NOAO-NSO Newsletter

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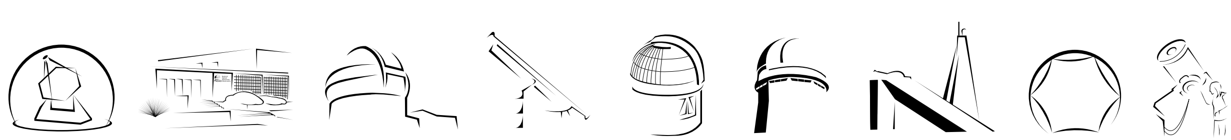

Both NOAO and NSO had an engaging presence at a National Science Foundation–sponsored public symposium on the future of ground-based astronomy, "The Universe From the Ground Up," held 7–8 October 2003 in Washington, D.C. NSO Deputy Director Mark Giampapa gave a talk on the Advanced Technology Solar Telescope (ATST), and other speakers highlighted the potential capabilities of the Large Synoptic Survey Telescope (LSST) and the 30-meter Giant Segmented Mirror Telescope (GSMT). This photo shows NOAO Manager of Public Outreach Rich Fedele and ATST Outreach & Education Officer Dave Dooling in front of the NOAO exhibit booth.

Notable Quotes

"I just want to commend the scientists in the audience. They have evolved into very nice people."

—New Mexico State Board of Education member Eleanor Ortiz of Santa Fe, commending astronomers and other scientists for writing more than 300 letters in support of a measure to stop language on the validity of "intelligent design" in evolutionary biology from being amended to new state science standards. The standards passed without amendments by a vote of 13–0.

Source: AAS Public Policy Web Site, 28 August 2003

"There are several lessons to absorb from this unusual event even as we collectively wipe the coronal plasma from our face. The first, and most obvious, is that it's no longer safe to assume, as most educated people have for hundreds of years, that the Sun is a boring, inert yellow object in the sky, trapped in a hamster-wheel existence, unable to think of anything to do with itself other than shine.

No: The Sun is more like a god. It has moods. It can be an angry god, tempestuous, hot under the collar. It usually keeps its temper in check, but sometimes it starts flinging things, and if you're orbiting in the wrong place you'll get a CME right in the kisser.

The point being that, when the sun hurls, the spew is considerable."

—"Hot Star of the Week: The Sun's Dramatic Flare," by Joel Achenbach, Washington Post, *30 October 2003*

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

On the Cover

This G-band image of active solar region NOAA 0484 demonstrates the spectacular image quality now achieved with the high-order adaptive optics system at the Dunn Solar Telescope (DST) at Sacramento Peak, NM. Taken on 24 October 2003 during a period of solar storms that drew worldwide interest, the image shows evidence for dark penumbral cores, which were also recently reported at the 1-meter Swedish Telescope in La Palma. Data taken simultaneously with the Diffraction-Limited Spectro-Polarimeter (DLSP) and the Universal Birefringent Filter (UBF) at the DST are likely to give more information about the physical origin of these newly discovered features.

The DLSP is a collaborative project between the National Solar Observatory and High Altitude Observatory. (See related article on page 35)

Image Credit: NSO/AURA/NSF

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The Closest T Dwarf Is a Binary

Ken Hinkle, Bob Blum (NOAO), & Verne Smith (University of Texas at El Paso)

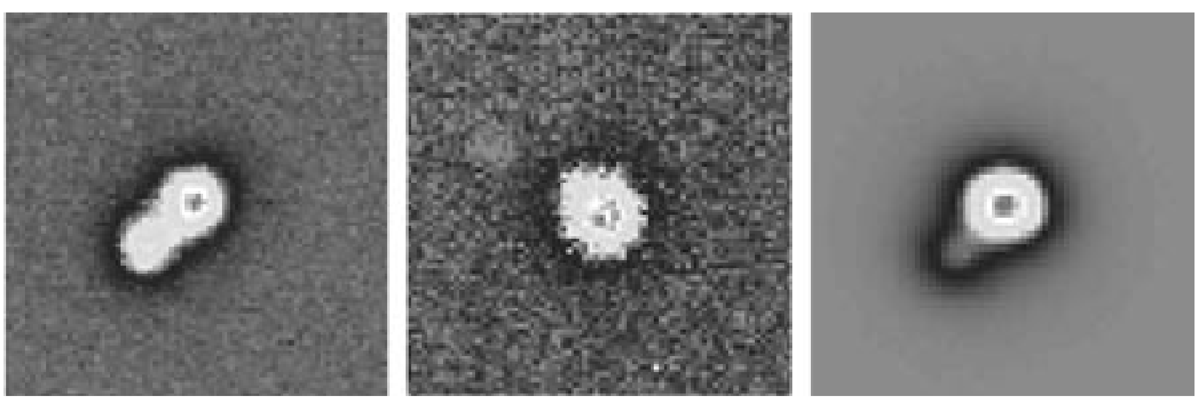
Observations of the lowest-mass dwarfs are of considerable interest in understanding the relation of these substellar objects to both the warmer hydrogen-burning dwarfs and the Jovian planets. While there has been a rapid increase in the number of L and T dwarfs known, many are quite faint even at the peak of their spectral energy distributions in the infrared (IR). Therefore, observers were delighted by the December 2002 announcement from a group at the European Southern Observatory (ESO) of a bright T dwarf, epsilon Indi B, located only 3.6 pc from the Sun (Scholz et al. 2003 *A&A* 398 L29).

One of the difficulties in studying substellar objects is that, because they are not massive enough to sustain nuclear burning, they cool with age. As a result, it is often difficult to obtain the mass and age of a substellar object from its observed temperature and luminosity. In this regard, epsilon Indi B is of even greater interest. As implied by its name, it is the companion of a well-studied K dwarf. Hence, unlike the situation for most T dwarfs, epsilon Indi B has a well-known age and distance, and therefore its mass can be derived.

High-resolution IR spectroscopy of epsilon Indi B was carried out with Phoenix at Gemini in December 2002 and January 2003 (Smith et al. *ApJ Letters* in press). The temperature (T_{eff} = 1500) and gravity (log g = 5.2, in units of cm s^{-2}) were found spectroscopically, resulting in a spectroscopic mass estimate for epsilon Indi B of ~32$M_{Jupiter}$. Combined with the published luminosity of $\log(L/L_\odot) = -4.67$, Smith et al. determined a radius of ~0.07$R_\odot$. The high spectral resolution of the Phoenix observations allows the determination of an accurate projected rotational velocity, v sin(*i*) = 28±3 km s^{-1}. This implies that epsilon Indi B has a maximum rotational period of only about three hours!

A puzzling aspect of the Gemini spectroscopic results was that the temperature derived from the Phoenix spectra places epsilon Indi B at the boundary between the late-L and early-T dwarfs. However, the medium-resolution IR spectra of Scholz et al. indicated a later spectral type of T2.5. This puzzle was resolved with subsequent imaging at Gemini.

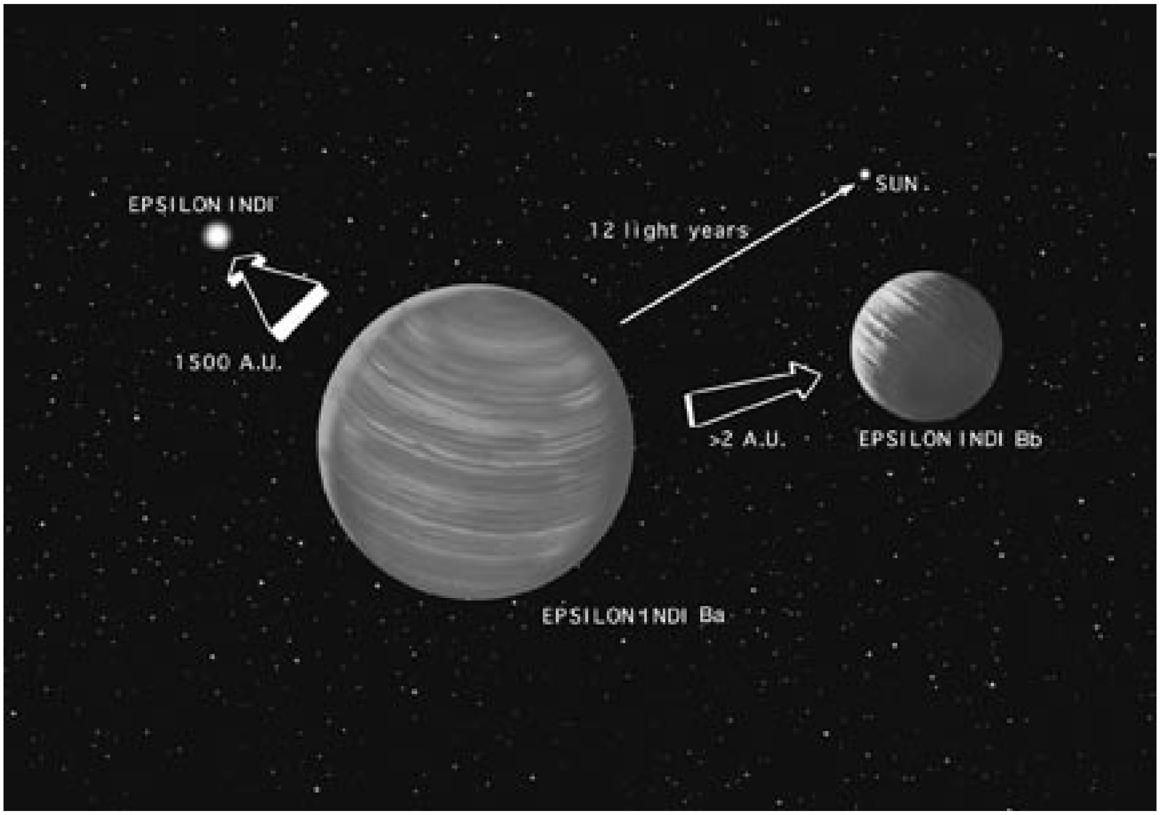
In August, epsilon Indi B was again observed with Phoenix at Gemini, but this time in the *J*-band as part of a project lead by Gordon Walker (University of British Columbia). The observations were carried out in the Gemini queue, and the NOAO Phoenix observer, Bob Blum, noted that epsilon Indi B was a close binary. Bob and the Gemini observer, Kevin Volk, quickly demonstrated that the companion star was easily visible in *J*, faintly visible in *H*, and nearly invisible at *K*. The previous Phoenix observations had



Images of the epsilon Indi Bab pair obtained with Gemini South. Left: The original detection image obtained on 18 August 2003 with Phoenix using a narrowband filter in the J-band. Center: Image obtained with Phoenix using a narrowband filter in the K-band. The companion is invisible at this wavelength because of the cool temperature of the object and the consequent deep methane absorption feature in its atmosphere. Right: Image obtained with GMOS-South on 2 September 2003 at the red end of the optical spectrum. The three images were obtained without adaptive optics and each is 4 arcsec on a side.

continued

Closest T Dwarf Is a Binary continued



Artist's conception of the epsilon Indi system showing epsilon Indi and the brown-dwarf binary companions. Due to the perspective of the brown dwarf companions, the relative sizes are not represented in this illustration. Artwork by Jon Lomberg. Credit: "Gemini Observatory Illustration."

been mainly in *K*. The separation is ~0.6 arcsec, so at least typical delivered image quality at Cerro Pachón is required to separate the two dwarfs.

The colors of the companion (epsilon Indi Bb) to epsilon Indi B (now epsilon Indi Ba) are those of a late-T dwarf. Thus, the puzzle was resolved. The disagreement between the Smith and Scholz temperatures resulted from the Smith spectra having been taken under good conditions at Gemini and only sampling the early T dwarf while the Scholz et al. spectra used a wide slit and sampled both stars. The discovery of epsilon Indi Bb was announced in IAU Circular 8188.

After the publication of the IAU Circular, an exchange of e-mail disclosed that the epsilon Indi Bab pair had been resolved by Laird Close while observing with an adaptive optics system at ESO about a week before the Gemini detection. Details of these observations, as well as limits on the orbit, and more information on the age and masses of the dwarfs can be found in McCaughrean et al. (*A&A* in press).

Further interesting results on the epsilon Indi Bab system can be expected since both the early- and late-T dwarfs in the system are bright enough for high-resolution spectroscopy.

Spectroscopy of z ~ 6 Quasars with MARS

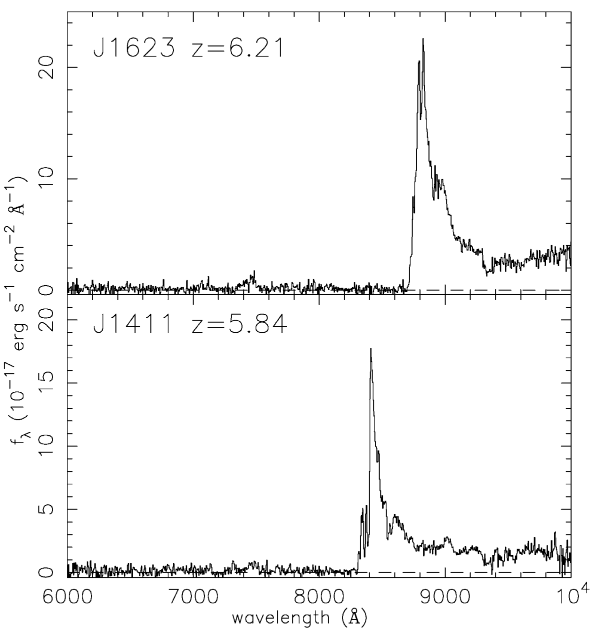
Xiaohui Fan (University of Arizona), Joseph F. Hennawi, Michael A. Strauss, Gordon T. Richards (Princeton University) & Donald P. Schneider (Penn State University) for the SDSS Collaboration

The past few years have seen a dramatic increase in both the number of known high-redshift quasars and the highest known quasar redshift. Powerful multicolor surveys, such as the Sloan Digital Sky Survey (SDSS), have led to the discovery of more than 600 quasars at $z > 4$, including more than 30 at $z > 5$. The quasar with the highest measured redshift is now at $z = 6.4$. These quasars provide insight into the formation of early generations of galaxies and quasars. Powered by accretion onto black holes of several billion solar masses, their evolution traces the history of black hole growth in the early universe. Many quasars show signs of active star formation and rapid chemical enrichment in their environments, indicating a close relationship between black hole formation and galaxy evolution. In addition, Lyα absorption in the quasar spectra is found to evolve strongly at $z > 5$, as the ionizing background declines quickly with increasing redshift. Gunn-Peterson troughs in the spectra of the highest redshift objects at $z > 6.2$ suggest that the intergalactic medium was reionized at $z \sim 6.2$.

The SDSS is being carried out at Apache Point Observatory, NM, using a dedicated 2.5-m telescope equipped with a large-format CCD camera. Images in five broadband filters (*u, g, r, i,* and *z*) are being obtained over 10,000 deg^2 of high-Galactic-latitude sky. With the inclusion of the *z*-band filter centered at ~9000 Å, quasars can be detected up to redshifts of $z \sim 6.6$. Over the past four years, we have used the SDSS imaging data to identify quasars at $z \sim 6$. Quasar candidates are selected based on their extremely red $i–z$ colors ($i–z > 2.2$) that result from strong Lyα absorption in the *i*-band at this redshift. They are extremely rare objects on the sky and are difficult to identify from the SDSS data alone because they are often close to the detection limit. They may also be confused with cosmic ray hits and brown dwarfs with similar colors. To improve our selection efficiency, we first obtain additional optical and near-IR photometry of candidates on other telescopes, then carry out detailed spectroscopic observations of these faint, red sources using larger telescopes.

Some of our recent spectroscopy has been carried out with the new Multi-Aperture Red Spectrometer (MARS) on the Kitt Peak 4-m telescope. MARS is equipped with a thick LBNL CCD that has a high quantum efficiency in the red, as well as new optics and a grism with high red throughput. Fully optimized for the red region ($\lambda > 8000$ Å), MARS is well suited for follow-up spectroscopy of these very red, faint quasar candidates.

With MARS, we have an opportunity to identify and obtain high-quality spectra of $z \sim 6$ quasars, a task that was previously possible only with larger telescopes. The figure shows the spectra of two $z \sim 6$ quasars that were observed with MARS during our run in Spring 2003 (Fan et al., submitted). J1623 (top, $z = 6.21$) is the third highest redshift quasar known. It has an extremely strong Lyα emission line and shows a clear Gunn-Peterson trough blueward of Lyα, which is consistent with those observed in other $z > 6.1$ quasars. The spectra also demonstrate the red sensitivity of MARS: the signal-to-noise does not decline even at $\lambda > 9000$ Å, and compares favorably with those taken with larger telescopes under similar conditions. As an added bonus, the data show little fringing in the red and near-IR, a problem that afflicts most thinned CCDs.



