

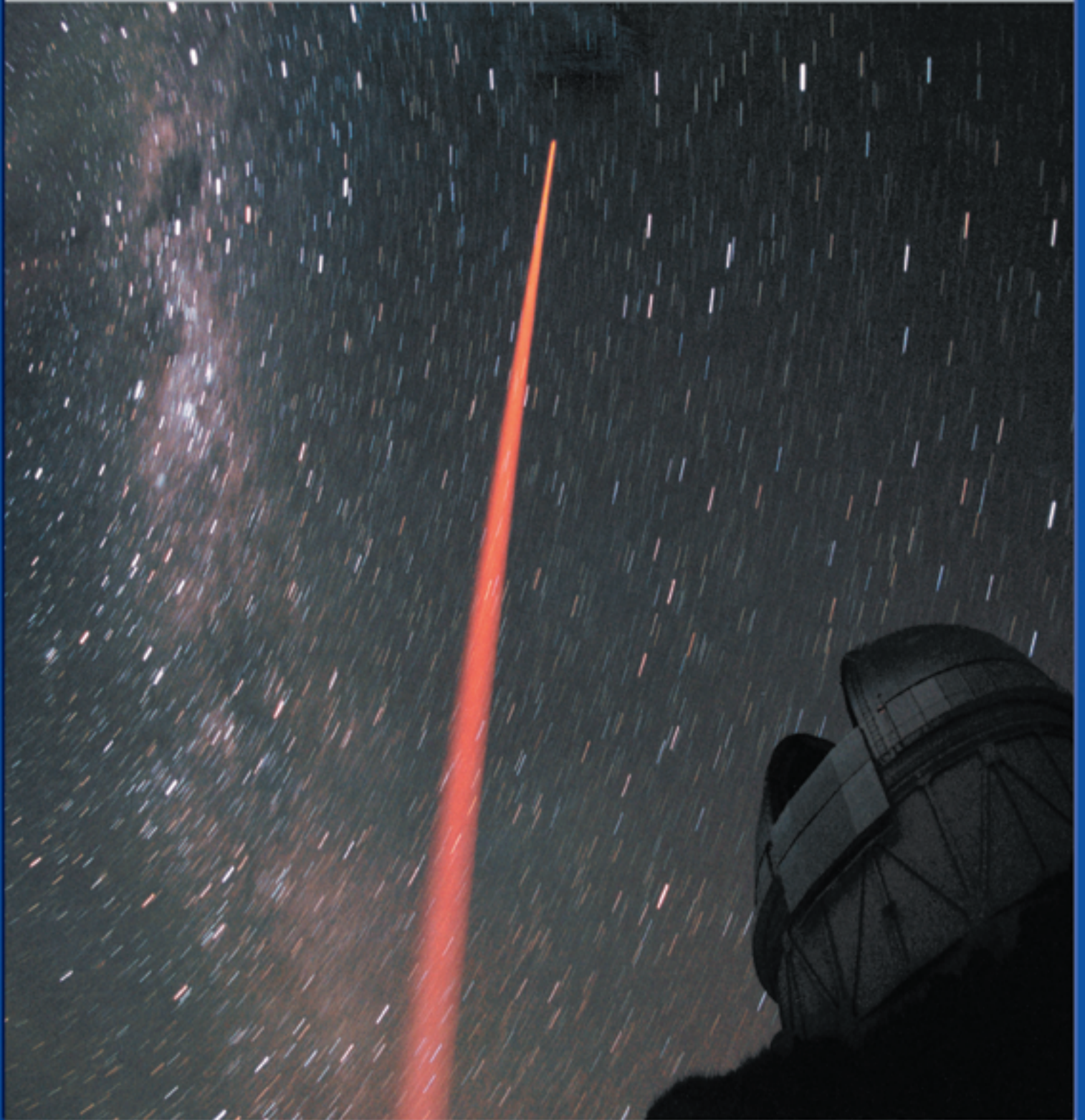


NATIONAL OPTICAL ASTRONOMY OBSERVATORY

Cerro Tololo • Kitt Peak • U.S. Gemini Program

NATIONAL SOLAR OBSERVATORY

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From the Editor:

This NOAO Newsletter is my first as the Editor.

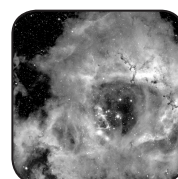
Recent reader feedback confirms that a hardcopy newsletter remains valuable in the Age of the Internet, but clearly there are some new topics to be addressed as NOAO prepares for the challenges of the future.

Our immediate editorial goals are to make the newsletter catchier and shorter in the print version (with more details on the Web), inherently reflective of the goals of the most recent Decadal Survey, and heavier on the science highlights that vividly demonstrate how NOAO facilities can be productive for you. We invite your comments and submissions to editor@noao.edu. We also welcome letters or commentaries from NOAO staff, users, and other members of the astronomy community.

Special thanks to the previous editor, Bruce Bohannon, and production manager, Sally Adams, who worked intensively with the NOAO PhotoLab to reshape the newsletter into a more effective and visually appealing communications tool.

With your attention and your input, the newsletter can continue to contribute to the future growth of NOAO.

--Doug Isbell



ON THE COVER

An orange cone of argon laser light is scattered in the lower atmosphere during a Laser Guide Star test at NOAO's Cerro Tololo Interamerican Observatory in February. The test was among the first in a year-long series of small-scale tests in preparation for a laser-aided Adaptive Optics system on Gemini South. The Blanco 4-meter telescope dome and the Milky Way are seen in the background.

Photo: Maxime Boccas/CTIO/AURA/NSF

For more details on the testing program, see p. 19.

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STAFF

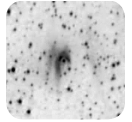
Doug Isbell, *Editor*

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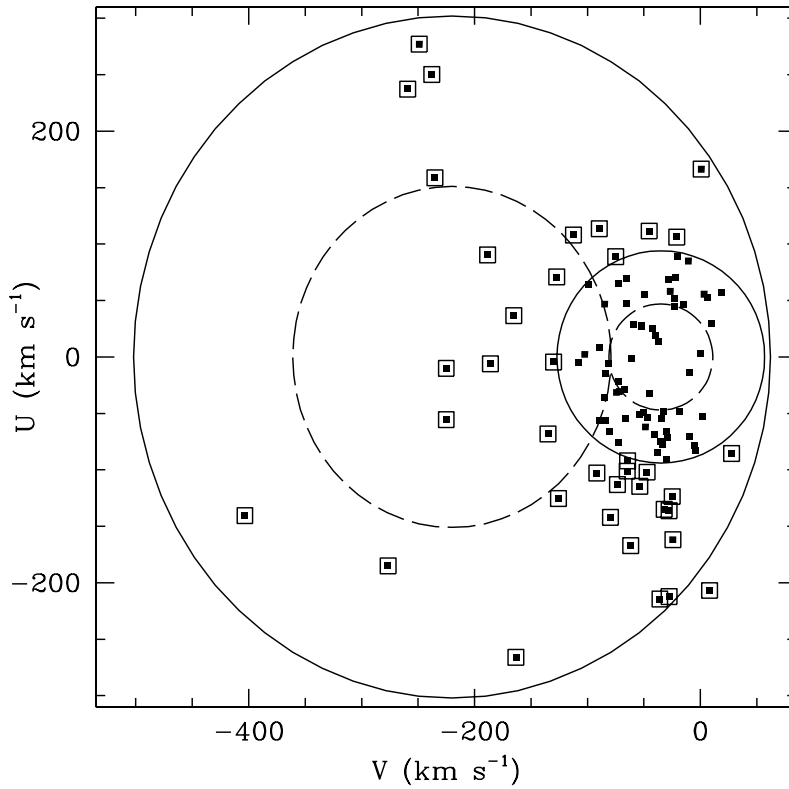
White Dwarfs - Dark Matters

Tod R. Lauer

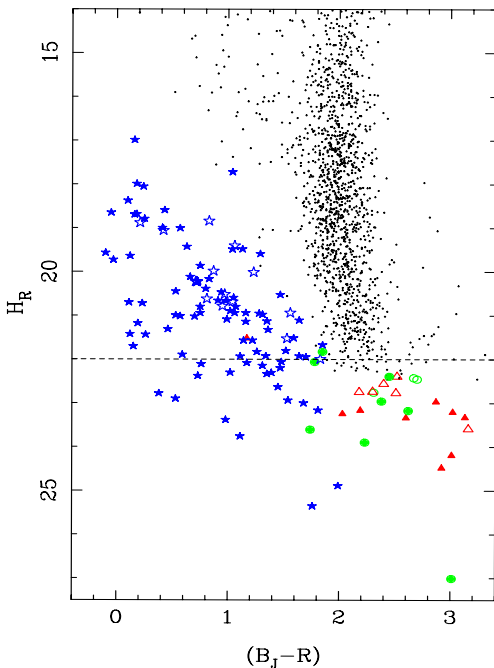
Ben Oppenheimer (Berkeley), N. C. Hambly, A. P. Digby (Edinburgh), S. T. Hodgkin (Cambridge), and D. Saumon (Vanderbilt) used the CTIO 4-m Blanco Telescope to identify a sample of white dwarfs that appear to be members of our galaxy's halo population. Detection of this new population argues that a substantial fraction of our galaxy's dark matter halo may be provided by white dwarfs.

Oppenheimer et al. used a three-epoch photographic survey of ~4,900 square degrees over the South Galactic Pole to identify faint stars with high proper motions. Proper motions were then used statistically to estimate distances, generating a color-magnitude diagram. Candidate white dwarfs are visible in the diagram below as the subluminescent sequence of objects to the left of the nearly vertical stellar main sequence.

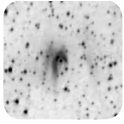
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A plot of the inferred galactic V (angular) and U (radial) velocities of the white dwarfs. The large dashed and solid circles correspond to the 1σ and 2σ velocity dispersions for the halo, while the smaller circles at the right give the same parameters for the old disk.



A color-magnitude diagram constructed from the Oppenheimer et al. photographic survey. The H_R magnitude is an estimate of the absolute magnitude based on proper motions. Filled stars are spectroscopically confirmed white dwarfs (open stars are suspected white dwarfs); other symbols are either M dwarfs or other subdwarfs. The horizontal line is the completeness limit of the classic Luyten catalog.



White Dwarfs continued

From this diagram, Oppenheimer et al. identified 92 stars for spectroscopic follow-up with the Blanco Telescope. Observations were obtained for 69 of the stars, of which 38 were identified as old cool white dwarfs.

Photometric distances to the white dwarfs allowed their proper motions to be converted to tangential spatial velocities. None of the stars showed spectral lines sufficient for the estimation of radial velocities; however, since the stars are all near the South Galactic Pole, their tangential velocities do provide for estimation of their galactic U (radial) and V (rotational) velocity components (see top image on previous page). The large range in U and the strongly negative V velocities argue that a substantial fraction of the white dwarfs observed are part of our galaxy's halo population.

Oppenheimer et al. estimate a local mass density of $1.3 \times 10^{-4} M_{\odot}/\text{pc}^3$ for the halo white dwarf component visible within their completeness limit, which is about 2% of the local mass density of $8 \times 10^{-3} M_{\odot}/\text{pc}^3$ for the halo overall. The number density of white dwarfs is still rising at this limit, however, and they do not observe any indication of the expected turnover due to the finite lifetime of the halo. Oppenheimer et al. thus argue that the true halo white dwarf component may be substantially larger, perhaps consistent with MACHO project estimates that 8% to 50% of the halo is in the form of compact objects. As it is, even a 2% white dwarf halo population is an order of magnitude larger than expected, given a standard initial mass function. The Oppenheimer et al. result may thus be a window on the early star formation in our galaxy as well as a current glimpse into the composition of its halo.

Mass Transit

Based on a contribution solicited from William Keel (Alabama)

William Keel used the DensePak fiber array at the WIYN Telescope in conjuncture with HST observations to map an apparent exchange of mass taking place between the NGC 1409 and NGC 1410 galaxy pair. This appears to be the first case in which mass is observed in the entire process of transfer between interacting galaxies. Such transfer has been inferred from polar ring galaxies and H I on the outskirts of some elliptical galaxies, as well as from the Magellanic Stream in our own neighborhood, but has proven elusive to catch in the act.

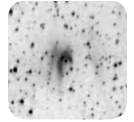
A striking dust structure suggestive of mass transfer in the NCG 1409/1410 pair was discovered by Keel in archival HST WFPC2 images, and was examined in detail using follow-up STIS images. A filament of dust appears leaving the spiral pattern of the Seyfert galaxy NGC 1410 (also known as III Zw 55), crossing the 8-kpc gap to NGC 1409, and twisting in a helical fashion around NGC 1409 to become a polar ring. This picture was amplified using a velocity field measured in H α and the adjacent [N II] lines, with the DensePak fiber array at the WIYN

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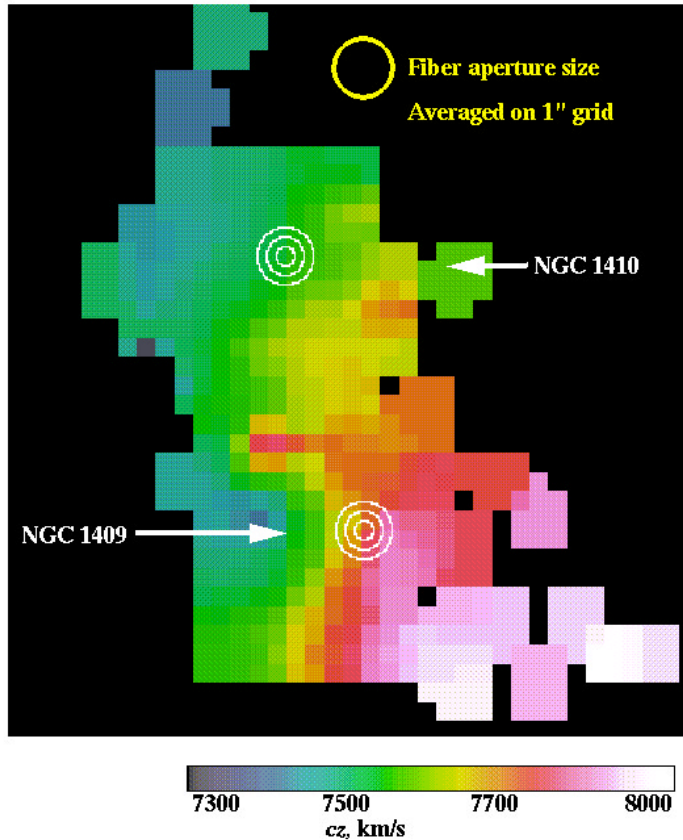
Interacting Galaxies NGC 1409 and NGC 1410 HST • WFPC2
NASA and W. Keel (University of Alabama) • STScI-PRC01-02

HST images of the NGC 1409/1410 pair. The left-hand (northern) galaxy is NGC 1410, cataloged as a Seyfert Galaxy (also known as III Zw 55). NGC 1409 is a lenticular galaxy lacking clear spiral arms or star formation. The dust lane leaves NGC 1410, crosses the gap, and disappears where it would go behind the starlight of NGC 1409 if it connects to the polar dust seen in front of the nucleus.



