NEAR INFRARED OBSERVATIONS OF GALACTIC WN STARS

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The observations reported here have been obtained with the ESO Reticon system attached to the Boller and Chivens spectrograph at the 3.6 m telescope. The reciprocal dispersion was 228 A mm^{-1} with a useful spectral range extending from 5800 A to 11000 A. The slit was 200 μm wide which corresponds to 1.4 arcsec on the sky and to about 33.5 μm($\sim$ 7.6 A) in the plane of the detector. Sky substraction was performed by means of observations at 93 arcsec. East and West of the object. The correction for atmospheric extinction was based on a mean extinction curve of La Silla (Tug, 1977). As a consequence the strongest atmospheric bands are still present on the final spectra. The data were also corrected for the instrument sensitivity response by using calibrated stars selected from Breger's catalog (1976). As these reference data are from filter photometry, they are not well suited to the resolution of our spectra, at least in some regions. This problem can be significant, as clearly illustrated by Johnson (1980).

In this paper we will concentrate on the Paschen region in the spectra of late WN and this in connection with the discussion on the Hydrogen to Helium ratio on the surface of WR stars.

Even if sometimes criticized, a "classical" way to derive the H/He ratio is the observation of the ratio between the Pickering lines of He II and the Balmer lines of H I. In the near infrared we have a similar situation : the Paschen lines of H coincide with every second line of the 6-n serie of He II.

A typical observation is illustrated with the spectrum of HD 86161 (figure 1), a WN8 star. On the tracing, in addition to the two series mentioned above we also observe

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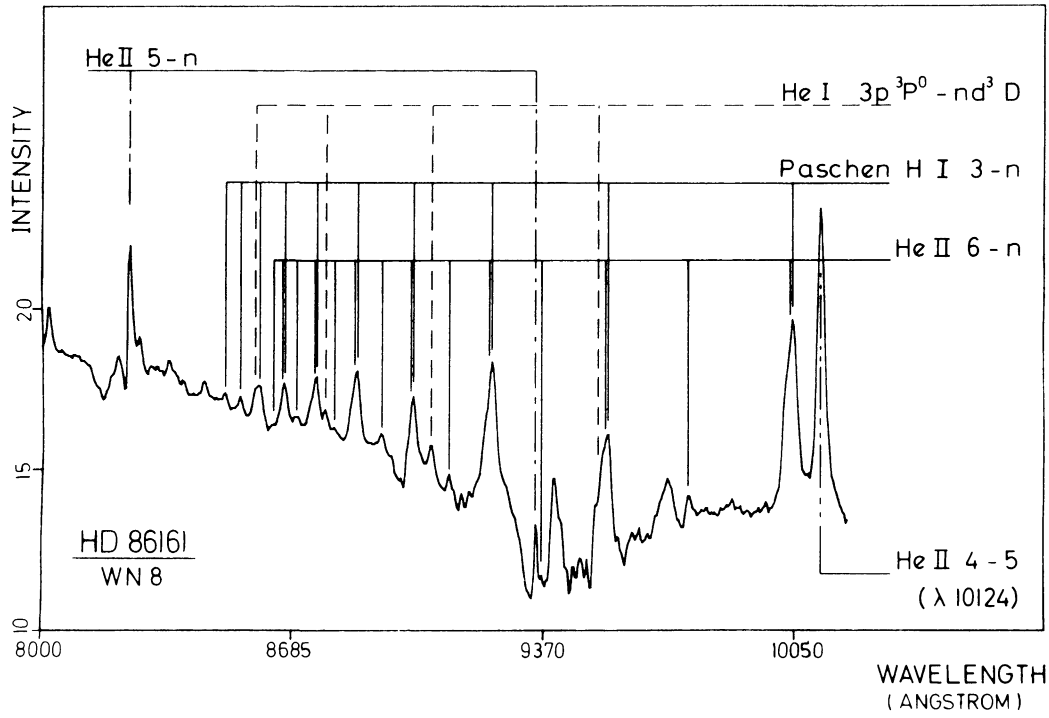

FIGURE 1. Spectra of the WN8 star HD 86161 in the Paschen region.

some lines of the 5-n serie of He II, some lines of the $3p^3P^o$ - nd^3D serie of the He I as well as the 4-5 transition of He II (λ 10124). From this spectrum we derive a number ratio of H II to He III of the order of 10 i.e. of the order of the cosmic abundance. A similar value is obtained from the spectra of HD 96548, another WN8 star.