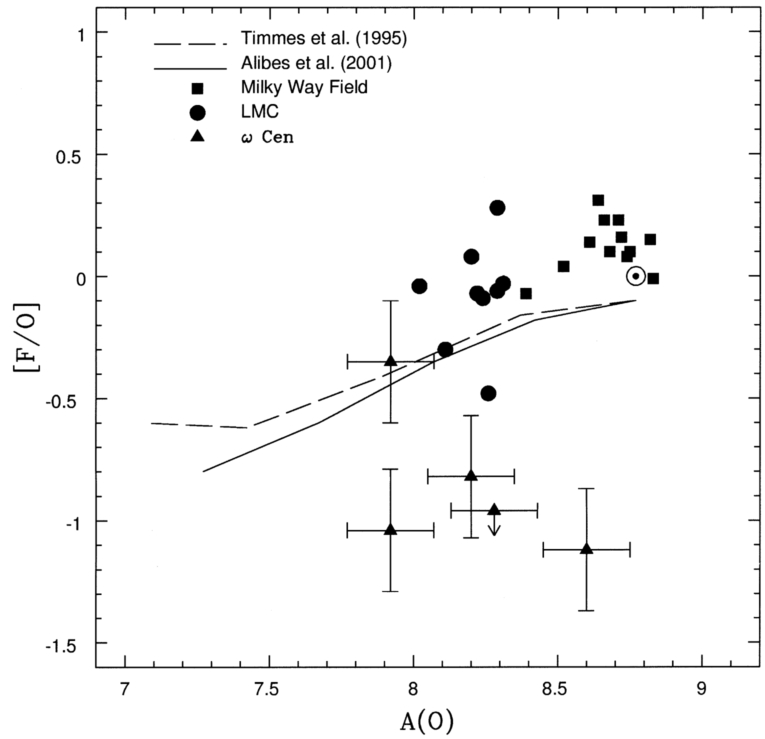
Spectra of two high-redshift quasars observed with MARS in June 2003. J1623 (top), at z = 6.21, is the third highest-redshift quasar known. It has an extremely strong Lyα emission line, and a clear Gunn-Peterson trough. The high throughput of MARS at λ > 8000 Å is well suited to the spectroscopy of quasars at z ~ 6.

These results bring to 11 the number of $z > 5.7$ quasars found thus far. Our survey is ongoing and we expect to establish a sample of more than 20 quasars at $z > 5.7$ in the next three years. With this sample of quasars, we will be able to address basic questions about the early evolution of quasars, the relationship between early supermassive black holes and galaxy formation, and the evolution of the intergalactic medium at the reionization epoch.

The Chemical Origin of Fluorine

Katia Cunha (Observatório Nacional, Brazil) & Verne Smith (University of Texas at El Paso)

Unlike most of its neighbors in the periodic table, such as carbon, oxygen, or neon, the nucleosynthetic origins of fluorine have remained somewhat obscure. The only stable isotope of fluorine, ^{19}F, is not easy to produce in stars as it is readily destroyed by either proton or α captures during many phases of stellar evolution. Attempts to account for the abundance of fluorine in the Galaxy have focused on three possible sources: 1) neutrino-induced spallation of a proton from ^{20}Ne following the core-collapse phase of a massive-star supernova—this is referred to as the *ν*-process (Woosley et al. 1990, *ApJ*, 356, 272); 2) synthesis during He-burning thermal pulses on the asymptotic giant branch (AGB), as suggested by Jorissen, Smith, and Lambert (1992, *A&A*, 261, 164); or 3) possible production of ^{19}F in the cores of stars massive enough to be Wolf-Rayet stars at the beginning of their He-burning phase (Meynet and Arnould 2000, *A&A*, 355, 176).



Fluorine to oxygen abundance ratio [F/O] as a function of logarithmic oxygen abundance A(O) for the LMC and ω Cen red giants studied by Cunha et al. These are compared with results from the literature for Galactic field stars and the results of two chemical evolution models.

From an observational point-of-view, fluorine is also difficult to detect spectroscopically. The only practical way to probe fluorine in stars is to observe molecular lines from HF in cool stars in the infrared (IR), near wavelengths of ~2.3 μm. Until recently, the only fluorine abundances measured in other stars had been the work of Jorissen et al. (1992). Their results concentrated on the chemically peculiar carbon-rich AGB stars, although they did also study a small number of more chemically normal (near-solar metallicity) giants of spectral type K or M.

Recently, Cunha et al. (2003, *AJ*, 126, 1305) have used the high-resolution IR spectrograph Phoenix on Gemini South to measure the fluorine abundances of red giants in the Large Magellanic Cloud (LMC) and in the Galactic globular cluster Omega Centauri (ω Cen). These red giants are significantly more metal-poor than the K and M giants studied by Jorissen et al. (1992). These observations show how the fluorine abundance varies as a function of the oxygen abundance, which, in turn, provides insight into the origin of fluorine.

The Cunha et al. (2003) results are summarized in the figure, where the fluorine to oxygen abundance ratio [F/O] is plotted against the logarithmic oxygen abundance. There is a gradual decline in [F/O] as the O-abundance declines from the Galactic field stars to the LMC field stars. The magnitude of the decline is in fairly good agreement with the predictions of the chemical evolution models of Timmes et al. (1995, *ApJS*, 98, 617) and Alibes et al. (2001, *A&A*, 370, 1103), which assume that fluorine is produced via the *ν*-process. (The offset between the model and observed abundances is primarily a normalization effect.)

The ω Cen [F/O] values stand out as generally much lower than the Galactic and LMC field values. This difference can be understood as a consequence of the star formation and metal-enrichment history in ω Cen. The ω Cen targets represent the metal-rich population of this cluster, and these stars formed from gas that was enriched by a more metal-poor population within ω Cen. The progenitor SN II that enriched the gas from which the more metal-rich ω Cen stars formed had A(O)~7, which should synthesize fluorine and oxygen such that [F/O]~-0.8, according to the chemical evolution models. This is what we observed. Taken together, the stellar populations from the Galaxy, the LMC, and ω Cen suggest neutrino-induced nucleosynthesis as the primary source of fluorine.

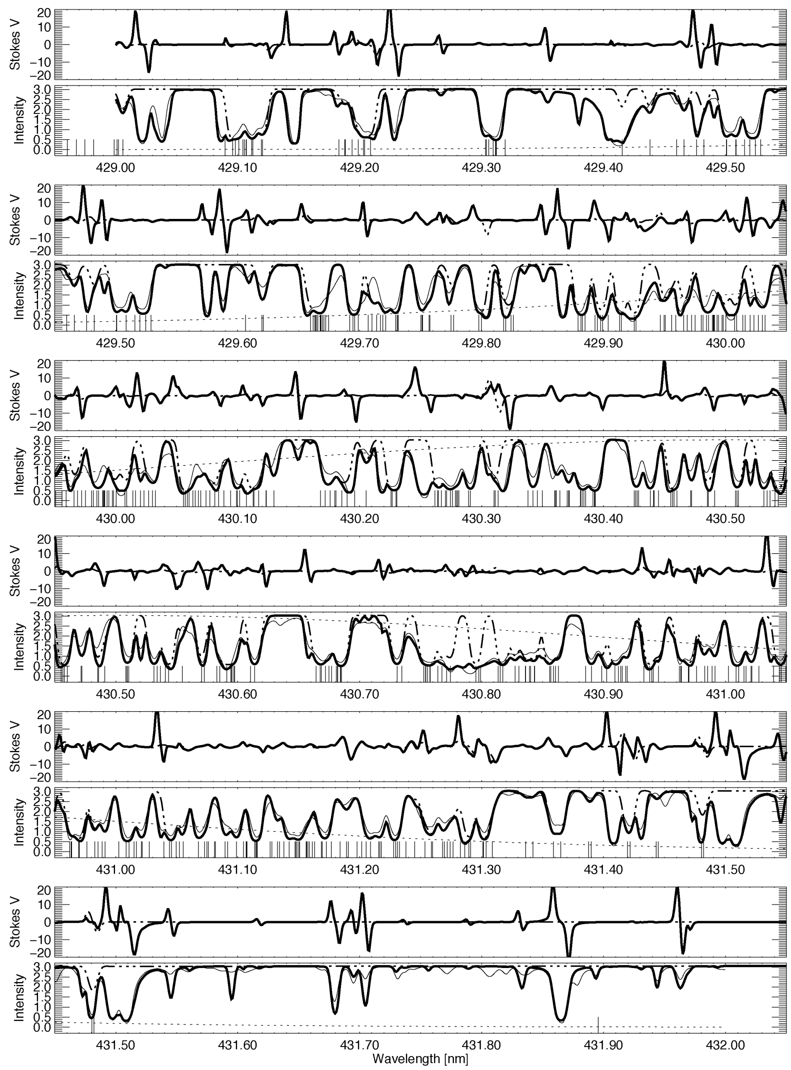
The Zeeman Effect in the G Band

Han Uitenbroek

A substantial fraction of the magnetic flux on the solar surface exists in the form of small-scale structures with sizes just at or below the current resolution limit of solar telescopes. If we want to understand and predict the behavior of the solar magnetic field, we have to learn how these small-scale elements form, evolve, and disappear, what their role is in the global evolution of the magnetic field, and how much flux they represent.

A popular method for tracking small-scale features is narrowband imaging in the G band with typical passbands of 1 nm FWHM. This technique is convenient because it allows a large throughput and short exposures. It is optimal for image improving techniques like adaptive optics and post facto image reconstruction. A drawback of G-band imaging is that it does not provide a measurement of the magnetic flux, which must be obtained by simultaneous and cospatial magnetograms in magnetically sensitive atomic lines. This is an arduous process, involving careful alignment of images taken at different wavelengths, and encumbered with the problem of understanding the relationship between two very different diagnostics. It would be preferable if magnetic flux could be measured in precisely those spectral lines that make up the G-band. Calculations now show that this should indeed be possible.

Most of the opacity in the G band is due to electronic transitions in the A-X band of the CH molecule, with added contributions from atomic lines of different elements. Molecular lines are susceptible to the Zeeman effect in the presence of an external magnetic field and may produce polarized radiation that can be analyzed to infer the properties of the field. If a molecule has a nonzero magnetic moment, the interaction of that moment with the magnetic field will split the molecular energy levels into a pattern that is, in general, more complex than in the atomic case because of the additional degrees of freedom inherent in molecular structure. In a diatomic molecule, both vibration along the internuclear axis and rotation around the center of mass influence level energies. However, only rotation affects the molecule's magnetic moment because it alters the way the electronic spin and orbital angular momenta are coupled to the total angular momentum (J) of the molecule. When all these



Calculated Stokes I and V spectra in the G band (thick solid curves). Also shown are the observed intensity spectrum (thin solid curve), calculated spectra due to CH lines only, without contribution from atomic lines (thin dash-dotted curves), and the typical transmission curve of a G-band filter (dotted curve). Vertical lines at the bottom of the graphs mark the location of each CH line.

continued

Zeeman Effect in the G Band continued

interactions are accounted for, the resulting effective Lande factors often have negative values and rapidly tend to zero for increasing J.

Although much of the required quantum mechanics had already been formulated by the end of the 1930s, the possibility of actually pursuing molecular line polarization for magnetic field diagnostics in the solar atmosphere has only recently been sparked by the ever more powerful computational possibilities. To investigate whether the CH lines in the G band would be useful in this respect, algorithms to calculate their splitting patterns were added to a numerical code for polarized radiative transfer. With this code, the emergent intensity and polarization in the G band around 430 nm were evaluated for several different solar models.

The result of one such calculation, through a one-dimensional hydrostatic model of the quiet Sun with an imposed vertical field of 1000 gauss, is shown in the figure. Clearly, the intensity spectrum in the G band is very crowded with thousands of lines from CH and various atomic species. Fortunately, the circular polarization signal (Stokes V) is less crowded because the effective Lande factors of most CH lines are much smaller than 1. Several locations can be identified where the intensity and polarization is dominated by CH lines (most notably at 430.35, 430.40, and 431.36 nm), without contamination by atomic lines. In these locations, the polarization signal is of the order of several percent of the continuum intensity and should be detectable with current polarimetric instrumentation. A similar conclusion is reached with a more realistic model of the solar atmosphere in the form of the output of a magneto-hydrodynamic simulation of the solar convection, showing that measurement of the magnetic field through the Zeeman effect in the CH lines is indeed a possibility.

From the Director

Jeremy Mould

New Leadership At NOAO South

Malcolm Smith stepped down as director of Cerro Tololo Inter-American Observatory (CTIO) last month after 10 years of service leading an observatory that provides the most unique research opportunity offered to US astronomers—access to the southern hemisphere.

Malcolm passes a transformed institution on to his successor: a newly developed site at Cerro Pachón, an additional four-meter telescope (SOAR), and a campus with twice the scientific staff he inherited in 1993, residing in a city that has become an international resort. An administrative transformation has also occurred in the last five years. AURA Observatories in Chile has become a service organization supporting both CTIO and Gemini South. These transformations have been accomplished with Malcolm's characteristic diplomacy, a skill that has earned him the respect of Cerro Tololo's research scientists, administrators, engineers, technicians, and unique mountain staff—as well as his fellow directors and Chilean government officials at every level.

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Malcolm continues as head of AURA Observatories Support Services, and as the *jefe de mision* of "AURA-O" in Chile. In addition to his responsibilities to AURA-O, research beckons. I join his colleagues in wishing Malcolm continued success, and the just rewards of being able to concentrate a bit more on his scientific pursuits.

NOAO is now very pleased to announce that the AURA Observatories Council has selected Alistair Walker to be the new director of CTIO. Alistair's initial acquaintance with the observatory was as a junior staff member from 1977 to 1979. He then spent seven years at the South African Astronomical Observatory (SAAO), and returned to join CTIO's tenure track in 1987. He served as Deputy Director from 2000 to 2003, and is very familiar with CTIO's current successes and challenges.

Alistair is well known for his work on RR Lyrae stars in the Magellanic Clouds and for his close association with CCD camera development, from the early days of these detectors through to their present full realization. He also has a broad interest in stellar populations research.

I look forward to working with Alistair as he leads CTIO in laying the foundations for the new US telescopes that are surely coming to Chile, while bringing a new generation of instruments to our favorite telescopes on Tololo and continuing to build the scientific community in La Serena.

Users' Committee Report 2003

NOAO Users' Committee members Robin Ciardullo, David Turnshek, Timothy Beers, Steven Majewski, Arlin Crotts, and James Lowenthal visited Tucson in October, with their Chair, Chick Woodward. Nicole Vogt and Todd Henry were unable to attend on this occasion. The committee considered KPNO, NGSC, and CTIO operations and underlined the importance of maintaining fully reliable 4-meter telescopes and a close connection with Gemini operations. According to the committee, the needs of the US observing system should be studied in a Scottsdale-type workshop in the coming year. Blanco and Mayall instrumentation are issues of considerable importance, they added. The Time Allocation Committee process and data archive development got good grades. The Users' Committee report is available at *www.noao.edu/noao_uc.html*.

New Opportunity: GNIRS Science Campaigns

Stephen Strom

NOAO is pleased to announce a pilot program aimed at encouraging long-term proposals for major science campaigns capable of exploiting the powerful capabilities of the new Gemini Near-Infrared Spectrograph (GNIRS).

The goal of this pilot program is to provide opportunities to schedule observations with high scientific potential that require significant blocks of time on Gemini. Successful campaign science proposals will be awarded 15 to 20 nights over the next two to three years. Proposers must agree to make all Gemini data and ancillary information available publicly following a minimal proprietary period (less than six months), a requirement similar to precedents set by the NOAO Survey Program and the SIRTF Legacy Program, among other examples. The scientific merit of these proposals will be evaluated by the Time Allocation Committee (TAC). However, the observing time to support proposals of this magnitude will come from the pool of discretionary time available to the NOAO Director. The Director will use the following criteria in making final time awards:

- intrinsic scientific merit as evaluated by the TAC
- breadth and quality of the scientific team and its demonstrated track record
- enhancement of undergraduate education through involvement in research
- potential value of the archival database to other users
- plans to manage data reduction and archiving, and deliver data products, in a timely fashion

In assembling teams to carry out these programs of scale, Principal Investigators are particularly encouraged to involve scientists and students from four-year liberal arts colleges. NOAO has played an important role historically in providing these scientists and their students with access to facilities. As NOAO transitions to an era when fewer opportunities are available for training via "contact nights" on smaller facilities, we are seeking innovative ways like this to continue to provide opportunities for faculty and students located at institutions that have traditionally produced first-rate students who pursue PhDs in astronomy.

Watch for the 2004B Call for Proposals for more details on this opportunity. For more information on GNIRS, see *www.noao.edu/ets/gnirs/manuals.htm*.

TSIP Begins Its Third Year with New Opportunities

Todd Boroson

The Telescope System Instrumentation Program (TSIP) has now completed two annual cycles. In the program's second year, funds were awarded to the California Association for Research in Astronomy (CARA) for continued development work on KIRMOS, a near-infrared imager and multi-object spectrograph for Keck-II, and to the Smithsonian Astrophysical Observatory (SAO) for the MMT and Magellan Infrared Spectrograph (MMIRS). In addition to providing the resources to create these new capabilities, the awards will provide 12 additional nights for the community on the Keck telescopes and 27 nights each on the MMT and Magellan telescopes.

The rules for TSIP have been modified a bit with the aim of increasing options for telescopes less than six meters in aperture. Such proposals are now permitted for new instrumentation. Two changes have been made to the TSIP guidelines and the review process to encourage such submissions. First, since the number of telescope nights to be made available to the community (equivalent in value to half of the funds awarded) may seem prohibitively large for smaller telescopes, proposers are urged to consider alternate types of access, such as carrying out community-defined surveys. Second, the review panel will develop separate, ranked lists for telescopes above and below the six-meter threshold, before merging these into a single list for funding.

Appeal of NOAO Postdoc Path Appears to Be Growing

Douglas Isbell & Stephen Hopkins

It was named the 10th worst job in all of science by the October 2003 issue of *Popular Science*—a "limbo of… drudgery leading to dashed dreams."

But this pessimistic caricature of post-doctoral fellowships does not seem to reflect the experiences of the current NOAO postdocs. In a series of recent interviews, postdocs in residence at NOAO North cited welcome growth in their total numbers, stronger institutional support for support tasks like data processing, and the active counsel of talented scientific staff members as key factors in making a postdoc fellowship an increasingly interesting and rewarding position at the national observatory.

"My knowledge of astronomy has improved greatly here," said Michael Brown, who is tracing the evolution of galaxies with the NOAO Deep Wide-Field Survey (NDWFS). Collaborating with NDWFS Principal Investigators Buell Jannuzi and Arjun Dey "has been really useful, they've pushed me." Recent additions to the NDWFS data processing team have been extremely beneficial, he added, speeding the progress of the survey and allowing time for research. Michael has been a research associate with NOAO since 2000, after completing his PhD at the University of Melbourne, Australia.

