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SPECTROSCOPIC ANALYSIS OF 48 LIB IN THE ULTRA VIOLET RANGE

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RESUMEN. Se presenta un análisis del espectro de esta estrella con envoltura, en el rango ultravioleta (λ1250-3100 A) en base a los datos proporcionados por el satélite IUE (International Ultraviolet Explorer) con la finalidad de determinar las condiciones físicas en la estructura gaseosa que rodea la estrella. Los resultados muestran que la envoltura posée escasa velocidad de rotación y que en ella se generan las líneas angostas y profundas del Fe II, Ni II y Ti III. En una capa más profunda que corrota con la estrella, están presentes las líneas del Al III y aparentemente del Si IV con perfiles ensanchados por elevada rotación.

ABSTRACT. To determine the physical conditions of the gaseous envelope of this star we analyze its spectrum in the ultraviolet range (λ1250-3100 A) on the basis of the data supplied by the International Ultraviolet Explorer satellite (IUE). The results show that the envelope has a small rotational speed. In this envelope the narrow and deep lines of Fe II, Ni II, and Ti III are originated. In a deeper thin region that rotates with the star the lines of Al III and -apparently- of Si IV are present. These lines show broad profiles due to a high rotational speed.

Key words: SPECTROSCOPY — STARS-ABUNDANCES

I. INTRODUCTION

48 Librae is a star with an extended atmosphere and high rotation (HD 142983, Spectral Class $B3_e$, V/R variable) as was observed by the IUE satellite on July 15, 1981.

The star presents the following peculiarities:

a) an early spectral type where the absorption lines of H, He and Si are prominent and broadened, apparently, by the rotation (Merrill and Burwell, 1943, 1949; Struve, 1946; Mc Laughlin, 1961).

b) cyclical variations of the shell. The period of the radial velocity oscillations has appeared to be about 10 years. (Struve, 1946; Mc Laughlin, 1961; Underhill, 1966; Delplace and Chambon, 1976).

c) luminosity not greater than the corresponding to the main sequence (Ringuelet, 1962; Aydin and Faraggiana, 1978).

d) absence of emission lines in the ultraviolet spectrum.

e) radial velocity of about -17 km. $s.^{-1}$

The object of this paper is to relate the parameters from the continuous and the profile of the spectral lines with the parameters that characterize the region of formation of lines in an extended atmosphere.

To obtain the T_{eff} and g_{eff} , models from Kurucz et al (1975) were used. For broadened lines the corresponding rotation velocities were computed using the Huang-Struve (1953) method.

For narrow lines the Goldberg (1958) method was used and the Doppler widths were calculated. Finally, the optical depths and atom columns were established following the technique used by Ringuelet, Fontenla and Rovira (1981).

II. ANALYSIS AND RESULTS.

The information registered by the IUE Satellite was processed at the Observatorio

Astronómico de La Plata, Argentina, calibrating and filtering the SWP 14480 and LWR 11065 images.

The models of Kurucz et al (1975) that correspond to the LTE conditions with line blanketing (line-blanketed models) were compared with the continuous spectrum, obtaining the best coincidence for T_{eff} = 18000° K and log g_{eff} = 4.5.

The analysis of two lines apparently broadened by rotation was made, following the Huang-Struve (1953) method. This is a logarithmic technique based on the assumption that the profile of the line is gaussian and associated to a γ parameter that is distorted by rotation through a convolution (see Figs. 1 and 2). For λ 1862.97 corresponding to the multiplet 1 of Al III we obtained v sen i = 93 km. s^{-1} , and for λ 1393.57 corresponding to the multiplet 1 of Si IV we obtained v sen i = 89 km. s^{-1} , even while this last measure seems to be uncertain.

To obtain the Doppler width of the narrow lines, we applied the Goldberg (1958) method to two lines of the multiplet 2 of Ti III, to three lines of the multiplet 44 of Fe II and to two lines of the multiplet 1 of Al III. The results are shown in Table 1.

Table 1. Parameters of 48 Librae.

iON	λ (Å)	Log (gf)	$\frac{F_c - F_L}{F_c}$	τ	Log $\left(\frac{N}{g}\right)$	$\Delta\lambda_{km/s}$	$V_{rad\, km/s}$
Fe II	1580.64	-0.492	0.83	1.77	1393 ±0.03	36.75	56
Fe II	1581.5	-0.77	0.56	0.87	1390 ±0.06	36.75	47
Fe II	1584.95	-0.584	0.72	1.33	1390 ±0.04	36.75	39
Al III	1854.72	0.066	0.82	3.4	1283 ±0.01	6.5	51
Al III	1862.78	-0.235	0.85	6.85	1344 ±0.01	6.5	47
Si IV	1393.73	0.03	0.77	1.82			3
Si IV	1402.73	-0.274	0.50	0.87			2
Ti III	1286.38					63.19	63
	1289.32						59

For Fe II, with a T_{ex} = 9800° K, (Cidale and Ringuelet, 1989), we determined a turbulence velocity V_t = 36 km. s^{-1} . To calculate the optical depths and atom columns, we assumed that an spherical simmetry and a plane-parallel solution of the transfer equation exists; also we considered that the source function is constant with the optical depth in the region of line formation.

