



## Director's Corner

Steve Keil

### Solar Physics and the Decadal Survey

The decadal survey (Astro2010) is now in full swing with an open meeting at the American Astronomical Society Long Beach meeting. Unfortunately, many solar astronomers (including me) usually do not attend this winter meeting, opting to attend the American Geophysical Union conference instead. Thus, if solar science is to find its way into the survey, it is imperative that we find avenues to do so. The first such avenue is the call for white papers by the survey committee at: [www7.nationalacademies.org/bpa/Astro2010\\_Request\\_for\\_Input.html](http://www7.nationalacademies.org/bpa/Astro2010_Request_for_Input.html).

We would like to encourage you individually or in groups to submit white papers on what you believe are hot topics in solar physics. These papers are supposed to be sent to the appropriate Science Frontier Panel(s) at: [www7.nationalacademies.org/bpa/Astro2010\\_Science\\_Frontier\\_Panels.html](http://www7.nationalacademies.org/bpa/Astro2010_Science_Frontier_Panels.html). The panels follow:

1. The Cosmology and Fundamental Physics (CFP) Panel
2. The Planetary Systems and Star Formation (PSF) Panel
3. The Stars and Stellar Evolution (SSE) Panel (Solar Physics is in here?)
4. The Galactic Neighborhood (GAN) Panel
5. The Galaxies across Cosmic Time (GCT) Panel

It is not completely clear where the various aspects of solar physics fit in to the panel structure. There are certainly aspects that are fundamental physics, others concerning what the Sun tells us about astrophysical and laboratory processes, and the Sun as driver of phenomena in the Solar System, including space weather. According to Roger Blandford, Astro2010 chair:

*"...the intent [of the white papers] is to help the Science Frontier Panels develop an exciting and scientifically compelling program organized around key questions and areas where we expect future discoveries to be made."*

He goes on to say:

*"Please address your submissions to specific panels and focus on the scientific opportunities. Do try to collaborate with your colleagues. It is the quality of the science, not the number of submissions that is of relevance here and you should aspire to make simple and clear statements that will help the panels and the survey committees write their reports."*

The astronomical object most relevant to humanity and life on earth is the Sun. Some of the many reasons for the intense, continuing interest in observing the Sun follow:

The Sun is the nearest and most readily studied astronomical object. Many physical processes that form the foundations of our current understanding of the universe are most accurately observed on the Sun. The Sun is a unique plasma physics laboratory. Its magnetic field configurations and environment provide conditions unattainable in

terrestrial laboratories and are close enough to study with precision. The Sun presents us with many important unsolved mysteries and unexplored domains that challenge science.

The Sun sustains life on Earth; it controls our environment and impacts our technological civilization. Understanding and predicting the influences of the Sun on the Earth's climate and on space weather in the near-Earth environment is a major challenge for science. Understanding the Sun and Sun-Earth connection is crucial for understanding planetary systems (solar and extra-solar) in general.

Over the last few decades a remarkable change has taken place in solar physics. The increasing power of numerical simulations, both in hardware performance and through development of new techniques, has transformed the field from a more phenomenological science, describing the appearance of the wide variety of magnetic phenomena, to a solid physical science that investigates their nature and connections between them. At the same time, the advent of adaptive optics on ground-based solar telescopes and high-resolution space-based missions has opened new observational windows that let us examine fundamental processes. These new assets, while greatly enhancing our ability to probe solar phenomena such as magnetoconvection, magnetic field stability throughout the solar atmosphere, and structure and evolution below the surface of the Sun among many others, have also raised many new questions that require new capabilities. For example, nowhere in the Universe is there a better place than the Sun to explore and understand how magnetism directs astrophysical and planetary change. It is crucial that we get these new questions in front of the Decadal Panel, which in turn helps build community support for our projects.

As stated in the call for the white papers, the output of each panel will include a short list of central questions to be answered and a single general area where there is unusual discovery potential. Thus, authors should focus their white papers on the detailed presentation of fundamental and important science opportunities, rather than on broad or general studies. White papers will be of most use to the panels if they identify directly specific, critical questions and opportunities as well as the potential measurements and/or theoretical advances that will address them. Although the white papers are not supposed to dwell on a particular project, when describing the type of measurements needed, it would certainly make sense to link those measurements to a facility such as the Advanced Technology Solar Telescope.

As a community, we need to make this case to the Astro2010 committee, so I strongly urge members of the solar community to submit white papers to the survey.

