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COMMUNICATIONS FROM THE OBSERVATORY AT LEIDEN

Provisional ephemerides of 25 variable stars in the region of η Carinae,

by *Ejnar Hertzsprung.*

The variable stars treated in the present note are listed in Table 1. The reciprocal periods indicated are those used for the calculation of the phase according to the formula:

phase = reciprocal period × (J.D. hel. M. astr. T. Grw.—2420000).

The period given in Table 1 has often been improved afterwards by the aid of later plates not included in the mean light curve. The variability of all these stars but one (CF Car) has been found independently by Leiden observers. In a few cases the variability was discovered by others and published before elsewhere. The average number of plates used for each object is about 800.

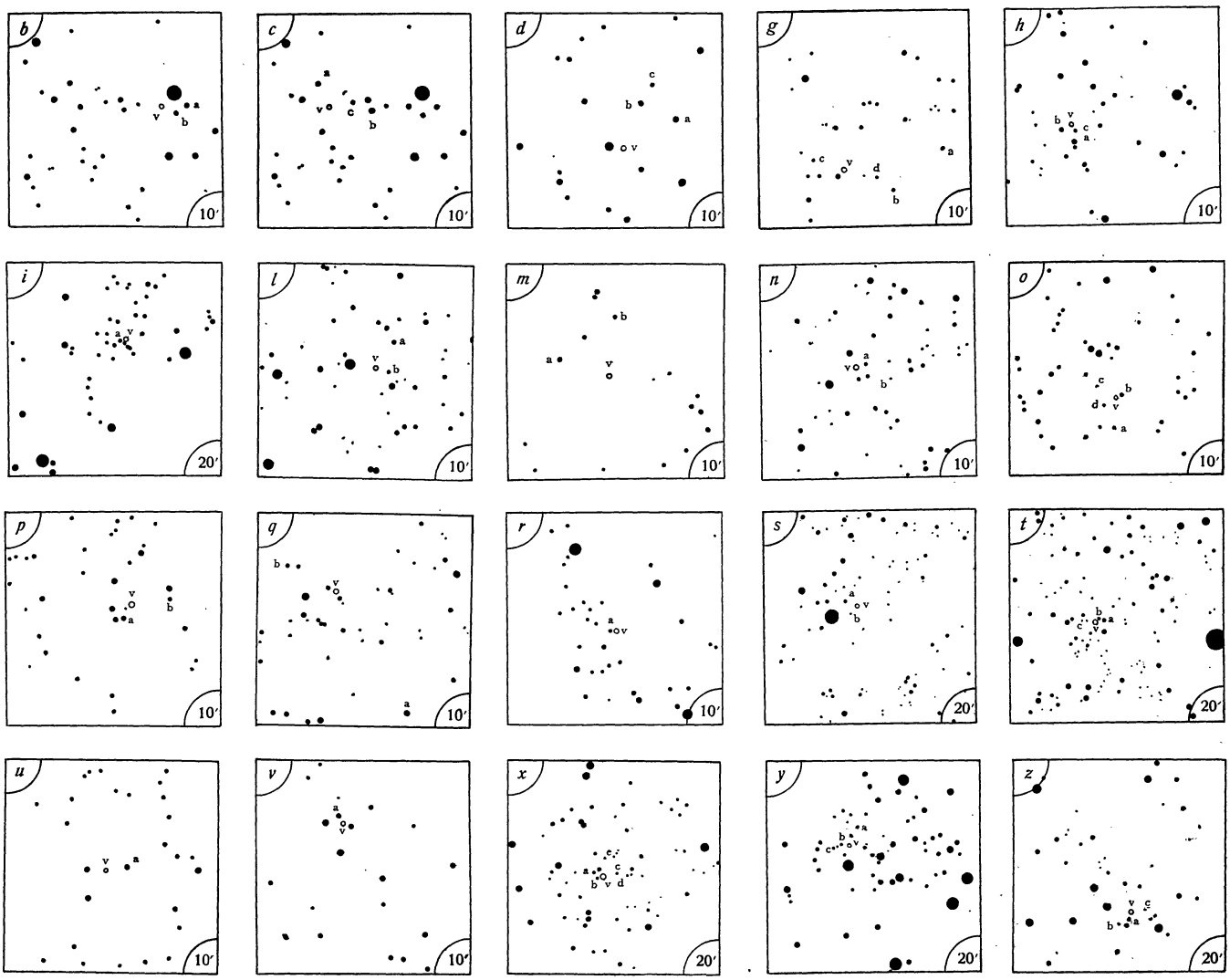


TABLE 1.

