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Magnetic perturbations to pulsations in stellar models of roAp stars

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Abstract. Magnetic perturbations to the frequencies of low degree, high radial order oscillations in stellar models permeated by a large scale magnetic field are presented. Results are shown for different configurations of the magnetic field. Examples of the effect that these perturbations might have on the power spectra of roAp stars are given.

Key words. Stars:variable – Stars: magnetic – Stars: peculiar

1. Introduction

Magnetic perturbations to the oscillations of stars permeated by an intense, large scale magnetic field have been computed by Dziembowski & Goode (1996), Bigot et al. (2000), Cunha & Gough (2000) and Saio & Gautschy (2004). These authors used a singular perturbation approach, that takes into account the fact that in the surface layers the magnetic effect on the oscillations cannot be treated as a small perturbation. In Cunha & Gough (2000) a variational approach to the calculation of the frequency shifts was applied. The present work follows that same approach and, except for the differences listed in the next session, the calculations were performed under the same approximations.

2. Model

Two main differences exist between the present study and that of Cunha & Gough (2000), namely, the equilibrium model and the configuration of the magnetic field.

Instead of the polytropic model used by Cunha & Gough (2000), in the present work we use a standard stellar model produced with the CESAM code (Morel 1997), obtained from the grid at www.astro.up.pt/corot/models/cesam/. The global parameters of the model are given in table 1. Moreover, three different magnetic field configurations were considered, namely, dipolar, quadrupolar, and a sum of aligned dipolar and quadrupolar components with the same polar strengths. Further results will be published in Cunha (2005).

3. Results

Figure 1 shows the schematic power spectra predicted with the model of table 1 for a dipolar and a quadrupolar magnetic field.

It is clear from the figure that the anomalies in the power spectrum, relatively to that expected in the absence of a magnetic field, depend on the *magnetic field configuration* and

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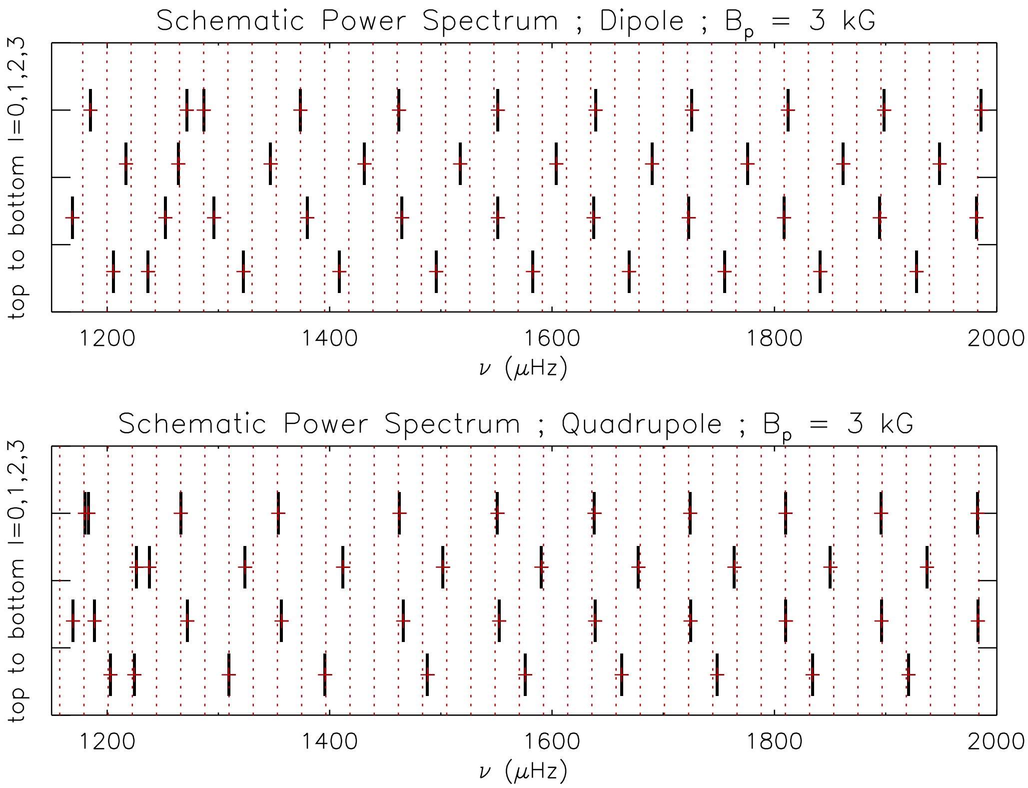

Fig. 1. Predicted schematic power spectra including the magnetic perturbations. Two magnetic configurations are shown, both with polar strength of 3kG. Within each panel, symbols show the position of modes of different degrees - $l = 0$ (1st line), $l = 1$ (2nd line), $l = 2$ (3th line), $l = 3$ (4th line). The position of the modes of different degree has been moved vertically. The vertical doted lines are used to guide the eye.

Table 1. global parameters of the model used in the computations. The Symbols have their usual meanings and are given in solar units.

Model	$M/M_\odot$	$R/R_\odot$	$T_{\rm eff}$	$\log(L/L_\odot)$
ZAMS	1.8	1.57	8362 K	1.035

on the *degree* of the modes considered. Also, the anomalies may be positive, meaning that a mode might have its frequency suddenly increased by a significant amount, or negative, if the opposite happens, compared to the frequency it would have in the absence of the magnetic field. In the case of a dipolar magnetic field the anomalies are found to be always negative, confirming the results of Cunha & Gough (2000) for polytropic models.

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