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THE ORBITS OF THREE SPECTROSCOPIC BINARIES, H.D. 164898, H.D. 208835 and H.D. 40372

BY

RUTH J. NORTHCOTT, T. A. MATTHEWS
AND PAUL-H. NADEAU

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THE ORBIT OF THE SPECTROSCOPIC BINARY H.D. 164898

By Ruth J. Northcott

The star H.D. 164898, $\alpha(1900)$ 17^h $58^m.3$, $\delta(1900)$ $+45° 21'$, vis. mag. 7.44, Harvard type B9, was discovered to be a spectroscopic binary with a range of about 100 km./sec. from seven plates taken at this observatory during 1936 and 1937.[1] Observation to determine the orbit was started in 1945 and by June 1948 fifty-two plates had been obtained with the one-prism spectrograph. The early plates and the last five plates were taken with a dispersion of 66 A./mm. at $H\gamma$, the rest with a dispersion of 33 A./mm. at $H\gamma$. The lines are of good quality; on the average 16 lines were measured on the higher dispersion spectra, with a probable error of less than two km./sec., judged from the internal agreement of the measures.

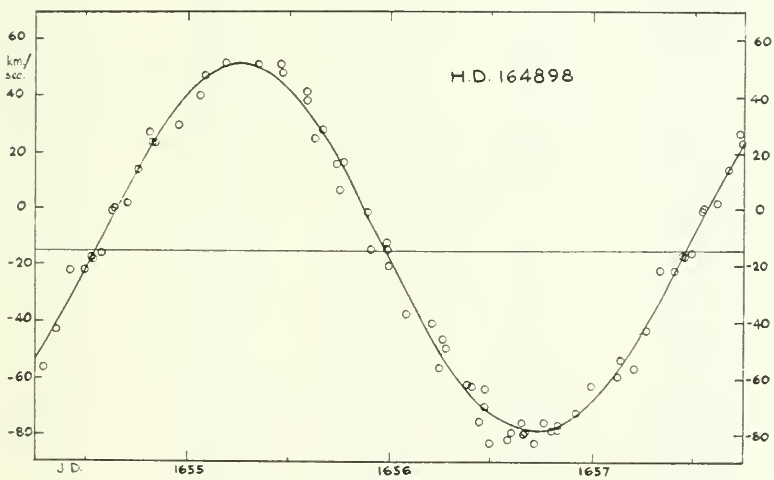

Figure 1

The observations cover about 1500 revolutions, so that the period was not included in the least-squares solution; the error in the period is estimated at ± 0.00005 day. The observations were studied by R. W. Tanner's[2] method to eliminate the possibility of a fictitious period. Table I gives the data from the plates.