Mass Transit continued

NGC 1409/10 H α +[N II] Velocity Field WIYN+DensePak



A gas velocity map made from WIYN DENSEPAK spectral observations

Telescope. In a half night of data taking last December, this device gave fully sampled coverage of the whole pair. Fortuitously, ionized gas was visible throughout the space between the galaxies. While it's hard to say just how much of the gas is associated with the 0.25" sized dust feature, the velocity field confirms the directions of relative motion inferred from the images and N-body simulations. NGC 1410

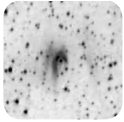
is undergoing a prograde (direct) encounter, which both analytical and numerical work shows to be most favorable for mass loss, while NGC 1409 sees a near-polar passage, in line with the polar orientation of the captured material. Further work, including specific simulations of this system, should help to answer immediate questions such as why is only a single filament of dust and gas crossing all the way over at one

time? The filament must be more of an "isochrone" than a pipeline.

Mass transfer has been a proposed mechanism to trigger AGN, but in this case the Seyfert Galaxy is the donor, and nuclear activity in the recipient (though weakly present, as shown clearly in the WIYN spectra) is about 20 \times weaker. Is this because of geometry? Has incoming material not reached the core yet, or are there other factors?

There is no evidence of ongoing star formation in NGC 1409. Why isn't the infalling material forming stars?

The rate of mass transfer is very modest — a few hundredths of a solar mass per year, based on the dust absorption and typical gas/dust ratios. This is far too little to drive a powerful starburst, and similar mass dumping at a hundred times this rate would be obvious in many pairs. This may imply that the mass transfer producing powerful starbursts either happens mostly in H I where surveys are less complete than optical imaging, or that it builds up slowly until a critical mass or density is reached.



Molecular Clouds Over Sunspot Umbrae

T. Alan Clark (University of Calgary)

Alan Clark, Marcel Bergman (University of Calgary), and Douglas Rabin (NASA/GSFC) have been using the Near Infrared Magnetograph (NIM) imager on the main spectrograph of the McMath-Pierce Solar Facility to image layers of molecules that appear over sunspots. Of particular interest in this work are the molecules H₂O and HCl, which form over the coolest central regions of the sunspot umbrae. SiO, while forming a more extensive layer than H₂O and HCl, also does not fill the area of the umbra. The molecule OH is detected in a layer over the full extent of the umbra and is detected weakly over penumbral regions. There is clear evidence that this molecule participates in the radial Evershed flow within the penumbral region. Other features of interest in these molecular layers are the apparent correlation of the equivalent widths of OH, SiO, HCl and H₂O lines with the intensity of the underlying continuum and the abrupt “turn-on” of H₂O and SiO absorption at specific (and different) continuum intensities (and hence, presumably, temperatures) as one approaches the coldest parts of the sunspot umbrae.

In the accompanying figures, a single spectral-spatial frame shows the spectrum across the center of a sunspot umbra, which appears as a dark horizontal band across the frame. Strong and weak absorption lines from N₂O and other molecules in the Earth’s atmosphere cross the whole frame, while absorptions from

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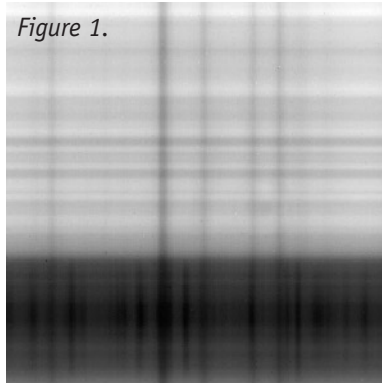


Figure 1.

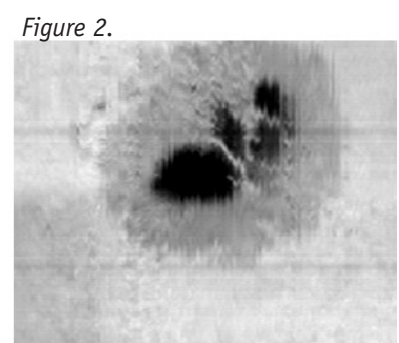


Figure 2.

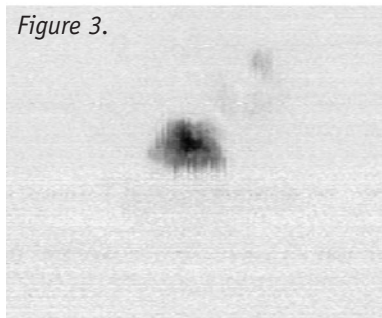


Figure 3.

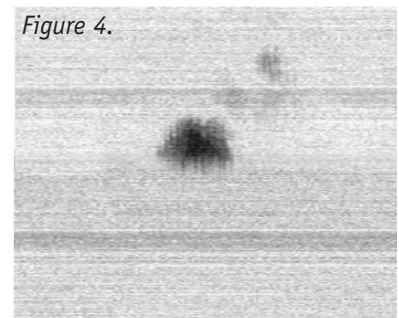


Figure 4.

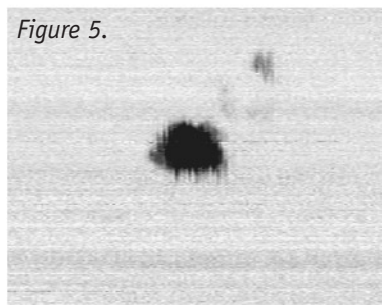


Figure 5.

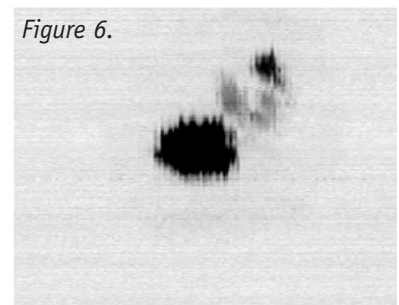


Figure 6.

Figure 1. This single spectral frame shows the region around 2428 cm⁻¹ over the active region AR8971 on 27 April 2000.

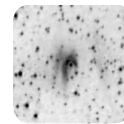
Figure 2. The IR continuum near the wavelength of Brackett α .

Figure 3. Excess absorption from H₂O over inner umbral regions.

Figure 4. Excess absorption from HCl over the umbral regions.

Figure 5. Excess absorption from SiO over the umbral regions.

Figure 6. Absorption from OH over penumbral and umbral regions.



Sunspot Umbrae continued

the above molecules appear only over the limited sunspot region. Spectroheliograms have been constructed by scanning the 52" slit across the sunspot in 0.8" steps. The image of the sunspot has been produced at a wavelength in the near-infrared continuum, while molecular images have been produced by

subtracting this spectroheliogram from those at the centers of absorption lines caused by each specific molecule. The penumbral component of the OH image is clearly visible. The more limited extent of the H₂O, HCl and SiO layers is also obvious on these images.

If molecular equilibrium calculations can be used to determine the temperature threshold for the formation of these molecules, observations such as these should lead to a method for defining the temperatures of sunspot umbrae more precisely.

Zeeman Splitting in OH at 12 Microns

Don Jennings (NASA/GSFC) and Claude Plymate (NSO)

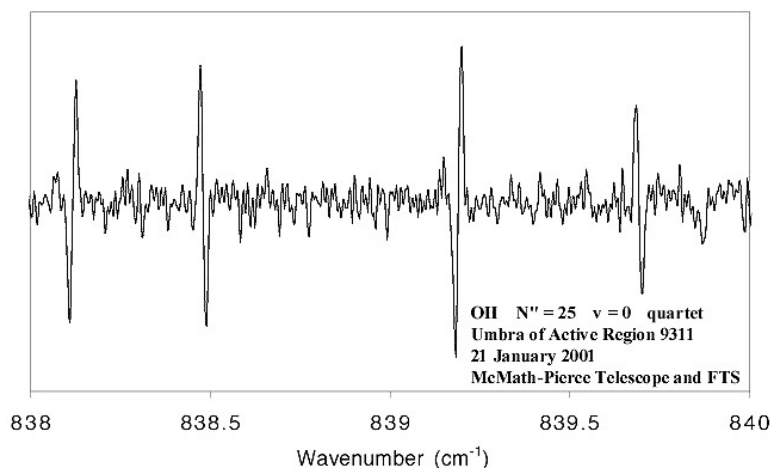
Zeeman splitting in the spectrum of the hydroxyl radical (OH) was recently detected in a sunspot. In January 2001, the Fourier Transform Spectrometer (FTS) at the McMath-Pierce Solar Facility was used to measure Stokes *V* profiles in OH lines near 12 microns. Splittings in these lines are of interest not only as a probe of magnetic fields, but also because the Zeeman effect is rarely seen in molecules. All four absorption components in each of the observed pure-rotational transitions exhibited small splittings, on the order of 0.01 cm⁻¹, in both the umbra and penumbra. The figure shows a spectrum of the *N*" = 25 quartet formed in the *v* = 0 ground vibrational state. Several quartets like this one, corresponding to *N*" = 23 to 28 in the *v* = 0 and 1 states, were seen in the 11–13 micron range. The simple *V* signature suggests that the splitting is close to a "normal" Zeeman pattern. Note the alternating direction of the splitting among the four lines.

To make the measurements, scans were recorded in *I* + *V* and *I* – *V* using a quarter-wave plate and a linear polarizer. Differences between these yielded the *V* spectra. The appearance of Mg I emission

of magnetic fields into umbrae where the Mg I lines disappear.

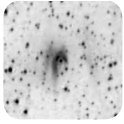
These observations were part of a continuing program to explore the solar spectrum in the mid-infrared.

OH Zeeman Splitting at 12 Microns



lines in this same spectral region help determine the OH magnetic sensitivity. In turn, the OH lines will extend the 12-micron measurements

The McMath-Pierce Solar Facility and FTS are unique in providing the capability to perform this research.

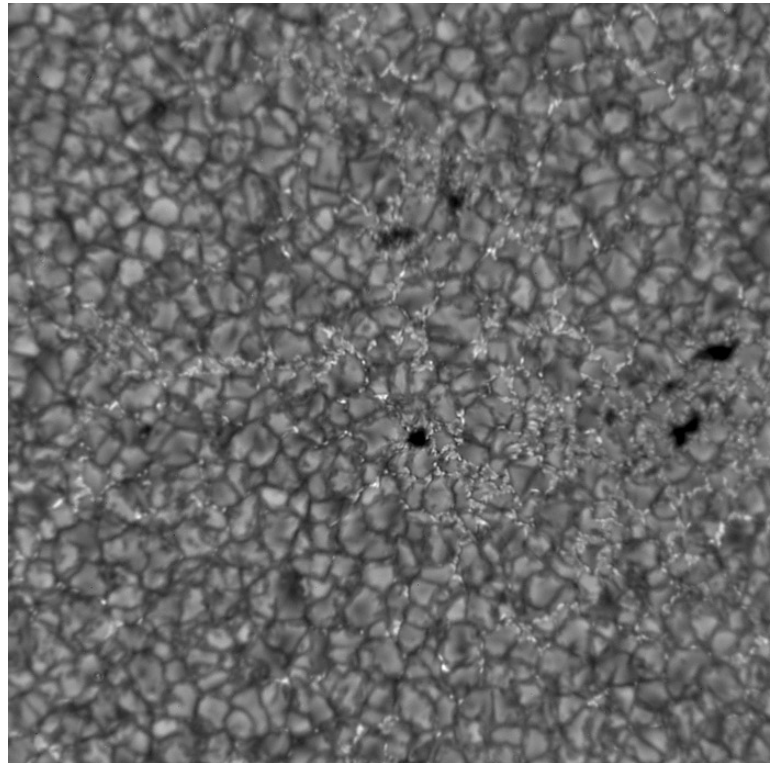


Solar Adaptive Optics Program Update

Thomas Rimmele and the NSO Adaptive Optics Team

NSO, in partnership with the New Jersey Institute of Technology (NJIT), the Air Force Research Laboratory (AFRL), and the Kiepenheuer-Institute (KIS) in Germany, recently started a three-year project to build three high-order adaptive optics systems for use on the 65-cm telescope at Big Bear Solar Observatory (BBSO), the 76-cm Dunn Solar Telescope (DST) at Sacramento Peak, and the planned 1.5-m German Gregory Telescope (GREGOR) on Tenerife. The high-order Adaptive Optics (AO) system will upgrade each of these leading high-resolution solar telescopes, greatly improving scientific output of each facility. These efforts will serve the diverse needs of a broad solar community, from individual researchers to teams conducting campaigns. The resulting systems will also serve as proof of concept for a scalable AO design for the much larger Advanced Technology Solar Telescope. The solar AO program is funded by the NSF Major Research Instrumentation Program and through substantial contributions by the partner institutions.

With the design phase nearing completion, development of the high-order solar AO system is progressing on schedule. A Digital Signal Processor board for the correlating Shack-Hartmann wavefront sensor processor unit has been selected. Two deformable mirror systems, one for BBSO and one for the DST, have been



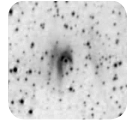
ordered, and a fast, flexible format wavefront sensor camera is under development. BBSO is developing a fast tip/tilt control system that will be an integral part of the high-order AO system. The servo loop has already been closed on this system. Three students have started their thesis work within the project, and additional students are expected to begin their thesis work this fall.

Software improvements and modifications to the optical setup on the low-order AO system at Sacramento Peak have resulted in better performance and a more user-friendly

system. Low-order AO is frequently used as a test bed for high-order AO development but also is in high demand for observing runs at the DST. A number of spectacular diffraction-limited observations of small-scale solar magnetic fields were recently achieved in the visible and at near-infrared wavelengths.

The figure above shows bright points observed in a plage region using a G-Band filter centered at 430.5 nm and with a FWHM of 1 nm. The field of view is 58 arcsec \times 58 arcsec. The image was taken at the DST

continued



Program Update continued

using solar adaptive optics. A CCD camera with a pixel resolution of 0.05 arcsec was used; the exposure time was six seconds.

G-Band is a band of spectral lines formed by the CH molecule. Small-scale magnetic flux elements appear bright when observed in G-Band. The actual size of the bright points is at or most likely below the diffraction limit of today's solar telescopes, and bright points can usually be observed only in images taken

during the very best seeing conditions and with very short (<20 ms) exposures in order to "freeze" the seeing. Spectroscopic and polarimetric analysis of these bright points, however, requires exposures typically lasting several seconds.

Adaptive optics can largely correct the adverse effects of seeing within an isoplanatic patch and thus enable diffraction-limited, long-exposure spectroscopy. The central part of the image where the AO system was

locked is visibly sharper, and the image contrast and resolution gradually deteriorate as one moves away from the isoplanatic patch.

In addition to G-Band images, narrowband UBF filtergrams are recorded and are currently analyzed with the goal of studying velocity patterns in and around magnetic flux tubes and the evolution of small-scale magnetic fields. Results are posted on the Web at: www.sunspot.noao.edu/AOWEB.

The NOAO Hokupa'a Image Analysis Workshop

Tod R. Lauer

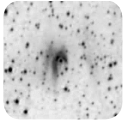
NOAO hosted a two-day workshop on February 26-27 concerning the analysis of images obtained with the Gemini North Hokupa'a adaptive optics camera. The primary goal of the meeting was to share understanding of the diverse issues, algorithms, problems, and tactics required to produce research-quality results from Hokupa'a images. Approximately 40 people attended, with heavy representation from the NOAO staff, the Gemini Observatory, and the NSF's Center for Adaptive Optics (CfAO). A portion of the attendees included those who had worked with other adaptive optics systems besides Hokupa'a. Most of the problems faced by observers using Hokupa'a are generic to natural guide-star adaptive optics systems. All but a few of the talks have been converted to Web documents at: www.noao.edu/usgp/ao_workshop.html.

