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Two Modes of Pulsation in the Rapidly Rotating O9.5 Dwarf, HD 93521

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Abstract. We present preliminary results of a time-series analysis on the He II λ4541Å, Si III λλ4552, 4567, 4575Å and Hβ λ4861Å lines of the late O-type dwarf, HD 93521. The spectra show line-profile variations (lpv) – 'bumps' and 'dips' – of amplitude ∼ 1% of the continuum, moving systematically redwards through the photospheric absorption lines. The analysis implies non-radial pulsation (NRP) as the origin for the lpv.

1. Introduction

HD 93521 is a rapidly rotating ($v_e \sin i = 400$ km s^{-1}, Lennon et al. 1991) O9.5 main-sequence star. Analysis of the UV P-Cyg profiles suggest that the stellar wind of HD 93521 forms a wind-compressed disc (Howarth & Reid 1993; Bjorkman et al. 1994). Fullerton (1990) identified lpv at ∼ 1% of the continuum. Subsequent time-series analyses (Fullerton, Gies & Bolton 1991, 1994; Howarth & Reid 1993) suggested that the photospheric velocity field of the star is dominated by a single prograde sectorial NRP ($\ell = -m = 9 \pm 1$).

2. Time-series analysis

New data were obtained in March 1994 with the WHT. They were analysed by using the Fourier technique of Baade (1988) and Gies & Kullavanijaya (1988). This technique incorporates the CLEAN algorithm (Roberts et al. 1987) which iteratively removes the aliasing associated with the sampling window. Two periods, $P_1 = 1.76$-hours and $P_2 = 2.90$-hours, were detected in the Si III triplet and in Hβ. An equatorial origin for the modulation is indicated by the absence of a detectable period in He II (confined to the polar regions because of rotationally-induced gravity darkening). Coupled with the cylindrical symmetry, implied by the sinusoidal phase across the line profile, an interpretation in terms of prograde

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sectorial NRP is suggested, with mode identifications of P_1: $\ell = -m = 9 \pm 1$; and P_2: $\ell = -m = 5 \pm 1$.

3. Discussion

The amplitude of variation across the line profile indicates the ratio of the horizontal-to-vertical pulsation velocity, k. For the 2.90-hour period in Si III, $k \sim$ 0.0-0.2 (by comparison with NRP models, Reid 1994). However, in Hβ, $k \sim$ 1-2.

Lee & Saio (1990) have shown that NRP-generated temperature variations, when coupled to rapid rotation, may significantly affect the appearance of lpv. For a line which is temperature-sensitive, NRP with large k will produce lpv indicative of small k. For lines which are weakly affected by temperature variations only NRP velocity variations are observed (Reid 1994), thus preserving k.

The equivalent width of Si III λ4552Å is very sensitive to temperature variations of a few kK in HD 93521. However, the strength of Hβ remains relatively constant. Thus, Hβ should be more sensitive to velocity variations and therefore, k. This may explain the discrepancy in the sinusoidal semi-amplitudes seen between the Si III line and Hβ for the 2.90-hour period.

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