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Rapid radial velocity variations in the cool roAp star HD 99563 ⋆

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Abstract. In a high resolution spectroscopic study of the rapidly oscillating Ap (roAp) star HD 99563 with the Ultraviolet-Visual Echelle Spectrograph (UVES) on the Very Large Telescope (VLT) we have discovered remarkably large amplitude pulsations with some spectral lines showing radial velocity amplitudes up to 5 km s^{-1} (10 km s^{-1} peak-to-peak) with a pulsation period of 10.7 min.

Key words. Stars: pulsations – Stars: atmospheres – Stars: radial velocities

1. Introduction

HD 99563 belongs to the group of rapidly oscillating Ap (roAp) stars; these are chemically peculiar, strongly magnetic A stars that pulsate in high overtone acoustic modes with periods between 5 − 21 min. Photometric variability with a period of 11.2 min and amplitude 4.0 ± 0.4 mmag was discovered in HD 99563 by Dorokhova & Dorokhov (1998) in the Strömgren v filter. Handler & Paunzen (1999) obtained new photometric observations that confirmed that HD 99563 is a roAp star. Handler et al. (2005), in an intensive study of multi-site data, found a frequency quintuplet centred on 1557.653 μHz (10.7 min) with the amplitude modulated with the 2.91169-d rotation period of star and reaching a maximum amplitude of over 5 mmag (peak-to-peak) through a Johnson B filter, one of the largest photometric amplitudes among the roAp stars. We obtained 110 spectra of HD 99563 with a maximum resolution of R = 110 000 in 2004 March with UVES at the ESO VLT. The exposure time for each spectrum was 40 s with a overheads of 25 s. The CCD images were processed using the UVES pipeline.

⋆ Based on observations obtained at ESO, as part of programme 072.D-0138.

2. Rapid radial velocity

In HD 99563 we find the largest pulsation amplitudes for lines of some Rare Earth elements (REE) and in the core of the Hα line (Figs 1 and 2). The highest amplitudes of 5 km s^{-1} are seen in rather weak lines of Eu II and Tm II. Stronger lines of Pr III and Nd III have pulsation amplitudes in the range 0.7 to 3.5 km s^{-1} for different lines. In the narrow Hα core the average amplitude is 2.6 km s^{-1}, but, as is the case for other lines, the amplitude and phase vary strongly with line depth (atmospheric height) with the amplitude of the radial velocity varia-

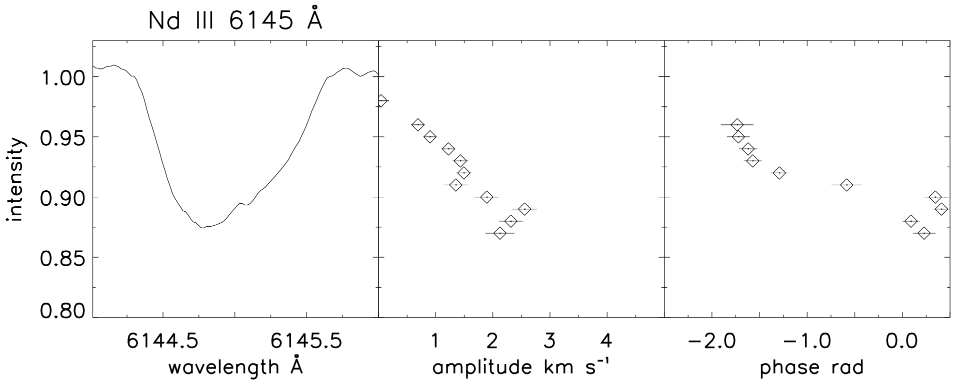

Fig. 1. Variations of the pulsation amplitude and phase as a function of line depth for the Nd III 6145 Å line. The left panel shows the line profile, the middle and right panels show the velocity amplitude and phase for the line bisector at various depths in the line. The amplitude increases with atmospheric height. The phase variations are possibly caused by varying contributions of the magnetic and acoustic components of the pulsation.

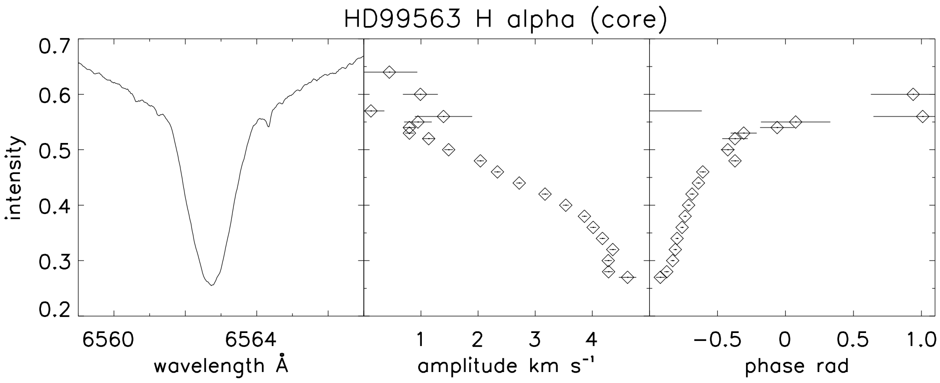

Fig. 2. Pulsation amplitude and phase as a function of line depth (atmospheric height) for the line bisector in the Hα core.

tions of the line bisector reaching a maximum of 4.3 km s^{-1} at the bottom of the core. Some other elements show pulsation amplitudes 0.1 to 0.7 km s^{-1}. Variations in velocity amplitude and phase for several spectral lines were studied using line-bisector measurements to obtain information about the vertical structure of the pulsation modes and the stellar atmosphere.

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