Briefly, Hokupa'a is producing cutting-edge results in a diverse set of research areas. The ease of extracting quantitative results varies widely from problem to problem, and successful observing with Hokupa'a requires

a sophisticated understanding of its limitations. Robert Blum (NOAO), for example, is conducting crowded-field stellar photometry on the Gemini Galactic Center data set and obtains significantly smaller scatter in an H-K CMD than that shown by HST NICMOS observations of areas in common. Tim Davidge (HIA) and collaborators at Gemini have recovered the AGB tip in highly crowded Hokupa'a images of M32. Joe Jensen (Gemini), in some sense observing "ultra" crowded fields, has obtained reliable SBF observations of nearby galaxies with Hokupa'a. The most difficult observations with Hokupa'a are those that require accurate knowledge of the Point Spread Function (PSF). Francois Rigaut (Gemini) presented a sobering assessment of the form of the Hokupa'a PSF and its variability with time and detector position. In short:

1. The PSF resolution and Strehl ratio decrease steadily with angular distance from the AO guide star.

continued



Science Highlights

NOAO Hokupa'a continued

2. The PSF is highly time variable -- 10% variations in FWHM are likely to occur on time scales longer than a few minutes.

3. PSF Strehl is a function of the AO guide star apparent magnitude.

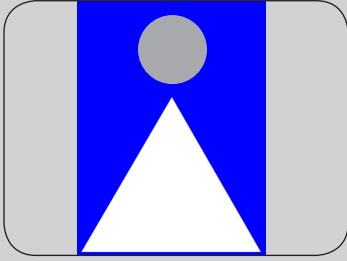
4. The PSF has a broad halo.

5. At high-contrast ratios, the PSF halo is highly non-uniform. Quasi-stationary "speckles" or hot spots occur in the halo that change only over time scales of several minutes or with selection of different stars.

Observations that are particularly challenging are detection of faint companions to the AO guide star and the detection of faint host galaxies associated with QSOs. For observations of these sorts there is no simple path to success. A key minimal requirement does appear to be repeated observations over a span of time and different conditions to discriminate between artifacts and real source structure. In addition, it is necessary to obtain PSF calibrations over a span of time with attention to characterizing the range of PSF variability and care to matching PSF observations to the properties of the source AO guide star.

Many of the talks presented at the workshop focused on characterization of the PSF, given its central role in the analysis of Hokupa'a observations. Mark Chun (Gemini) and Eric Steinbring (CfAO) emphasized programs to characterize the field variability of the PSF, while Joe Jensen (Gemini) explored recovery of the PSF from the SBF power spectrum itself. In short, it appears possible to characterize PSF spatial variations in crowded fields from a relatively sparse sampling of the PSFs over the field. The most challenging observations are those where only the AO guide star PSF is available or where the guide star itself is the target.

Clever image analysis algorithms are also central to success with AO observations. Keith Hege (Steward) and Julian Christou (CfAO) discussed the method of "blind deconvolution," which is particularly useful in an AO context because it is explicitly designed to leverage multiple observations obtained under varying conditions to separate the PSF and source structure. In conclusion, the workshop proved to be a successful sharing of AO experience, observing, analysis, calibration, and reduction issues. A quick skimming of the Web pages of the presentations should serve as an excellent point of departure for anyone interested in the problems of analyzing AO imagery.



Director's Office

The First Hundred Days

Jeremy Mould

First impressions are often lasting ones, and since arriving in La Serena in January and Tucson in February, I've had the opportunity to meet all of the National Observatory's staff. As it happens, I also had a chance at the end of last year to take a comprehensive tour of the European Southern Observatory with their Visiting Committee. I'm struck by the similarity between the missions of NOAO and ESO, our common opportunities and problems, as well as the evident enthusiasm amongst both staffs for an aggressive approach to the future.

ESO is proud of the efficiency of the Very Large Telescope (VLT), wondering about second-generation instruments, adding a 4-meter telescope to Paranal, trying to cross the bridge to its new millimeter astronomy project, and thinking its way toward an "overwhelmingly" large telescope. NOAO is adding locomotive power to Gemini to help the US public system catch the VLT while delivering first-generation instruments like GNIRS, adding SOAR to Cerro Pachón, entering the unfamiliar data landscape of the virtual observatory, and starting its Giant Segmented Mirror Telescope project.

For both observatories, partnerships with institutions in their communities are a vital part of their overall research capability. As I emphasized recently to the AURA Member Representatives, effective partnerships like WIYN and SOAR serve as fine models for future telescopes in the US system.

Communicating What We Do & Why

Observing our colleagues, we see a variety of approaches to public interest in astronomy. Some of us have a flair for publicity; others tend to share their research with the professional community only. Whatever our instincts may be, astronomy benefits enormously from public interest, and from news media attention that often feeds this public interest. Indeed, it's hard to know whether the major return on taxpayer investment in astronomy is realized in school classrooms, in the development of new technology, or in the broadest social awareness that science can be a driver of positive change.



None of these benefits is realized, however, if we go no further than *astro-ph* with the results of our research. We need to communicate discoveries and advances of every kind to a wider audience. NOAO is better able to assist its users with that communication through our newly reorganized Public Affairs and Educational Outreach Office. Doug Isbell and his staff are ready to work with you and your

university news office to get the word out about research progress made using NOAO facilities or expertise.

We have good linkages with the outreach efforts at the Space Telescope Science Institute and Gemini, and Doug participated in many successful joint efforts with STScI's Office of Public Outreach during his previous position in NASA Public Affairs. The National Science Foundation is no less eager than NASA to highlight the research that it funds or supports through NOAO. Doug is a regular attendee at each AAS meeting, and I encourage you to contact him at: disbell@noao.edu if you want to discuss any advance planning or news connected to NOAO.

Implementing the Decadal Survey

AURA's annual general meeting of member representatives took place in Tucson in April. The meeting featured a number of discussion groups, including a multifaceted one about the best ways to advocate the Decadal Survey. There is much to be done to translate priorities and strategies into a real plan.

continued



Implementing continued

One good way to “read NSF’s mind” on ground-based optical/infrared facilities is to look at: www.nsf.gov/pubs/2001/nsf0180/nsf0180.htm#DESC. This document is NSF’s solicitation of proposals for the future management and operations of NOAO, and it clearly states a role for the National Observatory in planning for the Large Synoptic Survey Telescope, the Giant Segmented Mirror

Telescope, and an O/IR ground-based node of the National Virtual Observatory. NOAO looks forward to working with many capable partners in planning and design work, and we’re facilitating broad community involvement through events like the LSST workshop, whose report is now available on-line through the NOAO home page.

FRED GILLETT: INFRARED ASTRONOMY PIONEER

International Gemini Observatory Project Scientist Dr. Fred Gillett died April 22 at the University of Washington Medical Center in Seattle at the age of 64, following a months-long battle with a rare bone marrow disorder.

Known throughout his career as an effective consensus-builder, Fred was an early advocate for optimizing the twin Gemini telescopes to focus on infrared science.

“Over the years, I relied greatly on Fred’s rigor, quiet wisdom, and friendship to guide us through many difficult times on Gemini,” said Gemini Director Matt Mountain. “Fred will be greatly missed by all of us. He has left a great void in our hearts and at our Observatory.”

“Fred played a key role in the Gemini project from inception to completion,” said Sidney Wolff of NOAO, the first director of the project. “He was the one who persuaded the astronomical community that infrared-optimized telescopes should be a top scientific priority. Then he carried out the detailed calculations that showed how to build them.”

Before taking on the project scientist position in December 1994, Fred was the Associate US Gemini Proj-

ect Scientist in the US Gemini Project Office in Tucson. Prior to that, he was a staff member at NOAO



and Kitt Peak National Observatory from 1973 to 1989, including a period as acting director of Kitt Peak. During the 1970s, he led the effort to develop state-of-the-art infrared detectors and instrumentation at KPNO and to optimize the performance of Kitt Peak’s telescopes in the infrared.

His scientific contributions in thermal infrared research included studies of Saturn, Uranus, and Neptune; observations of the center of the Milky Way; and observations of star forming regions in the Galaxy. “He was a member of a small group

who created infrared astronomy as a science,” said NOAO staff member Michael Merrill.

Fred also was active in space-based astronomy. He received NASA’s Exceptional Scientific Achievement Medal in 1984 for his work on the Infrared Astronomy Satellite.

He is survived by his wife Marian; his children Nancy Richardson, Michael Gillett, and Danuta Gessner, and five grandchildren. A memorial service, held in Tucson on April 28, was well-attended by NOAO staff.

A memorial scientific meeting is being planned for 11-13 April 2002, and the SOC is already at work.

Ad astra, Fred.



Science with LSST: Report Now Available

Todd Boroson

On 17-19 November 2000 a workshop titled "Science with the Large-aperture Synoptic Survey Telescope" was held in Tucson. This workshop, attended by 55 astronomers, was aimed at developing the performance and operations requirement for LSST, a wide-field-of-view facility that will repeatedly image the entire visible sky to substantial depth, opening up the time domain for studies of moving, transient, and variable

objects. Potential LSST science from four types of objects/observations were considered: (1) objects in the solar system moving at non-sidereal rates, (2) transient or variable objects, (3) whole sky imaging, and (4) ultra-deep imaging. Strategies for several scientific projects in each of these areas were explored, and the resulting requirements and goals were compared to better understand how the single facility could be designed, constructed, and operated to achieve an optimum mix of this science.

The report from this workshop is now available as a pdf file on the NOAO Web site at: www.noao.edu/gateway/lst_workshop/report.pdf. The report includes summaries of the presentations given at the workshop, a discussion of the outcome of the deliberations of the four groups, and a list of issues and concerns for further study. Appendices include the list of participants, agenda of the workshop, and viewgraphs of the presentations.

Notable Quotes

"Should one federal agency get sole custody of the Universe?"

-- Opening sentence of an April 26 *Washington Post* story by reporter Kathy Sawyer on the new national blue-ribbon panel charged with studying the balance of ground-based astronomy funding between NSF and NASA. Chaired by retired Lockheed Martin Corp. executive Norman R. Augustine, the committee's report is due on September 1.

"A telescope lacking good instrumentation is like a person without all their senses."

- NOAO Director Jeremy Mould, discussing the challenges of future large telescopes, during a late March telephone interview with the *Chronicle of Higher Education*.

"We are simply dumbfounded. The 12-meter telescope is very valuable to US astronomy and is likely to remain so for many years to come. We will continue our efforts to keep it going."

-- Comments from Steward Observatory Director Peter Strittmatter in an April 24 press release from the University of Arizona regarding a decision by the National Science Foundation to decline funding requested by UA and the University of Massachusetts to continue operation of the 12-meter radio telescope on Kitt Peak.

"NSF stands for 'Not Sufficient Funds.'"

-- Rep. Sherwood Boehlert (R-NY), Chairman of the House Science Committee, at an April 25 committee hearing on the FY 2002 budget requests for NASA, NSF, NOAA, and DOE's Office of Science. Boehlert pledged to work with his colleagues in Congress and the Bush Administration to increase funding levels beyond the requests for all of the agencies.

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



NOAO-Gemini New Initiatives Office

Steve Strom

The joint NOAO-Gemini New Initiatives Office (NIO) has hit the ground running with its work on the Giant Segmented Mirror Telescope, with the goal of completing its initial analysis of an engineering point design by October.

October 2001 is also the target date to publish a summary of an early look at GSMT science requirements, derived from community-based science cases, several concept-level instrument designs, and the point design.

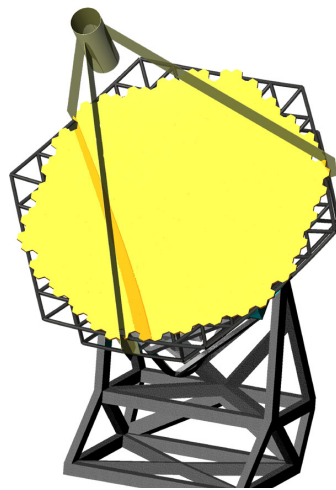
At that point, NIO plans to work intensively with the community to fund community-based studies of instrument and alternative systems concepts, to develop a detailed science-to-requirements flow, and to initiate a partnership that will carry out a Preliminary Design for the GSMT, while continuing vigorous in-house engineering studies.

NIO activities will receive \$4 million in funding across FY 2001 and 2002. Current plans call for an investment of \$15 million as our share of the Preliminary Design effort. We regard this investment as critical to ensuring deep community involvement in GSMT at all stages of its development, from early design activity through the beginning of operations in the next decade.

We also intend to maintain open lines of communication with ongo-

ing extremely large telescope projects both in the US and abroad, focusing on complementary activities that will enable all of us to achieve our collective goal of a publicly accessible GSMT more rapidly and economically.

The charter of the New Initiatives Office is to ensure broad US com-



The Point Design for the GSMT. This point design serves as a strawman to help define requirements and identify key technical issues.

munity access to an extremely large ground-based telescope with capabilities beyond any existing facility, as recommended in the May 2000 report of the Astronomy and Astrophysics Survey Committee. The NIO reports to the AURA Board through the AURA President, guided by a Management Board consisting of NOAO Director Jeremy Mould, Gemini Director Matt Mountain,

and AURA President Bill Smith, and a community steering committee comprised of senior astronomers and engineers.

Project Scientist Steve Strom has overall responsibility for the scientific goals of the NIO and will be the principal contact for interactions with the community. Systems Scientist Brooke Gregory provides scientific guidance to the technical studies and will lead the effort to define performance requirements based on the scientific goals. Program Manager Larry Stepp manages the technical studies and controls the schedule and budget. Alistair Walker manages the site assessment activity.

Staff members assigned to the NIO will report to the Program Manager, but will remain members of the technical staff of either Gemini or NOAO, who will provide capital equipment, software, etc. as required.

For more on GSMT as it develops, watch the new section of the NOAO home page, "Developing The Future," at: www.noao.edu/future/gsm.html.



Observational Programs

Proposals Received for 2001B

Todd Boroson

In March, NOAO received a total of 360 proposals for telescope time on facilities it coordinates in the US observing system. This semester marked the first call for Gemini-South proposals, and 25 were received. Fifty-four proposals were received for Gemini-North, with two proposals requesting time at both 8-m telescopes. Seven requests were made for community-access time on the MMT and four for the HET. One hundred and fifty proposals requested time at KPNO and 139 at CTIO. An additional 18 proposals for time on CTIO telescopes were forwarded to the Chilean TAC. Thirty-seven proposals requested time at more than one site -- most often KPNO and CTIO.

This year marked the third annual round of NOAO Survey Program proposals, and 14 were received. The new proposals

requested an average of 64 nights, spread over three to five years. An update on new and continuing survey programs and subscription statistics for all telescopes will appear in the next issue of this newsletter.

Telescope Allocation Committees met in Tucson from late April through early May, and KPNO and CTIO telescope schedules are being completed as this newsletter goes to press. Schedules should be posted and electronic notifications sent around the first week of June, followed by mailed paper copies about two weeks later. Gemini schedules will be released at the end of June.