TABLE I

Radial-velocity Observations of H.D. 164898

J.D. 242–243	V_o km./sec.	Phase from final T	V_c km./sec.	V_o–V_c km./sec.
8362.694	+24.9	0.272	+31.4	− 6.5
8380.649	−37.0	0.725	−28.6	− 8.4
8685.805	+29.4	2.519	+36.6	− 7.2
8707.742	−64.0	1.121	−70.8	+ 6.8
8720.662	+26.8	2.373	+20.9	+ 5.9
8727.672	−11.8	0.632	−15.6	+ 3.8
8734.653	−52.7	1.779	−55.8	+ 3.1
1671.676	−78.4	1.444	−78.0	− 0.4
1672.617	+23.4	2.385	+22.5	+ 0.9
1687.596	+52.0	2.779	+51.2	+ 0.8
1694.593	−62.1	1.025	−63.4	+ 1.3
1695.617	−21.7	2.049	−22.6	+ 0.9
1696.590	+48.2	0.105	+45.3	+ 2.9
1701.667	+02.0	2.265	+07.2	− 5.2
1702.554	+38.6	0.235	+35.1	+ 3.5
1704.629	+14.1	2.310	+13.1	+ 1.0
1705.549	+28.1	0.313	+26.8	+ 1.3
1706.538	−79.6	1.302	−78.2	− 1.4
1708.531	+15.8	0.378	+19.0	− 3.2
1715.549	−72.0	1.563	−73.2	+ 1.2
1719.524	+40.2	2.620	+44.7	− 4.5
1720.526	−20.0	0.706	−26.1	+ 6.1
1736.500	−17.6	2.095	−16.3	− 1.3
1962.835	−45.2	0.907	−51.6	+ 6.4
1975.794	−00.1	2.200	−01.7	+ 1.6
1980.786	−83.3	1.358	−78.7	− 4.6
2008.697	+51.5	0.100	+45.8	+ 5.7
2015.673	−80.0	1.242	−76.7	− 3.3
2047.681	−69.8	1.163	−73.3	+ 3.5
2056.578	−78.2	1.309	−78.3	+ 0.1
2062.572	−76.3	1.470	−77.1	+ 0.8
2066.662	+47.1	2.643	+46.1	+ 1.0
2067.570	−14.6	0.634	−16.1	+ 1.5
2076.541	−40.1	0.854	−45.4	+ 5.3
2079.521	−49.4	0.917	−52.7	+ 3.3
2081.511	+51.1	2.907	+50.7	+ 0.4
2082.572	−62.7	1.051	−65.7	+ 3.0
2086.516	−17.1	2.078	−18.6	+ 1.5
2089.542	−00.9	2.187	−03.5	+ 2.6
2090.505	+41.8	0.233	+35.3	+ 6.5
2091.562	−75.5	1.290	−78.0	+ 2.5
2096.515	+16.8	0.409	+15.1	+ 1.7
2097.509	−75.9	1.403	−78.5	+ 2.6
2098.499	+23.6	2.393	+23.4	+ 0.2
2100.493	−78.3	1.470	−77.1	− 1.2
2335.827	−00.9	0.532	−01.6	+ 0.7
2362.726	−82.9	1.179	−74.1	− 8.8
2368.605	−81.5	1.224	−76.1	− 5.4
2386.733	−56.3	1.850	−48.1	− 8.2
2391.607	−56.0	0.890	−49.7	− 6.3
2391.807	−75.3	1.090	−68.7	− 6.6
2446.533	+06.6	0.394	+17.0	−10.4
2446.697	−14.4	0.558	−05.3	− 9.1
2663.904	−42.8	1.912	−40.6	− 2.2
2672.885	−15.7	2.142	−09.7	− 6.0
2698.760	−58.8	1.765	−57.3	− 1.5
2704.808	−21.4	1.979	−32.1	+10.7
2727.812	−61.5	1.647	−67.7	+ 6.2

The observations were grouped according to phase into 28 observational equations; weights (1, 2, 3) were assigned according to the number of plates. The preliminary orbit was determined graphically and was circular. The five elements were found using T. E. Stern's[3] method of least-squares solution for small eccentricities. Σpv^2 was reduced from 1766 to 740 by two solutions. The preliminary and final elements are listed in Table II.

The individual observations are plotted in figure 1. The probable error of a single plate is ±3.6 km./sec.

TABLE II

ORBITAL ELEMENTS OF H.D. 164898

		Preliminary	Final	
Period	P	2.91694 days	2.91694	± 0.00005 est.
Eccentricity	e	0	0.0221	± 0.004
Angle of periastron	ω		11°.50	±0°.05
Epoch of mean long.	T_0	J.D. 2431655.57	2431655.554	± 0.002
Periastron passage	T		2431655.648	
Velocity of system	γ	−14 km./sec.	−14.93	± 0.21
Semi-amplitude	K	66 km./sec.	65.18	± 0.32
a sin i			2.614×10^6 km.	
$m_1^3 \sin^3 i/(m_1 + m_2)^2$			0.0838 ⊙	