### Changes

It is with regret that we announce that Dr. Aimee Norton has resigned from the NSO to join the faculty of James Cook University in Towns-

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*Director's Corner continued*

ville, Australia, as a lecturer in astrophysics. Aimee served the NSO and the community in the especially valuable role of SOLIS Program Scientist, where she assumed primary responsibility for producing the principal data product of the SOLIS facility—the VSM full disk vector magnetograms. In addition to her invaluable service to the SOLIS program, Aimee carried out an active research program using all

the major NSO facilities. Her “aimee-able” nature and keen intellect will be sorely missed by the NSO. However, we can look forward to the new students who will enter the field of solar physics under her mentorship in her new position at James Cook. We wish Aimee and her family all the best in their new lives down under. ☼

## ATST Update

*The ATST Team*

The Advanced Technology Solar Telescope (ATST) passed a series of design reviews in late October and early November 2008, setting the stage for a Final Design Review with the National Science Foundation (NSF) in March 2009. The Enclosure Control System and Mount Control System Design Reviews were held October 29. Next were three Systems Design Reviews (SDRs): Site and Science & Operations Building, November 4; Enclosure, November 5; and Telescope Mount Assembly (TMA), November 6. The NSF review—expected in late March—is intended to identify all risks and define budgets. Team managers also developed a white paper for the NSF describing the project's budget requirements in light of the potential funding available for FY 2009 and also a possible FY 2010 construction start scenario.

While the SDR committees identified several areas where additional work is needed by the team, they generally gave the ATST team high marks. “The review committee is overall very impressed at the level of detail, analysis, and the progress of the ATST project team,” wrote the Enclosure SDR review team. “The subsystems are well defined and the overall contracting approach is sound.” On the question of whether safety is adequately addressed, the committee concluded, “Definitely. The ATST Project has demonstrated that safety is a pervasive institutional value.”

The TMA review committee concluded that, “The documentation presented is to a very high standard and as such places the project in a good position for progressing towards contract placement. There are however a number of areas that still require some work to be fully

complete and clear. Sorting out these areas now will make life considerably easier during contract by reducing uncertainty and closing potential loopholes in both the specification and the Interface Control Documents (ICD)'s.”

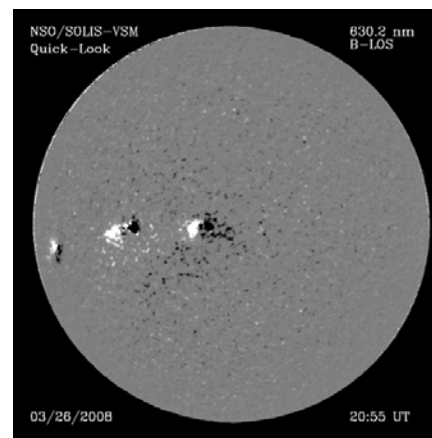
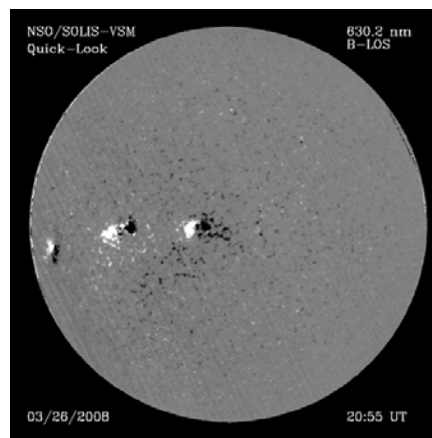
“Both collectively in the SDR meetings and in individual talks with the committee members throughout the week, I heard nothing but praise and words of approval for the ATST team and the work that we've done,” said Lead Mechanical Systems Engineer Mark Warner.

“The committee treated us well,” noted Systems Engineer Ron Hubbard, “while also giving us lists of improvements that we should make to the details of our document packages, and offering a couple of important suggestions for alternatives to our contracting strategy.”

## SOLIS

*Aimee Norton, Kim Streander & The SOLIS Team*

The Solar Optical Long-term Investigations of the Sun (SOLIS) team has made significant progress toward the release of science-grade vector magnetic-field data. In particular, successful fringe-removal algorithms were developed to clean up the spectra because application of conventional fringe-fitting and removal methods resulted in full-disk images that still contained “streaking.” Therefore, an improved approach to the fringe removal was employed that uses the observed polarization data itself, rather than the data from the flat-field observations, to fit the fringes. The fringe-removal code was then translated from the format in which it



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Figure 1: Sample data showing the effect of polarization fringes before (left) and after (right) removal.

*SOLIS continued*

was written (suitable for diagnostic efforts) to a streamlined code that operates efficiently within the routine processing platform. The first vector quick-look images processed in the pipeline using this code were made available via the NSO SOLIS Web page on 30 December 2008. For an example of Vector Spectromagnetograph (VSM) images before and after fringe removal, see figure 1.

Now that the polarization fringes can be removed with confidence, the SOLIS team members have turned their attention to the testing of the inversion codes to ensure that accurate results are obtained when inversions are performed on full-disk data. An example of the observed vector data, Stokes profiles I, Q, U, and V, and the resulting fits provided by the Milne-Eddington (ME) inversion code can be seen in figure 2.