Joint HST-NOAO Observing Proposals

Jeremy Mould

NOAO is again collaborating with the Space Telescope Science Institute to award observing time on NOAO facilities for highly ranked Cycle 11 HST proposals that request time on both HST and NOAO telescopes. The award of time on NOAO facilities will be subject to approval by the NOAO Director, after nominal review by the NOAO TAC to avoid duplication of programs. The important additional criterion for the award of NOAO time is

that both the HST and the ground-based data are required to meet the science goals of the project.

Up to 5% of NOAO's available observing time may be allocated to proposals meeting the stated criteria. NOAO observing time will be scheduled during the two semesters from August 2002 through July 2003. Under this agreement approximately 15 nights per telescope will be available on most telescopes, with

the following exceptions: only one to two nights will be available on the MMT and HET, and no time will be available on Gemini. In addition, time on the heavily subscribed Mosaic cameras may be limited by the NOAO Director.

Detailed information on available facilities is given on the NOAO/NASA Collaboration Web page at: www.noao.edu/gateway/nasa/.



A Status Report on the Hobby-Eberly Telescope

Thomas Barnes (McDonald Observatory) and Caty Pilachowski (NOAO)

The Hobby-Eberly Telescope (HET) was used for science operations for 29 nights during January - March 2001. During science observations, the median image quality (EE50) was 2.36 arcsec, while the best 10% was 1.64 to 1.97 arcsec. Experiments at the HET and at the 2.7-m Smith Telescope show that the more familiar FWHM is $EE(50)/1.2$. Thus the image quality in more familiar terms was 1.97 arcsec at HET, still much worse than specification.

The Marcario Low Resolution Spectrograph (LRS) is operating robustly in the HET queue, including multi-slit observations. The High Resolution Spectrograph (HRS) is in commissioning, and science observations with it should have begun before this newsletter went to press.

The HET schedule for May through August includes a science run each month, roughly centered on new moon, and significant periods of engineering and instrument commissioning focused on improving science operations capability and performance. Synoptic science programs will be continued through the engineering and instrument commissioning, to the extent possible.

The LRS may be returned to Austin in early July for refurbishment and installation of the higher quality SF2 CCD. The camera would remain in the Austin CCD lab for about three to four weeks, returning to the telescope in early August. This would make the LRS unavailable for the late July dark run.

Engineering activities are also scheduled in the next few months to improve HET performance. In May, a pneumatic cylinder will be installed and tested on the tracker. This structure will provide equipment and personnel safety in tracker operations and will prolong the life of the critical tracker y-slew motor by relieving it of 3/4 of its gravity load in normal operations. In June, HET operations staff will continue their development of the procedures and algorithms for use of the laser alignment system in tracker mount model refinement. The moving baffle is scheduled to be installed, integrated, and tested in July. This will provide signal-to-noise improvement in LRS spectra especially.

Image quality engineering will continue throughout the summer, including efforts to eliminate the observed drift of objects off the LRS slit, monitoring and improving the focus term of the tracker mount model, evaluating the improvement of image quality after insulation of the primary mirror truss, completion of the optical and mechanical design for new acquisition and guider camera optics, re-calibrating the tracker mount model using the new laser alignment system and new focus data, cooling in-dome electronics to improve dome seeing, and improving the initial mirror segment alignment. Work on the Segment Alignment and Maintenance System (SAMS) also continues, with completion expected early next year.



CTIO

OPERATIONS

From the CTIO Director

Malcolm G. Smith

Recent scientific output from CTIO continues to receive favorable reviews. Users and staff of CTIO have a long tradition of significant contributions to our understanding of stellar populations and their evolution, through studies in our galaxy (particularly its central and bulge regions), the Magellanic Clouds and local-group galaxies. Newer staff members have brought an emphasis on synoptic astronomy and even astrometry! Two groups using the facilities at Tololo have recently detected and then measured a remarkably high space density of white dwarfs in the halo of our galaxy, with implications for the nature of dark matter in that region of our galaxy and for the form of the stellar mass function in the early history of the Galaxy.

In support of such work, Tololo has always had a strong instrumentation program. This has resulted from a combination of carefully chosen new instruments and prioritized upgrades, i.e., new spectrograph cameras and new CCDs. Lately, much of the scientific emphasis has been on observational cosmology, as reflected in the work on Type Ia supernovae which has revealed an apparent acceleration of the expansion of the Universe, and on observational probes of large-scale structure through weak lensing and the study of MgII absorbers.

With the arrival in Chile of the VLT, Gemini South, and the Magellan telescopes, it is once again necessary to accelerate the process of change at CTIO. Our Web site illustrates the short-term changes we have already made. For the intermediate and longer term, we are in the middle of an intense process that will likely produce substantial change within CTIO. We are currently exchanging ideas with our users and outside committees. This is a tricky moment to be writing about the precise direction we are headed. Given the stimulating requirements of the Decadal Survey and the lack of significant additional funding from the NSF to carry out these requirements, it is clear that beyond the process of prioritization and re-organization within NOAO, searches for additional, non-traditional funding will be necessary -- probably through existing and new partnerships. This will help create sufficient resources to respond to these new challenges, while continuing to supply our user community with high quality, open observing access to the Southern Hemisphere skies.

Under Jeremy Mould's leadership, NOAO's process of prioritization and reorganization is underway, and CTIO is ready to do its part. Indeed, the staff is already making substantial contributions to many of the newer areas of NOAO activity. Brooke Gregory is working 2/3 of his time on the GSMT. Alistair Walker

is leading a staff group in a major survey of sites in various places, including the whole area of Northern Chile between -30 and -20 degrees latitude. Others are working closely with Celine d'Orgeville and her team from Gemini using two of the small telescopes on Tololo to characterize the nature of the sodium layer above Tololo (and Pachón) in preparation for development of adaptive optics for Gemini South and SOAR. (See cover image and the article by A. Tokovinin in this newsletter.) As reported in the last newsletter, several members of the staff have been working with Cornell University to survey in greater detail the 17,000-foot mountains around the ALMA site near Chajnantor. Bob Schommer is moving to Tucson in order to set up the NOAO Gemini Science Center. Patrice Bouchet, Stefanie Wachter, Bob Blum, and Chris Smith have all helped with the operations of Gemini North in Hawaii, thereby gaining the expertise necessary to help in a similar way on Cerro Pachón and in La Serena. Chris Smith and Ron Lambert are working with Gemini and SOAR to improve the communications bandwidth to AURA's observatory here (see article in this newsletter). Steve Heathcote is now the Director of SOAR and is returning to Chile after a year in Tucson with the SOAR construction project team. The entire former business and logistics division of CTIO, under Enrique

continued



From the Director continued

Figueroa's leadership, is now devoted to the support of all of AURA's operations in Chile (Gemini South, SOAR, and the telescopes on Cerro Tololo).

Once the commissioning of SOAR is completed, we expect significant shifts of effort within our engineering and technical services group towards support of some of NOAO's new activities. Many former members of the CTIO engineering and technical staff have transferred to the international Gemini project and are making major contributions there,

while several young, highly talented, new staff members have arrived to take their place. The next two years will see the assembly, integration, test, and commissioning of SOAR over on Cerro Pachón. We are experimenting with ways to use our new communications bandwidth to enable new styles of observing at the Blanco 4-m telescope. Don't be too surprised to find that you are eventually observing from La Serena or from home -- it is mainly a matter of bandwidth. We are currently consulting with our users to see

how we can transfer responsibility for the smaller telescopes on Tololo to university consortia as an option superior to that of closure, given the excellent site conditions on Tololo.

Continuing to improve our high standards through a period of such intense change and under likely conditions of substantially reduced funding is challenging. Please do not hesitate to send your comments or advice to me at: msmith@noao.edu and/or to the chairman of NOAO's Users' Committee.

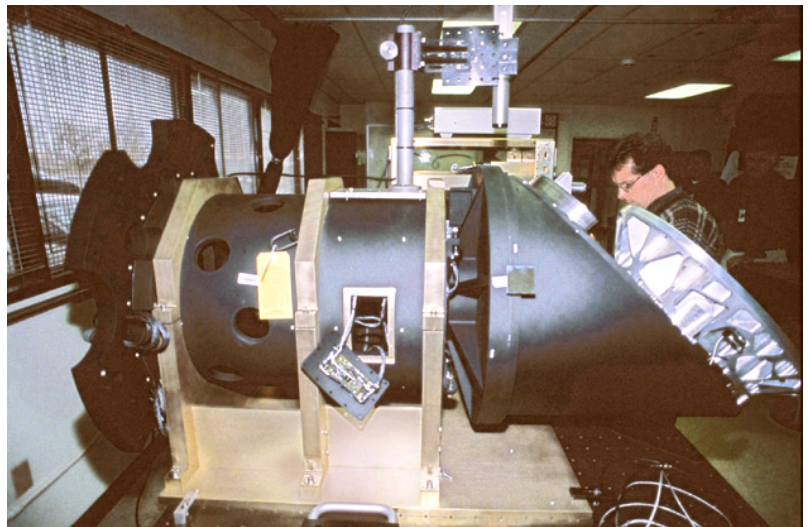
SOAR's Tip/Tilt Tertiary Nears Completion

Steve Heathcote

The control system for the Tip/Tilt Tertiary that forms the heart of SOAR's Adaptive Optics system was completed in April, while the mirror itself is now nearing completion.

SOAR's tip/tilt system consists of a 470 x 655 mm fast steering mirror, made from ULE glass, that can be wobbled about two axes driven by voice coil actuators. Pairs of position and velocity sensors, coupled to the mirror, provide the feedback needed to close the control loop with a bandwidth of greater than 50 Hz. During observations, an outer control loop, closed by a fast readout (500 Hz frame rate) CCD camera,

continued



The mechanism and control system for SOAR's Tip/Tilt Tertiary is put through its paces at the BF Goodrich facility in Albuquerque, New Mexico. For these tests an aluminum surrogate was used in place of the actual mirror.



SOAR's Tip/Tilt continued

will drive the mirror so as to null the motion of a guide star thus correcting for atmospheric tip/tilt and wind-shake. The entire mirror assembly can be rotated about its axis to direct the light to any of the five (two Nasmyth and three folded Cassegrain) focal stations.

The rear of the SOAR tertiary mirror blank is shown following completion of the light weighting process that reduced its mass by 80%.



Not Enough Stars In The Sky?

Andrei Tokovinin

Nowadays, most large ground-based telescopes are equipped with Adaptive Optics (AO) systems to compensate for atmospheric turbulence and achieve better angular resolution. To measure the perturbed wave fronts in real time, AO systems need guide stars that are bright enough and close enough to the scientific target. However, such stars are often not available, which is why astronomers want to implement artificial laser guide stars (LGSs). Furthermore, when using several LGSs, it will even be possible to do tomographic reconstruction of the instantaneous turbulent volume and to compensate it in three dimensions, a capability planned for the 8-m Gemini South telescope at Cerro Pachón.

LGSs must be high in the sky to properly simulate natural stars. The best choice is to use the glow of sodium atoms in the mesosphere, excited by a powerful laser beam. The mesospheric sodium layer has a typical altitude of 90 km and a typical thickness of 10 km. This sodium layer

is known to be highly variable on time scales from minutes to months. Sometimes strong “sporadic” layers with increased concentration of sodium appear and then slowly degrade. The properties of the sodium layer (total number of atoms, vertical profile) need to be known for a proper design of an AO system. Unfortunately, the available information is not sufficient, especially for the Southern Hemisphere, where most of the sodium LGSs are being planned.

The Gemini team took the initiative to organize a systematic campaign to measure the sodium layer in Chile. This is a collaborative project involving ESO, CTIO, and the Imperial College of London; the partners each provide financial support and each will benefit from the results. The team is chaired by Celine d’Orgeville (PI) from Gemini and consists of Gelys Trancho (Gemini), a group from CTIO (Brooke Gregory, Maxime Boccas, Andrei Tokovinin), and researchers from the Imperial College of London

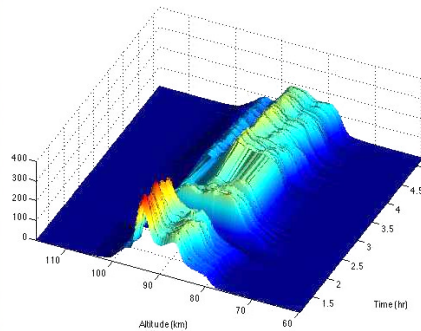
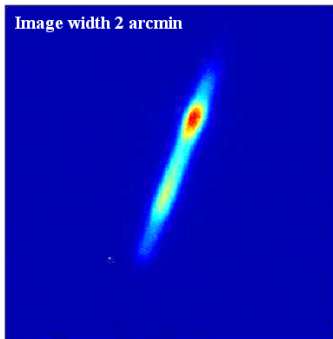
(Chris Dainty, John Quartel, Nick Wooder, and Laurent Michaille) who built the laser equipment and contributed their experience gained during previous sodium measuring campaigns (e.g., at La Palma, see Mon. Not. RAS, 318, 139, 2000).

The sodium experiment at CTIO is actually a small-scale simulation of the future LGS. The beam of a dye laser tuned to the Na D2 line is launched vertically into the atmosphere. Some light is scattered in the lower layers (0-30 km), making the beam visible even to the naked eye when standing close to the 50-cm launch telescope (see cover image). This so-called “Rayleigh cone” is not useful for AO, but its intensity is very sensitive to a presence of any additional scattering, e.g., to cirrus clouds. The sodium star has a magnitude of about 13 for the laser power of 0.4 W used in this experiment. In future systems with laser optical power of several W, stars of 10^m-11^m will be lit in the sky.

continued



Not Enough Stars continued



An image of the sodium stripe (left, artificial colors) and the temporal evolution of the sodium profile during one night (right).

The dye laser and its 7-W argon-ion pump laser are located in a utility building below the Blanco 4-m. The beam is launched through a circular hole in the roof. The sodium star is observed at the 0.9-m telescope with its standard CCD, through an interference filter for a better contrast against the sky. In this way, we see the mesospheric column of excited atoms “from the side” and we can measure the altitude distribution of sodium from the brightness profile of the observed stripe. The telescope is fixed, so stellar images in the field leave trails during the 10-30

second exposures. To measure the absolute height of the layer, simultaneous exposures are taken at the Curtis Schmidt telescope, and the displacement of the sodium stripe relative to the star trails permits us to do something like a triangulation.

The first run of this campaign took place on 12-20 February 2001. Data were taken successfully and are now being processed. Four more runs are planned until February 2002 to sample the sodium layer in different seasons. It is known already that there is important seasonal variability.

The sodium experiment is a combination of excitement (after all, it’s something unusual) and routine (monotonous data taking when everything goes smoothly), although it does not run smoothly all the time. The laser is very complex; sometimes it loses the lock on the sodium line, and sometimes additional experiments are conducted. Overall, it is a rather complicated endeavor involving three distinct locations on the mountain, many people from different organizations, and specific data processing. We hope that the results will be worth the effort, paving the road to LGS-assisted astronomical adaptive optics. Special thanks go to all CTIO staff who made this experiment possible by installing the optical table, drilling the hole in the roof, and enabling a water and power supply for the laser.

