Satellite Absorption Components (SACs) of the UV spectral lines NV, CIV, NIV and SiIV in the atmosphere of the Oe star HD 175754

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Introduction

HD 175754 is a luminous supergiant star of spectral type OeIIf with effective temperature T_{eff}=31800 ± 1100 °K (Morossi & Crivellari, 1980). Costero & Stalio (1981) and Costero et al (1981) studied the NV, SiIV and CIV profiles of this star and compared them with the profiles of similar type stars' spectra. They found individuality, which implies different structures and dynamics of the atmospheric layers above the photosphere. Carrasco et al. (1981) reported only small changes in the UV resonance line profiles. They interpreted them in terms of variations in dynamics and density/ionization structure of the stellar wind. Lamers et al (1982) noted the possibility of the presence of satellite components superimposed on the wide P Cygni profiles of the UV resonance lines. Finally, Franco et al (1983) studied the P Cygni profiles of the above resonance lines of HD 175754 observed at different epochs and they reported variability at the secondary satellite component. They proposed two different mechanisms for the explanation of the variability, namely, a thermal mechanism in a hot region at $T_c=2\cdot 10^5$ °K which produces the principal stationary component and a mechanism which gives rise to the secondary component by ionization of cooler high velocity stellar material from X-rays coming from inner coronal region.

In this paper we present the study of the superionized regions in the gaseous envelope of HD 175754 (Lamers et al. 1982 and Franco et al. 1983), based on the proposed by Danezis et al. (2003) model for the structure of the SACs regions in the early type atmospheres. This model presupposes that the regions, where these spectral lines are formed, are not continuous but consist of a number of independent absorbing density layers of matter, a number of emission regions and an external general absorption region. By this model, we calculate the apparent radial expansion/contraction velocities (V_{exp}), the apparent rotational velocities (V_{rot}), as well as an expression of the optical depth (ξ), for all the independent density regions of the superionized regions in the gaseous envelope of HD 175754. Finally, we calculate the variations of the above mentioned parameters, in the time period between 1978 and 1981.

Method of spectral analysis

In order to study the physical structure and the existence of SACs phenomena in the regions where these lines are created we used the model proposed by Danezis et al. (2002b, 2003a). This model presupposes the existence of independent density layers of matter in these regions. With this method we can calculate the apparent rotation (V_{rot}) and expansion/contraction radial velocities (V_{exp}) of these density regions, as well as their ξ value, which is an expression of the optical depth. The final function which reproduces the complex line profile is:

$$I = I_0 \prod_i \exp\{-L_i \xi_i\} + \sum_j S_e \left(1 - \exp\{-L_{ej} \xi_{ej}\}\right) \exp\{-L_g \xi_g\}$$

L_i, L_e, L_g: are the distribution functions of the absorption coefficients $k_{\lambda i}$, $k_{\lambda e}$, $k_{\lambda g}$ respectively. Each L depends on the values of the apparent rotation velocity as well as of the apparent expansion/contraction radial velocity of the density shell, which forms the spectral line (V_{rot}, V_{exp}) and

ξ: is an expression of the optical depth.

Observational Data

The data we used are the 7 spectra of HD 175754 taken with the IUE satellite with the Short Wavelength range Prime camera (SWP) at high resolution (0.1 to 0.3 Å). Our data are presented in the table 1.

In these spectra we studied the structure of the spectral lines SiIV λλ 1393.755 Å, 1402.77 Å, CIV λλ 1548.185 Å, 1550.774 Å, NIV λ 1718.551 Å and NV λλ 1238.821 Å, 1242.804 Å.

