THE O-TYPE SPECTROSCOPIC BINARY SYSTEM HD 93206

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The star HD 93206 (=QZ Carinae) is a double-lined (Conti et al. 1977), eclipsing (Moffat and Seggewiss 1972) binary with a period of 6 d. Walborn (1973) classified it 09.7Ib:(n). Since the star is probably a member of the cluster Collander 228 (which is near η Carinae), its distance can be assumed to be 2600 pc. In principle, one can determine the masses of the components of HD 93206 from observations of the radial velocities and the light curve, and a spectroscopic orbit is the object of this investigation. A mass determination for an evolved star such as this one is especially important for checking recently computed evolutionary tracks with mass loss for massive stars (de Loore et al. 1977, Chiosi et al. 1978, Dearborn et al. 1978).

Between 1974 March and 1977 April, we obtained 29 blue spectrograms of HD 93206 with the No. 1 coudé camera of the 1.5-m telescope at the Cerro Tololo Inter-American Observatory. All have dispersion 17 Å mm^{-1} and are widened to 0.6 or 0.8 mm. We measured them for radial velocity in both forward and reverse directions with a Grant oscilloscope comparator. For the orbital analysis, we used lines of He I. We traced six of the spectrograms and, using the method of Petrie (1940), we obtained the light ratio and the individual spectral types.

We used the technique of Lafler and Kinman (1965) to find the period of the velocity variation of the fainter star, which we henceforth call Star B. This period turns out to be essentially that of the eclipsing binary (Moffat and Seggewiss 1972). We then used a version of the program by Wolfe et al. (1967) to perform a differential-correction orbital solution. Figure 1 shows the radial velocities of both stars, plotted in the period we found for Star B, and, as a full curve, the theoretical velocities predicted from the orbital elements for Star B, which are listed in Table 1. The fit to the observations of Star B is reasonable in view of the internal errors (about 10 km s^{-1}), but the velocities of Star A show no indication of orbital motion with this period. In an attempt to fit the velocities of Star A, we searched for periods in the range 0.9 to 1.1 d and 15 to 40 d; the best-fitting period is 20.72 d. Figure 2 shows the velocities of Star A plotted in

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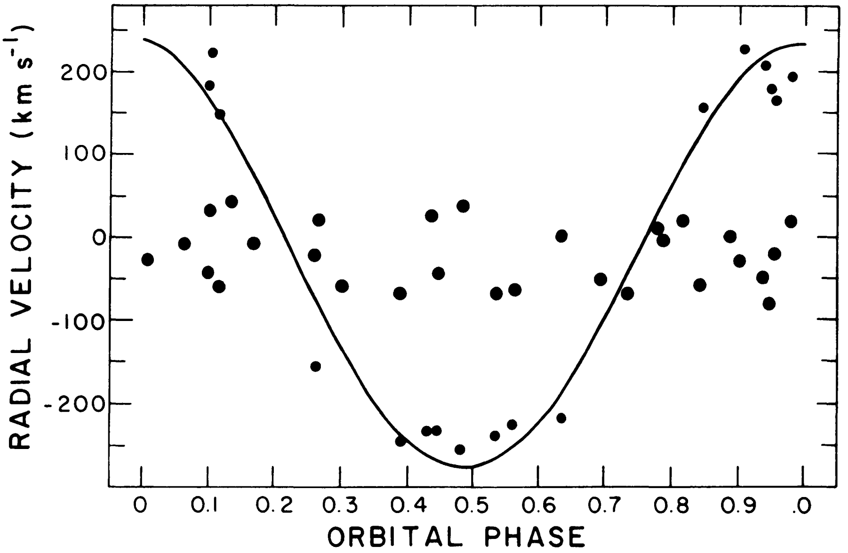

Figure 1. Radial velocities for HD 93206 AB as a function of orbital phase, which is defined by the orbital elements for Star B in Table 1. Large dots: Star A (the brighter star); small dots: Star B; full curve: theoretical velocities for Star B.

