The photospherical and the respective C IV regions rotational velocities in 20 Oe stars

Antoniou, A.[1], Danezis, E.[1], Lyratzi, E.[1], Nikolaidis, D.[1], Popović, L. Č.[2], Dimitrijević, M. S.[2] and Theodossiou, E.[1]

1. University of Athens, Faculty of Physics, Department of Astrophysics, Astronomy and Mechanics,
Panepistimioupoli, Zographou 157 84, Athens – Greece

2. Astronomical Observatory, Volgina 7, 11160 Belgrade, Serbia

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 complex profile of the spectral lines [1]. 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 $\Delta\lambda$, as they are created at different density regions which rotate and move radially with different velocity [2,3].

However, if the regions that give rise to such lines rotate with large velocities and move radially with small velocities, the produced lines are much broadened and little shifted. 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 Components is inappropriate and we use only the name SACs (Satellite Absorption Components). We presented a model able to reproduce the complex profile of DACs or SACs and a method to study many parameters of the regions that construct this kind of spectral lines [2,3].

In this paper, using method [4, 5, 6] and, using I.U.E - spectra we study the relation between the rotational velocities of the CIV regions of 20 Oe stars and their photospheric rotational velocities.

The Gaussian-Rotational model (GR-model)

Using GR model [2, 3, 5, 6] we can calculate many parameters of the regions that construct 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 and the product of the Source function S and the optical depth ξ of the independent regions of matter, which produce the main line and the discrete or satellites components (DACs, SACs) of the studied spectral lines.

The relation between the photospheric and the respective CIV regions rotation velocities of 20 Oe stars

This study is based on the analysis of 20 Oe stellar spectra taken with the IUE –satellite (IUE Database http://archive.stsci.edu/iue). We examine the complex structure of the CIV resonance lines ($\lambda\lambda$ 1548.155 Å, 1550.774 Å). Our sample includes the subtypes O4 (one star), O6 (four stars), O7 (five stars) O8 (three stars) and O9 (seven stars). The values of the photospheric rotational velocities are taken from the catalogue [7]. In our study we detect that the CIV spectral lines consist of two components in 9 stars, three in 7 stars, four in 3 stars and five in one star. In Figs 1a, 2a, 3a and 4a we present the ratio Vrot/Vphot of the first, second, third and fourth detected component as a function of the photospheric rotational velocity (Vphot).

This ratio indicates how many times the rotational velocity of the specific C IV layer is higher than the apparent rotational velocity of the star. In Figs 1b, 2b, 3b and 4b we present the respective ions' random velocities (Vrandom) as a function of the photospheric rotational velocity, where Vrotational is the rotational velocity of the successive CIV regions that construct each of these components.