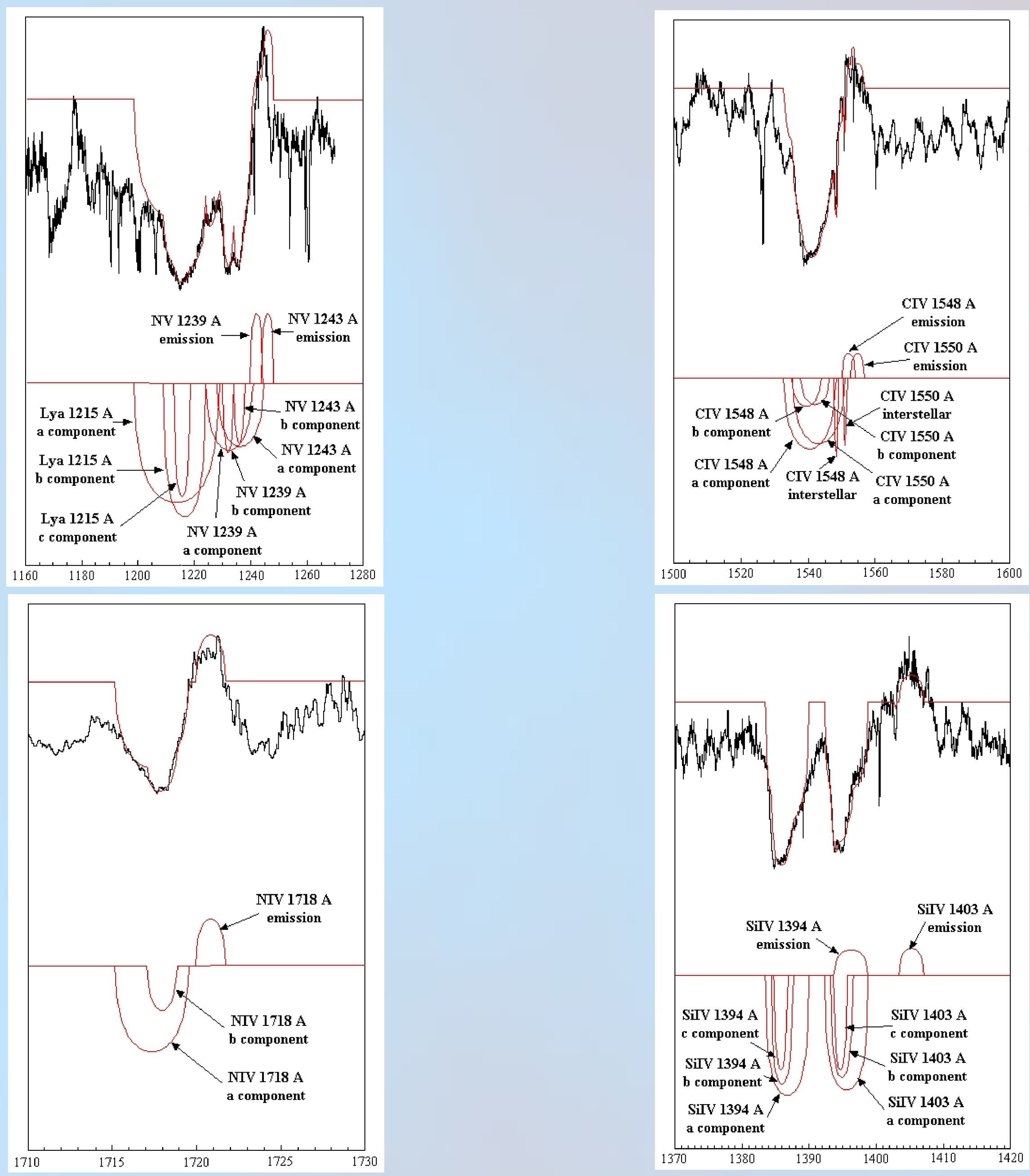
The calculated values of the apparent rotational and radial velocities correspond to the regions, where the Satellite Absorption Components (SACs) are created, and not to the star. Specifically, these values correspond to the density regions which result when streams of matter are twisted and form strings that produce blobs, puffs or bubbles.

