Long Term Variability of the Coronal and Post-Coronal Regions of the Oe Star HD 149757 (zeta Oph)

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Abstract. In the spectra of Oe and Be stars, many spectral lines present peculiar and complex profiles due to the fact that the observed absorption features are composed of two or more absorption components (Discrete or Satellite Absorption Components - DACs/SACs). Here we detected the presence the SACs phenomenon in the C IV, N IV and N V spectral lines in 11 spectra of the Oe star HD 149757 (zeta Oph), taken with IUE during a period of 13 years.

Keywords: stars: Oe, HD 149757; stars: line profiles – absorption components
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INTRODUCTION

HD 149757 (ζ Oph) is a bright O9V(e) star [1], rapidly rotating and a strong non radial pulsator [2, 3] that, on occasion, shows the distinct Hα emission [4].

Hoogerwerf et al. [5] consider it as runaway star from Sco OB2 association. (Binary Supernova Scenario, BSC).

In this paper, applying the Gauss-Rotation (GR) model [6, 7] to the star HD 149757, we study the C IV, N IV and N V regions through the variation of kinematical parameters, such as the apparent rotational and radial velocities, as well as the random velocities of the thermal motions of the ions.

THE STUDY OF THE CORONAL AND POST-CORONAL REGIONS OF THE MOVING ATMOSPHERE OF THE Oe STAR HD 149757

In Fig. 1a,b,c we present a spectral line from each of C IV, N IV and N V regions and their best fit. In the graph below each profile, we present the difference between the fit and the observed spectral line. Below the fit, is the decomposition of the observed profile to its SACs.

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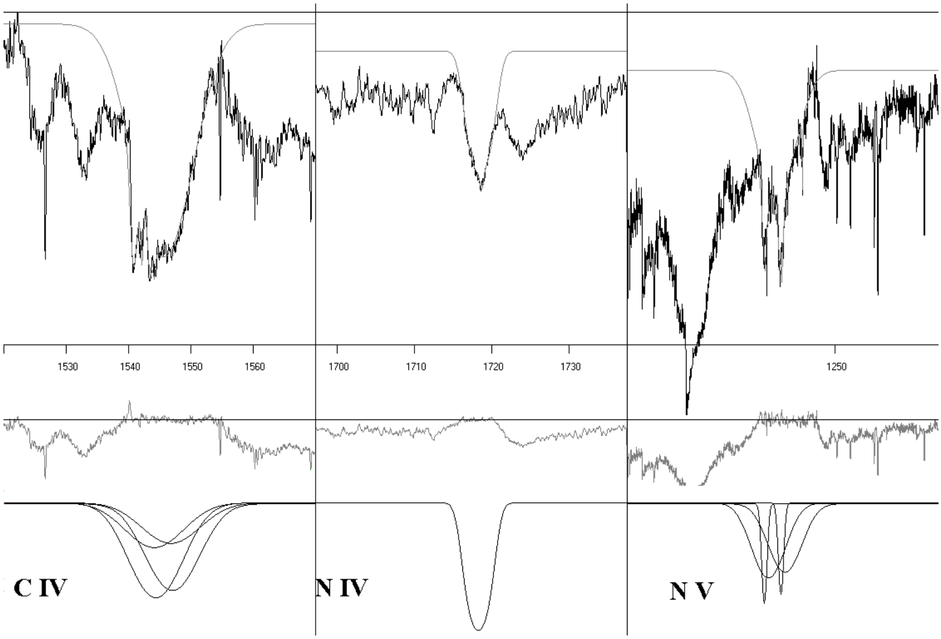

FIGURE 1a, b, c. The best fit of the C IV, N IV and N V resonance lines with two components in the spectrum of the star HD 149757. The graph bellow the fit indicates the differences between the observed spectrum and the fit. Below, one can see the decomposition of the observed profile to its SACs.

The Study of the C IV Density Regions

In Fig. 2a,b we present the time-scale change of the apparent rotational and radial velocities of the independent density regions of matter, which create the 2 satellite components of the C IV resonance lines (λλ 1548.155, 1550.774 Å).

In the case of the rotational velocities (Fig. 2a) and in the years 1980, 1981, 1990, 1991, relatively low values of about 300 km/s correspond to the spectra that we fit with the Gaussian way. This means that for these spectra the main reason for the line broadening is the random ion motions. All the rest spectra were fitted with the Rotational method, i.e. the main reason for the line broadening is the rotation of the region which creates the respective component. Apart from these values, we see a constant behavior of the apparent rotational velocities with values of about 1400 km/s for the first component and about 950 km/s for the second one. The marks x and + correspond to the spectra in which the best fit has been obtained with the Gaussian method. In the case of the radial velocities (Fig. 2b) we detect also a constant behavior with values of about -800 km/s for the first component and of about -700 km/s for the second component.

