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ORBITAL ELEMENTS OF SIX SPECTROSCOPIC BINARY STARS

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with an appendix by
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SUMMARY

Orbital elements of the spectroscopic binary stars, HD 1273, 148704, 167954, 194215, 202940 and 217792 are presented. HD 148704 shows double lines on a few plates and a somewhat uncertain mass ratio is determined. For HD 217792 elements have been previously published by Buscombe and Morris. The present solution uses a period almost exactly half theirs. The method described in the Appendix has been used to investigate thoroughly large ranges of trial periods and to eliminate some alternative cases, including, in the case cited, the period adopted by Buscombe and Morris.

The present investigation is a continuation of the series of determinations of elements of spectroscopic binaries published in previous papers (e.g. Barker, Evans & Laing 1967). The observations are mainly from the spectroscopic programme of the Royal Observatory at the Cape of Good Hope undertaken over many years with the Radcliffe 74-inch reflector at Pretoria. The timing of the observations in recent years has been mainly controlled by one of us (J. D. L.), who was also responsible for much of the preliminary arrangement of the data and for proposing some of the preliminary elements used in the final machine reduction. For the latter, the data were completely reviewed and period analyses undertaken by the methods described in the Appendix. The final reduction was undertaken by one of us (B. W. B.) using an iterative computer program (SPINORB) employed for the paper mentioned above. In most cases this worked satisfactorily, though it required some modification in the cases of small eccentricity to secure convergence of the iterations. Stars HD 148704 and 217792 have been mentioned in the summary above. We are in no doubt that the shorter period adopted for the latter is the correct one. This is a situation of especial difficulty because of the closeness of the periods proposed by the two sets of authors to one year and to six months respectively. Systematic deviations of the old Lick and Cape measures from the computed curve may indicate the presence of a third body in the system. As a matter of policy all measures from other observatories, e.g. Lick, old Cape, Stromlo and Mount Wilson have been assigned a weight of 50. The new Cape measures have been assigned weights according to the system adopted in previous papers, and these are only exceptionally as large as 50. In spite of this the residuals shown by the Cape–Radcliffe measures are almost always rather small, the principal exception being some of the plates of HD 148704, where it is thought that the trouble is due to line blending. The terminology used for the Radcliffe Cassegrain spectrograph denotes as *b*-dispersion, the camera giving 29 Å mm^{-1}, and as *c*-dispersion, that giving 49 Å mm^{-1}. Except where noted the plates are *b*-dispersion. One plate, DY 1147 of HD 217792, was obtained with the Radcliffe coudé on a dispersion of 6·8 Å mm^{-1}. In addition to two of us, (J. D. L. and D. S. E.) initials of plate measurers are A.M. = Mr Alexander Menzies, and I.M. = Mrs Irene Malin. Source identifications of other material are L = Lick: MW = Mount Wilson: S = Stromlo: C = Cape. We are indebted, particularly to the Mount Wilson Observatory, for making available details of some early measures of these stars. All six stars have considerable parallaxes, the first two being nearer than 20 parsecs, while HD 202940 is at almost exactly this distance, ($\pi = 0''·049$).

We are indebted to Professor R. H. Stoy, formerly H. M. Astronomer at the Cape for permission to wind up the discussion of these stars which had been outstanding for some time, to Professor Harlan J. Smith for time on the University of Texas Computer, and to colleagues at the Cape, Pretoria and Austin.

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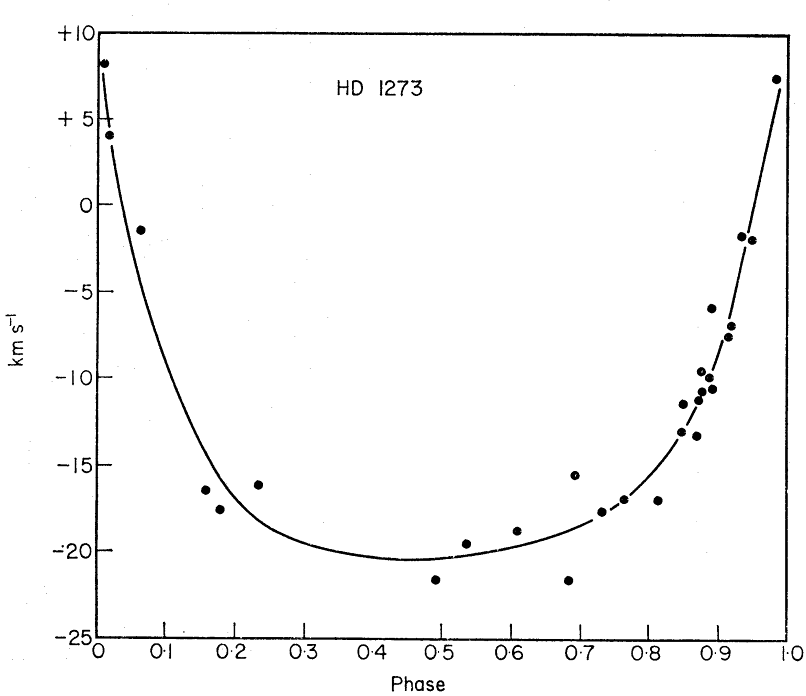
HD 1273

