# CHEMICAL COMPOSITION OF WOLF-RAYET STARS: ABUNDANT EVIDENCE FOR ANOMALIES

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## I. INTRODUCTION

We have observed 45 WN stars in our Galaxy and the LMC with the IUE satellite at a resolution of 6 Å. Examination of the spectra reveals surprising differences in line strength, in many cases at a given spectral subtype. This is similar to the description of the visual spectra given by Leep (1982). One generalization that can be made is that the equivalent width of He II λ1640 is correlated with the H/He ratio measured by Perry and Conti (1982), but not with spectral type.

## II. APPEARANCE OF THE SPECTRA

Nussbaumer, Schmutz, Smith and Willis (1981) have observed 10 WN stars with IUE, and our additional observations show qualitatively the same things. N V λ1238 is present in all but some of the WN7 and WN8 stars, and its strength decreases with later type. O V λ1371 is present in almost all WN5 and earlier types, while Si IV λ1393, 1402 starts to show up in WN5 and later types. C IV λ1548 is present in all but a few WN2 and WN3 stars. He II λ1640 is almost always the strongest emission line; it is present in all but the WN8 stars.

The spectra of some representative early WN stars from the Galaxy and the LMC are shown in Fig. 1. The equivalent width of He II λ1640 ranges from 10 Å in HD 9974 to about 170 Å in HDE 269549. C IV λ1548 ranges from practically nonexistent to a strong P Cygni profile, and in HDE 269485 it shows emission comparable to He II λ1640. The strength of N IV λ1718 increases relative to N V λ1238 between WN3 and WN4.

## III. HYDROGEN AND HELIUM IN THE SPECTRA

The H/He ratio has been determined by Perry and Conti (1982) from the enhanced fluxes in the even Pickering series over those of the odd



*C. W. H. de Loore and A. J. Willis (eds.), Wolf-Rayet Stars: Observations, Physics, Evolution, 105–107.*


https://doi.org/10.1017/S0074180900028746 Published online by Cambridge University Press

