GONG Newsletter

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Just when you thought that it was safe to go back to your mail box, here is yet another *GONG Newsletter*. Yes, it has been a long time, but have we ever accomplished a lot!

Among other delights that the serious reader will discover inside is the good news that we now have an instrument that we can properly calibrate, produces excellent data, and magnetograms to boot. We have made very considerable progress in getting the data management and analysis center defined and under development, and we have even done some preliminary merging of imaged helioseismic data — just artificial data for the time being; we don't have the network running yet after all. We have five of the six site Memoranda of Understanding signed and sealed, and there was a very well attended (100+ participants) and worthwhile "*GONG* ′92" meeting hosted at the High Altitude Observatory.

Data from the prototype instrument has proven to be scientifically interesting and publications are already starting to appear. You will find the "*GONG* Data Distribution and Publication Policy" that we discussed at last year's Annual Meeting in this issue of the *Newsletter*. *Please do read this section,* starting on page 25.

We continue to make good progress and are hopeful that network operations can start in 1994 — 24 months from now — if our funding is maintained as planned. All of this thanks to the outstanding efforts of a dedicated project team and the suggestions and work of many, many members of the community. We have conducted a number of external reviews of the Project's activities, including one of the overall data system that is discussed in this *Newsletter*, and we are planning another major one in the near future of the overall instrument production and fielding plan. We want to thank the members of the Scientific Advisory Committee [Peter Gilman, Bob Noyes, Alan Title, Juri Toomre (chair), and Roger Ulrich], the Team Leaders (particularly *DRAT* leader Tuck Stebbins who chaired the *DMAC* review and now chairs the *DUC* as well) and the members of the *ad hoc* review committess, and many others who continue to contribute their expertise and energy.

Next year's *GONG Annual Meeting* will take place here in Tucson, April 19-21, and we will send you more information concerning it in the next issue of the *Newsletter* which will "go to press" on January 15, 1993. We invite you all to submit your contributions for inclusion.

John Leibacher

What is Inside

Project Reports

Sites

The site survey instruments continue to operate at the selected sites, and they will provide baseline data up until network operations commence.

The project has now concluded negotiations with the host institutions of five out of the six field sites, and talks with the sixth site are proceeding satisfactorily. Formal memoranda of understanding have been signed with Cerro Tololo Interamerican Observatory in Chile, Big Bear Solar Observatory in California, Udaipur Solar Observatory in India, the Instituto d'Astrofísica Canarias in Spain, and the Learmonth Solar Observatory in Western Australia.

The Udaipur *MOU* was signed by Professor R. K. Varma, Director of the Physical Research Laboratory, in a ceremony in Ahmedabad in February. The Spanish *MOU* was signed by Professor Francisco Sánchez, Director of the *IAC*, and Goetz Oertel, President of *AURA* (*NOAO*'s corporate entity) in May at the *IAC* headquarters on Tenerife, in the presence of Marisa Tejedor, Rectora of the University of La Laguna, and other dignitaries. The Learmonth *MOU* was signed in September in a ceremony at Parliament House in Canberra. Senator Nick Bolkus, Minister for Administrative Services, signed for Learmonth, while Jim Kennedy represented *AURA/GONG*. Members of the U.S. diplomatic delegation, David Cole, Director of the *IPS* Radio and Space Services, and other notables participated.

The project is continuing to negotiate with the National Oceanic and Atmospheric Administration for access to the High Altitude Observatory site on Mauna Loa in Hawaii.

(Incidentally, the recent earthquake centered near Big Bear has not upset plans to deploy the first field station to that location during 1994.)

On another front, the *GONG* Project has decided not to place a seventh instrument at the Urumqi Astronomical Station in China. The decision was made after studying the differences in performance between the seven-site and the six-site network windows, and estimating the impact of these differences on the scientific goals of the Project. The scientific impact was assessed by examining the effect of the window spectrum sidelobes on the relatively strong p modes and the effects of the window spectrum background on the much weaker g modes. In all cases, the six-site network performed completely adequately. Indeed, spatial leakage due to the limited accessible area of the solar surface is likely to be much stronger than any residual temporal leakage.

The impact of the fundamental diurnal sidelobe is addressed first. Since the sidelobe power is proportional to the power of the mode associated with it, the largest effects will appear in the region of the p modes. The height of the first sidelobe was thus estimated and compared to the solar background noise surrounding the p modes. To quantify this, consider an average p mode with an amplitude A of 5 cm/s and a width W of 1 μHz. The power spectral density of this mode is A^2/W = 2500 $(m/s)^2$/Hz. Analysis of the observed six- and seven-site network windows shows that the height in power of the first diurnal sidelobe relative to the main component is about 4×10^{-4} for the six-site network, and 1×10^{-4} for the seven-site case. Thus, an average p mode will be surrounded by sidelobes with a height of 1.0 $(m/s)^2$/Hz in the six-site case, and 0.25 $(m/s)^2$/Hz in the seven-site case. Measurements of the solar background noise in this region are about 16 $(m/s)^2$/Hz (Jiménez *et al.* 1988, *Astron & Astrophys.* **192**, L7), thus the diurnal sidelobes for the six-site window are more than an order of magnitude smaller than the solar noise in this region of the spectrum. While the absolute improvement in sidelobe performance of the seven-versus the six-site network is a factor of four, relative to

Calendar

Event	*Date*	*Location and Contact*
Neutrino Astrophysics	December 29, 1992 - January 7, 1993	Jerusalem (John Bahcall & Steven Weinberg)
Annual GONG Meeting	April 19-21, 1993	Tucson (John Leibacher)
Advances in Solar Physics	May 11-15, 1993	Catania (Peter Hoyng)
Helio- and Astero-Seismology from the Earth and Space	Mid-May, 1994	Los Angeles (Roger Ulrich)

the background the performance of the six-site network is completely adequate in this regime.

Next, the impact of the overall background of the window spectrum is assessed. A low background is desirable for the detection of very low-amplitude low-frequency modes, such as g modes. Again, the approach is to compare the estimated effects of the window spectrum and the solar background noise. Since there are no consensus measurements of the properties of g modes, the estimate was done using a hypothetical g mode with A = 1 mm/s, and W = 0.1 μHz, giving a power spectral density of 10 $(m/s)^2$ /Hz. The power spectrum of the six-site window shows an overall average background power density of 7×10^{-6} relative to the main component; for the seven-site window, the value is 5×10^{-6}. Thus, the background power density produced by the hypothetical g mode would be $10\times5\times10^{-6} = 5\times10^{-5}(m/s)^2$ /Hz for the seven-site network, and 7×10^{-5} $(m/s)^2$/Hz for the six-site network. However, since the background is broad-band unlike the sidelobes, it is necessary to consider the combined overlapping background from several g modes. Theory predicts about 20 g modes within 60 μHz at a given ℓ in the more crowded regions of the g-mode spectrum. The combined background power for such a set of modes would thus be a factor of 20 higher than for a single g mode. Thus, the total g mode regime background caused by the interaction of the g modes themselves and the window function is estimated to be 1.4×10^{-3} $(m/s)^2$/Hz for the six-site network, and 1×10^{-3} $(m/s)^2$/Hz for the seven-site case. These levels are much lower than both the measured average solar background of 1200 $(m/s)^2$/Hz in the 100 to 160 μHz band, and the 10 $(m/s)^2$ /Hz power density of the hypothetical g mode. The performance of the six-site network is again completely adequate in this calculation.

The window spectrum is replicated around every point in the solar spectrum, regardless of whether the point contains power from a mode or from the solar background. It is therefore also necessary to estimate the amount of additional noise that would be created in the g mode regime by the interaction of the solar background, as opposed to the g modes, with the network observing window. As stated above, the average solar background noise power density is measured to be 1200 $(m/s)^2$/Hz between 100 and 160 μHz, and the relative background of the window functions are 7×10^{-6} for the six-site case, and 5×10^{-6} for the seven-site case. For a one-month time series, there are about 156 frequency points in a 60-μHz band, each surrounded by the window spectrum. The total noise added by the window is then roughly

The above results were obtained using windows that had been observed with the *GONG* Site Survey Instrument. However, the Site Survey Instrument is far less complex than the Doppler science instrument. In an effort to predict the future performance of the network with a more complex (and hence possibly less robust) instrument, and to assess the impact of a seventh site in this situation, the observed downtime was systematically increased at each station by factors ranging from two to ten. The network window was then constructed and analyzed in the usual manner. This study showed that the six-site network is satisfyingly robust, even in the extreme case of a tenfold increase in time loss. In the worse case, the fraction of observing time was 85.88%, and the height of the first sidelobe in the power spectrum increased to 0.2%, still far below the sidelobe height in a single-site window. For comparison, the six site survey instruments achieved a combined observing time fraction of 93.63%, and a sidelobe height of 0.04%. To assess the impact of the degraded networks on the science, consider the worst case of a tenfold increase in downtime. Then the relative power of the first sidelobe rises to 2×10^{-3} for the six-site network, and to 1.4×10^{-3} for the seven- site network. Performing the same calculation as above results in an estimate of 6 $(m/s)^2$/Hz for the six-site sidelobe heights around the p modes, and 4.2 $(m/s)^2$/Hz for the seven-site sidelobes. These numbers are to be compared again with the 16 $(m/s)^2$/Hz level of the solar background. Once again, the six-site network performs adequately, even in this scenario. For the g mode calculations, the relative background power rises to 2×10^{-5} for the six-site network, and 1.7×10^{-5} for the seven-site case. This results in an estimated g-mode background due to the modes of 4×10^{-3} $(m/s)^2$/Hz for the six-site network, and $3.4\times10^{-3}(m/s)^2$ /Hz for the seven-site case, both still far below the 10 $(m/s)^2$/Hz g-mode power density. The estimated additional noise due to the interaction of the solar background and the window function rises to 3.8 $(m/s)^2$/Hz for the six-site case, and 3.2 $(m/s)^2$/Hz for the seven-site case. All of these estimates are substantially below both the 10 $(m/s)^2$/Hz of the hypothetical g mode, and the 1200 $(m/s)^2$/Hz estimated level of the solar background in the g-mode regime. Again, the six-site network is seen to perform adequately.

The impact of adding a seventh site to the network can also be assessed by determining the amount of additional observing time that would be gained. The amount of additional observing time provided by the Chinese site can then be compared to the amount provided by any other single site. This can be done by constructing the windows for the seven-site network, and also for the six six-site networks formed by eliminating a single station. The differences of the filling factors of the windows can then be used to compute the number of days that a single given station is the only one observing. On a yearly basis, it was determined that the Urumqi site was solely carrying the entire network for a total of 4.38 days. It was also determined that the other six sites solely carried the network for periods ranging from 7.88 to 23.03 days per year, with an average of 15.85 days per year. Thus, the Chinese site carried the network a factor of three less time than the average of the other sites.

These results have led the Project to conclude that the addition of a seventh site at Urumqi is not cost-effective. While the network window would indeed be improved, the six-site window is entirely adequate for the project, and the additional expense in funds, personnel, and data-reduction effort is not justified. It should be noted that this decision has been based entirely on consideration of the integrated performance of the *GONG* network as a whole, and should in no way be construed as indicative of the utility of Urumqi as a site for other astronomical purposes.

The *GONG* Project would like to extend its warmest thanks and appreciation to the Urumqi group, particularly Xiao Suming and Huang Zhen, who have played very important roles in the testing of the Urumqi site. Because of this substantial contribution to the Project, the Urumqi personnel are considered to be permanent members of the *GONG* Project, with full access to the future data products.

Frank Hill and Jim Kennedy

Instrument

Since the last *Newsletter*, the principal Project effort has shifted from development of the prototype to production of the final instruments. Carpenters and electricians have been busy converting six shipping containers into *GONG* field stations. This work continues in the *GONG* staging area adjacent to *NOAO*'s main parking lot in Tucson. A crew made up of members of the *NOAO* Central Facilities Operations group and temporary help has nearly finished the work. A new site has been identified for use as an integration area when the field shelters are mated to the production instruments, and tested prior to deployment. The University of Arizona has again cooperated with the project, leasing a small plot of land within the Agriculture Department's Campbell Farm facility, six km from the *NOAO* offices. The shelters will be set up side by side for final assembly, testing and cross calibration of the field instruments.

A computer-controlled milling machine is running two shifts to produce the field instrument mechanical parts. Its first task was to make parts for the light feed systems. The production shipment of mirrors for the light feeds was received recently, tested for proper polarization performance and found to not meet specifications. The vendor identified a problem and the mirrors are being recoated. The second major task is to produce parts for the birefringent filter and the ovens. This task is nearly completed. At the same time, necessary lathe work is being done in parallel at *NOAO* and a number of tasks have been contracted to outside vendors. A filtered-air, optics assembly bench has been set up in a temperature and humidity controlled room at *NOAO* that was once used for ruling large gratings. During the next three months we expect to assemble all the birefringent filters and spares — a delicate task since each one consists of 25 pieces of crystal optics that must be accurately aligned.

The vendor of the Michelson interferometers that are the heart of the *GONG* instruments expects to deliver all of the production units by late November. We will carefully test these before installing them in the field instruments early next year.

Similar intense efforts are underway to produce the final electronic systems and computer programs required for the field instruments. Both of these jobs are large since careful documentation and checking are required. For example, more than 1000 separate electronic tasks appear on the project planning charts. Proper timing and synchronization of the *GONG* observations has occupied both the electronic and software groups. It is our current plan to take data synchronized with the measurements to be made with the Solar Oscillations Imager to be flown on *SOHO*. As we anticipated, a commercial replacement for the Omega time signal receiver became available. The new system is based on signals transmitted by the Global Positioning System (*GPS*) satellites. The new receiver has been working well since installation at the *GONG* prototype and it provides more than enough accuracy for our needs.

The prototype instrument has been waking itself every morning since early in 1992. It has been quite robust in most aspects. For example, we have had no problems at all recording the solar data on Exabyte tapes this year. The instrument survived the hot Tucson summer and our thunderstorm season with only one significant problem: the air conditioner clogged with ice on two occasions. One time was due to a loose piece of paper sucked into the air intake port. The second time is still an unsolved mystery. The production field stations have two redundant units to protect against problems of this sort. The backup power generator at first was not as reliable as we would like. Subsequent work has improved its reliability, and a program of weekly exercise makes sure that it is ready to start when needed.

Instrument development work centered in three areas since the last *Newsletter*. An intensive effort to replace our baseline *CCD* camera with a Texas Instruments model having square pixels was not successful. All characteristics of the camera were excellent except for its linearity. This appears to be a problem with the *CCD* itself which is a surprise since the same architecture is used in the baseline *CCD* camera that has excellent linearity. A similarly vigorous effort went into producing a stable laser reference signal. By using a dual-fiber scrambler and a rapidly rotating diffusing plate, the short-term noise level of the laser signal was brought down to about 1 m/s rms. This is about two orders of magnitude worse than the short-term noise of the solar signal. It appears that a major effort would be required to improve the laser signal that much.

