Hyper ionisation phenomena in the N IV region in 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).

In this paper, using the method that Danezis et al. (2003, 2005a,b) and Nikolaidis et al. (2006) proposed and using I.U.E - spectra we detect the presence of this phenomenon (DACs or SACs) in the C IV resonance lines of 20 Oe stars of different spectral subtypes. We calculate, for each component, the variations of the mean values of the Gaussian standard deviation, which contributes to the line broadening, the ions' random velocities, the Full Width at Half Maximum (FWHM), the absorbed energy and the column density, as a function of the spectral subtype.

THE GAUSSIAN - ROTATIONAL MODEL (GR-MODEL)

With Danezis et al. (2003, 2005a,b) and Nikolaidis et al. (2006) GR model we can calculate many parameters of the regions that construct spectral lines which present DACs or SACs, such 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 and the product of the Source function S and the optical depth ξ of the independent regions of matter which produce the main and the discrete or satellite components (DACs, SACs) of the studied spectral lines.

THE VARIATION OF THE PHYSICAL PARAMETERS IN THE N IV REGIONS IN 20 Oe STARS AS A FUNCTION OF THE SPECTRAL SUBTYPE

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 star.

In Fig. 1, we present the N IV spectral line of the O4 star HD 24534, and its best fit. The best fit has been obtained with 2 SACs. The graph below the profile indicates the difference between the fit and the real spectral line.

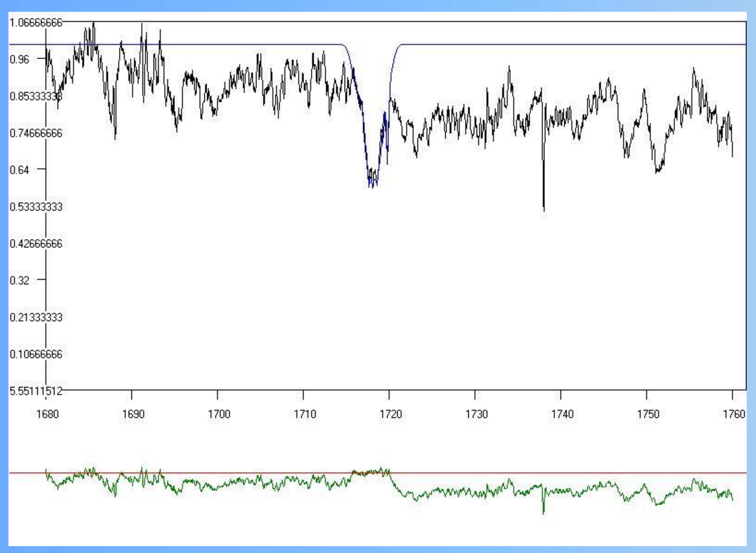

FIGURE 1: The N IV λ 1718.8 Å spectral line in the spectrum SWP 02082 of HD 24534. The N IV spectral line consists of two SACs.

The Gaussian standard deviation

In Fig. 2 we present the variation of the mean values for each component and of each spectral subtype of the Gaussian standard deviation 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. It is already known that the Gaussian standard deviation is a parameter which contributes to the line broadening.

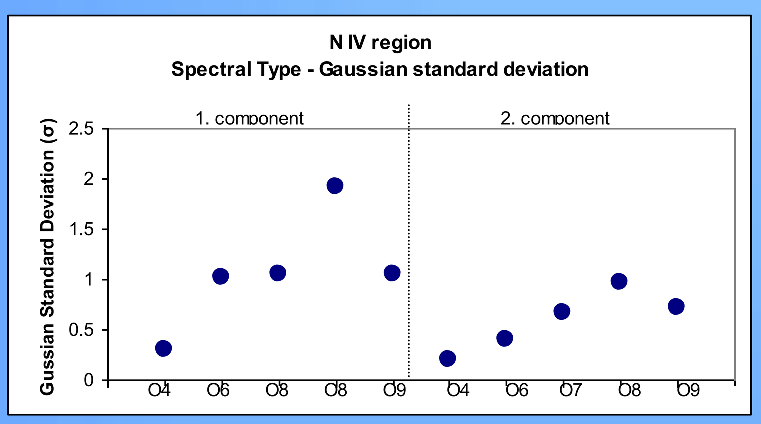

FIGURE 2. Variation of the Gaussian standard deviation of the N IV spectral line (λ 1718.8 Å) for the independent density regions of matter which create the 1 or 2 SACs as a function of the spectral subtype.

The Random Velocities

In Fig. 3 we see the variation of the mean values of the random velocities 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.

