RECENT CHANGES IN THE ULTRAVIOLET SPECTRUM OF THE Be STAR HR 2855

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High resolution IUE observations of the Be star HR 2855 (HD 58978) spaced five months apart have revealed striking variations in the resonance lines of C IV and N V. The nature of these variations can be seen in Figures 1 and 2.

When HR 2855 was first observed on 1979 October 23, each member of the C IV resonance doublet appeared to have three distinct absorption components. A similar pattern was seen in the N V resonance doublet. The centroid of each complex feature is violet shifted by 150 km s^{-1} relative to the photospheric lines. The C IV and N V features which were observed on 1980 March 31, did not display the complex structure observed five months earlier. Even though the profiles varied considerably, the velocity shift of the features remained the same. The

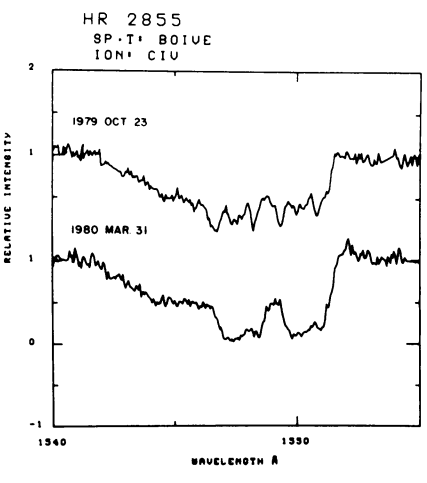

Fig. 1 - Conspicuous differences are seen between these normalized C IV profiles observed five months apart.

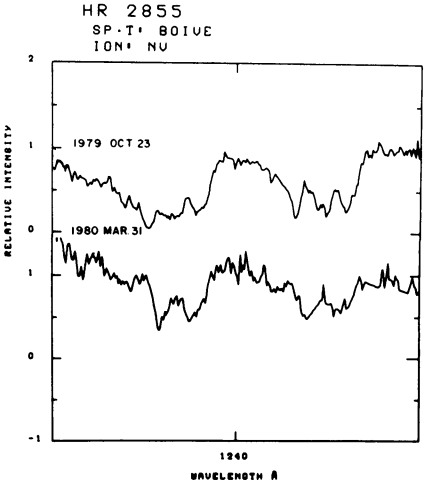

Fig. 2 - Same as Fig. 1 for N V.

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observations suggest that, in late October of 1979, the broader absorption features contained centrally reversed emission components. A weak emission component persisted in N V during the 1980 March observation.

In contrast to C IV and N V, the Si IV resonance lines remained invariant (Fig. 3). Although the presence of a wind is evident from the shallow slopes of the violet wings of the Si IV features, there is no evidence of mass outflow in discrete components. Radial velocities from the Si IV cores ($\simeq$30 km s^{-1}) agree very well with those from the photospheric features. It should be noted that the depressed violet wing observed in C IV is simply a blend of photospheric features which are strong in B0 stars; it is not the result of a wind.

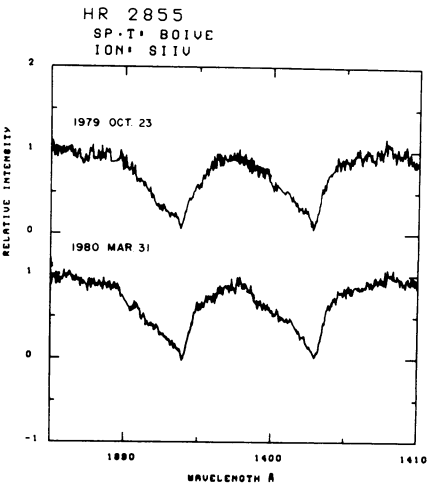

Fig. 3 - The Si IV doublet observed simultaneously with C IV and N V.

The spectral variations reported in this paper bear some resemblance to those recently observed in the active Be star 59 Cyg (Doazan, Kuhi, and Thomas 1980, Doazan, et al.1982). In both stars, it is the superionized species which undergo the changes; Si IV shows no statistically significant variation. In both cases, the active regions appear to be separate from the stellar photosphere.

During the past decade, the behavior of the Balmer lines in HR 2855 seems to have been slightly different from that reported for 59 Cyg (Doazan, Kuhi, and Thomas 1980, Hubert-Delplace and Hubert 1979). Spectrograms of HR 2855 obtained at Lick Observatory, Kitt Peak National Observatory, and UCLA's Ojai Observatory from 1969-1981 have shown the Balmer emission to be persistent (though relatively weak). V/R variations and transient shell features have frequently been observed. No period has been discovered but our data show that the lifetime of the shell is of the order of a few months or less.