The conversion of the ME inversion code from a small field-of-view application into a full-disk, large field-of-view application has

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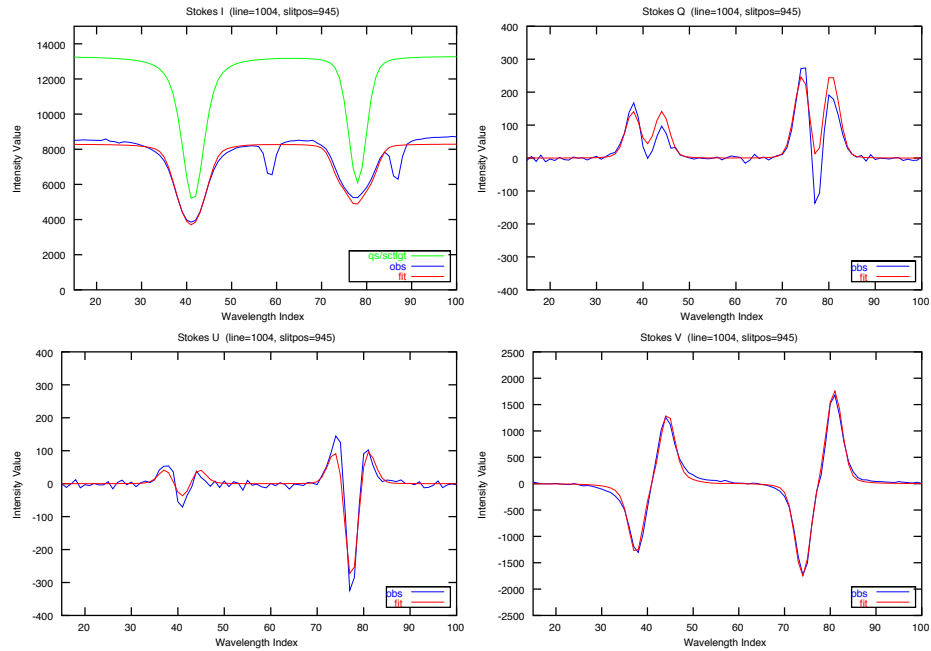


Figure 2: Example of the observed solar Stokes I, Q, U, and V profiles and the fits to these profiles as produced with the current ME inversion code model.

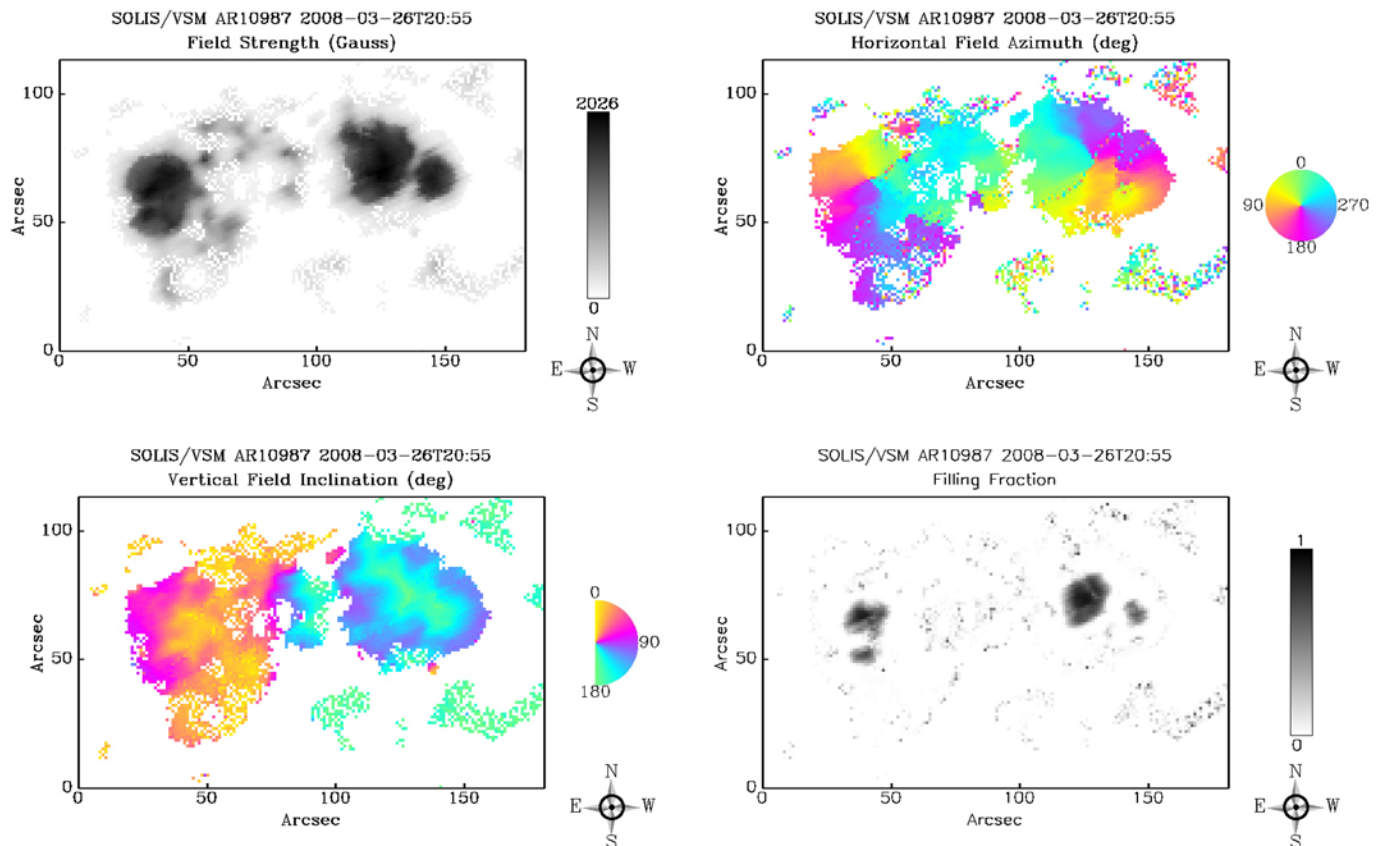



Figure 3: Parameters of a sunspot region as observed by SOLIS VSM near disk-center on 26 March 2008. Magnetic field strength, inclination, azimuth and filling fraction are plotted.

