Wolf-Rayet Phenomena in Massive Stars and Starburst Galaxies
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Selective absorption in γ^2 Velorum

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Abstract. Detailed analysis of the phase-dependent line-profile variations of *IUE* observations γ^2 Velorum it is found that selective absorption by the wind is the dominant source of variation in the UV. Excess emission from the shock zone also contributes but this too is selectively absorbed.

A simple absorption-line model has been developed to calculate the selective absorption in the winds of WR+O binaries, which takes into account the cavity in the WR wind created by the O star. By matching the profiles of lines formed in different regions of the wind it is possible to derive an approximate ionization balance which is then used to model the selective absorption. Details of the model and further results are being published elsewhere.

For the saturated P-Cygni lines the model suggests that the wind absorption is saturated across the whole width of the profile. As the O star emerges from behind the WR star the whole contribution of the O-star is progressively added to the profile from the red edge of the emission, ultimately to some way into the P-Cygni absorption. While the general character of the variation follows this pattern, in all these lines the magnitude of the variation is considerably larger than can be accounted for by selective absorption alone. The observed variation is typically 1.5 times the pseudo continuum of which the O star contributes ~ 0.8 depending on the luminosity-ratio. Many of the lines affected do not have strong O-star emission, so this cannot be a factor; indeed the variations of C III $\lambda\,1175$ and 2297 are among the largest.

In contrast to the saturated lines, the Fe IV pseudo continuum shows only modest variation and can be simply modelled. In the $\lambda\lambda$ 1500–1740 Å region 500 Fe IV lines with $gf \geq 0.02$ from the Kurucz-list have been used. The calculated profiles at $\phi = 0.62$ and 0.15 are shown in Figure 1 using the assumed ionization balance derived from fitting the C II $\lambda\,1335$ and C III $\lambda\,1909$ lines and adopting a solar Fe/He abundance. Ignoring the area of the strong P-Cygni lines, it can be seen that many of the individual features, as well as the more general change in shape of the pseudo continuum, is very well matched by the synthesised profile.

In their discussion of the Fe IV pseudo-continuum, St-Louis *et al.* (1993) found the absorption narrower than expected and also had to apply a velocity shift to their generated spectrum. They had assumed that the absorption is centred on the rest wavelength and taken the width from the saturated wind absorption lines. In the profile-fitting, both the velocity and width of the Fe IV pseudo-continuum lines are fitted naturally by the model on the basis of the adopted ionization balance alone. The only free parameter is the abundance. St-Louis *et al.* also found that the C III $\lambda\,1909$ line behaved in a similar way, but in this case the reason is due to the swaying of the emission peak as a

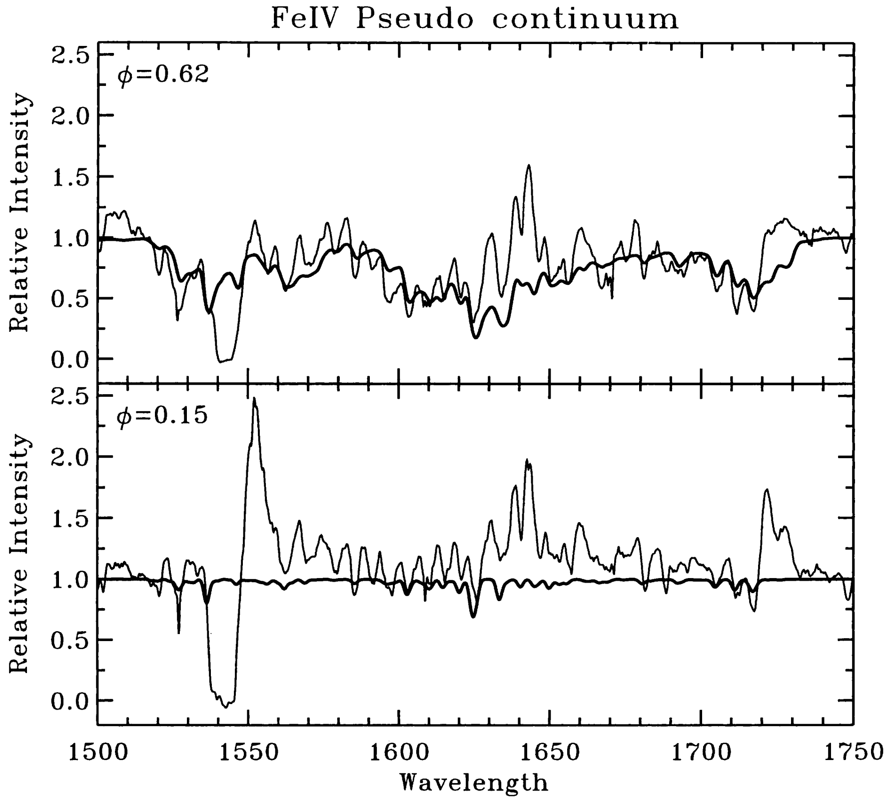

Figure 1. The Fe IV pseudo-continuum at two (*spectroscopic*) phases of γ^2 Velorum, $\phi = 0.62$ (*top*) and $\phi = 0.15$ (*bottom*) showing the observed profiles (thin line) and calculated profiles (thick line) using the assumed ionization balance and a solar Fe/He abundance. See the text for further details.

result of excess emission from the shock zone. By modelling this region of the spectrum, including the N IV λ 1718 line with the Fe IV lines it is possible to place a limit on the nitrogen abundance of N/He $< 10^{-4}$ by number. The analysis has also revealed that emission from the shock zone is a major contributor to the emission lines and has a large impact on the observed variation. The behaviour of the CIII] λ 1909 line is not consistent with selective absorption, but is broadly compatible with the excess-emission produced by the shock-zone as given by Lührs (1997). Similar emission is probably also responsible for the variation and strengths of the other major emission lines. The excess-emission also explains the anomalous line-ratios at inferior conjunction. The important point of difference between the Lührs model and the idea presented here, is that the excess-emission from the shock-zone also undergoes selective absorption by the wind.

References

St-Louis, N., Willis, A.J., Stevens, I.R. 1993, ApJ 415, 298
Lührs, S. 1997, PASP 109, 504