$00^h\ 14^m{\cdot}4,\ -52°\ 56'$ (1950)

$V = 6{\cdot}84 \quad B{-}V = +0{\cdot}64 \quad$ G2 V

$\mu_\alpha = +0''{\cdot}292 \quad \mu_\delta = +0''{\cdot}206 \quad \pi = 0''{\cdot}063$

HJD 2430000+	Phase	RV	PE	Lines	Wt	O–C	Measurer
4259·4725	0·0636	−1·5	±1·3	13	13	3·3	AM
4297·3631	0·1557	−16·5	1·4	14	12	−1·5	AM
5307·6183	0·6110	−18·7	0·6	23	46	0·9	AM
5441·2713	0·9359	−1·7	0·5	24	52	1·0	DSE
7873·5583	0·8474	−12·9	0·7	23	41	0·0	JDL
7875·5548	0·8522	−11·6	0·6	22	46	1·0	JDL
7882·5932	0·8693	−13·1	0·8	21	36	−1·8	JDL
7884·5460	0·8741	−11·1	0·7	22	41	−0·3	JDL
7886·5737	0·8790	−9·6	0·7	22	41	0·8	JDL
7888·4946	0·8837	−9·8	0·5	23	52	0·1	JDL
7891·5550	0·8911	−5·7	0·6	23	46	3·5	JDL
7901·5713	0·9155	−6·9	0·7	19	41	−0·8	JDL
7930·4541	0·9857	7·6	0·6	23	46	0·8	AM
8009·2470	0·1772	−17·6	0·7	23	41	−1·5	JDL
8032·2652	0·2331	−16·2	0·8	23	36	1·9	JDL
8221·6777	0·6935	−15·4	0·8	23	36	3·1	JDL
8236·5477	0·7296	−17·5	0·5	22	52	0·2	JDL
8249·5869	0·7613	−17·0	0·7	23	41	−0·1	JDL
8270·4678	0·8120	−17·0	0·8	23	36	−2·1	JDL
8303·3699	0·8920	−10·5	0·6	23	46	−1·4	AM
8311·3279	0·9114	−7·5	0·9	23	32	−0·8	AM
8326·3431	0·9478	−1·9	0·5	23	52	−1·6	AM
8351·2721	0·0084	8·1	0·6	23	46	1·4	JDL
8351·6675	0·4955	−21·6	0·6	23	46	−1·3	JDL
8568·6729	0·5368	−19·5	0·7	23	41	0·7	JDL
8629·4954	0·6846	−21·6	0·7	23	41	−2·9	AM



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HJD 2430000+	Phase	RV	PE	Lines	Wt	O–C	Measurer
8707·2645	0·8737	−10·7	0·5	23	52	0·2	AM
8765·2553	0·0146	4·0	0·5	23	52	−1·9	AM

First two plates, *c*-dispersion; remainder, *b*-dispersion.
Sum of weighted residuals squared is 2749.
Solution

$\gamma = -14{\cdot}32 \pm 0{\cdot}08$ km s^{-1}: $K = 13{\cdot}88 \pm 0{\cdot}10$ km s^{-1}: $e = 0{\cdot}5671 \pm 0{\cdot}0041$
$\omega = 4^\circ{\cdot}68 \pm 0^\circ{\cdot}79$: $T_0 = 2434233^{\mathrm{d}}{\cdot}31 \pm 0^{\mathrm{d}}{\cdot}77$
$P = 411^{\mathrm{d}}{\cdot}449 \pm 0^{\mathrm{d}}{\cdot}076$

RMS for solution is 1·8394

$a \sin i = 64{\cdot}7 \times 10^6$ km Mass function = 0·0639

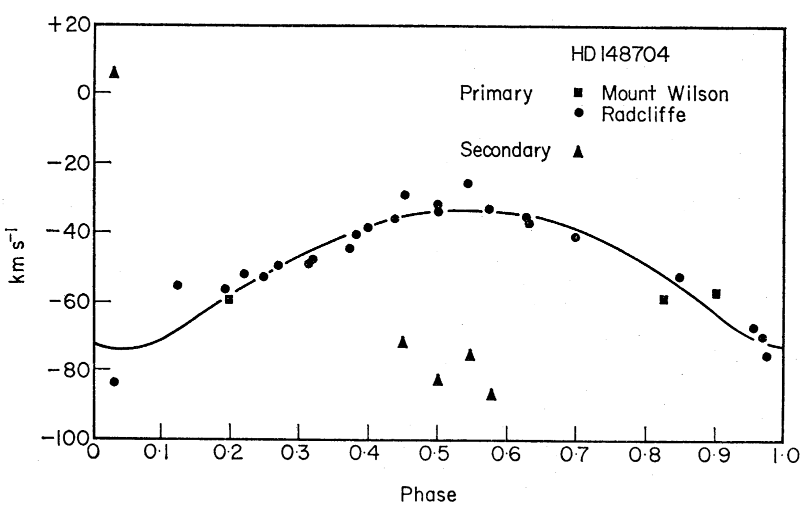
HD 148704

$16^{\mathrm{h}}\,28^{\mathrm{m}}{\cdot}1$, $-38^\circ\,54'$ (1950)