	α (1875)	δ (1875)	found by*)	type	reciprocal period used	final period with its m.e. in units of the last decimal		mean epoch with its m.e. in units of the last decimal J.D.— 2420000			limits of brightness in steps		m.e. of a single estimate	approximate limits of magnitude	
	h m s	° ′			d^{-1}	d	±	d	±		s	s	±s	m	m
a	10 0 50	—61 14·1	Oo	Algol		18·22465	18	3379·16	3	min	—	—		11	14
b	5 48	—60 23·5	Hzg	Algol	·0911325	10·97299	15	4996·978	13	min	·1	1·1	·18	12	13
c	6 21	—60 23·0	Oo	Algol	1·43691	2× ·6959383	25	4358·678	4	min	·13	·58	·12	11·9	12·5
d	12 22	—62 55·0	vG	cl. c.	2·48677	·4021		3900·710	4	max sin	·18	·52	·122	13·3	13·8
e	15 4	—56 46·6	Oo	Algol	1·24962	2× ·8002232	36	4348·182	6	min	—·005	·146	·073	8·5	8·8
f	15 56	—58 44·9	Hzg	δ Ceph	·24045	4·15898	12	4485·563	32	max sin	—·04	·23	·105	10·2	10·8
g	16 17	—60 37·2	vG	δ Ceph	·071	14·0722	13	4038·03	16	asc ·4	·22	1·61	·2	12·5	13·9
h	20 7	—58 54·3	Oo	δ Ceph	·19638	5·092090	44	4593·292	11	asc ·3	·04	·82	·136	12·7	13·9
i	33 46	—60 8·4	vG	Mira		109·03	32	4916	2	max	—	—		13	
k	34 43	—60 30·0	vG	δ Ceph?	·10869	9·2002	13	4404·94	10	min	—·09	·30	·094	9·0	9·8
l	39 2	—59 13·3	Hzg	Algol	·308361	3·242949	15	4389·943	9	min	·19	·74	·142	14·4	15·2
m	39 7	—62 14·6	Oo	RR Lyr	1·962367	·5095905	6	4922·734	2	asc ·25	—·30	·72	·12	13·6	15·0
n	41 22	—59 21·1	Hzg	Algol	·02606872	38·35941	36	6423·30	3	min	·00	—		14·6	
o	43 55	—59 24·1	vG	δ Ceph	·01555	64·24	2	4876·40	20	asc ·5	·12	1·07	·17	14·0	14·9
p	49 32	—60 40·8	Hzg	δ Ceph	·2101	4·75973	5	4486·12	2	asc ·4	—·06	·70	·14	12·5	13·7
q	51 27	—60 4·5	Oo	δ Ceph	·0735	13·606	7	4378·72	10	max sin	—·06	·17	·09	11·7	12·1
r	54 1	—59 36·7	CFCar	δ Ceph	·18199	5·4949	3	4326·75	4	asc ·4	—·52	—·03	·10	13·1	13·8
s	56 35	—63 37·0	vG	δ Ceph	·1404	7·1225	3	4394·09	9	asc ·3	—·20	·53	·175	14	15
t	11 0 11	—57 16·2	vG	Algol	·069995	14·2860	6	5009·04	3	min	·0	2·1		13·8	15·4
u	3 48	—58 59·8	Oo	WUMa	5·7793	2× ·1730312	4	4380·061	3	min	·05	·29	·104	12·2	12·6
v	6 10	—61 45·3	Hzg	WUMa	4·655458	2× ·2148016	4	4579·714	2	min	—·30	—·03	·092	13·6	14·0
w	6 53	—61 4·6	vG	δ Ceph	·1327	7·5356	12	4214·92	12	max	—·11	·16	·082	8·3	8·7
x	17 28	—61 6·5	vG	Algol	·301793	3·313506	9	4387·325	3	min	·07	1·05		12·8	14·3
y	18 22	—58 11·9	vG	Algol	·494439	2·022493	7	4313·091	4	min	·10	·94		13·1	14·6
z	19 44	—58 56·4	vG	Algol	·112448	8·893006	20	5307·940	4	min	·04	1·35	·14	12·8	15·3

*) vG: H. VAN GENT, Hzg: E. HERTZSPRUNG, Oo: P. TH. OOSTERHOFF

The limiting magnitudes given in Table 1 are rather inaccurate. They are meant merely to facilitate the identification of the objects.

For 7 of the variables of δ Cephei type the epoch given in Table 1 indicates the moment at which a point on the ascending branch is reached which is separated by a certain fraction of the period from the same brightness on the descending branch of the light curve.