Improved Performance of the f/14.8 Tip/Tilt Secondary System at the Blanco 4-m Telescope

Patrice Bouchet and Ron Probst

The CTIO Tip/Tilt System provides first-order wavefront correction and image stabilization for infrared imaging and spectroscopy on the Blanco 4-m telescope. The system consists of a f/14.8 Tip/Tilt Secondary, driven under closed loop control by three piezoelectric activators and an accompanying controller purchased from Physik Instrumente GmbH. The Tip/

Tilt Secondary serves as limiting telescope stop to reduce the thermal background. It is mounted in the prime focus cage and swings out of the beam when access to the prime focus is needed. A detailed description of the system is given by Probst et al. and Perez & Elston (SPIE, 3352, 1998).

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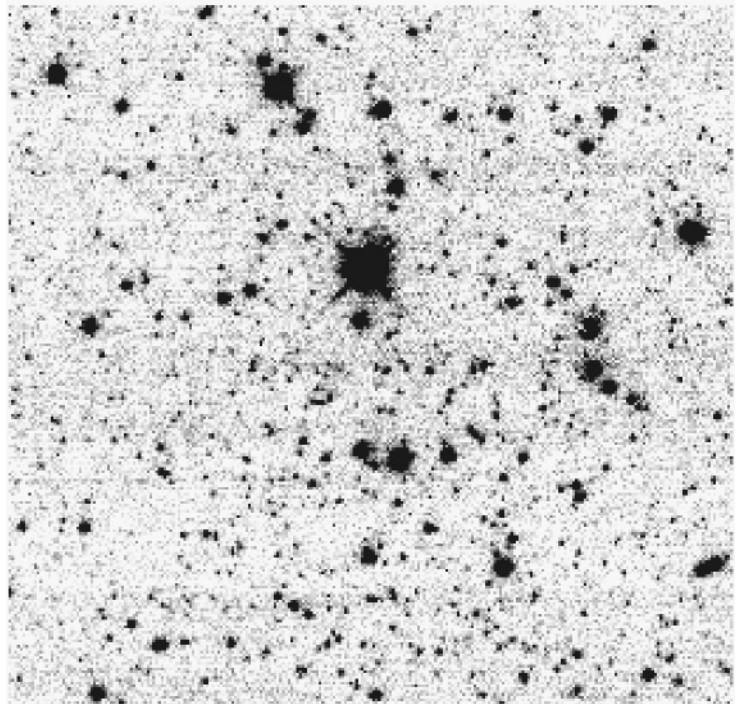


Improved Performance continued

Since the first description of the tip/tilt system the following improvements have been made:

- The CCD guide sensor. We are now using a small-field, high-speed, low-noise EEV 39B CCD. This is a 80×80 CCD with a nominal read noise of 4 electrons, and a frame rate of up to 2 KHz (for a 2×2 pixels frame without binning; standard set-up is 9×9 pixels without binning, which gives an actual correction frequency of 315 Hz). This gives a faster framing and thus allows a higher degree of correction, while lower read noise allows the use of fainter stars.
- The PC processing speed. We have acquired a Pentium P5-120 MHz processor.
- The telescope collimation. We are now operating the active primary of the Blanco 4-m telescope with a lookup table appropriated to the $f/14.8$ focus, whereas we used to adapt the $f/8$ lookup table.
- The algorithm used for the tip/tilt corrections. We have been testing various algorithms in order to optimize the corrections. Experience has shown that the so-called “centroid algorithm” gives better results than the other ones (“momentum” and “brightest pixel”; see CTIO Users’ Manual).

Two nights were devoted to the final characterization of the system (16-17 March 2001) and to determining the best setup parameters. Once these parameters were adjusted, we obtained images between 2 to 3 pixels (0.16 arcsec/pixel) with tip/tilt correction, while imaging the same fields without correction (but with guiding!) just before and after usually gave a Moffat value of 4 to 5 pixels. Obviously, the achieved correction varies with the atmosphere, and the better the “seeing,” the better the correction. However, typical conditions now deliver a “dome + outside” seeing of 0.6 to 0.8 arcsec, which translates to images in the near infrared (even in J!) regularly from 0.3 to 0.5 arcsec. The best images obtained during our engineering nights were 0.32 arcsec in H and 0.26 in K, in both cases with an exposure time of 15 minutes. The worst images were around 4 pixels (0.64 arcsec). It must be emphasized that the seeing was highly variable during these nights. Unfortunately, the CTIO seeing monitor was out of order, so we could not compare our results with it.



The center of the globular cluster M4 observed in K (with density filter) with OSIRIS and the tip/tilt system. The loop was closed on the brightest star, at a frame rate of 312 Hz. All the stars have a radial profile between 2.0 to 2.8 pixels (0.3 to 0.4 arcsec).

We found that we can obtain a fairly good correction closing the loop on a 16.5^m star (actual correction frequency of 10 Hz). Obviously a better correction is achieved for a 10-13^m star, for which we can close the loop up to a real frequency of 310 Hz. Considering the FOV of the stage range (the “panoramic” field is about 19 × 19 arcsec and can be displaced over a 6 arcmin² range), most of the science-targets fields would include a bright enough guiding star. We could not see any dependence on the angular separation between science target and reference star out to the limit of the accessible field.

In conclusion, we have now a very reliable and efficient tip/tilt system at the Blanco 4-m telescope. Both technical and user documentation exist, and reports on the final characterization are available on the web at: www.ctio.noao.edu/instruments/ir_instruments/tiptilt/. Last but not least, the CTIO operators are now very

continued



Improved Performance continued

well acquainted with the system and know how to optimize its operation, making it nearly transparent to the observer.

We would like to thank all the people from CTIO who have been involved and made it such a success. R. Elston (U. Florida) was the initiator of this project, together with G. Perez (now at Gemini). R. Schmidt, G. Schumacher (SOAR), and E. Mondaca developed,

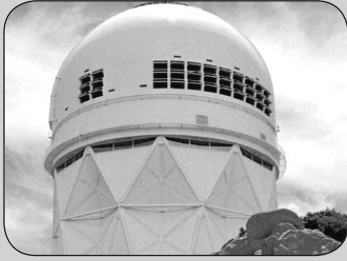
improved, and characterized the tip/tilt system. E. Mondaca also must be credited for the education and training of the technical staff at CTIO, as well as for the technical documentation. M. Boccas enthusiastically helped Patrice Bouchet build the “turbulator” which was used in La Serena to check most of the features of the system. Finally, R. Cantarutti applied his “magic fingerprints” to the algorithms and the user interface. Many thanks to all of them.

Other Happenings at CTIO

- With the help of a grant from the National Science Foundation, CTIO and Gemini together have recently installed a **new network link** connecting the La Serena offices to the telescopes on Cerro Tololo and Cerro Pachón. The new system provides a 155 Mbps “OC-3” link using new radio dishes mounted on a tower in La Serena, on the side of the Blanco 4-m, and on a small tower on Cerro Pachón. The connection will be shared between the Gemini South telescope on Cerro Pachón and NOAO-operated installations on both mountaintops (SOAR on Pachón, CTIO telescopes on Tololo). This jump in bandwidth will enable a new generation of remote support and operations from La Serena, opening exciting possibilities of remote observer support with parallel audio-video and computer connections and perhaps eventually remote observing from La Serena. Gemini and CTIO have now turned their attention to the relatively slow international link, in hopes of upgrading it soon to provide remote support and observing capabilities for both observatories from Tucson, Hawaii, and other locations in the US and around the world.
- Thanks to the hard work of many people, in particular Tom Ingerson and Roger Smith, a **camera designed especially for use with the Hydra-CTIO Bench Spectrograph** has been installed. The new camera produces significantly sharper images than the interim Air Schmidt, allowing use of all ~130 available 2” fibers in a single observation. Its SITE 2K×4K detector also has lower read noise ($3 e^-$) than the Loral 3K×1K CCD used with the Air Schmidt. The low read noise is especially important for faint object spectroscopy.

Prospective users of Hydra-CTIO should be aware that it is a demanding and complex instrument. Advice on producing accurate astrometry and preparing observing fields can be found at: www.ctio.noao.edu/spectrographs/hydra/hydra.html. We encourage observers to plan to be on the mountain one night early if they are new to the instrument.

- Since February, the scientific staff of CTIO and Gemini have been getting together for **journal club**. We meet in the conference room every Wednesday morning at 10:30 am to discuss recent literature. Please feel free to join these discussions whenever you are in La Serena.
- On April 26, NOAO Director Jeremy Mould, KPNO Director Richard Green, and other **Tucson staff met with La Serena Mayor Adriana Peñafiel**, Pedro Sanhueza, Director of the Office for the Protection of the Quality of the Sky of Northern Chile, Enrique Piraino, a lighting engineer with the Universidad Catolica de Valparaiso, and CTIO Director Malcolm Smith to discuss dark-sky issues and joint public outreach possibilities.



K P N O

Operations

Spectroscopy of “Real” Auroral Lines

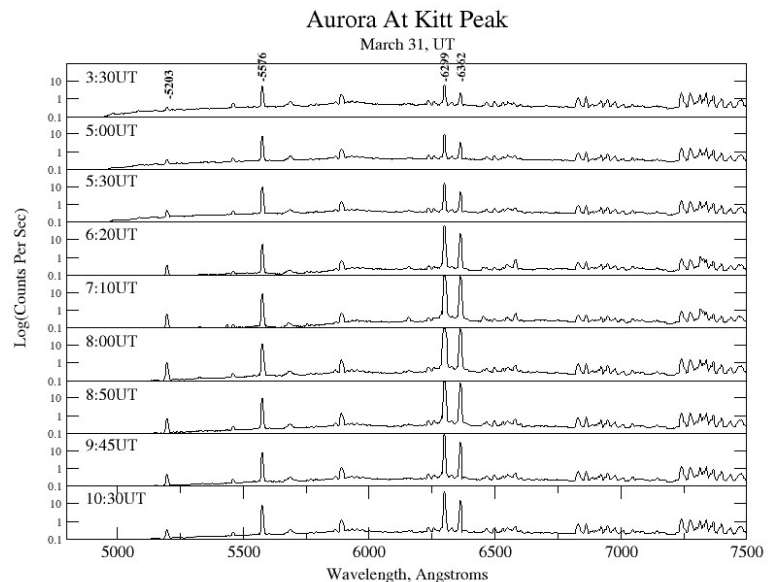
John Glaspey and Charles Corson

On 30-31 March 2001, Phillip Richter (Wisconsin) was observing quasar fields on the 3.5-meter WIYN Telescope on Kitt Peak with Charles Corson (NOAO) using the DensePak fiber array and the Bench Spectrograph, when the sky lit up in a brilliant red color. Auroral displays of such intensity are rare in southern latitudes, but strong solar flares during periods of solar maximum make them possible even at Kitt Peak, which is at a magnetic latitude of about 40 degrees, about 50 degrees from the north magnetic pole.

(An interesting collection of color images obtained around the world from this particular event can be viewed on the Web at: www.spaceweather.com/aurora/gallery_31mar01.html)

Although bright sky emissions are never welcome during astronomical observations, particularly those intended for deep, faint object detections, it was interesting to find out what wavelengths were contributing to the auroral light. Luckily for fans of aurora science, the spectrograph configuration in use

covered wavelengths from 4800 Å to 10,000 Å. The figure shows a time lapse record of the auroral spectra on a logarithmic intensity scale.



The spectra show “quick look” reductions using the four sky fibers and two random array fibers of DensePak. The first spectra at 3:30UT represents the “normal” sky, prior to any auroral activity seen by the naked eye.

Margaret Edmondson Fellowship

Richard Green

The Margaret Edmondson Fellowship program provides an opportunity for astronomy graduate students to gain hands-on experience with instrumentation through support of extended visits to Kitt Peak to work at the WIYN Observatory. This year's fellowship support goes to Brent Bryan of Yale University. Bret received his B.A. in Astronomy/Physics and Mathematics from Whitman College in Walla Walla, Washington in May 2000. He is working this summer with Chuck Claver on the assembly, integration, and lab testing of the WIYN Tip/Tilt Module. Brent's efforts are particularly appreciated because a critical period of assembly and testing coincides with the optics realignment of the 4-meter after aluminizing, requiring Chuck to be in two places at once.

The Fellowship was founded by a generous donation from Dr. Frank Edmondson, Emeritus Professor of Astronomy at Indiana University. The gift memorializes his wife, Margaret Russell Edmondson. (See the March 2000 Newsletter for further details.)



USGP

U.S. GEMINI PROGRAM

Status of the Gemini Telescopes

Bob Schommer

During 2001A, Gemini North has been striving to operate in 50% science and 50% engineering mode. Telescope engineering has included work on efficiency improvements in acquisition and guiding, active optics improvements, mirror cover mechanical work, and high-resolution wavefront sensor performance.

Classical observing runs have been scheduled and executed with the visitor teams for OSCIR and Hokupa'a. See the telescope schedule at: www.us-gemini.noao.edu/sciops/schedules/schedIndex.html. Two US observers received data from the "mini-queue" operated by USGP, and more mini-queue observations are scheduled in June.

During the acceptance tests of NIRI (the University of Hawaii Near-InfraRed Imager) on Gemini North over the past several months, it was found that NIRI exhibited "flexure." This image motion instability problem was far larger than expected and outside the original NIRI science requirements. Though various attempts at correcting the problem have led to gradual improvements, none of these has achieved an acceptable performance. Both the IfA and Gemini accepted that further commissioning of NIRI would be suspended and that priority would instead be directed at fixing its image motion problems. This fix involves redesigning and re-engineering the steering motor that is responsible for the majority of the flexure. The IfA and the Gemini Observatory will proceed on the assumption that NIRI will be available for Semester 2001B, although NIRI will not be formally scheduled before September 2001.

GMOS, the optical imager and spectrograph, passed laboratory acceptance testing in Edinburgh and arrived in Hilo in mid-April. Lab testing with the combined UK and Canadian instrument teams will proceed through May, and first telescope tests are scheduled for the (northern) summer.

The Gemini South telescope is undergoing commissioning tests now and will ramp up to 25% science time starting in semester 2001B. Current efforts include pointing and tracking tests, active optics system work, and implementation of the closed

cycle helium system. NOAO is shipping a near-IR imager (Abu) to Gemini South in May, and commissioning images are due to be taken near the end of the month.



GMOS-N (the Gemini Multi-Object Spectrograph for Gemini North) is delivered! Here, Gemini staff members Chas Cavedoni, James Patao, and Wendy Mays unpack and inspect the new instrument.

Learning about how to make best use of Gemini and keeping up with the fast pace of new instrumentation can be challenging, but USGP is here to help. NOAO staff involved with the US Gemini Program are available to visit your institution to give colloquia and seminars on Gemini and to provide hands-on training for submitting Gemini proposals and learning to use the Phase II tool for planning observations. If you would like to schedule a visit from one of us, please contact the USGP Administrative Support Officer, Sally Adams, at sadams@noao.edu.

In addition to presentations and training, visiting staff are interested in hearing your views on the future directions of Gemini. How can Gemini play a more important role in your scientific research? Visiting staff will also schedule discussion panels to explore future options for Gemini and to identify goals important to US astronomers.