$V = 7{\cdot}25$ $B{-}V = +0{\cdot}87$ $(U{-}B)_c = 1{\cdot}96$ *dK1*

$\mu_\alpha = -0''{\cdot}416$ $\mu_\delta = -0''{\cdot}330$ $\pi = 0''{\cdot}051$

HJD 2420000+	Phase	RV	PE	Lines	Wt	O–C	Measurer
4364·6780	0·8990	−56·8			50	6·0	MW
4628·9729	0·1982	−58·8			50	0·0	MW
4744·6614	0·8309	−59·0			50	−6·3	MW
HJD 2430000+							
5926·5629	0·9550	−67·2	±2·7	11	5	2·8	AM
6296·5798	0·5740*	−33·4	1·2	22	22	0·2	DSE
6350·4659	0·2661	−49·9	0·6	23	46	0·5	DSE
6802·2770	0·4534*	−29·2	1·7	22	13	6·5	AM
6805·1983	0·5452*	−25·6	0·9	22	32	8·0	AM
8147·5323	0·6959	−40·8	1·0	23	28	−2·5	DSE
8476·6373	0·0302*	−83·6	1·1	20	25	−9·6	JDL
8479·6181	0·1238	−56·2	2·5	18	7	11·8	JDL
8482·6113	0·2178	−52·4	0·8	25	36	3·9	JDL



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HJD 2430000+	Phase	RV	PE	Lines	Wt	O–C	Measurer
8483·5907	0·2485	−53·2	1·0	25	28	−0·7	JDL
8489·5842	0·4367	−35·8	1·1	23	25	0·6	JDL
8517·4380	0·3114	−48·9	0·6	25	46	−3·3	JDL
8517·5915	0·3162	−48·0	0·7	25	41	−2·9	JDL
8519·4979	0·3761	−44·5	1·0	25	28	−4·4	JDL
8538·3415	0·9678	−69·9	1·6	24	14	1·4	JDL
8538·5929	0·9757	−74·8	1·8	23	12	−2·9	JDL
8545·4576	0·1912	−57·0	0·6	22	46	2·7	JDL
8551·4631	0·3798	−41·3	0·7	24	41	−1·5	JDL
8559·3380	0·6271	−36·1	1·2	23	22	−1·4	JDL
8591·2689	0·6297	−36·9	0·8	24	36	−2·1	AM
8598·2372	0·8486	−53·0	0·5	23	52	2·3	AM
8870·5186	0·3985	−39·2	0·7	24	41	−0·6	AM
8905·5576	0·4988*	−31·9	0·8	23	36	2·3	AM
8937·3812	0·4981	−34·2	0·9	24	32	0·0	AM

The first Radcliffe observation is on *c*-dispersion: all following are on *b*-dispersion. Plates marked * show double lines. There are evidently difficulties with line blending on some of the plates leading to diminished accuracy.
Sum of weighted residuals squared = 12928.
Solution

$\gamma = -50{\cdot}59 \pm 0{\cdot}20$ km s^{-1}: $K = 20{\cdot}26 \pm 0{\cdot}35$ km s^{-1}: $e = 0{\cdot}1638 \pm 0{\cdot}0142$
$\omega = 165^\circ{\cdot}8 \pm 5^\circ{\cdot}4$: $T_0 = 2424336{\cdot}05 \pm 0{\cdot}44$
$P = 31^{\mathrm{d}}{\cdot}846010 \pm 0^{\mathrm{d}}{\cdot}000308$

RMS for solution is 4·9503
$a \sin i = 8{\cdot}75 \times 10^6$ km Mass function = 0·0264.

The observations of the secondary spectrum are of rather small weight. They are as follows

HJD 2430000+	Phase (primary)	RV	PE	Lines
6296·5798	0·5740	−87		3
6802·2770	0·4534	−71·4	±3·8	11
6805·1983	0·5452	−74·2	2·1	16
8476·6373	0·0302	4·5		4
8905·5576	0·4988	−82		5