Thus we have (Ringuelet, Fontenla and Rovira, 1981):

$$(F_c - F_\lambda)/F_c = 1 - \exp(-\tau) - \alpha[1-2E_3(2\tau)] \quad (1)$$

Where: $\alpha = 2\pi R_e^2 S / D^2 F_c$

being: R_e = radius at the region of line formation
D = distance to the star
S = line source function
F = flux of continuous

The optical depths of each analyzed multiplet must satisfy the relations (Cidale and Ringuelet, 1989):

$$\tau_1/\tau_2 = (\lambda gf)_1 / (\lambda gf)_2 \quad (2)$$

This calculation process is shown in Figs. 3 and 4 and the results obtained are given in table 1.

To calculate the atom columns, log(N/g), the following relation(Cidale and Ringuelet, 1989) was used:

$$\tau = C\ gfN_i/V_D\ g_i \qquad (3)$$

where: N_i represents the atom column in cm^{-2} , $C = 1.5 \times 10^{-15}$ and V_D is the Doppler velocity in km. s^{-1} (see table 1).

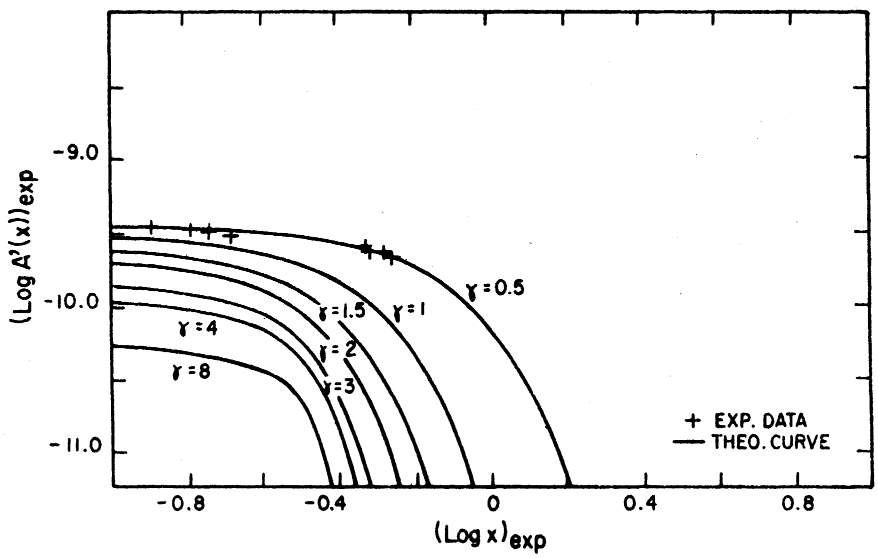

Fig. 1. Determination of v sen i for Si IV. The fitting of the measures corresponds to the theoretical curve with $\gamma = 0.5$.

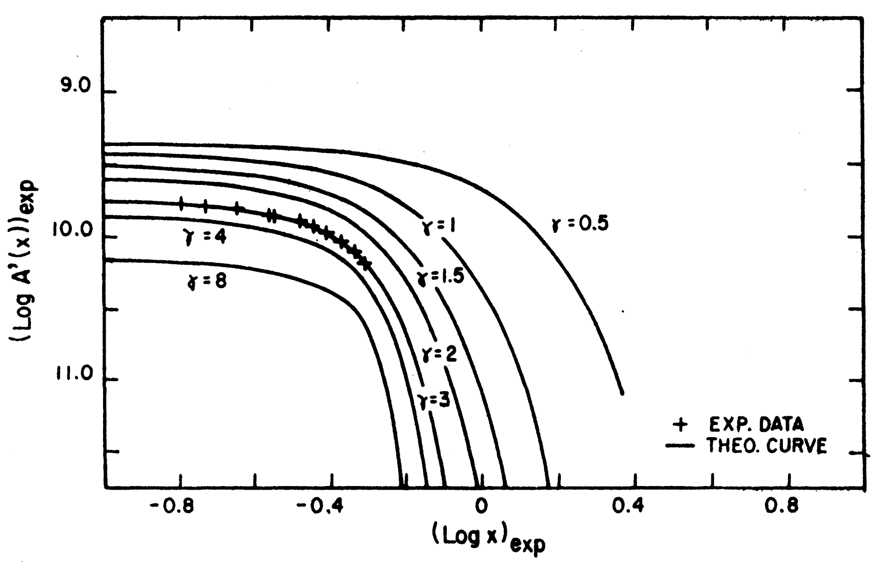

Fig. 2. The same as Figure 1 for Al III. The fitting of the measures corresponds to the theoretical curve with $\gamma = 3$.

