The N IV region in the spectra of 20 Oe stars

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Introduction

As it is already known, some of the spectral lines of many Oe and Be stars present Discrete Absorption Components (DACs) which, due to their profiles' width, as well as the values of the radial velocities, create a complicated profile of the main spectral lines (Bates & Halliwell, 1986). The DACs are not unknown absorption spectral lines, but spectral lines of the same ion and the same wavelength as a main spectral line, shifted at different Δλ, as they are created at different density regions which rotate and move radially with different velocity (Danezis et al. 2003a).

However, if the regions that give rise to such lines rotate with large velocities and move radially with small velocities, the produced lines have large widths and small shifts. As a result they are blended among themselves as well as with the main spectral line and thus they are not discrete. In such a case the name Discrete Absorption Component is inappropriate and we use only the name Satellite Absorption Components (SACs).

Here we analyze the presence of Satellite Absorption Components (SACs) in the N IV spectral lines of 20 Oe stars of different spectral subtypes and we study the physical parameters which characterize the N IV density regions in the atmospheres of 20 Oe stars. We apply the method proposed by Danezis et al. (2003, 2005) on the spectra of 20 Oe stars, taken with I.U.E. We found that the N IV spectral line consists of one or two Satellite Absorption Components. We calculate the values of the apparent rotational and radial velocities, the Gaussian standard deviation of the random motions of the ions, the random velocities of these motions, as well as the optical depth, the column density, the Full Width at Half Maximum (FWHM), the absorbed and the emitted energy of the independent regions of matter which produce the main and the satellites components of the studied spectral lines. Finally, we present the variations some of these physical parameters as a function of the spectral subtype.

Method of spectral analysis

In order to study the N IV resonance lines of 20 Oe stars, we use the so-called G(Gauss)R(Rotation) – Model proposed by Danezis et al. (2005, 2007).

It is already known that two dominant reasons for line broadening are the rotational velocity of the spherical region, which creates the line and the random velocities of the ions, causing Doppler broadening. Danezis et al. (2005, 2007) proposed a new approach, which includes both of these factors in the calculation of the final line function. We consider that the area of gas, where a specific spectral line is created, consists of independent absorbing shells followed by independent shells that both absorb and emit and an outer absorbing shell. Such a structure produces DACs or SACs (Danezis et al. 2003).

We apply the method proposed by Danezis et al. (2003, 2005), Nikolaidis et al. (2006) and Danezis et al. (2007) on the N IV resonance lines of 20 Oe stars and we calculate some parameters of the regions that construct these spectral lines which present DACs or SACs, as the apparent rotational and radial velocities, the Gaussian deviation of the ions' random motions, the random velocities of these motions, as well as the optical depth, the Full Width at Half Maximum (FWHM), the absorbed and the emitted energy of the independent regions of matter which produce the main and the discrete or satellite components (DACs, SACs) of the studied spectral lines.

Observational data

This study is based on the analysis of 20 Oe stellar spectra taken with the IUE – satellite (IUE Database http://archive.stsci.edu/iue) and we examine the complex structure of the N IV spectral line (λ 1718.8 Å). Our sample includes the subtypes O4 (one star), O6 (four stars), O7 (five stars) O8 (three stars) and O9 (seven stars). In our sample we detect that the N IV spectral line consists of two components in 17 stars, and one in 3 stars.

The variation of the physical parameters in the N IV regions of 20 Oe stars, as a function of the spectral subtype

In Fig. 1, we present the N IV spectral line of the O9 star HD 24534 and its best fit. The best fit has been obtained with two SACs. The graph below the profile indicates the difference between the fit and the real spectral line. Below the fit we present the analysis of the observed profile to its SACs.