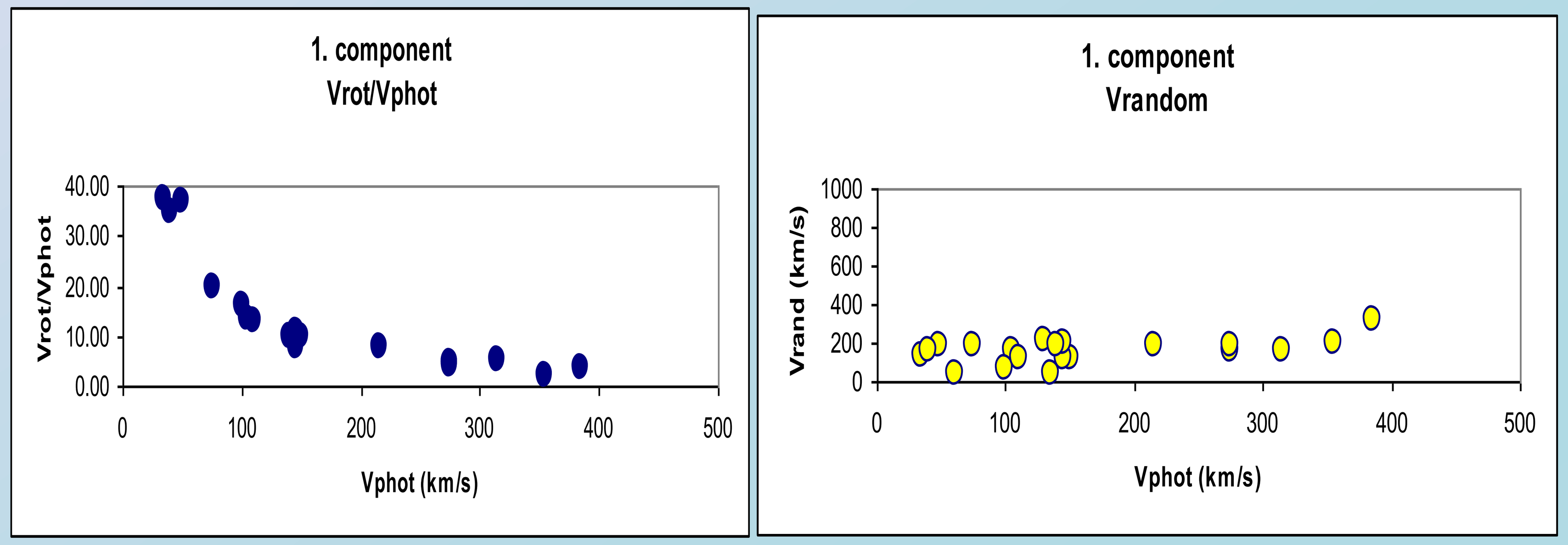

FIGURE 1a, 1b. The ratio **Vrotational/Vphotosphere (left)** and the ions' **random velocities** (right) as a function of the photospheric rotational velocity **Vphotosphere** of the first component in the sample of 20 Oe stars.

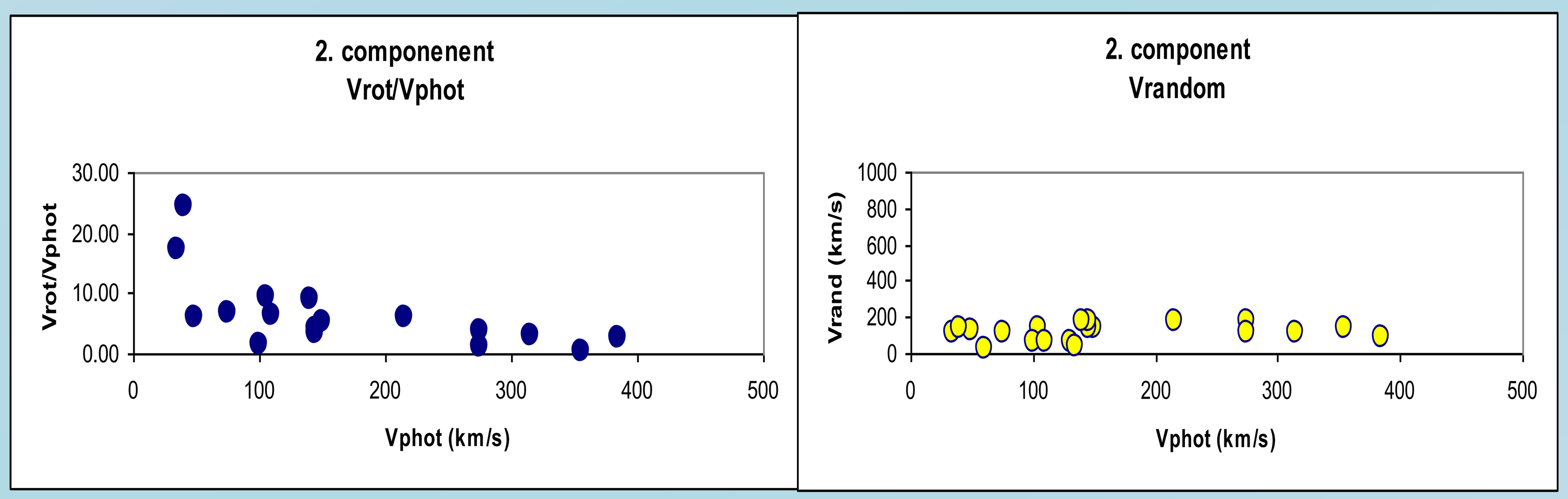

FIGURE 2a, 2b. The ratio **Vrotational/Vphotosphere (left)** and the ions' **random velocities (right)** as a function of the photospheric rotational velocity **Vphotosphere** for the second component in the sample of 20 Oe stars.

