has benefited greatly from the City of Tucson and Pima County lighting codes that minimize the impact of the lights from the metropolitan area. Kitt Peak is actually located in the Tohono O'Odham Nation, some 50 miles west of Tucson. We are pleased to report that lighting for the new sports field at the Indian Oasis Baboquivari High School has been carried out keeping in mind the protection of dark skies. Lights were added to the football field of the new site of the high school in Topawa, about 17 miles by air from Kitt Peak. Jerry Carlyle, Director of Operations for the school district, requested information from KPNO as to what type of lights would have the least negative impact on the scientific operations at the observatory.

Jerry Carlyle, Director of Operations for the Indian Oasis Baboquivari Unified School District, was instrumental in ensuring that the lights installed at the new high school sports field did not brighten the relatively dark skies of Kitt Peak.

Once the lights were installed, we were treated to a demonstration of how the new lights looked as viewed from Kitt Peak. The results are impressive. Although the lighted field could clearly be seen from the mountain, the lights themselves were carefully aimed and well shielded, so that light is directed onto the ground, not into the sky. While we made no quantitative measurements, the impact of the new facility on observing will clearly be negligible.

We compliment Mr. Carlyle and the administration of the School District on their neighborly concern for the scientific productivity of Kitt Peak.



USGP
U.S. GEMINI PROGRAM

Gemini Telescopes Update

Bob Schommer

The Gemini telescopes continue to progress significantly in engineering and science domains. Among the highlights are:

- The first Gemini science results, the Galactic Center Demonstration Science observations, are available on the Web at *http://www.us-gemini.noao.edu/gallery/observing/release_ doc/manual.html* (see article on Page 3 and release details below).
- Chopping and guiding on Gemini North are now mostly fixed so that the 2000B QuickStart queue and Demonstration Science programs for OSCIR have been rescheduled for November.
- Gemini South remains ahead of schedule; first engineering light was achieved in September, and substantial progress has been made on the Pachón coating chamber and the primary and secondary support systems. Pointing and system tests on the sky resumed in late October.
- The USGP has provided additional resources for the start of early science operations on Gemini North. Bob Blum participated in the Galactic Center Demonstration Science effort in July/August, and Patrice Bouchet is scheduled to be in Hilo and Mauna Kea for the OSCIR Demonstration Science program in November. Stefanie Wachter was at Gemini North in October to assist with the Hokupa'a/QUIRC QuickStart programs (Blum also participated in several QuickStart programs in August), and Bouchet will work with the IGO for the OSCIR QuickStart programs in November/December.

There has been considerable effort on the US instrument program, which is detailed in the accompanying article by Taft Armandroff and Mark Trueblood.

We have also been very actively involved in the planning of the MCAO workshop, which was held October 23–25 at CfAO. The Gemini MCAO system is described in the article on the next page and at the Gemini Web site (*http://www.gemini.edu/sciops/instruments/adaptiveOptics/AOIndex.html)*. Steve Strom, Taft Armandroff, and Tod Lauer were members of the organizing committee and co-chairs of two of the discussion groups. We invited 15 prominent scientists from US institutions to participate in the science conference. Results of the workshop will appear in the next newsletter.

First Gemini Data Released

François Rigaut
International Gemini Observatory

The International Gemini Observatory announced the first release of Gemini Science Data from the Hokupa'a/QUIRC Demonstration Science program. In July and August 2000, 3.5 GigaBytes of data were obtained on the Galactic Center with the adaptive optics system Hokupa'a and the infrared camera QUIRC on the Gemini North Telescope. These data have been reduced and sixty images (250MB) are available on request. For information about the data set, see the Gemini Web site at *http://www.us-gemini.noao.edu/gallery/observing/release_doc/manual.html*. For any questions regarding the data set, or to get a copy on CD-ROM, please contact François Rigaut (*frigaut@gemini.edu*) at the International Gemini Observatory.

Proposed MCAO System for Gemini South

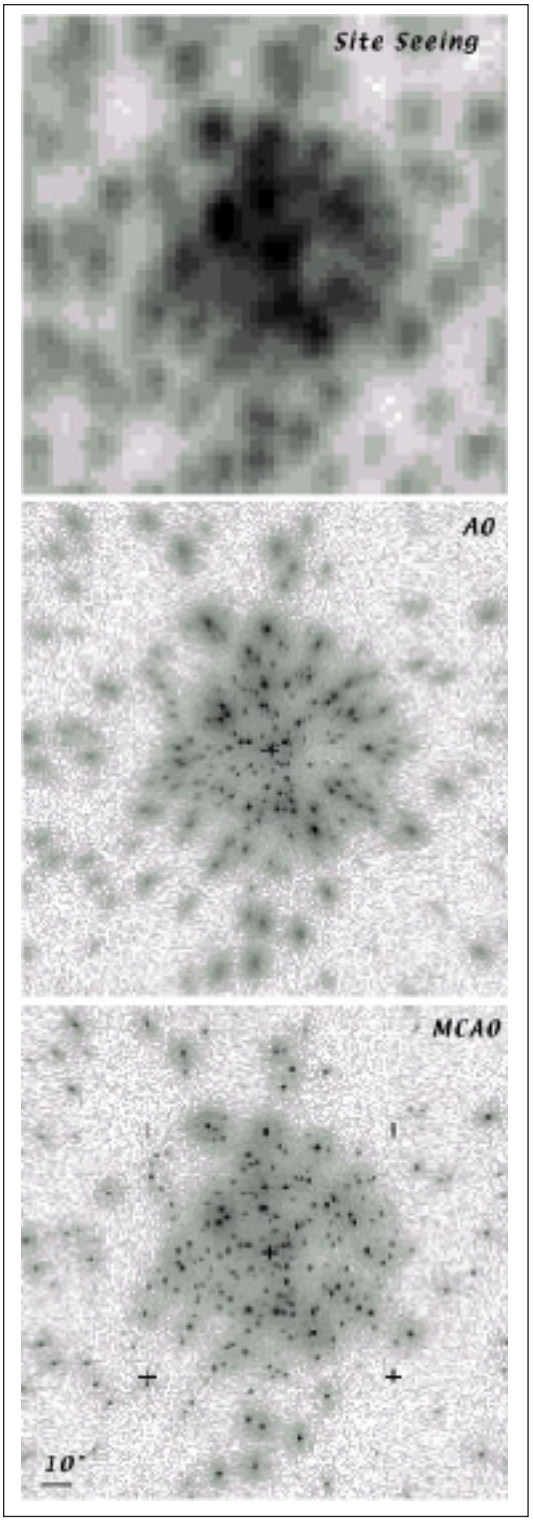
Bob Schommer

The Gemini Multi-Conjugate Adaptive Optics system (MCAO) is a facility proposed for Gemini South on Cerro Pachón. Its goal is to deliver diffraction-limited images, with a uniform image quality over a one arcminute field of view. It does so by using several deformable mirrors that are optically conjugated at different altitudes in the atmosphere and multiple wavefront sensors that use laser beacons as their guide sources. The intent is to measure and compensate for the turbulence-induced phase aberrations in three dimensions ("atmosphere tomography").

