

VIOLET ABSORPTION EDGES OF C IV LINES IN WOLF-RAYET SPECTRA: POSSIBLE SUPERPOSITION WITH DIFFUSE INTERSTELLAR BANDS AT 5780Å AND 5797Å

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ABSTRACT

It is shown that the violet edges normally seen in Wolf-Rayet stars around 5800 Å are principally due to displaced C IV absorption. The diffuse interstellar bands are seldom of comparable strength and can be seen separately if the absorption characteristics of the envelope of the Wolf-Rayet stars are such as to avoid an overlap between the two.

Key Words Wolf-Rayet stars - diffuse interstellar bands - violet absorption edges

The C IV lines in the yellow region of the spectrum at 5804 Å are of common occurrence in Wolf-Rayet spectra of both the carbon and nitrogen sequences. With a few other emission lines in these stars, they share the tendency to display violet absorption edges. The Doppler displacements of many of these have been listed by Bappu (1973) for several of the brighter stars. Most of the velocity displacements are in the neighbourhood of 1100 km s⁻¹ that would bring these violet edges close to positions occupied by the two diffuse interstellar bands 5780 Å and 5797 Å. It is of interest, therefore, to clarify whether the absorption features seen at these wavelengths are essentially interstellar or whether Doppler displaced absorption does exist.

The values of Doppler displacement of the violet edges display a dependence on excitation potential. The largest displacements in any Wolf-Rayet spectrum are for the He I triplets. The 3889 Å line can be used to select stars that have likely values of C IV violet absorption that are either much larger or smaller than the critical value of 1100 km s⁻¹. HD 166783 and HD 193793 have 3889 Å violet edges that have velocities of 1889 km s⁻¹ and 2562 km s⁻¹ respectively. The corresponding value in the WC8 like star, HD 184738, is -510 km s⁻¹. These stars are therefore well suited to establish the occurrence of the C IV violet edge and to indicate the intensity differences with respect to the diffuse interstellar bands.

Figure 1 contains intensity tracings of these three stars in the 5800 Å region obtained from Mount Wilson coude spectra of dispersion 20 Å mm⁻¹. The velocities encountered in HD 193793 are by far the largest known in any Wolf-Rayet star. The He I 5876 absorption edge is displaced 46.7 Å away from its normal position. The evidence of C IV displaced absorption is clear in this star. The tracing shows the presence of the interstellar bands 5780 Å and 5797 Å. We estimate the equivalent widths to be 0.24 Å and 0.05 Å respectively. The value for the other strong diffuse interstellar feature at 6284 Å in this star is 1.1 Å. The C IV violet absorption is very much more intense than the interstellar contribution. Its presence is well established both by consideration of wavelength separation and intensity. In HD 166783 the entire shape of the 5801-5812 Å emission feature shows undoubtedly the role of the violet absorption edge. The interstellar band at 5797 Å is seen weakly superposed on the emission feature, while 5780 Å is lost in the absorption profile corresponding to C IV 5812. The C IV displaced velocity is 1605 km s⁻¹ that matches the He I 3889 Å value of 1889 km s⁻¹, after allowance for the excitation dependence. We would also conclude independently that it would be so, from the value of the violet absorption of O III 3765 Å of 1404 km s⁻¹. The displaced violet edge of He I 5876 in HD 184738 has a velocity of 825 km s⁻¹. The violet edges of the C IV

