

# Investigation of the post coronal density regions of Oe stars, through the N V UV resonance lines

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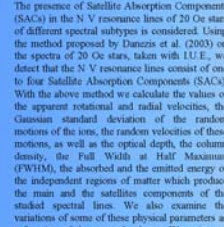


## Investigation of the post coronal density regions of Oe stars, through the N V UV resonance lines

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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  $\Delta\lambda$ , 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). The presence of Satellite Absorption Components (SACs) in the N V resonance lines of 20 Oe stars of different spectral subtypes is considered. Using the method proposed by Danezis et al. (2003) on the spectra of 20 Oe stars, taken with IUE, we detect that the N V resonance lines consist of one to four Satellite Absorption Components (SAC) with the above method we calculate the values of the apparent rotational and radial velocities, the Gaussian standard deviation and 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. We also examine the variations of some of these physical parameters as a function of the spectral subtype. We point out that the values calculation of the above parameters and their variations as a function of spectral subtype, has been performed by using the DACs or SACs theory.



**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 V resonance lines ( $\lambda\lambda$  1238.821, 1242.804 Å). Our sample includes the subtypes O4 (one star), O4e (four stars), O7 (five stars) or O8 (three stars) and O9 (seven stars). In our sample we detect that the N V spectral line consists of one component in 2 stars two components in 7 stars, three in 9 stars and four in 2 stars.

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

In Fig. 1, we present the N V doublet of the O9 star HD 34656, and its best fit. The best fit has been obtained with three SACs and one emission component. 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.

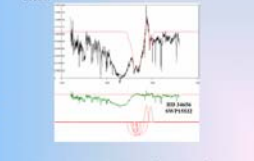


FIGURE 1: The N V  $\lambda\lambda$  1238.821 Å, 1242.804 Å resonance lines in the spectrum SWP18941 of HD 34656. Each of N V spectral lines consists of three SACs and one emission component. Below the fit we present the analysis of the observed profile to its SACs.

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

In Figs. 2, 3, 4 and 5 we present the variation of the mean values of the radial velocities, of the rotational velocities, of the random velocities and of the Full Width at Half Maximum (FWHM) of the ions, for the N V independent density regions of matter (SACs) which create the 1, 2 or 3 satellite components in each of the  $\lambda\lambda$  1238.821, 1242.804 Å N V resonance lines, as a function of the spectral subtype, respectively.

In Figs. 6 and 7 we present the variations of the absorbed energy (Ea) in eV, of the  $\lambda\lambda$  1238.821, 1242.804 Å N V resonance lines for all the independent density regions of matter which create the 1, 2 or 3 satellite components in all the stars of our sample as a function of the spectral subtype. We point out that for each component of both of the resonance lines the variations as a function of the spectral subtype are the same.

Finally, in Figs. 8 and 9 we see the variation of the Column Density (CD) in  $10^{17} \text{ cm}^{-2}$  of the  $\lambda\lambda$  1238.821, 1242.804 Å N V resonance lines for the independent density regions of matter which create the 1, 2 or 3 satellite components in all the stars of our sample as a function of the spectral subtype. We note again that each component of both of the resonance lines presents the same variation.

### REFERENCES

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### The Radial Velocities

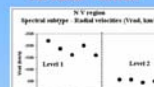


FIGURE 2: Variation of the radial velocities' mean values of the N V resonance lines ( $\lambda\lambda$  1238.821, 1242.804 Å) for the independent density regions of matter which create the 1, 2, 3 or 4 satellite components as a function of the spectral subtype. There are two mechanisms which create the radial velocities. The first one creates high radial velocities and the second one creates low (Franco et al. 1983, Bates & Halliwell 1986, Cranmer & Owocki 1996). In this Fig. we see the same phenomenon. We can see two levels of values of the radial velocities. The first level has values between 2300 and 1500 km/s and the second level has values between 500 and 100 km/s.

### The Rotational Velocities

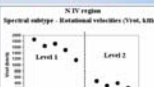


FIGURE 3: Variation of the mean rotational velocities of the ions of the N V resonance lines ( $\lambda\lambda$  1238.821, 1242.804 Å) for the independent density regions of matter which create the 1, 2, 3 or 4 SACs as a function of the spectral subtype. There are two levels of values. The first has values between 1800 and 1100 km/s and the second has values between 400 and 200 km/s.