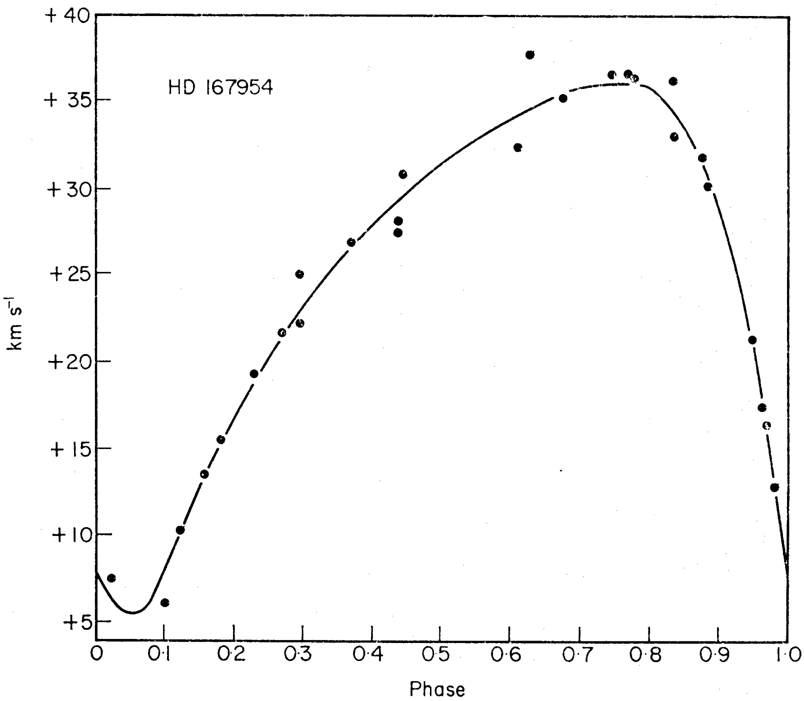
Weighting the second and third observations at three times the weight of the others we arrive at a tentative mass–ratio of 1·61 ± 0·12 (p.e.). The deduced values of $m \sin^3 i$ for the two components are then 0·29 and 0·18 solar masses.

HD 167954

$18^{\mathrm{h}}\ 16^{\mathrm{m}}{\cdot}0$, $-45^\circ\ 43'$ (1950)

$V = 6{\cdot}85$ $B-V = 0{\cdot}54$ $(U-B)_c = 1{\cdot}68$ *dF8*
$\mu_\alpha = -0''{\cdot}054$ $\mu_\delta = -0''{\cdot}110$ $\pi = 0''{\cdot}039$

HJD 2430000+	Phase	RV	PE	Lines	Wt	O–C	Measurer
6720·5271	0·9736	16·4	±0·4	20	58	0·8	AM
6797·2610	0·6130	32·4	0·8	22	36	−1·9	AM
6805·2418	0·6795	35·2	0·6	22	46	−0·3	AM



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HJD 2430000+	Phase	RV	RE	Lines	Wt	O–C	Measurer
7064·5525	0·8403	33·1	0·6	22	46	−1·3	JDL
7119·3852	0·2972	25·1	0·5	22	52	2·1	JDL
7136·3681	0·4387	27·5	0·5	21	52	−1·8	AM
7413·6000	0·7488	36·6	0·6	22	46	0·6	DSE
7416·6259	0·7741	36·6	0·6	24	46	0·7	DSE
7441·5261	0·9815	12·8	0·4	21	58	−0·9	DSE
8479·6566	0·6321	37·7	1·4	18	18	3·0	JDL
8517·5429	0·9478	21·3	0·7	22	41	−0·3	JDL
8519·6125	0·9650	17·4	0·5	22	52	−0·3	JDL
8538·4775	0·1222	10·3	0·6	22	46	0·4	JDL
8545·4917	0·1807	15·5	0·6	21	46	0·4	JDL
8551·4919	0·2307	19·4	0·4	22	58	0·5	JDL
8559·4060	0·2966	22·2	0·3	22	64	−0·8	JDL
8568·3978	0·3716	26·9	0·5	22	52	0·2	JDL
8576·4867	0·4390	28·1	0·4	22	58	−1·3	JDL
8629·2600	0·8787	31·9	0·6	22	46	0·0	JDL
8656·1945	0·1032	6·0	0·5	22	52	−2·2	JDL
8857·6243	0·7816	36·2	0·9	22	32	0·3	AM
8870·5574	0·8894	30·1	0·7	22	41	−0·8	AM
8886·5557	0·0227	7·4	0·4	22	58	1·1	AM
8902·5942	0·1564	13·5	0·6	22	46	0·5	AM
8916·5350	0·2725	21·8	0·6	22	46	0·2	AM
8937·5082	0·4473	30·9	0·6	22	46	1·3	AM
8984·4537	0·8385	36·4	0·7	22	41	1·9	AM

Sum of weighted residuals squared is 1638
Solution

$\gamma = +25{\cdot}19 \pm 0{\cdot}04$ km s^{-1}: $K = 15{\cdot}48 \pm 0{\cdot}08$ km s^{-1}: $e = 0{\cdot}4282 \pm 0{\cdot}0042$
$\omega = 134^{\circ}{\cdot}41 \pm 0^{\circ}{\cdot}53$: $T_0 = 2430003{\cdot}28 \pm 0{\cdot}44$
$P = 120^{d}{\cdot}0074 \pm 0^{d}{\cdot}0066$

RMS for solution is 1·3686.

a sin *i* = $23{\cdot}1 \times 10^6$ km. Mass function = 0·0341.

