Wolf-Rayet Phenomena in Massive Stars and Starburst Galaxies
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The IUE orbit of γ^2 Velorum

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Abstract. Using *IUE*-SWP spectra, an orbital solution is derived for both components in the γ^2 Velorum, which supports the lower mass of the O star found previously.

The orbital elements of γ^2 Velorum have been derived using the same cross-correlation technique that has been successfully applied to a large number of early-type binaries in a series of papers which have appeared in *The Observatory* magazine.

The contentious point about the orbit of γ^2 Vel has been the velocity amplitude of the O star. The previous *IUE* orbit (Stickland & Lloyd 1990) and archival optical observations (Pike *et al.* 1983) suggested a lower amplitude, and hence lower mass for the O star, by a factor of about two, than other determinations (*e.g.*, Moffat *et al.* 1986) and earlier solutions. However, the situation has now been resolved, as Schmutz *et al.* (1997) have derived a new solution, based on a long series of high-resolution, high signal-to-noise optical spectra combined with earlier data which supports the lower mass determinations.

Using *IUE* high-resolution SWP spectra the spectrum is compared with a library of O-type stars and single WC stars. γ^2 Vel give the strongest correlation against stars of mid-to-late O spectral type, with HD 9546, O8 finally chosen as the primary template for its symmetrical and relatively sharp cross-correlation profiles. For the WC component WR 57 and WR 90, both WC7, gave useful correlations but the strongest was with WR 135, WC8, which matches γ^2 Vel both in spectral type and terminal velocity. The cross-correlation is made in relative velocity-space against the interstellar lines. From absolute measurements of the interstellar line-velocities, it is possible to put the measured velocities on a near absolute basis.

After considerable experimentation with the spectral masks and other measurement parameters a number of single-line orbital solutions were derived for the O star. Using HD 9546, the solutions with the smallest residuals gave the parameters $K_{\rm O} \simeq 35\,{\rm km\,s^{-1}}$ and $e \simeq 0.4$, with σ typically $15\,{\rm km\,s^{-1}}$.

For the WR component a number of solutions were derived using different masks and measuring techniques. The cross correlation function was broad but the peak gave a variation of with $K_{\rm WR} \simeq 130\,{\rm km\,s^{-1}}$, $e \simeq 0.5$ and with $\sigma \simeq 17\,{\rm km\,s^{-1}}$. Two of the best single-line measurements were combined into a double-lined solution, which is shown in Figure 1.

It is satisfying to note that the amplitudes and eccentricity are consistent with the more reliable solution of Schmutz *et al.* The agreement on $K_{\rm O}$ between this solution and that of Schmutz *et al.* is probably due to the heavy smoothing applied to the spectrum prior to cross-correlation, which removed the slopes

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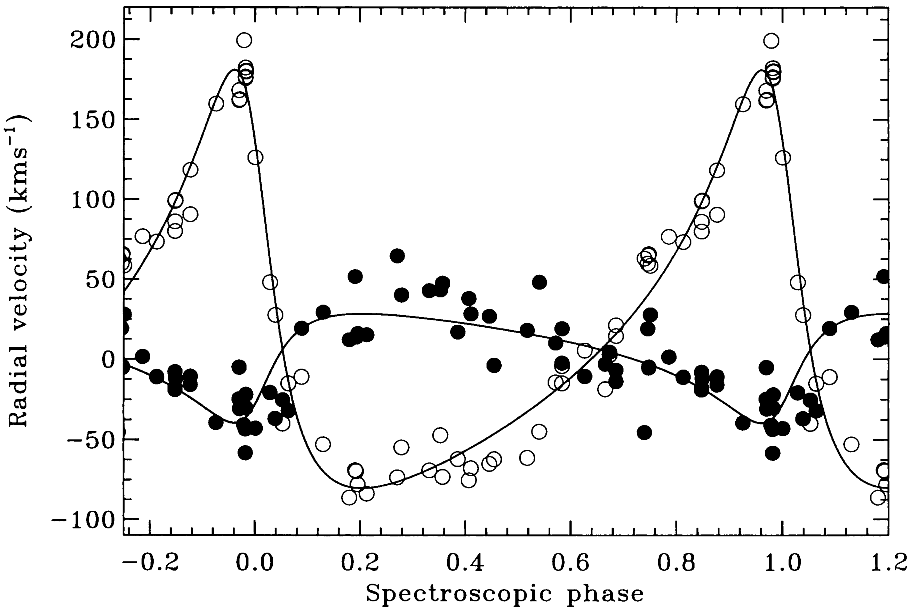

Figure 1. The *IUE* orbit of γ^2 Vel from a representative double-lined solution. The O star (filled circles) is treated as the primary. The phases are spectroscopic, measured from periastron passage. See the text for details.

that troubled the previous optical measurements. The agreement on $K_{\rm WR}$ is less good, and there is some internal inconsistency in the determination of e from the two components in the *IUE* solution. It was also noted that when the more recent *IUE* data were added to the solution the errors became far worse. For the WR star, this appears to be random but in the case of the O star it seems to be due in part to a general increase in velocity relative to the earlier data. Such systematic differences point to long term changes in the spectra of the system and mirrors the comments of Schmutz *et al.* who also noticed a difference between the data for the two years of their observations.

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