### The Random Velocities

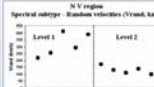


FIGURE 4: Variation of the mean random velocities of the ions of the N V resonance lines ( $\lambda\lambda$  1238.821, 1242.804 Å) for the independent density regions of matter which create the 1, 2, 3 or 4 SACs as a function of the spectral subtype. We note again that there are two levels with values between 400 and 200 km/s for the first and between 150 and 80 km/s for the second one.

### Full Width At Half Maximum (FWHM)

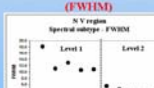


FIGURE 5: Variation of the mean value of the Full Width at Half Maximum (FWHM) for the N V independent density regions of matter which create the 1, 2, 3 or 4 SACs as a function of the spectral subtype. We see two levels of values. The first level has values between 18 and 10 Å and the second level has values between 6 and 7 Å.

### The Absorbed Energy

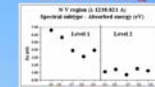


FIGURE 6: Variation of the absorbed energy (Ea) in eV of the N V resonance line at 1238.821 Å for the independent density regions of matter which create the 1, 2, 3 or 4 satellite components as a function of the spectral subtype. The first level has values between 1.00 and 3.00 eV and the second between 1.00 and 0.5 eV.

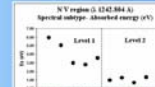


FIGURE 7: Variation of the absorbed energy (Ea) in eV of the N V resonance line at 1242.804 Å for the independent density regions of matter which create the 1, 2, 3 or 4 satellite components as a function of the spectral subtype. The first level has values between 6.3 and 2.7 eV and the second between 0.9 and 0.45 eV.

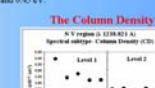


FIGURE 8: Variation of the Column Density (CD) in  $10^{17} \text{ cm}^{-2}$  of the N V resonance line at 1238.821 Å for the independent density regions of matter which create the 1, 2, 3 or 4 satellite components as a function of the spectral subtype. We note again that there are two levels with values between  $5 \cdot 10^{16} \text{ cm}^{-2}$  and  $1 \cdot 10^{16} \text{ cm}^{-2}$  for the first and about  $2 \cdot 10^{16} \text{ cm}^{-2}$  for the second one.

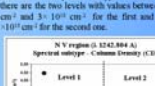
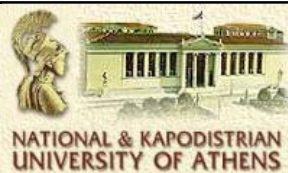


FIGURE 9: Variation of the Column Density (CD) in  $10^{17} \text{ cm}^{-2}$  of the N V resonance line at 1242.804 Å for the independent density regions of matter which create the 1, 2, 3 or 4 components as a function of the spectral subtype. We note again that there are two levels with values between  $4.5 \cdot 10^{16} \text{ cm}^{-2}$  and  $2 \cdot 10^{16} \text{ cm}^{-2}$  for the first and about  $2 \cdot 10^{16} \text{ cm}^{-2}$  for the second one.