This new technique not only increases the compensated field of view by an order of magnitude or more and provides a uniform point spread function over this field, but it also solves for the cone effect, a consequence of the use of laser guide stars. In a classical AO laser system, the cone effect reduces the performance at short wavelengths on large telescopes.

In addition to the 10-fold gain in angular resolution, MCAO potentially pushes the detection limit by 1.7 magnitudes on unresolved objects with respect to seeing-limited images. The figures to the right show the effectiveness of MCAO.

An MCAO Science Workshop was held on 23–25 October at the Center for Adaptive Optics in Santa Cruz, California. The goal of this workshop was to explore the scientific opportunities for MCAO, quantify its advantages over current and planned conventional AO systems for a comprehensive set of science cases, and derive the MCAO instrument requirements. We will report on the results of this workshop in the next newsletter.



Compared with classical adaptive optics, the Gemini Multi-Conjugate Adaptive Optics system would produce a ten-fold gain in angular resolution, with an order of magnitude wider field, and 1.7 magnitude deeper detection limit. The figure shows simulations of 320 stars in a 2.5′ square field with 0.7″ natural seeing (top panel), the effect of a natural guide star AO system with one deformable mirror and one wavefront sensor (middle), and the Gemini MCAO system with two deformable mirrors, five wavefront sensors, natural guide stars. Stars have been magnified for clarity. Simulation courtesy of International Gemini Observatory.

US Gemini Instrumentation Program Update

Taft Armandroff and Mark Trueblood

The US Gemini Instrumentation Program has seen much activity over the past several months. Instrument design and construction are underway both in-house at NOAO and in the wider community. This article gives a status update as of mid-October.

NIRI is a 1-5 μm imager with three pixel scales, designed and built by Klaus Hodapp and his team at the University of Hawaii. NIRI passed its Pre-Ship Acceptance Test in Honolulu in May. NIRI was then shipped to the Gemini North Base Facility in Hilo and set up in the instrument lab. A team of controller and detector experts from NOAO traveled to Hilo in June and successfully resolved problems with ringing in the NOAO-supplied NIRI array controller. NIRI was tested on Gemini North in August and September, and it imaged successfully. Delivery of the 1 frame per second upgrade to the NIRI controller by NOAO is planned for later this fall. On-telescope final acceptance testing of NIRI is also planned for later this fall.

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. The majority of the T-ReCS optics have been received and inspected. The instrument's 320 × 240 Si:As IBC array detector has also been received. Mechanical parts fabrication is nearing completion; mechanical assembly, the electronics, and software development are well along. In particular, the dewar and the cold mechanisms are nearly complete. The mechanisms have been assembled and cold tested. The dewar has been vacuum tested and is undergoing its first cold test as of mid-October.

GNIRS, the Gemini Near-Infrared Spectrograph, is a long-slit spectrograph for the Gemini North telescope that will operate from 1 to 5 μm 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 Neil Gaughan (Project Manager) and Jay Elias (Project Scientist). GNIRS held a Pre-Fabrication Review on May 11 and 12. The review committee examined the GNIRS team's progress on mechanical design, mechanical analysis, thermal analysis, software design, and prototyping efforts in the areas of cold motors, mechanism drives, and lens mounts. The review committee delivered a positive report. The project is now completing the detailed design while initiating fabrication of those sub-assemblies for which design is complete. A major milestone was the initiation of fabrication of the optical benches in September. The critical optics have all been ordered, and somewhat over one-third have been delivered and accepted.

Phoenix is a high-resolution near-infrared spectrometer that has been in productive scientific use on the KPNO 4-m and 2.1-m telescopes.

The T-ReCS dewar and cryocooler during its first cold test at the Department of Astronomy, University of Florida. The T-ReCS mechanical engineer, Jeff Julian, provides a perspective of scale.

Phoenix yields spectra with resolution up to R=70,000 in the wavelength range 1 to 5 μm. Phoenix will be shared equally between Gemini South and CTIO/SOAR. An agreement has been signed between NOAO/USGP and IGP regarding the modification of Phoenix for Gemini and how the instrument will be supported. Phoenix will be offered as a Visitor Instrument on Gemini South, beginning with the inception of scientific use of Gemini South. An IGP-provided ALADDIN InSb array will be installed in Phoenix; the performance of this array is expected to yield a significant improvement in Phoenix's sensitivity. The mechanical design of the frame that will couple Phoenix to the Gemini Instrument Support Structure is underway.

continued

Gemini Instrumentation continued

FLAMINGOS 2 is a concept for a near-infrared multi-object imaging spectrograph for the Gemini South telescope, developed by Richard Elston and his team at the University of Florida. The FLAMINGOS 2 concept builds on the heritage of the original FLAMINGOS imaging spectrograph. (The original FLAMINGOS will be offered as a visitor instrument on Gemini.) FLAMINGOS 2 has been developed in response to the "Gap Filler" opportunity for Gemini South, wherein the relatively rapid deployment of a near-infrared spectroscopy and imaging capability was sought. A conceptual design review of FLAMINGOS 2 was held on April 28. The Gemini review committee judged FLAMINGOS 2 to be suitable for Gemini's needs and aspirations. IGP, USGP, and Florida have begun the process of contracting for the detailed design and fabrication of FLAMINGOS 2.

Gemini Proposals for 2001A

Caty Pilachowski

NOAO received 77 proposals for time on the Gemini North telescope for the 2001A semester. These 77 proposals requested a total of 122 nights. Since only 34 nights are expected to be available for allocation to US programs, this represents an over-subscription factor of 3.6. The shortest request is for an hour of time, while the longest requests ask for four nights. The average amount of time requested is 1.6 nights.

The proposals were well balanced among the three instruments: 21 requests for Hokupa'a, 28 requests for NIRI, and 31 requests for OSCIR. Ten investigators took advantage of the US "mini-queue" opportunity for observations with Hokupa'a and OSCIR for programs needing a half night or less. Mini-queue observations will be taken by USGP and NOAO staff.

Investigators can expect to hear from us in mid-December about the outcome of their proposals, after the International Gemini TAC meets and the telescope schedule is finalized.

GMOS Coming for 2001B

The first Gemini Multi-Object Spectrograph (GMOS) should be available for proposals for the 2001B semester. Delivery is expected in a few months. GMOS provides optical spectroscopy and imaging over a 5.5 arcmin field of view. The GMOS will also be equipped with an Integral Field Unit (IFU), making it possible to obtain spectra simultaneously of an area of about 50 square arcsec with a sampling of 0.2 arcsec. The GMOSs are under construction as a collaboration between the UK and Canada.

How to Contact the US Gemini Program

The Web	http://www.noao.edu/usgp
Questions	gemini@noao.edu
E-mail a Staff Member	first initial+last name@noao.edu

NOAO Workshop on Hokupa'a Image Analysis and Data Reduction

Tod R. Lauer

NOAO will be hosting a workshop on Hokupa'a image analysis and data reduction February 26–27, 2001, at NOAO–Tucson headquarters. The emphasis will be strongly oriented toward understanding what is required to produce leading-edge science returns from successful observations. Investigators with Hokupa'a data or observational experience are especially encouraged to attend. We also invite those with experience on similar instruments or who are interested in the general problems of Adaptive Optics image analysis. We do hope to keep the workshop small and informal enough, however, such that detailed discussions as well as more formal presentations can occur.