Michael Brown

Several postdocs cited their earlier acquaintance or active research with staff members as keys to their move to NOAO. Lucas Macri, who comes to NOAO after receiving a PhD from Harvard University, credited the flexibility of NOAO science managers such as Steve Strom in working to accommodate his Hubble Fellowship, and the family-friendly atmosphere needed by a "dual career couple in science," as strong factors in his move to Tucson from the East Coast. Lucas, a native of Argentina, is currently studying Cepheid variables in M33, originally discovered by Project DIRECT, to improve the accuracy of the Extragalactic Distance Scale.

Rachel Mason

Most of the postdocs seemed to hear of the opportunity from the AAS job register, though some, like new NGSC postdoc Rachel Mason, were tipped by officemates or previous contact with NOAO scientific staff. Rachel, who received her PhD in August at the University of Edinburgh, Scotland, is working with the NOAO Gemini Science Center on research related to dust in the interstellar medium and in active galactic nuclei, as well as on some NGSC service tasks. "I'm still not sure that I want to be a full-time researcher for the rest of my life, and I like the idea of having a job that involved a little bit of something else, as well as having two-thirds of my time to do exactly what I want" in research, Rachel said.

The postdocs have heard "mixed reports" on the prospects for getting access to immediately useful quantities of data from the Gemini telescopes in areas such as multi-object spectroscopy, they said. But capabilities such as the Phoenix spectrograph and the potential KAOS instrument make it a promising area to explore further. In particular, Lucas Macri has helped with Gemini North queue observations for six nights over the past year in what he termed a "thoroughly positive experience."

NOAO received strong marks in human resources areas such as visa support for the international postdocs. But the city of

continued

Appeal of NOAO Postdoc Path continued

Tucson itself received mixed reviews from the NOAO North crew, with the noted difficulty of getting around the "Old Pueblo" by foot. "My view of Tucson improved radically when I started riding a bike, and seeing some of the neighborhoods," said Jason Aufdenberg, who received his PhD from Arizona State University, and is no stranger to Western cities. Jason is working with Steve Ridgway to improve the temperature scale for O- and B-type stars, measure the mass-loss rates from the stellar winds of the nearest hot supergiant stars, and measure the distorted shapes of the nearest rapidly rotating stars.

"Tucson was very different at first, especially from my previous experiences in Europe," agreed Frank Thim, who received his Master's in Germany and his PhD at the University of Basel, Switzerland. "But I've come to really like it." Frank has been at NOAO since August 2001 working with Abi Saha on, among other things, Cepheid distances, variable stars, photometry, and the Hubble Constant. The postdocs were in agreement that the key to getting the most from Tucson was getting involved in the large variety of outdoor activities that the surrounding areas offer, like hiking and mountain biking.

The quality of the scientific community around NOAO, on the other hand, was universally appealing to the postdocs. "Being able to go across the street and get perspective from the staff at Steward Observatory, where they may have some different specializations that aren't necessarily copied over here, has been really useful," Michael said. "I'm looking forward to the arrival of Mark Dickinson at NOAO—discussing high-redshift galaxies with him is going to be really useful."

The NOAO environment also appears to be welcoming to female astronomers. "The working environment is very nice," Rachel said. "I like the way people say hello and introduce themselves. It's clear that NOAO is making an effort [to attract more women to the scientific staff] with its advertising" and using language that appeals to both genders, Rachel added. "It seems like people here do care."

NOAO's reputation for doing active, high-quality educational outreach was also a factor in some decisions to come here. "One aspect that really pleased me was all the premiere educational programs and dark skies activities that are run out of here," Jason said, "It's a great opportunity to volunteer some time, and learn, since I am interested in doing some teaching as part of my career."

When asked about the prestige of NOAO as a location for postdocs as compared to other astronomical research organizations, the current group said that the national observatory's reputation is on the upswing.

Kate Brand

"Certainly I had some doubts about that when I arrived, but I had a bit of faith," Macri said. "The GSMT, LSST, and NVO are interesting projects, and given enough resources, [the organization] will go up."

NOAO's participation in several large surveys was also mentioned as a sign of its increasing impact in the astronomical community. Indeed, scientific productivity remains the key attraction of any postdoc position. "Being able to get [data on] almost all of cosmic time in one uniform well-understood survey is going be really valuable," Michael added. The appeal of combining NDWFS data with related observations from Chandra, VLA, SIRTF and other sources is what drew new postdoc Kate Brand to NOAO after receiving her PhD at Oxford in September. Kate is working on the NOAO deep wide field survey and looking at the clustering and evolution of AGN.

The long-term effort required by some postdoc positions is reflected by Michael, in his fourth year with the NDWFS. "Research always takes longer than you hope—with [NOAO] Deep-Wide we have just gotten to the point of publishing results." (Michael's paper on the evolution of galaxy clustering and the NDWFS was recently published in the *Astrophysical Journal*.) Michael adds, "I still have important research to do that I was planning when I first arrived at NOAO."

Next issue: the postdoc experience in Chile at NOAO South.

Gemini Update

Taft Armandroff

For the Gemini partnership, 2003 continues to be exciting and productive. Several new instruments are being successfully commissioned at Gemini. These new instrument capabilities are providing frontier scientific opportunities for astronomers in the Gemini partner communities.

At Gemini South, the T-ReCS mid-infrared imager and spectrometer represents one of the new opportunities. As of late October, the T-ReCS system verification observations have been obtained. This paves the way for TAC-approved science observing to begin. T-ReCS has performed very well, and the T-ReCS diffraction-limited images are spectacular (see *www.us-gemini.noao.edu/sciops/instruments/miri/T-ReCS-news-2003sep16.html*). In addition, the Gemini South telescope is exhibiting very low emissivity, which enables excellent mid-infrared performance.

Also at Gemini South, GMOS-South is seeing much use in its multi-object spectroscopy, long-slit spectroscopy, and imaging modes. The delivery of GMOS-South's integral field unit (IFU), a copy of that on GMOS-North), is expected before the end of 2003. Once installed, Gemini users will have whole-sky access for optical IFU spectroscopy. The GMOS-South IFU is being implemented in such a way as to permit GMOS's popular nod-and-shuffle mode to be used with it.

On Gemini North, commissioning of the Altair adaptive optics system, in its natural guide star mode, with the Near-Infrared Imager (NIRI) has gone very well. System verification observations with the Altair and NIRI combination are expected to begin soon. In semester 2004A, Altair plus NIRI will be used for TAC-approved scientific programs. Also at Gemini North, system verification of the Michelle mid-infrared instrument's imaging mode is expected to begin shortly.

The NOAO Gemini Science Center (NGSC) saw a strong response from the US community to the Gemini Call for Proposals for semester 2004A. On Gemini North for 2004A, 77 proposals were received: 50 for GMOS-North and 29 for NIRI; 10 of the NIRI proposals requested its use with the Altair adaptive optics system. Fifty-nine US proposals requested Gemini South: 25 for T-ReCS, 23 for Phoenix, and 12 for GMOS-South. In total, 133 US Gemini proposals sought 301 nights on the two Gemini telescopes.

As the new instruments come on line, and as additional US community members gain experience with Gemini data, we expect the uses of various capabilities by our community to evolve. We enthusiastically encourage US astronomers to explore the relevance of the new instruments on Gemini to their scientific interests. Available resources include the Gemini and NGSC Web pages (*www.us-gemini.noao.edu*), questions via the Gemini HelpDesk (*www.us-gemini.noao.edu/sciops/helpdesk/helpdeskIndex.html*), and the NGSC contact scientist for each Gemini capability (*www.noao.edu/usgp/noaosupport.html*).

GNIRS Coming Soon

Jay Elias, Dick Joyce & Ken Hinkle

As discussed below in the article on the NGSC instrumentation program, the Gemini Near-Infrared Spectrograph (GNIRS) passed pre-ship acceptance tests in Tucson and arrived in Chile on October 27. GNIRS is scheduled to be installed on the Gemini South telescope in December, with first light expected in January 2004. Commissioning of its major observing modes is expected to commence in January.

GNIRS is a complex instrument with four cameras, cross-dispersed or long-slit options, three gratings, and a spectropolarimetry mode, so extensive commissioning is envisaged. An infrared (IR) on-instrument wavefront sensor is included in GNIRS. The only feature of GNIRS that is not yet functional is the integral field unit, which is being constructed by the University of Durham and has not yet been delivered. The spectropolarimetry option requires the Gemini Polarimeter (GPOL-S), which has yet to be commissioned, so this mode will also be delayed.

GNIRS will offer resolutions of ~1700, 5500, and 18000. A principal goal of GNIRS is sensitive point source spectroscopy, and for point sources, cross-dispersion is possible. When cross-dispersed at R = 1700, the entire spectrum from 0.9 to 2.4 microns can be observed. At higher resolution, cross-dispersion can also be used, but coverage is limited by the 1024-pixel size of the detector to segments of the spectrum. The highest resolution mode, R = 18000, comes with the caveat that a very narrow (0.1 arcsec) slit is required, which is not

continued

GNIRS Coming Soon continued

well matched to the typical delivered image quality (DIQ). At R = 1700, a 5-sigma detection should be possible in one hour at J = 21 and K = 19. GNIRS does work into the thermal IR as far as 5.1 microns. Thermal IR performance is, of course, limited by thermal background, and limiting magnitudes of about L = 14 and M = 11 are expected.

The large cross-dispersed wavelength coverage of GNIRS at R = 1700 and the faint magnitude limits, especially when combined with the excellent DIQ of Gemini South, suggest a number of scientific applications, including spectral classification of sub-stellar objects, spectroscopy of the most highly embedded stars, determinations of initial mass functions for very young clusters, abundance determinations for extragalactic stars, and spectroscopy of galactic nuclei. NGSC expects that there will be opportunities for GNIRS system verification projects in the next six months. Prospective users wishing to submit proposals to the Time Allocation Committee (TAC) should watch for announcements of GNIRS availability in future calls for proposals.

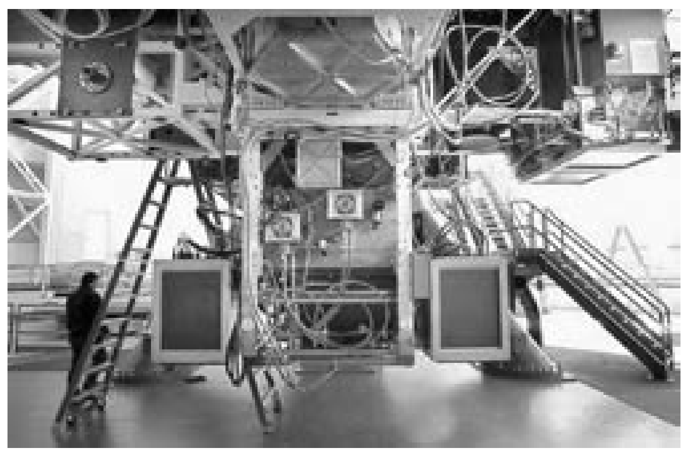
Michelle Update

Ken Hinkle

Michelle, a mid-infrared imager and spectrograph, is anticipated to make a significant contribution to NASA's Space Infrared Telescope Facility (SIRTF) follow-up science. Efforts to deploy Michelle as a facility instrument at Gemini North are continuing. Readers may be familiar with Michelle as a United Kingdom Infra-Red Telescope (UKIRT) facility instrument. With the move to Gemini, both the very low emissivity and 8-meter aperture will significantly enhance the performance of Michelle.

Conversion of Michelle for use on Gemini has proven more difficult than earlier envisaged due to both technical and scheduling hurdles. Gemini was working toward permanent deployment of Michelle at Gemini North when the UK Particle Physics and Astronomy Research Council (PPARC), the oversight organization for UKIRT, requested that Michelle be returned to UKIRT in 2004A. Sharing of Michelle between the sites is a term of the loan agreement with PPARC. At this time, NGSC believes that Michelle will only be required for a few months at UKIRT. Potential Gemini Michelle users should look for a discussion of Michelle availability in the 2004B Call for Proposals. In the current (2003B) semester, commissioning of the Michelle imaging modes has been undertaken and queue science observations have begun.

Due to the complexity of Michelle, its conversion for cutting-edge research at Gemini is challenging. Optical work carried out thus far includes realigning the pupil and removing vignetting at the detector. A problem that has been identified but not yet addressed is detector thermal control. The detector temperature is currently too warm and the temperature stability not sufficient to minimize detector noise when Michelle is used for spectroscopic applications. Gemini has developed plans to work on the thermal problems from multiple fronts. The current broadband N filter saturates in imaging mode. A new, slightly less broad N filter has been ordered. The interim N band observations employ a tandem neutral density filter. Gemini has also reviewed the efficiency of Michelle operations, and a number of software changes are planned to significantly reduce overheads.



Michelle mounted on the up-looking port of Gemini North.

NGSC at the January 2004 AAS Meeting

The NOAO Gemini Science Center will have a booth at the January AAS meeting in Atlanta. The NGSC presence will include information on how to propose for Gemini observing opportunities, brochures on Gemini instrument capabilities, and tutorials on the Gemini Phase II Observing Tool.

Please stop by and see us!

NGSC Instrumentation Program Update

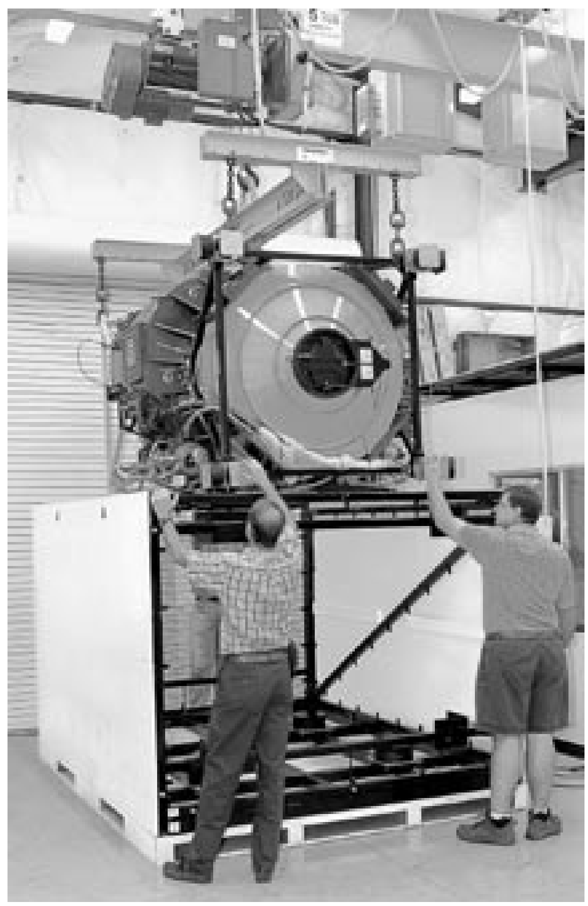
Taft Armandroff & Mark Trueblood

The NGSC Instrumentation Program continues its efforts to provide innovative and capable instrumentation for the Gemini telescopes in support of frontline science programs. This article gives a status update on Gemini instrumentation being developed in the United States, with progress since the September 2003 *NOAO/NSO Newsletter*.

GNIRS

The Gemini Near-InfraRed Spectrograph (GNIRS) is an infrared spectrograph for the Gemini South telescope that will operate from 1 to 5 microns and will offer two plate scales, a range of dispersions, as well as long-slit, cross-dispersed, and integral-field modes. The project is being carried out at NOAO in Tucson under the leadership of Neil Gaughan (Project Manager), Jay Elias (Project Scientist), and Dick Joyce (Co-Project Scientist).

GNIRS pre-shipment acceptance testing took place in August and October. A team of Gemini scientists and engineers traveled to Tucson to carry out the testing, with GNIRS operating on the NOAO Flexure Test Facility. The Gemini Team carried out a comprehensive battery of tests, including image quality, mechanical and optical stability as the instrument orientation changes, thermal stability, detector performance, space envelope compliance, and software interface compliance. On October 15, the Gemini Team determined that GNIRS had met all of the stringent pre-shipment requirements. GNIRS was then carefully disassembled and packed. On October 24, the shipment of GNIRS from Tucson to Gemini South took place. GNIRS arrived at Cerro Pachón on October 27. It next will be



GNIRS is lowered into its crate for shipment to Gemini South under the control of Ron George and the steady hand of Dick Joyce.

continued

NGSC Instrumentation continued

reassembled, cooled, and fully integrated with the Gemini South control systems and hardware interfaces. GNIRS will then undergo final acceptance testing, which will include on-sky observations. Several NOAO staff members will spend significant time at Gemini South assisting with GNIRS reassembly, integration, acceptance testing, and commissioning. We anticipate that GNIRS will have advanced sufficiently in its testing and commissioning activities to be included in the Gemini 2004B Call for Proposals.

Crate of GNIRS electronics cabinets being removed from the NOAO Flexure Test Facility in preparation for shipment to Gemini South.

NICI

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

The NICI vacuum jacket parts have been received and assembled, and the first vacuum test is expected soon. The NICI mechanisms have also been received and assembled. MKIR received the Gemini-provided, cooled electronics cabinets and is in the process of finalizing the cable lengths. Overall, 70 percent of the work to NICI final acceptance by Gemini, which is planned for December 2004, has been completed.

GNIRS leaving the NOAO facilities in Tucson for Chile.

