HOW GOOD ARE THE PREDICTIONS FOR OSCILLATION FREQUENCIES?

KIRAN JAIN, S.C. TRIPATHY and A. BHATNAGAR

Udaipur Solar Observatory, A Unit of Physical Research Laboratory, Off Bari Road, Dewali,
P.B. No. 198, Udaipur 313001, India

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Abstract. We have used available intermediate degree \(p\)-mode frequencies for solar cycle 23 to check the validity of previously derived empirical relations for frequency shifts (Jain et al., 2000). We find that the calculated and observed frequency shifts during the rising phase of cycle 23 are in good agreement. The observed frequency shift from minimum to maximum of this cycle as calculated from MDI frequency data sets is \(251 \pm 7\) nHz and from GONG data is \(238 \pm 11\) nHz. These values are in close agreement with the empirically predicted value of \(271 \pm 22\) nHz.

1. Introduction

An understanding of the physical processes responsible for the changes in the solar \(p\)-mode frequencies could provide an important clue to the inner workings of the solar activity cycle. It is now well established that these frequencies change with time (Woodard and Noyes, 1985) and show a positive correlation with activity indices (Woodard et al., 1991; Bachmann and Brown, 1993). Over the last two decades, attempts have been made to precisely measure the changes in \(p\)-mode oscillation frequencies. More recently, with the Global Oscillation Network Group (GONG) (Harvey et al., 1996) and Michelson Doppler Imager (MDI) on board Solar and Heliospheric Observatory (Scherrer et al., 1995) instruments, the measurements are made consistently with an accuracy of one part in \(10^5\) or better. These continuous data sets further confirm that the oscillation frequencies are well correlated with the activity indices (Jain, Tripathy, and Bhatnagar, 2000, and references therein). Following a different approach and using a data set of eight years between 1981 and 1989, Rhodes et al. (1993) reported that the frequency shifts are also correlated with the change in various activity indicators. This study was extended to the rising part of the cycle 23 by Jain et al. (2000, hereafter JTBK). Using the GONG frequencies for the period May 1995 to October 1998, they confirmed that the frequency shifts are better correlated with the change in activity indices. In an attempt to quantify the changes in mode frequencies, JTBK derived empirical relations between the shift in frequencies and change in the level of activity indices and showed that these relations do not change significantly from cycle to cycle. Using a limited data set from the GONG network for the ascending part of the