As information about the workshop becomes available, it will be posted on the Web at *http://www.noao.edu/usgp/ao_workshop.html* .

At this time we would enjoy hearing if you are interested in attending and if you would like to give any sort of talk or presentation at the workshop. Please contact Tod Lauer (*tlauer@noao.edu*).

NSO National Solar Observatory

From the NSO Director's Office

Steve Keil

Working with a broad segment of the solar community, NSO has focused its efforts this past year on the Advanced Technology Solar Telescope (ATST) design and development (D&D) phase proposal. The ATST is currently envisioned as a 4-meter, off-axis, reflecting telescope equipped with adaptive optics (AO), active thermal control, and low-scattered-light optics. It will be designed to work from the near UV (~300 nm) to 35 μm. A versatile set of reconfigurable polarization optics, filters, and spectrographs will be developed as focal plane instrumentation and will permit spectroscopy, narrow-band imaging, and polarimetry in the visible, near-IR, and thermal-IR.

The first goals of the development and design phase will include establishing telescope requirements based on science objectives, site survey and selection, fleshing out the telescope concept, and technical trade studies for critical components (e.g., primary mirror, heat rejection and cooling systems, and adaptive optics). Following a successful concept design review, a preliminary design will be developed and reviewed. The last phases of the D&D effort will be to develop the final design for the telescope and instrumentation. One of the major objectives of the D&D phase is to provide a well-costed proposal for ATST construction and operation. There will be substantial emphasis on selecting, designing, and costing the instrumentation needed to meet the science objectives. You can obtain additional information at the ATST Web site at *http://www.sunspot.noao.edu/ATST*. If you would like to read the proposal for the telescope, send an e-mail to *nso@noao.edu*.

The joint NSO, New Jersey Institute of Technology/Big Bear Solar Observatory (NJIT/BBSO), Kiepenheuer Institute for Solar Physics (KIS), and USAF Research Laboratory proposal to develop high-order adaptive optics systems for the Dunn Solar Telescope (DST) on Sacramento Peak, the 64-cm Big Bear Solar Observatory telescope, and the planned 1.5-m GREGOR telescope on Tenerife has been funded by the NSF/MRI (Major Research Instrumentation) program. The proposal includes cost sharing of about $1M by NJIT, NSO, and KIS. Recruitment of staff and design development for the high-order systems have begun. The program will result in AO systems for each of the telescopes with approximately 80 degrees of freedom. It will also serve as proof-of-concept for a scalable AO design for the much larger ATST. A low-order (24 degrees of freedom) system is currently available to support high-resolution observations at the DST.

NSO and the High Altitude Observatory (HAO) have begun a team effort to upgrade the Advanced Stokes Polarimeter (ASP) to match the resolution limit of a dedicated AO system.

The first round of public outreach exhibits at the NSO Visitor Center in Sunspot, NM, will soon be complete. The exhibits cover topics ranging from general galactic and extra-galactic astrophysics to the role of the Sun in sustaining life on Earth. Properties of light, the solar system, the Sun and stars, and telescopes are discussed. Most of the demonstrations are hands-on and have proven to be very popular with school groups and the public. There will soon be a light feed for a live solar image and a solar spectrum inside the center. NSO is now making movies of the full-disk Hα patrol available in near real-time at its Web site (*http://www.sunspot.noao.edu/)*. The

continued

Director's Office continued

exhibits represent a joint effort of NSO, Apache Point Observatory, and the US Forest Service. The effort is led by Ray Smartt.

Programmatic separation of NSO from NOAO is reinforced in NSO's Provisional Program Plan for FY 2001. The plan, available at *http://www.nso.noao.edu*, outlines NSO's strategy for completing SOLIS and GONG^{++}, for continuing telescope operations, and for starting on the ATST program. ATST site testing instrumentation is being developed using NSO base funding and should be ready for deployment this coming spring.

We're pleased to announce the hiring of Brady Jones for our computer system administrator position at Sacramento Peak. Jones will be responsible for computing and network system operations and maintenance at the Peak. He and his wife come to us from St. Louis, where Brady has worked for the Air Force and Citibank Mortgage. Brady's SUN Solaris and Windows NT experience should serve him well at NSO.

Sankarasubramanian Kasiviwanathan (Sankar) has recently joined the Sac Peak staff as a postdoctoral research associate. Sankar was a graduate summer research assistant at NSO in 1999 and received his Ph.D. this year from the Indian Institute of Astrophysics in Bangalore. He has a sound background in solar instrumentation and experience with polarimetry in particular. Sankar will work with Thomas Rimmele and Michael Sigwarth on reducing spectro-polarimetric data recorded recently at the DST using the adaptive optics system. He will also participate in the development, testing, and scientific use of a new, high-resolution polarimeter that is currently under development at NSO, in collaboration with HAO.

We also welcome to the NSO–Tucson staff Elena Malanushenko as a KPVT observer and data analyst. Elena has worked as an observer and staff member at the Crimean Astrophysical Observatory and is completing her doctoral dissertation on observations of solar activity in He I 1083 nm. In addition to her observing and data reduction duties, she will continue her research and collaborate with Harry Jones on new studies of the 1083 nm line.

New NSO Users' Committee

Steve Keil

The membership of the NSO Users' Committee has changed with the start of the new fiscal year. Members of the new committee are:

Thomas Ayres, Chair (Colorado, CASA)
Thomas Berger (Lockheed Martin, Palo Alto)
Timothy Brown (High Altitude Observatory/NCAR)
Philip Goode (New Jersey Institute of Technology/Big Bear Solar Observatory)
Ernest Hildner (Space Environment Center, NOAA)
Donald Jennings (NASA Goddard Space Flight Center)
Kimberly D. Leka (Colorado Research Associates)
Douglas Rabin (NASA Goddard Space Flight Center)
Edward Seykora (East Carolina)
Gregory Ginet, *ex-officio* (Air Force Research Laboratory/VSBS)
Daniel Weedman, *ex-officio* (National Science Foundation)

Thomas Duvall (NASA/GSFC at Stanford), Richard Shine (Lockheed Martin), and Rita Sagalyn (Air Force Research Labs/VSBS) have completed their terms on the committee. We wish to thank them for their contributions as members during the past three years.

NSO 20th Annual International Summer Workshop

Michael Sigwarth

The 20th NSO–Sac Peak Summer Workshop on "Advanced Solar Polarimetry—Theory, Observation, and Instrumentation" was held 11–15 September 2000 at Sunspot, NM. There were 80 participants, more than half of whom were from overseas—China, Finland, France, Germany, India, Japan, Netherlands, Russia, Saudi Arabia, Spain, and Switzerland.

Solar activity and variability are driven and controlled by magnetic fields. Polarimetry—analysis of the polarization state of light from the Sun induced by the presence of magnetic fields in the solar atmosphere—is one of the most important tools for obtaining information on the magneto-hydrodynamic processes on the Sun.