*SOLIS continued*

been challenging. The inversion of spectropolarimetric data has been traditionally performed for small fields of view on the Sun, and attempts to invert data over the full disk thus necessitated changes in the existing code. In particular, codes for determining quiet-Sun profiles were developed and then optimized to decrease processing time. Quiet-Sun values were put into a table-lookup in order to increase the computational speed by a factor of 15,000. Analysis shows the optimal table size to be around 1000 micron entries (about 0.5 megabytes in memory). In addition, smear-fitting code was developed to determine the best value to use for smearing in the quiet-Sun code for a best fit with the data. Preliminary results from the ME inversion are shown in figure 3 for a selected active region; the sunspot region near disk-center on 26 March 2008 is shown with magnetic field strength, azimuth, inclination, and filling fraction.

In addition to progress made on VSM data processing, the Integrated Sunlight Spectrometer (ISS) data calibration method was compared to that of the McMath-Pierce Solar Telescope when analyzing data taken simultaneously with both instruments. It was determined that if the 2-point ISS calibration method were applied to the McMath-Pierce data set, then there is virtually exact agreement between the K-line parameters, see figure 4. 

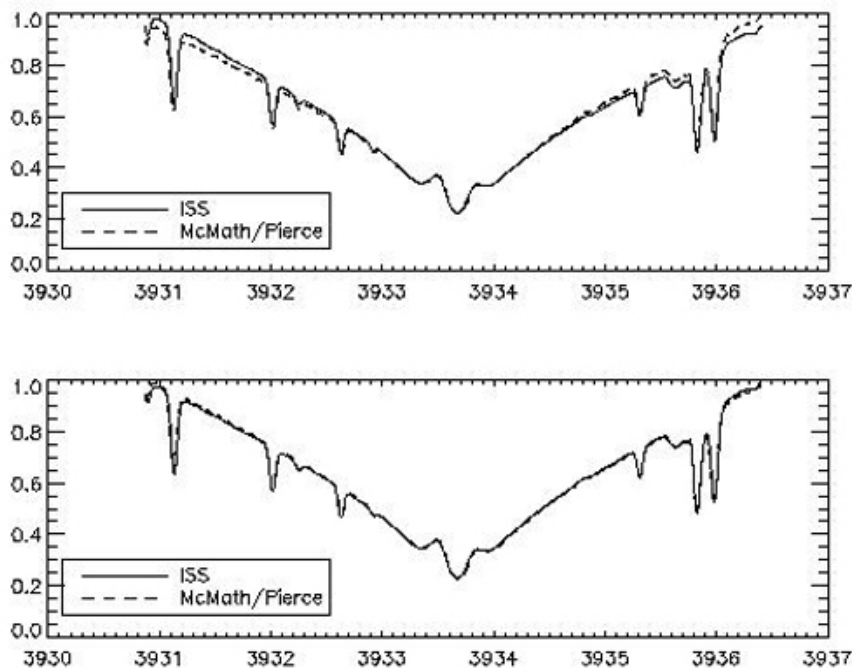


Figure 4: Calcium-K intensity is plotted as a function of wavelength in Angstroms. The upper image shows a comparison of K-line intensity as observed with the SOLIS ISS instrument and the McMath-Pierce main spectrograph before implementing a 2-point calibration method to the McMath-Pierce data. The lower image shows a comparison after the new calibration method is applied.

## GONG++

*Frank Hill & The GONG++ Team*

### Introduction

The Global Oscillation Network Group (GONG++) Team is gearing up with the start of the new year. The US Air Force Weather Agency (AFWA) funds for the new H-alpha observing system arrived, and we have begun its development. Scientific advances continue to emerge from the data stream, including one-minute merged magnetograms. Additionally, the third year of our educational program in India is underway.

### Science Highlights

Rudi Komm has recently found a signature of emerging magnetic flux in the GONG++ subsurface flow maps. Figure 1 shows the average vertical velocity as a function of depth for 801 active regions classified in a variety of ways. The solid line shows the vertical velocity averaged over all of the regions and all of the observations. The filled squares show the vertical velocity for regions with emerging flux—the

25 percent of regions with the highest increase in flux. Similarly, the filled circles are for regions with decaying flux—the 25 percent with the greatest decrease in flux. The open squares are for the remaining 50 percent of the regions. The plot shows that emerging flux is associated with strong upflows in the deeper layers (10–15 megameters), and weaker downflows near the surface. The decaying flux shows the opposite: stronger downflows near the surface, and weak upflows at deeper depths. This is the first unambiguous indication of a subsurface effect arising from an emerging magnetic field.