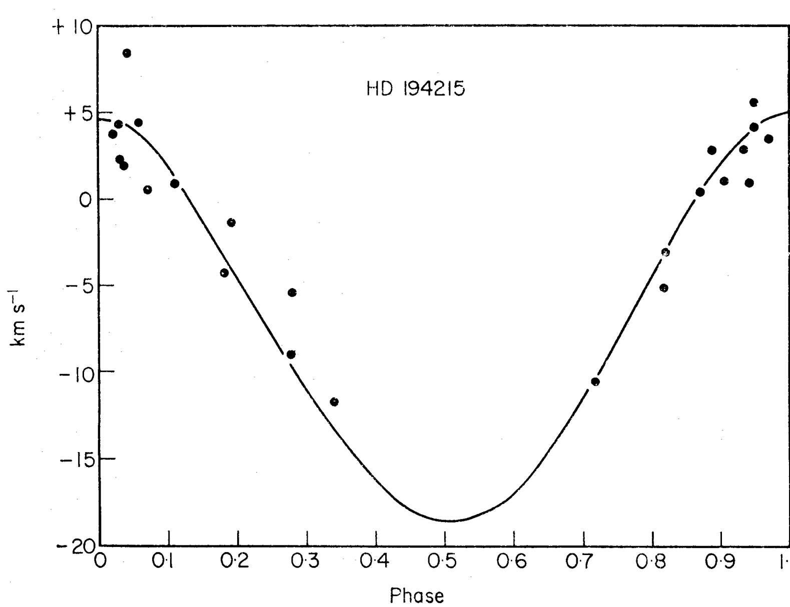
HD 194215

$20^h\,22^m{\cdot}4$, $-28°\,50'$ (1950)

$V = 5{\cdot}84$ $B\!-\!V = +1{\cdot}10$ $(U\!-\!B)_c = 2{\cdot}15$ $K3V$

$\mu_\alpha = +0''{\cdot}016$ $\mu_\delta = +0''{\cdot}011$ $\pi = 0''{\cdot}031$

HJD 2430000+	Phase	RV	PE	Lines	Wt	O–C	Measurer
6720·5867	0·0569	4·4	±0·6	23	46	0·6	AM
6772·3772	0·1940	1·4	0·6	24	46	2·7	AM
6805·2868	0·2812	−5·3	0·4	23	58	4·8	AM
6827·3312	0·3396	−11·8	0·4	23	58	1·7	AM
7057·6395	0·9495	6·6	0·6	23	46	2·6	AM
7093·5292	0·0445	8·5	0·7	23	41	4·4	JDL
7103·4999	0·0709	0·6	0·6	24	46	−2·7	JDL
8517·6401	0·8160	−5·2	0·4	23	58	−1·9	JDL
8519·6597	0·8214	−3·1	0·5	23	52	−0·1	JDL
8538·6398	0·8716	0·4	0·7	23	41	0·0	JDL
8545·5335	0·8899	2·8	0·4	23	58	1·4	JDL
8551·5215	0·9057	1·0	0·4	23	58	−1·3	JDL
8562·5540	0·9350	2·8	0·4	23	58	−0·7	JDL
8565·5431	0·9429	0·9	0·7	23	41	−2·9	JDL
8568·5154	0·9507	4·2	0·5	23	52	0·2	JDL
8576·5421	0·9720	3·4	0·7	23	41	−1·1	JDL
8595·4632	0·0221	3·8	0·3	23	64	−0·8	JDL
8598·4036	0·0299	4·4	0·5	23	52	0·0	JDL
8599·4328	0·0326	2·2	0·4	23	58	−2·2	JDL
8601·4148	0·0379	2·0	0·5	23	52	−2·3	JDL
8629·3015	0·1117	0·8	0·5	22	52	−0·5	JDL
8656·2568	0·1831	−4·3	0·4	23	58	−1·0	AM
8692·2889	0·2785	−9·0	0·5	23	52	0·9	AM
8857·6369	0·7164	−10·7	0·9	23	32	−0·5	AM
8916·5637	0·8725	3·8	0·7	23	41	3·4	AM
8979·4972	0·0391	5·9	0·7	23	41	1·6	AM
8984·4846	0·0524	9·0	0·6	23	46	5·1	AM
9048·2474	0·2212	−5·9	0·5	23	52	0·1	AM



Sum of weighted residuals squared is 6565
Solution

$\gamma = -7{\cdot}25 \pm 0{\cdot}20$ km s^{-1}: $K = 11{\cdot}19 \pm 0{\cdot}28$ km s^{-1}: $e = 0{\cdot}0687 \pm 0{\cdot}0138$
$\omega = 0^\circ{\cdot}00 \pm 9^\circ{\cdot}46$: $T_o = 2430279^{\rm d}{\cdot}9 \pm 10^{\rm d}{\cdot}8$
$P = 377^{\rm d}{\cdot}60 \pm 0^{\rm d}{\cdot}25$

RMS for solution is 2·2594.