The previous NSO summer workshop on solar polarimetry was held ten years ago. Since then, major progress has been made and new research fields in this area have opened. Theoretical models and "numerical experiments" have become important tools for understanding and predicting fundamental physical processes involving solar magnetic fields. In the past, most polarimetric investigations were based on the Zeeman effect. Atomic polarization and the Hanle effect have since become important tools for investigating very weak magnetic fields on the solar surface. The goal of this year's workshop was to present an overview of new research areas and the latest results and developments, including instrumentation, and to develop a perspective on solar polarimetry for the next decade.

Michael Knölker (HAO) opened the workshop with provocative comments, encouraging theoreticians, observers, and instrumentalists to go beyond the boundaries that are often based on traditions descended from the "solar grandfathers." High-resolution polarimetry, for example, should no longer focus on the photon mean free path, but on the MHD scale models that are predicted to be significant for the formation of flux tubes as small as a few kilometers.

The solar community acknowledges that the time is ripe for new, sophisticated instrumentation like the Advanced Technology Solar Telescope (ATST), with a minimum 4-m aperture and fully corrected by a high-order AO system, which is being pursued by NSO and its partners. Other key issues are the need for three-dimensional numerical MHD codes, the need to measure the vector magnetic field in the corona which may well be a potential source of surprises, and the need for extremely high spatial and spectral resolution in polarimetric measurements.

20th NSO Summer Workshop participants in front of the Sunspot Astronomy and Visitor Center. (Photo by T. Brown, NSO)

continued

NSO Workshop continued

The workshop was thematically organized in the following sessions: New Instrumentation, Weak Polarization and Coronal Magnetic Fields, IR Polarimetry and the Physics of Active Regions, MHD Simulations, High-Resolution Polarimetry and the Physics of Flux Tubes, and the Analysis of Stokes Profiles.

A. Van Ballegooijen (Harvard) concluded the meeting with a summary of the scientific discussions that took place during the four-day workshop. The quality of contributions during the week was *perhaps* most aptly described by Rob Rutten (Utrecht): "There was no boring talk so that I could take a nap."

There were several social events during the workshop, including a classic Sac Peak barbeque; an evening slide show by Bill Livingston (NSO), Cao Wenda (Beijing), and Yuanyong Deng (Beijing) of their recent "seeing" tour of the Himalayas; and an evening picnic on the gypsum dunes at White Sands National Monument.

This successfully stimulating week of scientific exchange was made possible by the tireless efforts of Rebecca Coleman and members of the local organizing committee, as well as the NSO–SP staff who kept everything running smoothly from behind the scenes. The workshop was sponsored by NSO, the National Science Foundation, National Aeronautics and Space Administration, and the US Air Force Office of Scientific Research through its European and Asian offices. The workshop proceedings will be edited by M. Sigwarth and published in the ASP Conference Series. A more extensive version of this article, with details on the session discussions, can be found at *http://www.sunspot.noao.edu/INFO/MISC/WORKSHOPS/index.html*.

Workshop participants "on the beach" at White Sands National Monument.

SOLIS

Jack Harvey

The SOLIS project continues to make progress toward initial operational capability in 2001. Major milestones since the last newsletter include the following:

- Power has been applied to the drive motors of the mount, which is now temporarily located at the GONG prototype site a few kilometers from the Tucson offices.
- Uncertain delivery of custom CCD cameras for the highest priority instrument, the Vector Spectromagnetograph (VSM), is a matter of serious concern. Several options to acquire usable cameras are being explored. The positive aspects of this situation are that the vendor demonstrated a fully functioning front-side illuminated CCD that exceeded performance requirements, and that construction of the first camera housing and its contents appears to be making good progress.
- The VSM entrance window was mounted in its cell and then tested for birefringence and wavefront distortion; it met optical requirements. Completion of the silicon secondary mirror of the VSM telescope was delayed by a problem with pits and scratches in final polishing, which was solved by the vendor. The main housing of the VSM is being machined at a local shop and is on schedule. Numerous VSM mechanisms are being exercised under software control, and the cooling system is an active area of work. A commercial data acquisition board has been programmed to receive the huge flow of data from the VSM.
- The Integrated Sunlight Spectrometer was little used because of the summer monsoon and also because the heliostat light feed was not working correctly. Both of these impediments have been removed and observations intended to cross-calibrate with existing monitoring programs are planned for the near future.
- The objective lens of the Full Disk Patrol (FDP) has been assembled, tested, and mounted. The 1083 nm birefringent filter is being modified for use in the FDP. Design of the tunable filter covering 390–670 nm is complete, as is the design of all of the mechanical portions of the FDP. Many components are now being built. A shutter system, made available by the kind cooperation of the solar group at Lockheed Martin, has been duplicated and successfully tested. Delivery of the CCD cameras for the FDP is expected momentarily, and some custom optics are still on order.
- The software group is testing the flow of data from the VSM through to quick-look reduced magnetograms. This is being done using a simulated full disk magnetogram with polarized spectral line profiles at every arcsecond of the disk. A problem with implementing the Storage Area Network (SAN) that stores data was identified and is being resolved with the vendor of the SAN.

Three REU summer students completed their work that supported SOLIS activities. Two engineers from China visited the SOLIS project and assisted with filter design and software issues. Prof. T. Sakurai, Director of the Solar Division of the National Astronomical Observatory of Japan, is visiting NSO and has proposed a new method for resolving the azimuth ambiguity that affects transverse magnetic field measurements. Contacts have been made with experts in Stokes profile inversions at HAO to foster cooperation in using their community codes to reduce SOLIS data.

McMath-Pierce East Auxiliary Telescope Upgrade Nears Completion

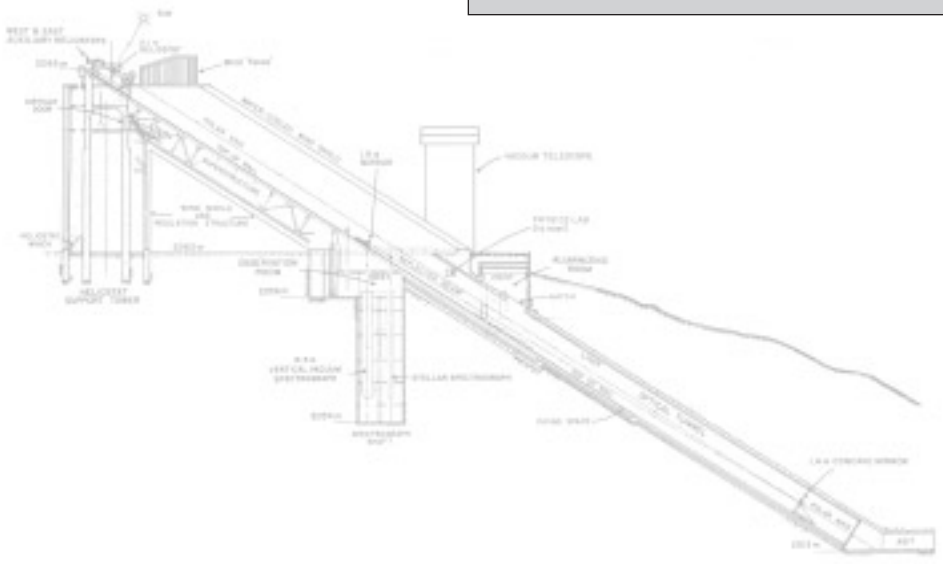
Claude Plymate, Teresa Bippert-Plymate, Christoph Keller, and Andrew Potter

