PHOTOSPHERIC AND "CHROMOSPHERIC" CIV LINES IN B-MAIN-SEQUENCE STARS

Fiorella Castelli*, Carlo Morossi* and Roberto Stalio**
(*)Osservatorio Astronomico, Trieste
(**)Dipartimento di Astronomia, University of Trieste

The presence in the far-UV spectra of early-type stars of spectral lines of superionized atoms is argument of controversial debate among astronomers. Presently there is agreement on the non-radiative origin of these ions but not on the proposed mechanisms for their production nor on the proposed locations in the stellar atmosphere where they are abundant. Cassinelli et al. (1978) suggest that the Auger mechanism is operative in a cool wind blowing above a narrow corona to produce these ions; Lucy and White (1980) introduce radiative instabilities growing into hot blobs distributed across the stellar wind; Doazan and Thomas (1982) make these ions to be formed in both pre- and post-coronal, high temperature regions at low and high velocity respectively.

The definition of superionization and the identification of the superionized species are also object of debate. If we define as superionized those ions which cannot be formed in a stellar photosphere because of the too large radiative energy necessary, then OVI is always superionized and NV is "almost" always superionized, being possibly present in the photospheres of the hottest stars. On the contrary the definition of the superionization character of the CIV resonance lines requires some further analysis also because CIV has been widely observed on a very large number of early-type stars and its presence or absence may give some clue for the understanding of the atmospheric structure of these stars.

Previous literature reports on the presence of CIV lines in main sequence B stars (these are the best to study because there is little effect on the CIV profiles from thick stellar winds) at approximately photospheric velocity are: 1) by Underhill (1982) who reports that CIV lines are observed to be moderately strong in B1 main sequence stars and display blue extended wings; they are instead weak and sharp at B3 and B5; 2) by Doazan et al. (1984, 1985) who show the presence of variable CIV at spectral type B7 in an ex-Be star, ϑ CrB; 3) by Molaro et al. (1982) who observed CIV absorption lines in HD119921, A0 V.

No photospheric model, constructed under standard equations, can predict the existence of CIV ions over the temperature range indicated by the observations. Thus the question is: at what spectral type in a main sequence star photospheric CIV ceases to contribute to the observed profile? In order to answer this question we compared IUE spectra of a set of B main sequence stars with synthetic photospheric spectra (Castelli 1985) obtained from the solar abundance model atmospheres reported in Table 1. The spectral range investigated was from 1541 to 1553 A. The results are summarized in Figures 1, 2 and 3.

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Figure 1 compares the observed spectrum of γ Peg (B2 IV, V sin i ∼ 10 km/s) with the synthetic spectrum obtained from model A and of ι Her (B3 IV, V sin i = 11 km/s) with the spectrum from model B. Both synthetic and observed spectra show sharp and deep lines of CIV at stellar velocity, indicating its photospheric origin. Note that the 1550 line is blended with a strong Fe III line (at 1550.2). Figure 2 compares two observed spectra of ϑ CrB, an ex-Be star (B6 V, V sin i = 393 km/s) taken at different epochs with model C. The strongest contributors to the absorption lines indicated by the dots correspond to lines of Fe II-1547.8, Fe II-1548.7, Fe III-1550.2, Fe II-1550.9, Fe II-1551.2. Thus there is no photospheric CIV at the effective temperatures of a B6 star. We note the variability of the observed profiles (this point is more extensively discussed in Doazan et al., 1985) which suggest a change from a one component, low velocity absorption profile to a two components at low and high velocity profile. Figure 3 compares the observed spectrum of HD119921 (A0 V, V sin i > 400 km/s; 220 km/s according to Molaro et al.)) with model D. The same arguments as for ϑ CrB can be raised to infer the non-photospheric character of the observed CIV.

We conclude that the boundary at which photospheric CIV disappears is between spectral types B3 and B6 in main sequence stars. After B6 it is fully superionized. The observations (we refer in particular to ϑ CrB which we are monitoring since several years) seem to support Doazan and Thomas (1982) model of chromospheric CIV. In ϑ CrB, and possibly in HD119921, it is formed both in a pre-coronal, solar-like chromosphere, at low velocity, and in a post- coronal "chromosphere" at high velocity. Variable mass loss makes the profile components to vary in strength and eventually in velocity.