THE ORBIT OF THE SPECTROSCOPIC BINARY H.D. 208835

By T. A. Matthews

The star H.D. 208835, α(1900) $21^h\ 53^m.9$, δ(1900) +46° 23′, vis. mag. 7.39, Harvard type A0, was announced as a spectroscopic binary from six plates taken at this observatory between 1935 and 1938.[1] These plates were taken with the one-prism spectrograph and a dispersion of 66 A./mm. at Hγ. During 1945 and 1950 twenty-six additional plates were obtained with a dispersion of 33 A./mm. at Hγ. The earlier plates were used to determine the period, but were not otherwise used in the solution. The observations were tested for a fictitious period by the method of R. W. Tanner;[2] no related period was indicated. Table III lists the times, phases, observed and computed velocities and residuals for each plate.

The spectrum is of fair quality. An average of eight lines per plate were measured. The helium lines, 4471 and 4026 are unusually

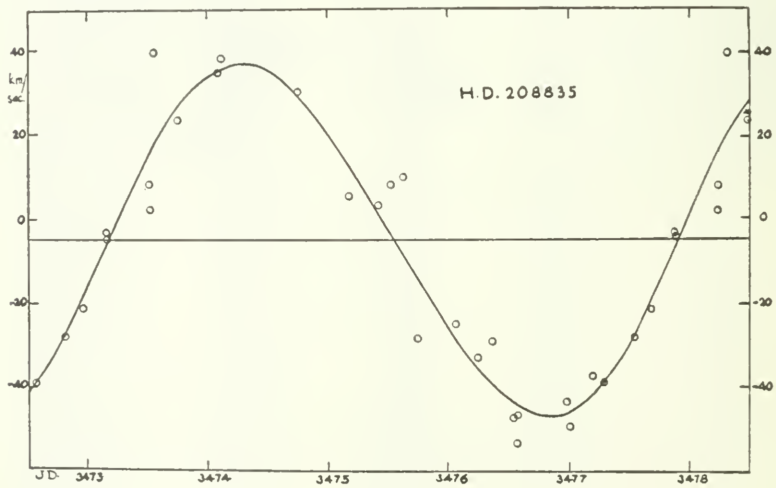

Figure 2

broad and diffuse compared with MgII, 4481, and SiII, 4128, 4130. The quality of the helium lines appears to be somewhat variable. There may possibly be changes in the intensity of this line compared to MgII, 4481. On a few plates the hydrogen lines Hγ and Hδ seem

TABLE III

RADIAL-VELOCITY OBSERVATIONS OF H.D. 208835

J.D. 242–243	V_o km./sec.	Phase from final T	V_c km./sec.	V_o–V_c km./sec.
8042.656	+24.5	2.458	−05.1	+29.6
8403.717	+30.6	0.066	+01.4	+29.2
8844.551	+36.4	1.926	+19.1	+17.3
9119.758	−46.6	3.364	−42.3	−04.3
9144.692	+06.4	4.697	−11.7	+18.1
9175.617	−33.6	2.582	−11.1	−22.5
1701.792	−53.4	3.476	−44.8	−08.6
1708.764	+37.4	1.008	+35.9	+01.5
1745.572	−03.2	0.055	−06.7	+03.5
1747.594	+05.4	2.077	+12.7	−07.3
1749.611	−37.4	4.094	−42.1	+04.7
1763.557	−43.7	3.879	−46.5	+02.8
3468.797	+02.4	0.425	+16.1	−13.7
3470.797	+08.2	2.425	−03.5	+11.7
3471.860	−46.7	3.488	−45.0	−01.7
3478.796	+34.7	0.984	+35.6	−00.9
3484.848	+03.3	2.316	+01.7	+01.6
3485.797	−29.2	3.265	−39.6	+10.4
3487.717	+39.6	0.464	+18.2	+21.4
3489.788	−10.1	2.535	−08.8	−01.3
3490.696	−47.6	3.443	−44.1	−03.5
3491.687	−28.1	4.434	−27.6	−00.5
3491.837	−21.1	4.584	−18.8	−02.3
3496.749	−04.7	0.056	−06.6	+01.9
3499.662	−25.0	2.969	−28.7	+03.7
3499.842	−33.0	3.149	−35.7	+02.7
3500.612	−49.6	3.919	−46.0	−03.6
3500.883	−38.9	4.190	−38.9	00.0
3501.827	+08.3	0.414	+15.5	−07.2
3506.792	+23.7	0.659	+27.1	−03.4
3507.781	+30.0	1.648	+28.9	+01.1
3508.773	−28.5	2.640	−13.9	−14.6