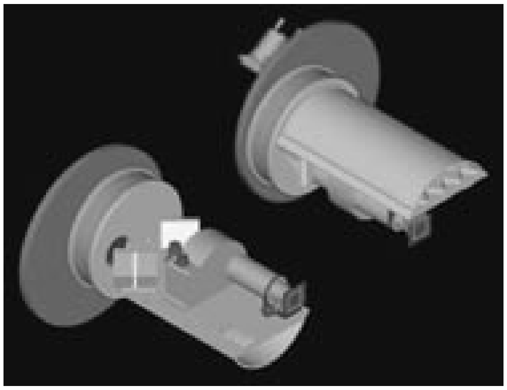
FLAMINGOS-2

FLAMINGOS-2 is a near-infrared multi-object spectrograph and imager for the Gemini South telescope. It will cover a 6.1-arcmin-diameter field at the standard Gemini *f*/16 focus in imaging mode, and will provide multi-object spectra over a 6.1×2-arcmin field. It will also provide a multi-object spectroscopic capability for Gemini South's multiconjugate adaptive optics system. FLAMINGOS-2 is being built by the University of Florida under the leadership of Richard Elston (Project Scientist), Steve Eikenberry (Co-Project Scientist), and Roger Julian (Project Manager).

continued

GNIRS in the Gemini Cerro Pachón clean room.

NGSC Instrumentation continued



Solid modeling of the FLAMINGOS-2 camera dewar showing the optical bench, detector, and filter/grism wheel.

A Critical Design Review (CDR) for FLAMINGOS-2 took place on 20–21 August 2003 in Gainesville, FL. Participating in the review were CDR Committee members Darren DePoy (Chair, Ohio State University), Larry Ramsey (Pennsylvania State University), James Larkin (University of California at Los Angeles), Tom O'Brien (Ohio State University), Manuel Lazo (Gemini Observatory), and Kim Gillies (Gemini Observatory). FLAMINGOS-2 passed its CDR, except for software, which requires further refinement. The Florida team also finalized a contract for the FLAMINGOS-2 On-Instrument Wavefront Sensor (OIWFS). This important item will be provided by the Herzberg Institute of Astrophysics, which is basing the FLAMINGOS-2 OIWFS on the OIWFS that they developed for the two GMOS instruments.

NGSC Webcast

We are happy to report that the first NGSC Webcast for the US community was a success. The topic of the Webcast was the September 30 observing proposal deadline, in particular Gemini instrument capabilities for the 2004A semester. After the presentations, questions were entertained from the audience. The presentations are available in PDF format on the NGSC Web site at *www.noao.edu/usgp/ngsc_webcast.html*.

Please watch our Web site and the *NOAO/NSO Newsletter* for announcements of future Webcasts. Also, let us know (*ngsc@noao.edu*) if you have any suggestions or topics of interest you would like to see covered in future programs.

NGSC scientist Ken Hinkle and NGSC Director Taft Armandroff addressed the audience during the 17 September 2003 Webcast to the US community.

2004A Proposal Process Update

Dave Bell

NOAO received 405 observing proposals for telescope time during the 2004A observing semester. These included 133 proposals for Gemini, 131 for KPNO, 125 for CTIO, 35 for Keck, and 4 for HET. Ten of the Cerro Tololo proposals were processed on behalf of the Chilean National Time allocation Committee (TAC), and five of the Kitt Peak proposals were processed on behalf of the University of Maryland TAC. Thesis projects accounted for 23 percent (93 proposals) of those received, and 12 proposals requested long-term status. Time-request statistics by telescope and instrument appear in the following tables. Subscription rate statistics will be published in the March 2004 *Newsletter*.

As of this writing, proposals are being reviewed by members of the NOAO TAC (see the following listing). We expect all telescope schedules to be completed by 11 December 2003, and we plan to notify principal investigators (PIs) of the status of their requests at that time. Mailed information packets will follow the e-mail notifications by about two weeks.

Looking ahead to 2004B, Web information and forms will be available on line by late February 2004. The March 2004 *Newsletter* will contain updated instrument and proposal information.

NOAO Survey Program Update

The NOAO Survey program provides up to 20 percent of the time at most NOAO telescopes for major programs of up to five years duration. Fifteen programs have been approved, and several are now complete or nearing completion. Survey time is at the 20 percent cap through 2004B, so there will not be a call for new surveys starting in that semester. Watch this space for information on future calls for NOAO Survey proposals. Letters of intent are required for all NOAO Survey proposals, and are generally due about two months before the proposal deadline. We will notify potential investigators (through this *Newsletter*) of the next call at least eight weeks in advance of the deadline for letters of intent.

2004A Instrument Request Statistics by Telescope

KPNO

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
KP-4m		**63**	**66**	**227.8**	**85**	**37**	**3.5**
	ECH	7	7	24.5	4	16	3.5
	FLMN	12	12	45	2	4	3.8
	MARS	3	3	9	0	0	3
	MOSA	17	17	52.5	44	84	3.1
	RCSP	22	22	82	35	43	3.7
	SQIID	5	5	14.8	0	0	3
WIYN		**41**	**42**	**144.2**	**68.5**	**47**	**3.4**
	DSPK	3	3	15	2	13	5
	HYDR	16	16	64.5	41	64	4
	MIMO	10	10	26.2	15	57	2.6
	SPSPK	4	4	14	2	14	3.5
	VIS	4	4	12	0	0	3
	WTTM	5	5	12.5	8.5	68	2.5
KP-2.1m		**31**	**34**	**169.2**	**71**	**42**	**5**
	CFIM	9	10	65	50	77	6.5
	FLMN	5	5	18	0	0	3.6
	GCAM	15	16	74	21	28	4.6
	SQIID	3	3	12.2	0	0	4.1
KP-0.9m		**3**	**4**	**25**	**25**	**100**	**6.2**
	MOSA	3	4	25	25	100	6.2

CTIO

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
CT-4m		**82**	**99**	**298.2**	**75**	**25**	**3**
	ECH	8	9	27	0	0	3
	HYDRA	15	16	54.5	11	20	3.4
	ISPI	26	30	92.5	0	0	3.1
	MOSAIC	20	21	52.3	35	67	2.5
	RCSP	20	22	68	29	43	3.1
	VIS	1	1	4	0	0	4
CT-1.5m		**9**	**9**	**38.5**	**10**	**26**	**4.3**
	CSPEC	9	9	38.5	10	26	4.3
CT-1.3m		**16**	**16**	**64.2**	**7.5**	**12**	**4**
	ANDI	16	16	64.2	7.5	12	4
CT-1.0m		**2**	**2**	**12**	**12**	**100**	**6**
	CFIM	2	2	12	12	100	6
CT-0.9m		**16**	**17**	**114**	**18**	**16**	**6.7**
	CFIM	16	17	114	18	16	6.7

Gemini

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
GEM-N		**77**	**91**	**177.7**	**91.8**	**52**	**2**
	GMOSN	50	58	115.2	88.4	77	2
	NIRI	29	33	62.5	3.4	5	1.9
GEM-S		**59**	**64**	**123.4**	**8.8**	**7**	**1.9**
	GMOSS	12	12	16.5	8.8	54	1.4
	Phoenix	23	23	46.1	0	0	2
	TReCS	25	29	60.8	0	0	2.1

Community Access

Telescope	Instrument	Proposals	Runs	Total Nights	Dark Nights	% Dark	Avg. Nights/Run
Keck-I		**13**	**13**	**21**	**10.5**	**50**	**1.5**
	HIRES	6	6	11	4	36	1.8
	LRIS	4	4	6.5	6.5	100	1.6
	LWS	3	3	3.5	0	0	1.2
Keck-II		**22**	**25**	**39.5**	**10**	**25**	**1.6**
	DEIMOS	5	5	9	9	100	1.8
	ESI	1	1	1	1	100	1
	NIRC2	4	6	7	0	0	1.2
	NIRSPAO	2	2	3	0	0	1.5
	NIRSPEC	10	11	19.5	0	0	1.8
HET		**4**	**4**	**7.5**	**5.2**	**69**	**1.9**
	HRS	2	2	3.5	2	57	1.8
	LRS	2	2	4	3.2	80	2

2004A TAC Members

Extragalactic (28–29 October 2003)
Dave De Young, NOAO (C)
Tod Lauer, NOAO (C)
John Mulchaey, Carnegie Observatories (C)

Lee Armus, CalTech
Stephane Courteau, University of British Columbia
Roelof De Jong, STScI
Ian Dell'Antonio, Brown University
Arjun Dey, NOAO
Erica Ellingson, University of Colorado
Harry Ferguson, STScI
Anthony Gonzalez, University of Florida
Crystal Martin, University of California at Santa Barbara
Brian McNamara, Ohio University
Philip Pinto, University of Arizona
Lisa Storrie-Lombardi, SIRTF Science Center
Nick Suntzeff, NOAO/CTIO
Rogier Windhorst, Arizona State University
Ann Zabludoff, University of Arizona

Galactic (30–31 October 2003)
Sidney Wolff, NOAO (C)
Abi Saha, NOAO (C)
Suzanne Hawley, University of Washington (C)

Lori Allen, SAO
Suchitra Balachandran, University of Maryland
Michael Briley, University of Wisconsin
Margaret Hanson, University of Cincinnati
Rob Hynes, University of Texas at Austin
Ray Jayawardhana, University of Michigan
James Liebert, University of Arizona
Julie Lutz, University of Washington
Ken Mighell, NOAO
Knut Olsen, NOAO/CTIO
Caty Pilachowski, Indiana University
Steve Ridgway, NOAO
Verne Smith, University of Texas at El Paso
Kim Venn, Macalester College
Rene Walterbos, New Mexico State University

Solar System (27 October 2003)
Dave De Young, NOAO (C)

William Hubbard, University of Arizona
Robert Millis, Lowell Observatory
Susan Wyckoff, Arizona State University

Enhancing Excellence

Alistair Walker

The past few years have been a period of rapid change at CTIO. We have welcomed new projects—Gemini South and, more recently, the Southern Astrophysical Research Telescope (SOAR). Elsewhere in Chile, the Very Large Telescope (VLT) and Magellan have commenced operations, and earlier this month the groundbreaking ceremony for the Atacama Large Millimeter Array (ALMA) took place. The way astronomers are doing their science is changing too: large collaborative efforts involving many facilities, on the ground and in space, are increasingly the norm. The rapid growth in communications bandwidth is permitting easier access to archives storing astronomical data from many facilities, and allowing educational, technical, and astronomical interactions between colleagues separated by thousands of kilometers. These are exciting times, and CTIO will be playing a very full and active part in 21st century astronomy.

Support of US astronomers using Gemini is a vital duty of the NOAO Gemini Science Center (NGSC), which has staff stationed in both Tucson and La Serena, and we are looking forward to the imminent appointment of an NGSC Deputy Director, who will be stationed in La Serena. The Blanco wide-field telescope is also a crucial element of the US system of telescopes, and over the next few years its performance will be enhanced with new instruments. CTIO will soon be operating the high-performance SOAR 4-meter, with a suite of state-of-the-art instruments, and will later install an innovative Adaptive Optics system that will be a precursor to the type required for the next generation of extremely large telescopes. Indeed, CTIO staff are fully engaged in both the Thirty-Meter Telescope (TMT) and Large Synoptic Survey Telescope (LSST) projects, along with our Tucson colleagues and other partners. The NOAO Major Instrumentation Program and Data Products Program are essential to the optimum utilization of the present facilities, and will also serve the future telescopes. Again, the skills of CTIO personnel play an important role in these programs. Finally, innovative ways to keep small telescopes operating at low cost have been developed, with the SMARTS consortium rejuvenating the small-telescope science at CTIO and providing new opportunities for NOAO users. In 2004, the consortium will deliver new instrumentation and move from a three- to a four-telescope system.

I am proud to have been appointed director of Cerro Tololo Inter-American Observatory, and thus have the opportunity to lead its scientific and technical staff in these exciting and challenging efforts I see the primary function of the CTIO Director as providing the scientific leadership necessary to enhance the capabilities of CTIO as an observatory, plus working together with associate directors and other managers of NOAO programs to ensure efficient and integrated operation of NOAO in developing new facilities and capabilities.

A notable feature of CTIO, and one that is directly responsible for its enviable international reputation, is the cohesiveness and motivation of its highly dedicated staff. This has been a feature of CTIO for 40 years, and as the new CTIO director, I will strive to preserve and enhance these vital characteristics.

A Tribute to Malcolm Smith

Nicholas Suntzeff

Malcolm Smith has stepped down as the director of the Cerro Tololo Inter-American Observatory (CTIO) after a ten-year tenure in the position. Fortunately, he will continue as the AURA Observatories Director in Chile and as an astronomer at NOAO.

Malcolm has been a long-time member of the NOAO staff and a tireless supporter of the US national observatories. He was a postdoctoral research associate at Kitt Peak National Observatory (KPNO) from 1967–69, and an astronomer at CTIO from 1969–76, where he participated in the inauguration of the Blanco 4-meter Telescope. From there he went to the Anglo-Australian Observatory (AAO) as a Research Scientist, then to the Royal Observatory Edinburgh as Head of Technology, finally moving to Hawaii as the Director of the Joint Astronomy Center (JAC).

Malcolm has led CTIO through ten years of remarkable change, and is leaving it a significantly stronger observatory. Through his leadership, he has integrated the Gemini South 8-meter telescope into the umbrella of AURA Observatories in Chile, merging the service aspect of both CTIO and Gemini into

continued

Tribute to Malcolm Smith continued

a coordinated support operation, much as he did at the JAC. Perhaps his most important achievement as CTIO Director and AURA representative in Chile was working with the Chilean Executive Branch and Chilean Congress to craft a law allowing foreign observatories like CTIO and Gemini to operate in Chile under important guarantees. I have heard some of my Chilean colleagues state that it was Malcolm's quiet and reasoned diplomacy that was the single key in getting the Astronomy Law passed through Chilean Congress.

Malcolm has also worked to get a new 4-meter facility installed at CTIO, the Southern Astrophysical Research Telescope (SOAR). Following the previous Decadal Survey recommendations for the funding and building of 4-meter-class telescopes, CTIO will have a new state-of-the-art 4-meter telescope on Cerro Pachón, in collaboration with the SOAR partners at the University of North Carolina, Michigan State University, and Brazil. Through the SMARTS partnership, CTIO has also added a 1.3-meter telescope (the 2MASS telescope) to the suite of small telescopes available to the US community. Malcolm leaves an observatory that offers more telescope aperture than when he began, and a bright future for further telescope projects.

I have heard some of my Chilean colleagues state that it was Malcolm's quiet and reasoned diplomacy that was the single key in getting the Astronomy Law passed through Chilean Congress.

Malcolm has also been a strong supporter of public outreach in Chile and internationally. He has helped bring in funding for an educational planetarium for the area, and has worked to fund a municipal observatory in Vicuna. Both of these efforts have greatly raised interest in astronomy in the La Serena area and have stimulated students to pursue science careers in Chilean universities. Malcolm and his wife, Anamaria, worked hard to make La Serena a sister city to Hilo, HI, forming a very beneficial and active teacher exchange program between the two cities. Right now, a number of La Serena teachers are in Hilo, giving classes and learning new educational technologies to bring back to Chile.

During Malcolm's tenure, it became evident that the remarkable growth of Chile would bring about one downside—light pollution. Malcolm consequently organized an effort to study the effects of light pollution, and helped Chilean authorities draft a light pollution law that should minimize the effects of light pollution on the observatories, not only in the La Serena region, but across the whole country.

Malcolm is the second famous native of Tavistock, England to leave his mark on the La Serena area. The previous one sacked and burned our neighboring city, Coquimbo. Fortunately, with such a strong light pollution law in place, it is fair to say that such heinous behavior by the likes of Sir Francis Drake would not be tolerated by the authorities now.

Frankly though, I can't say I will miss Malcolm. After all, he is not going anywhere! I look forward to being his colleague on the CTIO staff, where he will once again be able to fully pursue his scientific interests in QSO and AGN research. Malcolm was a pioneer in the 70s and 80s in the field of emission line galaxies. He has kept up an active interest in the field, and he will now have more time to do the science he loves with the facilities that he was instrumental in building.

SOAR AOS Passes Acceptance Testing

Steve Heathcote & Victor Krabbendam

The SOAR project passed a major milestone during October with the successful completion of acceptance testing of the telescope's Active Optics System (AOS), marking the culmination of more than four years of design and optical fabrication efforts by contractor Goodrich Aerospace. This series of tests, carried out over a three-month period, establishes that the completed AOS is functioning properly and fully meets SOAR's exacting requirements.

In one especially crucial set of tests, interferometric measurements were used to demonstrate that the active support system for the primary mirror can precisely and reproducibly control the mirror's figure. By properly adjusting the forces on the 120 electromechanical actuators it was possible to optimize the shape of the mirror, achieving a surface quality of better than 22 nanometers RMS, (easily surpassing the 26 nanometers RMS requirement) or alternatively "dial-in" predictable amounts of various optical aberrations.

Another set of tests established that the servo control system for the tertiary fast-steering mirror meets strict requirements

continued

SOAR AOS Passes Testing continued

on closed-loop bandwidth and residual jitter. A final system level test verified that all the AOS components function properly together under the command of the SOAR telescope control system.

With testing complete, the AOS is being disassembled and packed carefully for its long journey to Chile. The components of the AOS will be trucked from the Goodrich plant in Danbury, CT, to the Port of New York, where they will be loaded aboard a freighter that will carry them through the Panama Canal to the Port of San Antonio, Chile. From there, according to the current schedule, a truck will deliver the optics to Cerro Pachón during the first week of January.

Once on site, the primary mirror will be aluminized in the Gemini South coating chamber, the components of the AOS will be integrated with the telescope mount, and everything will be readied for first light. We hope that this will be achieved in early April, *just* in time for the formal dedication of the SOAR telescope on Saturday, 17 April 2004, six years to the day after the laying of the first stone at the SOAR site.

The SOAR primary mirror, mounted on its support structure, is seen with members of Goodrich Aerospace staff and the SOAR project team following the successful completion of acceptance testing of the active optics system.

SOAR Optical Imager Integrated on Cerro Pachón

Hugo E. Schwarz

The first-light instrument for SOAR, the SOAR Optical Imager (SOI) has been successfully integrated in the SOAR building on Cerro Pachón. After the first trial run in August, some minor modifications had been made to make the mounting and dismounting of the instrument easier, and a test with the instrument without its optics was successfully performed on October 30.