$a \sin i = 58{\cdot}0 \times 10^6$ km. Mass function = 0·0546.

The radial velocity measures will also fit a pure sine curve having half the period, but with considerably greater scatter. This alternative was eliminated as less preferable on the basis of the period-finding analysis.

HD 202940

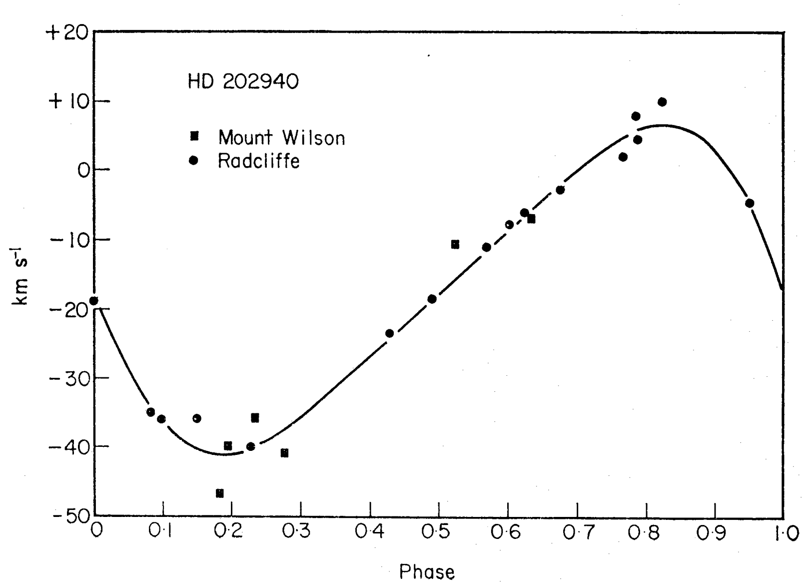
$21^{\rm h}\,16^{\rm m}{\cdot}9 \quad -26^\circ\,34'$ (1950)

$V = 6{\cdot}55 \quad B{-}V = 0{\cdot}73 \quad (U{-}B)_c = 1{\cdot}80 \quad G5\ V$

$\mu_\alpha = -0''{\cdot}539 \quad \mu_\delta = -0''{\cdot}352 \quad \pi = 0''{\cdot}049$

ADS 14847 A: 10, K 4, 3″

HJD 2410000+	Phase	RV	PE	Lines	Wt	O–C	Measurer
9227·9259	0·1787	−46·8			50	−5·7	MW
9633·8392	0·1944	−39·8			50	1·1	MW
9699·6235	0·2762	−41·2			50	−4·4	MW
HJD 2420000+							
4336·9617	0·5203	−11·3			50	4·2	MW
4394·8058	0·2301	−36·1			50	3·5	MW
4424·7040	0·6307	−7·3			50	−2·0	MW
HJD 2430000+							
6068·3577	0·0976	−36·1	±0·7	24	41	1·0	AM
6078·3484	0·5656	−11·2	0·6	23	46	0·1	AM



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HJD 2430000+	Phase	RV	PE	Lines	Wt	O–C	Measurer
6386·5354	0·0032	−18·6	0·8	26	36	−0·9	DSE
6467·2645	0·7851	4·7	0·8	24	36	−1·1	AM
6772·3999	0·0796	−35·2	0·7	26	41	−0·6	AM
8153·6417	0·7863	7·9	0·6	24	46	2·0	DSE
8538·6338	0·8219	10·1	0·8	22	36	3·3	JDL
8545·5831	0·1474	−35·6	0·7	23	41	5·1	JDL
8551·6099	0·4298	−23·1	0·5	23	52	0·8	JDL
8562·6469	0·9468	−4·5	0·7	23	41	−0·4	JDL
8568·6202	0·2267	−40·0	0·5	24	52	−0·3	JDL
8576·6553	0·6031	−7·6	0·4	23	58	0·2	JDL
8595·5722	0·4893	−18·5	0·6	23	46	−0·2	JDL
8598·5013	0·6265	−6·4	0·5	24	52	−0·7	JDL
8599·5347	0·6749	−2·6	0·4	23	58	−1·1	JDL
8601·5153	0·7677	2·1	0·7	23	41	−2·9	JDL

Sum of weighted residuals squared is 6582.
Solution

$\gamma = -17{\cdot}19 \pm 0{\cdot}11$ km s^{-1}: $K = 23{\cdot}98 \pm 0{\cdot}15$ km s^{-1}: $e = 0{\cdot}2514 \pm 0{\cdot}0068$
$\omega = 89^\circ{\cdot}48 \pm 1^\circ{\cdot}34$: $T_0 = 2419224^{\rm d}{\cdot}11 \pm 0^{\rm d}{\cdot}12$
$P = 21^{\rm d}{\cdot}34622 \pm 0^{\rm d}{\cdot}00010$

RMS for solution is 2·9764

$a \sin i = 6{\cdot}81 \times 10^6$ km. Mass function = 0·0277.

