

LINE STRENGTHS IN WN STARS

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We have analyzed high-dispersion spectra of over 100 WN stars in the Galaxy and the Large Magellenic Cloud (LMC). Most of the spectra were obtained through 4-m telescopes (Conti, Leep, and Perry 1981). The measured strengths of the WN classification lines N III $\lambda\lambda 4634-41$, N IV $\lambda 4057$, N V $\lambda 4604$ (Smith 1968) for stars of WN subtypes 2.5-8 are shown in Figure 1. The assignments of WN subtypes are based on visual estimates of ratios of line strengths according to the scheme of Smith (1968), except that stars appearing to be earlier than WN3 are classified as WN2 or WN2.5 as explained by vander Hucht *et al.* (1981) and by Conti, Leep and Perry (1981).

The observed relationship between line strengths and spectral subtype is qualitatively what one expects from consideration of ionization equilibrium: N III is strong on late-type stars, N IV is strong in WN5 stars and weaker in both early- and late-type stars, and N V is strong in early-type stars. Note, however, that line strengths of the WN7 stars are on the average less than one might have expected based on subtypes WN6 and WN8. This deficiency appears not only in the nitrogen lines but also in the He II Balmer-Pickering series. The WN7 subtype is unusual also in that its members are generally more luminous than other WN stars and that about 75% of WN7s have larger H/He ratios than do stars of other subtypes. These unusual features are probably consequences of the different evolutionary state of these stars.

In the figures, there appears to be very little difference between LMC and Galaxy stars, except possibly for the WN3 and WN7 stars in the LMC, whose N IV lines are stronger than those of the Galaxy stars. This suggests that the pattern of evolution of WN stars in the LMC is similar to that of our Galaxy.

The most important point revealed by Fig. 1 is the great diversity of line strengths within each subtype. For different stars in a given

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Fig 1: Nitrogen line strengths of WN stars. Circles: Galaxy stars. Squares: LMC stars. Filled symbols: stars with absorption lines and stars known to be binaries.