Table 1

Camera	Date
Swp 02813	30/09/1978
Swp 04901	09/04/1979
Swp 06269	23/08/1979
Swp 09320	20/06/1980
Swp 13591	27/03/1981
Swp 13728	16/04/1981
Swp 14803	24/08/1981

Figures

The best fit is not just the graphical composition of some components (line profiles). The reproduced feature is the result of the final function of the model. In these figures we present some best fits of the star HD 175754's spectra, which present SACs. The black line presents the observed spectral line's profile and the red one the model's fit. We also present all the components which contribute to the observed features, separately.



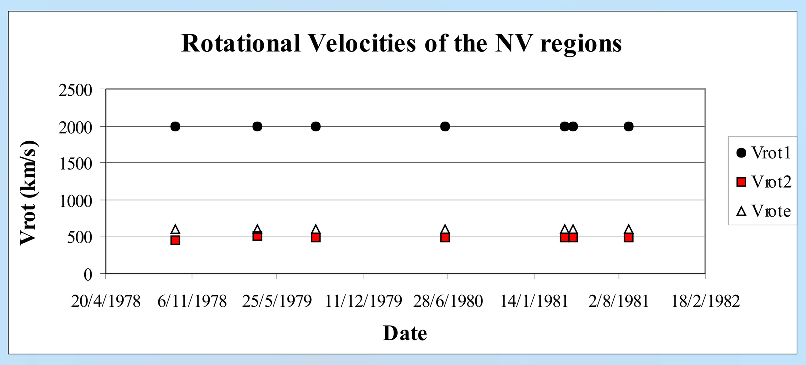


Diagram 1: Apparent rotational velocities of all the SACs as a function of time. The rotational velocity of the first and the second SAC is about 2000 km/s and 484 km/s, respectively. The emission's rotational velocity presents the value of 600 km/s.

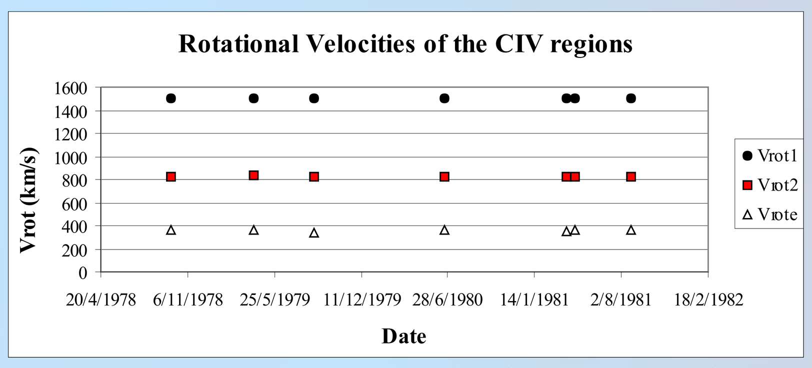


Diagram 3: Apparent rotational velocities of all the SACs as a function of time. The rotational velocity of the first and the second SAC is about 1500 km/s and 830 km/s, respectively. The emission's rotational velocity presents the value of 360km/s.

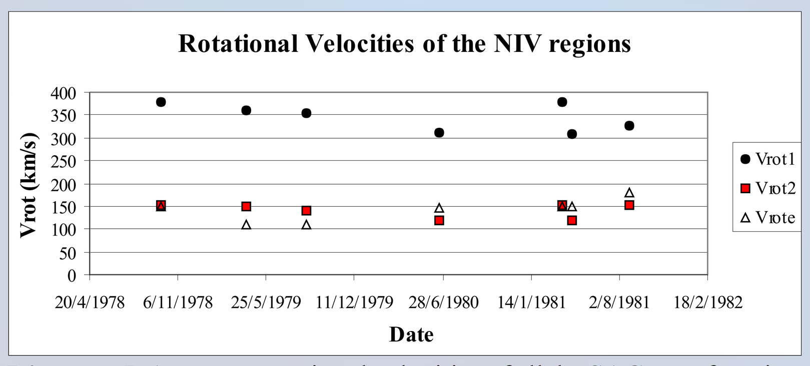


Diagram 5: Apparent rotational velocities of all the SACs as a function of time. The rotational velocity of the first SAC is about 345 km/s. The second SACs'and the emission's rotational velocity present the value of 140 km/s.