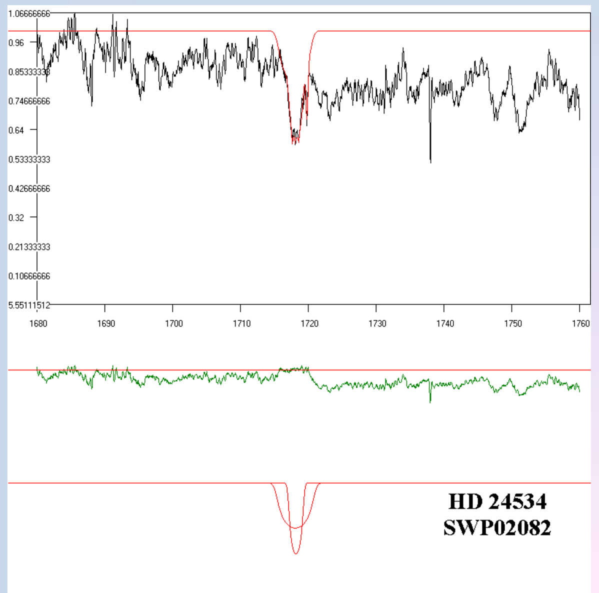

FIGURE 1: The N IV λ 1718.8 Å spectral line in the spectrum SWP 02082 of HD 24534. The N IV spectral line consists of two SACs. Below the fit we present the analysis of the observed profile to its SACs.

In the following Figures we see the variation of the physical parameters in the N IV regions of 20 Oe stars, as a function of the spectral subtype. Specifically:

In Figs. 2, 3, 4, 5 and 6 we present the variation of the mean values of the radial velocities, the random velocities, the Full Width at Half Maximum (FWHM), the absorbed energy (Ea) in eV and the Column Density (CD) in 10^{10} cm^{-2} of the ions, for the N IV independent density regions of matter (SACs) which create the 1 or 2 satellite components in the λ 1718.8 Å N IV spectral line, as a function of the spectral subtype, respectively.

The radial velocities

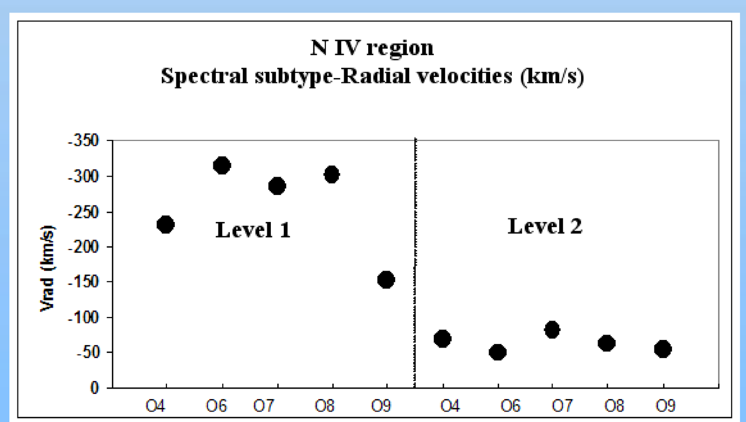

FIGURE 2. Variation of the radial velocities of the N IV spectral line (λ 1718.8 Å) for the independent density regions of matter which create the 1 or 2 SACs as a function of the spectral subtype. There are two levels of values of the radial velocities. The first level has values between -350 and -150 km/s and the second level has values about -70 km/s.

The Random Velocities

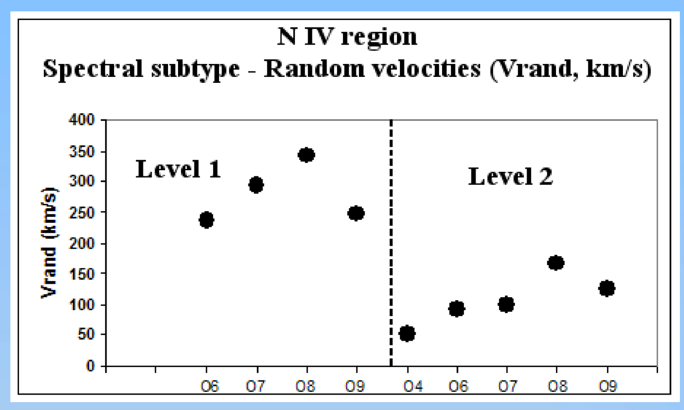

FIGURE 3. Variation of the mean random velocities of the ions of the N IV spectral line (λ 1718.8 Å) for the independent density regions of matter, which create the 1 or 2 SACs as a function of the spectral subtype. We detected two levels of random velocities. The first level has values between 350 and 220 km/s and the second level has values between 150 and 50 km/s.