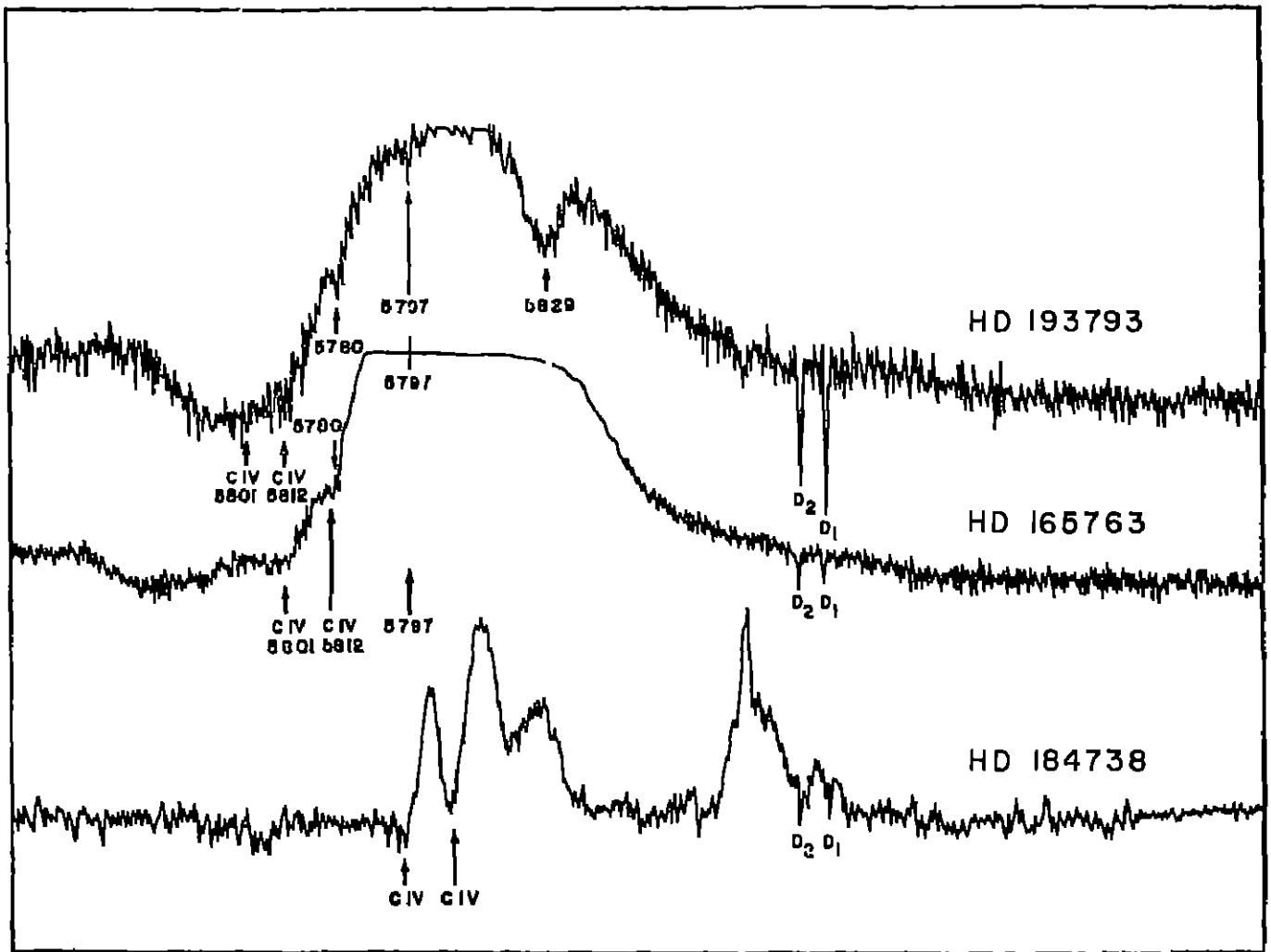


Fig 1 Intensity tracings of HD 193793, HD 165763 and HD 184738 in the 5800 Å region

lines have measured shifts of 306 km s^{-1} and 369 km s^{-1} . The emission profile of C IV 5801 displays a depression caused by interstellar absorption at the wavelength 5797 \AA . The plate available with us has an underexposed continuum that would be insufficient to show the interstellar feature at 5780 \AA . In Kavaluri spectra of HD 68273, the absorption features of C IV are striking. There can be little doubt that these are violet edges with a displacement of -830 km s^{-1} . The interstellar lines of Ca^+ and Na are very weak in the spectrum of this star. It is therefore only reasonable that the diffuse interstellar bands be exceedingly weak.

Having established in the spectra of the Wolf-Rayet carbon sequence the role of the C IV violet edges, we examine these features in the nitrogen sequence. We give in Table 1 a summary of velocity shifts associated with He I 5878 and C IV for the

Table 1. Velocity displacement of violet absorption edges of different ions

| | He I 3889 Å km s ⁻¹ | C IV 5801 Å km s ⁻¹ | C IV 5812 Å km s ⁻¹ | He I 5878 Å km s ⁻¹ |
|-----------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| HD 50808 | -1509 | -1363 | -1322 | -1444 |
| HD 68273 | | -972 | -780 | -1173 |
| HD 92740 | | | | -1020 |
| HD 151832 | | | | -1028 |
| HD 165763 | -1589 | -1585 | -1805 | |
| HD 184738 | -810 | -308 | -389 | -825 |
| HD 181785 | -1611 | -1051 | -1002 | -1611 |
| HD 182103 | -1195 | -1080 | -847 | -1084 |
| HD 182163 | -1360 | -1085 | -1119 | -1367 |
| HD 182641 | -1041 | -1093 | -1127 | -1333 |
| HD 183077 | -1340 | -1343 | -1202 | -1230 |
| HD 183793 | -2552 | -2088 | -2180 | -2388 |

stars studied. The spectrum of HD 50896 shows broad emission features. The violet absorption of He I 3889 is displaced by 1509 km s^{-1} . The corresponding value for He I 5876 is 1444 km s^{-1} . The displaced violet edges of 5801\AA and 5812\AA have velocities of 1363 and 1322 km s^{-1} respectively. The broad emission contour has depressions in it coinciding with the location of the interstellar bands 5780\AA and 5797\AA . These are well separated from the C IV violet displaced absorption. In HD 193077 the location of the C IV absorption lines differ from the location of the interstellar bands. The absorption velocity of He I 3889 is 1340 km s^{-1} and the emission profile of the C IV complex shows the two violet edges as well as the interstellar absorption features. In the spectrum of HD 192163, the C IV 5801\AA violet absorption has a velocity of approach of 1085 km s^{-1} . This Doppler shifted line lies superposed on the interstellar absorption at 5780\AA . The violet absorption of 5812\AA is clearly visible. A similar situation of overlap by one of the lines prevails also in the spectrum of HD 191765. Two broad absorption features exist at 5772\AA and 5781\AA . On the basis of wavelength spacing it appears that these are due to

violet displaced C IV absorption. The velocity of approach would then be 1000 km s^{-1} .

The southern WN7 stars HD 151932 and HD 92740 show weak C IV emission when compared to that seen in the earlier types discussed above. Any possible violet edges to these lines are therefore quite weak. The interstellar features are however, quite strong, with both the diffuse bands and the D lines of appreciable intensity. The diffuse band 5780\AA has equivalent widths of 0.31\AA and 0.25\AA respectively in the two stars.

We conclude that C IV violet edges are characteristic of all the WR stars with C IV of sufficient intensity. The diffuse interstellar bands can be seen separate from these absorption effects depending on the absorption velocities prevalent in the WR atmosphere.

References

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