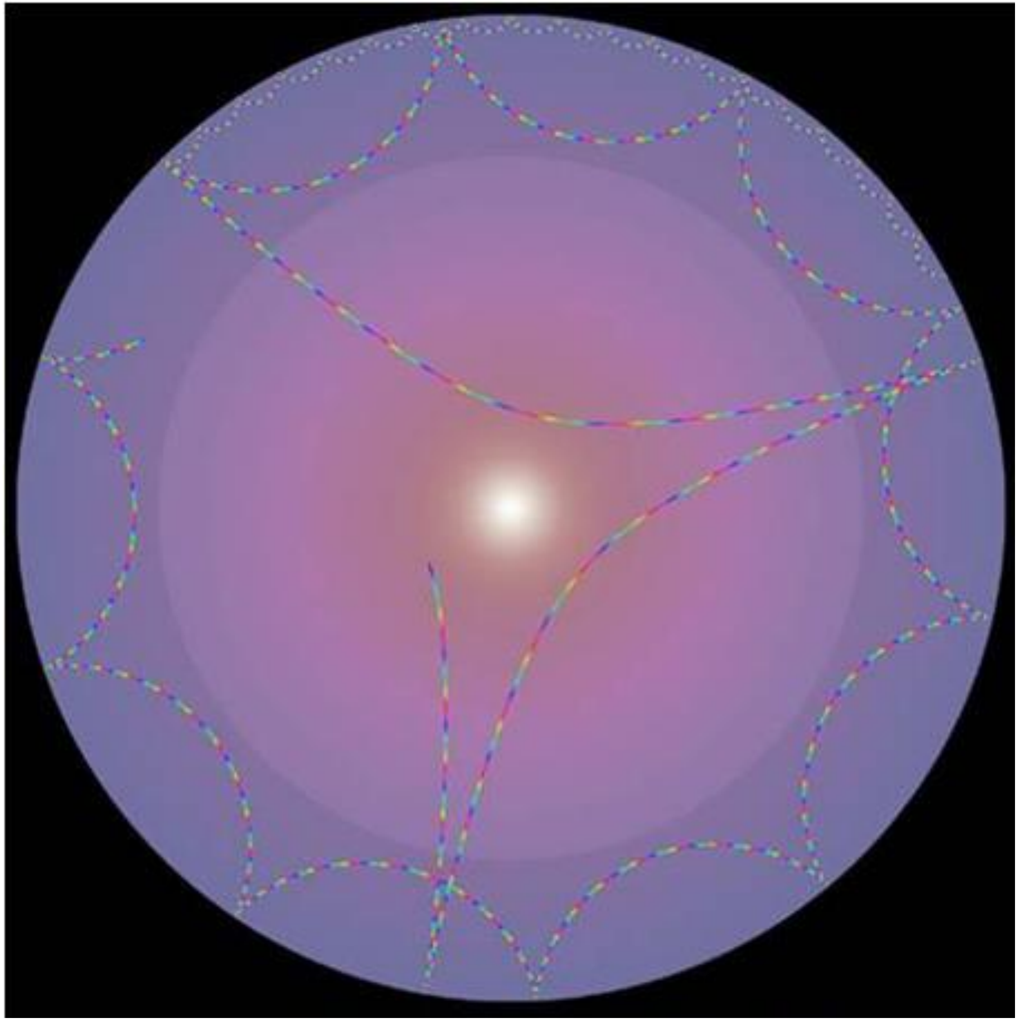
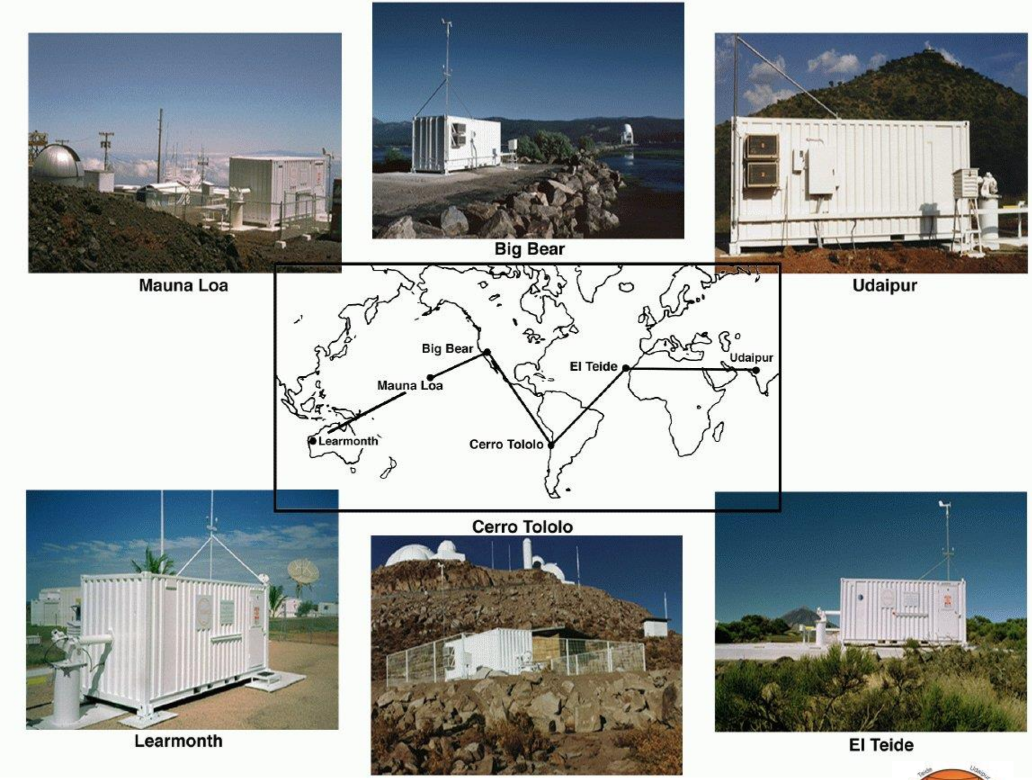