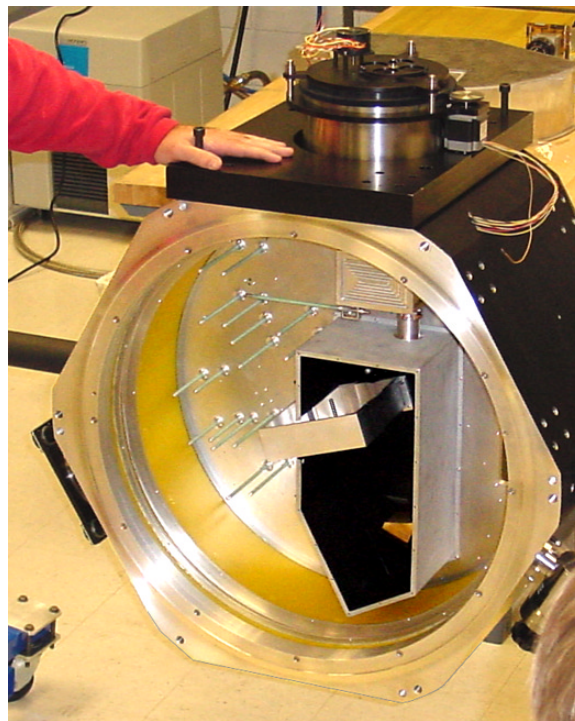
US Gemini Instrumentation Program Update

Taft Armandroff, Mark Trueblood, and Ken Hinkle

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 T-ReCS optics have been mounted together and tested at room temperature, demonstrating good optical performance. Mechanical parts fabrication is essentially complete. The dewar has been vacuum tested, has had its mechanisms installed, and has undergone cold tests that have demonstrated good thermal performance. Software development for mechanism control is nearing completion, and electronics development is progressing well. The team is in the midst of system integration and testing, which will culminate in T-ReCS's Pre-Ship Acceptance Test. A USGP Quarterly Review of GNIRS occurred on April 19, and USGP expects the Pre-Ship Acceptance Test to be completed this summer.

GNIRS, the Gemini Near-Infrared Spectrograph, is a long-slit spectrograph for the Gemini South telescope that will operate from 1 to 5 microns and will offer two plate scales and a range of dispersions. The project is being carried out at NOAO in Tucson under the leadership of Neil Gaughan (Project Manager) and Jay Elias (Project Scientist). Fabrication of GNIRS parts is underway at NOAO and at subcontractor facilities. In

particular, the construction of the GNIRS optical benches, that provide support for the optics and mechanisms, is nearly complete. GNIRS held a Mid-Fabrication Review on March 7. The review committee examined the GNIRS team's progress on mechanical design, mechan



The T-ReCS dewar during mechanism attachment on 19 April 2001. The window changing mechanism is shown on top, with the aperture wheel mechanism, the filter wheel box, and one of the diamond-turned mirrors also visible. The forearm of the T-ReCS mechanical engineer, Jeff Julian, provides a perspective of scale.

ical fabrication, electronics design, electronics fabrication, software, and procurement, and delivered a positive report. The team expects to begin subsystem integration late this summer, with delivery expected in the fall of 2002.

NICI, the Near-Infrared Coronagraphic Imager, is funded by the NASA Origins Program. NICI will provide a 1-5 micron infrared coronagraphic imaging capability on the Gemini South telescope. Mauna Kea Infrared (MKIR) was the successful competitive bidder for the NICI conceptual design study and the only respondent to an RFP for building the instrument. NOAO awarded a contract to MKIR for the detailed design and fabrication of NICI. USGP visited the contractor in February to review the development of a Management Plan consisting of a Project Plan, Work Breakdown, and a detailed schedule; the complete Management Plan was delivered in early April. The Preliminary Design Review is scheduled for March 2002.

Phoenix is a high-resolution near-infrared spectrograph that has been in productive scientific use on the KPNO 4-m and 2.1-m telescopes. Phoenix yields spectra with resolution up to $R=70,000$ in the wavelength range 1 to 5 microns. Phoenix will be shared equally between Gemini South and CTIO/SOAR and offered as a Visitor Instrument on Gemini. An IGP-provided ALAD-DIN InSb array has been installed in Phoenix. Additional mechanical upgrades were performed, and Phoenix was used on the Kitt Peak 4-m telescope for twelve nights in March. The modified Phoenix performed well, and the high quality of the new

continued



Instrumentation Update continued

InSb array has yielded a significant improvement in Phoenix's sensitivity. The fabrication of the interface unit and counterweights that will attach Phoenix to the Gemini Instrument Support Structure is nearing completion. Phoenix will be shipped to Gemini South during the northern summer of this year.

Phoenix will be offered to users starting in the 2002A semester. While Phoenix is a very good optical and scientific match to the 8-meter Gemini telescopes, it originally was designed for use on the 4-meter Mayall telescope at Kitt Peak. Similar in size and weight to other instruments on the Mayall telescope, Phoenix nearly fills the 4-meter Cassegrain cage and weighs slightly over a half ton. To be mounted on Gemini, Phoenix must match much larger weight and moment specifications, which require that about one ton of counter weights be mounted with Phoenix.



Phoenix instrument scientist Ken Hinkle sits on the handling frame for mounting Phoenix on Gemini, holding one of the 60-pound steel counter weights. The pallets to the right hold additional counter weights and handling equipment.

GMOS CCDs

NOAO is responsible for procuring the CCDs for the two GMOS spectrographs, and for integrating the CCDs with a dewar provided by the GMOS team, Gemini-provided CCD controllers, and other Gemini subsystems. For GMOS II for Gemini South, the CCD dewar was

shipped for integration with the spectrograph in March 2001, completing the deliverables from NOAO and GMOS. Next, the NOAO team, including Richard Wolff and Rich Reed, plans to work on the CCD hardware and software for the bench HROS for Gemini South.

Gemini Proposals for 2001B and 2002A

Caty Pilachowski

NOAO received 77 proposals for time on the Gemini telescopes during the 2001B semester, requesting 94 nights on Gemini North and 33 nights on Gemini South. Oversubscription factors are about 2.5 on Gemini North and 2 on Gemini South. The most popular instruments were NIRI and GMOS on Gemini North and OSCIR on Gemini South. For 2001B, proposers had the option of using either the NOAO proposal form or the Gemini Observatory Phase I Tool, and we received five proposals submitted with the Phase I Tool.

US Gemini proposals were reviewed by the NOAO TAC in early May, and accepted proposals were immediately

forwarded to the International Gemini Observatory for review by IGO's International TAC in mid-June. The Gemini schedules will be posted in late June, following e-mail notification to investigators.

We anticipate the next call for proposals for time in the 2002A semester on the Gemini North and South telescopes will occur in late August, with proposals due on 30 September 2001. Interested observers should keep a close watch on the NOAO Web site at that time. The instrumentation to be available on each telescope will be announced then as well.



Gemini Remote Observing Center Underway

Caty Pilachowski

The USGP is establishing a Remote Observing Center in Tucson with high-speed Internet connections to both Gemini sites at Mauna Kea and Cerro Pachón. The Remote Observing Center will be used by NOAO staff for instrument commissioning and support of US observers on both Gemini telescopes. This facility will enable NOAO staff to participate more fully in the support of Gemini users and in support of US instrumentation efforts on Gemini. Staff will also use the Observing Center for training and for conducting engineering programs to enhance the productivity of Gemini observing. Although the Gemini Observatory as yet has no policy on

remote observing, we hope eventually to offer the Center for use by visiting observers.

The NOAO Gemini Remote Observing Center will be located in the IRAF Lab in the basement of the Tucson headquarters. In addition to high-speed Internet connections, the Center will be equipped with voice and video communications to Gemini control rooms. We anticipate that the Remote Observing Center will begin operations within the next few months to allow NOAO/Tucson staff to assist with commissioning of Abu and Phoenix on Gemini South, and with support of other NOAO-supplied instrumentation, such as array controllers and CCDs.

Gemini Phase II Observing Tool Released

Caty Pilachowski (NOAO) and Phil Puxley (IGO)

The International Gemini Observatory has announced the release of the Gemini Phase II Tool. The tool is to be used for all queue-mode programs using Gemini facility instruments and is recommended for classically-scheduled programs as well.

Data are extracted from successful Gemini proposals and imported into the Phase II Database at the Gemini Observatory. The Phase I information forms a skeletal description of each observation that must be further refined in Phase II. Investigators are notified by e-mail that their proposal has been ingested and provided with a password for access to their own observations. Observing plans can then be downloaded and refined off-line (i.e., disconnected from the Gemini site) using the Observing Tool. The Tool

is the only supported means of generating complete observing plans and of ensuring their validity.

After completion of the detailed definition, the observing plans are uploaded back into the Phase II Database by the investigator, who notifies the Gemini Contact Scientist by e-mail. The Contact Scientist then performs a verification that all necessary information is present and copies the observations into the Active Observing Database. Once in this database, the observations are available to be executed.

NOAO's USGP staff are available to assist Gemini users prepare their Phase II programs. The Tool itself can be obtained from the Gemini website at: www.us-gemini.noao.edu/sciops/ObsProcess/ObsProcIndex.html.

Plans for the bHROS

Bob Schommer

The High Resolution Optical Spectrograph (HROS) project encountered significant setbacks over the past year, including loss of critical personnel. In early January, the UK instrument team opted to rescope HROS into a fiber-fed bench spectrograph (labeled bHROS). The baseline design is for an R=150,000 (3-pixel resolution) instrument with an iodine cell option; an extension to R=300,000 was regarded as "straightforward." An aggressive schedule and new management plan proposed that this instrument be delivered to Gemini South in mid-2002.

The baseline design is a fiber-fed image slicer, with 0.7-arcsec and 1.0-arcsec focal plane implementations being explored. Of course, this will not be as efficient as the original beam-fed Cass instrument design. Current cal-

culations, however, show a relatively efficient system with throughputs (including fiber losses and focal ratio degradation) approaching 16% to 17% between 5500-7000 Å. S/N ratios for 0.33 arcsec spatial binning (unbinned pixels are 0.033 arcsec), for a 3600s integration give about 10/1 on a B=17th mag object. This is about one magnitude brighter than the R=120,000 camera that was an original HROS option.

The R=300,000 option adds a Barlow lens before the camera (and relocates the camera). This looks to be inexpensive and very attractive. A third option called "oneshot" involves using the original HROS camera to give full coverage and R=34,000. Since this option involves a second camera and detector system, it will require significant additional resources to implement. This new bench HROS is scheduled to undergo a design review in mid-May.

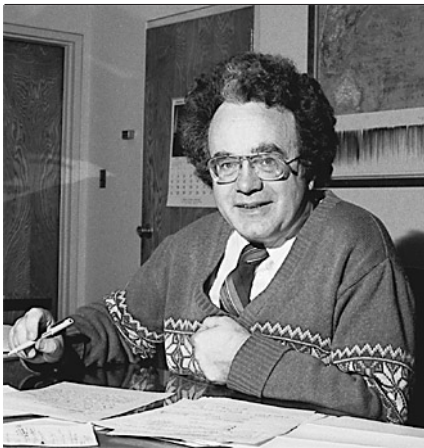


National Solar Observatory

From the NSO Director's Office

Steve Keil and Mark Giampapa

Jacques Beckers retired on March 30, after more than 35 years of service to NSO and the astronomy community. Jacques has shared his vision through leadership roles that include serving as Director of NSO (1993-98), Director of the NOAO Advanced Development Program (1984-88), Director of the Multiple Mirror Telescope Observatory (1979-84), and leading the Very Large Telescope effort at the European Southern Observatory as Program Scientist



(1991-93). His extensive scientific contributions have been recognized by the award of the National Academy of Sciences Arctowski Medal in 1975 for research in solar physics, and by memberships in the Academies of Sciences in The Netherlands and Norway. Jacques' contributions to solar and stellar instrumentation and to the understanding of atmospheric seeing, as well as his

large telescope designs for both solar and nighttime astronomy, have left an enduring legacy. Jacques will continue to contribute to astronomy as an NSO emeritus astronomer and as a senior scientist in the University of Chicago Department of Astronomy and Astrophysics. We wish him the best in his future endeavors and look forward to his continued participation in the Advanced Technology Solar Telescope (ATST) project.

The ATST proposal received a favorable review at NSF and funding levels for the design and development phase are now being negotiated with the Foundation. We hope to begin the design phase this summer. Plans for launching the site survey are starting to come into place, and the site survey instrument program is described in a subsequent article.

The upgrade of GONG from a 256×256 array to a 1024×1024 array is nearing completion, and we expect the last unit to be installed this summer. At that point, the full GONG+ system will be operational. The next step will be to install computer hardware that can handle the enhanced data flow and transition into GONG++ operations that will enable routine local helioseismology.

The low-order Adaptive Optics (AO) system at the Dunn Solar Telescope continues to provide spectacular results and has become a standard part of the

observing setups. Efforts to improve performance and make it a user-friendly system are nearing completion. The high-order (80 degrees of freedom) AO development program is now well underway. Recent results from that program are presented in the "Science Highlights" section of this newsletter.



We are delighted to announce that Rebecca Coleman is this year's recipient of the AURA/NSO service award, and Rachel Howe and Rudi Komm are the joint recipients of the 2001 AURA scientific achievement award. Rebecca has been on the NSO staff at Sacramento Peak since 1987. She started in a part-time position and has progressively increased her responsibilities to her current position as administrative assistant. The

continued

Director's Office continued

service award reflects the dedication and professionalism with which Rebecca has performed a multitude of administrative and personnel support tasks. Among her many responsibilities, Rebecca's handling of the logistics for the NSO/SP workshops and visitor housing has contributed significantly to the reputation of NSO and to the popularity of our workshops in general. Rebecca is an extremely efficient, organized, and hard working employee who has had broad impact on many NSO users, visitors, and staff.

Working together and with colleagues around the world, Rachel Howe and Rudi Komm (see photo at right, with AURA President William Smith) have made significant contributions to our knowledge of the interior of the Sun and its variation through the solar cycle. Of particular note is their recent discovery that the rotation rate near the base of the



solar convection zone, in the region where it is believed that the solar dynamo originates, increases and decreases rhythmically with a period of 1.3 years. This surprising finding, based on their analysis of GONG

data and subsequently verified with measurements from the SOHO spacecraft, provides significant new information on the temporal evolution of the internal dynamics of the Sun. Congratulations Rebecca, Rachel, and Rudi!

SOLIS

Jack Harvey

The SOLIS project continues to make progress toward initial operational capability late in 2001. Major recent highlights include the first trial fitting of pieces of the Vector Spectromagnetograph (VSM) in its housing, completion of the software and electronic interfaces of the VSM mechanisms, continued progress on software that presents the VSM data to the community, and intense efforts to acquire cameras for the VSM. After a successful review of plans for data handling, the project and its NASA partner have made the first installment of the major computer hardware purchases.

Data reduction emphasis was mainly on reviewing and initiating hardware purchases for the final plan to handle data. Some high-level algorithms to produce user-friendly data products were tested using data from the Kitt Peak Vacuum Telescope (KPVT) obtained during the recent burst of solar activity. At another recent observing session with the KPVT, it became apparent that it should be possible to easily obtain simultaneous chromospheric and photospheric longitudinal-component magnetograms using SOLIS.

The SOLIS mounting is temporarily located at the GONG prototype site in Tucson. Motor and tracking tests continue. Preparations for moving the mounting to the top of the KPVT are under study. A failure of the northwest clamshell hydraulic ram occurred, however, and the long-term viability of this weather-protection system is under review.