The McMath-Pierce east auxiliary telescope (McMPE) upgrade is nearing completion. All of the major refits and upgrades are completed. The final details are now being addressed. The original right ascension (RA) bearing has been replaced and a second bearing was added to help support the polar axis. All new digital drives and encoders have been installed in both the RA and declination axes. Gone is the old weight-dangling-from-the-RA cable wrap preload. In its place is a new chain-driven electrical preload. The telescope is now fully computer controlled. The #2 (imaging) mirror focus and collimation adjustments have been motorized with encoders installed for easy, in-the-observing-room collimation and computer-controlled slew-to-focus. There is also a remote control console in the FTS room. This upgrade was funded by a NASA grant for a proposed near-earth object (NEO) follow-up study and was carried out by DFM Engineering, Inc., in Longmont, Colorado.

Funds have just been received from NASA for a prototype camera system. This CCD camera will be used with the McMPE for the proposed near-earth object astrometry project. The objective of this study will be to refine the orbits of newly discovered objects, and improve and maintain the orbits of known near-earth objects.

How to Contact the National Solar Observatory

The Web	http://www.nso.noao.edu
Questions	nso@noao.edu
E-mail a Staff Member	first initial+last name@noao.edu



NSO Observing Proposals

Dick Altrock

The deadline for submitting observing proposals to the National Solar Observatory is 15 February 2001 for the second quarter of 2001. Forms and information are available from the NSO Telescope Allocation Committee at P.O. Box 62, Sunspot, NM 88349 for Sacramento Peak facilities (*sp@sunspot.noao.edu*) or P.O. Box 26732, Tucson, AZ 85726 for Kitt Peak facilities (*nso@noao.edu*). A TeX or PostScript template and instruction sheet can be e-mailed at your request; obtained by anonymous FTP from *ftp.sunspot.noao.edu* (cd *observing_templates*) or *ftp.noao.edu* (cd *nso/nsofor*ms); or downloaded from the WWW at *http://www.nso.noao.edu/*. A Windows-based observing-request form is also available at the WWW site. Users' Manuals are available at *http://www.sunspot.noao.edu/telescopes.html* for the SP facilities and *http://www.nso.noao.edu/nsokp/nsokp.html* for the KP facilities.

NSO Telescope/Instrument Combinations

Dunn Solar Telescope (SP):

Echelle Spectrograph
Universal Spectrograph
Horizontal Spectrograph
Universal Birefringent Filter
Fabry-Perot Filter System
Advanced Stokes Polarimeter
Slit-Jaw Camera System
Correlation Tracker
Branch Feed Camera System
Horizontal and Vertical Optical Benches for visitor equipment
Optical Test Room

Evans Solar Facility (SP):

40-cm Coronagraphs (2)
30-cm Coelostat
40-cm Telescope
Littrow Spectrograph
Universal Spectrograph
Spectroheliograph
Coronal Photometer
Dual Camera System

Razdow (KP):

Hα patrol instrument

Hilltop Dome Facility (SP):

Hα Flare Monitor
White-Light Telescope
20-cm Full-Limb Coronagraph
White-Light Flare-Patrol Telescope (Mk II)
Sunspot Telescope
Fabry-Perot Etalon Vector Magnetograph
Mirror-Objective Coronagraph (5 cm)
Mirror-Objective Coronagraph (15 cm)

McMath-Pierce Solar Telescope Facility (KP):

160-cm Main Unobstructed Telescope
76-cm East Auxiliary Telescope
76-cm West Auxiliary Telescope
Vertical Spectrograph: IR and visible gratings
Infrared Imager
Near Infrared Magnetograph
CCD cameras
1-m Fourier Transform Spectrometer
3 semi-permanent observing stations for visitor equipment

Vacuum Telescope (KP):

Spectromagnetograph
1083-nm Video Filtergraph

GONG

Global Oscillation Network Group

GONG

John Leibacher

The Global Oscillation Network Group (GONG) Project is a community-based activity to operate 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 are available to any qualified investigator. Information on the status of the project and the scientific investigations, as well as access to the data, are available on our WWW server (http://www.gong.noao.edu).

The Sun continues to develop the most spectacular magnetic active regions of the solar cycle, and the GONG+ team is working to put the finishing touches on the new, high-spatial resolution GONG+ camera system. Solar maximum seems to be on our side, and in spite of some delays, it looks as though the new system will be on-line in time to capture much of the excitement. The project held two reviews of GONG+, an "End-to-End Functional Test and Review" and a "DMAC Readiness Review," August 23 and 24, respectively. During these reviews, community members provided a careful scrutiny of the system's performance and concurred with our plans for deployment.

Following a "Deployment Readiness Review," the first GONG+ system will be shipped to Big Bear after the New Year. In addition to installing the first new system, we will demonstrate there that we can continue the GONG Classic low- to medium-ℓ p-mode program using the GONG+ system, and start merging of the GONG+ high-resolution data. Deployment to the other five sites will follow the Big Bear installation; we should complete the effort by the end of May.

GONG site representatives enjoying a beautiful sunset at the El Teide instrument.

GONG 2000 was held in conjunction with SOHO 10 in Tenerife, Spain, 2–6 October, hosted by the Instituto Astrofísica de Canarias and organized by Peré Pallé. The 140 attendees enjoyed the hospitality of the municipalities of Santa Cruz and La Laguna, and had an opportunity to visit the GONG site on El Teide. The workshop focused on the results from continued GONG operations and the helioseismic experiments aboard SOHO (MDI/SOI, GOLF, and VIRGO). Results from other ground-based multi-

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GONG continued

site projects (BiSON, IRIS, ECHO, and TON) were also included. All of the helioseismic projects have contributed a wealth of data of unprecedented quality from which new insights on the structure and dynamics of the Sun continue to be inferred. Representatives from five of the sites attended, providing a special opportunity for us to discuss site issues together.

The DMAC Users Committee and the Project's Scientific Advisory Committee also met and had very productive meetings. The GONG+ deployment and possible strawman GONG++ scenarios dominated the discussions, resulting in several ideas for helping to move the efforts forward.

Operations

Despite some lingering problems and a novel malady, the GONG network of telescopes performed well during the third quarter of 2000. Again no preventive maintenance (PM) trips were made during this time, which reduces the hours of network downtime, but the absence of PM is beginning to take its toll and causing system deficiencies to accumulate and making the telescopes more susceptible to failure.

Specifically, the lingering deficiency is the weak batteries in the uninterruptible power supplies (UPS). The batteries are so weak in some cases that they will not support the system during power outages on the order of minutes. This has been particularly troublesome at the Udaipur site where the utility power is problematic during the monsoon season. Since usable spans of data are sparse during the monsoon anyway, the frequent power dropouts resulted in a decision to shut the site down. At least 11.5 days of downtime resulted during the third quarter, and more downtime may still be recorded as tapes from this period arrive. The Udaipur site staff are waiting for delivery of the batteries and will install them in the near future, which should improve the situation considerably. Other sites are showing symptoms of UPS failure, and new batteries are ready for installation once the PM teams arrive.