The third major development effort was calibration of the prototype solar data. A difficult problem arose when the optical package was moved from the old *GONG* lab facility in the *NOAO* building to the prototype site. We had no problem calibrating the solar data until the move. However, at the prototype site, the calibrations always left residual defects. After experimenting with several new calibration methods and dozens of optical tests, the problem was still unsolved. We finally moved the optical system back to the old lab but the problem persisted. The difficulty turned out to be a bad figure on our in-house interferometer. In the course of the original move to the prototype site, the interferometer had been installed in the second of two possible orientations. This placement presented a poorly figured portion of the interferometer to the active part of the optical path. When combined with limb darkening of the solar image (important in the calibration mode), this led to defective calibrations. Turning the interferometer to its first orientation improved the figure across the used portion of the aperture and the calibrations were again satisfactory.

After that problem was fixed, we found what appeared to be a Fabry-Perot fringe pattern that varied with the temperature of the air in the instrument enclosure. The fringe pattern was of a scale that it should have arisen either from an air gap of about 5 mm or a piece of glass about 3 mm thick. No dimensions closely corresponding to these numbers exist in the instrument. Blowing hot air on various pieces of optics finally revealed that the offensive piece was a 6 mm exit window of the birefringent filter oven. A temperature difference of 15 K across the window distorted the expected Fabry-Perot fringes and caused them to change with ambient temperature. It has been replaced with a slightly wedged window. This appears to be the last significant calibration problem. We expect to be working on calibration improvements until the instruments are deployed, but the current performance appears to be completely adequate for the main scientific goal of the *GONG* project. The design philosophy of deliberately imaging optical elements that are likely to cause problems has been painful. An alternative is to blur these elements to hide difficulties. In the end, the hard choice will pay off since we have located and corrected subtle problems that could easily have degraded the solar data after the network became operational.

Magnetogram made with the *GONG* prototype instrument on August 27, 1992. Integration time was 60 seconds giving a noise level of about 10 gauss per 8 arc sec pixel.

Testing of the magnetograph capability of the *GONG* instrument had been postponed until fairly recently. It was most alarming that our baseline design, which had worked fairly well in breadboard form, produced very poor results. The problem was traced to a non-uniform liquid crystal modulator. A different modulator produces much better results.

During the transition from development to production, it became clear that all of the features that we planned to incorporate into the instrument could not be ready in time for the scheduled network deployment. These capabilities were examined from a scientific viewpoint, discussed with the Scientific Advisory Committee and with several Teams at the recent *GONG* meeting. As a result of these consultations, the following decisions have been made by the project:

Stable Laser: Deleted

Since the stable laser reference signal is currently about two orders of magnitude noisier than the instrumental part of the solar signal, and it is not clear how to improve the present performance by such a large increment, the laser reference will be deleted. This means that a relative zero velocity point will have to be derived from the solar data. It also means that a breach of the hermetic seal of the interferometer could be a serious problem. To counter this possibility, a barometer signal will be substituted for the laser signal in the data stream. We have done this before so no new engineering is required. The velocity zero point can probably be derived adequately by removing from an observed solar velocity image the ephemeris velocity and a model of differential rotation and the limb effect. An average of the residual velocities, masking out active areas, should give a fairly stable reference.

5 Å Filter Monitor: Deleted

A real-time monitor of drift of the 5-Ångstrom prefilter will not be installed. The rationale is that the vendor of the filters is using a new technique that should reduce drift to a negligible level. We will measure the wavelength stability of the filters during the semiannual maintenance visits to each site.

Square Pixels: Deleted

We plan to use the rectangular pixel cameras that have been in service for a number of years. However, since it is over three years since we tested commercial cameras, and a number of promising models have appeared on the market, we will run a set of tests of a few of the most promising models to see if a square-pixel camera can easily be swapped for the existing model. Such a swap would give the benefit of uniform resolution of the solar image.

Camera Rotator: Kept

A mechanism to rotate the camera to follow the rotation of the solar image during each day has been designed, built and tested in the prototype. An alternative to building six more of these rather complicated and precise devices is to have a simple fixed camera mounting and let the image of the Sun rotate on the *CCD* during the day. This leads to an undesired blurring of the images and varying response to spherical harmonic patterns on the solar image. These effects were deemed scientifically unacceptable, particularly in light of the rectangular pixels, and so the camera rotators will be built and installed.

Magnetograph: Kept

As mentioned above, magnetograms obtained with the prototype instrument were of poor quality. This led to the possibility of deleting the capability of making magnetograms. Consultation with the community made it clear that this is not a good idea. Fortunately, a simple change of modulator type has greatly improved the quality with very little design impact. We plan to retain the magnetogram capability and to continue evaluation of the new modulator as long as this does not delay fielding of the *GONG* network. However, we will not build a computer-controlled focus mechanism to compensate for the slight focus change produced when the modulator is inserted into the optical beam. An alternative is to use a block of glass in normal observing mode to shift the focus by the same amount. We reject that action because of the danger of introducing fringes into the solar velocity data. Thus the magnetograms will be very slightly out of focus relative to the velocity data, which are already purposely defocussed.

Scattered-light Detector: Deleted

The prototype instrument has a detector to measure scattered light in the sky beyond what can be measured in the corners of each *CCD* image. This can be operated only when dark frames are taken with the *CCD* camera. Recent work has shown that even short gaps in the series of velocity images significantly compromise the quality of the oscillation spectra. Thus, fewer and shorter calibrations will be made during an observing day. (Magnetogram observations also produce velocity images and so do not interrupt the velocity time series). The value of the distant scattered light detector would be questionable if it were used so seldom as to greatly undersample the variations of scattered light. Accordingly, the field instruments will not have this capability. On rare occasions when scattered light measurements are required, we can simply point the telescope far enough away to get the data using the main data system.

Enhanced Automation: Deferred

Early in the *GONG* project, the concept of the instrument was similar to a spacecraft that operates itself with only occasional intervention. Experience has taught us that operating on the ground presents a wider variety of environmental challenges than operating in space. As a result, the degree of automation built into each instrument will be modest and we will rely on human operators to react to abnormal events rather than trying to plan for every possible circumstance. Normally, each instrument will acquire the Sun in the morning by itself, do calibrations automatically, and continue data recording during the day until sunset without intervention being required. The prototype has operated in this manner for many months. However, although equipped with several environmental sensors, it is not aware or intelligent enough to know what to do in case of bad weather or other abnormal conditions. The current plan is to rely on human intelligence to do this job while increasing the degree of automation gradually and appropriately as experience is gained at each site following deployment.

Jack Harvey and Rob Hubbard

Data System

During network operations, the Data Management and Analysis Center (*DMAC*) will be required to process 1 GB of data per day (12 kB/s) in order to keep in cadence with the input data flow from the instruments in the field. The actual data processing rate must also incorporate a margin of 100% to allow reprocessing without falling behind the input data stream. The *DMAC* will incorporate a pipeline of processing steps, a Data Storage and Distribution System (*DSDS*), and on-site visitor facilities.

The data products of the *DMAC* will consist of the following items:

- Raw Field Data (1000 GB)
- Merged Velocity Images (200 GB)
- Day, Month & Three-Year Velocity Time Series (1100 GB)
- Day, Month & Three-Year Velocity Power Spectra (600 GB)
- Month & Three-Year Velocity Mode Frequencies (0.775 GB)
- Hourly Magnetograms (5 GB)
- Ten-Minute Averaged Velocity, Intensity & Modulation Images (100 GB)

The *DMAC* staff currently numbers eleven: the Data Scientist, Data Manager, five scientist/programmers working on the pipeline development, two data base specialists working on the *DSDS* development, and two data technicians. In addition, the *DMAC* has greatly benefited from the help of several members of the *GONG* community.

In May of 1992, the *GONG* Project conducted an outside review of the *DMAC* System Development Plan. A six-month series of internal reviews culminated in *GONG* Technical Report No. 92-1, which describes the plan in detail. Copies of this Report, along with the Review Panel's recommendations and the Project's responses to the recommendations, are available on request. The Review Panel consisted of Tuck Stebbins (*JILA*, Chair), Ron Allen (*STScI*), Tim Brown (*HAO*), Richard Grubb (*NOAA/SEL*), Gareth Hunt (*NRAO*), and Roger Ulrich (*UCLA*).

The Panel endorsed the overall *DMAC* plan to use multiple high-end workstations for the pipeline, and to use Exabyte tapes as the *DSDS* medium. The Panel also had several specific recommendations; here we summarize the more important issues along with the Project's responses. (The Panel Report and the Project Response are included later in this *Newsletter*.) The Panel recommended that the Project choose a single vendor for the workstations, and the Project has selected *Sun* to supply the hardware. The Panel thought that more direct community input to the *DMAC* was necessary, and the Project has appointed a *DMAC* Users Committee, which will be discussed more fully below. The Panel suggested the use of bar codes and electronically readable labels to identify the 15,000 Exabyte tapes that will be flowing through the *DSDS*, and the Project has selected and purchased a bar code reader for development purposes. The Panel also recommended that the movement of tapes through the *DSDS* be minimized, the Project is currently studying various methods of achieving this. More details on these and the other recommendations can be obtained by requesting a copy of *GONG* Technical Report 92-1.

The Panel recommended the establishment of a user's group to provide more direct community input into the *DMAC* development. The Project has organized a *DMAC* Users Committee (*DUC*) initially composed of Tuck Stebbins (Chair), Tim Brown, Jørgen Christensen-Dalsgaard, Todd Hoeksema, and Roger Ulrich. The *DUC* will meet 3-4 times per year, usually

A new method for accurately determining the image geometry and estimating the observational Modulation Transfer Function (*MTF*) for a full-disk solar intensity image has been developed by Toner and Jefferies. The method exploits the zero crossing properties of the Hankel transform of an observed image to recover the image's true dimensions to better than 0.01 of a resolution element, and to reconstruct the *MTF* to within 5% at low spatial frequencies and 15% at high spatial frequencies. On the left we compare the dimensions recovered using this method (small dots with 1 sigma error bars) with the dimensions obtained using the *FNDLMB* function from the *GRASP* package (large dots) and the true dimensions (dashed lines) for a time series of synthetic images in which the "seeing" and "scattering" were varied from image to image to mimic rapid changes in sky conditions. On the right the recovered *MTF*s are compared to the input *MTFs* for synthetic images that were computed using a Gaussian seeing model with different values for the dispersion. The x-axis is the spatial frequency relative to the Nyquist frequency. From top to bottom the dispersion is: 0.25, 0.50, 0.75, and 1.00 pixel.

This figure shows the difference in m-averaged $\ell = 20$ and $\ell = 100$ frequencies measured from two synthetic oscillation spectra. One spectrum was obtained from a time series of merged degraded synthetic images, while the other was created from the corresponding unmerged undegraded "perfect" images. The merging was performed by simply averaging with equal weights all available detrended remapped velocity images at a given time step. The figure shows that the deviation is typically less than 0.25 μHz, with occasional large fluctuations that may be due to imperfections in the simulation. The rms deviation is 0.40 μHz for the $\ell = 20$ modes, 0.14 μHz for the $\ell = 100$ modes, and 0.31 μHz for the entire mode set. These rms deviations, from a single realization of a one-day time series, are a factor of five or more smaller than the random error in frequency of 2 μHz predicted for this temporal length by Anderson, Duvall and Jefferies (1990, Ap. J. **364**, p. 699). From this preliminary result, it appears that a simple average merge will suffice for the *GONG* p-mode pipeline. We are currently developing more sophisticated merging schemes with weights determined from quality measures of the data, and are constructing a better artificial data set.

in Tucson, and the members have been assigned two- and three-year terms. New members of the *DUC* will be recruited from the general *GONG* community as needed. The purpose of the *DUC* is to act as community representatives to advise the *GONG* Data Scientist on such matters as the setting of priorities for software development, science data products, user interface, visitor support, and standards of pipeline performance. Non-*DUC* members of the *GONG* user community should raise specific *DMAC* issues with the *DUC* members who will then channel the concerns to the *GONG* Data Scientist. The *DUC* had its first meeting at the Boulder *GONG* 1992 Meeting, and the second *DUC* meeting will take place in Tucson in late September, early October. [Editor's Note: see the *DUC* report starting on page 21.]

One aspect of the *DMAC* plan is the definition of a baseline pipeline. This baseline system consists of prototype software functional components that are now available, and represents the minimum state of the processing that will be done to the *GONG* data. Development of baseline areas will continue for the forseeable future, and we anticipate that enhancements will be made to the pipeline even during the network operational phase. Currently, the relevant aspects of the baseline comprise statistical bad-image identification supplemented by visual movie inspection; no image restoration; a simple average merge either of detrended remapped velocity images or of spherical-harmonic coefficients; peak-fitting for every value of ℓ, *m*, *n*, but without computing spectral sideline error matrices; and the computation of ten-minute averages for the low frequency/steady flow analysis. The further development of these baseline components will be prioritized in consultation with the *DUC*.

In addition to the developments discussed above, the *GONG DMAC* staff has made progress in several other areas. A total of 20 days of data have been processed in support of the prototype instrument development, and a study of the overall timing and organization of the pipeline has been completed.

Ingres has been selected as the *RDBMS* underlying the *DSDS*, and a prototype *DSDS* user interface has been developed. Substantial progress has been made in the development of the velocity calibration procedure as the prototype instrument proceeds. A method of measuring the radius of a full-disk solar intensity image with an accuracy and precision of a few parts in 10^3 while simultaneously determining the *MTF* of the image has been devised (see box on page 7). An artificial data set that includes steady flows and several thousand p modes for use in developing merging algorithms and for validation of the pipeline is being assembled. A simple merge by averaging remapped degraded artificial images together with equal weights has been performed (see box on this page). A comparison of the spectrum of the "perfect" data with the merged degraded data indicates that this baseline merging scheme does not substantially alter the measured frequency of the modes. The large effects, that short frequent gaps have on the power spectrum, have been demonstrated and some methods of filling such gaps have been tested. Several papers discussing these developments will be published in the *GONG* '92 proceedings and elsewhere.

The future plans of the *DMAC* development depend to a large extent on the advice of the *DUC*. Several tasks need to be addressed in the 18 months, or so, leading up to the deployment of the network. The *DMAC* must continue to process prototype data, and will be required to process the test data from the six field instruments as they are completed. The integration of the pipeline must be both started and completed by the time of network deployment.

A new release of the *GRASP* software package will be available in mid-February 1993. Standard tests for validation of the pipeline must be developed. The baseline pipeline modules of merging, image restoration, peak finding, bad image rejection, and detrending require further development. The newly-formed *DUC*, along with the advice of the *GONG* Community, will be essential in helping the Project determine priorities.

Rob Cavallo who had been reducing data for the *GONG* project left the group on June 18 to attend graduate school at the University of Maryland. Rob had been working part-time for the project while completing his undergraduate work at the University of Arizona, and we wish him well in his new venture.

In August, Jean Nowakowski joined the project accepting a position as a data reduction specialist. Jean transferred to the *GONG* project from the Kitt Peak staff where she had been a large telescope operator and had acquired considerable experience with *IRAF* and with *Sun* workstations.