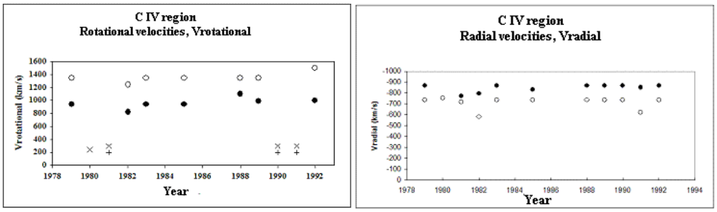

FIGURE 2a,b. Timescale variations of the apparent rotational velocities V_{rot} (km/s) (left) and radial velocities V_{rad} (km/s) (right) of the two C IV line components between the years 1979 and 1992.

The Study of the N IV Density Region

In Fig. 3a,b we present the timescale changes of the apparent radial velocities V_{rad} (km/s) and the random velocities V_{rand} (km/s) of the density region where the N IV (λ 1718.8 Å) spectral line is created.

In the case of the radial velocities (Fig. 3a) we detect a constant behavior with values lower than -50 km/s.

In the case of the random velocities (Fig. 3b), the values of about 100 km/s correspond to the spectra fitted with the Rotational method. This means that in these spectra the random ion velocities are not dominant. The values between 350 and 400 km/s (points ×) correspond to the spectra fitted with the Gaussian method.

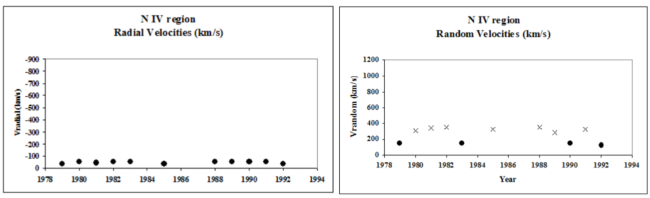

FIGURE 3a,b. Timescale variations of the apparent radial velocities V_{rad} (km/s) (left) and the random velocities V_{rand} (km/s) (right) of the density region where the N IV λ 1718.8 Å spectral line is created.

The Study of the N V Density Regions

In Figs. 4a,b we present the timescale variations of the values of the apparent radial velocity V_{rad} (km/s) and the random velocities V_{rand} (km/s) of the ions, in the density regions which create the two or three absorption components of the N V resonance lines at λλ 1238.821, 1242.804 Å.

For the radial velocities (Fig. 4a) we detect a constant behavior with values of about -1160 km/s for the first component (points o), of about -1400 km/s for the second (points ●) and about -1450 km/s for the third one (points Δ).

For the random velocities (Fig. 4b) we calculate values of about 1000 km/s for one satellite component and values of about 200 km/s for the others (points ×). The points ● correspond to the spectral lines which are best fitted with the Rotational method.

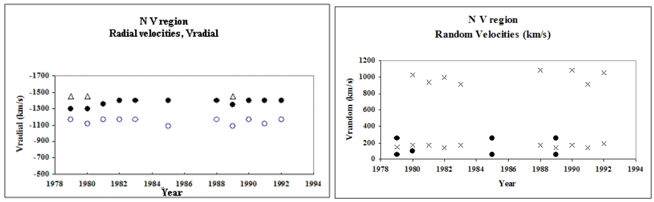

FIGURE 4a,b. Timescale variations of the values of the apparent radial velocity V_{rad} (km/s) (left) and the random velocities V_{rand} (km/s) (right) for the independent density regions of matter which create the 2 or 3 satellite components of the N V resonance lines at λλ 1238.821, 1242.804 Å.

CONCLUSIONS

The detected timescale variation of the parameter values in the C IV, N IV and N V density regions in the UV spectrum of the Oe star HD 149757 indicate that the radial, rotational and random velocities present only small variations. This fact lead us to accept that the matter which creates DACs/SACs remains, practically, stable during the studied period of 13 years. Another explanation of this phenomenon is that in the area where we can detect high density regions, matter flows and only the physical properties (conditions), which lead to the high density, remain stable (e.g. magnetic fields, shocks from a companion in the case of a binary system)

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