### Program

The US Air Force Weather Agency (AFWA) has provided funds for adding H-alpha observing capability to the GONG instrument. During the last quarter, Jack Harvey and Neill Mills have come up with an optical and mechanical conceptual design, which is shown in figure 2. Major hardware components for the project have been selected,

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GONG++ continued

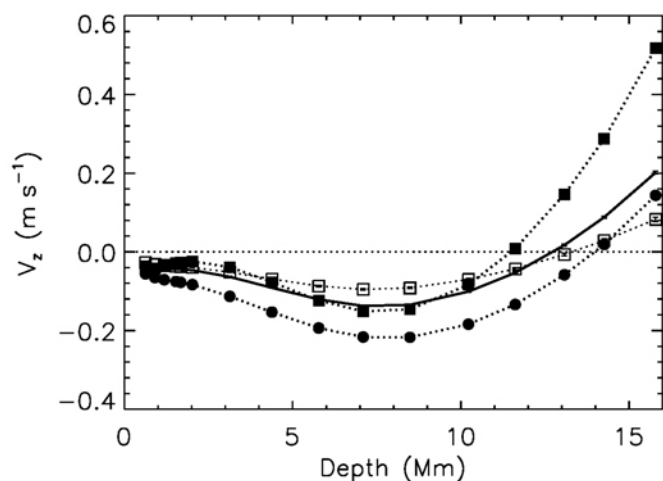


Figure 1: The average vertical velocity as a function of depth for 801 active regions classified in a variety of ways. The solid line shows the vertical velocity averaged over all regions and all observations. The filled squares show the vertical velocity for regions with emerging flux—the 25 percent of regions with the highest increase in flux. Similarly, the filled circles are for regions with decaying flux—the 25 percent with the greatest decrease in flux. The open squares are for the remaining 50 percent of the regions. The plot shows that emerging flux is associated with strong upflows in the deeper layers (10–15 megameters), and weaker downflows near the surface. The decaying flux shows the opposite: stronger downflows near the surface, and weak upflows at deeper depths. Error bars are smaller than the plotting symbols. This is the first unambiguous indication of a subsurface effect arising from an emerging magnetic field.

and now that funds have arrived at the NSO, sample lenses have been ordered. The loan of a camera (with an accompanying H-alpha filter) has been arranged for proof-of-concept evaluation and testing. We will acquire some data to use in the software development, which will be a major part of the observing system. Thanks to the design work and background research already done by Jack, Neill, and George Luis, we should be able to move forward expeditiously.

**Network Operations & Engineering**

The last quarter of 2008 continued to bring additional problems with Global Positioning System (GPS) receivers. After resolving the problems with the Mauna Loa unit and spare, new software for monitoring the GPS status was installed around the network. However, this revealed that the Big Bear receiver was compromised although working well enough that no data was being lost, the Udaipur spare GPS unit was not usable, and the Learmonth receiver indicated that it was not registering the full complement of satellites. Currently, a functional spare is in transit to Udaipur, and another unit is being readied in Tucson for shipment to Learmonth. Mauna Loa and Big Bear are still without spares, but a working unit can be sent quickly from Tucson if

**GONG/AFWA H $\alpha$  Concept**

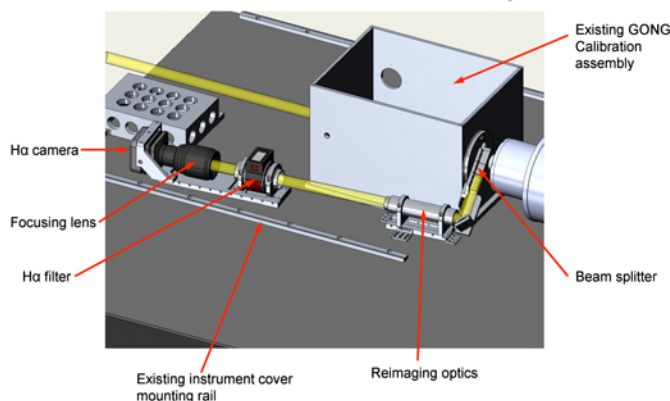



Figure 2: A rendering of the first design of the AFWA-sponsored H-alpha observing system. This system will provide full-disk solar images (2048 × 2048 pixels) at a wavelength of 6563 Angstroms with a 20-second cadence around the GONG++ Network. The data will be returned to Tucson within one minute of acquisition, and ingested into the Air Force Space Weather system at Offutt AFB to provide flare alerts.

required. We have acquired additional units, but they are not compatible with the current real-time software. Work is underway to modify and test new code that will allow us to employ these newer units.

The light-feed turret oscillation at Mauna Loa, which appeared to be fixed after the last preventative maintenance visit there, has reappeared, and we now suspect that it could be a result of the colder winter conditions. As it happens, the Tucson instrument is exhibiting similar behavior and is giving us the opportunity to investigate and understand the problem and, we hope, formulate a solution.