Installation of the ADCs, optics, rotator, filter slides, guide probe, guide camera, cable wrap, CCD controllers, and the dewar with the science CCDs proceeded without complications, and the guide probe was aligned with the optical axis of the SOI. Preliminary flexure tests show that everything is within specified limits, both using the guide probe and straight through the optics. Images were taken with the science CCD, and the complete instrument went on the telescope on November 3 for more extensive flexure and other tests.

Congratulations to the SOI team for a job very well done!

New Arrivals

Chris Smith

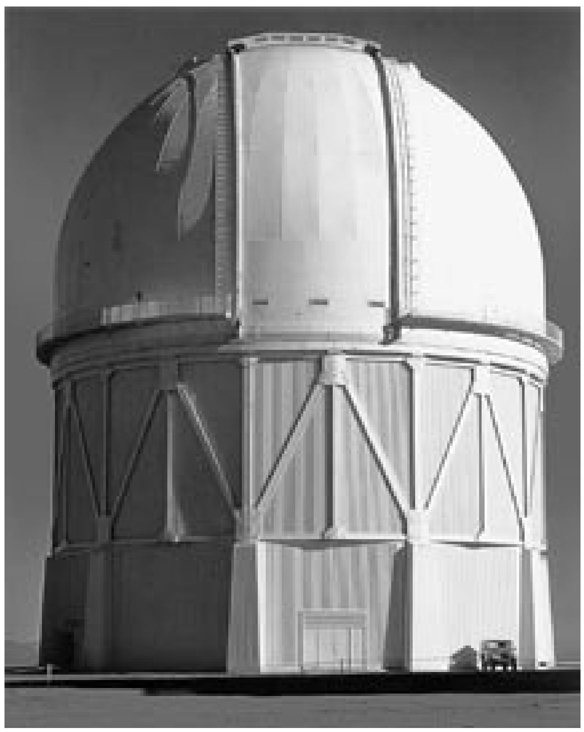
Sean Points joined the NOAO South scientific staff in La Serena in October. He arrived from Northwestern University, where he has been a postdoctoral fellow for the past two years working on studies of the interstellar medium with the Far Ultraviolet Spectroscopic Explorer (FUSE). Sean has a PhD from the University of Illinois, where he worked with You-Hua Chu on a study of the large-scale structure of the interstellar medium in the Large Magellanic Cloud at optical, radio, and X-ray wavelengths. Sean was a frequent visitor to CTIO for his thesis and related observations.

Sean is joining the NOAO staff as a postdoctoral fellow working with Chris Smith on the Magellanic Cloud Emission-line Survey and related science. He has also joined the Data Products South group (about one-third of his time) to provide scientific input and guidance to their projects. We are very pleased to have him back on site.

Announcement of Opportunity for a Blanco Instrumentation Partnership

Alistair Walker

NOAO announces a partnership opportunity to develop a major new instrument for the Blanco 4-meter Telescope at Cerro Tololo Inter-American Observatory (CTIO). Although there are no restrictions on the type of instrument that can be proposed, we see a special opportunity to exploit the wide-field capability of the prime or RC foci of the telescope. Additionally, any proposed instrument should be consistent with a system-wide view of facilities available to the US community, in particular those in the southern hemisphere. Guidance on the US system can be obtained from the report on the first workshop on the ground-based optical/infrared (O/IR) system, at *www.noao.edu/gateway/oir_workshop/*.



The full Announcement of Opportunity, and links to descriptions of the Blanco telescope and its instrumentation, can be found at *www.ctio.noao.edu/telescopes/TheFuture/Blanco_prop.html*. By the likely time of the commissioning of the new instrument solicited here, we expect to have retired the RC and Echelle spectrographs, since their capabilities will have been replaced by new instrumentation on SOAR and Gemini. We plan to begin sharing the wide-field infrared imager NEWFIRM with the Mayall 4-meter Telescope on Kitt Peak in 2006. NEWFIRM is described at *www.noao.edu/ets/newfirm/*.

Proposers will need to submit a science plan, a technical plan, and a management plan. The science plan should include a description of compelling science to be undertaken by the proposing team, which may be in partnership with NOAO, and also an outline of anticipated astronomy community use of the instrument through merit-based proposals. The technical plan should present a conceptual design of the instrument in sufficient depth for peer reviewers to assess the feasibility of the project with the resources to be committed. The management plan should outline the proposed sharing of responsibilities for work packages covering optomechanical and focal plane design and development, data acquisition, and data management between the proposer and NOAO. A general management structure, along with a schedule of project reviews and acceptance testing, should be included. The management plan should also include a basic plan for educational and public outreach, and explain the broader impacts of the project.

Up to 30 percent of Blanco telescope time for five years commencing in 2007 or 2008 is available for the science project. NOAO will contribute the operation of the telescope and an upgraded control system with a combined nominal annual value of $4 million at real-year prices. NOAO would expect to partner with the successful proposer in developing a data management system, including data acquisition, that is compatible with the National Virtual Observatory. The successful proposer can expect to work with an engineering interface at NOAO with optomechanical and other expertise.

Letters of intent are due at NOAO on 15 March 2004. At that time, an NOAO contact person will be appointed to answer proposers' technical inquiries, and to give guidance on the form and scope of the proposal. Instructions and technical information will also be available at *www.ctio.noao.edu/telescopes/TheFuture/Blanco_prop.html*. Full proposals are due 15 August 2004.

Potential proposers are encouraged to contact Alistair Walker at *awalker@ctio.noao.edu*. We look forward to working with you.

A Year of Ambitious Plans for WIYN Projects

Richard Green

Invigorated by the crisp fall weather in Madison, WI, the WIYN Board met in early October and encouraged vigorous progress on four major WIYN instrumentation initiatives.

As the external five-year review pointed out in 2001, WIYN delivers the best images over a wide field of view of any continental US facility. That compliment is validated by the reported modal seeing over the last year and a half of 0.58 arcsec. To further capitalize on this ability, the consortium is focusing on investments in wide-field spectroscopy and in rapid guiding for sharpened imaging.

The first project slated for completion is the Hydra positioner upgrade. The current x-y stages require critical alignment and are obsolete in terms of direct replacement parts for lead screws, motors and controllers. Building on the Hydra/CTIO heritage, Gary Muller and an NOAO-based technical team have designed a replacement system that is maintainable and more tolerant to alignment errors, and which may shorten the reconfiguration time considerably. The design passed critical design review in September, and is already well along in fabrication. Behzad Abareshi is porting the code to Linux, and a substantial lab testing period is planned before installation during next summer's shutdown. Commissioning is likely to extend into early fall of 2004, in order to validate astrometric solutions during stable weather conditions. The result will be a system that promises reliable performance for the remainder of the decade.

The result will be a system that promises reliable performance for the remainder of the decade.

The original design of the bench spectrograph concentrated on spectral purity and assumed only modest focal ratio degradation from the fiber outputs. The consequence for the as-built system was a modest throughput and noticeable light losses for end fibers. Matt Bershady (University of Wisconsin) and Charles and Di Harmer have led an effort to modify the optomechanical design of the bench to increase throughput with only minimal degradation in spectral resolution. They have also investigated an off-axis collimator and novel field lens group that can lead to up to three times greater throughput. The Board approved the design project to proceed to Preliminary Design Review next spring. Meanwhile, the KPNO technical group is fabricating a mount for a new 740 lines per millimeter VPH grating. Such gratings typically deliver additional improvements in throughput (up to a factor of two).

This new grating affords approximately 400 angstroms of coverage between half power points with R ~ 2000 in first order, with a central wavelength range between 8000 angstroms and 1 micron. In second order, it has an almost equally high throughput (greater than 90 percent). The grating will be tested on the telescope this fall, thanks to the Harmers' development of a working configuration, which includes a flat that will accommodate the transmission optic on the existing bench.

The WIYN tip-tilt module (WTTM) is expected to have its most marked effect in the near infrared. Its general performance in the optical range was validated in October by cross-comparison with John Tonry's University of Hawaii OPTIC camera containing orthogonal transfer (OT) CCDs. In both cases, the fast guiding improved the 0.4-arcsec delivered images to approximately 0.3 arcsec FWHM, as expected. Pat Knezek obtained a narrowband [O III] image in a half-hour exposure ending at two airmasses, with a FWHM of 0.6 arcsec with the OPTIC camera. To capitalize on the excellent imaging potential of WTTM, Margaret

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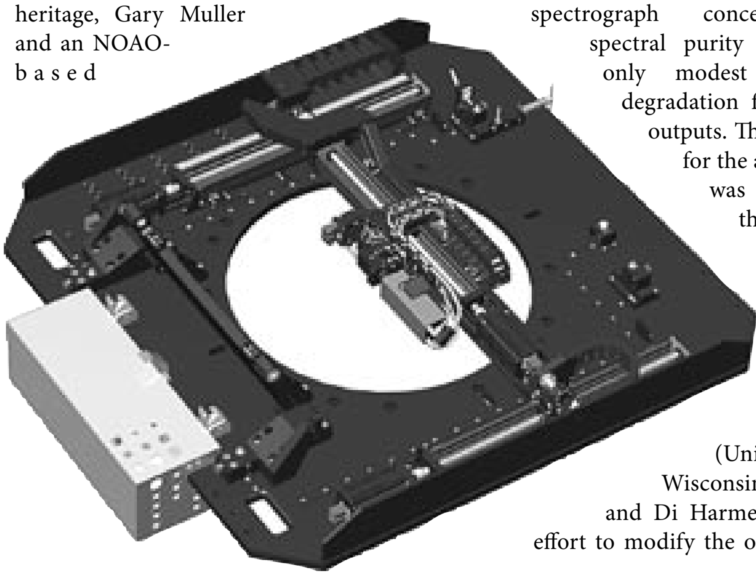


NOAO engineer Gary Muller's model image of the Hydra positioner stage.

Ambitious Plans for WIYN continued

Meixner at Space Telescope Science Institute has received internal funding to start construction of WHIRC, the WIYN High-Resolution IR Camera. It will be designed to produce two pixel scales, 0.06 arcsec and 0.12 arcsec, on a 2K×2K HgCdTe detector. The initial implementation would be with a 1K×1K detector provided by NOAO. With additional resources provided by WIYN, the preliminary design should be completed early next calendar year.

Finally, the prospects of image improvement through local fast guiding have motivated the development of the One-Degree Imager. This gigapixel camera will be based on orthogonal transfer arrays (OTAs) of OT CCDs. The project has made tremendous progress, with the successful initiation of the first foundry run of OTAs.

George Jacoby (Project Scientist) has engaged the design and production talents of Dick Bredthauer (Semiconductor Technology Associates) to produce the masks to run through the Dalsa foundry. Mike Lesser (ITL) will perform the thinning and packaging. The design is the result of a highly productive collaboration between Jacoby, Bredthauer, and Lesser with Barry Burke of MIT Lincoln Labs and John Tonry and Gerry Luppino of the University of Hawaii through interaction between WIYN and the PanSTARRS project. NOAO is simultaneously developing a version of its new Monsoon data acquisition system to operate OTAs. The confluence is expected next March or April, with a working OTA and controller in the lab for the beginning of testing. The WIYN Board authorized George and the development phase manager, Pat Knezek, to proceed with mechanical design to bring the entire system up to Conceptual Design Review level. The goal is for science operations to begin in 2007.

Kafka and Honeycutt's composite B and Z image of M3 taken with WTTM.

Add to these considerable instrumentation efforts the planned aluminization of the primary mirror next summer and the near-term replacement of the azimuth precision bearings, and you can get an idea of the extremely busy year ahead for WIYN, as well as the amount of contributions KPNO and NOAO/Tucson are making for these impressive improvements.

From the NSO Director's Office

Steve Keil

NSO staff and several of our partners have been busy this fall preparing a construction proposal for the Advanced Technology Solar Telescope (ATST). The proposal will be submitted by the end of 2003 to comply with the National Science Foundation Major Research Equipment program schedule for a potential startup in 2006. The proposal is based on the conceptual design developed over the past few years that was reviewed at a Conceptual Design Review in late August.

A parallel effort to submit a proposal to the European Union (EU) to participate in the final stages of the design effort is being organized for the EU Sixth Framework Program. This will hopefully set the stage for later European participation in the telescope construction phase.

Because of the unique role the ATST will play in resolving fundamental magnetoconvection processes and magnetic fine structure throughout the solar atmosphere, its impact will be much broader than solar physics alone. The ATST will elucidate the mechanisms involved in plasma-field interactions that are seen throughout astrophysics, plasma physics, and solar-terrestrial and space physics. Our guest editorial by Eugene Parker presents a wonderful summary of some of these broader impacts.

✹

After a month of overlapping magnetograms with SOLIS, the Kitt Peak Vacuum Telescope (KPVT) took its last observations on 21 September 2003. Many of the staff and community who operated the KPVT and used its output showed up for a final farewell ceremony. The KPVT facility is now being prepared for SOLIS, which we anticipate moving up to the mountain early in 2004.

✹

Several changes in NSO observing capabilities have begun to take place recently. The solar group from Arcetri Astrophysical Observatory in Florence brought their Interferometric BI-dimensional Spectrometer (IBIS) narrowband filter system to Sacramento Peak, where it has been installed at the Dunn Solar Telescope (DST). IBIS is a next-generation bidimensional spectrometry instrument based on a dual Fabry-Perot interferometric system. It combines high-spectral resolution with short exposure times and a large field of view, as well as the ability to work in polarized light. This will allow it to address a variety of observational programs in solar physics. IBIS is one of the concepts under consideration for a visible light, narrowband filter for the ATST. It is currently fed by the low-order adaptive optics system and can be used simultaneously with the horizontal spectrograph and other filter systems.

New data collection computers are being installed at the DST facility, and a data transfer system is being established to allow users to take the data home on the medium of their choice. The system will be available for users during the next several quarters.

✹

After a short hiatus from workshops, NSO is planning to hold its 22nd Sacramento Peak Workshop on large-scale processes and the role they play in solar activity. Dates of the meeting are still being determined, and an official announcement will be made soon. Feel free to contact K. Sankarasubramanian (*sankara@nso.edu*) if you have questions about the workshop or would like to participate.

Next spring, Sac Peak will also host a NASA-sponsored US Planning Workshop for the 2007 International Heliophysical Year. For more information on this planning workshop, contact K. S. Balasubramanaiam (*bala@nso.edu*).

✹

NSO is pleased to welcome three new employees. Mark Komsa, an instrumentation engineer comes to Sac Peak from Youngstown, OH, where he gained experience with a variety of hardware and software working in application and software engineering. Andrew Whitehorse has been hired as a general maintenance person and will work with craftspersons at Sac Peak in support of the facilities maintenance program. Igor Suarez-Sola will work with Frank Hill on the Virtual Solar Observatory (VSO) project in Tucson as a senior software engineer.

Guest Column

Scientific Perspective for the ATST

The magnetic-gravitational-plasma Universe is the subject of contemporary astrophysics, and it exhibits a seemingly endless variety of exotic phenomena that are mysterious, baffling, and challenging. Each major advance in observational technology reveals a new facet of the Universe.

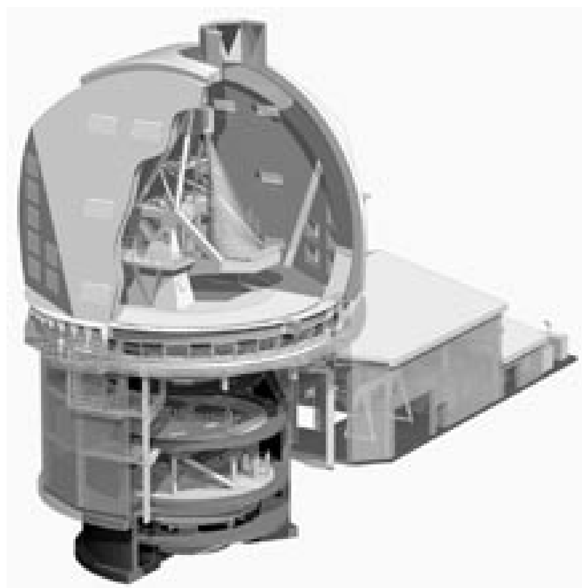
The one common thread is the involvement of plasma and magnetic fields. Presumably the diverse plasma phenomena are all consequences of the basic laws of physics, learned from observations of the solar system and from experiments in the terrestrial laboratory. It should be understood, however, that the basic laws of physics—Newton, Maxwell, Lorentz, Boltzmann, Planck, Einstein, Schrödinger, Heisenberg, Dirac, et al.—allow an infinite variety of effects, so we generally understand the manifestations of the basic laws only insofar as nature exhibits them to us. The distant plasma manifestations observed in the Universe turn the problem around, demanding a connection back to the basic laws. So we speculate on the nature of the exotic plasma effects in the distant phenomena.

It is natural to ask what dynamical manifestations can be seen in laboratory experiments with magnetized plasma. Unfortunately, the small size of the terrestrial plasma physics laboratory mostly limits the experimental effects to transient phenomena. Steady flows of plasma can be studied, but any quasi-equilibrium of field and plasma is short lived. Indeed, the complexity of the plasma dynamics is astounding. Were it not, plasma fusion of hydrogen into helium would have been achieved long ago, and today plasma fusion might well be a major energy source in the world.

Larger dimensions are needed to explore the dynamics of plasmas and magnetic fields, and the astronomical Universe is the available venue. The magnetosphere of Earth is the nearest "natural" plasma dynamical demonstration, but it suffers the disadvantage of transparency. The ground-based observer looks right through it, so that diagnostics are limited to magnetic fluctuations at the surface of Earth with measurements of the field, plasma, and fast particles carried out in situ with spacecraft instruments.

The solar wind is, of course, an integral part of the magnetospheric dynamics, again suffering from nearly perfect transparency and, hence, studied only through in situ measurements.