TABLE IV

ORBITAL ELEMENTS OF H.D. 208835

		Preliminary	Final	
Period	P	4.72015 days	4.72015	
Eccentricity	e	0	0.075	± 0.030
Angle of periastron	ω		263°.3	± 25°.2
Epoch of mean long.	T_0	J.D. 2433469.69	2433469.640	± 0.021
Periastron passage	T		J.D. 2433473.092	
Velocity of system	γ	−5.13 km./sec.	−4.9	± 0.97
Semi-amplitude	K	43.85 km./sec.	42.0	± 1.50
a sin i			2.718×10^6 km.	
$m_1^3 \sin^3 i/(m_1 + m_2)^2$			0.0360 ☉	

to have sharp cores and asymmetrical wings which are sometimes to the red and sometimes to the violet. The changes in the spectrum do not appear to depend on the phase. They have some characteristics of a shell star spectrum.

The preliminary elements were determined graphically and a least-squares solution was made using 16 normal places. Since the eccentricity was found to be small, Sterne's[3] form of least-squares solution for small eccentricities was used. Five elements were included in the solution. The reduction in Σpv^2 was from 1162 to 920. Table IV lists the preliminary and final elements and their probable errors. Figure 2 shows the individual observations plotted with the final curve. The probable error of a single observation is ± 5.0 km./sec.

THE ORBIT OF THE SPECTROSCOPIC BINARY H.D. 40372

By Paul-H. Nadeau

The star H.D. 40372, $\alpha(1900)$ 5^h $53^m.2$, $\delta(1900)$ $+01°$ $49'$, vis. mag. 6.06, Harvard type A5, was announced to be a spectroscopic binary from four plates taken at this observatory during 1943 and 1944.[4] During 1946 and 1947 thirty-four plates were obtained from which the orbit was computed. The plates were taken with the one-prism spectrograph, and all but the last six were taken with a dispersion of 33 A./mm. at Hγ; the other plates were taken with a dispersion of 66 A./mm. at Hγ. The information from these plates is listed in Table V. Fictitious values of the period were eliminated by using the method of R. W. Tanner;[2] the period was not included

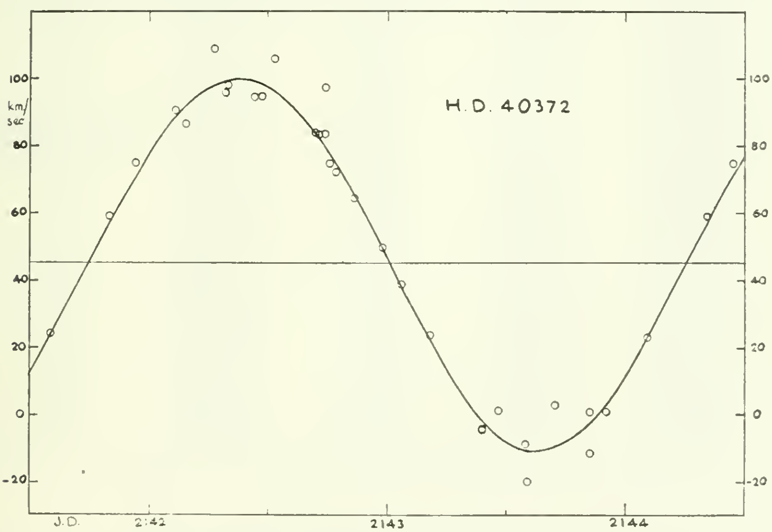

Figure 3

in the least-squares solution. The observations were grouped according to phase into 23 observational equations; weights (1, 2) were assigned according to the number of plates.