By J.D. is always meant J.D.hel. M. astr. T. Grw.

For 20 of the variables diagrams are given showing their surroundings and the situation of the comparison stars. The angular size of the square is indicated in the lower right corner of the diagram.

The following remarks refer to the individual objects:

a = CPD—61°1454, $9^m{\cdot}8$. This star is outside the majority of the Franklin-Adams plates of the η Car region but present on a few plates of an adjacent field.

Miss HOFFLEIT has been kind enough to look this star up on 653 Harvard plates, from which 18 well pronounced minima were collected. In Table 2 these are combined with the 8 minima found on Franklin-Adams plates for determination of the period. The minimum may be constant for about $^d{\cdot}6$, but on

TABLE 2.

star *a* = CPD—61°1454

observatory	number of plates	min. at J.D.	E	O—C
		d		d
H	2	2412480·88	0	+ ·01
H	1	5341·86	157	— 28
H	1	6253·54	207	+ 17
H	2	7237·66	261	+ 15
H	1	7711·53	287	+ 18
H	1	8367·41	323	— 2
H	1	22048·63	525	— 18
J	5	3816·42	622	— 18
J	5	71·31	625	+ 3
J	1	89·47	626	— 3
J	3	3907·32	627	— 41
J	1	26·21	628	+ 26
J	3	44·26	629	+ 9
J	2	62·24	630	— 16
H	1	4290·60	648	+ 16
H	1	4527·68	661	+ 32
H	1	63·68	663	— 13
H	1	5292·58	703	— 22
H	1	6131·23	749	+ 10
H	1	6787·44	785	+ 22
H	3	6805·33	786	— 11
H	2	7188·26	807	+ 10
H	1	7516·43	825	+ 22
H	1	7807·56	841	— 24
J	2	7953·30	849	— 30
H	1	8719·29	891	+ 26
				m.e. ± ·21

plates taken with longer focal length the variable seems to have a close companion, the light of which may prevail near minimum. The total duration of the minimum is about $^{p}\cdot09$ or $1^{d}\cdot6$.

b. Comparison stars: a $^{s}\cdot00$, b $^{s}\cdot92$. The period of this Algol variable was derived from 9 observations in 7 nights on the descending and 7 observations in 4 nights on the ascending branch of the light curve. The time at which each plate had been taken was reduced to a brightness equal to that of the comparison star b, $^{s}\cdot92$, by the aid of the formula $\pm\,^{d}\cdot22\ (s-\cdot92)$, where the signs + and — are used for the descending and the ascending branch respectively.

The least squares solution of the data given in Table 3 yielded the values: mean epoch of minimum (E = 106) = J.D. 2424996·978 ± ·013 (m.e.), semiwidth of the minimum at the brightness $^{s}\cdot92 = {}^{d}\cdot217 \pm {}^{d}\cdot015$ (m.e.) and period = $10^{d}\cdot97299 \pm {}^{d}\cdot00015$ (m.e.). The figures given in Table 3 are rounded off, as the calculation was, rather superfluously, carried out with two decimals more.

Mean values of phase and brightness for 882 plates divided into 21 groups are given in Table 4. The minimum extends over about one tenth of the period and it may be constant for about a fortieth of the period.

c. Comparison stars: a $^{s}\cdot00$, b $^{s}\cdot27$, c $^{s}\cdot58$. The period of this Algol variable was derived from 60 plates (out of 737) on which the star was found faint. The 40 epochs of minimum derived from these 60 plates are collected in Table 5. Mean values of phase

TABLE 3.

star *b*

brightness	J.D.— 2420000	reduced to $^{s}\cdot92$	kind of branch	O—C
s	d	d		d
·81	3833·58	·60	+ 1	—·02
·86	·60	·62	+ 1	— 1
·74	3877·47	·51	+ 1	0
·86	·50	·51	+ 1	0
·90	3932·31	·32	+ 1	+ 1
·87	65·25	·26	+ 1	— 3
·77	76·23	·26	+ 1	— 1
·76	4558·38	·34	— 1	+ 7
·83	5381·36	·34	— 1	+ 9
·92	5776·25	·25	— 1	— 2
·92	·28	·28	— 1	0
·71	·30	·25	— 1	— 2
·71	·32	·27	— 1	0
1·02	6423·27	·25	+ 1	0
·92	·57	·57	— 1	— 11
1·00	6829·33	·32	+ 1	+ 7
				±·05

TABLE 4.