It is only when we get to the Sun that remote, ground-based study becomes possible. The visible surface of the Sun is opaque, by definition, and it exhibits numerous magnetic phenomena that are a part of the overall activity of the Sun. The sunspot is the classic example, followed by flares, prominences, the corona, magnetic active regions, magnetic fibrils, etc. So the concept of a placid "eternal" Sun has been supplanted by the revelation that it is an ordinary star, despite its multibillion-year life expectancy, alive with transients that are for the most part created by the interaction of magnetic fields and the convectively driven plasma. We are so used



ATST layout design presented at CoDR.

to this concept nowadays that we fail to appreciate the full implications—that the magnetic activity of a star is a whole field of astrophysics in its own right.

In recent decades, astronomical observations have found the Universe to be full of violently active objects, from X-ray stars to active galactic nuclei and their black holes, from accretion disks to relativistic jets. Activity, whether the magnetic activity of a star like the Sun or the gravitationally fed explosive activity of an active galactic nucleus, is the rule

continued

Scientific Perspective for the ATST continued

rather than the exception. Unhappily, we have no way to see more than the gross features of the distant stars and galaxies, thus limiting theoretical speculation and explanation to only large-scale effects.

The Sun, whose activity is comparatively modest, continually exhibits magnetic activity that a distant observer would not detect, nor the theoretician have guessed. The X-ray emission from the Sun is probably the one exception, placing the Sun among the myriads of weak X-ray emitters that can be detected at a distance. However, it has become clear in recent years that very small-scale structure plays an essential role in the major active phenomena on the Sun, and those very small scales are difficult to see even from our vantage point on Earth. The major phenomena that we have in mind are such things as coronal mass ejections and flares, the heating of the X-ray corona, as well as the rapid, but quiet, readjustments of the magnetic field connections to minimum energy configurations above regions where fresh magnetic flux is emerging through the visible surface. None of these large-scale effects could occur if there were not internal small-scale processes. In particular, there is no rapid reconnection of magnetic fields in the highly conducting solar atmosphere without the dynamical development of very small (meters and kilometers) scales.

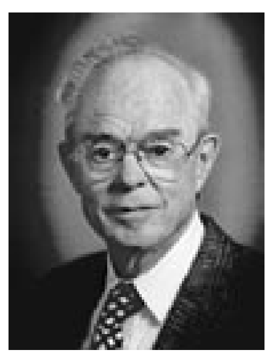
We infer that other stars exhibit similar dynamical phenomena, but we cannot very well extrapolate quantitatively from the gross theories of the active solar phenomena of today to other classes of stars and to galaxies without first developing a more precise understanding of the small scales. So, the activity exhibited by the Sun provides the necessary plasma physics laboratory for building a solid theoretical foundation for magnetic activity. And, as already noted, the Sun is none too close to accomplish this fundamental scientific task. The active small scales range from meters, in the thickness of the current sheets formed in rapid magnetic reconnection, up to 100 kilometers (0.04–0.1 arcsec) seemingly involved in the structure and interactions of individual magnetic fibrils. Even 100 kilometers is not resolved effectively in current solar telescopes.

It must be appreciated, then, that the magnetic fields of the Sun emerge through the visible surface as a complex tapestry of individual magnetic flux bundles, or fibrils. The larger fibrils (100–200 kilometers in diameter) are directly detected by their brightness and, while not properly resolved, measurements of the total magnetic flux can be made during brief periods of excellent seeing. The smaller fibrils, whose existence is indicated by momentary appearances, are not presently measurable. The fibrils interact with each other in complicated ways, accompanied by microflares and nanoflares, and the nature of their individual structure and interactions remains theoretical guesswork. The manner of their forming beneath the surface of the Sun is unknown. It is these myriads of fibrils that form the complex magnetic active regions, sometimes coalescing locally for some reason to form a sunspot, with its complicated filamentary umbra and penumbra. Tiny jets of hot gas show up in ultraviolet and extreme ultraviolet in the chromosphere and transition region. The SoHO, TRACE, and ACE spacecraft reveal a fantastic world of active loops and threads at coronal levels, all rooted in the magnetic fibrils, but this world is not at all understood because we cannot see the fibrils well enough for systematic exploration and study.

So there is a new astronomical world hiding from present observations, waiting to be detected and, ultimately, understood. There is no way to anticipate what surprises await us on scales of 30 to 200 kilometers among the interacting fibrils and the associated small-scale fluid motions and temperature structure. The small-scale fluid motions are simply not known at present, nor are the atmospheric effects of the fibril interactions up through the chromosphere, transition region, and corona, because they are just too small in size to be seen with existing instruments.

This microworld of the Sun is waiting to be discovered by new observational technology like the Advanced Technology Solar Telescope (ATST). It will take large numbers of photons to provide the high dispersion, rapid cadence, and high spatial resolution necessary to closely observe this microworld. And when, after some years of studying its behaviors, we have a better understanding of its complex nature, we will come to better appreciate what is involved in the diverse activity of other stars.

Eugene N. Parker
S. Chandrasekhar Distinguished Service Professor Emeritus
The University of Chicago
Departments of Astronomy & Astrophysics, and Physics



ATST Passes through Conceptual Design Review

Jim Oschmann & the ATST Team

The first major design review of the Advanced Technology Solar Telescope (ATST), the Conceptual Design Review (CoDR), was held in August in Sunspot, NM. There were approximately 70 people in attendance. The project received constructive feedback from the 11-person design review committee, chaired by Matt Johns of Carnegie Institute, and from the ATST Science Working Group (ASWG), led by Thomas Rimmele. Responses to the CoDR Committee and ASWG, which include plans for addressing the very useful recommendations offered by both groups, were prepared by the project team. The team has also been working on the ATST construction proposal for submission to the National Science Foundation by the end of the calendar year.

The remainder of this article summarizes several aspects of the material presented at the CoDR. The individual presentations, as well as the CoDR Committee and Science Working Group reports are available at *atst.nso.edu/meetings/codr/*.

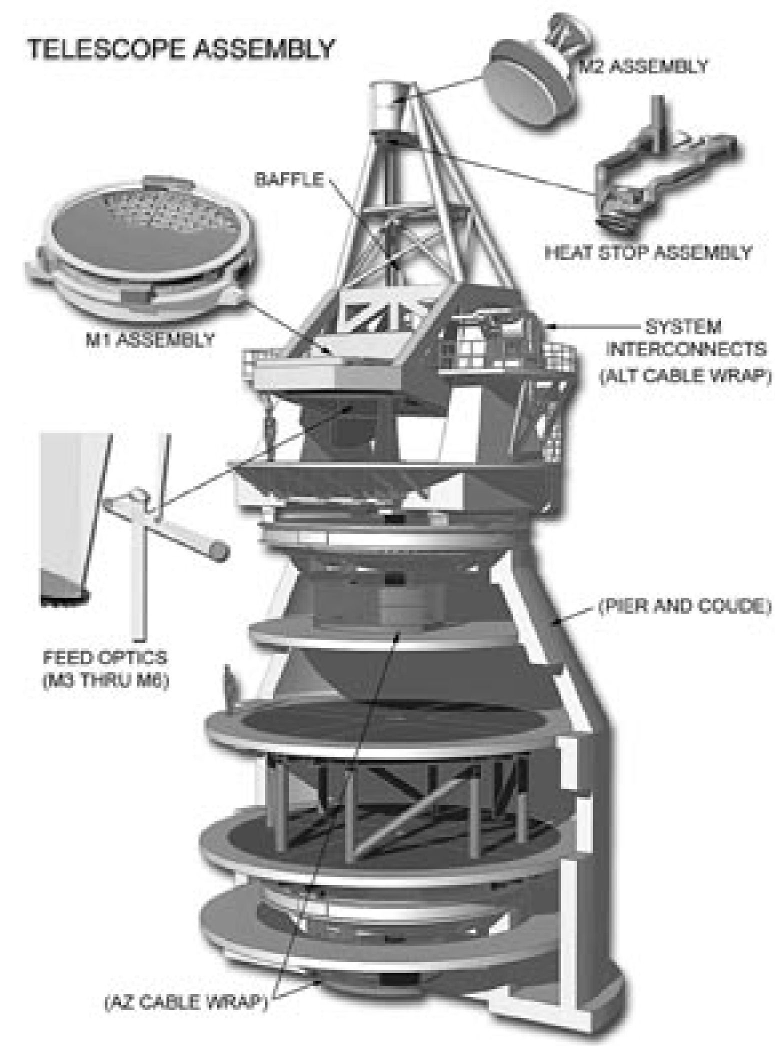


Figure 1. ATST Telescope Assembly.

Enclosure

A number of modifications were made to the enclosure design prior to the CoDR. The major changes from previous designs were to the passive ventilation system. A three-dimensional CAD model of the enclosure was sent to Fluent Incorporated for initial Computational Fluid Dynamics (CFD) modeling. This modeling effort was used to assess air-flow rates and patterns inside the dome under a variety of external wind conditions. The average calculated throughput was approximately 20 to 30 percent of the outside wind speed. This occurs near the center of the dome with all vents open. We will be adjusting the design and performing additional CFD modeling to raise this by a factor of two under most wind direction conditions. Future modeling will likely add thermal aspects and site-specific topography once the ATST site is chosen.

Telescope and Facility Design

Mark Warner, Ron Price, Nathan Dalrymple, and Rob Hubbard presented various aspects of the telescope assembly design and performance details. The telescope design is shown in figure 1, with expanded critical areas such as the primary and secondary mirror assemblies, heat stop, and feed optics. Details such as supports, thermal systems, cable wraps, and piping have evolved in most areas beyond what is normally considered at a conceptual level. There are also, however, a few areas that we need to bring up to an

continued

ATST Passes Review continued

equivalent level, such as how we will calibrate the polarization properties of the telescope to required levels. As a direct result of this review, we are adding a rotator at the Gregorian instrument area. There was unanimous agreement between the committee and the ASWG that this feature would be critical to the science use of the Gregorian instrument station.

Thermal Considerations

Nathan Dalrymple presented thermal control and seeing effects of the ATST hybrid enclosure design. Data from Gemini and Big Bear measurements were used to validate his modeling of temperature differences with resulting seeing effects. Daytime temperature variations were used in his model for the dome and the primary mirror. Cooling needs were estimated for these and a number of other systems, including the secondary mirror, heat stop, and feed optics. Further work lay in the interface between the ambient air telescope environment and the relatively warm coudé lab environment, and in thermal aspects of the deformable mirrors. Initial discussions with vendors for such mirrors have begun.

Optics

There were no major changes to the telescope optics and their systems leading up to the CoDR. More thermal analysis, design concept details, and thermal control options were presented for all of the optics. Thermal finite element modeling for the baseline secondary mirror was complete and looks acceptable with implementation of a relatively simple cooling system. Some of the feed optics and the deformable mirrors remain thermal challenges to address during the preliminary design phase.

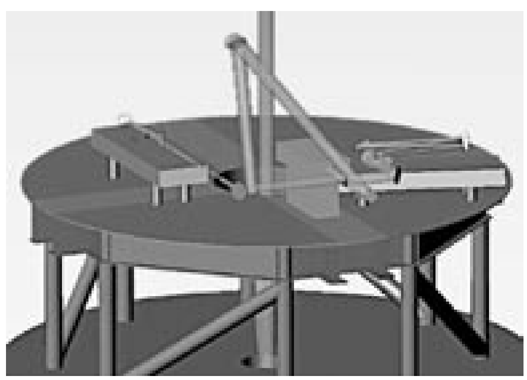


Figure 2. Beam reducer, instrument camera feed paths, and two-instrument concept examples on the upper coudé lab.

Results of the M1 fabrication studies were presented in closed session to protect proprietary vendor information. These studies support the feasibility of the manufacturing and testing of the ATST off-axis concept.

One area of significant evolution is in the optical design to feed multiple instruments. From the collimated feed to the coudé lab, our present concept uses a beam reducer. This provides a 100-millimeter collimated beam with the pupil relayed to a convenient height above either of the two coudé lab floors (see figure 2). The input of the collimated beam is meant to address the flexibility needs of ATST, allowing a variety of instrument combinations and future changes. A draft design for feeding two instruments simultaneously is shown, but more can easily be added. For each new instrument added, an appropriate beam splitter is inserted into the collimated path above the coudé lab floor, followed by a two-mirror camera system. The two-mirror camera system was one of several concepts presented at the CoDR. This system allows for easy changes of the two elements to modify the plate scale or magnification at the input to any instrument while maintaining the location of the flat, telecentric focal plane. With the reflective optics, instruments at any wavelength can be used and money can be saved by purchasing multiple sets of identical camera feed optics to feed multiple instruments.

Instrumentation

Concepts and initial thoughts on the following instruments were presented for the purpose of evaluating the facilities provided by the telescope and observatory for simultaneous and flexible use: visible light broadband imager (Lockheed); visible spectropolarimeter (High Altitude Observatory); near-infrared spectropolarimeter (University of Hawaii); imaging, visible, tunable, narrow-passband filter (NASA, NSO, Kiepenheuer Institute); tunable infrared filter system (Big Bear Solar Observatory and Solar Research Center, New Jersey Institute of Technology).

Controls and Software

The system-level controls and software design were presented, including requirements, functional design overview, technical design overview, and the "Virtual Instrument Model." An overview of the control systems for each major telescope subsystem was presented (such as mount control, primary mirror control, etc.), along with how these interact and are controlled through the telescope control system.

A key area is how we support a diverse and flexible arrangement of instruments that need to work together in various observing scenarios. This is where the virtual instrument model steps in as a very flexible building block system that handles changes in a common observing method. Readers are encouraged to look at our Web

continued

ATST Passes Review continued

site for more information on this and other aspects of ATST controls and software.

Systems Engineering

Rob Hubbard presented top-down, system-level error budgets. His efforts have focused on the three highest priority budgets, all of which bear on delivered image quality. We have added initial estimates and statistical data where available (including site seeing, wind and thermal model statistics) to the bottom-up error budget analysis. With the distributions, Monte Carlo analysis of the telescope and delivered image quality were presented for the three primary image-quality error budgets (AO, active optics, and open loop). This effort continues to be refined throughout the D&D phase.

Upcoming Milestones

The project's upcoming major milestones include the site selection, completion of the construction phase proposal at the end of this calendar year, and the start of the preliminary design stage at the beginning of the new year. Keep an eye on our Web site for the latest developments. It will be a very busy winter/spring period.

SOLIS

Jack Harvey & the SOLIS Team

It has been a busy and exciting time for SOLIS. The major SOLIS instrument, the 50-centimeter aperture vector spectromagnetograph (VSM) has been taking data regularly since mid-August. This was coordinated with similar data taken at the Kitt Peak Vacuum Telescope (KPVT) until the latter facility was closed on 22 September 2003, after 30 years of service. Comparison of the old and new data is ongoing, but it is already obvious that only a small correction factor will be required to place both data sets onto a common scale.

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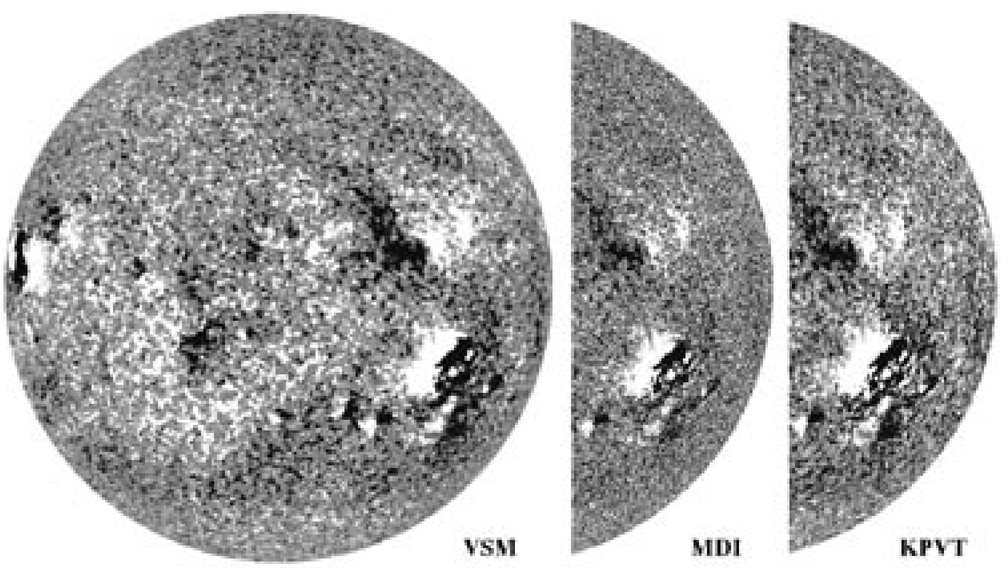


Figure 1. Portions of three full-disk magnetograms showing the line-of-sight component of the photospheric magnetic field. The sign of the signal is displayed as lighter or darker than gray and the displays saturate at 15 Maxwells per square centimeter. VSM is the vector spectromagnetograph of SOLIS; scan time was 11 minutes. MDI is the Michelson Doppler Imager, a filter-based instrument onboard SoHO; acquisition time was 1 minute. KPVT is the Kitt Peak Vacuum Telescope spectromagnetograph; scan time was 40 minutes.

SOLIS continued

The VSM data are clearly superior to the old KPVT data. Signal-to-noise ratio is at least 20 times better for equal observing durations, and the new data are essentially free of instrumental polarization effects or zero point error. Figure 1 compares nearly simultaneous photospheric longitudinal-component magnetograms from three instruments. The superior noise characteristics of the VSM data should be clear. In this display, every feature on the VSM image is a real solar structure. Figure 2 is a rough, partly reduced version of the first full-disk vector magnetogram obtained with the VSM. Even this incomplete reduction shows that the vector field may be measured in quiet Sun network and polar regions, where they are radial, as well as in active regions, where they are non-radial.