This Fall, part of the *DMAC* group will move from their present offices in the *NOAO* building to a building located about 50 meters to the northeast that several years ago housed the *AURA* corporate offices. This building will be occupied by the people and equipment that make up the project's computer operation. In the near future, this building will be linked to the *NOAO* building with fiber optic cables that will support both *FDDI* and Ethernet communication. In addition, there will be some minor renovation of the interior of the *AURA* building. Since the computer hardware plans for the project involve desk-top and desk-side workstations, major renovation (that would have been needed if the project had planned on installing super minicomputers) will not be needed. The *AURA* building also has a room-sized vault that will be used as the Exabyte cartridge library.

Frank Hill and Jim Pintar

Access to the GONG On-line Storage Facility

The *GONG* Project has maintained a publicly readable on-line storage facility since August, 1989. It includes one gigabyte of disk space installed on *NOAO*'s *VMS/VAX*. This will serve as *GONG*'s on-line storage facility for the near future.

It may be accessed via *INTERNET* using *FTP* by an anonymous user. The procedure is as follows:

```
host:        robur.tuc.noao.edu or 140.252.1.10
login:       anonftp
password:    guest
```

followed by: *cd gong*.

To access the disk via *NSI-DECNET* use:

noao::ga0:[ftp.gong] or
5355::ga0:[ftp.gong];
i.e., ga{zero}

At present, the *GONG* project is not providing full function remote login. Anyone having questions about these procedures should contact Jim Pintar.

Project Management

The *GONG* Project has had a budget history not unlike many other Federally funded programs. The proposal, prepared in 1985, called for funding of about $3M in three of the first five years, in order to finance the technical development and major purchases necessary to construct and deploy the network. The proposal was approved and first funded in Fiscal Year (FY) 1987. However, the vagaries of the Federal budget have caused the Project to be funded at the levels varying from $1M to $2.3M, far below the optimum profile. Nevertheless, excellent progress has been made, although the program is necessarily taking more time to complete than originally proposed.

Various adjustments in both the strategy and tactics of the project plan have been made over time to deal with the realities of the funding. In 1990, the Project presented a detailed revision to a formal *NSF* review. Two funding scenarios were presented, one of which led to full network operations in December 1993 and the other led to operations in December 1994. Although the plans were favorably received, the actual and projected cumulative funding is below the "December 1993 Plan" requirements by $1.4M.

Since 1990, the Project has pursued a plan intermediate to the two options above. This calls for network operations in June of 1994. The success of this plan depends on both the budget and the resolution of the few remaining technical issues.

On the funding side, the program has been depending on annual budget increases from $2.3M in FY 92, to $2.55M and $2.68M in FY 93 and FY 94, respectively. However, at this writing, the FY 93 budget increase is in serious question, as is the likelihood of the FY 94 increase.

The cumulative funding to date has been about the same as the "December 1994 Plan". This makes it tempting to suggest that this would be a reasonable "new" target date for operations. However, if funding remains at the current level in both 1993 and 1994 there will be a shortfall of about $400K for even the December 1994 date.

The uncertainties in the schedule are exacerbated by a number of technical problems that were very resistant to solution. These have included calibrating the images, finding an "ideal" camera (*i.e.* a technically suitable square-pixel camera), producing a low-noise stable laser system, and finding a suitable modulator for the the magnetograph. The additional time spent addressing these problems has delayed the development of a number of other desirable, though lower priority, items. These include a 5-Ångstrom filter monitor, a scheme for compensating for a timing bias in images taken near the horizon, and a higher level of automation for the turret to respond to various environmental conditions, beyond merely acquiring the Sun in the morning, tracking it through the day, and shutting down in the evening.

For the past several months the Project has been engaged in a very detailed re-planning process directed at understanding the impacts of both the funding and the development issues, and the alternative responses. The objective has been to develop a program that will provide the earliest possible fielding of the complete network of robust, scientifically acceptable instruments.

Assuming level funding in FY 1993 and FY 1994, this plot shows the differences between the actual/projected cumulative funding and that required to support the December 1993 and December 1994 plan options, respectively. Note that this funding is $400K short of even the December 1994 plan requirements.

In one scenario, it was assumed that the requested funding profile for 1993 and 1994 remained intact. This scheme shows that the June 1994 date might still be achievable if the following changes were made in the scope of the instrument:

- Rectangular-Pixel Camera
- No Magnetograph
- No Laser
- No Timing-bias Correction
- No 5 Å Filter Monitor
- Limited Automation

This approach sidesteps the development delay by canceling further work on features or systems that remain unfinished at this point. Unfortunately, this appears to be a plan without much slack. Any further perturbations would likely delay the network completion date beyond June. Obviously such descopes will have an impact on the scientific capabilities of the instrument and these impacts were discussed vigorously at various scientific team meetings in Boulder. The Project received many useful thoughts about these issues and they were considered carefully before the descope decisions were actually made.

Other actions to expedite network deployment are also being considered. Among these are reducing the time devoted to testing, burning in, and certifying the field instruments before deployment. In the current plan, there are several levels of quality assurance, including tests at the board, mechanism, subsystem, system, and fully-integrated levels. It is possible to curtail or skip some of these steps. Similarly, the plan calls for two months of daily operations for each instrument in Tucson before it is dismantled and shipped to its field site. This period could be shortened.

This plan is devoted to the notion that, in the end, the fielded system will be much more reliable, field outages that might compromise the whole network will be shorter, and the network will be far less expensive to maintain, if we pay considerable attention to making sure that the start-up problems have been cured and each system works correctly before it is deployed. It is the Instrument Team's position that any shortcuts taken in the quality-assurance area be very carefully considered, lest they have serious impacts on the scientific efficacy of the system.

In some sense, the issue may be moot. If the funding profile is not maintained, then a deployment delay is inevitable in any case. Since this looms as a very real possibility, the option of taking the extra time and limiting the descopes is also a reasonable prospect. This would strengthen the capabilities of the instrument at the expense of time that really could not be recovered anyway. It should be pointed out that since a six-month delay, back to the December 1994 date, would provide access to three months of FY 95 funds (the Project is funded annually from October to September), this could be used to cover at least some of the funds shortfall.

The real choices will be clear in the next several weeks when the Federal budget comes into sharper focus. In the meantime, the Project is working vigorously to expedite the conclusion of the production, and the deployment of the field stations. The final configuration of the instrument has been frozen, included some, but not all, of the potential descopes mentioned earlier (see the instrument report for details). Network deployment strategies have been devised for both the June 1994 and December 1994 full network operations dates (see below).

We believe that the average deployment time for a station will be about one month. There will be two different teams each doing the "rough" installation of three stations, and one team that will do the final alignment and certification for operation.

The teams will alternate in the field so that the unavailability of any one person will not obstruct an installation; that skill can be borrowed from the other team. Similarly, if a particular installation runs into trouble, as much as two months can be devoted to it without delaying the overall schedule.

The order of the first two deployments is driven by logistics, training, and merging considerations. The California site is the physically closest site to Tucson and it will represent a first "baby step" deployment effort. Supply and communications lines are shortest here. It will represent a training exercise for both teams under fairly controlled circumstances.

Moreover, the prototype instrument will be in daily operation in Tucson. As soon as the Big Bear instrument comes up, the *DMAC* team will have its first access to real data to test and practice merging. The Hawaiian installation represents the next logical extension of these same philosophies. Here the testing of three-site merging will become practical. The balance of the deployment order is based on expectations of seasons and weather:

January-June Deployment

Jan	California	Winter	A
Feb	Hawaii	Winter	B
Mar	India	Spring	A
Apr	Chile	Fall	C
May	Spain	Summer	B
Jun	Australia	Winter	C

July-December Deployment

Jul	California	Summer	A
Aug	Hawaii	Summer	B
Sep	Spain	Fall	B
Oct	Australia	Spring	C
Nov	India	Fall	A
Dec	Chile	Summer	C

The A, B, and C identify conjugate longitude pairs. One can begin to approximate a network when at least one set of conjugate pairs is operational. In the two options above, this happens after the deployment of the third station in each case.

The decisions on schedule, scope, and budget will be made by the Project in consultation with the Scientific Advisory Committee and the Science Team leaders during the Fall, as hard fiscal information becomes available.

Jim Kennedy

Data Management and Analysis Review

Report of the DMAC Review Panel

The *GONG DMAC* Review panel, comprising Ron Allen, Tim Brown, Dick Grubb, Gareth Hunt, Tuck Stebbins (chair) and Roger Ulrich, met at the National Solar Observatory in Tucson May 25 and 26, 1992. The panel members had previously received a reference document, entitled "GONG's DMAC: System Development Plan Review" (*GONG* Technical Report #92-1). The panel heard presentations from *GONG* Project members about *DMAC* requirements, development and plans. A computer system solution was described and costed. The panel's report consists of a response to each of the three parts of its charge and a set of recommendations.

By their very nature, reviews of this sort concentrate on tasks not yet completed and on suggesting changes. However, we wish to acknowledge at the outset the accomplishments and progress of the *GONG* Data Team. The task of building the *DMAC* is closer to the end than to the beginning. The Project has extensive experience with Exabytes, the medium underlying the whole enterprise. Prototype software for most of the processing is in hand. Data from breadboard and prototype have been reduced. Several novel algorithms have been developed along the way: calibration of the instrumental idiosyncrasies; a new method of radius and *MTF* determination; the spherical harmonic transform is no longer the overwhelming computational burden it was once thought to be; the merging of synthetic data has been demonstrated; and a unique peak-finding algorithm has been developed. The design and construction of the *DSDS*, the final component of the *DMAC*, has begun. A competent and professional staff has been assembled.

The problem of *GONG* data processing and storage has been sized, and a comprehensive plan is in hand. The baseline system appears to be implementable within the budget. We commend the Data Team for these achievements.

Response to the Charge

"Will the planned system provide an optimum solution for achieving the project's objectives in a cost effective manner?"

The panel endorses a distributed computing system similar to Plan A described in the document. Such a system has the great strength of extensibility by increments which have the performance and price available at the time of purchase. This, together with the interoperability of software on *UNIX* systems, gives the Project the flexibility to respond to changes in the marketplace and avail themselves of the latest technical advances. However, we suggest a couple of modifications: the *DMAC* should have one machine function as a server of common software to all others to reduce management costs as a benefit of the network interconnections (see the Recommendations Concerning Software Engineering below); and a single vendor should be chosen, if at all possible. If vendor change is dictated during the lifetime of the project, the Project will have to sustain the costs associated with migrating software to another architecture at that time, but need not incur that cost before, nor bear the burden of supporting multiple platforms, possibly unnecessarily.

The Project's objectives, as stated in section 2 of the reference document, are likely to be met by a distributed system, but whether such a system will satisfy the expectations of the science community is not clear, since, as demonstrated by discussions during the panel meetings, those expectations are not well known. See Recommendations Concerning Community Involvement below.

"Will the planned system accommodate the development of the currently undefined components of the system?"

At the level of the baseline *DMAC*, some of the undefined components (cf. section 3 of the reference document) are in fact defined. The instrument calibration is, or has been, successful. It isn't yet known whether recent instrument changes have rendered it unsuccessful. Image restoration is not part of the baseline PIPE, but is currently considered an enhancement. The baseline PIPE includes a multi-site merge that appears to work.

The panel notes with satisfaction the high priority given to bringing the computational requirements of the mode frequency identification algorithm within the reach of affordable computers. The expandability of a distributed architecture assures that processing power can be added to the extent affordable. This component is rendered "undefined" not for want of an algorithm, but rather because of a conflict between cost and budget. What is needed here is an alternate algorithm demanding less computational power — a situation not likely to be incompatible with the recommended plan.

The panel regards automatic bad image identification and rejection as necessary to the success of the *DMAC*. This algorithm should be part of the baseline system, and its development should be accorded appropriate resources. We note the preliminary reports of some early progress. We suggest that the data acquisition system at the observing sites might aid in the identification of bad images.

"Will the planned system provide a flexible basis for the evolution of computer systems, enhancement of data reduction algorithms, and improvements to the observing instrument throughout the lifetime of the project?"

A distributed system with affordable computers, running *UNIX*, does provide a flexible basis for expanding the *DMAC*, or migrating the system to another hardware platform if that should be desirable. [See the Recommendations Concerning the Data Storage and Distribution System for a suggestion concerning evolution of the system from operator mounted tapes to a robotic carousel.] Likewise, the distributed system admits expansion for algorithm improvements. Note, however, that the prototype nature of the *DMAC* demands a scheme for managing the evolution of the software. Our recommendations are found below in the context of suggestions for software engineering. We also make recommendations about augmenting the functionality of the *DMAC* below in the context of community interaction.

We believe that the project would benefit from the development of a prioritized list of possible enhancements to the *DMAC* baseline, in which priorities reflect both desirability and cost (see Recommendations Concerning Community Involvement below).

We don't know enough about possible improvements of the observing instrument to assess whether the planned architecture structurally impedes adaptation of the *DMAC*.

Recommendations Concerning Community Involvement

The committee notes that the *DMAC* team does not appear to have a mechanism for feedback from the *GONG* user community which is sufficiently frequent to be of effective use in guiding the development of the *DMAC* project. The lack of frequent and effective feedback means that a heavy burden of responsibility is put on the *DMAC* group to make cost and schedule decisions which accurately reflect the priorities of the helioseismology community, and conversely exposes the development group to bear the full brunt of mistakes in that process. On the other side, the *GONG* user community is not currently intimately involved in the necessary cost-schedule tradeoffs occurring in the present *DMAC* design process, and therefore may well find that the resulting product is, in the end, not

Yet Another Newsletter

The δ Scuti community has a newsletter edited by Michel Breger (breger@avia.una.ac.at). It contains abstracts of papers and other newsworthy items that many of our readers might well be interested in.

acceptable to them. The result is that both sides can lose. It is imperative to build a line of communication which ensures that the responsibility is shared. We view this as the most important advice we can give to the *DMAC* project at this time.

The committee therefore recommends that the *DMAC* leadership actively explore ways to involve the solar physics community in a more direct and frequent manner in the *DMAC* development process. As a possibility, we suggest the creation of a *DMAC* Users Committee consisting of perhaps no more than 4-6 persons who would meet with the *DMAC* development group in Tucson for perhaps a day every 3-4 months in order to review parts of the system in detail through *e.g.* hearing stand-up presentations and evaluating hands- on demos of the software. This Users Committee would be a subcommittee of the *GONG* Data Analysis and Reduction Team, would report back to that team on perhaps a yearly basis, and would have a mandate from the team to act on their behalf in matters pertaining to the development of *DMAC*. The project needs, and the Users Committee could provide, community input on the priority of the various science data products, the definition of the user interface, the priority of *DMAC* augmentations, and the nature and level of visitor support in Tucson. On the other side, this Users Committee can be seen by the *DMAC* development group as the sounding board from whom they may seek approval and support for the inevitable trade-offs which must be made during the development process, and as the body which shares the responsibility for those decisions.

