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Temporal variations of solar p-mode frequencies on time scales of 27 days

S.C. Tripathy, Kiran Jain and A. Bhatnagar

Udaipur Solar Observatory, Physical Research Laboratory, PO Box No. 198, Udaipur 313 001, India

Abstract. We have studied variations in the frequencies of intermediate degree solar oscillation modes on a time cadence of 18 and 27 days. We report that the p-modes adjust to changes in the activity measures on time scales as short as 18 days.

Key words: Sun: oscillations, Sun: activity

1. Introduction

The frequencies of solar oscillations are known to vary with solar cycle (Jain, Tripathy & Bhatnagar, 2000 and references therein). It is believed that the phenomena responsible for these variations are localised very close to the surface of the acoustic cavity. However, an exact driving mechanism still remains elusive and calls for further investigation of the oscillation frequency changes with solar cycle.

2. Analysis and Results

Since the oscillation modes are global, we compute frequencies and splitting coefficients on a time scale comparable to the Sun's rotation period. Specifically, we choose a time cadence of 27 days and calculate frequencies from the Global Oscillation Network Group (GONG) time series through the GONG pipeline (Hill *et al.*, 1996). To further understand, if the global modes correlate with solar activity on time scales shorter than the rotation period, we also compute frequencies with a time cadence of 18 days. The change in frequencies ($\delta\nu$) for the 17 data sets of 18-d and 27-d each, which covers a period of five years from 19 February 1996 to 26 March 2001, is computed with respect to the first data set. This analysis is also restricted to the modes which are present in all the sets in the degree range of 20–100 and frequency range of 1900–3900 μHz. It may be noted that these data sets are non-uniformly distributed over the entire epoch.

The variation of mean frequency shifts with time and activity is shown in Figure 1. We have charactrized the observed shifts as a function of various indices representing the photospheric, chromospheric and coronal activities. From the regression and correlation analysis of mean frequency shifts with activity indices for both the 18-d and 27-d data sets, it is observed that the gradients and correlation measures are highly significant and agree satisfactorily with each other. Though, we have not considerd the effect of finite mode life time on the shorter time scales, it is apparent that the p-modes adjust to changes in the activity measures on time scales as short as 18 days.

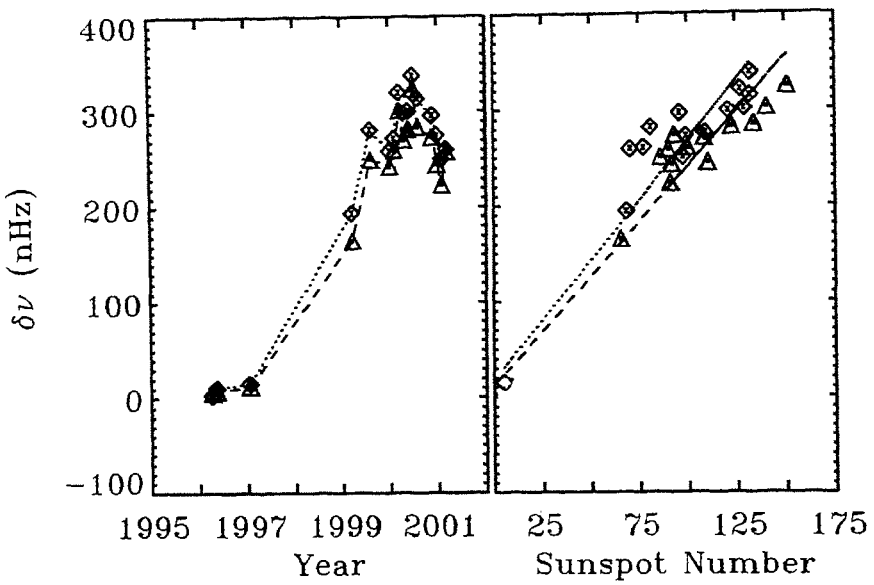

Figure 1. Calculated mean frequency shifts for 18-d (diamonds) and 27-d (triangles) are plotted as a function of time and activity index represented by sunspot number. The dotted line in the right panel is the linear fit for 18-d and dashed line is for 27-d. The error bars of mean shifts has a magnitude of ≈ 2 nHz.

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