Winter weather has been the source of downtime at CTIO. Occasionally water will get between moving parts of the turret and then freeze during the night. When the turret tries to locate the Sun in the morning, the motors draw more current than the breaker is meant to carry and the system shuts down until someone can visit the site and restart data acquisition. Nearly five days have been lost due to this problem. Fortunately, this happens when the weather is typically poor and little data can be used anyway.

A problem at the CTIO site, symptoms of which had been seen previously at both CTIO and Mauna Loa, has thus far eluded a solution. It involves a runaway rotation of the calibration wheel when it is commanded to move just prior to the acquisition of a daily dark image. Instead of finding its proper location, the wheel rotates to the physical stop and will not respond to commands to reposition it. The problem has been fixed previously by replacing the resolver card, but on one occasion, changing the card made no improvement. Other cards involved in controlling the position of the wheel were replaced, but with similar results. The problem has been sidestepped by using a spare position in the wheel and modifying the commands to move to this port to get the dark image. This has proven to be an acceptable solution until troubleshooting can be done on site. There have been about 22 hours during which the wheel has been lodged at the stop and prevented data from being acquired.

We had hoped to complete the GONG+ deployment during 2000, but as this is not the case, there is some concern about the ability of the old data computers to handle the year change to 2001. A short test was performed at the Teide site, during a brief visit at the end of September, which caused about 1.5 hours of downtime. Results of the test are forthcoming.

Although in general, problems with Exabyte drives are somewhat less frequent than in the past, this generality may not be the opinion of the Big Bear and Teide staff. These sites had more than their share of Exabyte difficulties this quarter, and

continued

GONG continued

we owe the staff there considerable gratitude for the efforts spent dealing with the problems. The images lost because of Exabyte failures and repairs are difficult to tabulate, but are expected to amount to a few days.

Data Management and Analysis

During the past quarter, the DMAC produced month-long (36-day) velocity, time series, and power spectra for GONG months 48 and 49 (ending March 4, 2000), with respective fill factors of 0.79 and 0.91. Tables of mode frequencies were computed from the power spectra using the three-month-long time series centered at GONG months 46 and 47.

In addition to routine data reduction, the DMAC is actively involved in upgrading systems and applications for the reduction of GONG+ data. To assist in these efforts, an external panel review of the GONG+ DMAC upgrade plan was held on August 24, 2000. The review committee was made up of DMAC User Committee members Jesper Schou, Philip Stark, and Sylvain Korzennik, and SOLIS Data Scientist Carl Henney. The committee offered a number of very helpful suggestions that the Project will implement.

In anticipation of the arrival of GONG+ data, the DMAC began a long overdue replacement of a few of the pipeline workhorses. Incremental changes in the equipment will set the stage for GONG++.

Data Algorithm Developments (and Some Science)

We now have a new version of *peakfind*, implemented in C. This version replicates the algorithm used in the IRAF/SPP version, but is now portable to other platforms. Comparisons with the existing code show no significant differences in either the estimated mode parameters or the execution time.

We can now use the new *peakfind* to develop alternative algorithms to improve the accuracy and precision of the measured mode parameters. More accurate reduction algorithms are crucial to the continuing progress of helioseismology, as detailed comparisons indicate that the dominant source of differences in the inferred conditions inside the Sun as observed by GONG or SOI is a result of the processing of the data and not the data themselves. Some of the modifications planned for *peakfind* include the incorporation of line asymmetries, *m*-leakage, and ridge fitting.

Along these lines, Caroline Barban has joined the project to investigate the possibility of improving the parameter estimates by simultaneously fitting the spectrum obtained in velocity and intensity. A detailed comparison of the spectra, particularly the phase and coherence between the observables, should also shed more light on the physics of mode excitation and damping.

The advent of the new *peakfind* has already produced a new result in helioseismology. During the tests, it was noticed that several multiplets in the 3.3-mHz band were failing to produce converged sets of splitting coefficients. This result was surprising, since this frequency band is a region of very high signal-to-noise, free of severe leakage problems, and has previously not caused fitting problems. Closer inspection revealed the presence of sharp hook-shaped features in the ridges for the nearly sectoral modes, where m is approximately equal to ℓ. These "hooks" are the consequence of the equatorward migration of solar activity, the high correlation between the even splitting coefficients and the surface magnetic field, and the concentration of the sectoral modes near the solar equator. Thus, near solar maximum, it is essential that the determination of the frequency splittings be extended to sufficiently high order (at least 16) to adequately resolve this feature.

A new method for determining the frequency splitting has been developed. The new procedure is superior to the "official" one in that it produces a higher number of more reliable estimates and more accurately represents the splittings with higher order terms. In the near future, splittings from the new method will become the official data product for community use.

continued

GONG continued

On a somewhat different note, readers may recall that GONG+ will produce a magnetogram at each site every minute. These data should be useful for studies of magnetic field evolution on time scales of 5 minutes and for space-weather studies. In fact, current GONG magnetograms are already available in near real-time for anyone who needs rapid information on the large-scale surface magnetic field. These images are copied to the GONG anonymous FTP area (*ftp://argo.tuc.noao.edu/pub/gong/magnetograms/*) shortly after they are obtained at the sites. The cadence is one per hour at a given site, staggered around the clock so that potentially a magnetogram is available every 20 minutes from the network. These images are already being used for space-weather predictions at SSL/Berkeley (see *http://sprg.ssl.berkeley.edu/~yanli/GONGmags.html*).

GONG+ Camera Development

We are swatting the last few bugs in the camera and high-speed electronics. Software developed to correct for the difficulties will provide enhanced error tolerance in the field. The SMD camera itself operated without flaw during the period that we investigated the fault.

A series of one-week tests of the new instrument components, as integrated systems, has now been concluded at the Tucson GONG engineering site. These tests will be followed by a multi-week reliability demonstration, which will complete our acceptance testing regime. The upgrade kits will soon be prepared for shipment, prior to a "Deployment Readiness Review."

Currently, it is expected that our first deployment will be to the Big Bear observing facility after the New Year. Not only will we verify our installation procedures, but we will also compare the data with that collected at the Tucson site in order to certify proper operation. Deployments to the other sites will follow, and with an estimated three weeks installation at each site, GONG+ should be a reality by the end of May 2001 and local helioseismic data should start becoming available shortly thereafter.