Recommendations Concerning Software Engineering

In order to track the changes during the development of the project, we recommend that you adopt a Configuration Management system to maintain the code. We note that the *DMAC* code modules will not, in the normal process of events, be modified by more than one person. Nevertheless, the historical tracking of the software system may be extremely important later in the project. The configuration management should include

- archiving of any software change made to the production system
- inclusion of software release version numbers in the history
- information associated with the processed data

In order to facilitate future maintainability and to ease the reassignment of software personnel, we recommend that the project adopt a set of software standards. We note that coding standards exist for modules written in the *GRASP* system. We recommend that similar coding standards also be applied to all other software. These include

- selection of a programming language
- selection of a common *UNIX* shell
- coding standards for the selected language(s)
- code documentation standard and documentation extractor(s)
- peer review of code submitted to the system

We suggest effort be devoted to isolate implementation specific *UNIX* operating system and shell dependent functions into specific libraries. This will ease the conversion effort required to move the code from one *UNIX* hardware platform to another, should this become necessary.

We strongly recommend that you use a configuration of workstations to minimize the personnel cost of system management. Where possible the operating system, system utilities, and other common general purpose software should be centrally installed and maintained. Although we recognized that several different architectures may be necessary, we recommended that you limit the number of different architectures where possible. System management tools vary considerably between different architectures.

Recommendations Concerning the Data Storage and Distribution System

The committee recommends that several steps be taken to minimize the risk of human error in handling the Exabyte tapes, both to prevent loss of data due to mistakes in mounting tapes and to prevent actual physical damage or loss. Specifically:

Physical labels for both the tape and its container should contain the Volume ID number in bar coded form. The use of bar code readers at the library checkout then guarantees correct entry of transactions into the catalog data base and facilitates searches for a tape which has been physically misplaced in the storage system.

When the tape is originally certified and issued an ID, this number should be recorded in an ID block at the beginning of the tape. If each stage of the processing then registers tape use with the catalog, this will permit automatic tracking of the tapes through the pipeline and independent verification that the correct tape has been mounted at each stage.

To avoid original data tapes becoming misplaced or damaged it is suggested that their movement be restricted to as small an area and as few locations as possible. One possibility is that all data be transferred electronically from a single server with multiple Exabyte drives adjacent to the library. This would essentially emulate a robotic carousel using a human tape

GONG Papers Submitted for Publication

E. Anderson, Gap Filling the ***GONG*** Data Set
R. Bogart, F. Hill, ***et al.***, Artificial Data for Testing Helioseismology Algorithms
J. Harvey, F. Hill, J. Kennedy, and J. Leibacher: "***GONG*** Project Update"
S. Korzennik and S. Sabbey: Measurement of the Phase Relation Between Velocity and Intensity Fluctuations Induced by Solar P-Modes from ***GONG*** Breadboard Data
D. Hathaway: Doppler Measurement of the Solar Meridional Circulation
J. Pintar and M. Trueblood: ***GONG***'s ***DMAC***: Update and Current Plans
C. Toner and S. Jefferies, Accurate Measurement of the Geometry for a Full-Disk Solar Image and Estimation of the Observational Point Spread Function
W. Williams, F. Hill ***et al.***, Tests of Simple ***GONG*** p-mode Merging Algorithm

operator. This would facilitate later conversion to an automatic system, and we recommend that the project keep this possibility in view as affordable robotic systems are likely to become available in the future. Another alternative, given that the pipeline processing will be remote from the main library, would be to set up a separate staging library for the tapes in use by the pipeline adjacent to the processing area and provide for local access to the catalog data base. The necessary transfers from the staging library to the main library could then be made more infrequently in bulk and under more formal control than would be the case for frequent individual tape movements.

Recommendations Concerning Personnel

We are concerned that the planned personnel level is not adequate to deal with contingencies. The plan is configured primarily to manage the ongoing reduction of the incoming data from the network. The operational personnel seems about right to keep up with the incoming data. However, we feel that there will almost certainly be substantial sequences which will need to be reprocessed to utilize improvements in data reduction algorithms. Experience with other large astronomical databases from projects like *GONG* indicates that the initial reduction methods are invariably not the best that can be done. In this case the full utilization of the database will require a complete re-analysis of the data which was reduced prior to the improved algorithm. Re-reduction of substantial portions of the database could also be required if, for example, difficulties in the data merging — the most novel aspect of the *GONG* project — were discovered after some time period. Because of the probability of such contingencies, we feel it is likely that the personnel for the operations has been underestimated.

We recommend that likely contingencies be analyzed to determine their impact on *DMAC* operations, especially on staffing. Past experience with the processing of breadboard and prototype instrument data might illustrate where on the data processing learning curve the Project is and what personnel resources might be called for.

The personnel assigned to the development of new algorithms drops from nine to four after the start of network operations. We regard continued development as an essential ingredient of a scientific study where many tasks are poorly defined prior to the operation of the experiment. The prototype nature of the *DMAC* and the scientific importance of the augmentations already being considered (*e.g.* peak-finding on the full power spectrum, low frequencies, steady flows) suggests that higher development staffing be considered. This shortage would be exacerbated if the development personnel must also support the above mentioned contingencies.

While students will be adequate for some routine production work, the pressures associated with normal course activity may introduce undesirable schedule irregularities in their availability. Long term operators will also develop experience with appraising incoming data and intermediate data products which will likely be crucial to the operation of the pipeline. A core of professional operators may be more appropriate for the pipeline reductions with the student operators used in a flexible backup role. This will allow participation by students in the *GONG* project without necessarily making them responsible for performing time-critical tasks. We recommend that a substantial fraction of the *DMAC* operators be professional operators as opposed to student operators.

Project Response to the Recommendations from the DMAC Review Panel

The plan for the *GONG*'s DMAC was reviewed by a panel of outside experts on May 25 and 26, 1992. The project was gratified by the contributions of the panel; in particular, by the scope and depth of their inquiry, and we are pleased that the panel felt that the plan will satisfy the requirements and objectives of the project. In addition, the panel has offered several useful suggestions that will significantly improve the project. Below is a list of the recommendations (in italics) ex-

Data Requests

The following *GONG* members have received data:

David Hathaway — Meridional Flows
Sylvain Korzennik and Bob Noyes — Velocity-Intensity Phase Relations
Roger Ulrich and John Beck — Signatures of Magnetic Active Regions

tracted from the Panel's written report followed by the project's response to each item.

A single vendor should be chosen, if at all possible: The project agrees that a homogeneous hardware environment offers many advantages and has begun the process of selecting a single vendor.

Develop a mode frequency identification algorithm within the reach of affordable computers: A mode frequency identification algorithm capable of operating at cadence on affordable equipment is a requirement for the baseline system. A high level of priority has been attached to this objective.

Include bad image identification and rejection in the baseline system.: The project agrees with the importance of this objective and will automate the identification and rejection of bad images to the degree possible.

Actively explore ways to involve the community in a more direct and frequent manner in the DMAC development process: There are many project issues that can only be answered through dialogue with the *GONG* community. A formal users' committee will be a very effective means for the the project to obtain concrete input from the scientific community regarding these issues. The project will promote and facilitate the creation of a permanent users' committee.

Employ a configuration management system including the archiving of old versions, version numbers in the process histories of the images, and processing parameters in the process histories of the images: This recommendation will be implemented. Before 1992, the project had assembled and released a version of the project's software packages inside *IRAF*. The project will return to this practice. The desirable features of these "released versions" are that the process of assembling the release controls the proliferation of development code, the obsolete releases are routinely retained, and the project has a well-documented procedure for the assembly of the release. In the near future, the project will take several steps to record time stamps and processing parameters more systematically. For the non-*IRAF* part of the system, *SCCS* is being evaluated as a mechanism to track and control source code and compilations.

Establish consistent software standards: select a programming language and a UNIX shell, isolate OS and shell dependencies, establish coding standards, provide code documentation extraction, and peer review of code submitted to the system: Currently, three compiled languages: *FORTRAN*, *C*, and *SPP* (*IRAF*'s compiled language) are used for the image reduction applications. This is consistent with the recommendations of the Pre-Alpha Design Review (1990) and with past expressions of opinion from the community. The compiled language for the field tape reader and *DSDS* is *C*. In the near future, the project will select a *UNIX* shell. We agree that it is appropriate to begin introducing commonly accepted software quality practices. In particular, the project will begin using peer reviews to help ensure the quality and consistency of the code and related products that the *DMAC* produces.

Centralize workstation administration: At the start of network data reduction, the project will have two people who will share responsibility for system administrative tasks (assuming that the transition to a homogeneous environment will be completed).

Use bar-coded volume serial numbers and a bar-code reader and put a machine readable, tape label on the cartridge as part of the cartridge conditioning and initialization process: The project is actively investigating both of these suggestions. It is likely that both will be implemented. A bar-code reader will be purchased and evaluated in the near future.

Minimize the movement of original data cartridges throughout the physical space occupied by the DMAC: The project has several options that can be pursued to enhance the physical security of the cartridges in the data storage facility. These range from changes to the computer system plan to methods of restricting physical access to the facility. The project agrees that improved physical security is needed and is currently evaluating the available options to develop a solution that will be effective in terms of cost, security, and performance.

May need more processing personnel to deal with the possible need for reprocessing and more personnel to provide for ongoing development: The implementation of this recommendation will depend on the level of available funds for salaries and computer equipment and will likely require that the project request additional funding from the *NSF*. The project will not pursue an increase in the *DMAC's* budget now; however, this possibility will be factored into out-year budgets.

Use professional operators rather than student operators: We agree with the Panel's recommendation that the extensive use of student operators would likely be counter-productive. Savings in salary would be lost to lower production associated with frequent training of new employees and constant reassignment of tasks to accommodate students' academic schedules.

Team Reports

The six *GONG* teams met during the "*GONG* '92" meeting, and here are their reports.

Data Reduction and Analysis

The following issues were discussed in the Data Reduction and Analysis Team meeting: the baseline pipeline, merging, the database and data catalog, the Data Management and Analysis Center (*DMAC*) Review Panel and the *DMAC* Users Committee (*a.k.a. DUC*). Tuck Stebbins opened the team meeting with a call for input from the community to *DUC*.

A discussion of the baseline pipeline arose spontaneously following the *GONG* Project Update session as a result of Frank Hill's report of Project activity in the previous year and the solicitation for *DUC*. One outgrowth of the discussion was a concern with peak finding using *m*-smoothed spectra. [This choice in the baseline software reflects the fact that *m*-independent peak finding requires more computational capacity than the Project can afford, and maintain cadence.] A Peak-Finding Subteam was spontaneously formed by Ed Anderson, Jørgen Christensen-Dalsgaard, Sylvain Korzennik, Phil Stark, and Jesper Schou to investigate alternate algorithms which preserve *m* information and are compatible with processing resources.

The Project has successfully merged artificial data. Dave Hathaway generated solar velocity images with a variety of solar velocity fields. Tim Brown contributed a code to degrade those images into network images with realistic noise models. Winifred Williams, Cliff Toner and Frank Hill then extended Tim's software and successfully merged the data with a simple averaging algorithm. These results were reported in poster paper #7-3. Tim has experimented with other merging algorithms on artificial asteroseismology data, reported in poster #7-5. He concludes that simple data-averaging is better than other methods, except a good data window, which is best.

Mark Trueblood gave a presentation on the user interface and structure of *GONG*'s Data Storage and Distribution System (*DSDS*). He described how queries will be formulated and how requests for data will be presented. There followed a discussion of the pros and cons of making engineering and data quality information available to the users. In the baseline plan, the Project does not have this information in the user-accessible database. Vicki Johnson showed a mock-up of the user interface for the *SOI* database. The graphical user interface includes information about the spacecraft, observing campaigns, and operations, and it supports graphical presentation of some data parameters and data requests.

In May, a *DMAC* Review Panel was asked to review the progress of the *GONG* data reduction effort and future plan. Frank Hill summarized the review process in his presentation as part of the *GONG* Status Report. A background document, a Panel Report and a Project Response have been compiled, and are (or soon will be) available for distribution to interested member of the *GONG* community. Contact Frank Hill at *NSO* for a copy.

One outgrowth of the *DMAC* Review Panel was a Users Committee, to meet three or four times per year in Tucson. The purpose of the committee was to act as a conduit between the *DMAC* development group and the *GONG* community. The Committee was intended to advise on cost/schedule decisions in a manner which reflects community priorities and to ensure that the resulting product is acceptable to the community. The current membership of the group is Tuck Stebbins (Chair), Tim Brown, Jørgen Christensen-Dalsgaard, Todd Hoeksema and Roger Ulrich. Members will serve either two or three year terms to provide for rotation and continuity. Members of the greater *GONG* community are encouraged to voice their opinions about the *DMAC* to *DUC* members.

Tuck Stebbins

Models

1. Introduction.

There has been little organized Model Team activity since the previous *GONG* meeting. Hence, the status of the models comparison project is unchanged and as described in *GONG Newsletter* No. 17: very decent agreement has been found between the results of four independent calculations of models with simplified physics, indicating that there are no significant numerical problems in these calculations. These results should ideally be collected in a publication wrapping up this part of the project, and defining a simple reference with which other independent calculations could be compared; that this has not happened is solely due to the inefficiency of the team chairman responsible for this comparison project. In addition, there have been comparisons between calculations using realistic physics, again indicating overall good agreement.

Much activity has been concerned with computing solar models and oscillation frequencies with the recent *OPAL* opacities from Livermore (*e.g.,* Rogers & Iglesias 1992). A review of some of these results was given by Mike Thompson at the *GONG* meeting. Dziembowski, Pamyatnykh & Sienkiewicz (1992) found that using

OPAL opacities resulted in a striking improvement in the agreement between the model sound speed and the sound speed resulting from inverting solar data. Subsequent improvements in the *OPAL* opacities, particularly the adoption of a revised iron abundance, has increased the discrepancy somewhat, however. A second area of substantial activity has been investigation of the diagnostic potential of the phase function $\alpha(\omega)$ arising in the Duvall law for the asymptotic behaviour of acoustic-mode frequencies. This is particularly relevant for investigations of the equation of state in the hydrogen and helium ionizations zones, and for determinations of the envelope helium abundance (see Christensen-Dalsgaard & Pérez Hernández 1992; Vorontsov, Baturin & Pamyatnykh 1992). A detailed investigation of the ability of determining the envelope helium abundance from helioseismology, given the uncertainty in the equation of state, was carried out by Kosovichev *et al.* (1992). Although the uncertainties are substantial, the results generally indicate an envelope helium abundance Y_e by mass of 0.23 - 0.25, somewhat lower than the value of the initial helium abundance Y_o of about 0.27 required to calibrate the models to have the correct present luminosity.