### RESULTS

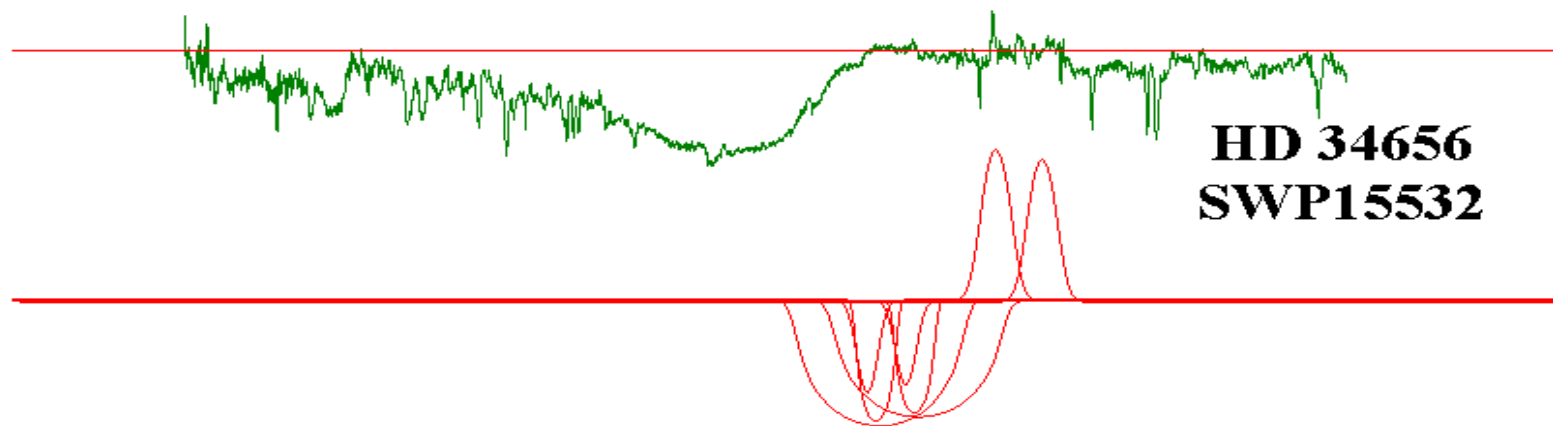
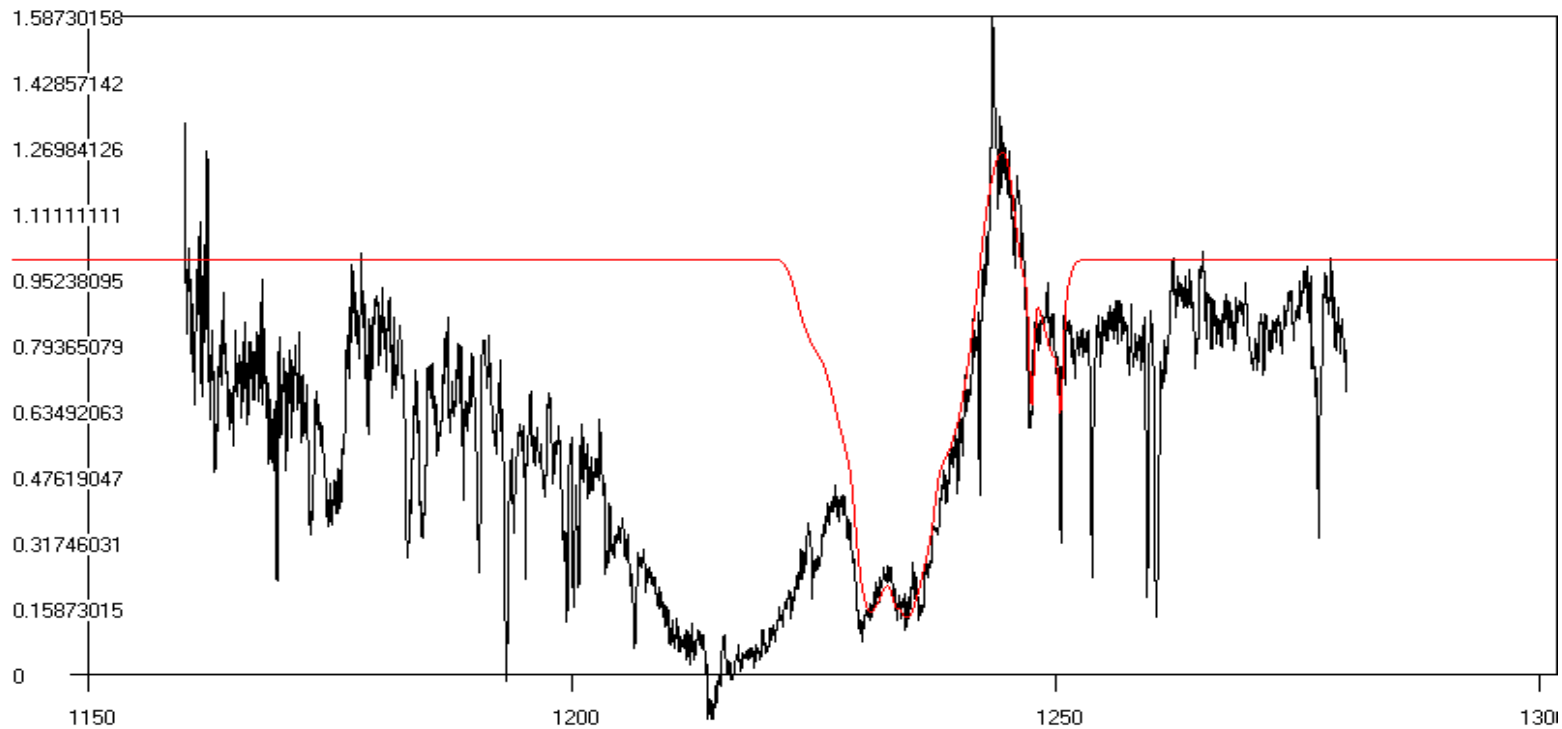
Franco et al. 1983, Bates & Halliwell 1986, Cranmer & Owocki 1996, noted that there are two mechanisms which create the radial velocities. The first one creates high radial velocities and the second one creates low velocities. We also detect the same phenomenon in others parameters, as the rotational velocities, 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.