The preliminary elements were determined graphically. The value of Σ pv^2 was reduced from 1374 to 1110. The preliminary and final

TABLE V

RADIAL-VELOCITY OBSERVATIONS OF H.D. 40372

J.D. 243	V_o km./sec.	Phase from final T	V_c km./sec.	V_o–V_c km./sec.
0726.697	+ 11.9	2.392	+04.5	+ 7.4
1113.641	– 05.8	0.184	–04.8	– 1.0
1377.861	+101.3	1.318	+99.7	+ 1.6
1427.787	+ 62.5	1.914	+61.0	+ 1.5
1822.717	+ 20.2	2.212	+23.8	– 3.6
1896.510	+ 41.1	2.012	+49.8	– 8.7
2143.814	– 20.0	2.671	–10.9	– 9.1
2144.756	+ 74.8	0.873	+71.6	+ 3.2
2145.762	+ 64.4	1.879	+65.1	– 0.7
2165.732	– 08.9	2.665	–10.8	+ 1.9
2173.751	– 04.4	2.462	–01.3	– 3.1
2174.781	+ 59.0	0.752	+57.5	+ 1.5
2186.692	+ 83.5	1.701	+83.5	0.0
2190.692	– 11.5	0.220	–02.9	– 8.6
2194.667	+ 94.7	1.454	+98.3	– 3.6
2202.667	+108.8	1.233	+98.1	+10.7
2204.658	+ 23.1	0.484	+23.8	– 0.7
2208.661	+ 97.3	1.746	+79.4	+17.9
2212.616	+ 00.7	0.220	–02.4	+ 3.1
2219.641	+ 74.6	1.764	+77.6	– 3.0
2228.560	– 04.3	2.461	–01.2	– 3.1
2230.630	+ 71.9	1.791	+74.9	– 3.0
2233.591	+ 49.8	2.012	+48.9	+ 0.9
2236.544	+ 23.6	2.224	+22.4	+ 1.2
2250.560	+ 01.3	2.537	–06.2	+ 7.5
2252.508	+ 85.6	1.745	+79.5	+ 6.1
2256.540	+ 00.6	0.296	+03.8	– 3.2
2257.544	+ 98.1	1.300	+99.5	– 1.4
2264.523	+ 02.9	0.058	–10.3	+13.2
2265.519	+ 90.8	1.054	+88.5	+ 2.3
2276.531	+ 86.6	1.104	+92.0	– 5.4
2501.659	+106.1	1.511	+96.2	+ 9.9
2501.863	+ 83.5	1.714	+82.4	+ 1.1
2518.601	+ 50.0	2.010	+49.1	+ 0.9
2518.689	+ 38.7	2.097	+38.1	+ 0.6
2520.616	+ 95.7	1.284	+99.3	– 3.6
2520.749	+ 94.4	1.417	+99.1	– 4.7

elements are listed in Table VI. The individual observations are shown in figure 3. The probable error of a single plate is ±4.1 km./sec.

TABLE VI

ORBITAL ELEMENTS OF H.D. 40372

		Preliminary	Final	
Period	P	2.74050 days	2.74050	
Eccentricity	e	0.03	0.018	± 0.022
Angle of periastron	ω	183°	183°.0	± 1°.81
Periastron passage	T	J.D. 2432141.16	2432141.143	± 0.020
Velocity of system	γ	47.0 km./sec.	45.3	± 1.84
Semi-amplitude	K	55.0 km./sec.	55.6	± 1.19
a sin i			2.093×10^6 km.	
$m_1^3 \sin^3 i/(m_1 + m_2)^2$			0.0600 ☉	

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