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High-frequency interference peaks in solar-like stars

C. Karoff [1,2]

[1] Department of Physics and Astronomy, University of Aarhus, Denmark
[2] Danish AsteroSeismology Centre, University of Aarhus, Denmark

Introduction

The oscillation modes we observe in solar-like stars are the eigenmodes of the stars. This means that these modes are the sound waves that make constructive interference with themselves inside the stars and, in order for a wave to make constructive interference, it needs to be reflected somewhere. The p modes in solar-like stars are reflected by the stellar atmosphere, but this reflection only takes place up to a given frequency – known as the acoustic cut-off frequency. But from observations of the Sun (García et al. 1998) and α Cen B (Kjeldsen et al. 2005) we know that these stars do show oscillations with frequencies above the acoustic cut-off frequency. These oscillations are known as High-frequency Interference Peaks (HIPs).

Analysis

Two different models exist for explaining the nature of these oscillations known as HIPs. Balmforth & Gough (1990) have suggested that the HIPs are due to reflection of ordinary p modes at the transition layer between the chromosphere and the corona. Kumar & Lu (1991) on the other hand have argued that constructive interference between a direct and a reflected wave from a source just below the photosphere could cause the HIPs. The two different models predict different behaviour of the frequency separations of the HIPs (equivalent to the large separation for the p modes) as a function of frequency. It is the plan for future work to use the model predictions of the large separation to evaluate the success of the model in predicting the observations.

In order to evaluate the two different models of HIPs I have carried out the same data analysis to the Sun, β Hydri and α Cen A & B. The data on the Sun are from the GOLF instrument on SOHO, while the data on β Hydri and α Cen A & B are from UCLES at AAT, HARPS at La Silla or UVES at VLT (see: García et al. 2005, Bedding et al. 2007, Butler et al. 2004, Kjeldsen et al. 2005). In order to see the HIPs I have calculated the echelle diagram of half the large separations for the 4 stars and smoothed them with a Gaussian PSF with a FWHM of $\Delta\nu/16$ in the horizontal and 8 echelle orders in the vertical direction. This is a technique that is well known from image manipulation – that one increases the contrast in an image by defocusing it a little bit. The large separations can then be obtained as the peak in each echelle order in the echelle diagram. The obtained large separations are shown in Fig. 1.

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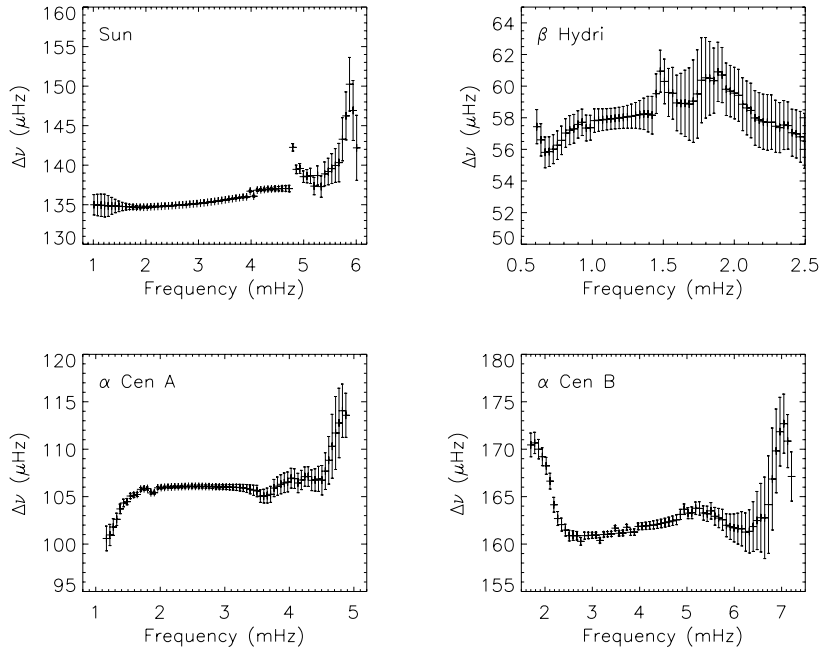

Figure 1: The large separation as a function of frequency.

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