HD 217792 = π PsA

$23^{\rm h}\,00^{\rm m}{\cdot}7$ $-35^\circ\,01'$ (1950)

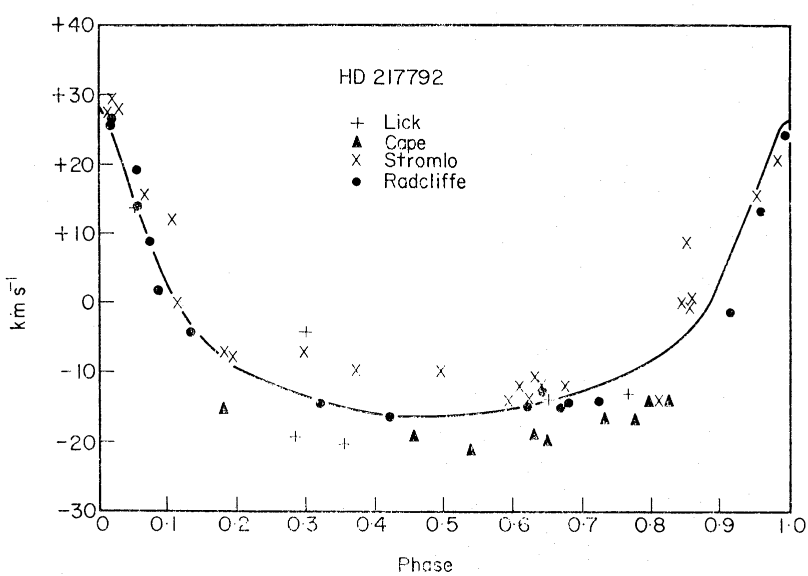
$V = 5{\cdot}10$ $B{-}V = 0{\cdot}29$ $(U{-}B)_c = 1{\cdot}56$ *F0V*

$\mu_\alpha = +0''{\cdot}071$ $\mu_\delta = +0''{\cdot}085$ $\pi = 0''{\cdot}044$

HJD 2410000+	Phase	RV	PE	Lines	Wt	O–C	Measurer
9334·6600	0·3563	−20·0			50	−4·9	L
9585·9200	0·7653	−13·0			50	−2·8	L
9636·8300	0·0508	14·0			50	−0·8	L
9678·7000	0·2856	−19·0			50	−5·5	L
HJD 2420000+							
0038·6000	0·3039	−4·0			50	10·0	L
0100·5300	0·6512	−14·0			50	0·3	L
2262·3500	0·7746	−17·0			50	−7·3	C
2267·3400	0·8026	−14·0			50	−6·2	C
2271·3100	0·8249	−14·0			50	−8·0	C
2918·4700	0·4541	−19·0			50	−3·0	C
2933·4300	0·5380	−21·0			50	−5·2	C
2949·3400	0·6273	−19·0			50	−4·3	C
2953·3300	0·6496	−20·0			50	−5·7	C
2967·3300	0·7281	−17·0			50	−5·1	C
3761·3000	0·1807	−15·0			50	−6·9	C
HJD 2430000+							
5293·2720	0·8516	8·4			50	11·7	S
5386·0260	0·3718	−9·7			50	5·6	S

Continued

HJD 2430000+	Phase	RV	RE	Lines	Wt	O–C	Measurer
6035·2140	0·0124	27·5			50	2·2	S
6036·2140	0·0180	29·6			50	5·4	S
6038·2170	0·0293	28·2			50	6·8	S
6067·1440	0·1915	−7·8			50	1·1	S
6143·9260	0·6221	−14·1			50	0·7	S
6175·9450	0·8016	−14·1			50	−6·2	S
6410·1880	0·1153	0·1			50	0·6	S
6478·0100	0·4956	−10·1			50	5·9	S
6501·9540	0·6299	−10·6			50	4·1	S
6503·9350	0·6410	−12·0			50	2·5	S
6509·9220	0·6746	−12·0			50	1·7	S
6718·2430	0·8428	0·0			50	4·2	S
6720·3170	0·8544	−0·5			50	2·4	S
6737·3100	0·9497	15·5			50	−1·1	S
6759·4680	0·0740	8·9	±0·9	16	32	0·8	AM
6778·1960	0·1790	−7·1			50	0·8	S
6799·1500	0·2965	−6·9			50	6·9	S
6851·9900	0·5929	−13·9			50	1·4	S
7077·3330	0·8566	1·1			50	3·8	S
7099·3250	0·9799	20·7			50	−4·0	S
7115·2800	0·0694	15·4			50	6·1	S
7121·2540	0·1029	12·0			50	10·3	S
7210·9890	0·6061	−11·8			50	3·3	S
7578·3500	0·6663	−15·1	±1·3	13	20	−1·2	DSE
7580·3430	0·6774	−14·4	1·1	16	25	−0·8	DSE
7588·3340	0·7223	−15·0	1·6	13	14	−2·8	AM
7927·3060	0·6232	−14·6	1·2	15	22	0·2	AM
7930·3620	0·6403	−12·8	1·1	16	25	1·7	AM
8360·2450	0·0511	14·1	0·9	15	32	−0·6	AM
8360·2540	0·0512	19·5	0·7	16	41	4·9	AM
8692·3230	0·9134	−1·2	1·2	16	22	−8·2	IM
8700·2080	0·9576	13·3	0·8	16	36	−5·6	IM
8707·2120	0·9969	24·3	0·8	16	36	−2·3	IM
8710·4350	0·0150	26·9	1·1	15	25	2·0	IM
8710·4510	0·0151	26·5	0·7	15	41	1·6	IM