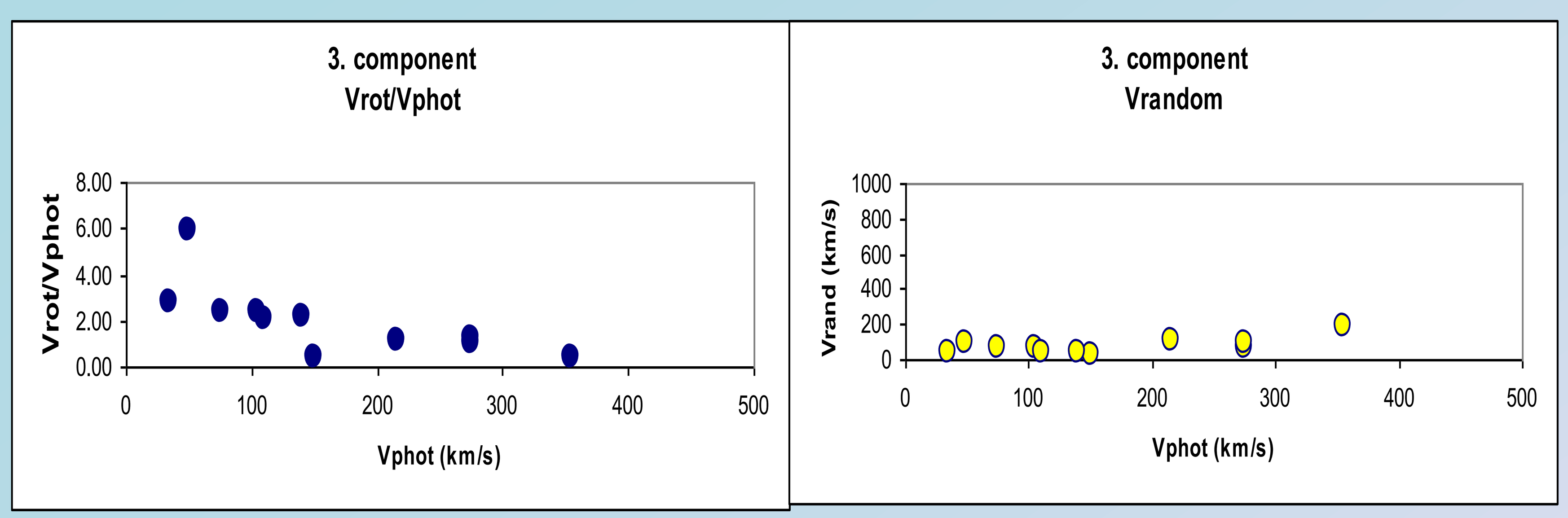

FIGURE 3a, 3b. The ratio **Vrotationalt/Vphotosphere (left)** and the ions' **random velocities (right)** as a function of the photospheric rotational velocity **Vphotosphere** for the third component in the sample of 20 Oe stars.