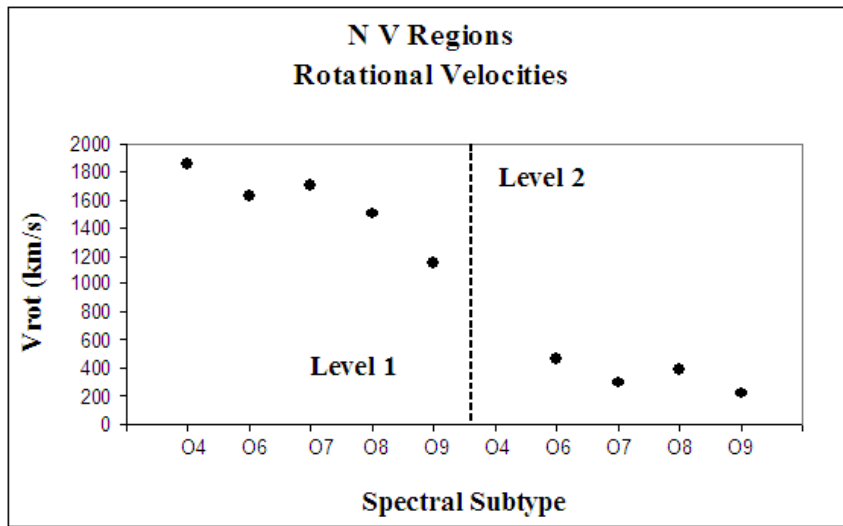


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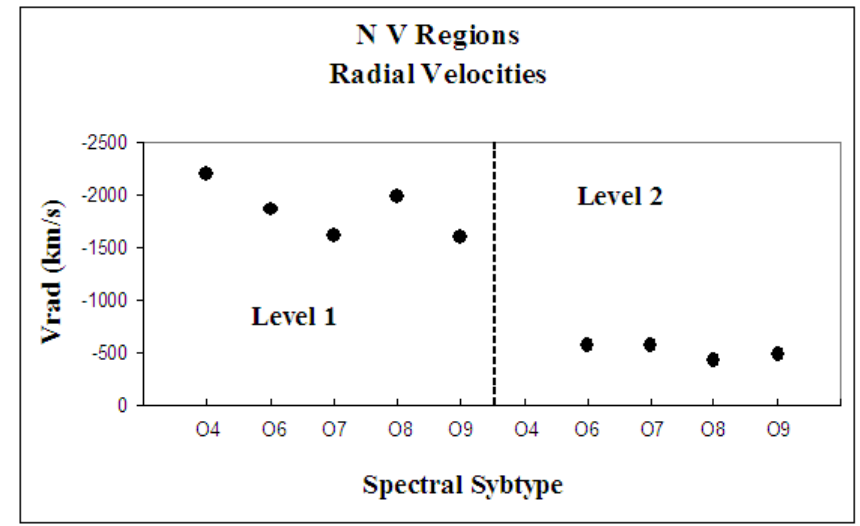
http://www.cc.uoa.gr/fasma | e-mail: elyratzi@phys.uoa.gr | edanezis@phys.uoa.gr



