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The long period spectroscopic binary HR 1176

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Abstract. The radial velocity measurements of the long period spectroscopic binary HR 1176 carried out at the Japal-Rangapur Observatory are combined with those available in the literature to obtain its revised elements.

Key words : spectroscopic binaries—HR 1176—orbital elements

1. Introduction

Wilson's *General catalogue of stellar radial velocities* mentions HR 1176 (= HD 23838) as a spectroscopic binary. HR 1176 was included by Bidelman (1954) in a list of stars which showed Ca II H and K emission. The spectral type assigned by Markowitz (1969) to this system is G2 III + F2 V, while Cowley & Bidelman (1979) classified it as G2 III—IV.

Pedoussaut *et al.* (1987) observed this system during 1973–85 from Haute Provence Observatory and have obtained its spectroscopic orbital elements.

2. Observations, results and discussion

The spectroscopic observations of HR 1176 were made during the years 1981–88; twentyfour spectrograms were obtained at a linear reciprocal dispersion of 33 Å/mm around H_γ with the Meinel spectrograph at the Nasmyth focus of 1.22 m telescope of the Japal-Rangapur Observatory. All the spectra were recorded on Kodak IIa-O emulsion.

The spectra were measured on Gaertner's moving carriage comparator. Table 1 gives the spectral lines measured and table 2 lists the measured radial velocities. The Ca II H and K lines were also measured, but their residuals were somewhat larger and hence excluded from the plate average. The Japal-Rangapur data are not enough for an independent solution, though these observations cover some of the phases not covered by earlier observers. Hence our observations have been

Table 1. Spectral lines measured in HR 1176

Wavelength (Å)	Identification
4005.205	Fe I
4045.827	Fe I
4063.607	Fe I
4071.751	Fe I
4101.743	Hδ
4143.772	Fe I
4187.370	Fe I
4226.640	Ca I, Fe I, Ti II
4260.429	Fe I
4271.630	Fe I, CH
4340.540	Hγ, Cr I, Ti II
4383.820	Fe I
4404.745	Fe I, Ti I
4461.793	Fe I, Mn I

Table 2. Radial velocity observations of HR 1176

HJD 2400000 +	Phase	R. V. km s^{-1}	O − C	Ca II H & K emission
44627.13	0.430	20.7	2.6	no
44967.26	0.783	28.5	0.1	no
44979.46	0.796	27.4	−1.4	very faint
44980.16	0.800	26.7	−2.1	no
44994.15	0.811	29.9	0.5	very faint
45011.14	0.829	29.0	−1.1	no
45256.40	0.084	−0.5	−1.0	very faint
45305.24	0.134	5.2	−0.2	no
45306.25	0.136	5.1	−0.4	very faint
45308.28	0.138	7.9	2.2	no
45309.27	0.139	8.5	2.7	very faint
45331.25	0.161	6.4	−0.9	no
45339.25	0.169	9.1	1.2	very faint
46806.13	0.693	24.4	−1.1	no
46812.16	0 699	24.8	−0.9	no
46860.11	0.749	28.4	1.2	no
46861.11	0.750	26.3	1.0	no
47154.23	0.055	−4.2	−1.0	no
47163.27	0.064	−2.9	−1.0	no
47164.24	0.066	−3.1	−1.3	no
47166.26	0.068	−3.4	−2.0	no
47167.26	0.069	−1.4	−0.1	no
47171.22	0.073	4.1	4.9	no
47172.22	0.074	−3.7	−3.0	no

combined with the earlier data given by Pedoussaut *et al.* (1987), Abt (1970) and Young (1939) for determining the elements by the computer program of Wolfe *et al.* (1967). However, three observations at Mount Wilson (Abt 1970) and David Dunlap (Young 1939) Observatories which gave large residuals (greater than $3\sigma \approx 6$ km s^{-1}) have been deleted from the calculations of the orbital elements. Table 3 gives the results so obtained along with those given by Pedoussaut *et al.* (1987) and figure 1 shows the combined radial velocity curve.

As can be seen from table 3, the combined solution gives somewhat larger errors compared to those of Pedoussaut *et al.* (1987). This could be due to a number of reasons. (i) The spectra obtained at Mount Wilson, David Dunlap

Table 3. Spectroscopic orbital elements of HR 1176

Elements	Pedoussaut *et al.* + present study	Pedoussaut *et al.* (1987)
P (d)	962.7 ± 0.16	962.8 (fixed)
T (HJD)	2447101.1 ± 0.9	242288.1 ±0.6
w (deg)	107.3 ± 1.8	108.8 ± 0.9
e	0.735 ± 0.006	0.724 ± 0.005
K (km s^{-1})	20.4 ± 0.3	20.2 ± 0.2
V_0 (km s^{-1})	18.5 ± 0.1	18.4 ± 0.1
$a \sin i$ 10^6 km	182.4 ± 2.9	184.4 ± 2.3
$f(m)$ ($M\odot$)	0.260 ± 0.026	0.270 ± 0.010