The three major instruments are in various states of completion. The Vector Spectromagnetograph main support structure was received from

continued

Solis continued

the paint shop, and this 1,500-pound element is now mounted on its handling cart in the solar lab for final assembly and checkout.

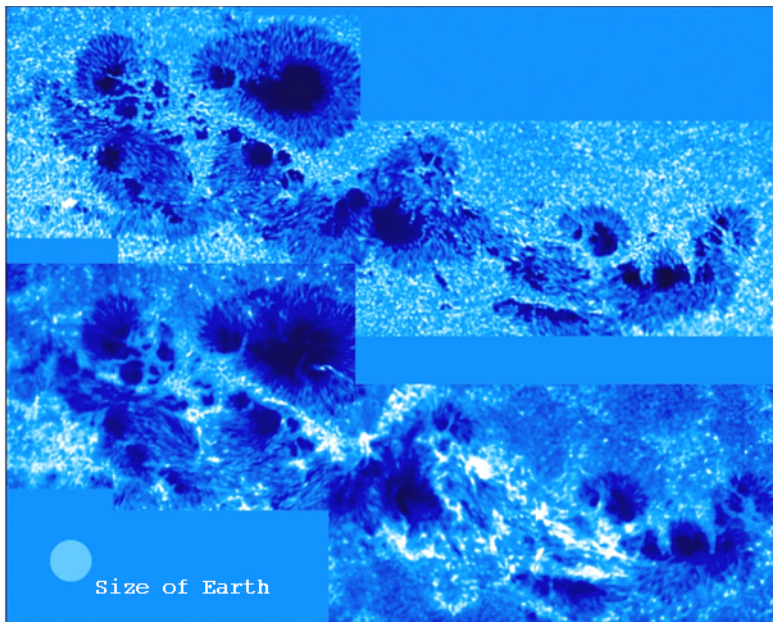
Preparations have been made for high-reflectivity silver coating of the VSM primary and secondary mirrors and ancillary optics. After a vendor site visit, a lifting/rotating band for the primary mirror was designed and is being fabricated.

A long delay has been associated with slow fabrication and delivery of custom CCD cameras for the VSM. The vendor has undergone a major reorganization and now plans to produce usable CCDs by August 2001. Two backup plans for acquiring interim camera systems were developed. After intense study, however, one was eliminated due to its failure to meet one critical requirement and the large amount of in-house effort that would be needed to make it usable. A detailed response from the other vendor was received and upon review deemed to be a viable interim camera option. The project is working through the technical details and negotiating the procurement of these interim cameras.

The two 2K × 2K CCD camera systems for the Full Disk Patrol (FDP) were received and were tested. One camera failed to produce an image, and the other one produced an image with many defects. We are working with the vendor to resolve these difficulties. Two birefringent filters for the FDP are under construction. The 1083 nm filter optics are in assembly, while parts for the tunable 380-660 nm filter are still being built.

Most Vigorous Sunspot Activity in a Decade Recorded

M. Sigwarth, J. Elrod, K. S. Balasubramaniam, S. Fletcher (NSO)



This composite image shows the largest sunspot group of the current 23rd solar activity cycle at two different wavelengths in the blue part of the solar spectrum. The data were obtained on 29 March 2001 (14:45 - 15:30 UT) at the Dunn Solar Telescope at Sacramento Peak. At that time, the sunspot group was located close to the solar meridian and extended over more than 220,000 km (compared to the Earth's diameter of 13,000 km).

During its first transit across the solar disk from 22 March to 3 April 2001, this active region caused several major solar flares and coronal mass ejections (CMEs). The largest solar flare now on record occurred on 2

April 2001. On March 29, a smaller X-class flare occurred. Associated with this energy burst was an Earth-directed CME and a high-energy particle event that caused an aurora that was visible even in northern Mexico. This flare occurred a few hours after this image was taken, while a smaller ongoing flare is captured in the central part of the spot group.

The upper image is a composite of four individual frames, taken in the "G-Band," a molecular band-head of the CH molecule. Images taken in this 1 nm wide spectral range, centered around 430.5 nm, show the typical photospheric

continued



Vigorous Sunspot continued

intensity pattern, with granulation and sunspots at high contrast. Small-scale magnetic structure, as well as specific granules, often appear brighter than in other continuum wavelength ranges. The reason for this effect is not completely understood.

The lower image was taken in the line core of the strong absorption line of ionized calcium at 393.4 nm (Ca II K). The image is also a composite of four frames, taken with a 0.3-nm wide interference filter in the same time span that the above G-Band images were obtained. The line core of Ca II K is formed in the high photosphere and lower chromosphere. Hot gas in these layers is causing emission within the absorption line core. The bright (hot) areas are mainly visible to the right of the spot group. Here the complex magnetic field structure very likely leads to magnetic energy release that is heating the solar plasma. The intense brightening on the right side of the central spot, for example, is related to a small flare at this location.

Molecular Spectroscopy Research at NSO

Leah O'Brien (Southern Illinois University at Edwardsville)

The McMath-Pierce Solar Facility supports a program of laboratory measurements on gas phase molecules through funding by the National Science Foundation Division of Chemistry. Leah O'Brien is one among a group of visiting investigators from various institutions in the US and Canada who has conducted research at the McMath-Pierce 1-m Fourier Transform Spectrometer (FTS) for more than a decade. Her research activities have focused on high-resolution spectroscopy of metal-containing radicals, such as CuO, CuS, CuCl and AgO. These types of molecules can be used to understand the nature of metal-ligand bonding. These molecules are important in solid-state materials, such as high-temperature CuO-based superconductors, and are part of the active site in several enzymatic reactions.

O'Brien's experiments are based on Fourier transform emission spectroscopy, with special interest in record-

ing rotationally-resolved molecular electronic transitions. The objective of her research program is to provide many fundamental molecular constants for diatomic metal-hydride, metal-oxide, and metal-nitride molecules. The significance of the research is based on the interpretation of the obtained molecular constants, especially as they relate to chemical structure, bonding, and molecular reactivities. Using the FTS at Kitt Peak, O'Brien and her students have been successful in recording the electronic spectra of CuO, CuS, NiCl, AgO, AgCl, and AuCl. Several methods are used to obtain electronically-excited, gas-phase radicals. These include a hollow cathode sputter source, microwave discharge, and a King-type carbon tube furnace. The FTS at Kitt Peak is a unique instrument with high sensitivity at high resolution, which makes it a superb instrument for this work in molecular spectroscopy.

The ATST Site Survey

Frank Hill

One of the most important decisions for the Advanced Technology Solar Telescope (ATST) design and development phase is the location of the telescope. Many site characteristics are factors in both the science goals and the technical design challenges: seeing is a major determinant of the spatial

resolution and impacts the adaptive optics; dust content contributes to the scattered light level and must be considered in studies of optics contamination and heat transfer; and water vapor content is a factor in infrared observations. Other site characteristics must be considered in the overall facility design: geology,

meteorology, the environment, and logistics all play a role in shaping the structure.

NSO has embarked on a site survey to select the location for the ATST. The survey will be conducted in four broad phases: the establishment of a

continued

ATST Site Survey continued

set of site requirements, the identification of candidate sites based on surveys of meteorological and nighttime data, the testing of a set of viable candidates with a range of instrumentation, and the selection of the best available site. The first three of these phases are underway in parallel.

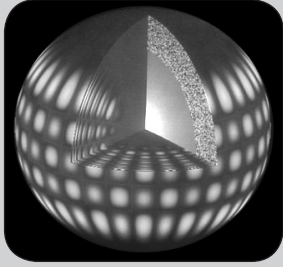
The highest priority science of the ATST is high-resolution magnetic field studies, and thus the most heavily weighted site characteristics are the daytime seeing statistics and clear time fraction. NSO has developed an instrument to quantitatively estimate these factors. This instrument consists of a Solar Differential Image Motion Monitor (S-DIMM) and an array of six scintillometers. The device will provide measurements of the Fried parameter (r_0), the fraction of clear time, the scintillation, and the height dependence of the structure function over 1 km near the ground. The instrument and a weather station will be mounted on a tower six meters in height. A second device will be added later to measure the sky brightness near the Sun, and the precipitable water vapor content of Earth's atmosphere. The viable sites will be tested for one to two years.

NSO will build at least six of these instrument packages. Three locations have been selected for testing with these devices: Big Bear Solar Observatory in California; Observatorio del Roque de Los Muchachos on La Palma in the Canary Islands, and Sacramento Peak. It is likely that another package will be deployed to a site in Hawaii, and the locations



Site Survey Working Group Chair Frank Hill with the ATST S-DIMM/scintillometer array mounted on top of the Dunn Solar Tower at Sacramento Peak. The two large holes (left panel view of the instrument) are the entrance apertures for the S-DIMM; the bar across the center holds the six scintillometers.

of the last two units remain under discussion. We expect that the first system will be installed at Big Bear this summer, with the other units to be deployed throughout the rest of 2001.



G O N G

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, do the basic data reduction, provide the data and software tools to the community, and coordinate analysis of the resulting rich data set. GONG data is available to any qualified investigator whose proposal has been accepted. Information on the status of the Project and its scientific investigations, as well as access to the data, is available at: www.gong.noao.edu.

It has been an extremely busy time as we continue to operate the GONG Classic network and to support the GONG+ deployment effort, which is now in full swing. Since January, we have passed several milestones: acceptance testing and integration (which wasn't trouble free!); an extremely useful Deployment Readiness Review, in which two former GONG VIPs, Jim Kennedy and Rob Hubbard, participated; and the deployment of the first GONG+ systems to Big Bear, CTIO, and Learmonth. Shipments to the remaining sites – Udaipur, Mauna Loa, and El Teide – are in route or on the dock, and the deployment teams are scheduled to follow in alternating three-week

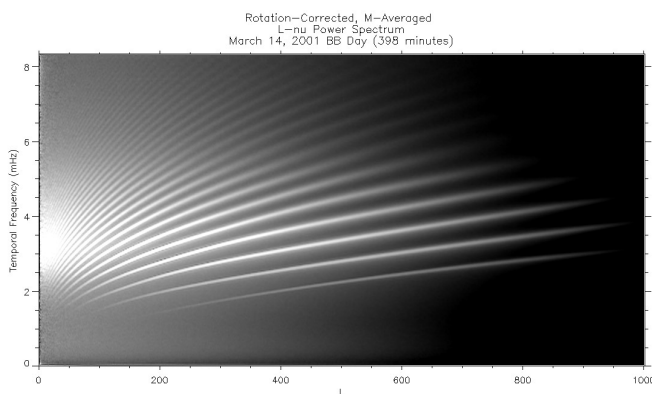
visits. Completion of the GONG+ deployment should culminate on Friday, the 13th of July, but we anticipate a few “opportunities” between now and then.

The Learmonth deployment completes a three-site network and marks the transition to GONG+ network operations. The Big Bear/Tucson GONG+ comparison (correlation coefficients of order unity for $\ell < 300$) suggests that we can successfully merge the GONG Classic and GONG+ data, which might improve the duty cycle during the network transition to the new cameras.

Operations

Readying the GONG+ systems for deployment has kept the operations staff extremely busy. In addition to the troubleshooting and repair of recent instrument problems and the usual daily tasks necessary to keep the GONG Classic network operational, there has been the development, production, and acceptance testing of the GONG+ hardware and software. The difficulties encountered along the way forced a delay of the GONG+ system deployments and required additional investment of resources to sustain progress toward achieving an acceptable system. There was also the need to document the GONG+ hardware and software modifications, develop new installation and operator maintenance manuals, and compile training procedures for our

continued



The first Big Bear GONG+ data for 7 hours showing excellent sensitivity out to ℓ of 1000



GONG continued

on-site staff. Time was also invested in updating inventories, packing and crating the hardware, and tending to many shipping and customs details.

All the hard work is finally paying off. GONG+ is a reality! After a successful Deployment Readiness Review on February 28, Team A (Roberta Toussiant, Roy Tucker, Sang Nguyen, and Guillermo Montijo) departed for Big Bear on March 5 to deploy the first GONG+ site, and were joined a week later by Team B (Ron Kroll, Lana Britanik, and Bert Villegas). The visit by Team B lasted only one week, but members gained some valuable field experience with GONG+ and were able to provide some help to Team A as well. Team A then stayed on for a third week to complete the installation. Team B has subsequently completed the CTIO installation, and Team A is back on the road to Learmonth. Each site visit incorporates not only the changeover to the GONG+ configuration, but also long overdue preventive maintenance work, which has been delayed for nearly two years to coincide with the deployments.

The order of remaining deployments is: Udairpur (Team B), Mauna Loa (Team A), and El Teide (Team B). Each visit is scheduled for three weeks, and is situated back-to-back so there will be minimal, if any, overlap of the two teams in Tucson until the scheduled end of the deployments in mid-July.

Data Management and Analysis

During the past quarter, the Data Management and Analysis Center (DMAC) produced month-long (36-day) velocity, time series, and power spectra for GONG months 52, 53, and 54 (ending 000831), with respective fill factors of 0.84, 0.82, and 0.77. Tables of mode frequencies were computed from the power spectra using the three-month-long time series centered at GONG months 51 and 52.

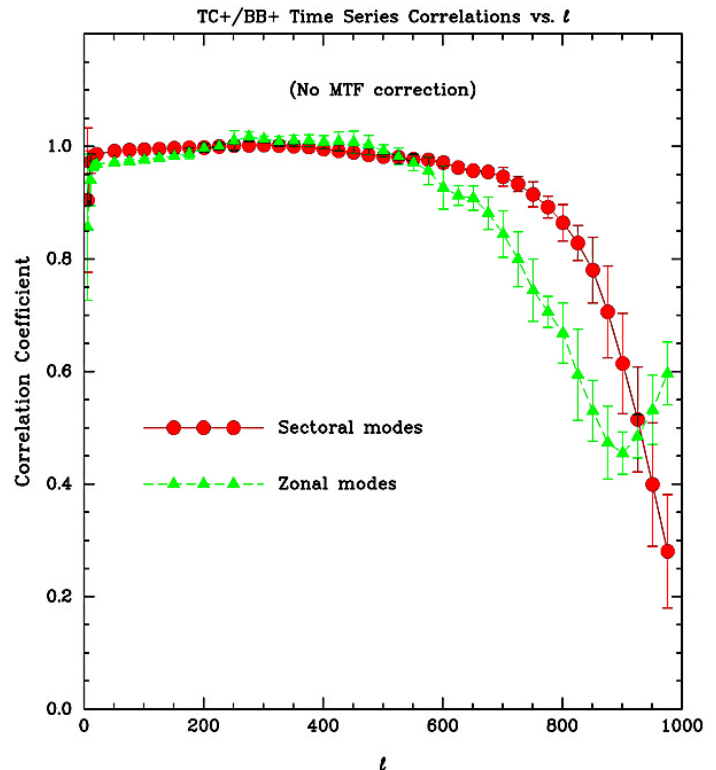
The DMAC continued upgrading systems and applications for the reduction of GONG+ data, and routinely processed data acquired by the

Tucson engineering test site through site day ℓ - v power spectra. Late in the quarter, the first GONG+ site-days from the upgraded Big Bear observing stations were processed.