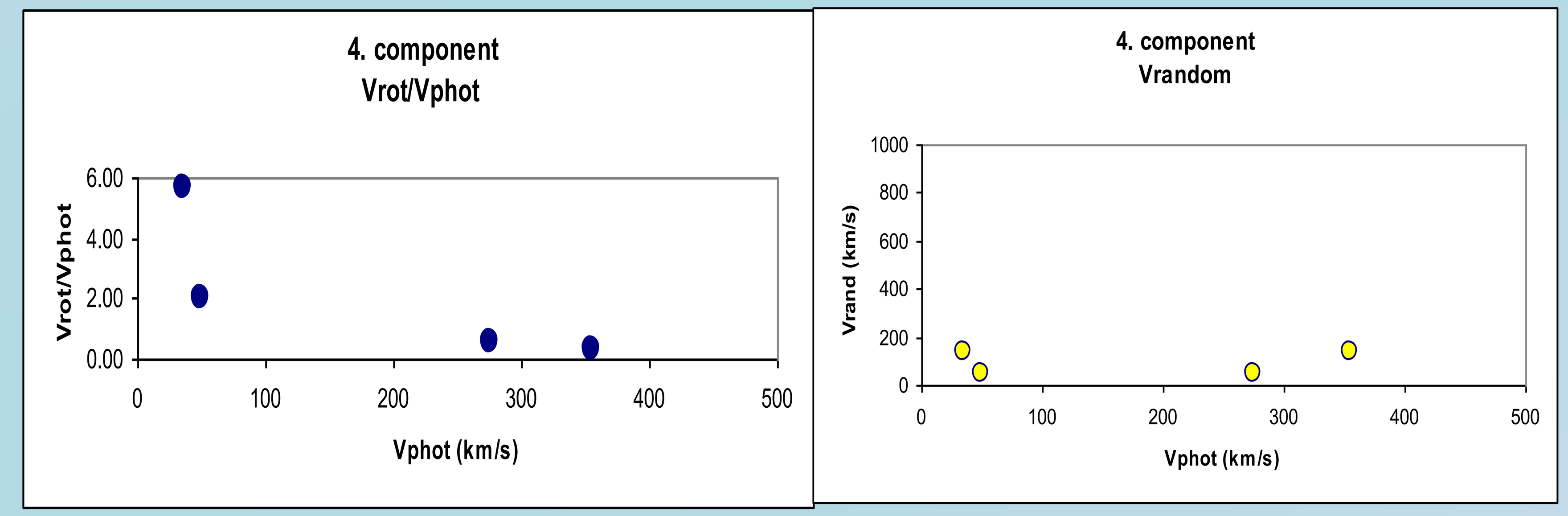

FIGURE 4a, 4b. The ratio **Vrotational/Vphotosphere (left)** and the ions' **random velocities (right)** as a function of the photospheric rotational velocity **Vphotosphere** for the fourth component in the sample of 20 Oe stars.

Results

In each region and for each component we can conclude that there exists a **logarithmic relation** between the ratio **Vrotational/Vphotpsphere** and the photospheric rotational velocity **Vphotosphere.** The maximum ratio Vrotational/Vphotpsphere varies from 40, for the first to 5 for the fourth component (Figures 1a, 2a, 3a, 4a). A possible explanation of this situation **is the inclination of the stellar axis.** In order to verify this hypothesis, we studied the ion's random velocities of each component for all the studied stars. As we know the ions' **random velocities do not depend on this angle**. This means that the mean values of the ions' random velocities **must be almost constant.** We can confirm this phenomenon in Figures 1b, 2b, 3b, 4b.

Acknowledgments

This research project is progressing at the University of Athens, Department of Astrophysics, Astronomy and Mechanics, under the financial support of the Special Account for Research Grants, which we thank very much. This work also was supported by Ministry of Science and Environment Protection of Serbia, through the projects "Influence of collisional processes on astrophysical plasma line shapes" and "Astrophysical spectroscopy of extragalactic objects".

References

1. B. Bates and D. R. Halliwell, *Mon. Not. R. astr. Soc.* **223,** 673-681 (1986).
2. E. Danezis, D. Nikolaidis, V. Lyratzi, M. Stathopoulou, E. Theodossiou, A. Kosionidis, C. Drakopoulos, G. Christou and P. Koutsouris, A&SS, **284**, 1119 (2003).
3. E. Danezis, D. Nikolaidis, E. Lyratzi, L. Č. Popović, M. S. Dimitrijević, E. Theodossiou and A. Antoniou, Mem. S.A.It., in press (2005a).
4. E. Danezis, D. Nikolaidis, E. Lyratzi, L. Č. Popović, M. S. Dimitrijević, E. Theodossiou and A. Antoniou, Proceedings of 7th HEL.A.S. Conference, in press (2005b).
5. D. Nikolaidis, E. Danezis, E. Lyratzi, L. Č. Popović, M. S. Dimitrijević, A. Antoniou & E. Theodossiou, Proceedings of XXVI IAU General Assembly, to be published (2006a).
6. D. Nikolaidis, E. Danezis, E. Lyratzi, L. Č. Popović, A. Antoniou, M. S. Dimitrijević, & E. Theodossiou, Proceedings of 23rd Summer School and International Symposium on the Physics of Ionized Gases August 28 - September 1, Serbia , to be published (2006b).
7. R. E. Wilson, *General Catalogue Of Stellar Radial Velocities*, Washington, Carnerie Institution of Washington Publication 601, 1963.

23rd Summer School and International Symposium
on the Physics of Ionized Gases
August 28 - September 1, 2006, Serbia