It has come to be realized that diffusion and settling may play a significant role in the Sun. Proffitt & Michaud (1991) made a careful comparison of different formulations used to treat these processes. They concluded that as a result of settling the present value of Y_e would be reduced by 0.03, relative to the initial value Y_o. Including weak turbulent mixing beneath the convection zone would reduce this decrease somewhat; however, if the mixing is constrained by restricting lithium and beryllium destruction to be consistent with the current observed surface abundances, there remains a decrease of Y_e of about 0.02. Very similar results for the basic diffusion (neglecting possible turbulence) were obtained by Bahcall & Pinsonneault (1992); they also pointed out that as a result of diffusion the depth of the convection zone of the model is increased, to match quite closely the value determined from helioseismology. It should also be noted that difference between the present Y_e and the initial Y_o may account for the discrepancy between the helioseismically inferred helium abundance and the value required to calibrate the models. Very recently, Christensen-Dalsgaard, Proffitt & Thompson (in preparation) have found that inclusion of diffusion, using also the most recent *OPAL* opacity tables, results in good agreement between the sound speed in the model and the solar sound speed inferred from inversion of observed frequencies.

During the *GONG* meeting a special joint discussion was held of the Model and Inversion Teams. Here the model-related discussion centered on the provision of reference solar models for the *GONG* project. One such model, computed by R. K. Ulrich, has been available for some time. JC-D offered to make available a recently computed model, using up-to-date *OPAL* opacities and a thermodynamically consistent implementation of the Coulomb correction to the equation of state. This model was computed with 1201 mesh points, and hence should be numerically quite accurate; it has the further advantage that the underlying evolution code has been tested through the comparison of models with simple physics. The model would be provided together with a program for computing adiabatic oscillation frequencies and eigenfunctions, to allow setting up the kernels required for, *e.g.*, rotational inversion. It is hoped that this package will be ready by the end of the year.

There was a very interesting discussion about the most suitable form for such a model, and the possible uses of it. There is a strong advantage to have a single accepted reference model on which, *e.g.*, inversions are based; in this way a unique meaning can be assigned to resulting differences between the Sun and the model. It may be less important that the model is “right”, in the sense of providing the best possible fit to the data, although it should of course be based on the best possible current physics. Indeed, given the uncertainty in the treatment of the superficial layers of the Sun, perfect agreement between the computed adiabatic oscillation frequencies and observed frequencies would almost have to be spurious, resulting from a cancellation of errors. (It should be recalled that such uncertainties give rise to an error in the computed frequencies which, when properly scaled, is a function of frequency alone; *e.g.*, Christensen-Dalsgaard & Berthomieu 1991). This might argue for using a model with very good and well-defined physics, but with no attempt to adjust parameters to improve the fit to the observations. On the other hand, for application of the model to inversions, this argument may have to be reconsidered. Insofar as the interior of the model is concerned, it seems plausible that current realistic models are sufficiently close to the Sun that linearized structure inversion would be adequate, regardless of the details of the model. However, the uncertainties at the stellar surface introduce phase shifts in the eigenfunctions, and hence in the kernels, which could lead to systematic errors in the inversions. This clearly applies also to inversion for rotation, or other properties of the solar interior not directly related to the spherically symmetric component of structure. To avoid problems of this nature it might be preferable to adjust the model such as to minimize the effects of the surface uncertainties. This can in fact be achieved through artificial changes in the surface opacity. It might then be tempting also to “improve” the reference model in the interior, through further opacity modifications, in order to reduce further the differences between observations and theory. The drawback of such a procedure is evidently that the model becomes more difficult to define precisely and to reproduce.

These issues were not resolved at the meeting, and hence further discussion is needed. One problem that requires immediate attention is the effect of model uncertainties on the results of, for example, inversion for rotation. Christensen-Dalsgaard and Gough (1984) made experiments of that nature, by setting up artificial data based on one solar model and inverting them with kernels computed for a rather different solar model. The conclusion at that time was that the uncertainty in the model had little effect on inversions based on five-minute modes; but the question probably has to be reconsidered, given the improved precision of the observations and the resulting change in standards. It might also be noted that Christensen-Dalsgaard, Gough & Thompson (1991) and Kosovichev *et al.* (1992) found certain aspects of the structure inversion to be rather insensitive to the choice of reference model, over a substantial range of such models. Again, there is a need for more systematic investigations, however.

My current inclination would be to provide two reference models: one with no artificial modifications, and one where the atmospheric opacity has been increased artificially to eliminate as far as possible the frequency-dependent part of the difference between observed and computed frequencies. Diffusion would not be taken into account: although undoubtedly significant, it is still a somewhat "non-standard" feature, and furthermore there is considerable uncertainty about the detailed description of turbulent mixing beneath the convection zone. Speedy comments on this suggestion would be much appreciated.

Jørgen Christensen-Dalsgaard

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Inversions

Approximately 30 enthusiasts attended the meeting of the Inversion Team, which was chaired by Juri Toomre, one of the team co-leaders. Douglas Gough, the other co-leader, was unfortunately unable to attend the meeting.

During the past year, some effort has been directed towards the production of standardized user-friendly inversion software packages. These packages will allow new workers to quickly gain the ability to invert helioseismic data. Jørgen Christensen-Dalsgaard, Jesper Schou, and Mike Thompson are developing an *IDL*/X-windows-based package that was available during the *GONG* meeting for hands-on demonstrations. This package performs a smoothness-constrained least squares inversion. It is expected that this software will be publicly available when development is complete, and that it will eventually be integrated into the *SOI SSC*.

John Brown brought the existence of a journal exclusively devoted to inverse theory to the attention of the Team. The journal, titled *Inverse Problems*, is eager to publish more astronomical applications of inverse theory, and is planning a special issue on astronomical inverse problems in the next year or so. John, a member of the editorial board of the journal, encouraged the Team to submit papers and/or volunteer to contribute to the review issue.

As some of the more senior Team members may recall, last year the Team planned to coordinate a two-dimensional Hare and Hound exercise. For various technical reasons, this exercise did not take place last year, but it is now ready to begin. Interested parties will be able to find instructions for the exercise below.

Frank Hill

Magnetic Effects

Jack Harvey queried the members of the Magnetic Effects Team as to their view of the consequences of the *GONG* decision to take only one magnetogram per site per hour. The team was re-assured by his statement that more frequent magnetograms would be be possible during "campaigns". Doug Braun emphasized that the magnetograms could be used with p-mode data to study acoustic power deficits proceedings the emergence of active regions.

Bernie Roberts reminded us that a similar comparison of data would be useful in studying p-mode frequency changes induced by magnetic fields. This could be particularly useful for the study of the structure of the atmospheric canopy field. Ted Tarbell pointed out the surprising result that the f-mode showed no frequency change between canopy and non-canopy (weak field) regions. This result certainly merits further study. Roger Ulrich argued for the highest possible quality magnetograms.

Phil Goode

Mode Physics

Approximately 40 people attended the meeting of the Mode Physics Team. This team has not been as active as its importance deserves during the past two years since it has had no leader. This year's meeting was a reflection of that problem. Once again the meeting was chaired by the *GONG* project liaison, Jack Harvey. One of the main agenda items was to find a new leader for the team. Happily, after the meeting, Roger Ulrich volunteered to do this job in addition to his many other activities in the *GONG* project.

The meeting began with a review of the previous team meeting in Tucson (see *Newsletter* 17). Most of the remaining time was spent discussing the impacts of removing some features from the *GONG* instrument and the data reduction pipeline. Jack Harvey presented the list of potential instrument changes in the form of pro and con arguments from a scientific perspective. These issues are discussed in some detail in the Instrument Update elsewhere in this *Newsletter* and will not be repeated here. The team was most concerned about lack of magnetic field information in helping to understand the physics of how modes interact with surface and submerged magnetic field structures. This discussion was taken by the project as advice to maintain a magnetograph capability. Another issue that received a lot of discussion was the need (or not) for square pixel geometry and the related need for tracking of the rotating solar image. That discussion did not produce a clear consensus of advice to the project.

The final discussion of instrument changes centered on the effect of long-term drift of the velocity zero point on mode frequency measurements. In the absence of a reference laser, there was concern about how data will be merged from one site to another, and how low frequency oscillations and slow flows might be degraded. It was agreed that short period oscillations (*i.e.* p modes) should not suffer from the loss of a stable reference signal.

Other instrumental issues were not judged to be obviously significant to the study of mode physics. There was concern about current plans to not process data for the study of low frequency oscillations beyond the production of temporal averages of the velocity data.

The meeting ended abruptly when the temporary chairman called again for volunteers to lead the team in the future.

Jack Harvey

[Editor's Note: Roger Ulrich very kindly volunteered to chair the Mode Physics Team after the Team Meeting, and he has contributed the following report.]

I am happy to accept the additional responsibility for this area of study since I believe there are a number of important questions yet to be answered related to mode physics. Sample problems include: the energy flow through the modes, the effects of magnetic fields and spectral line formation in the presence of various oscillation velocities and temperature fluctuations. I would like to thank Jack for his temporary service in leading this group along with his very substantial duties as the principal magician in making the instrument work. We as a community have the responsibility to contribute to the scientific analysis so that when the network begins operations, we will quickly derive enough exciting science to support the case for a extension of the time coverage. Although the mode physics problems are not the core objectives of the *GONG* program, there is nonetheless a high probability of exciting discoveries here. We need to be ready with the right tools to make these discoveries early.

Specific questions:

Can we used phase relations between the amplitude modulation parameter, intensity and velocity to learn about energetics?

Can we plan co-ordinated high time rate coverage between the *GONG* instrument and a magnetograph to study MHD problems on selected areas of the solar surface?

What work is available on the full time-dependent line transfer problem in the presence of waves and oscillations?

I will be happy to facilitate discussion of these and related questions by e-mail or other means so that we can have a productive team meeting next spring.

Roger Ulrich

"Low & Slow"

[Editor's Note: The Low Frequency Team and the Nearly Steady Flows Team met together as in years past. They have filed this joint report.]

Our discussion focused on several proposed *GONG* descope options that impact the science goals of the teams.

Elimination of Stabilized Laser

The basic problem is that laser calibration is less constant than the solar calibration, at least on the short term. This probably has the greatest impact on the low frequency investigations and is a serious problem, but hopefully not lethal. It is probably worth keeping the laser calibration even with a higher noise level, to monitor long term trends in the instrument.

Elimination of Camera Rotation

While everyone would prefer square pixels, there seemed to be no fundamental objection to rectangular pixels, at least in the absence of image rotation. Having a rotating image introduces several sources of uncertainty and may simply push the difficulty from hardware to software. There was a strong consensus that the camera should rotate.

No Magnetograms
Everyone would lament the loss of the magnetogram dataset. This is in part because of its intrinsic value and in part because it is uncertain whether modulation and intensity data alone can be used to construct an adequate proxy. This question should be studied. Even if the blotches, fringes, and digitizing errors can not be solved completely, the group felt that *MGM's* should be produced on a best effort basis.

No Measurement of Distant Scattered Light
While not of photometric quality, most people felt that near Sun measurements of the scattered light in the corners of the *CCD* should be sufficient for determining the scattering kernel. This will eliminate the need for a mechanism and shorten the hourly calibration procedure.

No Processing of Low & Steady Pipeline Past Production of 10 Minute Site Images
Time constraints are limiting the amount of effort programmers can spend on the non p-mode analysis. While people are disappointed that more fix cannot be done, this does not present an insurmountable obstacle. Efforts should be made to push the processing as far as consensus permits. This might include image restoration (see below) or more. Perhaps the team should volunteer to develop a consensus method for the other analysis steps — *e.g.* limb figure, rotation removal, remapping, *SHT* analysis and so on. 10 minute averages will have to be constructed from registered single site images. Averages should be gaussian averages constructed from 20 minutes of data on 10 minute centers (for p-mode detrending as well). Enough information characterizing the images must be readily available so that investigators can perform a reasonable merging of the data. The merging can probably be left to individuals [editorial comment — I think *GONG* will want to have at least one standard merged data set].

No Image Restoration
While cut with the rest of the pipeline analysis, this should probably be done to the 10-minute averages. The program exists and is probably fast enough for the reduced cadence data sets. This may affect the discussion of item 5, above, but probably not.

No Merge
This is most critical for low frequency analysis. Most people at the meeting seemed comfortable developing their own merging strategy. It is important that data quality information be easily available so intelligent merge decisions can be made by anyone reducing data. The project will probably want to have a default merge algorithm for use in producing movies, synoptic charts, *etc*…

While not all of these descopes will be implemented and not all are irreversible, it is clear that the project does not have sufficient resources to do everything. We need to carefully evaluate the outstanding questions and provide feed back. Can we form a small working group to develop a consensus "pipeline" that is simple enough to implement?

J. Todd Hoeksema

DMAC Users Committee

The *DMAC* Users Committee had two meetings at the 1992 *GONG* Workshop, the first was an organizational meeting and the second was open attendance at the *DRAT* Meeting.

In the organizational meeting, Frank Hill, the *GONG* Data Scientist and *DUC* advisee, presented the Project's response to the *DMAC* Review Panel report. He also outlined major tasks which the *DMAC* programming staff will be working on in the near future. They are (not in prioritized order):

- A new release of *GRASP* in January 1993
- Support instrument development by processing prototype data
- Begin pipeline integration and quality control development
- Develop standard test data sets for validation of pipeline
- Continue development of: *DSDS* & User interface, merging algorithm, image restoration, efficient peak finding, image culling, and detrending

In the executive session that followed, the committee discussed its charge, its style, potential action items (*c.f.* the *DMAC* Review Panel Report) and a next meeting date and place, likely October 2nd or 9th in Tucson.

After screening the team meetings, some of the potential action items for *DUC* are:

- Priority of science data products, such as: magnetograms, further low frequency and steady flow processing (*e.g.* scattering correction and merging), *m*-averaged peak finding
- Impact of rectangular pixels and loss of image rotation and laser calibration on data products
- *DSDS* Interface: availability of engineering data and quality information
- Priority of *DMAC* augmentations, *e.g.* image restoration
- Interoperability between *GONG* and *SOI*

There were indications in the Low Frequency and Steady Flows, the Magnetic Effects and the Data Reduction and Analysis Team Meetings that subteams might form to address some of these issues.

The members of *DUC* solicit the greater *GONG* community for reactions to the Project's baseline plan. It's about 18 months to fielding of the network. Plans for the initial *DMAC* are firming up and the priorities for its evolution over its three year operating life are being decided. Contact a member of *DUC* today!

[Editor's Note: The *DUC* met in Tucson on

October 2, and will meet again on January 29.]

Tuck Stebbins

Time Series Interpolation Schemes

As is well known, at Birmingham we have oscillations data stretching back over many years and from various stations. Originally the level of automation was very low but as we have expanded the network we have greatly increased the automation. This has obvious advantages but also has disadvantages. One problem that we have had to face is that our clocks drift and we have had to interpolate the data to mesh data from different stations. This article will discuss the interpolation procedures and will leave for another occasion questions of the accuracy of synchronization and how we tell what the timing errors are anyway.

Interpolation involves using a simple function, of very low order compared with the number of data points, to estimate the value of a function between the existing sample points. I have tested three different interpolation functions: a simple parabola, cubic spline and a truncated sinc function. Interpolation, by definition, involves a degree of smoothing and can be expected to multiply the spectrum by something which changes both the amplitude and phase of the fourier components. There is a further problem that noisy data exacerbates the problem. The data on different days and from different stations need to be properly phased if they are to be transformed efficiently.