Data Algorithm Developments—and Some Science

Now that he has two sites (Big Bear and Tucson) to analyze, Cliff Toner is working on the merging of the GONG+ data. He is carefully measuring the relative angular offset between the two sites and is able to achieve a precision of 0.003° . In the process of this analysis, Cliff has rediscovered one of our instrumental quirks — there is a small periodic error in the camera rotator encoder, which is now visible in the angular offset between two GONG+ sites. This error has a magnitude of 0.01° and

continued



Correlation between simultaneous Big Bear and Tucson observations



GONG continued

is sinusoidal with a period of 10° in camera rotator position angle. While this error is negligible for GONG Classic-style analysis up to ℓ of 200, it will probably be noticeable in local helioseismic analyses. Luckily, this error can be measured with a Ronchi grating for each site and removed during the data reduction process. Cliff has also computed the cross-correlation between spherical harmonic coefficient time series obtained from Big Bear and Tucson GONG+ in simultaneously collected data. The agreement is excellent between the two sites, producing correlation coefficients of unity for ℓ below 300, and slowly decreasing to 0.9 at $\ell = 600$.

Rachel Howe and Rudi Komm are working on a new method to latitudinally and temporally localize the sources of the observed shifts in frequency, amplitude, and width. This can be crudely done by taking the shifts, as a function of time and spherical harmonic degree, and constructing the corresponding latitudinal distribution from the sum of the relevant Legendre polynomials, weighted by the observed shifts. The resolution can be improved by performing an inversion to localize the response functions. Preliminary results indicate that the shifts arise primarily from the zonal bands of surface magnetic activity.

Caroline Barban is studying the relative phase and coherence between the velocity (V) and intensity (I) signals in the GONG data. She has been able to produce high-quality phase and coherence spectra for individual modes, as a function of m , rather than having to average the signal over m . This should provide more information on the driving and damping of the oscillations, and eventually lead to improved estimates of the oscillation parameters.

Kirin Jain from Udaipur Solar Observatory visited Tucson in February and March. During that time, she produced ring diagrams from GONG+ data using both V and I. A comparison of these ring diagrams showed that the large apparent frequency shift between oscillations observed in V and I above 5 mHz clearly persists to high degrees. In addition, the results show that the shift strongly increases with ℓ , reaching a value of around 200 μHz at $\ell = 550$.



Public Affairs & Educational Outreach

NEW PUBLIC FACE FOR NOAO ON THE WORLD WIDE WEB

Doug Isbell

The new Internet home page for NOAO made its public debut on April 9, following “many moons” of intense brainstorming, design, testing, and review.

This much-simplified electronic presentation of NOAO slims down the number of initial links presented to a Web surfer from several dozen to 13. It is visually clean, yet inherently more appealing through a stronger focus on a frequently updated and colorful new image.

The home page also includes a major new hyperlink at the very top of the page, titled “Developing The Future.” This link leads to the latest information on the actions that NOAO is undertaking to address the recommendations of the most recent AASC Decadal Survey. These pages should be a frequent destination for anyone interested in the latest developments related to the role of the National Observatory in the Giant Segmented Mirror Telescope, the Large Synoptic Survey Telescope, the National Virtual Observatory, and beyond.

The yellow box on the main page just below the primary links features an evolving set of the most timely new links and announcements.

Other new Web page features include an improved Search function, more extensive FAQs, and a comprehensive “News Releases” page listing every recent NOAO and NSO press release, along with image releases, links to major media stories about our activities, and even links to our frequent hits on the vaunted “Astronomy Picture of the Day” -- all in chronological order.

Future efforts will focus on propagating the new look downward through the third and fourth levels of our Web presence, along with upgrades of the main pages for Kitt Peak and WIYN.

Check it out at: www.nao.edu





Do “Star Pilots” Need Special Seatbelts?

Peter Spotts, a veteran astronomy reporter for the international *Christian Science Monitor*, visited Kitt Peak for three nights in mid-March to research and report a series of articles on the observatory and the people who work there. His central story, titled “Star Pilots” (29 March 2001), is an entertaining yet serious look at the working environment on the mountain and the personalities of the observing assistants and instrument support staff who enable Kitt Peak to function so successfully each day. Another story in the series reported on emerging plans for the National Virtual Observatory.

KPNO + HST: It’s All Good

Images from the venerable 0.9-meter telescope on Kitt Peak have played a co-starring role in two recent releases from the Hubble Heritage Program, a popular monthly release of interesting images from the Hubble Space Telescope (HST) archives.

First, in early April, an image by Travis Rector of M51, the Whirlpool Galaxy, was used to complete an HST image of the galaxy’s center, which would have looked awfully bare without its surrounding spiral arms. Joint credit was given to HST and KPNO on Space.com and several other Web sites.



A few weeks later, on April 24, a magnificent wide-field image of the Horsehead nebula, also obtained by Travis Rector, was used to provide some necessary context for a tight HST view of the horse’s “head.” The colorful Kitt Peak image was also used as the bridge between a naked eye view and the HST image in an impressive digital “fly-in” movie. Yet another 0.9-meter image, this one by Nigel Sharp, was used to fill in the corners of the HST image. This package was released on April 24 in honor of the 11th anniversary of the launch of Hubble.

See: <http://heritage.stsci.edu>

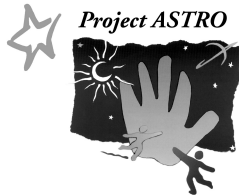
New Public Outreach Staff

Two new faces have joined the Public Outreach Group of the NOAO Office of Public Affairs and Educational Outreach. New Public Outreach Manager Rich Fedele is bringing fresh ideas and displays to the Kitt Peak Visitor Center and will increase our profile within the community of Tucson visitor attractions. We’ll report on related progress in future issues of this newsletter. Visiting astronomers at Kitt Peak may run across Program Coordinator Robert Wilson as he provides special tours and escorts members of the media through the mountain’s major facilities, including the cafeteria!



Educational Outreach

Suzanne Jacoby



A new staff member and some positive signs about future grant funding make it clear that the NOAO Educational Outreach Office is on the threshold of an exciting time.

Dr. Connie Walker has recently joined the NOAO Educational Outreach staff. Her duties include being Site Coordinator for Project ASTRO-Tucson. As an astronomer, science educator, and Project ASTRO astronomer partner, Connie brings considerable expertise and experience to our group.

Thirty-two astronomers and teachers attended a follow-up workshop at NOAO headquarters in March. Participants worked with stucco to sculpt 63 boxes containing models of the surface of Venus. Thirty-five of the boxes stayed with NOAO Educational Outreach as loaners, while the remainder went home with the teachers. These Venus Topography Boxes will be used in classrooms to explore methods of remote sensing as described in Activity C-7 of *The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook*.

Our partnership continues with Joni Chancer and Gina Rester-Zodrow, authors of *Moon Journals: Art, Writing and Inquiry through Focused Nature Study*. They will be presenters at our sixth annual Project ASTRO workshop in October 2001, which features an integrated approach to learning science by promoting inquiry. The workshop includes a visit to the Kitt Peak Visitor Center 16-inch telescope, hands-on activities for teaching astronomy from Project ASTRO, and methods of integrating art and writing into a month-long study of the Moon.



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. Begun by the Astronomical Society of the Pacific, Project ASTRO expanded to Tucson in 1996 with NOAO as the lead institution. Since that time, more than 250 teacher and astronomer partners have attended the annual two-day training workshop at NOAO.

Newsletter readers interested in knowing more about Project ASTRO or in attending a workshop in Tucson should contact Connie Walker (520/318-8535; cwalker@noao.edu).



TEACHER LEADERS IN RESEARCH BASED SCIENCE EDUCATION (TLRBSE)

Suzanne Jacoby



The NOAO Teacher Enhancement Program, "The Use of Astronomy in Research Based Science Education (RBSE)," and its pending successor, "Teacher Leaders in Research Based Science Education (TLRBSE)," provide pathways for teachers to implement authentic research opportunities in middle and high school classrooms using the unique facilities of the national observatories.

TLRBSE develops master teachers prepared to mentor a second tier of novice teachers in the use of research based science education within the appealing context of astronomy. Participants are provided training in content, pedagogy, and leadership skills through a two-week, face-to-face workshop and our year-round presence on the Internet.

The main goal of TLRBSE is to address the on-going challenge of "Teacher Retention and Renewal." By linking experienced teachers with novice teachers in a supportive partnership, TLRBSE helps the experienced teachers avoid burn out

and keeps the less-experienced teachers from giving up in frustration. We expect the attrition rate of new teachers to be lowered and the careers of experienced teachers to be extended beyond their first opportunity to retire.

While still waiting for the actual award letter, all signs are 'GO' that the TLRBSE program will be funded for three to five years. Recruitment is underway to select the first bevy of teacher participants. The two-week 2001 summer institute will include observing time on Kitt Peak and Sac Peak. Considerable time will be spent with participants developing a

year-round distance learning course that will be made available online in 2002. Katherine Stiles of WestEd and the National Institute for Science Education joins our team to develop a TLRBSE Leadership Institute; Don McCarthy (UA/Steward Observatory), Jeff Lockwood (TERC), and Travis Rector (NOAO) continue as co-investigators on this project.

Readers are encouraged to contact Suzanne Jacoby (520/318-8364; sjacoby.noao.edu) for more information about TLRBSE or any of our programs.

CTIO REU Students Have a Busy Summer

Donald W. Hoard

A group of eager young astronomers participated in the first CTIO summer student program of the new millennium. While their northern counterparts toiled through another dreary winter of class work, the four NSF-funded Research Experiences for Undergraduates (REU) students got a taste of astronomy research during the Chilean summer (January-March 2001). The 2001 CTIO REU students and their mentors were:

Gabriel Brammer, Williams College
Kathy Cooksey, Valparaiso University
Shadrian Holmes, College of Charleston
Rodolfo Montez, University of Texas

Stefanie Wachter and Donald Hoard
Stefanie Wachter and Donald Hoard
Chris Smith and Knut Olsen
Hugo Schwarz

continued



CTIO REU Students continued

All four of these REU students will attend the January 2002 meeting of the American Astronomical Society to present posters based on their REU projects.

Exposure to the international astronomical community and the opportunity to work side by side with scientists and students from other countries are key components of the CTIO REU experience. The US undergraduate students were joined by two Chilean master students in the parallel Programa de Prácticas de Investigación en Astronomía (PIA). The two students, Erika Labbe and Jorge Cuadra, attend Pontificia Universidad Católica de Chile. Nick Suntzeff served as mentor for them both.

In addition to working on their individual research projects, all of the astronomy students participated in observing runs on Cerro Tololo. These included working in pairs for two nights each for an orientation observing run on the Curtis Schmidt telescope with the REU Site Director, as well as additional observing runs with CTIO staff members. The students observed several RR Lyrae stars during their run on the Schmidt telescope, in conjunction with Dr. Andrew Layden and the Bowling Green State University Variable Star Project. Other activities included weekly scientific seminars presented for the students by the CTIO staff, a “mini-course” on professional and career aspects of astronomy, and a tour of the Gemini South site on Cerro Pachón. A highlight of the 2001 REU program was participating in the scientific meeting, “Magnetic Fields Across the H-R Diagram,” which was held in Santiago at the end of January.

We are now planning for next year’s REU program, which will run from January-March 2002. Look for announcements in future newsletters and check our CTIO REU Web page at: www.ctio.noao.edu/REU/reu.html for the most up-to-date information about the program.



False-color image of M104 (the Sombrero Galaxy) obtained by CTIO REU students Gabe Brammer and Rudy Montez using the CTIO Schmidt telescope



The 2001 REU Program at Kitt Peak National Observatory

Kenneth Mighell

We are pleased to announce that we have selected eight talented college students to come to Tucson this summer to participate in astronomical research under the sponsorship of the National Science Foundation's Research Experiences for Undergraduates (REU) program. All KPNO REU students will work full time as research assistants for 10 to 12 weeks this summer. They will work under the supervision of KPNO staff members on specific aspects of major on-going research projects. As part of their research activities, the REU students will gain experience with KPNO's telescopes, attend a special lecture series, visit nearby astronomical facilities, as well as develop expertise in astronomical data reduction and analysis. The following are the names of the 2001 KPNO REU students, their university or college affiliations, and the names of their mentors:

Matthew Grabelsky, Rice University	Michael Brotherton
Heather Jacobson, University of Texas at Austin	Caty Pilachowski
Elana Klein, Brandeis University	Nigel Sharp
Valerie Mikles, Johns Hopkins University	Buell Jannuzi
Melissa Miller, Macalster College	Tom Kinman
Sarah Robinson, Rochester Institute of Technology	Ken Mighell
John Pina, University of Arizona	Sam Barden
Daniel Wik, Ohio University	Joan Najita

Summer 2001 NSO REU, RET, and SRA Programs

Priscilla Piano

Eight undergraduate students have been accepted into the Summer 2001 NSO Research Experiences for Undergraduates (REU) program. Through supplemental funding, four teachers—two of whom have been identified to date—are expected to participate in the Summer 2001 Research Experiences for Teachers (RET) program, which will parallel the REU program. NSO also has a graduate Summer Research Assistant (SRA) program that is funded by various external grants. This year four students have been selected to be SRAs. REU, RET, and SRA program participants work on specific research projects in close collaboration with a member of the scientific staff.

NSO REU, RET, and SRA program participants, their home institutions, and mentors are listed below.

REU 2001 Participants

Stephen Ammons, Duke University
 Daniel Brickman, Rice University
 Kristen Brock, Bates College
 Kara Dunn, New Mexico State University
 Daniel Isquith, Yale University
 Danielle Kalitan, University of Central Florida
 Eliza Miller-Ricci, Middlebury College
 Tiffany Titus, Illinois Institute of Technology

RET 2001 Participants

Thomas Seddon, Alamogordo High School, NM
 Travis Stagg, Girard College High School, PA

Graduate Summer Research Assistants

Eugenia Christopoulou, University of Patras
 Patricia Jibben, Montana State University
 Miruna Popescu, Astronomical Institute, Bucharest
 Arnaud Premat, Ecole Nationale Supérieure de Physique de Grenoble

Mentors

Christoph Keller (Tucson)
 Michael Sigwarth (Sac Peak)
 Alex Pevtsov (Sac Peak)
 Harry Jones (Tucson)
 Bill Livingston (Tucson)
 Christoph Keller and Andrew Potter (Tucson)
 Han Uitenbroek (Sac Peak)
 K.S. "Bala" Balasubramaniam (Sac Peak)

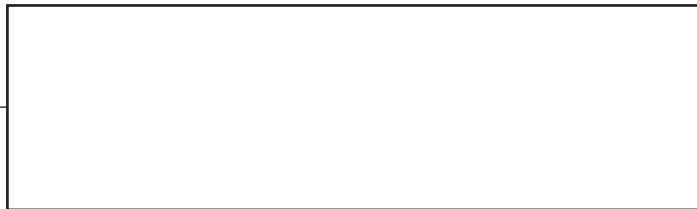
Mentors

Bala, Steve Keil, and Han Uitenbroek (Sac Peak)
 Frank Hill and Harry Jones (Tucson)

Mentors

Bala (Sac Peak)
 Bala (Sac Peak)
 Harry Jones and Charlie Lindsey (Tucson)
 Thomas Rimmele (Sac Peak)

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