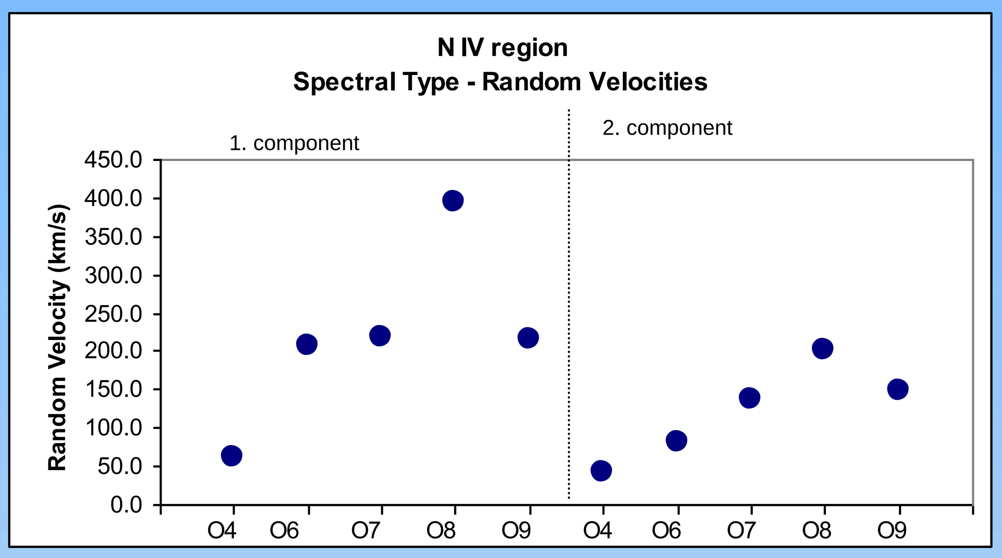

FIGURE 3. Variation of the mean random velocities of the ions of the N IV spectral line (λ 1718.8 Å) for the independent density regions of matter, which create the 1 or 2 SACs as a function of the spectral subtype.

Full Width At Half Maximum (FWHM)

Fig. 4 indicates the variation of the mean value of the Full Width at Half Maximum (FWHM) for the N IV independent density regions of matter which create the 1 or 2 satellite components in all the stars of our sample, as a function of the spectral subtype.

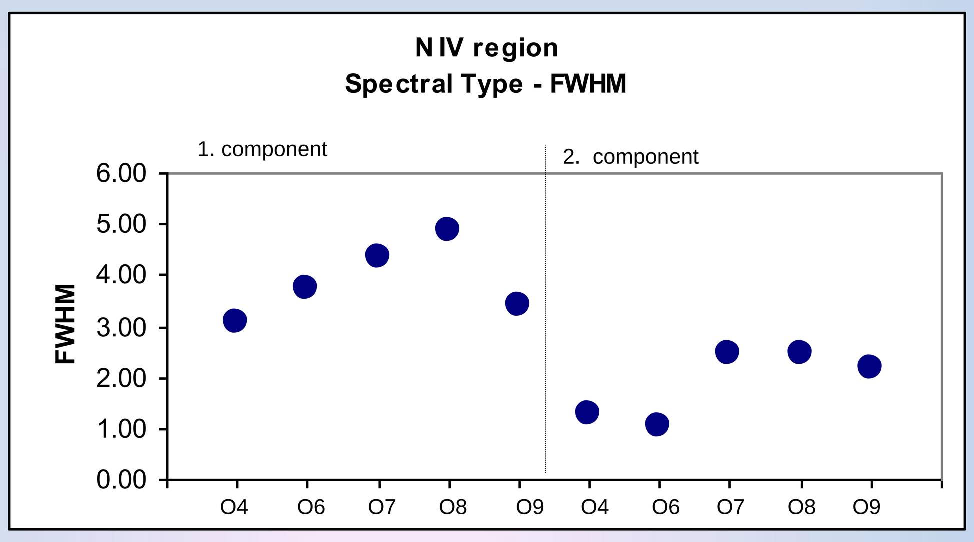

FIGURE 4. Variation of the mean value of the Full Width at Half Maximum (FWHM) for the N IV independent density regions of matter which create the 1 or 2 SACs as a function of the spectral subtype.

The Absorbed Energy

In Fig. 5 we present the variations of the absorbed energy (Ea) in eV, of the λ 1718.8 Å N IV spectral line for all the independent density regions of matter, which create the 1 or 2 satellite components in all the stars of our sample, as a function of the spectral subtype.