I tested the interpolating functions theoretically using digital filtering theory and have also interpolated data of various qualities. Some details are given below and there is an internal report which I am happy to send to anyone who wants it. However, the bottom line is that if you are interested in data in the upper half of the spectrum then neither cubic spline nor parabolic interpolations are adequate and a sinc function (truncated to 6 terms on either side of the centre) is better.

Residuals

Figure 1

Figure 2

To illustrate the point, consider the single day of data from Haleakala shown below (Figure 1). The graph shows the power spectrum as a function of frequency in microHertz. In order to investigate the effects of interpolation, I recalculated the raw data at

Figure 3

Figure 4

various offsets using the different interpolation schemes and then compared the fourier transform of the data with the fourier transform of the original set. I was interested in any changes in the computed power and any phase shifts which would present problems when I merged the data. Clearly, when I interpolate the data, I expect to see a linear phase shift due to the new starting position, so I have subtracted that from the data.

The next graph shows the phase errors in degrees for parabolic and spline interpolation for the Hawaiian data (Figure 2) and following that the same thing for a sinc function for artificial data (Figure 3) computed for different amounts of time shift in units of 1 sample. (Note that the sinc function is apodized an well as truncated). Even the sinc function does not give perfect reproduction but it is good up to 9 mHz. Notice too that the phase error tends to some extent to show structure where the spectrum itself is weak. The effect on the power is shown in the next 2 graphs. First is the parabolic and spline for artificial data (Figure 4) and then sinc function interpolated Hawaiian data (Figure 5, page 24). In these cases the power in the interpolated spectrum is divided by the power in the original spectrum.

Yvonne Ellsworth

Instructions for the Two-Dimensional Hounds

In 1988, the Inversions team of the *GONG* Project conducted a “Hare and Hounds” experiment. In this exercise, Douglas Gough played the role of “hare” by computing theoretical rotational splittings from a standard solar model and an underlying rotation curve that only he knew. The splittings and the corresponding kernels were then distributed to a pack of “hounds”, inversion enthusiasts who sought to correctly infer the unknown rotation rate. The exercise was a great success, and the interested reader can peruse the extensive report that appeared in the September 1988 issue of the *GONG Newsletter* (#9).

That first exercise was a one-dimensional problem, *i.e.* the rotation rate was dependent only on depth, and was independent of latitude. Matters have progressed, and the Inversions Team has just begun a new two-dimensional Hare and Hounds exercise in which the rotation rate varies with both depth and latitude. Recently, an e-mail message announcing the call to the hunt was sent to the potential players listed below. If you would also like to

Figure 5

participate, you may do so by following the directions below. Please also contact F. Hill if you plan to respond to the horn, so that we may be aware of your participation.

The list of potential hounds chasing the 2-D hare includes: R. Barrett M. Brodsky, J. Brown, J. Christensen-Dalsgaard, P. Goode, D. Gough, S. Horner, F. Hill, S. Korzennik, A. Kosovichev, E. Lavely, P. Milford, M. Ritzwoller, R. Rosner, P. Scherrer, J. Schou, T. Sekii, H. Shibahashi, P. Stark, A. Thompson, M. Thompson, J. Toomre, P. Wilson

The object of this exercise is for the Hounds to use the information provided by the Hare (Douglas Gough) to infer the two-dimensional rotation curve $\Omega(r, \theta)$ from the data. The Hare has constructed three files that contain the information provided to the Hounds.

`gong_csp_coarse.dat` contains the independent variable mesh, the density, and the sound speed in the solar model. The format is:

First line: number of points in the mesh (501)
lines 2-502: A counter I, the mesh *r/R* density (cgs), Sound Speed (cgs)

The total size of this file is 40587 Bytes.

`efkp_004_nomesh.dat` contains the eigenfunctions of 1380 oscillation modes. The data for each mode is contained in sections of 502 lines. The format is:

First line: ℓ, n, ν (mHz)
lines 2-502: ξ, η, L where ξ is the vertical component, η is the horizontal component of the eigenfunction, and $L = (\ell(\ell+1))^{1/2}$.

The total size of this file is 20,161,800 Bytes.

`splt_gong_20mar_noerrs.dat` contains the splittings for 69,662 modes. Despite the name of the file, normally-distributed noise *has* been added to the splittings. However, the Hare has decided not to provide the standard deviations of the noise at this time. The format of the file is:

First line: number of modes (69662)
lines 2-69663: ℓ, n, m, ν (mHz), β splitting (nHz), where β is the integral of the rotational splitting kernel for the mode.

The total size of this file is 3,134,796 Bytes.

The data has been placed on the *NOAO* anonymous ftp disk. To access this data, use the FTP utility with the following inputs:

```
host: robur.tuc.noao.edu or
140.252.1.10
ftp login:  anonftp
ftp password:  guest
cd gong
cd handh
get gong_csp_coarse.dat
get splt_gong_20mar_noerrs.dat
get efkp_004_nomesh.dat
bye
```

If you must use *NSI/DECnet* (formerly *SPAN*), the location is

```
noao::ga0:[ftp.gong], or
5355::ga0:[ftp.gong]
```
(*i.e.*, `ga{zero}.`)

The total size of the data set is about 23.3 MB; at a 56 kb transfer rate it should take about one hour to transfer. If you have absolutely no access to electronic transfer, contact Frank Hill with information on your desired tape medium.

If you plan to participate in this exercise, please notify Frank Hill at the above address. We anticipate that a comparison of results will occur at the 1993 *GONG* meeting. To facilitate and encourage this goal, we have set a deadline of February 15, 1993, for a progress report from all participating Packs of Hounds.

In order to directly compare results with a minimum of headache, we request that the results of your inversion be plotted on the supplied mesh in the radial direction, and on a mesh in θ of 251 points (250 intervals) evenly spaced in latitude from -90 to +90 degrees. The physical dimensions of the plot should be 15×15 cm (on transparency material). The data should be displayed as a contour plot, in units of nHz in a sidereal reference frame. There should be 11 contour levels (10 intervals) from 300 to 500 nHz. Note that these contour levels may be revised after the February 15 status report.

Frank Hill

Data Distribution and Publication Policy

I. Objectives

GONG is a collaborative project to make definitive helioseismic observations and to reduce, analyze and communicate the results. The basis for participation in the *GONG* investigation is through active membership in one, or more, of the *GONG* teams. This Data Distribution and Publication Policy is intended to encourage active participation and to ensure equitable recognition of contributions.

In order to achieve the full potential of *GONG*, we must ensure that a broad range of investigations is pursued by our distributed community. There will be no long-term exclusive rights to *GONG* data. For this to succeed, we must implement some elementary communication and review procedures, which encourage participation and do not stifle creativity. The following is intended to achieve this.

II. Data Distribution

II.A Data Policy

"The initial publication of the papers presenting the data, the methods by which they are acquired and processed, and the immediate scientific implications shall be authored by the Members of that Team directly responsible for the contents of the paper. The data shall be available solely to the Teams until these assessments are made within the first year, and thereafter the data shall be made available to any qualified scientist. The broad contents of the papers shall be determined by mutual agreement between the Teams to avoid unnecessary duplication." (*GONG* Membership Plan, § 4: Publication and Data Access. *GONG Newsletter* #3, December 1986) That is to say, data will only be available to active members of *GONG* for the first year following data availability, which will be announced in the *Newsletter* (and we anticipate on an electronic bulletin board). The Members will already have submitted a Membership application with their original scientific objectives.

II.B Data Request

Specific data should be requested from the project using a *Data Request Form* which includes descriptions of both the scientific objectives and the data requested. An activity will be assigned to a Team to assure that coordination and collaboration with similar investigations occurs. Provided that the applicant is an active member, the data request will be satisfied unless more data is requested than is appropriate for the proposed investigation. (We may be forced to prioritize the servicing of very large requests that tax the Data Storage and Distribution System's capabilities.) The "Scientific Objectives of Proposed Work" and "Data Requested" are intended to be 75 words or less, and they will be published in the *GONG Newsletter* (and we anticipate making them available electronically, as well).

II.C Progress Report

For an investigation to remain active, a brief (75 words or less) progress/activity report will be required for the *GONG Newsletter* every six months. Presentation of work in progress will be a major item of business of the Annual *GONG* Meeting and Team meetings. The intent is to share intermediate results, stimulate collaborative work where appropriate, and to avoid unproductive, competitive activities.

II.D Coordinating Committee

A Coordinating Committee, consisting of the Scientific Advisory Committee and the Team Leaders, will oversee the progress of the various investigations and encourage the principal data reduction and analysis tasks developed by the Teams. The Coordinating Committee will periodically review these policies.

III. Publication Process

III.A Notice of Intent to Publish

Prior to submission for publication or presentation of results utilizing *GONG* data, a brief "Intention to Publish" — essentially the paper's abstract — must be submitted, for publication in the *GONG Newsletter* (plus electronic availability).

III.B Internal Reviews

A copy of the paper must be made available for a Technical/Instrumental Review by Project personnel, to help avoid misunderstanding or confusion over potentially known instrumental or processing artifacts, as well as a Team Scientific and Coordination Review to be overseen by the Coordinating Committee. This latter Review will be similar to many institutions' internal reviewing procedures — it *must* be rapid and not significantly delay publication, and is intended to provide collegial advice and clarification, not an obstacle. The box on page 27 contains a checklist to be completed prior to publication.

III.C GONG Acknowledgement

All publications based upon *GONG* data must — according to our obligations to the *NSF* — contain the following footnote or acknowledgment: "This work utilizes data obtained by the Global Oscillation Network Group (GONG) project, managed by the National Solar Observatory, a Division of the National Optical Astronomy Observatories, which is operated by AURA, Inc. under a cooperative agreement with the National Science Foundation." For network data, authors should also include the following: "The data were acquired by instruments operated by the BBSO, HAO, LMSO, USO, IAC, and CTIO."

IV. Project Phases

We can already identify several different phases for the *GONG* data and hence somewhat different sorts of publications.

IV.A Project-Produced Instrument and Data Processing Articles

These will consist of archival references to support the scientific articles with descriptions of the instrument's and data processing system's nominal performances. They will have large authorship lists consisting of *GONG* project personnel and *GONG* Members who have made significant contributions. There have already been a number of descriptive articles about the Project. The first of these to contain real data will describe the *GONG* site survey and its results.

IV.B Prototype Data

GONG data has already been obtained to support instrument development. The prototype instrument will produce science grade data prior to full network operations. It is *GONG*'s intention to provide this prototype data to a broad community in order to stimulate understanding of the instrument and the data processing, as well as to generate new knowledge. This *GONG* community participation and oversight contributes significantly to the development of the instrumental, data processing and distribution aspects of the data. It will also exercise the Teams and Coordinating Committee, as well as these Publication Policies prior to network operations. We want the data to be used as soon as it is useful.

IV.C GONG Symposium (first network results)

The first publication of *GONG* full network data and analysis will be focussed by a Symposium to highlight Team activities and result in the landmark, refereed publications. To encourage initial team activities and avoid unproductive rushing to publication, the initial results of the Team activities — and once again all work at the outset will be under the auspices of the Teams — will appear at a "*GONG* Symposium" to be held nominally one year after first light from the full network. It is intended that the articles be refereed prior to publication together in an archival journal.

Authorship of these initial papers will consist of all those having made a substantial contribution to the research presented in the publication, including key *GONG* Project personnel and (at least) one representative from each of the sites operating network instruments.

We anticipate that in addition to the *GONG* Symposium papers, there will be an initial series of papers published about one year after first light in a broad circulation journal, such as *Nature* or *Science*, that will contain the

GONG Data Request

Requester names: ____

Program Title: ____

Program #, Date Received: __________________________________
(to be filled in by Project)

Scientific Objectives of Proposed Work:

Data Requested:

Potential Collaborators: ____________________________________

Related GONG Programs: ___________________________________

Cognizant Team:

- ☐ Reduction & Analysis
- ☐ Inversions
- ☐ Models
- ☐ Mode Physics
- ☐ Low Frequency
- ☐ Magnetic Effects
- ☐ Nearly Steady Flows & Magnetic Fields
- ☐ None seem to Apply

first data, including mode frequencies, as well as results from the Team activities. We accept the possibility that some "hot results" could merit reconsideration of the first-year publication embargo, or that *DMAC* processing delays could suggest an extension. Handling of such an eventuality would be overseen by the Coordinating Committee.

IV.D "Ever After"

Following the first year, *GONG* data will be made available to the broad community while Team membership will continue to be strongly encouraged. All data requests will be announced and assigned to Teams and coordination assured through the Coordinating Committee. Whereas authorship for the earlier phase papers will be very extensive, authorship throughout the remainder of the Project will be basically those responsible for the incremental work. However, the Teams will continue to function, and we anticipate that they will organize Workshops and continue to encourage collaborative analysis of the *GONG* data products.

GONG Publication/Presentation Release Checklist

☐ Authors' Names: ______________________________

____

☐ Program Title and Number: ______________________________

☐ Publication/Presentation Title: ______________________________

☐ To be submitted/presented to: ______________________________

☐ Anticipated submission/presentation date: ______________________________

☐ GONG Membership

☐ Data Request

☐ Newsletter Abstract of Data Request: ______________________________

☐ Newsletter Progress Reports: ______________________________

☐ Newsletter Abstract from Notice of Intent to Publish: ______________________________

☐ Project "Artifact" Review

☐ Team Review

☐ GONG Footnote Acknowledgement

☐ Contributions to GONG: ______________________________

☐ Other GONG Programs by Authors in progress: ______________________________

☐ GONG Publications: ______________________________

☐ Related GONG Programs: ______________________________

GONG 1992
SEISMIC INVESTIGATION
OF THE SUN AND STARS
or
The View From Boulder

August 10-14, *HAO* hosted the annual meeting of the Global Oscillation Network Group (*GONG*). In past years, *NSO* has always hosted the annual *GONG* meeting in Tucson. This year, however, it was decided that the project had developed to the point that the annual gathering should be in the form of a regular scientific meeting, held in some other location. Also, it was felt that the scientific concern of the meeting should be broadened to include discussion of multi-mode pulsations in stars other than the Sun. The result was this year's meeting, "*GONG* 1992: Seismic Investigation of the Sun and Stars," hosted by *HAO* and sponsored jointly by *NCAR*, *HAO*, and *NSO*.

With 129 attendees from more than a dozen countries, this gathering was not only an exciting scientific event, but also an opportunity for *HAO* to show off its new facilities to its friends worldwide.

The meeting's focus was provided by an outstanding series of invited talks, covering a range of topics related to the seismology of the Sun and stars, as well as to the basic physics of stellar interiors. Adding to the scientific pleasures were the ninety-odd contributed poster papers, many of them announcing new and exciting results. Considerable time was allotted for discussion of the talks and posters, and for meetings of the *GONG* teams and various other special interest groups. The largest of these, (occupying the entire day before the main *GONG* conference) was devoted to the annual *SOI/MDI* team meeting. Both the invited talks and the poster papers will appear in the meeting proceedings, which are to be published as part of the A.S.P. Conference Series. Social activities included a reception at the *NCAR* Foothills Lab, and a banquet (graced with a full moon, not to mention Peter Wilson's hitherto untold explanation of the meaning of *GONG*) at the *NCAR* Mesa Lab. Throughout the week, whether discussing seismology in general or the specifics of *GONG* or *SOI*, the same two thoughts tended to emerge: (1) progress is being made at a terrific rate, and (2) there is still a great deal to do.