How to Contact GONG

The Web	http://www.gong.noao.edu
Questions	gong@noao.edu
E-mail a Staff Member	first initial+last name@noao.edu

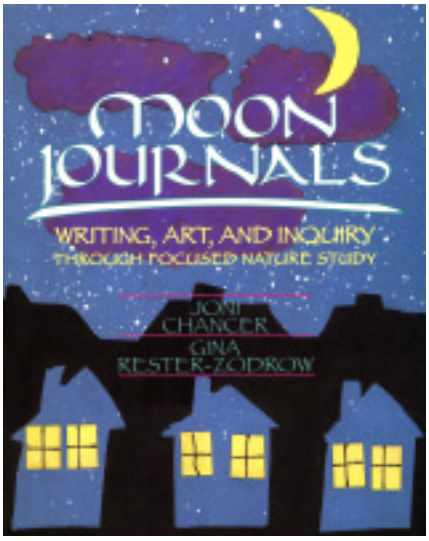
Project ASTRO Workshop Number Five

Ginny Beal

Project ASTRO is a program that pairs professional and amateur astronomers with educators throughout the country to enhance astronomy education and increase students' interest in science. Led by NOAO, the Project ASTRO–Tucson site hosted its fifth annual workshop October 13–14 at the Kitt Peak Visitor Center and the NOAO downtown offices. This year's workshop was partially funded by a NASA IDEAS grant titled "Did You See the Moon Last Night?—Scientific Inquiry through Writing, Art, and Observation."

Twenty-two teachers were paired with seventeen astronomers to form partnerships and teams. Most participants were from the Tucson area, but some traveled from the Tohono O'odham Nation, Casa Grande, Safford, Phoenix, and Russellville, Arkansas. Workshop presenters included authors Joni Chancer and Gina Rester-Zodrow (*Moon Journals: Writing, Art, and Inquiry through Focused Nature Study*), Dr. Robert Strom from the UA Lunar and Planetary Lab, Tohono O'odham Storyteller Daniel Lopez, and local educators Larry Dunlap, Michael Crawley, and Renee Crawley.

The Friday evening session at the Kitt Peak Visitor Center 16" telescope was hosted by Adam Block and Richard Barchfield, observers with the Nightly Observing Program (NOP). Unlike typical astronomer visitors, Project ASTRO participants were delighted by the rising full moon, and awed by observations they could make using telescopes, binoculars, and the naked eye. The Visitor Center NOP observers and Project ASTRO astronomers served as knowledgeable resources, and the exchange of astronomy facts was beneficial to all.



The goals of this year's Project ASTRO–Tucson workshop are to extend concepts from the book *Moon Journals: Writing, Art, and Inquiry through Focused Nature Study* into the area of authentic scientific inquiry and to have teachers work in collaboration with trained astronomers to assist with student investigations of the Moon.

Project ASTRO National Network

In November 2000, Project ASTRO–Tucson will complete its term as first Project ASTRO National Network chair to the group of eleven expansion sites around the country. As members of the National Network Publicity Committee, Tucson staff will produce brochures and an exhibit to promote the group at the AAS/AAPT meeting in San Diego, January 7–11, 2001. Several Project ASTRO sites, including Tucson, will present poster papers at the meeting as well.

Public Presentation of NOAO Images and Science

Doug Isbell and Mark Newhouse

Images

NOAO maintains a library of astronomical images obtained with NOAO facilities. New additions to the NOAO Image Gallery, shown here, are available for downloading over the WWW at a variety of resolutions from the NOAO Image Gallery: *http://www.noao.edu/image-gallery/*.

- High resolution versions of the spectrum of the Sun and of Arcturus have been added to the gallery. Nigel Sharp created the images from digital atlases observed with the Fourier Transform Spectrometer at the McMath-Pierce Solar Facility on Kitt Peak. An educational poster, which uses these spectra to explain spectroscopy and how it is used in astronomy, will be available at the NOAO exhibit at the January AAS meeting in San Diego.

- An image of our Moon, superimposed at the correct scale on an image of the Andromeda Galaxy (M31), demonstrates the impressive size of M31 in the night sky.

- The NSF-funded Research Experiences for Undergraduates (REU) program at KPNO produced an image of NGC 4676, which is also known as The Mice because of the long tails of stars caused by the interaction of the two galaxies that make up this system.

- The star-forming region NGC 7129 was also imaged during the REU 2000 program at Kitt Peak National Observatory. Herbig Haro 103 can be seen in the image as well.

Four new images have been added to the NOAO Image Library. Clockwise from top: NGC 4676, The Mice; M31 and the Moon; McMath-Pierce FTS Colorized Spectrum; NGC 7129.

Web Pages

Work has begun on a redesign of the NOAO Web site. A preview of the new look can be seen by visiting the US Gemini Program pages at *http://www.noao.edu/usgp/*.

The addition of Doug Isbell (see below) as NOAO's science writer helps our efforts to make the science facilitated by NOAO more accessible to the public.

Building on the foundation laid by Research Experiences for Teachers (RET) participants Cindy Weehler and Stan Hart, a number of Current Science articles, written at a public level, have been posted to the web site at *http://www.noao.edu/outreach/current/*. The most recent articles include links to additional information and, in some cases, links to classroom resources for teachers.

Media

Doug Isbell has joined NOAO as its new Public Information Officer and is responsible for media activities and supporting materials, and related functions like public inquiries. Doug will also be doing some general science writing for the NOAO Web pages and other outlets. He comes to Tucson from NASA Headquarters in Washington, where he managed diverse public affairs campaigns for planetary missions including the Mars Pathfinder and Galileo, along with international news events involving the Hubble Space Telescope, Compton Gamma Ray

continued

Public Presentation continued

Observatory, and many others. Please let him know well in advance of publication or posting when you have interesting science results, exciting imagery, or other news that you would like people to hear about. Contact Doug at (520) 318-8214 or *disbell@noao.edu*.

Gemini North released its first scientific data on October 16—announced via a news release and an electronic image of the Galactic Center—which highlighted a bow-shock produced by a star as it plows through a gas cloud located just three light-years from the core. (See the Highlights section of this issue.) In the first few days, the release was reported by several news organizations, including the BBC, MSNBC.com, *Florida Today's* Space Today home page, space.com, and astronomy.com, and was featured as the "Astronomy Picture of the Day." The event received strong local media coverage in Hawaii and on TV outlets such as the BBC and Discovery Channel Canada.

In addition, an image of the Gemini North observatory made the cover of *TIME For Kids*, which has a circulation of more than three million.

NOAO issued a news release in mid-November focused on an *Astrophysical Journal* paper by Debra Burris and NOAO researchers Caty Pilachowski and Taft Armandroff concerning a more precise time line for epochs of early star formation in the Milky Way, based on a census of nearby, ancient halo stars (for a summary, see the Highlights section of this issue).

The Hubble Heritage Program archive release for November was an HST image of the galaxy collision in NGC 6745, taken under the guidance of Roger Lynds of NOAO/KPNO. Media coverage of this image included Page One of the *Tucson Citizen*, the *Arizona Daily Star,* CNN.com, and the "Astronomy Picture of the Day."

The RBSE Program Continues to Shine

Travis A. Rector

The NOAO Teacher Enhancement Program, The Use of Astronomy in Research-Based Science Education (RBSE), consists of a four-week summer workshop for middle school and high school teachers who are interested in incorporating astronomy research within their science classes. RBSE extends the experience to the classroom with materials, data sets, support, and mentors during the academic year.

Sixteen middle school and high school science teachers from across the country came to Tucson to participate in this year's RBSE summer workshop. The teachers learned the astronomy content, image processing and data analysis techniques, and research education pedagogy necessary to implement the RBSE research programs in their classroom.