**Data Operations and Software Development & Analysis**

The new Data Management and Analysis Center (DMAC) Magnetogram pipeline will be placed in service within a few weeks. From the fully calibrated GONG site magnetograms, we will generate one-minute cadence network-merged magnetograms and Carrington rotation duration synoptic maps. Similar products are already available as quick-look images, but this is our first formal venture into routine, fully calibrated magnetogram products. The DMAC is also finalizing the Solaris-to-Linux port and testing methods to expedite the site image calibration process.

Processing to date includes time series, frequencies, merged velocity, and rings through GONG Month 135 (centered at 080807), with a fill factor of 0.773. Last quarter, the GONG Data Archive distributed 1500 gigabytes of data. All GONG data products can be obtained at: [gong.nso.edu/data](http://gong.nso.edu/data). 

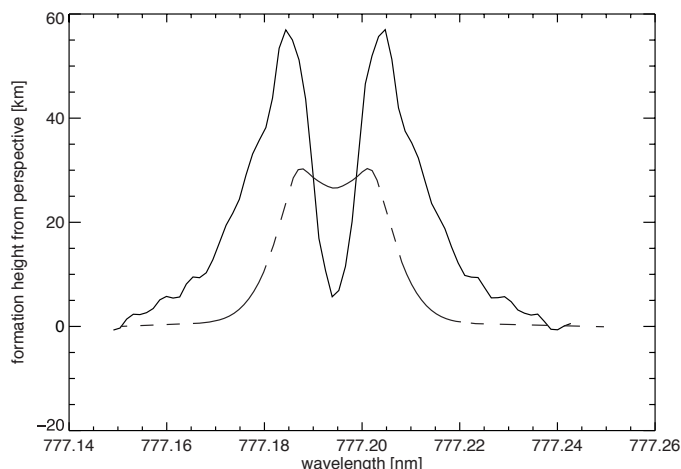
# Estimation of O I Line Formation Heights from Perspective Shift Measurements

Han Uitenbroek (NSO/Sacramento Peak), Marianne Faurobert & Claude Aime (Université de Nice Sophia Antipolis, Nice, France)

If the current rate of decline in its abundance continues, the Sun is estimated to run out of oxygen soon (the “solar oxygen crisis,” see Ayres 2008, ApJ, 686, 731). This slightly unconventional interpretation of the data notwithstanding, the problem remains that recent oxygen abundance determinations have resulted in values that are uncomfortably low. These values are in serious conflict with what is considered a well-established, standard solar model determined from helioseismology (Basu & Antia 2008, Phys. Rep., 457, 217), and they no longer match meteoritic values, while results were previously in a consistent range for both cases.

Traditionally, the abundance of an element is determined by fitting the equivalent widths of its spectral lines calculated from a one-dimensional hydrostatic atmospheric model to observed values. This fitting procedure involves a free parameter for line broadening, namely the microturbulence, which, like the abundance, has to be determined from the line fit (increasing the uncertainty in the latter). Only recently has it become possible to employ more sophisticated and realistic three-dimensional atmospheric models taken from hydrodynamic solar convection simulations. These models no longer require the fudge of microturbulence because the convective motions in the simulation account naturally for Doppler broadening over the thermal values. Use of these models caused the solar oxygen abundance to be revised downwards by a factor of almost two (Asplund et al. 2004, A&A, 417, 751). Even though the simulations have no direct free parameters, their realism possibly is impaired still by the choice of physics that can be implemented, and the numerical resolution that can be achieved. These field limitations (and the fact that the three-dimensional oxygen abundance determination is well below values established in other fields) suggest that further tests are required to validate the simulations.

Ideally, observational tests should be as independent of circumstances, instrument, and theoretical model as possible. The good agreement of the precise, convection-induced shape of spatially- and temporally-averaged spectral line profiles between observations and simulations is one example that has been used to argue the realism of the latter. Here we present a different test. It is based on a measurement of the small perspective shift that occurs when two images at different wavelengths in a spectral line, sampling different heights in the atmosphere, are viewed toward the solar limb. The shift is determined from the slope of the phase as a function of spatial frequency in the Fourier transform of the correlation between the two images, and it is therefore independent of telescope resolution and seeing conditions. To ensure perfect instrumental alignment between images at different wavelengths, the images were constructed by sampling slit spectra along the dispersion direction while the slit was positioned away from disk center, oriented in the direction of the offset towards the limb.



The perspective shift of images taken at different wavelengths through the O I 777.19 nanometers line, relative to the continuum image. Observation (black curve) at a relative radius of  $R = 0.5$  in the N-S direction, simulation (dashed) at the equivalent viewing angle.

On 5 July 2008, we used the horizontal spectrograph at the NSO/Dunn Solar Tower to take slit spectra of the O I triplet at 777 nanometers at several positions on the disk with radial positions of  $R = 0, \pm 0.5$  in the solar N-S direction, scanning the slit in the E-W direction. Dark- and gain-correction images were constructed at all wavelengths through the three spectral lines. The phase of the Fourier transform of the correlation function between images at successive wavelengths is indicative of their relative perspective shift in the solar N-S direction. This perspective shift can be directly compared with that obtained from simulations. We calculated the emergent spectra in the three oxygen lines from several snapshots of a magneto-hydrodynamic simulation of solar convection at the equivalent viewing angles, and determined the apparent perspective shift of images at different wavelengths through the lines in the same way as in the observations. A comparison of the perspective shift between images through the 777.19 nanometer line determined from observations (solid black) and simulation (dashed curve), respectively, is shown above. It is clear that there are significant differences between the two curves. In particular, in the wings of the line, the formation height of intensities at wavelengths towards the core of the line seems to increase much faster in the real Sun than in the simulated one. This suggests that the density stratification with height falls off much slower in the former than in the latter, and, therefore, seriously questions the appropriateness of the simulations for abundance simulations.