Both evaluations are quite compatible with the abundances derived from visible spectra by Perry and Conti

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(1981). This is a conforting agreement and it would be pleasant to extend this method to a larger sample of stars. However, when we go to the WN7, the situation is quite different as illustrated in the next figure (figure 2), where the stars have been ordered according to the aspect of the Paschen lines.

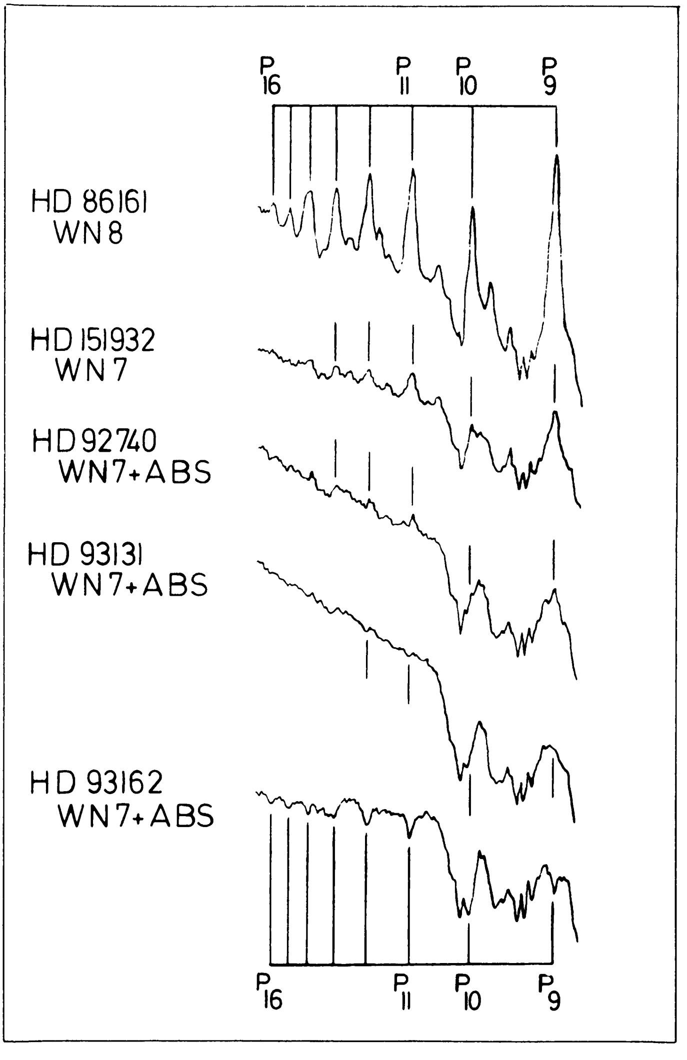

FIGURE 2. Spectra of late WN stars in the Paschen region, ordered according to the aspect of the Paschen lines.

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On this figure, all the stars have the same spectral subclass which means that these objects have very similar ionization conditions in their atmospheres, at least as the classification lines are concerned i.e. as the nitrogen ions lines are concerned. But, clearly, there is something dramatically different in their atmosphere concerning the hydrogen. The most spectacular case could be HD 92740 which exhibit hydrogen lines in absorption in the visible part of the spectrum (i.e. the Balmer serie) but hydrogen lines in emission in the near infrared (i.e. the Paschen serie).

When looking on this figure we are clearly looking on stars of the same spectral class with very different physical conditions in their atmosphere and it is tempting to interpret this figure as an illustration of different balances between emission lines originating in a high temperature outer sheet around the star and absorption lines originating from the photosphere. This could be produced either by different values of the two components themselves either by a different value of the opacity of the layers above the photosphere (which could be due to differences in the density and/or the temperature of these layers).

Whatever the reason for the differences, we clearly have to be very cautious when we try to derive abundances because the last figure illustrate how different the physical conditions can be in stars of the same spectral subclass.

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DISCUSSION

Conti: Although all 3 WN stars are classified similarly, both HD 93131 and HD 93162 have nitrogen ionization states closer to WN6. They are classified as WN7 because HeI shows P-Cygni profiles. The spectral differences in the Paschen lines again demonstrate the spectral heterogeneity among WN subtypes.

Cassinelli: The 3 WR stars in your last figure are 3 stars observed with the EINSTEIN X-ray satellite by Seward, as I mentioned yesterday. It is interesting that the star with the weakest WR characterisctics is HD 93162 is the only strong X-ray source. This suggests that there is an inverse correlation of X-ray luminosity with the strength of the WR emission lines. Maybe there is simply less absorption of X-rays in stars with the lower density winds.