Data Distribution and Publication Procedures

1) Data Availability Announced
2) Data Request Submitted to Project
3) Activity Assigned to a Team
4) Data Delivered
5) "Scientific Activity" and "Data Delivered" Announced in *Newsletter*
6) Biannual Activity Reports Published
7) Presentation at *GONG* Annual Meeting
8) Publication/Presentation Release submitted for Publication Review by Team (for Scientific Coordination) and Project (for instrumental and data processing considerations)

Invited Talks

Norman Murray (California Institute of Technology) "The Excitation of Solar p-Modes"

Michael J. Thompson (Queen Mary & Westfield College, London) "Seismic Investigation of the Sun's Internal Structure and Rotation"

Pawan Kumar (High Altitude Observatory) "Waves with Frequencies Above the Acoustic Cutoff Frequency"

Forrest Rogers (Lawrence Livermore Laboratory) "Equation of State and Opacity of Stellar Plasmas"

Werner Däppen (University of Southern California) "Theory of delta Scuti Stars"

Jaymie Matthews (University of Montreal) "Observing the Eigenmode Spectra of roAp and delta Scuti Stars"

Donald Winget (University of Texas) "The Whole Earth Telescope"

Thierry Appourchaux (ESA/ESTEC) and Douglas Gough (Cambridge University) "PRISMA: The First Space Mission to Look Inside the Stars"

J. Harvey, F. Hill, J. Kennedy, and J. Leibacher (NSO) "*GONG* Project Update"

Jeffrey Kuhn (Michigan State University) "What Causes Cycle-Related Global Solar Changes?"

Barry LaBonte (University of Hawaii) "Seismology of Solar Active Regions"

Poster Papers

Andersen, B. & Andreassen, Gravity Wave and Convection Interaction in the Solar Interior

Anderson, E., Gap Filling the *GONG* Data Set

Antia, H. & Chitre, S., Mesogranulation as a Solar Convective Eigenmode

Bachman, K., Schou, J. & Brown, Observations of Intermediate Solar Oscillations: April-June, 1989

Barrett, R., On the Optimal Choice of Regularization Parameter for the Inversion of Solar Oscillation Data

Belmonte, J. & and the STEPHI Team, STEPHI 92: BN & BU Cancri, two Scuties in the Praesepe Cluster

Bogart, R., Hill, F. et al, Artificial Data for Testing Helioseismology Algorithms

Bogdan, T., Brown, T. et al, The Absorption of p-modes by Sunspots: Variations with Degree and Order

Braun, D., LaBonte, B. et al, The p-mode Scattering Properties of a Sunspot

Brown, T., Data Merging Techniques for Astero- and Helioseismology

Brummell, N., Hurlburt, N et al, Turbulent Compressible Convection with Rotation

Chang, H. & Gough, D., On the Determination of the Temporal Properties of Free Oscillations

Chaplin, W., High Precision Velocity and Magnetic Measurements of the Star Procyon (F5 IV-V)

Christensen-Dalsgaard, J., On the Asteroseismic HR Diagram

Christensen-D, J. & Thompson, A Hands-on IDL Program for Helioseismic Inversion

Davies, A., Avalanche Photodiodes in Stellar Spectroscopy

Delache, Ph., Gavryusev, et al, Time Variations of Solar Acoustical Mode Frequencies, Radius and Neutrino Counting Rate

Demarque, P., Guenther, et al, A Limit on the Variability of G from Helioseismology

Dumbill, A., Measurements of the Longitudinal Component of the Solar Magnetic Field

Duvall, T., Jeffries, S. et al, Asymmetries of Solar Oscillation Line Profiles

Dziembowski, W. and Goode, P., Seismic Limits on the Sun's Internal Toriodal Field

Dziembowski, W. and Goode, P., The Sun's Internal Angular Momentum from Seismology

Dziembowski, W. and Goode, P., The Sun's Internal Rotation During and after the 1986 Activity Minimum

Fan, Y., Fisher, G & Deluca, E., The Origin of Morphological Asymmetries in Bipolar Active Regions

Fernandes, D, Scherrer, et al, High Frequency and High Wavenumber Solar Oscillations

Genovese, C. & Stark, P., l-1 Spectral Estimation: Algorithms and Tests of "Superresolution"

Gilliland, R., Brown, et al, M67 Stellar Oscillations: CCD Ensemble Photometry on a Network of 4m Telescopes

Gough, D. & Kosovichev, A., Seismic Analysis of Stellar p-mode Spectra

Gough, D., Merryfield, Toomre, Inversion for Background Inhomogeneity from Phase Distortions of One-Dimensional Wave Trains

Gough, D. & Novotny, E., Asteroseismic Calibration of Stellar Clusters

Gough, D. & Sekii, T., On the Detection of Convective Overshoot

Gough, D. & Stark, P., Are the 1986-1988 Changes in Solar Free- Oscillation Splitting due to Sunspots?

Gouttebroze, P. & Toutain, Oscillation Mode Visibility: An Eulerian Approach

Guenther, D. & Demarque, Seismology of Procyon

Harvey, J., Duvall, et al, Chromospheric Oscillations and the Background Spectrum

Harvey, J. et al, *GONG* Instrument Development

Hathaway, D., Doppler Measurement of the Solar Meridional Circulation

Horner, S & Brown, T., The Search for Pulsations in Late-Type Giants: Preliminary Results

Jain, R. & Roberts, B., P-mode Frequency Shifts and Chromospheric Magnetism

Johnston, A., Wright & Roberts, A Modified Bohr-Sommerfeld Condition for p-modes

Jones, a. et al, Observations of delta Scuti Stars from Aarhus

Jones, a. et al, A Simple Multi Color CCD Photometer

Jones, P., Merryfield & Toomre, Interaction of Externally-Driven Acoustic Waves with Compressible Convection

Kelly, J & Ritzwoller, M., Observing Giant Cell Convection with Helioseismic Linewidths

Kennedy, J, Jeffries & Hill, Solar g-mode Signatures in p-mode Signals

Kennelly E, Merryfield et al, Mode Identification in delta Scuti Stars by Fourier Analysis of Line-Profile Variations

Komm, R., Harvey & Howard, Torsional Oscillations and Internal Rotation

Kopp, G., Helioseismic Prospects in the Mid-Infrared

Korzennik S, Rhodes & Johnson, Helioseismology on a Massively Parallel Architecture: Reduction of 1024 by 1024 Full-Disk Dopplergrams on Intel's Touchstone Delta Supercomputer

Korzennik S, Cacciani & Rhodes, Towards a Better Determination of Frequency Splittings at Intermediate and High Degree: Preliminary Results of Sectoral Frequency Splittings from a 90-day Observing Run

Korzennik S. & Sabbey, Measurement of the Phase Relation Between Velocity and Intensity Fluctuations Induced by Solar P-Modes from *GONG* Breadboard Data

Kotov, V. & Lyuty, V., A Puzzle of the 160-min Periodicity in the Sun, RR Lyr Stars and AGN's: the Signatures of a Cosmological Origin?

Kotov, V, Scherrer, et al, The Search for 160-min Oscillations in the Stanford and Crimean Solar Velocity Observations, 1974-1991

Lazrek, M & Hill, F., Temporal Window Effects and their Deconvolution from Solar Oscillation Spectra

Libbrecht, K. & Woodard, M., Helioseismic Observations of the Solar Cycle 1986-90

Libbrecht, K, et al, The form of the Angular Velocity in the Solar Convection Zone

Lindsey, C, Braun, et al, Prospects in Local Acoustic Diagnostics of Subsurface Magnetic Structure

Merryfield, W. & Kennelly, E., Fourier Analysis of Variable Line Profiles

Milford, P., Hill & Tarbell, Subsurface Transverse Flows Near an Active Region

Milford, P., Frank, et al, High Frequency p-mode Spectrum

Monteiro, C-D & Thompson, On Detecting Overshoot Below the Sun's Convective Envelope

Narasimha, D. & Roxburgh, Convective Overshooting in Stars

Noyes, R. et al, The Advanced Fiber Optic Echelle Spectrograph for Asteroseismology

Palle, Perez-Hernandez et al, Observations of Low Degree p-modes with Odd l+m

Patron, J., Hill, et al, Ring Diagram Analysis of Mt. Wilson Data

Perez-Hernandez & C-D, The Phase Function for Solar-Like Stars

Peri, M. & Libbrecht, K., A New Echelle Spectrograph for Asteroseismology

Pijpers, F. & Thompson, M., Faster Formulations of the OLA Method

Pijpers, F. & Thompson, M., Inversions for the Sun's Rotation and its Radial Derivatives

Price, G., The Effects of Leakage into the Solar Atmosphere on Acoustic Mode Properties

Rast, M, Nordlund, et al, Ionization Effects in Solar Granulation Simulations

Rast, M. & Toomre, J., Acoustic Generation by Thermal Boundary Layer Instability in a Partially Ionized Fluid

Regulo, C., Fossat et al, On Full Disk Helioseismology Power Spectra Around the Cut-Off Frequency

Rhodes, E., Cacciani et al, Plans for Mt. Wilson-Crimean Astrophysical Observatory High-Degree Helioseismology Network

Rhodes, E, Rhodes et al, Observations of the Thermal Response of the Terrestrial Atmosphere to the Eclipse of July 11, 1991

Rieutord, M., Coherent Structures and the Differential Rotation of the Sun

Ronan, R. & LaBonte, B., High Frequency Solar Oscillations

Rosenthal, C & Gough, D., When is an f-mode not an f-mode?

Roxburgh, I., Seismology of the Solar Envelope. The Phase Shift of Low l Modes due to the Helium Ionization Zone and the Base of the Convective Envelope

Roxburgh, I. & Vorontsov, S, Seismology of the Solar Envelope: The Base of the Convective Zone as Seen in the Phase Shift of Acoustic Waves

Scherrer, P., Hoeksema & Kotov, On the Upper Limit for Detecting g-mode Oscillations of the Sun

Schou, J, C-D & Thompson, Two-Dimensional Helioseismic Inversions

Sekii, T., On a $\{1 \times 1\}$-Inversion Technique for Solar Rotation

Tomczyk, S. & Veitzer, S., An Instrument to Observe Low-Degree Solar Oscillations

Toner, C. & Jeffries, S., Accurate Measurement of the Geometry for a Full- Disk Solar Image and Estimation of the Observational Point Spread Function

Toutain, T. & Gouttebroze, Visibility Functions for Global Intensity Measurements

Ulrich, R., Observations of the Time-Dependent Gravitational Redshift of the Na D1 Line

Ulrich, R. & Evans, S., Response of the Solar Atmosphere to Low Frequency Perturbations

Ulrich, R. & Henney, C., Modeling of Integrated Sunlight Velocities due to Surface Darkening by Magnetic Fields

Veitzer, S, Tomczyk & Schou, Requirements for the Observation of Low-Degree Solar Oscillations

Vidal, I & Belmonte, J., CCD Asteroseismology in the Open Cluster NGC6802

Wheeler, S., High Frequency Solar Velocity Noise

Williams, W, Hill, et al, Tests of Simple *GONG* p-mode Merging Algorithm

Wilson, P., Forward Calculations for Several Classes of Iso-Rotation Surface Models

Woodard, M. & Libbrecht, K., Solar Activity and Oscillation Frequency Splittings

Wright, A. & Thompson, M., On the Effects of Chromospheric Magnetic Perturbations on Solar Oscillation Frequencies

More Data Products Available

Four days of data acquired by the *GONG* Prototype instrument (August 30 and 31 and September 5 and 6, 1992) have been reduced. These are "calibratable" data days and are comparable in quality to the June 8 and 9 1989 Breadboard days.

The reduced data products include:

- calibrated velocity, modulation, intensity images
- ten-minute resampled velocity, modulation, and intensity images
- times series of mode coefficients
- power spectra of mode coefficients
- l-ν spectra of mode coefficients

The ten-minute averages and the l-ν spectra are accessible on-line on *GONG*'s anonymous ftp disk. (Access instructions appear on page 9 in this *Newsletter*). The raw images, calibrated images, times series and power spectra are available on Exabyte cartridges.

