LOW-DEGREE *P*-MODE SOLAR CYCLE TRENDS FROM BISON DATA

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An in-depth discussion of the analysis presented here can be found in an up-coming paper (Chaplin *et al.*, 1997).

1. Trends at frequencies up to $\sim 3900\,\mu$Hz

In order to investigate the solar-cycle dependence of the low-degree p-mode frequencies, we have analysed eighteen 4-month frequency spectra generated from BiSON Doppler velocity residuals collected between 1991 January 01 and 1997 January 05. These data cover the falling phase of solar activity cycle 22, up to the cycle 22/23 boundary. Fig. 1(a) shows frequency shifts, averaged over two orders in n, up to $\sim 3900\,\mu$Hz – as derived from the analysis of the 4-month spectra – normalised to unit change in the 10.7-cm radio flux. The dashed line lying above the BiSON data is a fit to the BBSO 1989-minus-1986 frequency shifts, for $4 \leq \ell \leq 140$ (Libbrecht & Woodard, 1991). The dotted line passing through the data corresponds to the best-scaled fit of the BBSO data to the BiSON data – the best-fit requires the BBSO data to be scaled by 0.71 ± 0.03. This is reasonably consistent – as expected – with the mean, overall ratio of the inverse mode masses of those data used in the BiSON and BBSO analyses (≈ 0.67). Fig. 1(b) shows the BiSON activity-normalised frequency shifts, plotted as a function of inverse mode mass – here, as anticipated, there is a clear correlation between the variables.

2. Trends at frequencies above $\sim 4000\,\mu$Hz

At high frequencies we have fitted the low-ℓ pairs to a single-Lorentzian model in 4 and 8-month averages of short, 7.6-d spectra. The bottom figure below shows the solar-cycle dependence – again normalised to unit change in the 10.7-cm flux – derived

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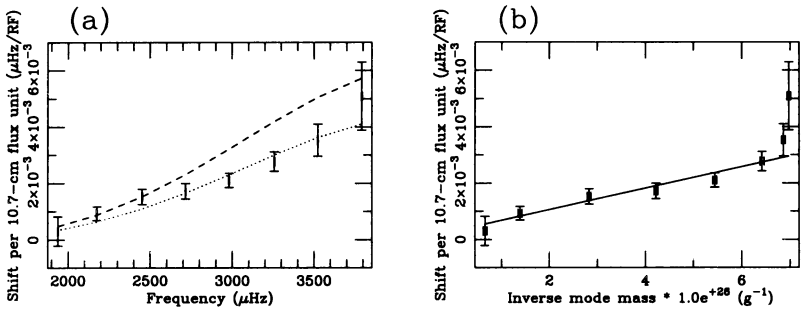

Figure 1. Solar-cycle dependence of fitted BiSON modes at frequencies up to $\approx 3900\,\mu$Hz. In (a) – plotted as a function of frequency. The dashed line lying above the BiSON data is a fit to the BBSO 1989-minus-1986 frequency shifts, for $4 \leq \ell \leq 140$. The dotted line passing through the data corresponds to the best-scaled fit of the BBSO data to the BiSON data. And in (b) – plotted as a function of inverse mode mass.

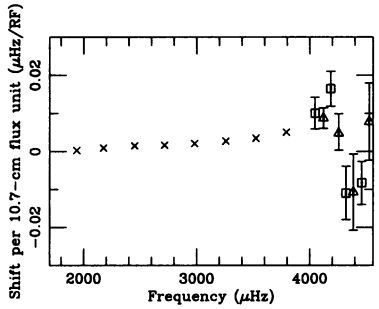

Figure 2. Solar-cycle dependence at high frequency – again normalised to unit change in the 10.7-cm flux – derived from single Lorentzian fits to 4-month averaged $\ell = 2/0$ pairs (triangular symbols with errors) and $\ell = 3/1$ pairs (square symbols with errors). The crosses are the data from Fig. 1(a).

from single Lorentzian fits to 4-month averaged $\ell = 2/0$ pairs (triangular symbols with errors) and $\ell = 3/1$ pairs (square symbols with errors). We also include data from Fig. 1(a) as a lower-frequency reference. If we consider the extracted solar-cycle coefficients, the data are suggestive of a turnover and possible sign reversal (a straight-line fit gives a gradient significant at the 3σ level). Clearly, one must be cautious (e.g., possible systematic complications for the $\ell = 3/1$ fits; see Chaplin *et al.*, 1997).

References

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