III. CONCLUSIONS

From the results obtained we infere that the atmosphere has an envelope in which the lines of Fe II, Ni II and Ti III are generated. Their radial velocities are high and they are not broadened by rotation.

The optical depths of the Fe II are near to 1 and from the Doppler width we infere a high turbulence. For Al III the rotation velocity is high and the optical depth much higher than for Fe II. From this we deduce that Al III is present in a region that rotates with the star. On the spectrum the profile of Si IV line is not clearly defined as a rotation profile and it is blent.

Besides its fitting to the theoretical curve from Huang-Struve method is less precise than for Al III and its optical depth is much smaller.

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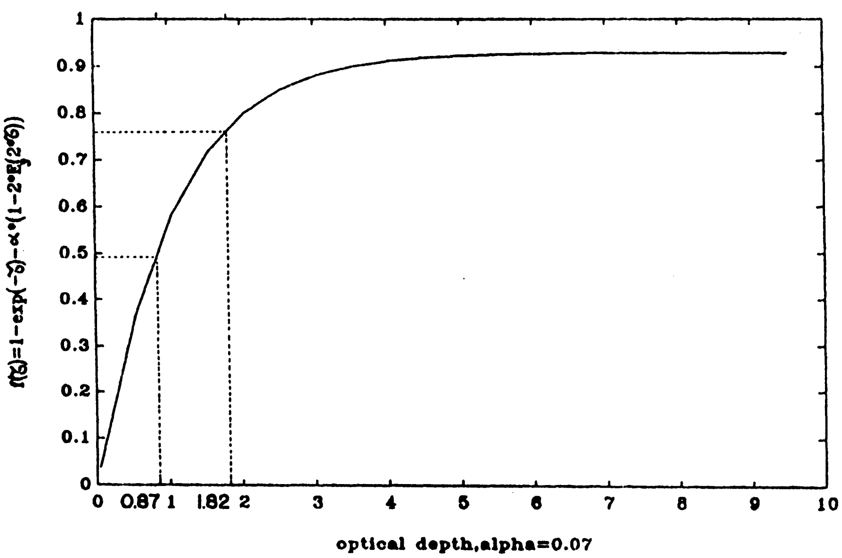

Fig. 3. Determination of the optical depths corresponding to the multiplet of Si IV.

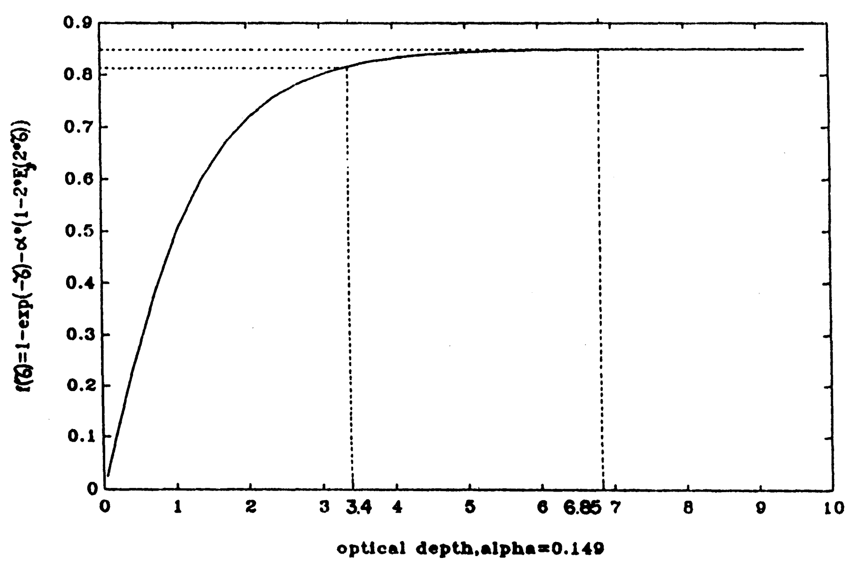

Fig. 4. Determination of the optical depths corresponding to the multiplet of Al III.

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