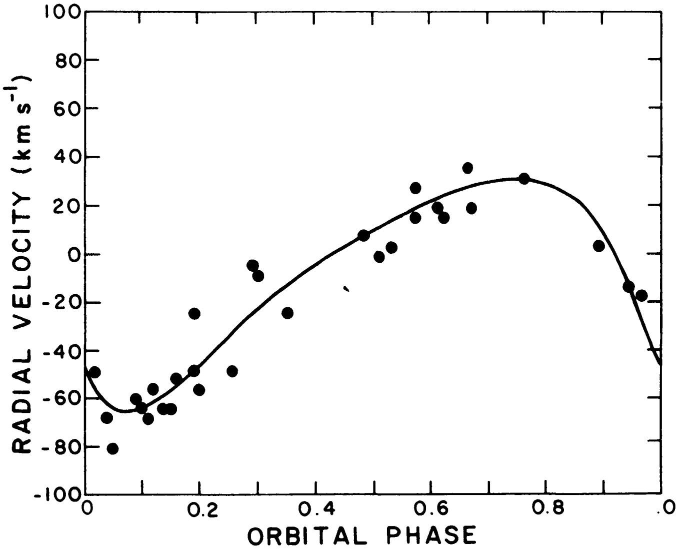

Figure 2. Radial velocities for HD 93206 A as a function of orbital phase, which is now defined by the elements given for Star A in Table 1. Full curve: theoretical velocities for Star A.

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Table 1. Orbital Elements for HD 93206

	A	B
Period (d)	20.72 ± 0.02	5.9965 ± 0.0015
K (km s^{-1})	48 ± 2	256 ± 10
V_0 (km s^{-1})	-8 ± 2	-26 ± 7
e	0.34 ± 0.04	0.04 ± 0.04
ω (rad)	2.2 ± 0.2	0.09 ± 0.83
a sin i (10^6 km)	13.0 ± 0.6	21.1 ± 0.8
f(m) ($m_\odot$)	0.20	10.5
Spectral type	09.5I	09III
J.D. of zero phase	2442529.8 (periastron)	2443235.9 (maximum positive velocity)

this period, along with the theoretical velocity curve computed from the orbital elements in Table 1.

We conclude that the two stars we observe do not belong to the same binary system, but probably to two widely separated binary systems, with Star A the primary of one and Star B of the other (which eclipses). The data do not allow us to state whether the two systems are gravitationally bound to each other. Given that multiple systems are common among later-type spectroscopic binaries (Batten 1973), it is not surprising that an O-type binary should turn out to be multiple. When orbital analyses for this spectral type are complete, the theory of formation of massive stars will benefit from a comparison of the incidence of multiple systems with that at later types.

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DISCUSSION FOLLOWING MORRISON AND CONTI

Underhill: What spectral lines did you measure? The possible interpretations may be affected by your choice, for some lines may be formed in a surrounding disk or gas stream. I think of famous systems such as HD 47219, Plaskett's star, and β Lyrae and the many interpretations that have been given for them.

Morrison: The velocities I showed are determined from lines due to He I. Velocities from an average of Si IV and N III are well correlated with these velocities; hence, the scatter that is shown when the velocities of star A are plotted in a 6-day period is not observational scatter.

Leung: There seems to be a very large eccentricity in your radial velocity curve but the photometric light curve of Tony Moffat showed that the secondary minimum occurred at phase 0.5. Thus, yours must have a very special orientation.

Morrison: The light curve refers to the 6-day star, which according to our analysis has zero orbital eccentricity. Hence, the two sets of data are consistent.

Cowley: In the case of your star "A", you show both a large velocity amplitude and a rather long period which implies substantial masses. Could you comment on these values?

Morrison : The masses implied are not particularly large, since the mass function is only 0.20 $M_{\odot}$. A rough estimate for the mass of the companion can be derived from the assumptions than sin i = 1 and the mass of the primary of the 20-day component is 30 $M_{\odot}$. Then the mass of the secondary is 6 $M_{\odot}$.

Moffat: I should point out that Seggewiss' and my slightly higher dispersion, 12 Å/mm Coudé spectrograms show fairly sharp Si IV 4089 absorption for each component (A and B) implying that star B is also a supergiant (BOIb). The mass function and the 6-day light curve (deeper minimum when the BOIb star is in front) leads to a mass of the unseen 6-day companion of star B which is larger than star B.

Morrison: The difference between our luminosity classifications for star B might be due to the difference in dispersion or to a different drawing of the continuum. The larger mass for the companion of star B is also consistent with the spectroscopic data and is very interesting.