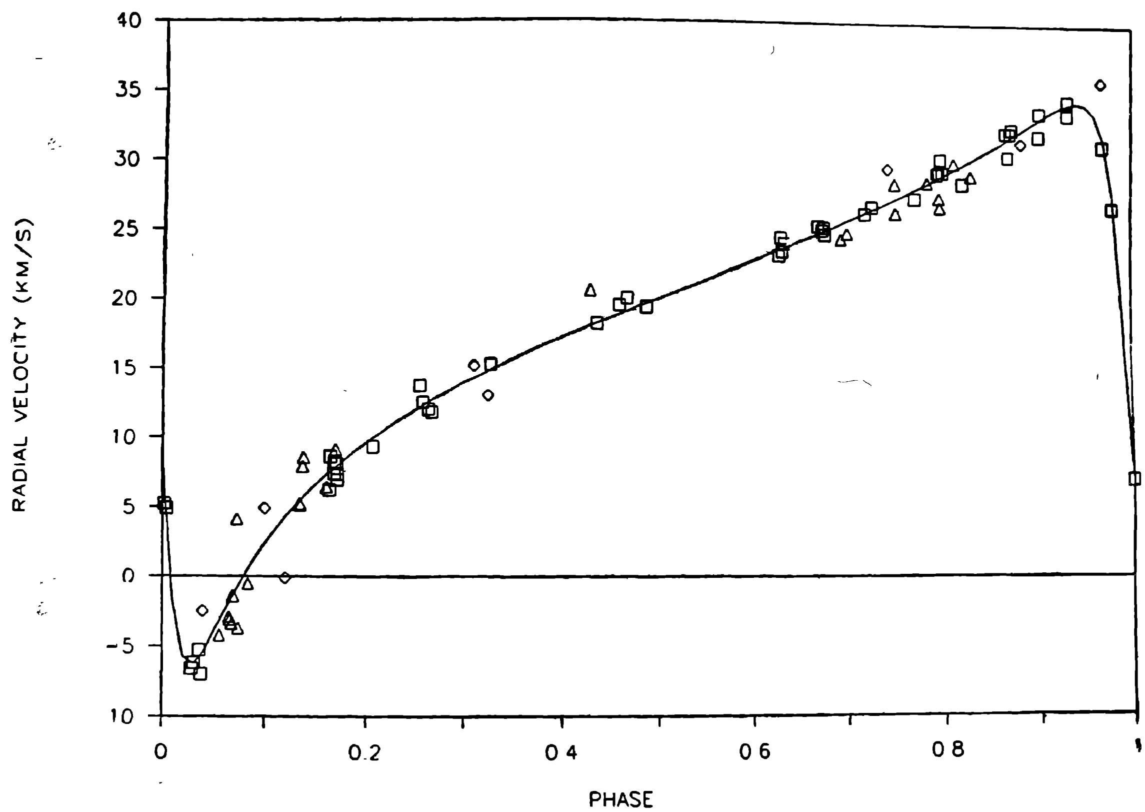

Figure 1. Combined radial velocity curve of HR 1176. The zero phase corresponds to time of periastron passage. The diamonds represent the Mount Wilson and David Dunlap data; the squares, the Haute Provence data; and the triangles, the Japal-Rangapur data.

and Japal-Rangapur Observatories are at a lower dispersion (33 A mm^{-1} and lower) compared to the spectra obtained by Pedoussaut *et al.* (1987) (20 A mm^{-1} and higher). (ii) The measuring technique at the three observatories is visual compared to the computerized technique employed by Pedoussaut *et al.*). (iii) Pedoussaut *et al.* have not included the Mount Wilson and Dunlap data in their orbit determination (except the period), unlike our combined solution. Orbital solutions obtained by combining different sets of data are expected to show some difference in the results and the associated errors.

Since HR 1176 showed Ca II H and K emission (Bidelman 1954, Eggen 1978), it was suspected to be an RS CVn type star. On some of our spectrograms Ca II H and K emission is very faint as indicated in table 2. But the photometric investigations of Rao *et al.* (1985) and the radio observations of Mutel & Lestrade (1985) have not shown any significant variations of luminosity or of radio emission as is expected for an RS CVn type binary Further, the value found for the period is too high for a binary of the RS CVn type; even for the long period binaries of this group (Hall 1976), the value of P rarely exceeds about 100 days. From these observations it could be said that the Ca II H and K emission in HR 1176 is incidental or episodic and that it may not be binary of the RS CVn type, as thought earlier. Continued monitoring may reveal something more definitive about this system.

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