The RBSE research projects are real research programs led by NOAO scientists using data taken with Kitt Peak facilities. Currently, there are three projects: One involves using full-disk solar images taken daily with the Kitt Peak Vacuum Telescope. In this project, students are searching for a connection between the lifetime of sunspots and their physical parameters: area, flux, latitude, and rotation rate. Students are also "blinking" multiple-epoch images of the Local Group galaxies M31, M33, and NGC 6822 from the KPNO 0.9-m and 2.1-m telescopes to search for novae. The long-term goal is to accurately determine the nova rate for these galaxies. Finally, students are studying optical spectra of objects in the FIRST and ROSAT-Green Bank Surveys to determine their identity, to search for quasars and radio galaxies, and perhaps to discover something altogether unexpected.

RBSE continues to enjoy a high level of visibility with professional astronomers and the media. This year's workshop was featured in articles in the *Arizona Daily Star* and the *Christian Science Monitor*. Astronomer mentors were found for all 16 teachers participating in this year's program; we extend our appreciation to the following individuals for their participation:

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RBSE 2000 Teachers and Mentors

TEACHER	SCHOOL	LOCATION	MENTOR	INSTITUTION
Linda Stefaniak	Allentown High School	Allentown, NJ	Tad Pryor	Rutgers University
Richard Spitzer	Round Valley High School	Springerville, AZ	Travis Rector	NOAO
Margaret Holzer	Chatham High School	Chatham, NJ	Dale Gary	New Jersey Institute of Technology
Jim Hoffman	Franklin Central High School	Indianapolis, IN	Brian Murphy	Butler University
Theresa Roelofsen	Bassick High School	Bridgeport, CT	Eric Rubenstein	Yale University
Scott Tracy	Ellington High School	Ellington, CT	Bill Herbst	Wesleyan University
Helen Peyton	St. Bernard School	Omaha, NE	Tom Gehringer	Harry A. Burke High School
Walter Glogowski	Ridgewood High School	Norridge, IL	Bernhard Beck-Winchatz	DePaul University
			James T. Lauroesch	Northwestern University
Kate Meredith	Sturgeon Bay High School	Sturgeon Bay, WI	Robert Allen	University of Wisconsin
Melynda Thomas	Morrilton Junior High School	Morrilton, AR	Jeff Robertson	Arkansas Tech University
Andy Miller	Cummings Middle School	Brownsville, TX	Mario Diaz	University of Texas
Amy Stoyles	King Middle School	Bradenton, FL	Reggie L. Hudson	Eckerd College
Kaye Sullivan	Staples High School	Westport, CT	David Goldberg	Yale University
Edward Roberts	Pottsville High School	Pottsville, AR	Jeff Robertson	Arkansas Tech University
Carl Katsu	Fairfield High School	Fairfield, PA	Larry Marschall	Gettysburg College
Robert Groover	Bordentown Regional High School	Bordentown, NJ	Michael Strauss	Princeton University

This workshop was the last to be supported on the current RBSE grant. Our funding for RBSE will be completed in the spring of 2001. However, we have submitted a proposal to the NSF ESIE Teacher Retention and Renewal program to reach larger numbers of teachers and to support more novice teachers in their efforts to integrate research and inquiry into their classrooms. The program will also address the high attrition rate among science teachers, especially those beginning their teaching careers.

For more information regarding the RBSE program, please contact either Suzanne Jacoby (*sjacoby@noao.edu*) or Travis Rector (*rector@noao.edu*).

The 2000 and 2001 REU Programs at Kitt Peak National Observatory

Buell Jannuzi and Kenneth Mighell

Every summer KPNO is fortunate to have a group of talented university students come 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.

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We anticipate being able to support six REU positions during the summer of 2001. 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 no later than early June. A salary of $355 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 22 January 2001. Additional information and application forms are available from *http://www.noao.edu/kpno/reu*.

During the summer of 2000, 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.

At the end of the summer, the students shared their results with the Tucson astronomical community through oral presentations describing their research. Most of these students will be attending the January 2001 AAS meeting in San Diego as part of the REU program (thanks to the NSF), and we encourage you to stop by their posters or attend their talks.

Their end-of-summer presentation titles (which may change by the time of the AAS meeting) and advisors are listed below:

The summer of 2000 saw eight undergraduates come to Tucson as participants in the KPNO REU program. Shown are (left to right) Abigail Hedden (Carleton), Christopher Greer (Northwestern), Heather Groch (Brown), Michael Cooper (Grinnell), Veronica Ponce (Virginia), Karin Sandstrom (Harvard), Stuartt Corder (Kansas), and Kimberly Mach (Beloit).

Michael Cooper (Grinnell):
Star Counts in the Deep Wide-Field Survey: The Galaxy at Faint Magnitudes
Joan Najita

Stuartt Corder (Kansas):
Stellar Populations Near the Nucleus of M33
Kenneth Mighell

Christopher Greer (Northwestern):
Evolution of Elliptical Galaxies in the Deep Wide-Field Survey
Arjun Dey

Heather Groch (Brown):
Mosaic Image Reductions for the Deep Wide-Field Survey
Buell Jannuzi

Abigail Hedden (Carleton):
Infrared Observations of the Red Rectangle
Kenneth Hinkle and Dick Joyce

Kimberly Mach (Beloit):
Investigations into the Dust Atmosphere of 2060 Chiron
Nalin Samarasinha

Veronica Ponce (Virginia)
Variable Stars
Nigel Sharp

Karin Sandstrom (Harvard)
Metallicity of RR Lyrae Stars in M3
Caty Pilachowski and Abi Saha

How to Contact Educational Outreach

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NOAO Preprint Series

The following preprints were submitted during the period July through November 2000. Please direct all requests for copies of preprints to the NOAO author marked.

884 Chaboyer, B., Sarajedini, A., *Armandroff, T.E., "The Age of the Inner Halo Globular Cluster NGC 6652"

885 *Méndez, R.A., Ruiz, M.T., "The Luminosity function of Magnitude and Proper-Motion Selected Samples. The Case of White-Dwarfs"

Other NOAO and NSO Papers

Preprints that were not included in the NOAO preprint series but are available from staff members are listed below.

*Hoard, D.W., Layden, A.C., Buss, J., Demarco, R., Greene, J., Kim-Quijano, J., Soderberg, A.M., "Distance to the RR Lyrae Star V716 Monocerotis"

*Hoard, D.W., Szkody, P., Honeycutt, R.K., Robertson, J., Desai, V., Hillwig, T., "Long-term Optical and X-ray Observations of the Old Novae DI Lacertae and V841 Ophiuchi"

Martin, C.L., Lotz, J., Ferguson, H.C., "An Emission-Line Search for Star-Forming Dwarf Galaxies toward Abell 851"

Oey, M.S., Dopita, M.A., Shields, J.C., Smith, R.C., "Calibration of Nebular Emission-Line Diagnostics: I. Stellar Effective Temperatures"

Schmidt, G.D., *Smith, P.S., "Evidence for Polarized Synchrontron Components in Radio-Optical Aligned Quasars"

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