REFERENCES

Cassinelli, J.P., Olson, G., Stalio, R.: 1978, Astrophys. J., 220, 85.
Castelli, F.: 1985, Astronet Documentation Facility, no. 6.
Doazan, V., Thomas, R.N.: 1982, in "B-Stars with and without Emission Lines", ed. A.B. Underhill and V. Doazan, NASA SP-456
Doazan, V., Morossi, C., Stalio, R., Thomas, R.N., Willis, A.J.: 1984, Astron. Astrophys., 131, 210.
Doazan, V., Morossi, C., Sedmak, G., Stalio, R., Thomas, R.N.: 1985, Astron. Astrophys., in press.
Lucy, L.B., White, R.L.: 1980, Astrophys. J., 241, 300.
Molaro, P., Morossi, C., Ramella, M., Franco, M.L.: 1983, Astron. Astrophys., 127, L3.
Underhill, A.B.: 1982, in "B-Stars with and without Emission Lines", ed. A.B. Underhill and V. Doazan, NASA SP-456.

Table 1: The set of models

Model	Teff	log g	V sin i	Model	Teff	log g	V sin i
A	21780	4	0	C	13500	4	220
B	17460	4	10	D	10000	4	250

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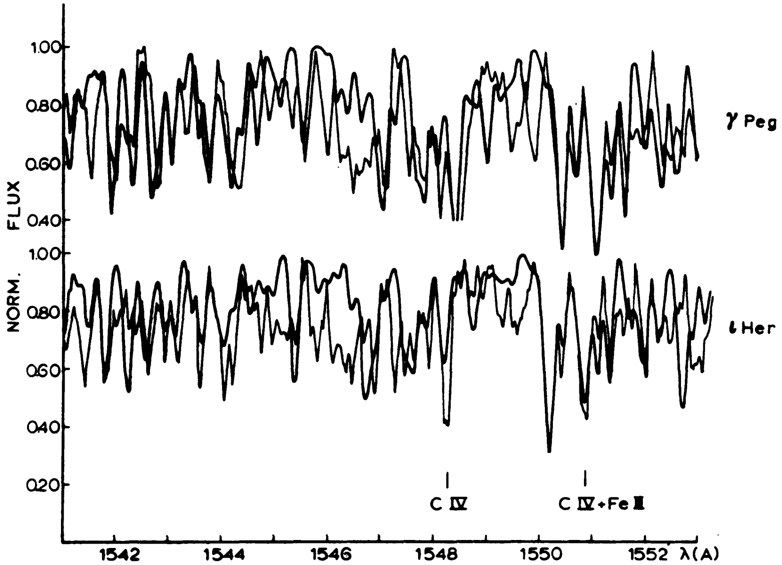

Figure 1: Observed (thin line) and synthetic (thick line) spectra of γ Peg and ι Her.

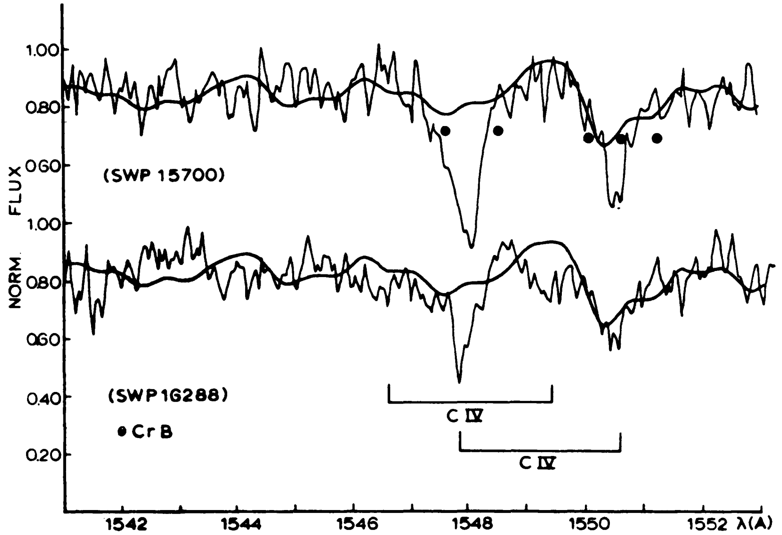

Figure 2: Same symbols as in Fig. 1; the IUE spectra of ϑ CrB were taken on Dec. 10, 1981 and Feb. 8, 1982.

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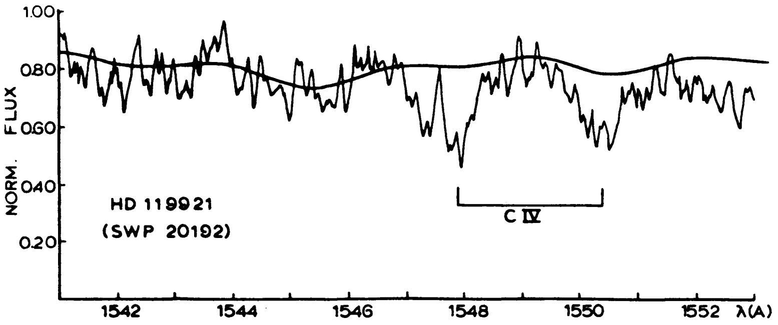

Figure 3: Same symbols as in Fig. 1.

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