Global Oscillation Network Group (GONG)



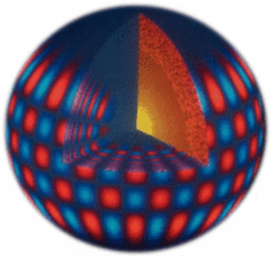
http://gong.nso.edu

The Global Oscillation Network Group (GONG) is an international program conducting a detailed study of internal structure and motions of the Sun using helioseismology

Helioseismology uses measurements of the frequencies of millions of waves that echo around inside the Sun. These sound waves are below the range of human hearing, taking about five minutes to complete a single cycle; however, they cause small motions of the surface of the Sun that can be observed and measured with specialized optical instruments.

In order to make nearly continuous observations, GONG has set up a six-station network of extremely sensitive and stable solar velocity imagers located around the Earth. The stations are spaced so that there are always at least two stations that can see the Sun at any given time, to minimize lost data due to bad weather or equipment problems. The six GONG stations are automated. Data from each of the stations are recorded and transferred in real time to the program's headquarters in Tucson, USA. More than 5 gigabyte a day of data are processed and distributed for analysis to the scientists in different countries around the world. These solar physicists are unraveling the mysteries of the solar interior and are developing a clearer understanding about how our Sun and other stars work, and how the Sun affects the Earth.

Hot gases constantly boil up to the surface of the Sun where they release their energy as the light we see. These tremendous updrafts and downdrafts produce a broad range of very low-pitched acoustic noise; much like blowing air across the top of a bottle sets off a few notes. These oscillations occur in millions of different modes, that can be distinguished from one another by the very specific kinds of surface patterns they set up on the Sun. The surface oscillations can be detected by observing the red and blue shifts of spectral lines in the light coming from the surface. Some of these modes extend all the way down to the center of the Sun, while others are refracted at various depths beneath the surface of the Sun. In much the same way that a bell rings with a certain note and overtones because of its size, shape, temperature, and materials, the particular solar frequencies are determined by the same parameters in the Sun. Sophisticated analyses of these frequencies allows scientists to reconstruct what the inside of the Sun is made of: its temperatures, pressures, densities, motions and many other characteristics.



