LOI AND GONG LOW-DEGREE ROTATIONAL SPLITTINGS

T.APPOURCHAUX, M.C.RABELLO-SOARES
ESA/ESTEC
P.O.Box 299, 2200 AG, Noordwijk, Pays-Bas

AND

L.GIZON
W.W.Hansen Experimental Physics Laboratory
Center for Space Science and Astrophysics, Stanford University
Stanford, CA 94305-4085, USA

1. Observations

Two different data sets have been used to derive low-degree rotational splittings. One data set comes from the Luminosity Oscillations Imager of VIRGO on board SOHO; the observation starts on 27 March 96 and ends on 26 March 97, and are made of intensity time series of 12 pixels (Appourchaux et al, 1997, Sol. Phys., 170, 27). The other data set was kindly made available by the GONG project; the observation starts on 26 August 1995 and ends on 21 August 1996, and are made of complex Fourier spectra of velocity time series for $l = 0 - 9$. For the GONG data, the contamination of $l = 1$ from the spatial aliases of $l = 6$ and $l = 9$ required some cleaning. To achieve this, we applied the inverse of the leakage matrix of $l = 1, 6$ and 9 to the original Fourier spectra of the same degrees; cleaning of all 3 degrees was achieved simultaneously (Appourchaux and Gizon, 1997, these proceedings).

2. p-mode fitting

The Fourier spectra were fitted using the technique described by Appourchaux and Gizon, (1997) (these proceedings) after the work of Schou (1992) (PhD thesis, Aarhus University). The leakage matrix of LOI and GONG were derived from theoretical computations for spherical harmonics filters. The noise covariance matrix of the LOI was also computed theoretically, while that of GONG was measured directly on the data using cross-spectra. For each n, l mode we fitted a central frequency, a common linewidth to the $2l + 1$ components, a_i splitting components (using Clebsh-Gordan polynomials), $2l+1$ amplitudes, and various noise parameters (3 for the LOI and $l+1$ for GONG).

F.-L. Deubner et al. (eds.), New Eyes to See Inside the Sun and Stars, 167–168.

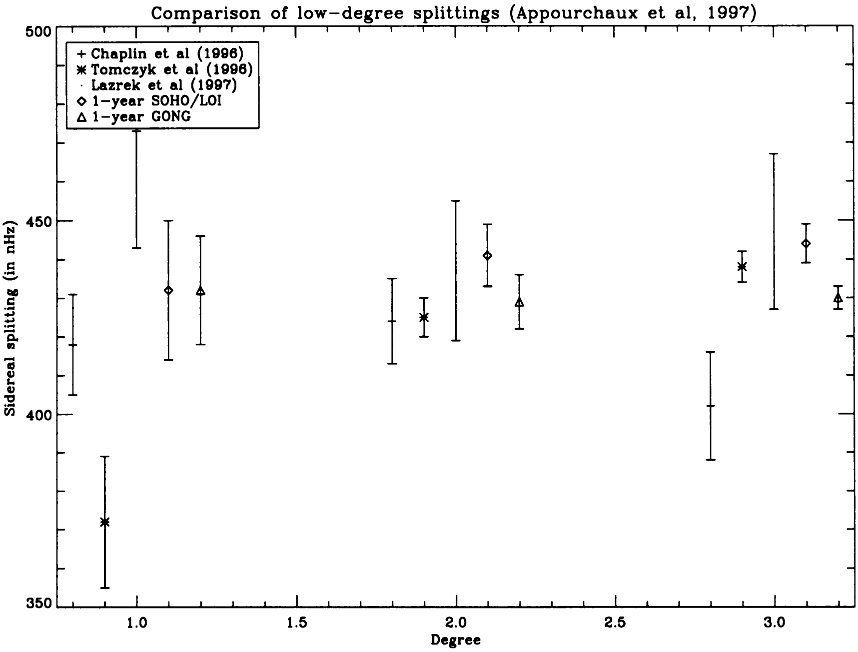

Figure 1. Comparison of low-degree splittings from different instruments. For all the instruments but GOLF (Lazrek et al, 1997, Sol. Phys., in press) the splittings were computed using a weighted mean over n using the formal errors returned by the fit. All the instruments but GOLF displays a_1; GOLF displays a weighted average over the odd a_i. The LOWL data are known to be biased for $l = 1$ due to the poor signal-to-noise ratio and the presence of the temporal alias of the $l = 3$. The LOI and GONG splittings result from this analysis. Note that 'our' GONG splittings do not have the large systematic errors that of the GONG project; these latter were obtained by fitting power spectra. (Chaplin et al, 1996, MNRAS, 280, 849; Tomczyk et al, 1996, ApJ, 488, L57)

3. Results

Figure 1 shows the results of our measurements compared to other previous results. We noticed that the LOI data for $l = 2-3$ are systematically higher than the other imaging velocity instruments. The preliminary forward modeling, that we made, showed that the shell $0 - 0.3R_\odot$ was rotating about 30 ± 18 % faster with the LOI than with the other instruments. We have shown that an error in one of the leakage element will lead to underestimating the a_1 coefficient. For example, for GONG and $l = 1$ we have $a_1 = 430 - 160(1 - \alpha)^2$ where α is the matrix element relative to its nominal value. For a 10 % error in the leakage element, we underestimate the splitting by less than 2 nHz. This is a general feature of any fitted a_1, either GONG or LOI (Appourchaux et al, 1997, submitted to A&A). If the LOI splittings are overestimated, we have no reason to believe that it is directly due to the fitting procedure. Other source of bias such as leakage of other degrees or of solar origin will be investigated.