In conclusion, HR 2855 should be included in a growing class of Be stars which display a "chromospheric" type activity. Future UV observations which are planned will allow us to determine the time scale for the variations and whether the activity parallels that seen in the extensively observed Be star 59 Cyg.

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Doazan, V., Grady, C., Kuhi, L.V., Marlborough, J.M., Snow, T.P., and Thomas, R.N.: 1982, this volume, pp. 415-418.
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DISCUSSION OF PAPERS BY G.J. PETERS

a. ω Ori, 66 Oph

Harmanec: May I ask you how safe your identification of different UV lines is? Some of your identifications appear to be done somewhat arbitrary in a flat portion of broad blends. I have no personal experience with the UV spectra and I feel a bit worried after seeing the theoretical UV spectra, full of lines, shown yesterday by Dr. Marlborough, and after hearing that many unidentified lines were found in the UV spectra.
2. How do you explain the two other components of the UV lines found in ω Ori?

Peters: 1. The lines are strong in ω Ori. The Si IV features in 66 Oph are only about 4σ, However, in view of the agreement between the Si IV velocities and those of the stronger C IV and weak Si III, I believe the identifications of the weaker lines. The v sin i's for these stars are high enough to completey rotationally broaden the numerous photometric lines which exist in the vicinity of C IV and Si IV. Therefore the sharp components are most assurely formed in the circumstellar matter.
2. I interprete the presence of the multiple component as evidence for the existence of multiple discrete "clouds" or "shells". Further observations should be able to tell us more about this interesting pattern of mass loss.

Henrichs: The high velocity features in ω Ori and 66 Oph are exactly like those observed in γ Cas (see page 431). If you plan new observations you might consider our experience with γ Cas that these high velocity absorptions are observable only during a few weeks. Their column densities decay according to t^{-2} (like we had predicted, 2nd IUE Conf. Tübingen), which is very rapid.

Slettebak: With regard to the spectral type of ω Ori, B2 III is a better type than B3 III, in my opinion. Also, I now believe that v sin i for 66 Oph is closer to 240 than 280 km/s.

b. Interacting binaries

de Groot: I have just heard that Sahade has found a change in behaviour of the mass outflow in AU Mon, but I don't have further details. Do you know anything about this?

Peters: In the UV, N V (and C IV) are quite variable. H_α observations reveal that the disc is extended (comparable in size of the Roche surface of the primary) and that there is enhanced mass-loss near $\phi = .5$.

Henrichs: The variable high excitation lines you described remind me of the x-ray binary 4U900-40 where in the optical counterpart a

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nice orbital phase dependence was found.
This was predicted by MacCray '75, as being a direct consequence of the wind-ionization dependence of the nearby x-ray companion. Therefore, x-ray observations, if they are feasible, might help towards an explanation.

Peters: I agree, but to the best of my knowledge only one of the program stars, HR7084, is a x-ray source (Plavec, personal communication).

c. HR 2855

Doazan: I would like to emphasize the importance of G. Peters observations which give direct evidence of 1. mass ejection in pole-on stars, i.e. mass ejection in polar regions if one accepts the rotational model, 2. variability of the superionized lines, which seem now to be a general phenomenon. You will see that in 59 Cyg this variability is observed in a striking manner.

Snow: We know from ample evidence presented here that the Be stars themselves have winds, almost always highly variable in velocity and strengths of multiple components. In view of this, I just don't see how you can even hope to find phase effects at the relatively low velocity amplitudes of these binary systems. The mass-loss components are broad and variable. I am very skeptical that binary phase effects can be seen in the ultraviolet wind profiles, especially with IUE data.

Peters: Generally speaking, we have not observed the winds in our program binaries to be highly variable. If variations exist at all, they are slight (more like those seen in δ Cen as opposed to the activity observed in 66 Oph, ω Ori, 59 Cyg, etc.). We have found IUE data to be quite adequate for detecting the major phase dependent changes that exist such as the doubling of the equivalent width of certain spectral features around $\phi \simeq 0.9$. Indeed, using IUE, one can easily detect ($>> 3\sigma$) redward asymmetries in numerous resonance lines due to the mass transfer. This absorption prevails throughout the phase interval predicted by theory. We have observed most of the stars over several cycles at the same phase points to check for transient activity and have reported suspected instances in this paper (N V in AU Mon and HR 7084). Evidence for the phase dependence of the wind in HR 2142 is found in both IUE and Copernicus data.