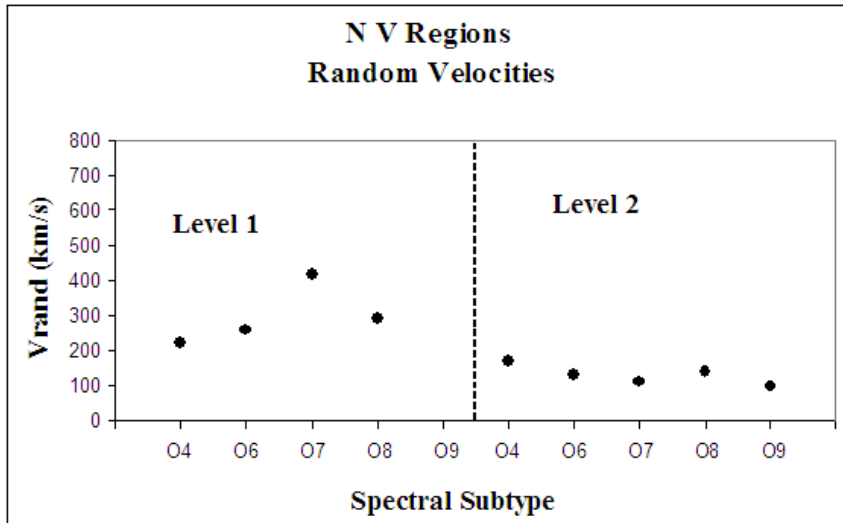




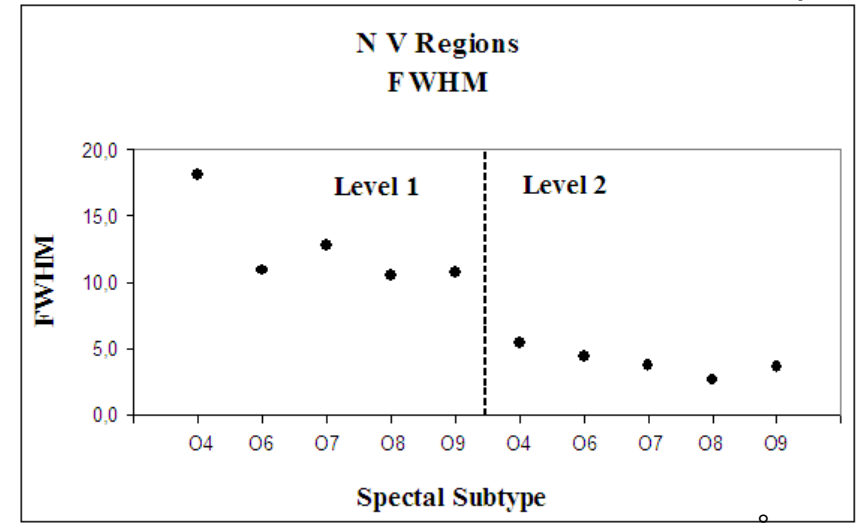
**Vrot:** 1st level: 1800 and 1100 km/s  
2nd level: 400 and 200 km/s



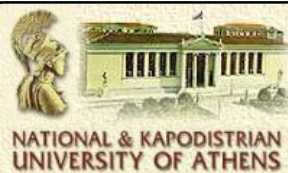
**Vrad:** 1st level: -2300 and -1500 km/s  
2nd level: -500 and -100 km/s



