Radial and Nonradial Pulsations as Probes of Stellar Physics
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53 Piscium, an SPB Star with Activity

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1. Introduction

The star 53 Psc (HD 3379, B2.5 IV) has been observed as variable by several authors (Sareyan et al., 1979) with frequencies around $10\,\mathrm{c\,d^{-1}}$ and has been classified as a β Cephei star. Conversely, other authors (e.g. Percy, 1971) found it to be constant.

New high resolution, high signal-to-noise ratio, spectroscopic observations have been performed at the Observatoire de Haute-Provence in 1996 over 11 nights. The spectral domain covers around 200 Å and is centered on Hδ. Radial velocities were deduced from an auto-correlation technique with a scatter around $0.4\,\mathrm{km\,s^{-1}}$.

No high frequency variations are observed. Three frequencies have been detected with a false alarm detection above the 1 % level. A fourth one may be present but its amplitude is below this 1 % level. Results are displayed in Table 1.

Table 1. Results provided by the sine-fit with the 4 detected frequencies simultaneously applied to the correlation data set. The residuals (rms) are $0.37\,\mathrm{km\,s^{-1}}$, the uncertainty of the $2K$ amplitudes is $0.1\,\mathrm{km\,s^{-1}}$.

Frequency $[\mathrm{c\,d^{-1}}]$	$2K$-amplitude $[\mathrm{km\,s^{-1}}]$
$\nu_1 = 1.81$	2.24
$\nu_2 = 0.11$	1.92
$\nu_3 = 1.22$	1.38
$\nu_4 = 1.57$	0.92

Considering its position in the HR Diagram and the observed ν_1, ν_3 and ν_4 frequencies, 53 Psc must be classified as an SPB star. The ν_2 frequency is too low for an SPB star. However, this observed value can be due to a frequency shift due to rotation ($\nu_{\mathrm{obs}} = \nu_0 - m(1 - \frac{1}{\ell(\ell+1)})\Omega$, Cox, 1980). For instance, with an $(\ell, m) = (3, 3)$ mode, ν_2 becomes $0.385\mathrm{c\,d^{-1}}$ in the co-rotating frame, thus compatible with an SPB typical frequency.

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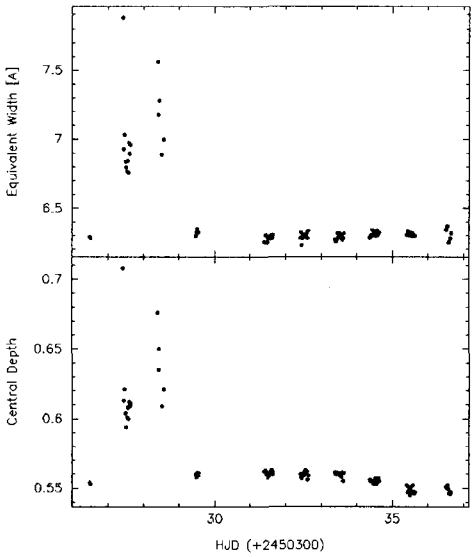

Figure 1. Equivalent width (upper panel) and central depth (lower panel) of the Hδ line as a function of time.

2. Activity

A main result of this study is the unexpected variations of the equivalent widths and central depths of the lines. Two phenomena appear (Fig. 1):

- a smooth variation present on all lines with a time scale of 10 days which could be related to the stellar rotation and a magnetic field.
- a sudden and important increase (20 %) of the equivalent widths and central depths of Hδ and He I lines occurs on two consecutive nights.

These variations in the equivalent width are mainly due to the increase of the central depths. This suggests the existence of NLTE effects due to the low density plasma in the upper layers of the stellar atmosphere. A transition from B-type to Be-type can be invoked.

References

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