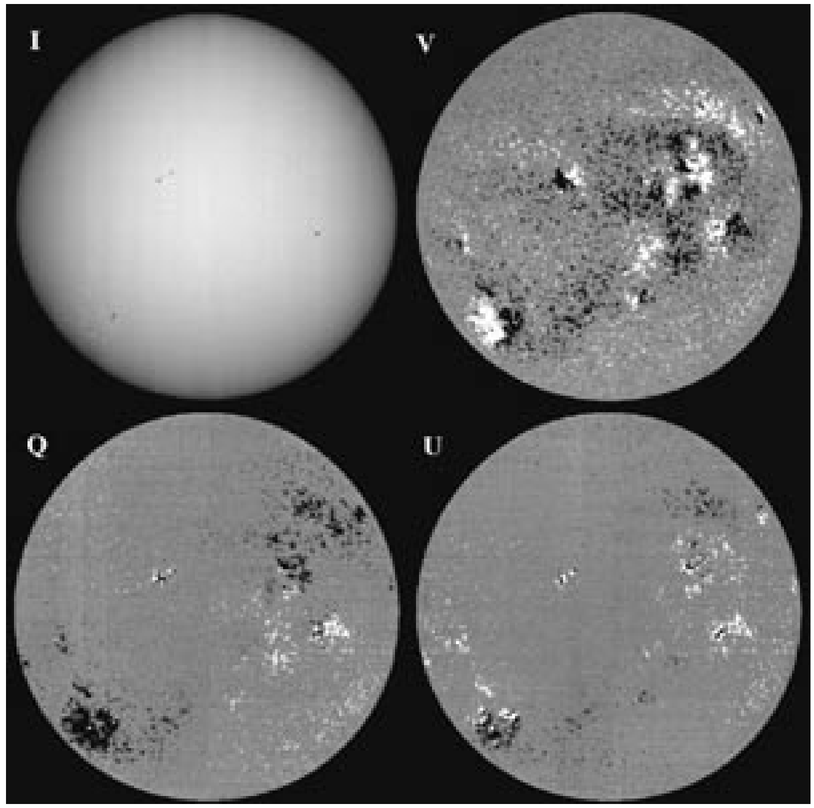


Figure 2. Rough, partly reduced VSM vector magnetogram taken on 30 August 2003 with short integrations and poor seeing conditions. These images are derived from the 630.25-nanometer line only. V is the antisymmetric component of polarization across the line profile, roughly proportional to the field component along the line-of-sight. Q and U are the symmetric polarization components, roughly proportional to the square of the transverse field along azimuth axes that differ by 45 degrees. Geometric rectification of the images has not been done here.

Since the closure of the KPVT observing facility, the regular observing program has been conducted with the VSM at its temporary site at the Campus Agricultural Center of the University of Arizona, while the old KPVT is being refurbished as the new SOLIS Tower. In the next few months, SOLIS will be moved to this location until a final move is made to the future Advanced Technology Solar Telescope (ATST) observing site.

Unfortunately, the operations budget for SOLIS in FY 2004 is expected to be significantly less than originally proposed and less than required to realize the operational and scientific potentials of SOLIS. To help compensate for these budget shortages, we are currently looking for partners.

Work on the remaining SOLIS instruments, the Full-Disk Patrol (FDP) and the Integrated Sunlight Spectrometer (ISS), is slow since most of the team is currently working on the VSM. The FDP instrument is being used as a test bed for the nearly identical fast guider systems for both the FDP and the VSM (the latter is currently running with just open-loop, ephemeris-derived tracking). Fast guiding should significantly improve the image quality of both the VSM and the FDP.

Diffraction-Limited Polarimetry at the Dunn Solar Telescope

DLSP & AO Teams

The Diffraction-Limited Spectro-Polarimeter (DLSP) obtained its first ultrahigh-resolution Stokes profiles of a sunspot at the Dunn Solar Telescope (DST) on 24 October 2003. The DLSP is a collaborative project between the National Solar Observatory (NSO) and the High Altitude Observatory. The DLSP is integrated with the newly developed high-order adaptive optics (AO) system and, after having been fully commissioned in March 2004, will become a permanent facility instrument that can take full advantage of periods of good seeing and targets of opportunity (e.g., flares) as they arise.

In the final phase of this project, a new modulation unit using ferroelectric liquid crystal (FeLC) modulators was integrated. The modulation scheme used for the DLSP is similar to the modulation scheme of the Vector Spectromagnetograph (VSM) of SOLIS. A high-quantum-efficiency PixelVision Pluto camera is used to achieve a spatial sampling of 0.09-arcsec per pixel, i.e., a spatial resolution of 0.18 arcsec, which is the diffraction limit of the DST at 630.2 nanometers. The camera runs at up to 50 frames per second. Different modules (modulator, demodulation, spectrograph control, calibration control) were integrated and successfully tested during an engineering run of the DLSP.

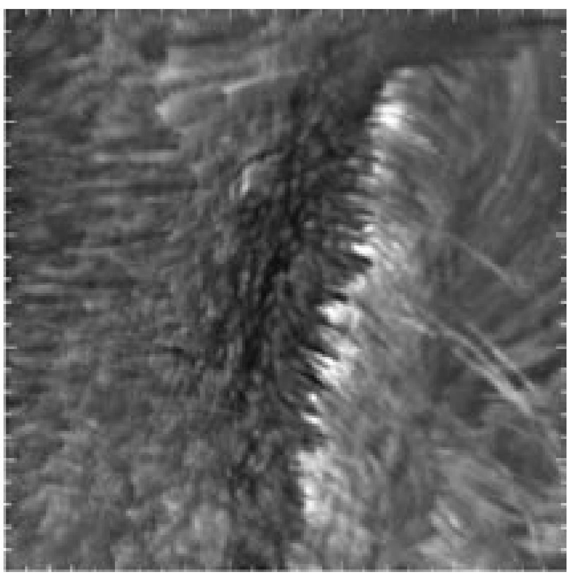


Figure 1. Hα image of a flare. The small sunspot observed close to the limb on October 24 was part of the big active region that produced the X17.2 flare on October 28. The movie shows a super-penumbral loop system eruption. It appears that the footpoints of the loops, as well as some loop tops, become bright during the flare. The data indicate that the flare was triggered by new flux emerging in the lower right corner of the image. This particular image is from near the end of the flare. Tick marks are 1 arcsec. Structure on spatial scales of 0.2 arcsec is visible in this image.

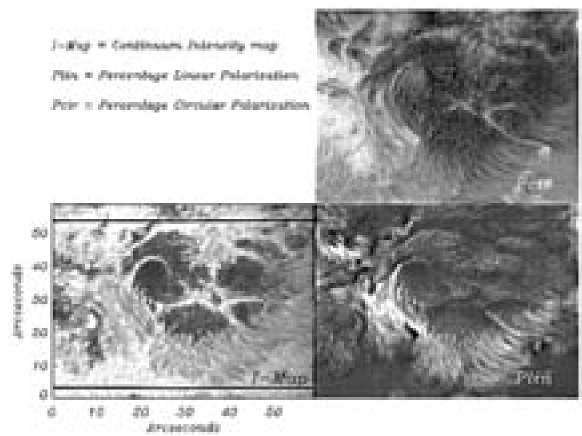


Figure 2. DLSP scan of active region NOAA 0484. Several of these maps were recorded on October 24.

On 23–25 October 2003, the DLSP recorded several scans of active regions. During much of the observing time, the high-order AO delivered excellent and consistent image quality, and we were able to scan a sunspot with the DLSP's highest spatial resolution mode (0.09-arcsec step size). The Universal Birefringent Filter (UBF) recorded high-resolution Hα filtergrams and spectral scans of a photospheric line (Fe I 543.4 nanometers). G-band images were recorded to provide contextual information, and flare activity was observed in two different active regions. Movies of Hα filtergrams, dopplergrams, and G-band images are currently being produced. A stunning first Hα flare movie has been posted on the NSO Web page (*www.nso.edu*) showing, to our knowledge for the first time, flare structure at scales of 0.2 arcsec (see figure 1). DLSP vector magnetic field maps were recorded before and after the flare.

As an example of the quality of the DLSP data, the observed Stokes profiles were processed to produce polarization maps of the sunspot. Figure 2 shows the continuum intensity

continued

Diffraction-Limited Polarimetry continued

and polarization map of the observed sunspot. A total of 660 steps were used to scan the field of view and it took about 50 minutes of observing time to produce this high-resolution map. Structure close to the diffraction limit of the DST is visible in these maps, showing that the goal of diffraction-limited polarimetry has been achieved. The cover of this *Newsletter* shows a G-band image of the same region and demonstrates the spectacular image quality now achieved with the high-order AO system at the DST. The combination of DLSP and high-order AO will provide DST users with exciting new scientific opportunities.

The Sun Sets on the Kitt Peak Vacuum Telescope

Jack Harvey

The NSO Kitt Peak Vacuum Telescope (KPVT) was closed on 22 September 2003 after 30 years of outstanding service. Harrison Jones, our long-time NASA/GSFC KPVT partner, and his wife, Pat, hosted a gala dinner party on September 20. Many former and present KPVT observers and scientists attended, including three people from out-of-state. The following day, a large group watched the final observations being made by Bill Livingston, the guiding force behind the facility.

Bruce Gillespie (left) watches the guider image of the KPVT along with the father of the telescope, Bill Livingston, to make sure that the last magnetogram is a good one.

It is often said that astronomers never retire any telescope. This is a strong counter-example to that folklore. It might have been a sad event if it were not that the KPVT is being replaced by SOLIS, which provides far superior observations. Moreover, since the KPVT had such a long and very productive run at relatively low cost, the event was more of a celebration than anything else. The facility has a bibliography of about 1,000 research papers, as well as many theses and other works to its credit. A remarkable number of discoveries and firsts arose from the telescope and its instrumentation. However, without the right people involved, the KPVT could just as easily have been a failure.

Leo Goldberg, the KPNO director in 1972, realized that the 1973–1974 NASA Apollo-Telescope-Mount Skylab missions (the space station follow-on to the Apollo lunar missions) needed ground-based support for its solar telescopes. Bill Livingston seized the opportunity by quickly proposing a telescope and a focal plane instrument devoted to synoptic observations of the Sun's magnetic field. This would allow the otherwise irregular observations done with the McMath Telescope to be made every day with a state-of-the-art instrument. Leo liked the proposal, charmed some financial support from NASA, and gave the project high priority in the observatory's considerations. Dale Schrage was assigned as project engineer and manager. Under Dale's strong prodding, the telescope was built in record time with first light coming a mere couple of months after the first Skylab mission began.

The first magnetogram worth keeping was taken by Bruce Gillespie, Jack Harvey, Bill Livingston, and Charles Slaughter on 21 September 1973 with an instrument that had been in use at the McMath Telescope for three years. A new magnetograph, specifically designed for the KPVT, took its first data on the last day of 1973. When the last Skylab mission ended in February 1974, the KPVT had successfully accomplished its mission. If there was to be a future for the telescope, it needed a new mission.

Fortunately, Randy Levine and Marty Altschuler had been using the magnetograms to construct extrapolations of the coronal magnetic field. They learned a lot about the

continued

Sun Sets on the KPVT continued

May 2003 view of the Kitt Peak Vacuum Telescope.

association of regions with field lines open to interplanetary space, high-speed solar wind streams that cause geomagnetic storms, and voids in the corona called coronal holes. After the Skylab mission ended, which terminated its X-ray observations that showed where coronal holes were located on the solar disk, I found that we could see the boundaries of these holes from the ground using the 1083-nanometer line of He I and the KPVT. Here was a rich research area that also had a practical application on Earth—a rarity in astrophysics. This was enough to interest NASA and NOAA in joining as partners to operate the KPVT.

If it had not been for the strength of having three partners, the KPVT would have closed decades ago. Each of the partners suffered severe budget cuts in the post-Apollo shrinkage of support for space science, and the KPVT was frequently on the chopping block. However, the budget cuts were never simultaneous, so the triumvirate managed to continue the program. NOAA had sent an NOAA Corps officer to help collect observations to support the Skylab mission, and afterward, they stationed veteran observer Frank Recely here. We applied for a NASA grant to hire some observer support, but Dave Bohlin rejected this with a counter offer. NASA GSFC had a field operation in New Mexico that was in need of a change and the offer was to station Harrison Jones and one other employee, yet to be hired, in Tucson. We jumped at the offer and hired Tom Duvall. These folks plus our own skilled observer, Bruce Gillespie, kept the program alive and thriving, both observationally and scientifically.

We worked hard to make the synoptic data as available to users as possible, given the technology available. This open data policy was rather novel at the time and paid handsome dividends. The original magnetograph was showing its age by the end of the 1980s, and NASA was able to help replace the old instrument with a better one. This went into service successfully in 1992. By the mid-1990s we realized that to keep pace with the needs of the community, major upgrades were required and a project to do so was started. At nearly the same time, an unexpected opportunity arose to propose a completely new facility. This was done, rather hurriedly, and was accepted by the National Science Foundation. When funding actually started arriving in 1998, resources from the KPVT project contributed to the new SOLIS project.

The KPVT will continue to serve the research community through its archive of tens of thousands of observations spanning 30 years. The building is being refurbished as the Kitt Peak SOLIS Tower (KPST) and will serve as the home for SOLIS in the near term. By any measure, the KPVT was a great success, thanks to good luck, dedicated engineers, technicians, observers and scientists, and fortunate circumstances. We expect that its successor, SOLIS, will be equally successful.

Attendees on the occasion of the final observations with the KPVT. Left to right: Bill Livingston, Keith Pierce, Detrick Branston, Elena Malanushenko, Harrison Jones, Teresa Bippert-Plymate, Trudy Griffen-Pierce, Tom Duvall and Linda Klemz, Kevin Schramm, Gerry Duffek, Dave Johnson, Bruce Gillespie, Michael Duffek, Dave Hauth, Claude Plymate. Missing: Jack Harvey (who took this picture).

IBIS Successfully Installed at the Dunn Solar Telescope

Fabio Cavallini (Arcetri Astrophysical Observatory) & the IBIS Team

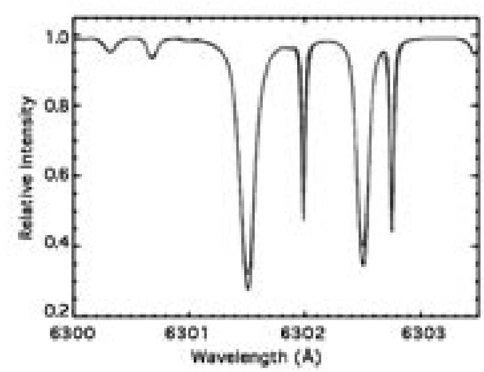
The Interferometric BIdimensional Spectrometer (IBIS) was successfully installed in June at the Dunn Solar Telescope (DST). The instrument comprises two Fabry-Perot interferometers that are used in a classical mounting and in axial mode, in series with a set of narrowband interference filters, to obtain imaging spectral scans of the solar photosphere and chromosphere with high spectral, spatial, and temporal resolution. The width of the instrumental profile ranges from 25 to 40 milliangstroms in the 5800- to 8600-angstroms range for which the instrument is optimized. The high instrumental transmission (about 15 to 20 percent) and nearly instantaneous interferometer tuning (a few milliseconds) allow a full spectral line to be scanned in just a few seconds. IBIS has an 80-arcsec-diameter field of view, which allows observation of a wide range of structures.

During the inaugural run, observations were made of a range of solar features, including granules, active regions, and prominences. IBIS is fed by a beam corrected by the low-order adaptive optics system available at the DST, allowing a stable image to be maintained during the spectral scan. The instrument, constructed by the author with additional contributions from the Universities of Florence and Rome, will remain at Sac Peak for at least two years.

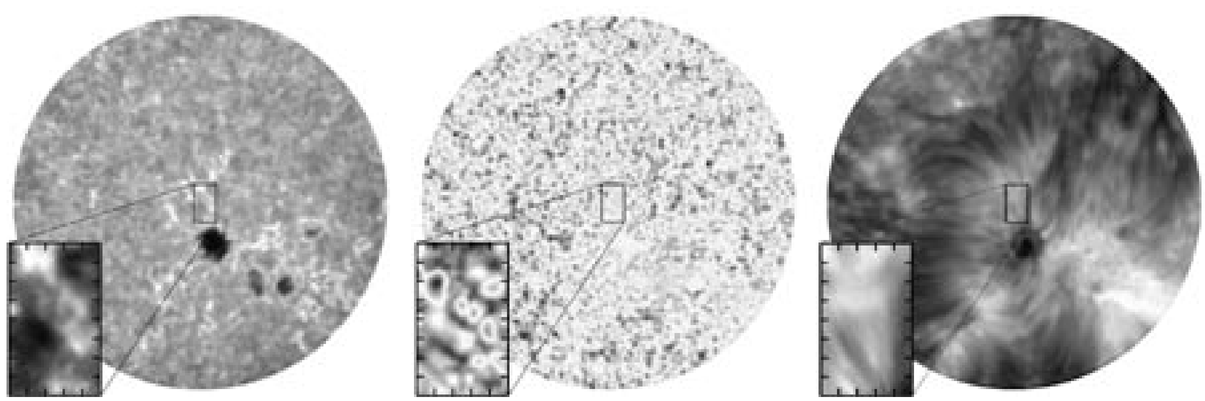
IBIS is equipped with several auxiliary alignment channels, including laser and continuum references, which allow the instrument to be quickly prepared for observations. The Fabry-Perot interferometers are temperature controlled to within 0.01 degree Celsius, which keeps the temperature-induced wavelength drift to within 1 meter per second per hour.

IBIS is capable of tuning to any wavelength within the 5800–8600 angstrom band, limited only by the availability of the order isolating prefilter for a given wavelength. Presently, the following filters are available, listed by the principal spectral line in each range:

- Na D_1, 5896 angstroms, chromosphere
- Fe I, 6302 angstroms, g = 2.5, photosphere
- Fe I, 7090 angstroms, g = 0, upper photosphere
- Fe II, 7224 angstroms, g = 0, deep photosphere
- Ca II, 8542 angstroms, chromosphere



Disk-center spectrum of solar iron and telluric oxygen lines in the range 6301–6303 angstroms obtained by IBIS (dashed line) as compared to Liege solar atlas (solid line).