**vrand:** 1st level: 400 and 200 km/s  
2nd level: 150 and 80 km/s



**FWHM:** 1st level: 18 and 10 Å  
2nd level: 6 and 2 Å



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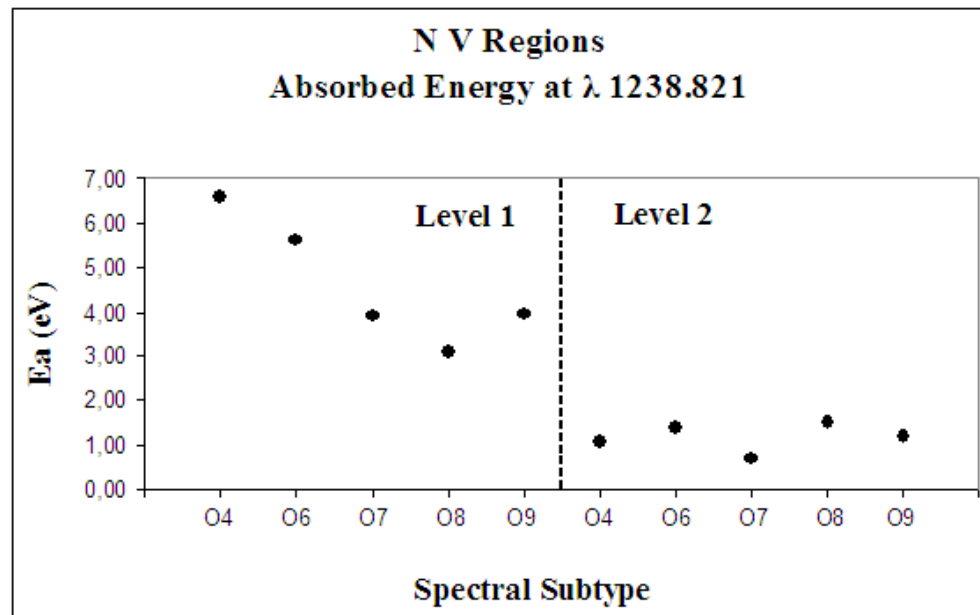


