WIND ABSORPTION EFFECTS IN THE N IV 1718Å LINE IN THE WN4+O5 BINARY HD 90657

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Abstract. Using a simple absorption line model the phase dependent effects of 'wind eclipses' have been studied for the N IV 1718Å line in the WN4+05 binary, HD 90657. The varying strength of the absorption, as measured by the equivalent width, has been compared with the model for a range of wind parameters and assumptions. It is found that the fraction of absorbing atoms drops quickly, to the first or second power of the radius, and that a significant fraction persists beyond 60 $R_\odot$.

Key words: stars: Wolf-Rayet – winds – individual: HD 90657

In Wolf-Rayet plus O-star binaries the principal lines frequently show additional phase dependent absorption. These are the so-called wind eclipse features and are due to the passage of the continuum of the O-star through the extended WR wind. It is possible to use the bright continuum of the O star as a probe to investigate the WR wind at different radii in a way that is impossible for single stars.

A simple absorption line model is used to calculate the additional phase dependent absorption in the 8 day WN4+05 binary, HD 90657. The diagrams show the equivalent width measurements as a function of phase with different model calculations superimposed. The change in the strength of the line is initially very slow, and may even be constant around phase zero but then drops rapidly towards quadrature and then tails off to a constant level. Very little variation takes place after phase 0.2 or 0.3 which is when the O star emerges from behind the wind. The minimum wind radius sampled by the O star is 34 $R_\odot$ so the bulk of the absorption line is formed between here and ~60 $R_\odot$, the radius of the system.

The first set of models assume a finite radius for the wind and all match the variation up to phase 0.1. Those with larger wind radii produce too much absorption and too much variation at later phases (see Fig. 1). A wind radius of 50 – 60 $R_\odot$ produces an acceptable fit to the data, but there is an unrealistic, sharp discontinuity in the wind. The next sets of models assume that the wind has infinite radius but that the fraction of absorbing atoms decreases with radius (see Fig. 2). The general form of the models follows the data although the linear reduction suggests too much absorption between phases 0.1 and 0.2 while the quadratic reduction in line strength is perhaps too aggressive at early phases.

The N IV atoms forming the 1718Å absorption occur at radii between 34 – 60 $R_\odot$ and probably beyond. The linear and quadratic reductions in the fraction of absorbing atoms, which are an acceptable fit to the data, permit

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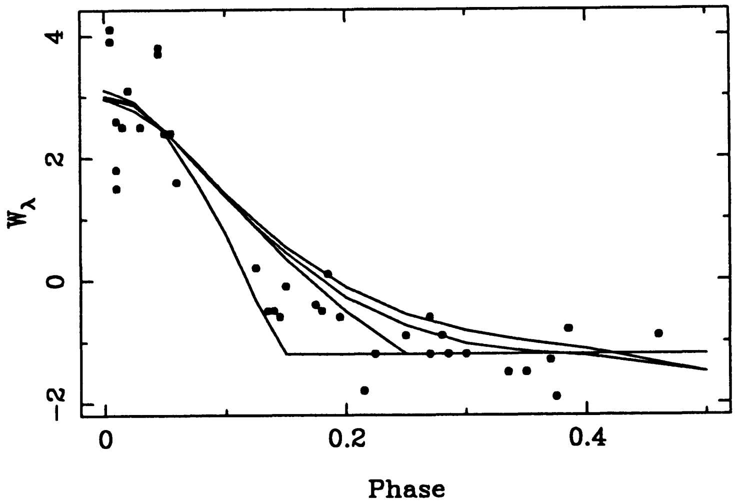

Fig. 1. The first set of models assume that the wind has a limiting radius of 50, 60, 70 and 80 $R_\odot$. Inside this radius the fraction of absorbing atoms is constant while outside it is zero

from a half to a quarter of the absorbing atoms at $r = 34\,R_\odot$ to exist beyond $60\,R_\odot$. Within the limits of the data it seems most likely that the reduction in the fraction of absorbing atoms falls as r to a power between 1 and 2 in the region sampled by the O star. It is possible that for the innermost regions the fraction of absorbing atoms is constant.

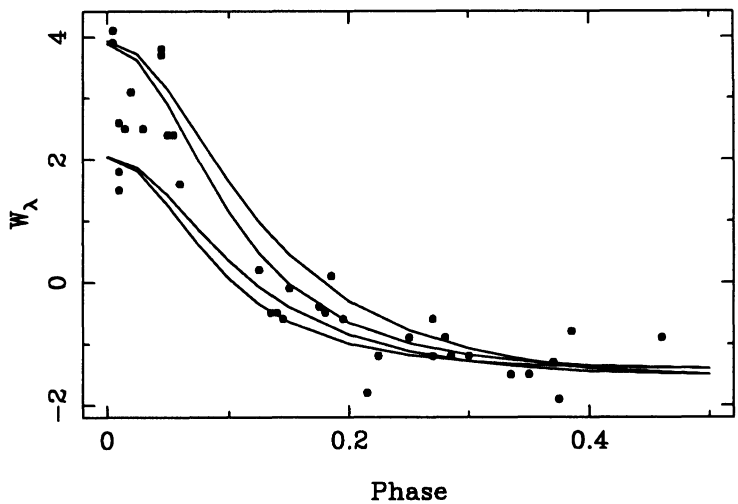

Fig. 2. These two sets of models assume that the wind has infinite radius but that the fraction of absorbing atoms drops linearly with radius, and as r^2 (the steeper lines). The upper and lower pairs of lines differ by about a factor of 2 in the number of absorbers.

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