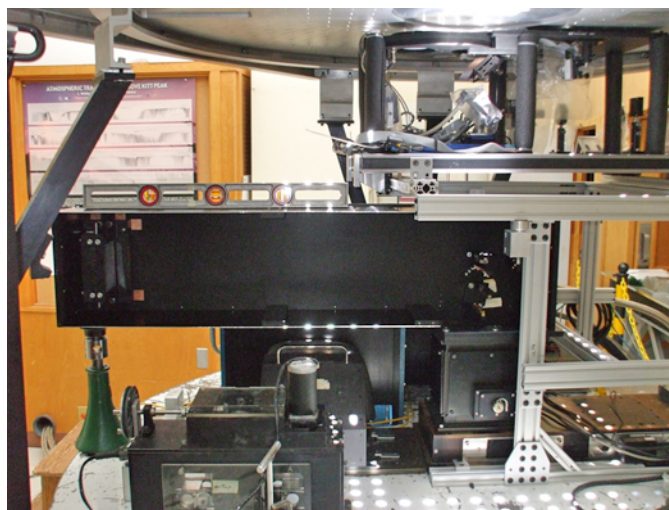
## An Integral Field Unit for the McMath-Pierce Solar Telescope

Kim Streander

A state-of-the-art, image slicer Integral Field Unit (IFU) has been developed for the NSO/McMath-Pierce Solar Telescope (McMP). The work has been a joint effort between California State University Northridge, Utrecht University, and the National Solar Observatory.

The IFU samples a small, adaptive-optics-corrected field of view simultaneously for three-dimensional (3-D) spectroscopy and polarimetry. It consists of 19 effective slices that correspond to a field of view of  $7 \times 6.3$  arcseconds. The IFU will create a 155-arcsecond-long slit for an existing spectrograph for diffraction-limited 3-D spectroscopy. The 3-D instrument is being used for high-spatial and high-temporal resolution solar imaging, which is crucial for the magnetic field and spectroscopic studies of two-dimensional solar fine structures.

In December 2008, Dr. Deqing Ren (California State University Northridge) performed verification tests at the McMP, see figure. The instrument was then returned to California in order to apply a gold coating to the mirror and make minor adjustments to the alignment mechanism. The instrument will return in April/May of 2009 to be commissioned as a user instrument.



IFU (large black box) during verification testing. Note the universal mounting platform with adaptive optics that is used in conjunction with the IFU.

## Second Quarter Deadline for NSO Observing Proposals

The current deadline for submitting observing proposals to the National Solar Observatory is February 15 for the second quarter of 2009. Information is available from the NSO Telescope Allocation Committee at:

P.O. Box 62, Sunspot, NM 88349  
for Sacramento Peak facilities  
([sp@nso.edu](mailto:sp@nso.edu)), or

P.O. Box 26732, Tucson, AZ 85726  
for Kitt Peak facilities  
([nsokp@nso.edu](mailto:nsokp@nso.edu)).

Instructions may be found at [www.nso.edu/general/observe/](http://www.nso.edu/general/observe/). A Web-based, observing-request form is available at [www2.nso.edu/cgi-bin/nsoforms/obsreq/obsreq.cgi](http://www2.nso.edu/cgi-bin/nsoforms/obsreq/obsreq.cgi). Users' manuals are available at [nsosp.nso.edu/dst/](http://nsosp.nso.edu/dst/) for the Sacramento Peak facilities and [nsokp.nso.edu/](http://nsokp.nso.edu/) for the Kitt Peak facilities. An observing run evaluation form can be obtained at: [ftp.nso.edu/observing\\_templates/evaluation.form.txt](http://ftp.nso.edu/observing_templates/evaluation.form.txt).

Proposers are reminded that each quarter is typically oversubscribed. It is to the proposer's advantage to provide all information requested to the greatest possible extent no later than the official deadline. Observing time at the national observatory is provided as support to the astronomical community by the National Science Foundation.

# The Sunspot Solar System Model

Dave Dooling

The National Solar Observatory (NSO) will bring the Sun and planets down to Earth with the quarter-billion-scale Sunspot Solar System Model centered at Sunspot, New Mexico, and extending outward. It will be funded by a \$75,000 grant from the New Mexico Tourism Department as part of capital outlay funding sponsored by State Senator Vernon Asbill of Carlsbad, NM. As part of its contribution to the International Year of Astronomy 2009, the model will draw more tourists and students to Sunspot to learn about the importance of studying and understanding solar activity and the NSO's role in it.