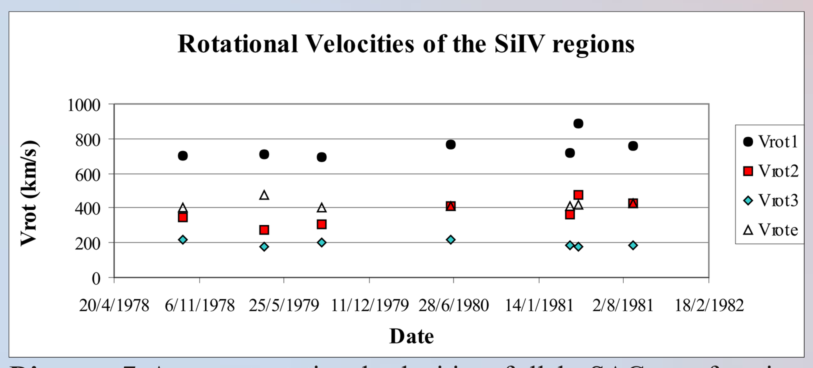


Diagram 7: Apparent rotational velocities of all the SACs as a function of time. The rotational velocity of the first, the second and the third SAC is about 746 km/s, 370 km/s and 194 km/s, respectively. The emission's rotational velocity presents the value of 422 km/s.

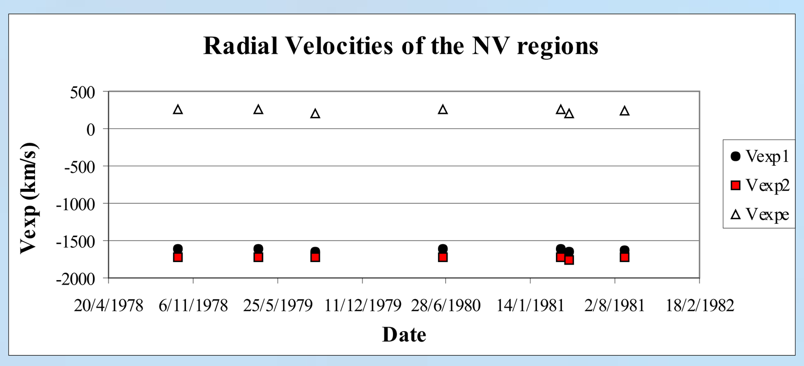


Diagram 2: Apparent radial velocities of all the SACs as a function of time. The radial velocity of the first and the second SAC is about -1630 km/s and -1725 km/s, respectively. The emission's radial velocity presents the value of 242 km/s.

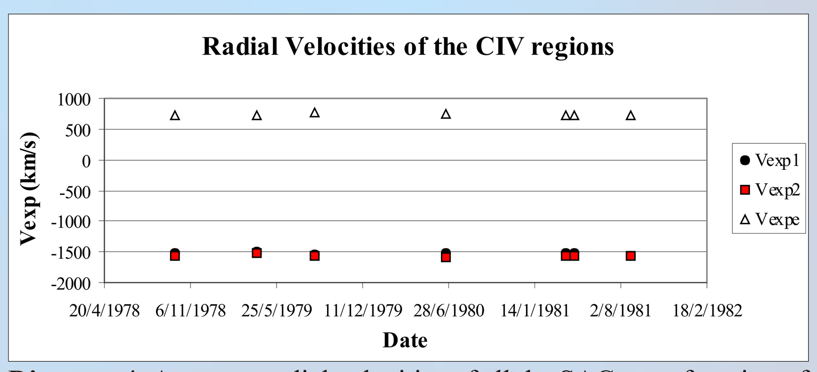


Diagram 4: Apparent radial velocities of all the SACs as a function of time. The radial velocity of the first and the second SAC is about -1522 km/s and -1560 km/s, respectively. The emission's radial velocity presents the value of 730 km/s.

