GROUND BASED OBSERVATIONS OF SOLAR LUMINOSITY OSCILLATIONS

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ABSTRACT. Results from ground based observations of low degree solar luminosity variations are presented. By using data from up to 15 consecutive excellent days the majority of the l=0, 1 and 2 peaks in the region 2.5-3.5 mHz may marginally be identified.

1. INTRODUCTION

Several attempts have been made to study the low degree mode structure of oscillations in the solar luminosity (Fröhlich 1984, Deubner 1981, Claverie et al. 1981). Up until now only the results from the ACRIM instrument on SMM have unquestionably shown the existence of the l=0, 1, 2 p-modes in the solar luminosity (Woodard and Hudson 1983).

The main source of interference of ground based solar luminosity measurements is the transparency variation of the terrestial atmosphere. This causes a typical integrated fluctuation in luminosity of 100 ppm on the best days at the best sites. On most days the terrestial noise level is 5-10 times higher in the visual region. However, due to the non-coherent structure of this noise it could still be possible to reach the desired noise levels in the 5 minute band.

2. OBSERVATIONS

A multicolour sunphotometer has been operated at Izaña since 1984 (Jimenez et al. 1986). Currently this instrument measures the solar intensity at 500, 680, 870 and 1060 nm every 13 seconds. Here we present results of 15 consecutive days starting on 8 February 1986. For each of the 4 observed wavelengths the daily long term variation was removed with a running mean and polynomial fit. Only periods with a typical noise level of less than 200 ppm at 680 nm were included in the further reduction. The resulting average daily coverage was 5.2 hours with a range from 1 to 8 hours. This low coverage generates a window function with very strong daily sidelobes. Every 3 points were averaged and a 15% cosine window applied to each observational period. A straightforward FFT was then carried out. The last 8 days

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of the series were reduced as a separate subset in the same way as the whole series.

In an attempt to reduce the influence of the terrestial atmosphere we also looked at the differences between different channels. The average power outside the 5 minute range (1.5-2.5 mHz and 4.5-6.5 mHz) was calculated for each channel. We assume that this power is of terrestial origin and calculate the ratio between the different wavelength channels. The power within the 5 minute region in each channel was then scaled using this ratio and subtracted.

3. RESULTS

To reduce the noise level in the data we added and averaged consecutive segments of 135.5 μHz of the power spectrum. Figure 1a shows a 150 μHz wide band of such an averaging process for 8 days of scaled differences between the 500 and 870 nm channels. The same structure of peaks are seen on all the data. The complexity of the peak structure is caused by the dirty window function. We generated a time series from 44 modes as found in the SMM data. This series was treated with the same window function as the current observations and reduced the same way, Figure 1b shows the result of this procedure. We clearly see the same peak structure as in our observations. The l=2 peak is in the wing of the first daily sidelobe of the l=0 peak making it difficult to estimate the absolute amplitudes of the peaks. For all wavelengths the relative amplitude of the l=1, 2 modes as compared to the l=0 are about 0.5. For the SMM data these ratios are about 1.2 and 0.5 for the l=1 and 2, respectively. The relative variation with wavelength from 500, 680, 870 to 1060 nm are as 1:0.5:0.3:0.2.

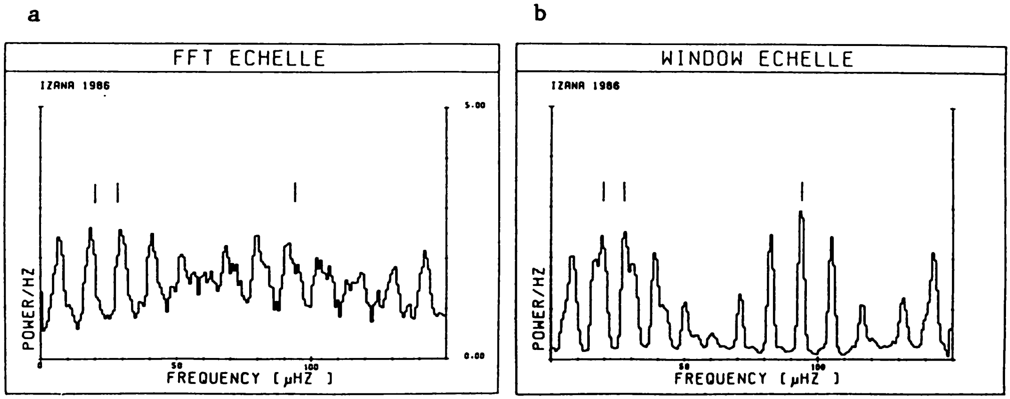

Figure 1: a) The folded power spectrum of 8 days observations with SLOT at Izaña. The scaled difference between 500 and 870 nm has been plotted. The folding frequency is 135.5 μHz and the starting frequency is 2.6 mHz. The vertical lines mark from left to right the position of the SMM l=2, 0, and 1 modes. The vertical scale is 5 ppm. b) The same window function as in a) has been applied on 44 l=0, 1, 2 frequencies observed by SMM. The vertical scale is arbitrary.

From the full data set we have attempted to find the individual peaks in the power spectrum. All the groups of peaks with comparable amplitude separated with the sidelobe distance of 11.57 μHz were marked off. In the Table 1 the central peaks are shown with the results from the SMM data. We see that the correspondence is very good for a large majority of the peaks. Within the 2.5-3.5 mHz region we only found 3 groups of lines with the correct sidelobe structure that did not correspond to the SMM peaks.

TABLE 1

Comparison of frequencies in mHz observed at Izaña (SLOT) and with SMM.Line groups in the SLOT data not seen in SMM have center frequencies at 2.776, 2.944 and 2.996 mHz

	l=0		l=1		l=2	
n	SMM	SLOT	SMM	SLOT	SMM	SLOT
16			2.425	2.419	2.487	2.490
17	2.496	2.493	2.559	2.559	2.620	2.619
18	2.629	2.631	2.692	2.692	2.755	2.756
19	2.763	2.764	2.829	2.823	2.888	2.886
20	2.897	2.898	2.964	2.962	3.025	3.023
21	3.033	3.035	3.099	3.098	3.160	3.161
22	3.168	3.170	3.234	3.234	3.294	--
23	3.303	3.305	3.370	--	3.430	3.431
24	3.437	3.441		--	3.568	3.568

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