The model uses the popular community solar system concept where astronomical societies, universities, and museums place models of the planets on a path leading from a museum or other feature and tailored to that area's geography. In like manner, this model places the Sun at the Sunspot Astronomy and Visitors Center and uses an existing corridor, the Sunspot Scenic Byway, NM 6563, with signs indicating the orbits of the planets to draw visitors inward. The 1:250-million scale model was set by having Neptune pass through the New Mexico Museum of Space History in Alamogordo. Pluto's orbit is eccentric enough that it transits Cloudcroft, a tourist destination that visitors must pass en route to Sunspot, and recreational attractions along NM 6563.

Because NM 6563 is a two-lane mountain road, only minimalist signs will be placed on it for driver safety. Explanatory markers will be placed at existing turnouts. Podcasts will narrate the journey inward. Neptune inward to the asteroid (or minor planet) Ceres will be on NM 6563—the only known state highway numbered for an astrophysical phenomenon (H-alpha light is 6563 Angstroms)—and the inner planets will be on Solar Physics Drive as you enter the observatory grounds.

In the Visitors Center, guests will encounter models of the Sun and planets and new

graphics. The planets will be represented by white plastic spheres, ranging from 1/8-inch Ceres to 22-inch Jupiter (with textured 39-inch rings!). Earth is a mere 2 inches in

Sunspot will indicate the relative diameters of giant stars. An 18-foot, cold-air balloon model of the Sun also will be developed for special events at Sunspot and area schools.

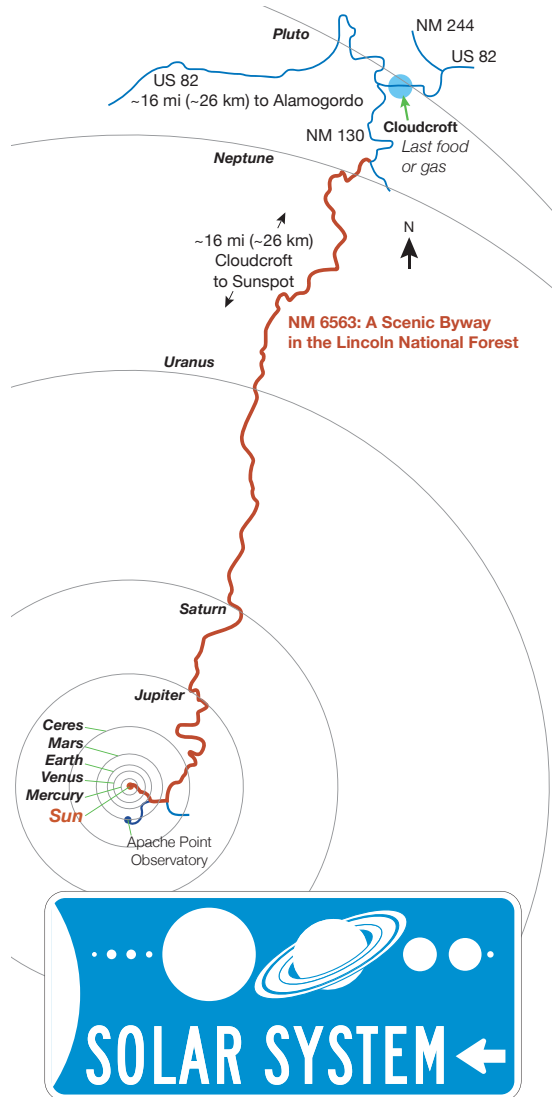
The Visitor Center will have four new graphics panels to complete the model. *Our Sun from the Inside Out* will depict the solar interior, the complexity of activity at and near its surface, and its reach to the heliopause. The lower section will introduce NSO's various telescopes. *Sizing Up Your Solar System* will present images of the planets at the correct scale of the model (and with reasonably correct colors). *The Goldilocks Star* will place the Sun into the context of other stars. Finally, *A Map of the Universe* will guide visitors from the surface of Earth to the edge of the Big Bang. It is based on the map developed by John Gott and Mario Juric of Princeton University.

Expanding the model across the state will be *Water in the Desert* markers planned for state parks with small star party observatories, and other locales. On the model's scale, most of New Mexico lies between the Kuiper Belt and inner Oort Cloud. The region is populated with icy bodies holding several times the total volume of water on Earth. Finding them though, is like finding water in the desert.

A planned expansion of the model features a second set of planet models surrounding an 18-foot radome in Planet Plaza outside the Sunspot Astronomy and Visitors Center. The model also includes educational activities being developed for middle and high school students.

For additional information, contact Dave Dooling at 575-434-7015 or [dooling@nso.edu](mailto:dooling@nso.edu).

Map depicts the Sunspot Solar System Model as it reaches from Sunspot up to Cloudcroft and Alamogordo. The route will be indicated by graphic identifier signs like the inset, which show a traditional (familiar) view of the Solar System.



diameter. An 18-foot-wide graphic will represent the Sun with overlays of features as seen through NSO telescopes. The models will not be painted because of the cost and complexity. This allows Sunspot to invite blind and visually impaired visitors to touch them and feel the relative sizes of the Sun and planets. In addition, markers on the walking tour of