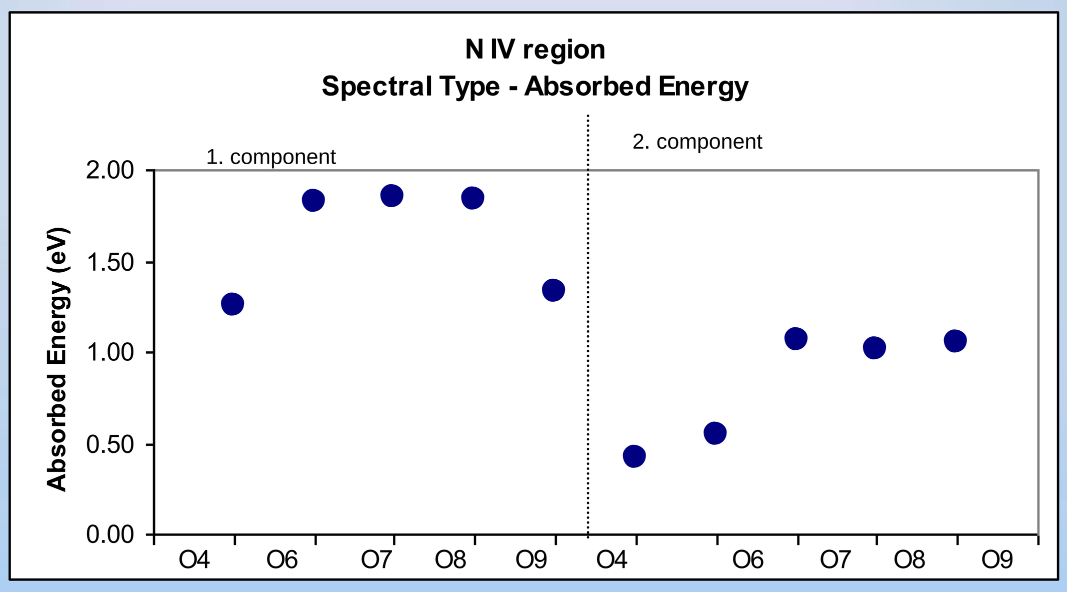

FIGURE 5. Variation of the absorbed energy (Ea) in eV of the N IV spectral line λ 1718.8 Å for the independent density regions of matter which create the 1 or 2 satellite components as a function of the spectral subtype.

The Column Density

Fig. 6 show the variation of the Column Density (CD) in 1010 cm-2 of the λ 1718.8 Å N IV spectral lines for the independent density regions of matter which create the 1 or 2 satellite components in all the stars of our sample as a function of the spectral subtype.

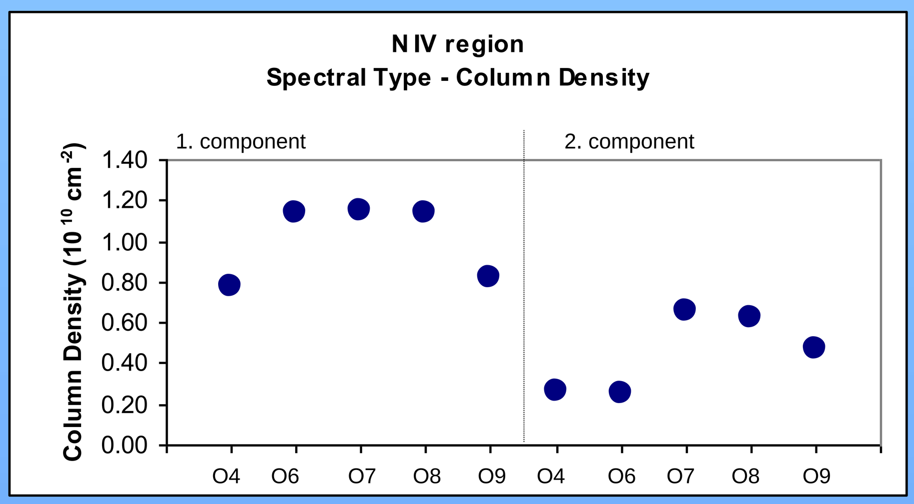

FIGURE 6. Variation of the Column Density (CD) in 1010 cm-2 of the N IV resonance line λ 1718.8 Å for the independent density regions of matter which create the 1 or 2 satellite components as a function of the spectral subtype.

RESULTS

Gaussian standard deviation: From the diagram in Fig. 2 we can conclude that the first component in all stars present higher mean values of the Gaussian standard deviation than the second one. This means that the first component contributes more to the line broadening. We also point out that for each component the variation as a function of the spectral subtype is the same.

Random velocities: The random velocities (Fig. 3) present the same image with the respective image of the Gaussian standard deviation (Fig.2).

Full Width at Half Maximum (FWHM): The Full Width at Half Maximum (FWHM) (Fig. 4) presents also the same image with the respective image of the random velocities (Fig. 3) and the Gaussian standard deviation (Fig. 2).

The absorbed energy: The variation of the absorbed energy (Fig. 5) present a decreasing trend from the first to the second component.

The column density: Similarly with the absorbed energy, the column density (Fig. 6) presents a decreasing trend from the first to the second component. It is remarkable that both of these absorption parameters present exactly the same image.

REFERENCES

Bates, B. and Halliwell, D. R, *Mon. Not. R. astr. Soc.* **223,** 673-681 (1986).

Danezis, E., Nikolaidis, D., Lyratzi, V., Stathopoulou M., Theodossiou, E.,. Kosionidis, A., Drakopoulos, C.,. Christou, G. and. Koutsouris, P., A&SS, **284**, 1119 (2003).

Danezis, E.,. Nikolaidis, D., Lyratzi, E., Popović, L. Č., Dimitrijević, M. S., Theodossiou, E. and. Antoniou, A., Mem. S.A.It., in press (2005a).

Danezis, E., Nikolaidis, D., Lyratzi, E., Popović, L. Č., Dimitrijević M. S., Theodossiou E. and Antoniou A., Proceedings of 7th HEL.A.S. Conference, in press (2005b).

Nikolaidis, D.,. Danezis, E, Lyratzi, E., Popović, L. Č.,. Dimitrijević, M. S, Antoniou, A. & Theodossiou, E., Proceedings of XXVI IAU General Assembly, to be published (2006).