Continued

HJD 2430000+	Phase	RV	PE	Lines	Wt	O–C	Measurer
8722·3410*	0·0817	1·9	0·5	32	50	−4·3	IM
8731·3260	0·1321	−4·3	1·0	15	28	−1·3	IM
8765·2340	0·3223	−14·1	0·7	16	41	0·3	IM
8782·2280	0·4176	−16·4	1·0	16	28	−0·6	IM

Sum of weighted residuals squared is 59495
* Coudé plate, DY 1477
Solution

$\gamma = -5{\cdot}97 \pm 0{\cdot}11$ km s^{-1}: $K = 21{\cdot}28 \pm 0{\cdot}16$ km s^{-1}: $e = 0{\cdot}5286 \pm 0{\cdot}0041$
$\omega = 2^{\circ}{\cdot}62 \pm 0^{\circ}{\cdot}81$: $T_0 = 2435319^{d}{\cdot}73 \pm 0^{d}{\cdot}25$
$P = 178^{d}{\cdot}3177 \pm 0^{d}{\cdot}0038$

RMS for solution is 4·7397.

$a \sin i = 44{\cdot}3 \times 10^6$ km. Mass function = 0·1092.

APPENDIX

PERIOD FINDING BY COMPUTER

The principle of our computer program for finding periods is essentially the same as the method one would use for hand calculations; one takes a trial period, constructs the diagram of radial velocity versus phase, and determines whether or not it is an acceptable fit. The advantage of using a computer is, of course, that many periods can be tried in a short time. The only subtlety is the method by which one determines, without human intervention to examine the phase diagram, whether or not the fit is acceptable. The present program differs from some that have previously been described, for instance by Lafler & Kinman (1965), only in the method by which goodness of fit is determined.

For a given trial period, the program calculates the phase for each observation, and orders the observations in phase. It then takes the absolute values of the differences between successive observations, and adds them together, including the difference between the last and the first. That is, it forms the quantity.

$$S = \sum_{i=1}^{N-1} |v_i - v_{i+1}| + |v_N - v_1|$$

where v_i is the ith radial velocity, in the phase order for that particular trial period. A little reflection will show that if the period is correct, and if there are no observational errors the value of this sum will be exactly twice the total range in the observations. If the period chosen were, for instance, twice the correct one, the value of this sum would be four times the total range in the observations, while for a period which is simply wrong, so that the points scatter all over the phase diagram, the sum is many times the total range. If Q is the total range of the observations, we define a discriminant function, r, as

$$r = \frac{S}{Q} - 2.$$

Because there are observational errors present in the radial velocities, the value of r will generally not be zero, even if the correct period is chosen. Our procedure is to input a discriminant level, ρ, to the program, along with the data, the minimum and maximum periods to be tried, and the period interval, ΔP, to be used between successive trials. The program then prints out those values of P which give a value of r less than ρ. The process is then repeated with a narrower range of period, and a smaller period interval, ΔP. In this way, we obtain an accurate period after two or three iterations. We have usually only carried this to four or five significant figures, which is normally sufficient for entering the formal solution for the elements of the binary orbit. We usually start with $\rho = 2$, and lower this to 1 after the first trial. Good fits generally give $r \approx 0{\cdot}5$, depending on the range of velocity variation. In this way, first trials for the period can be conducted over a wide range of period and with a relatively coarse ΔP. In the neighbourhood of the correct period, the value of r as a function of period shows a sharp minimum, with relatively broad 'wings', so that we can locate the vicinity of the correct period quite well, even for rather large steps in the period.

The whole procedure is made very convenient and fast by the use of a partial time-sharing feature on the CDC 6600 computer of the University of Texas. We enter the data and the program from a Teletype machine in the offices of the Astronomy Department, and perform one iteration in about 20 seconds, most of that time being 'waiting time' in the input queue of the computer. The final result is obtained in a few minutes. For checking, we can also have the phase diagram plotted directly at the Teletype, for any given period.