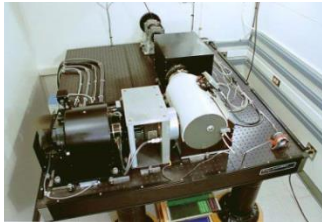
3-D cut of the Sun showing the internal layers and the radial modes of oscillations which produce blue and red shifts on the surface.

***GONG Network**: The stations are operated at Big Bear Solar Observatory (Caltech), Mauna Loa Solar Observatory (High Attitude Observatory), Learmonth Solar Observatory (IPS Radio and Space Services), Udaipur Solar Observatory (Physical Research Laboratory), EI Teide Observatory (Instituto de Astrofisica de Canarias), and Cerro Tololo Interamerican Observatory (NOAO). These sites are shown on the front cover page.*

The GONG Program is managed by the National Solar Observatory, a division of the National Optical Astronomy Observatory (NOAO). NOAO is operated by the Association of Universities for Research in Astronomy under a cooperative agreement with the U. S. National Science Foundation.

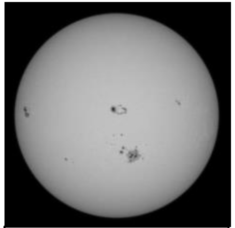
The back cover page shows the ray diagram for the propagation of the sound waves inside the sun

The GONG Instrument: This instrument is based on a Michelson interferometer called a Fourier Tachometer and is supported by a highly automated, portable installation. The instrument consists of two mirrors tracking the Sun in elevation and cross elevation axes that feed light horizontally into a cargo container housing the rest of the equipment. The optical system is sealed by a filtered window with an aperture of 8 cm. The layout of the main instrument on the optical table is shown in the adjacent picture.

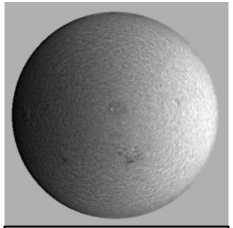


Near the focus of the 1-m focal length objective lens of aperture 8 cm is a box that contains various optics that can be moved in and out of the beam to allow calibration of the instrument. A variable polarization retarder can be put into the beam for the line-of-sight magnetic field measurement. All of these mechanisms are under computer control and automated. A hybrid filter of 1 Å passband isolates the Ni I line at 6768 Å. This filter consists of a 5 Å, two-cavity interference filter followed by three birefringent elements. All of these elements are mounted in an oven whose temperature is stabilized to the order of 0.00001 K. The heart of the instrument is a polarizing Michelson interferometer having a path difference of about 30,000 waves. This is constructed to have a wide angular field and to be thermally stable. The cosine-squared transmission pattern produced by the interferometer is scanned across the filtered spectrum of the Sun by a rotating wave plate and, thus, modulation is produced by the presence of the Fraunhofer line. The phase of the modulation is a measure of Doppler shift. Along with the main instrument, there is also an auxiliary optical set-up to image the chromospheric dynamic activities in H-alpha which is important for Space-Weather related studies.

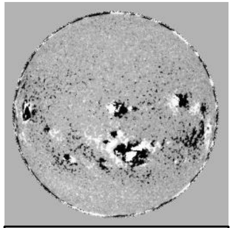
Data Products: The GONG instrument acquires full-disk Dopplergrams, Magnetograms (line-of-sight), and Continuum images of the Sun using Ni I 6768 Å solar photospheric line at the cadence of one minute with a spatial sampling of 2.5 arcsec per pixel. It also acquires the full-disk chromospheric images of the Sun using Hα 6562.8 Å line with a spatial sampling of 1 arcsec per pixel.



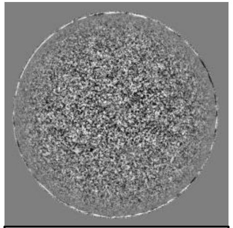
Continuum image (white light)



Dopplergram (total velocity)



Magnetogram (line-of-sight)



Dopplergram (p-modes)