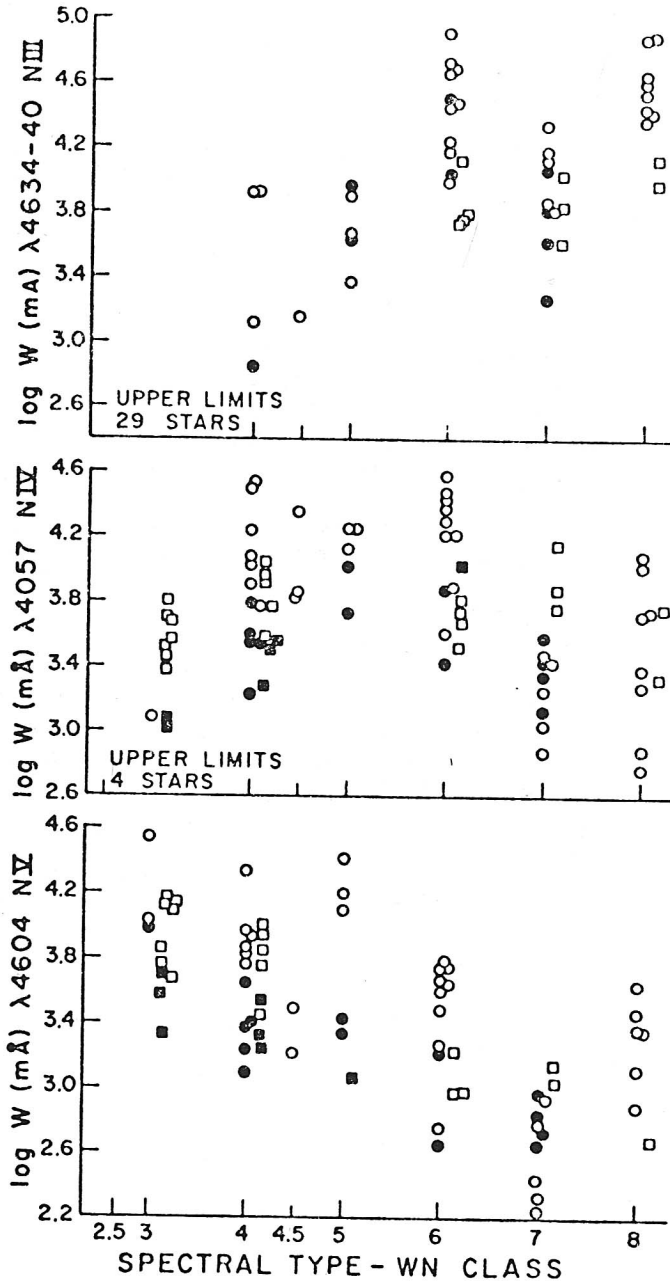
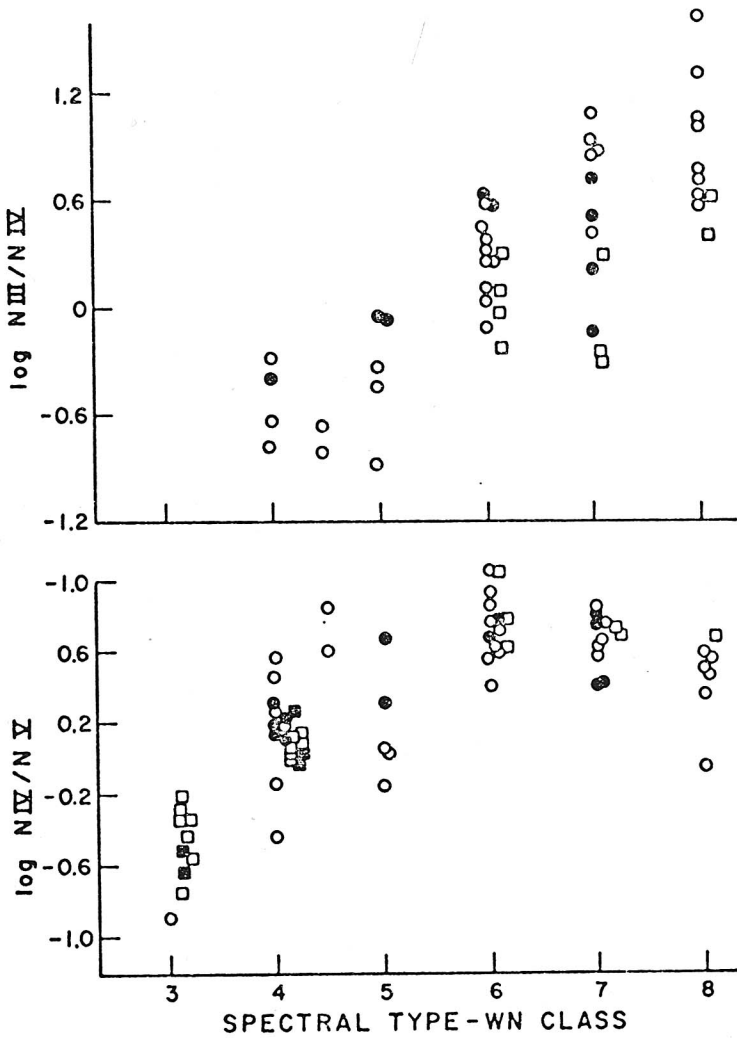


Fig 2: Ratios of line strengths in WN stars. Key to symbols: same as in Fig 1.



subtype, the line strengths can differ by factors of 4 to 10. Because of these large spreads, there is no "standard star" for each subtype (Beals 1938). Apparently there are other important parameters besides the ionization balance of nitrogen. For example, in the WN6, WN7, WN8 subtypes the behavior of He I and the hydrogen Balmer lines is important; the same is true of the He $\lambda 4686$ line.

Let us now turn to the line-strength ratios presented in Figure 2. As expected, there is a correlation between nitrogen line ratios and WN subtype, but again note the spread within each subtype. The similarity in line ratios among the WN6, WN7, WN8 subtypes suggests that these stars have similar ionization temperatures.

In summary, we have seen that stars in any one subtype are not a homogeneous group. Consequently, one cannot use the average properties of the subtype to predict colors, mass, luminosity, or effective temperature. Spectral appearance is influenced by composition, atmospheric structure, density, and extent of the winds, so that similar emission-line strengths could be produced by very different phenomena.

ACKNOWLEDGEMENTS

Financial support from the American Astronomical Society and from the International Astronomical Union, which enabled me to attend this meeting, is gratefully acknowledged. I also wish to thank Peter S. Conti for his interest and support of this work.

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DISCUSSION

Moffat: What is the observational scatter in line ratios ? Compare with the scatter about a smooth fit through the trends of line ratio with spectral subclass.

Leep: Our equivalent widths are good to 0.1 in the \log_{10} . The scatter around a smooth fit to our line ratios is about $\pm .3$ in \log_{10} .

Massey: You said that the N IV line is stronger for the LMC WN3's than for galactic ones. Did you try re-typing the LMC stars ? Maybe some of those WN3's are really WN4's.

Leep: No, we have not reclassified our early WN3 stars. And since the WN7 LMC stars also show strong NIV they may also need to be reclassified.