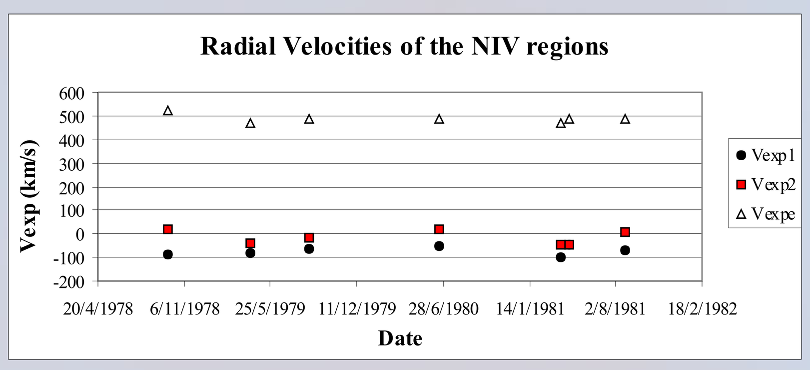


Diagram 6: Apparent radial velocities of all the SACs as a function of time. The radial velocity of the first and the second SAC is about -72 km/s and -15 km/s, respectively. The emission's radial velocity presents the value of 490 km/s.

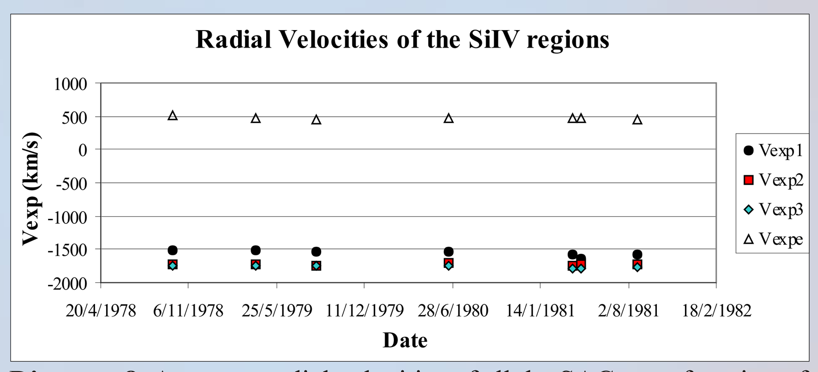


Diagram 8: Apparent radial velocities of all the SACs as a function of time. The radial velocity of the first, the second and the third SAC is about -1556 km/s, -1726 km/s and -1760 km/s, respectively. The emission's radial velocity presents the value of 470 km/s.

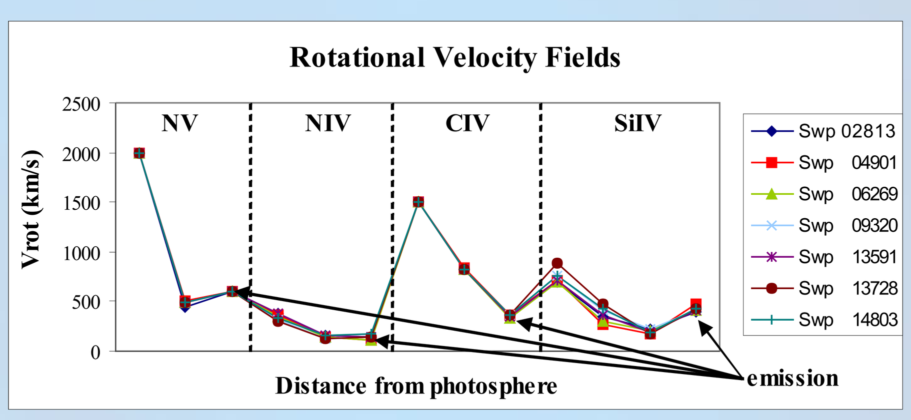


Diagram 9: Apparent rotational velocities of all the SACs as a function of the distance from the star.