Full Width At Half Maximum (FWHM)

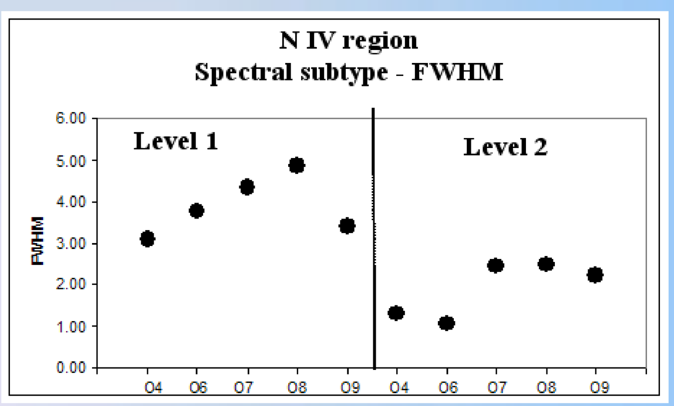

FIGURE 4. Variation of the mean value of the Full Width at Half Maximum (FWHM) of the N IV independent density regions of matter which create the 1 or 2 SACs as a function of the spectral subtype. We detected two levels of values of the FWHM. The first level has values between 5 and 3 Å and the second level has values between 2 and 1 Å.

The Absorbed Energy

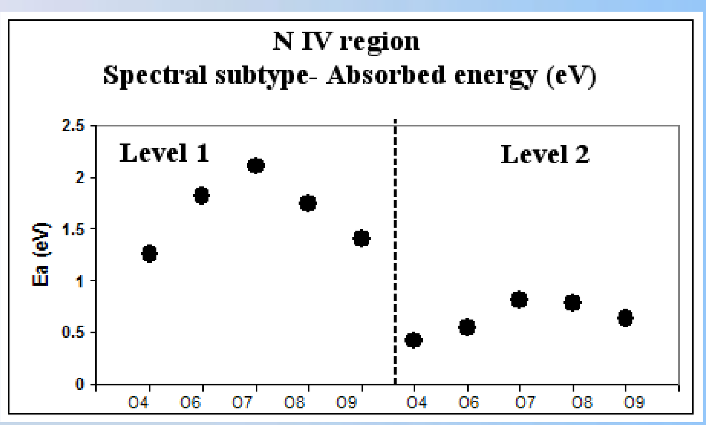

FIGURE 5. Variation of the absorbed energy (Ea) in eV of the N IV spectral line λ 1718.8 Å for the independent density regions of matter which create the 1 or 2 satellite components as a function of the spectral subtype. We can see two levels of values of the absorbed energy. The first level has values between 2 and 1.2 eV and the second level has values between 0.6 and 0.4 eV.

The Column Density

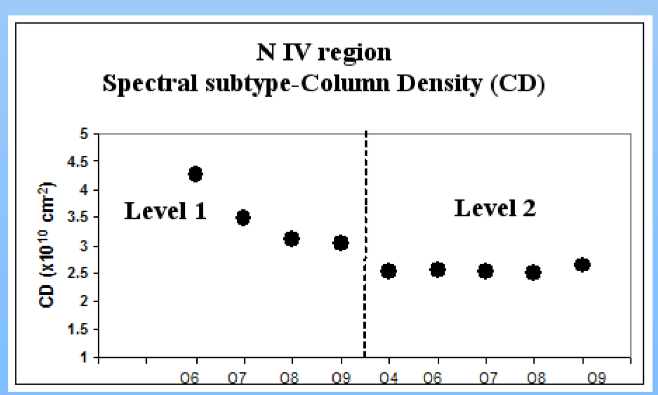

FIGURE 6. Variation of the Column Density (CD) in 10^{10} cm^{-2} of the N IV resonance line λ 1718.8 Å for the independent density regions of matter which create the 1 or 2 satellite components as a function of the spectral subtype. We can see two levels of values of the column density. The first level has values between 4.5×10^{10} cm^{-2} and 3×10^{10} cm^{-2} and the second level has a constant behavior with values about 2.5×10^{10} cm^{-2}.

RESULTS

Franco et al. 1983, Bates & Halliwell 1986, Cranmer & Owocki 1996) noted that there are two mechanisms which create the radial velocities. The first one creates high radial velocities and the second one creates low velocities. We also detect the same phenomenon in others parameters, as the random velocities, the Full Width at Half Maximum (FWHM), the absorbed energy and the column density. All these parameters present two levels of values. The first has high values and the second has low values.

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