Images obtained by IBIS during its installation in June 2003. Left to right: line center intensity in Fe I 7090 angstroms; line center velocity in Fe I 7090 angstroms (scaled to ±1.25 kilometers per second); line center intensity in Ca II 8542 angstroms. The full field of view is 80 arcsec in diameter and the box shows an enlargement of a 5×8 square arcsec region near the center of the field.

GONG

John Leibacher

GONG continues to stretch and grow with the new science applications for local helioseismology applications (see figures 1 and 2), and is looking forward to global analysis out to spherical harmonic degrees (ℓ) of 1000. At the same time, we are working hard to maintain ailing components and systems. But the good far outweighs the bad and GONG's future is very bright. GONG's new status as a Flagship Program of the National Solar Observatory (NSO) is highlighted below.

Simon Kras left the program in August to return to graduate school. Simon brought more than a good work ethic and bright mind to GONG, he was very actively involved in the Employee's Association and started NOAO/NSO's continuing involvement in the Habitat for Humanity program. Best of success, Simon… and look us up when you're ready for a postdoc. Caroline Barban left in October for Leuven, Belgium, and we look forward to continuing work on the velocity-intensity correlations.

As a quick reminder, next year's meeting, GONG 2004/SoHO 14, is being organized by Yale University and will be held 12–16 July 2004 in New Haven, CT. For more information, contact Sarbani Basu at *sogo04@astro.yale.edu*.

Paradigm Changes: Project to Program

During the last year, GONG has been in the process of restructuring its management plan from its original status of a limited-term project to a cornerstone program of the NSO. Coupled with this paradigm change has been the mandate from GONG's Scientific Advisory Committee and the AURA Solar Observatory Council to increase in-house science. The task at hand has been to rethink the decisions that were made in designing and developing an instrument and data processing system for a three-year run, and to find the means of transforming it into a system optimized to run continuously, as well as more efficiently and at reduced costs. The program's primary challenges for this transition have been addressing instrument maintenance and reengineering issues, and streamlining the data processing. We have identified a number of design choices, such as the "sneaker net" for transferring data between data reduction stages, and deferred items, such as turret covers, that were of low priority in the context of a three-year project. We have identified major long-period recurring items as well, such as data archive migration and the need for a replacement shelter. The list is long.

In an effort to address limited-lifetime-model issues, and to establish a program of continuous renewal, George Luis was hired to reestablish the prototype instrument at the GONG farm as a true ground simulator to examine reengineering options and plan the replacement shelter. Due mainly to aging components, failures in the field have resulted in the prototype instrument being stripped to provide spares for actual field systems. As a result, it is no longer available as an engineering site for testing and certification of fixes and modifications and as a test bed for the development of replacement technologies. The instrument shelters, modified 20-foot shipping containers, were expected to have a worst-case 11-year lifetime, and the worst case was always recognized to be Learmonth, due to its location on a dune a few hundred meters from salt water. The poor condition of the Learmonth shelter has been recognized for some time, and indeed all of the shelters are subject to various levels of environmental and usage deterioration. A plan to build a spare shelter is now being developed, with a design and construction review anticipated in the spring. The Tucson/Learmonth shelter swap would occur in 2007.

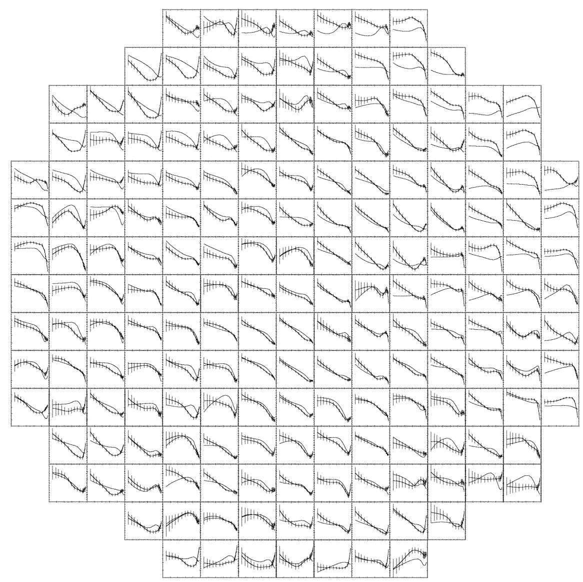


Figure 1. Preliminary comparisons of GONG and SoHO/MDI local helioseismology using ring diagrams. The variation of the zonal (east/west) flows with depth are shown. A total of 189 patches covering the surface of the Sun were compared down to a depth of 0.1 $R_\odot$. GONG data are dark lines with error bars, MDI data are gray lines. These data are in excellent agreement for this first analysis by Irene Gonzalez-Hernandez.

Similar restructuring and rethinking are taking place with the data processing and management. The original data-reduction "pipeline" consisted of a fairly labor-intensive "sneaker net," where serial

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GONG continued

processes were assigned to specific workstations and data were passed from machine to machine by human operators carrying removable media. The dependence on human labor broadly occurred at two levels: moving the data from process to process, and carefully inspecting intermediate data products for anomalies before advancing to the next process. Over the past year, we have made considerable progress in transitioning to process-controlled pipelines, which has substantially automated the data transfer and reduced the labor requirement. Automated image quality assessment software is in the final testing stages and should result in an even larger reduction in the hands-on quality assurance.

In addition to achieving and sustaining a steady-state operation, an out-year plan that addresses limited-life issues and continuous renewal and improvement is being put into place. This baseline plan will then be the platform upon which the development of new science and technical capabilities can be undertaken.

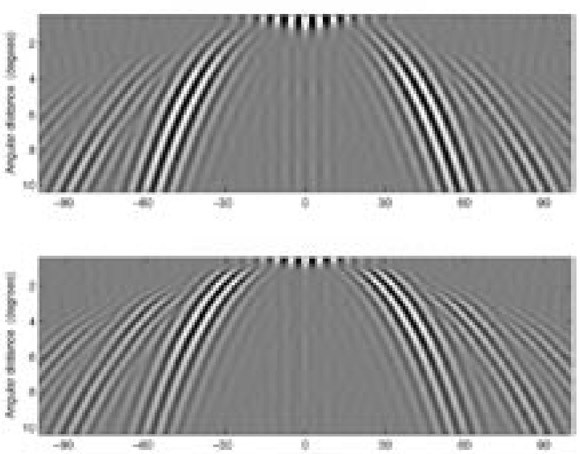

Figure 2. Preliminary comparisons by Shukur Kholikov of GONG (above) and SoHO/MDI (below) local helioseismology using time-distance. The fundamental data for "time distance" helioseismology is the delay between the signal at an origin and points at progressively greater angular separations (Δ degrees), as measured by their cross-correlation. Again, the agreement is excellent.

As mentioned earlier, the push for more in-house science is a major component of the restructuring process. The "sneaker net to controlled pipeline" transition has already led to the reprogramming of one position from data reduction to science, and we should add another scientist next year. The helioseismology community continues to be actively involved, with a renewed interest in short-term visits and in collaborative efforts such as the Local Helioseismology Comparison Group (LoHCo), which consists of over 30 members. From a science and management perspective, life in GONG is good and getting better!

Site and Instrument Operations

Operations activities for the months of July and August were focused on training activities for one of the site personnel. Sudhir Gupta from the Udaipur Solar Observatory visited Tucson for five weeks to become familiar with routine maintenance tasks and instrument troubleshooting procedures. Since Udaipur is the site most difficult to support, in terms of access by GONG personnel and shipment of replacement parts, having someone at the site with a greater depth of knowledge seemed beneficial for keeping the instrument operational. Sudhir was willing and able to assist us in that regard. During these months the monsoon was active in Udaipur, and the instrument there was shut down and the turret covered.

In preparation for Sudhir's visit, considerable effort was spent updating GONG documentation and procedures and creating a training manual. His training began with replacing the turret at the Tucson instrument along with a complete optical alignment. He became thoroughly familiar with camera removal and installation as he experienced some of the things that can and will go wrong. Sudhir's time with us was well spent and he now will be an even greater asset to GONG operations back in Udaipur. Before leaving, Sudhir was awarded the first certificate of recognition as a "Certified GONG Repair Person."

A preventive maintenance trip to Mauna Loa took place at the end of September. Other than replacing the CCD camera, only routine maintenance tasks were planned. The turret inspection, however, revealed that at least a couple of tablespoons of water had penetrated the environmental seals. As much water as possible was removed, and since the instrument was running well in spite of this, nothing more was done. It became clear, however, that the turret should be replaced and the problem corrected. This discovery does raise a larger issue. Why aren't the recently rebuilt turrets weatherproof? The turret at Mauna Loa has been in place for only 20 months and a turret installed at Learmonth was in place only about six months before failing. We are currently investigating the procedures used in refurbishing a turret and implementing tests, which will establish the effectiveness of the seals.

A large advance was made in eliminating noise in the velocity data seen at three of the network sites. Troubleshooting showed that the camera rotator was introducing noise in the temperature stabilizing electronics for the oven containing the Lyot filter and Michaelson interferometer. This small temperature fluctuation produced a somewhat periodic velocity signal, which was fortunately of such a low frequency

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GONG continued

that there was no significant impact on the oscillation data. Isolating the oven from the camera rotator by removing a ground strap from the oven chassis solved the problem.

Data Processing, Analysis, and Management

Testing has continued on the GONG local helioseismology pipeline. A run of early data (July 2001) through the ring diagram pipeline revealed days with the so-called "washing machine" effect, where the Sun is apparently spinning around disk center. Since we have reason to believe that the Sun is actually not behaving in this manner, we are investigating. It is suspected that the underlying problem is a temporally varying error in the alignment of the images with solar North. Cliff Toner is working on the problem, which currently has several potential solutions: the use of legacy MDI data as a fiducial, the initiation of more frequent drift scans at the sites, and the inclusion of camera rotator errors measured with the Ronchi grating in the instrument. In addition, Cliff is analyzing the recent Mercury transit data to develop an improved atmospheric refraction correction for the drift-scan analysis.

Rudi Komm has been supporting LoHCo. This group has had three recent get-togethers: a face-to face meeting in Boulder, CO, on July 28; and two teleconferences on August 14 and October 2. Doug Braun, Charlie Lindsey, and Martin Woodward at Colorado Research Associates very graciously and successfully hosted the Boulder workshop. The workshop materials can be found on the LoHCo Web page (*gong.nso.edu/lohco)*. The recent focus of this group has been on artificial data exercises. Rachel Howe has been constructing artificial three-dimensional power spectra based on a model of ring diagrams, and generating wave fields from the spectra. Irene Gonzalez-Hernandez and Shukur Kholikov have been taking these spectra and wave fields and analyzing them with ring diagram and time-distance techniques. They have been finding that the local analysis methods do a reasonable, but not completely accurate, job of recovering the input velocity fields. Work is underway to improve the artificial data since approximations in its generation may impact the results. Shukur has also continued work on the installation of Tom Duvall's time-distance code in the GONG local helioseismology pipeline.

In addition to the LoHCo community support, Rudi and Rachel have been pursuing scientific goals. Rudi is finishing up a study of the fluid dynamics of the convection zone as inferred from ring diagrams, and Rachel is working on localized mode parameter changes and a model of the global flow field. Caroline Barban has performed her V-I fitting method on a set of MDI data and compared it with GONG data from the same time period. She has found a rather different frequency dependence of phase shifts between V and I as observed by the two experiments. As mentioned earlier, Caroline left us for a position in Belgium at the end of October. She will be sorely missed.

Richard Clark continues to work on the automated rejection of bad images. He is running his method in parallel with the visual inspection done by Greg Ladd. Richard will soon have a GONG month of data processed through to global inversions to compare with the traditional handcrafted method. Katrina Gressett is working on producing a one-week-long power spectrum up to $\ell \approx 1200$. This data will be provided to the community for use in developing ridge-fitting techniques. Jean Goodrich is working on aspects of the near-real-time processing at the sites that will feed the farside pipeline.

We have enjoyed short-term visits from Anna Malanushenko, Thierry Corbard, and Paul Rajaguru. Anna is an undergraduate at Saint-Petersburg State University, and she has finished the installation and testing of the farside imaging code developed by Charlie Lindsey and Doug Braun. Thierry returned in October from the Observatoire de la Côte d'Azur for a month-long visit and is improving the ring parameter inversion code. Paul is installing the time distance code he is developing Mike Thompson at Imperial College (London) in the GONG local helioseismology pipeline.

Optics Education at NOAO Receives Major Boost

Douglas Isbell & Stephen Pompea

Optics education took center stage in recent activity by NOAO Public Affairs and Educational Outreach (PAEO) staff, with significant contributions to an international meeting of optics educators and the award of a major National Science Foundation informal science grant to a team including NOAO.

PAEO personnel presented four papers and led a workshop at the Education and Training in Optics and Photonics (ETOP) meeting held 6–8 October 2003 in Tucson. Convened every two years, the ETOP conference is the primary international forum for the exchange of ideas and experiences related to education in optics and photonics.

The meetings are held under the auspices of the International Commission for Optics (ICO), the Optical Society of America (OSA), and the International Society for Optical Engineering (SPIE). This meeting in Tucson had a special emphasis on approaches to encourage the next generation of engineers, scientists, and technicians, and was held in conjunction with the annual meeting of the OSA.

PAEO's Constance Walker, Steven Croft, and Stephen Pompea presented papers on teaching optics through the NOAO Teacher Leaders in Research Based Science Education (TLRBSE) program, effective ways to teach about the electromagnetic spectrum, and teaching about infrared imagery. Walker and Pompea organized and led a one-day workshop for 48 science teachers from throughout the state of Arizona associated with the Mathematics, Engineering, Science Achievement (MESA) program. Pompea, manager of science education in PAEO, was also the organizer and host of a special invited session titled, "Best Practices in Science Education," with noted speakers such as Sir Michael Berry of the University of Bristol and Michelle Hall-Wallace of the University of Arizona.

The fourth paper presented by NOAO PAEO staff at the meeting, "Hands-On Optics (HOO): Making An Impact With Light," was especially timely given that it described an exciting new project that received a three-year, $1.7 million NSF grant on September 30.

A collaborative effort by OSA, SPIE, MESA, and NOAO, the HOO program is designed to reach thousands of underrepresented middle school students, their parents, and their teachers with

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Math and science teachers from Arizona at an NOAO-led workshop during the Education and Training in Optics and Photonics (ETOP) meeting, held 6–8 October 2003 in Tucson.

Optics Education at NOAO continued

lessons in optics education using creative activities like building a kaleidoscope and a pinhole camera, and creating holograms.

"HOO is truly a unique program targeting scientific activities not only at students in critical populations—educationally disadvantaged, middle-school-aged learners—but also their entire support network. Its activities will be geared towards actively involving parents, teachers and community volunteers in the learning process," says OSA Executive Director Elizabeth Rogan. "Our goal with HOO is to enhance science education for these populations and to foster an interest in science, which may open doors to futures these students had never considered."

"This program fulfills a critical component of SPIE's educational mission," says SPIE Executive Director Eugene Arthurs. "We are confident that fostering an interest in science at an early age will help supplement the ranks of future optical engineers, those who will fulfill the promise of the 'century of the photon.' "

Based on recommendations from scientists, as well as science and technology educators and experts, HOO events will take place after school, during weekend sessions, and at summer camps or family workshops, which is a specific strength of the MESA program. Through the activity modules, students will gain a physical understanding of optics principles. They will rely on inquiry, critical thinking, and problem solving skills involving optics, and will also learn how optics interfaces with other disciplines.

"Children and adults everywhere are enthralled by light, shadows, and the colors of our natural world," Pompea explains. "Our fascination with astronomy and the microscopic world is fueled by advances in optics and optical technology. HOO has been designed to use the appeal of optical wonders to teach practical lessons about light and its uses."

Development of the pilot program for HOO has already begun. NOAO will play a key role in training teachers and volunteers, and in developing the related optics kits. MESA teachers in Arizona will implement the program initially, with expansion to selected sites across the country in 2004 and 2005.

For more information, contact *spompea@noao.edu*.

The 2004 REU Program at Kitt Peak National Observatory

Kenneth Mighell

Each summer, a group of talented college students comes to Tucson to participate in astronomical research at Kitt Peak National Observatory (KPNO) under the sponsorship of the National Science Foundation Research Experiences for Undergraduates (REU) program. The KPNO REU program provides an exceptional opportunity for undergraduates considering a career in science to engage in substantive research activities with scientists working in the forefront of contemporary astrophysics.

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

As part of their internship experience, all six of our 2003 REU participants will be presenting posters about their astronomical research projects at the January 2004 AAS meeting in Atlanta.

We anticipate being able to support six REU students during the summer of 2004. As required by the NSF, participants must be citizens or permanent residents of the United States. The KPNO REU positions are full-time for 10 to 12 weeks between June and September, with a preferred starting date of early June. The salary is $440 per week, housing is provided, and additional funds are provided to cover travel to and from Tucson.

Further information about the KPNO REU 2004 program, including the on-line application form, can be found at *www.noao.edu/kpno/reu*. Completed applications (including official transcripts and two or three letters of recommendation) must be received no later than 26 January 2004.

Fall 2003 Project ASTRO Training Workshop

Crater impact exercise—watch out for the cocoa powder ejecta!

Project ASTRO-Tucson held its 8th annual training workshop on 3-4 October 2003, hosting 33 teachers and 27 astronomer partners for two days of hands-on activities and lectures by speakers from NOAO, the University of Arizona, Biosphere 2 and the Space Science Institute in Boulder, among others. Topics included lunar craters, student misconceptions in astronomy, and how to integrate art, poetry and scientific journals, as well as an inspirational trip to Kitt Peak.

Kinesthetic astronomy exercise on the University of Arizona mall—which way to Saturn?