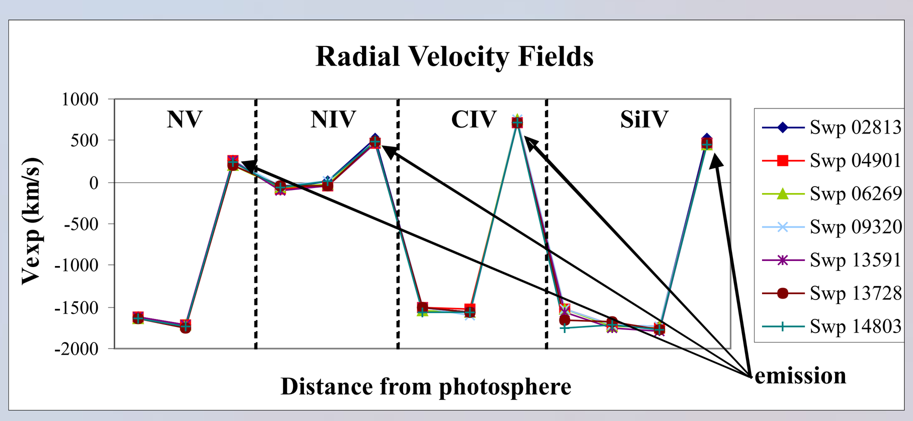


Diagram 10: Apparent radial velocities of all the SACs as a function of the distance from the star.

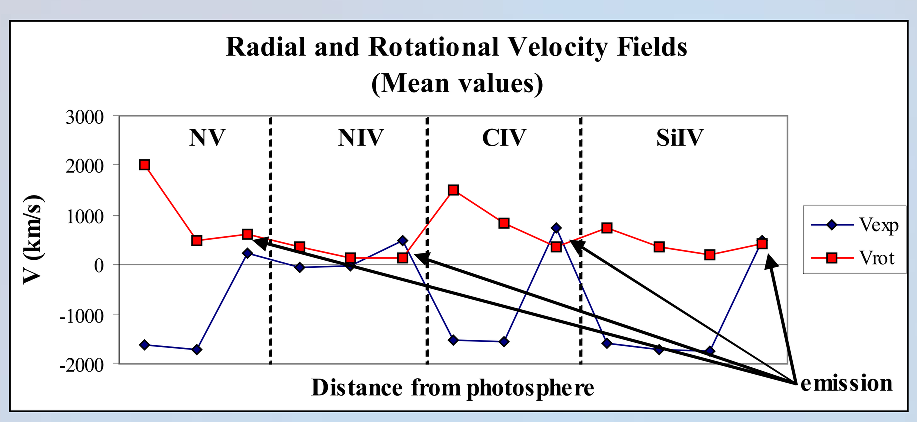


Diagram11: Mean values of the apparent rotational and radial velocities of all the SACs as a function of the distance from the star.

Conclusions

1. By applying the proposed by Danezis et al. (2003), model we are able to reproduce the profiles of all the spectral lines of the star HD 175754 with great accuracy. This means that the coronal model allowing the existence of successive, independent density shells of matter represents accurately the structure of the gaseous envelope of HD 175754.
2. The best fit of all lines derived by the model we described leads to the conclusion that the layer of matter in the region we studied {33eV (Si IV)-78 eV(N V)} is structured as the model describes:
   i) An area of gas consisting of i independent absorbing layers of matter.
   ii) One emitting layer of matter.
   iii) Occasionally, an external absorption layer of matter.
3. It is interesting to point out that in the regions we study there exist successive shells which move radially with velocities between -1760 km/s and 730 km/s, and rotate with velocities between 140 km/s and 2000 km/s.
4. Apparent rotational and radial velocities of each layer of matter show an insignificant variation between the three different spectra we used.

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