## Two levels of Absorbed Energy (E)

$\lambda$  1238.821 Å

First level: 7 and 3 eV

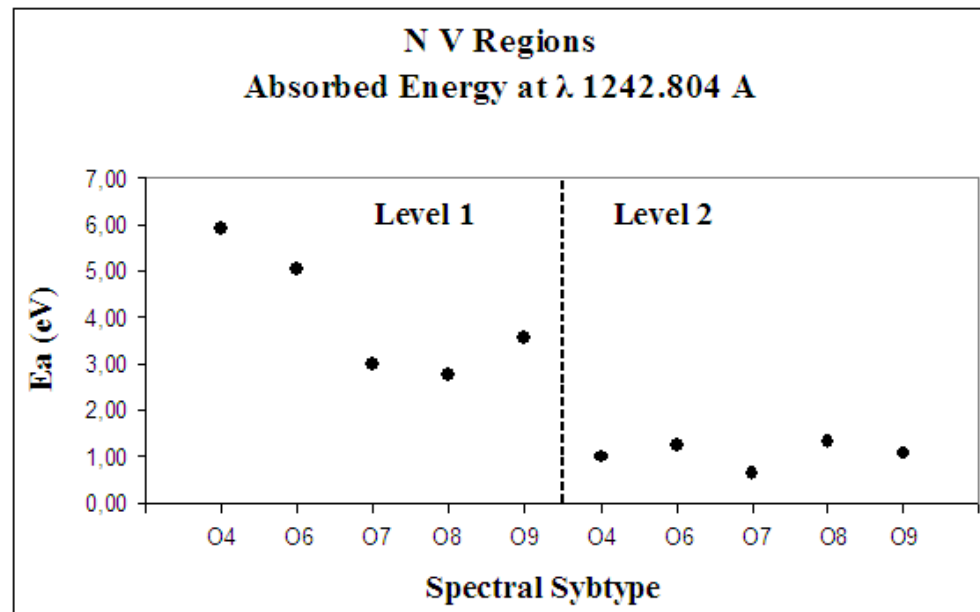
Second level: 1 and 0.5 eV



$\lambda$  1242.804 Å

First level: 6.3 and 2.7 eV

Second level: 0.9 and 0.45 eV



## Two levels of Column Density (CD)

$\lambda$  1238.821 Å

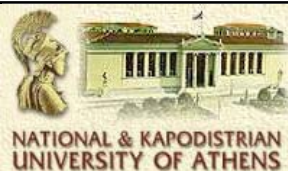
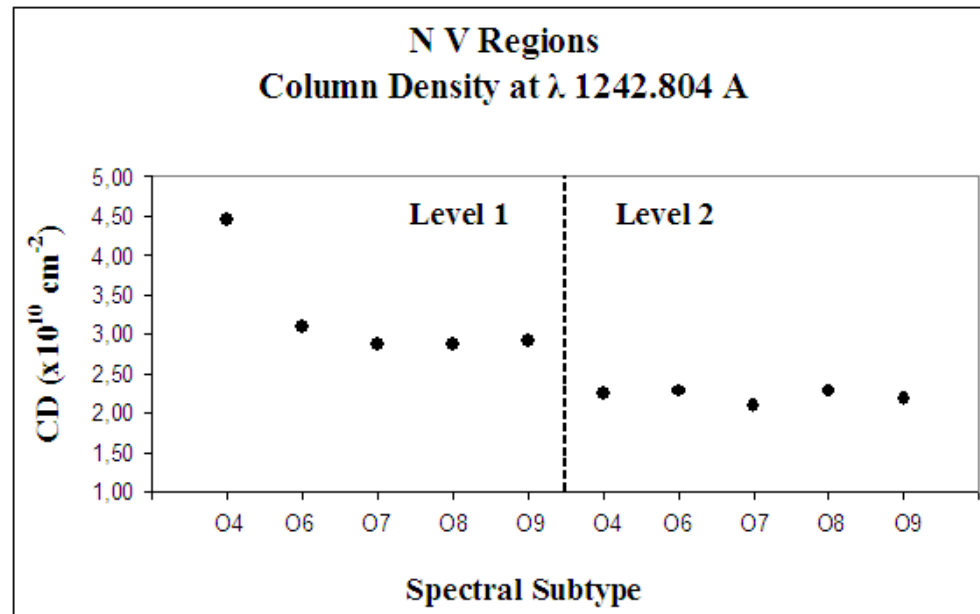
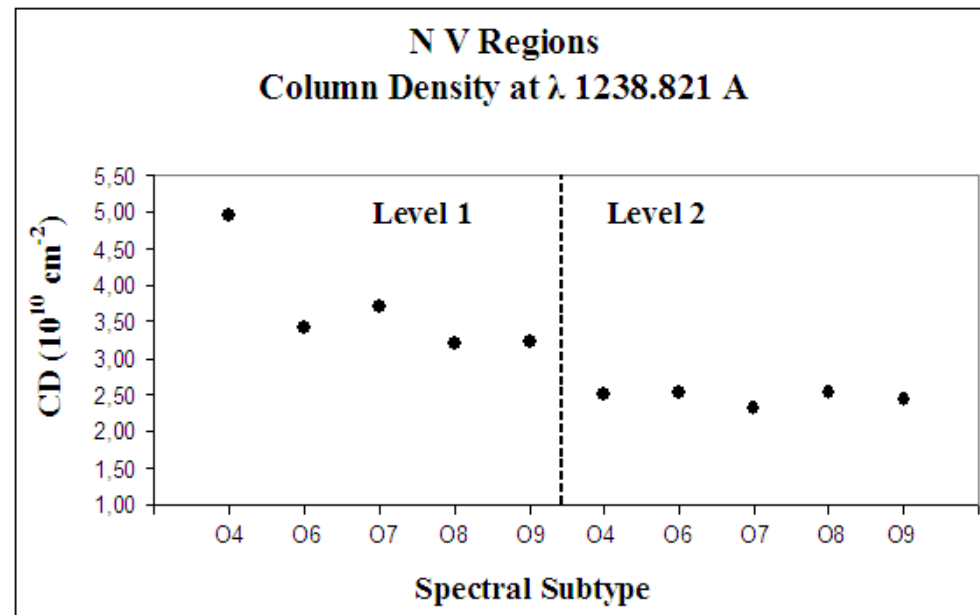
First level:  $5 \times 10^{10} \text{ cm}^{-2}$  and  
 $3 \times 10^{10} \text{ cm}^{-2}$

Second level:  $2.5 \times 10^{10} \text{ cm}^{-2}$

$\lambda$  1242.804 Å

First level:  $4.45 \times 10^{10} \text{ cm}^{-2}$  and  
 $2.7 \times 10^{10} \text{ cm}^{-2}$

Second level:  $2 \times 10^{10} \text{ cm}^{-2}$



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# Thank you!!!



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