Participants

Bo N. Andersen, Norwegian Space Centre, Norway

Ed Anderson, National Solar Observatory

Thierry Appourchaux, ESA/ESTEC, The Netherlands

David Armet, National Solar Observatory

Kurt Bachmann, High Altitude Observatory/NCAR

Lyle Bacon, Stanford University

Peter Bandurian, High Altitude Observatory/NCAR

Richard Barrett, Glasgow University, Scotland

Juan Antonio Belmonte, Instituto de Astrofísica de Canarias, Spain

Ira B. Bernstein, Yale University

A. Bhatnagar, Udaipur Solar Observatory, India

Richard S. Bogart, Stanford University

Thomas Bogdan, High Altitude Observatory/NCAR

Douglas C. Braun, University of Hawaii

Timothy M. Brown, High Altitude Observatory/NCAR

John Brown, University of Glasgow, Scotland

Nic Brummell, University of Colorado

Rock Bush, Stanford University

Bruno Caccin, Universit di Roma

Shelly Cadora, Stanford University

William Chaplin, Birmingham University, England

Shashikumar M. Chitre, Tata Institute of Fundamental Research, India

Jørgen Christensen-Dalsgaard, Aarhus Universitet, Denmark

Werner Däppen, University of Southern California

Andrew R. Davies, Birmingham University, England

Detlev Degenhardt, High Altitude Observatory/NCAR

Andrew Dumbill, Birmingham University, England

Thomas Duvall, Jr., NASA/GSFC

Wendy Erdwurm, National Solar Observatory

Scott Evans, University of California, Los Angeles

Yuhong Fan, University of Hawaii

Peter Fox, High Altitude Observatory/NCAR

Soren Frandsen, Aarhus Universitet, Denmark

Elena Gavryuseva, Instituto d'Astrofísica d'Canarias, Spain

Christopher Genovese, University of California, Berkeley

Ronald L. Gilliland, Space Telescope Science Institute

Peter Gilman, National Center for Atmospheric Research

Phil Goode, New Jersey Institute of Technology

Douglas Gough, Cambridge University, England

Pierre Gouttebroze, Institut d'Astrophysique Spatiale, France

David Guenther, Yale University

Deborah Haber, Colorado College

Fred Hall IV, University of Colorado

David H. Hathaway, NASA/Marshall Space Flight Center

Jack Harvey, National Solar Observatory

Carl Henney, University of California, Los Angeles

Frank Hill, National Solar Observatory

Bradley Hindman, University of Colorado

Todd Hoeksema, Stanford University

Scott Horner, HAO/NCAR, University of Chicago

Rekha Jain, University of St. Andrews, Scotland

Stuart Jefferies, Bartol Research Institute

Vicki Johnson, Stanford University

Andrew Jones, Aarhus Universitet, Denmark

Keith Julien, University of Colorado

Steven Kawaler, Iowa State University

John F. Kelly, University of Colorado

James Kennedy, National Solar Observatory

Edward J. Kennelly, University of British Columbia, Canada

Hans Kjeldsen, Aarhus Universitet, Denmark

Rudolf Komm, National Solar Observatory

Greg Kopp, National Solar Observatory

Sylvain G. Korzennik, Harvard-Smithsonian Center for Astrophysics

Alexander Kosovichev, University of Cambridge, England

Valeri A. Kotov, Stanford University

Jeffrey Kuhn, Michigan State University

Pawan Kumar, High Altitude Observatory/NCAR

Barry LaBonte, University of Hawaii

Mohamed Lazrek, CNCPRST, Morocco

John W. Leibacher, National Solar Observatory

Ken G. Libbrecht, California Institute of Technology

Jaymie Matthews, Université de Montreal, Canada

William Merryfield, University of Victoria, Canada

Barbara Mihalas, University of Illinois

Peter Milford, Stanford University

Mario Joao P.F.G. Monteiro, Queen Mary & Westfield College, England

Norman Murray, California Institute of Technology

D. Narasimha, Tata Institute of Fundamental Research, India

Rakesh Nigam, Stanford University

Eva Novotny, University of Cambridge, England

Robert W. Noyes, Center for Astrophysics

Pere L. Palle, Instituto de Astrofísica de Canarias, Spain

Jesus Patron, Instituto de Astrofísica de Canarias, Spain

Fernando Perez Hernandez, Instituto de Astrofísica de Canarias, Spain

Michal Peri, California Institute of Technology

Frank P. Pijpers, Queen Mary and Westfield College, England

James A. Pintar, National Solar Observatory

Martin A. Pomerantz, Bartol Research Corporation

Gary H. Price, SRI International

Mark Rast, University of Colorado

Clara Regulo, Instituto de Astrofísica de Canarias, Spain

Sergio R. Restaino, New Jersey Institute of Technology

Edward Rhodes, University of Southern California

Michel Rieutord, Observatoire Midi-Pyrenes, France

Mike Ritzwoller, University of Colorado

Bernard Roberts, University of St. Andrews, Scotland

Forrest Rogers, Lawrence Livermore National Laboratory

Robert S. Ronan, University of Hawaii

Colin S. Rosenthal, University of Colorado

Ian W Roxburgh, Queen Mary and Westfield College, England

Luiz A.D. Sa, Stanford University

Kenneth Schatten, National Science Foundation

Philip H. Scherrer, Stanford University

Jesper Schou, HAO/NCAR, Aarhus Universitet, Denmark

Takashi Sekii, University of Cambridge, England

Philip B. Stark, University of California

Robin Stebbins, University of Colorado

Margie Stehle, Stanford University

Ted Tarbell, Lockheed Palo Alto Research Laboratory

Michael J. Thompson, Queen Mary and Westfield College, England

Steve Tomczyk, High Altitude Observatory/NCAR

Clifford Toner, National Solar Observatory

Juri Toomre, University of Colorado

Mark Trueblood, National Solar Observatory

Roger Ulrich, University of California, Los Angeles

Bar Varda, Hebrew University of Jerusalem, Israel

Ram Varma, Physical Research Laboratory, India

Seth Veitzer, High Altitude Observatory/NCAR

Inmaculada Vidal, Instituto de Astrofísica de Canarias, Spain

Sarah Wheeler, University of Birmingham, England

Winifred E. Williams, National Solar Observatory

Robert Williams, Cerro Tololo Inter-American Observatory, Chile

Peter R. Wilson, University of Sydney, Australia

Donald Winget, University of Texas

Martin Woodard, California Institute of Technology

Andrew N. Wright, University of St. Andrews, Scotland

Igor Zayer, Lockheed Palo Alto Research Laboratory

Tim Brown

GONG '94

Roger Ulrich, Ed Rhodes and Werner Däppen have agreed to organize and host the general scientific meeting associated with the *GONG* project in 1994 in the Los Angeles area. Because this meeting comes just before the operation of several major helioseismology projects, it seems appropriate to have it sponsored as an *IAU* Symposium. Discussions are in progress with several of the *IAU* Commissions to obtain this sponsorship. In order to avoid a schedule conflict with the holding of the *IAU* General Assembly in August, 1994, this symposium will be held in mid-May, 1994. A title for the symposium of "Helio- and Astero-Seismology from the Earth and Space" has been chosen.

Roger Ulrich

GONG Scientific Visitors

Mohamed Lazrek, from the Centre National de la Recherche in Agdal-Rabat, Morocco, visted the *GONG* Project from May 15 through August 15, 1992. During his visit, he worked with F. Hill on developing and testing a deconvolution method to remove the residual effects of the temporal window from the power spectrum. The results were presented at the *GONG* 1992 meeting, and a paper will be submitted to Astronomy and Astrophysics.

D. Narasimha, from the Tata Institute in Bombay, India, visited the *GONG* project from July 2 to August 26, 1992. During his visit, he worked on an alternative method to decompose two-dimensional data into spherical harmonics. A *GONG* Technical Report, No. 92-2, is currently in preparation.

Frank Hill

Theses

Congratulations to the following recent Ph.D.'s in helioseismology:

David Fernandes, Stanford University, "The Detection and Characterization of High Frequency and High Wavenumber Solar Oscillations"

Bernhard Fleck, Universität Würzburg, "Untersuchungen zur Dynamik oszillatorischer Vorgänge in der Sonnenatmosphäre. (Studies on the dynamics of oscillatory motions in the solar atmosphere)"

Matthew Penn, University of Hawaii, "The Source of Five-Minute Period Photospheric Oscillations"

Robert Ronan, University of Hawaii, "Global Solar Intensity Oscillations Near Solar Maximum"

Recent Preprints in Helio- and Astero-seismology

The titles included here are preprints which have been sent, as a courtesy, to members of the *GONG* project staff. They are listed for the convenience of *Newsletter* readers. Please contact the author(s) for additional information. If you would like your preprint titles to be included in future *Newsletters*, send a copy of your preprints to one of the *GONG* staff. If you would prefer that you preprint titles do not appear in the *GONG Newsletter*, please indicate that when you send any of us a copy. Otherwise, we shall share it!

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Appourchaux, T., Gough, D., Hoyng, P., Catala, C., Frandsen, S., Fröhlich, C., Jones, A., Lemaire, P., Tondello, G., and Weiss, W.: "PRISMA: A New Space Mission for Stellar Physics"

Bahcall, J.N., and Pinsonneault, M.H.: "Standard Solar Models, With and Without Helium Diffusion and the Solar Neutrino Problem"

Bahcall, J.N., and Salpeter, E.E.: "Is Stellar Evolution Theory Wrong and the Solar Neutrino Problem Solved?"

Benkhaldoun, Z., Kadiri, S., Lazrek, M., and Vernin, J.: "A Simple Flux Integration Photometer for Day Time Site Testing at Oukaimeden"

Braun, D.C., Duvall, T.L., LaBonte, B.J., Jefferies, S.M., Harvey, J.W., and Pomerantz, M.A.: "Scattering of p-Modes by a Sunspot"

Brodsky, M., and Vorontsov, S.V.: "Asymptotic Theory of Intermediate- and High-Degree Solar Acoustic Oscillations"

Brown, T.M., Christensen-Dalsgaard, J., and Mihalas, B.W.: "How May Seismological Measurements Constrain Parameters of Stellar Structure?"

Christensen-Dalsgaard, J.: "The Structure and Evolution of the Sun"

Christensen-Dalsgaard, J.: "Pulsation Theory and Stellar Structure"

Christensen-Dalsgaard, J., Hansen, P. C., and Thompson, M. J.: "GSVD Analysis of Helioseismic Inversions"

Duvall, T.L., Jefferies, S.M., Harvey, J.W., Osaki, Y., and Pomerantz, M.A.: "Asymmetries of Solar Oscillation Line Profiles"

Dziembowski, W.A., Pamyatnykh, A.A., and Sienkiewicz, R.: "Seismological Tests of Standard Solar Models Calculated with New Opacities"

Edmonds, P., Cram, L., Demarque, P., Guenther, D.B., and Pinsonneault, M.H.: "Evolutionary Models and the p-Mode Oscillation Spectrum of α Cen A and B"

Evans, D.J., and Roberts, B.: "The Interpretation of Solar Cycle Variability in High Degree p-Mode Frequencies"

Fernandes, D.N., Scherrer, P.H., Tarbell, T.D., and Title, A.M.: "Observations of High Frequency and High Wavenumber Solar Oscillations"

Fossat, E.: "IRIS Data Merging. I. A Solution to Minimize the Low and Intermediate Frequency Noise"

Fossat, E., Réegulo, C., Roca Cortés, T., Ehgamberdiev, S., Grec, G., Khamitov, I., Lazrek, M., Sánchez Duarte, L., Gelly, B., and Pallé, P.: "On the Acoustic Cutoff Frequency of the Sun"

Frandsen, S.: "Asteroseismology from the Ground"

Frandsen, S., Douglas, N., and Butcher, H.: "An Astronomical Seismometer"

Frandsen, S., and Kjeldsen, H.: "Observational Constraints on Mode Excitation in δ-Scuti Stars in Open Clusters"

Gautschy, A.: "Exciting Alpha Cygni"

Glatzel, W., and Gautschy, A.: "The Treatment of Highly Nonadiabatic Nonradial Pulsations by Application of the Riccati Method to the Example of HdC Stars"

Gough, D.O., and Kosovichev, A.G.: "Is It Possible To Determine Whether A Star Is Rotating About A Unique Axis?"

Gough, D.O., and Kosovichev, A.G.: "Initial Asteroseismic Inversions"

Gough, D.O., Kosovichev, A.G., Sekii, T., Libbrecht, K.G., and Woodard, M.F.: "Seismic Evidence of Modulation of the Structure and Angular Velocity of the Sun Associated with the Solar Cycle"

Gough, D.O., and Stark, P.B.: "Are the 1986-1988 Changes in Solar Free-Oscillation Splitting Caused by Sunspots?"

Guenther, D.B., and Demarque, P.: "Evolution and Seismology of Procyon"

Hasan, S.S., and Christensen-Dalsgaard, J.: "The Influence of a Vertical Magnetic Field on Oscillations in an Isothermal Stratified Atmosphere"

Hill, F.: "On the Interpretation of Inversions of Helioseismic Rotational Splitting Measurements"

Jones, A.: "PRISMA - The Instruments"

Kalkofen, W., Rossi, P., Bodo, G., and Massaglia, S.: "The 3 Min Oscillations in Chromospheric Bright Points"

Kosovichev, A., Christensen-Dalsgaard, J., Däppen, W., Dziembowski, W., Gough, D., and Thompson, M.: "Sources of Uncertainty in Direct Seismological Measurements of the Solar Helium Abundance"

Kotov, V.A., Haneychuk, V.I., and Tsap, T.T.: "Seismic Evidence for a Rapidly Rotating Solar Core"

LaBonte, B.J., and Ryutova, M.: "A Possible Mechanism for Enhanced Absorption of p-Modes in Sunspot and Plage Regions"

Lazrek, M., and Hill, F., "Temporal Window Effects and Their Deconvolution from Solar Oscillation Spectra"

Monteiro, M.J.P.F.G., Christensen-Dalsgaard, J., and Thompson, M.J.: "Detecting Convective Overshoot in Solar-Type Stars"

Moskalik, P., and Dziembowski, W.A.: "New Opacities and the Origin of the β Cephei Pulsations"

Ronan, R.S., and LaBonte, B.J.: "Intermediate Degree p-Mode Frequency Splittings Near Solar Maximum"

Rossi, P., Kalkofen, W., Bodo, G., and Massaglia, S.: "Oscillations in a Stratified Atmosphere"

Schou, J., Christensen-Dalsgaard, J., and Thompson, M.J.: "Two-Dimensional Helioseismic Inversions"

Shou, J., Brown, T. M., and Bachmann, K. T.: "Preliminary Results from Observations with the Fourier Tachometer"

Toner, C.G., and Jefferies, S.M.: "Accurate Measurement of the Geometry for a Full-Disk Solar Image and Estimation of the Observational Point Spread Function"

Uitenbroeck, H, and Bruls, J.: The Formation of Helioseismology Lines. III: Partial Redistribution Effects in Weak Solar Resonance Linens.

Wilson, P.R.: "Helioseismology Data and the Solar Dynamo"

Graduate Student Research Fellowship

The National Solar Observatory (*NSO*) has a research opportunity for a graduate student in the field of helioseismology. This position is in support of the *NASA*/Stanford Solar Oscillations Investigation (*SOI*) project, but the successful candidate will reside in Tucson. Applicants must be currently enrolled, in good standing, in a doctoral graduate program at an accredited university, must have an official thesis advisor, and must have completed all course work and passed any necessary qualifying examinations at their university.

The research topic must also be approved by the candidate's thesis committee. The topic should be in the area of observational helioseismology, preferably using moderately high-resolution images similar to those that will be obtained by the *SOI* experiment. *NSO* will soon begin operating the High-Degree Helioseismometer (*HDH*) at the Kitt Peak Vacuum Telescope. This instrument will obtain 1024 × 1024 full-disk Ca K intensity solar images, which provide a useful proxy for the *SOI* data. Possible research topics include the development of techniques to measure the parameters of high-degree oscillations, the development of four-dimensional Fourier transform techniques to study wave propagation in the solar atmosphere, and the theoretical and observational study of wave trapping in supergranules.

The research advisor at *NSO* will be Frank Hill, the Global Oscillation Network Group (*GONG*) Data Scientist. Applications should be sent to

Revell Rayne
Personnel Director
NOAO
PO Box 26732
Tucson, AZ 85726-6732

Applications should be received by

The *GONG Newsletter* is a “quarterly” publication which is intended to keep the community abreast of news and progress relating to the *GONG* project and other activities within the field of helioseismology. The current mailing list for the *Newsletter* includes about 400 individuals who have expressed an interest in these topics. We welcome contributions from anyone wishing to disseminate information of general interest to this community. Contributors to this issue include Ann Barringer, Louise Bierle, Tim Brown, Jørgen Christensen-Dalsgaard, Yvonne Ellsworth, Phil Goode, Jack Harvey, Frank Hill, Todd Hoeksema, Rob Hubbard, Linda Johnson, Jim Kennedy, Jim Pintar, Tuck Stebbins, and Roger Ulrich.

John Leibacher
GONG Project Scientist, Editor

Mailing address: National Solar Observatory
950 N. Cherry Avenue
P.O. Box 26732
Tucson, Arizona 85726-6732

Electronic Mail: Internet ≡ jleibacher@noao.edu
NSI-DECnet ≡ 5355::jleibacher

Phone: (602) 325-9305

FAX: (602) 325-9278

Anyone on the *GONG* project staff can be reached via electronic mail by substituting their first initial and last name for *jleibacher* in the above electronic mail addresses.