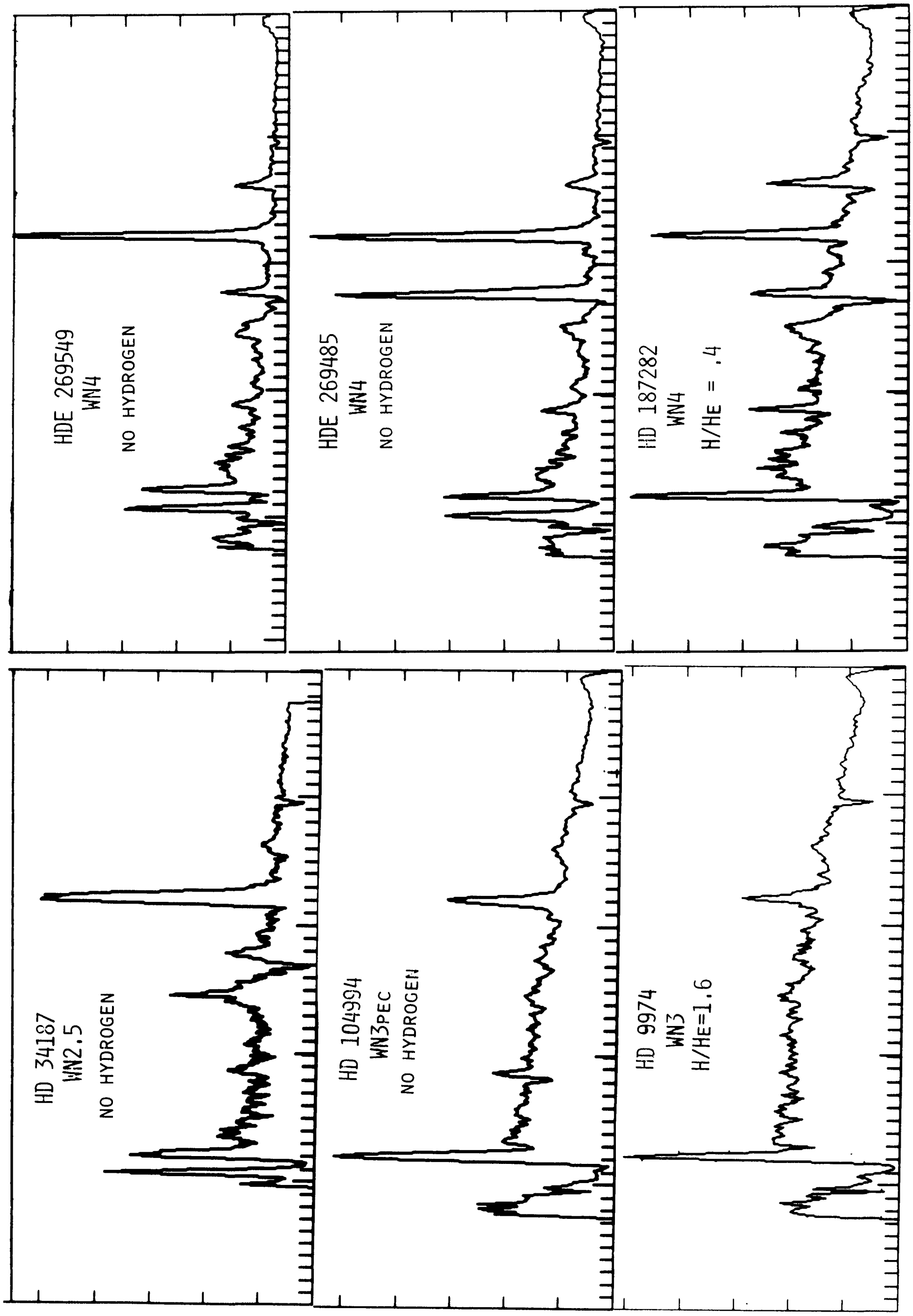


Figure 1. Representative early WN stars observed with IUE and converted to absolute fluxes.

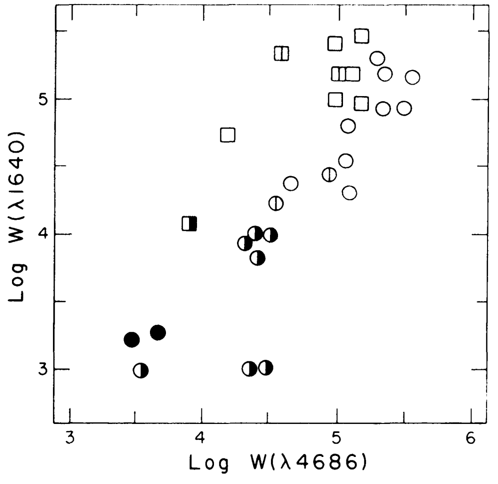


Figure 2. Equivalent width of He II λ1640 vs. λ4686 in a sample of WN stars. O = Galactic stars, □ = LMC. Open symbol = no hydrogen, vertical line = H/He between 0.2 and 0.7, half filled symbol = H/He greater than 1 filled symbol = Of-type stars.

numbered series. In Fig. 2 we compare the He II emission line strength with this H/He ratio. There is a very clear relation between the H/He ratio and the strength of He II, but almost no correlation with spectral type. Another noticeable effect in Fig. 2 is the separation of the LMC stars from the stars in the Galaxy; the LMC stars show systematically stronger λ1640 compared to λ4686. This may reflect different densities in the winds of the LMC stars compared to Galactic stars.

These data provide further evidence of the differences among subtypes, which includes the H/He ratios, the masses (Massey, 1981), and the absolute visual magnitudes (Conti, 1982). The physical reason for these differences is not yet clear.

This research was supported by NASA grant NAG5-78.

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