star *b*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	p	s		p	s
86	·085	·10	10	·421	·45
81	·173	·07	10	·432	·24
98	·263	·12	11	·439	·20
26	·326	·14	31	·452	·13
10	·345	·18	82	·525	·12
10	·352	·35	96	·617	·08
11	·358	·46	88	·717	·11
10	·363	·70	63	·802	·09
8	·372	1·06	73	·888	·14
3	·394	1·14	71	·974	·12
4	·408	·82			

TABLE 5.

star *c*

number of plates	min. at J.D.— 2420000	epoch E	O—C
	d		d
3	3814·440	0	—·014
1	21·377	10	— 37
3	28·387	20	+ 14
1	30·479	23	+ 18
2	42·327	40	+ 35
1	74·333	86	+ 28
2	76·377	89	— 16
3	78·478	92	— 3
1	80·489	95	— 80
1	81·313	96	+ 48
1	85·386	102	— 54
1	3904·268	129	+ 38
1	13·255	142	— 23
1	29·304	165	+ 20
1	36·260	175	+ 16
2	43·244	185	+ 41
3	45·283	188	— 8
1	59·228	208	+ 18
1	4141·527	470	— 18
2	71·434	513	— 37
1	4201·386	556	— 10
2	05·577	562	+ 5
1	61·240	642	— 7
2	86·332	678	+ 31
1	88·364	681	— 24
1	93·245	688	— 15
2	4560·481	1072	— 19
1	4650·320	1201	+ 44
1	4915·427	1582	— 2
1	5025·403	1740	+ 16
1	5382·338	2253	— 65
1	5774·233	2816	+ 16
3	76·292	2819	— 12
2	6007·368	3151	+ 12
1	6122·206	3316	+ 20
2	26·375	3322	+ 14
1	6449·294	3786	+ 17
1	6884·226	4411	— 12
2	7810·522	5742	— 10
1	8342·238	6506	+ 9

m.e. of unit weight ± ·031

and brightness for 737 plates divided into 20 groups are given in Table 6 and graphically represented in Figure 1. The apparent period of $^{d}\cdot696$ has evidently to be doubled, though no difference between even and odd minima has been observed.

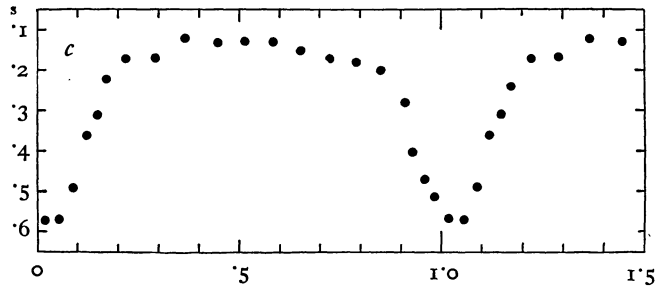
If the two components are supposed to be nearly equal their density will be about one tenth of that of the sun.

TABLE 6.

star *c*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
33	·021	·57	55	·515	·13
22	·055	·57	55	·589	·13
22	·089	·49	55	·657	·15
22	·122	·36	55	·724	·17
22	·149	·31	44	·791	·18
22	·175	·24	44	·856	·20
44	·225	·17	22	·906	·28
44	·294	·17	22	·934	·40
55	·364	·12	22	·959	·47
55	·446	·13	22	·983	·51

FIGURE 1.



d. Comparison stars: a $^{s}\cdot00$, b $^{s}\cdot29$, c $^{s}\cdot61$. The period and light curve of this star remind of the cluster type variables of BAILEY's type c. This comparison is further justified by the fact that the present object shows variation of period in a similar way as stars of type c in the globular cluster ω Cent (W. CHR. MARTIN: *Leiden Annals* XVII, part 2). All the phases were computed with the reciprocal period $2\cdot48677\,d^{-1}$.

The 370 observations from the year 1924 (between J.D. 2423786 and 3990) yielded the mean values of phase and brightness given in Table 7a. These values are well represented by the sinusoid:

$$s = \cdot346 - \cdot146 \sin 2\pi P - \cdot082 \cos 2\pi P$$
$$\pm \cdot007 \quad \pm \cdot009 \qquad \pm \cdot009 \quad \text{(m.e.)}$$

The corresponding maximum occurs at the phase $^{P}\cdot169 \pm {}^{P}\cdot009$ (m.e.) or at J.D. $2423900\cdot710 \pm \cdot004$ (m.e.) and the corresponding range is $^{s}\cdot335 \pm {}^{s}\cdot018$ (m.e.).

The following group of 184 plates extends from J.D. 2424141 to 4299. Mean values of phase and brightness for this group are given in Table 7b. The sinusoid determined by least squares is:

$$s = \cdot369 - \cdot173 \sin 2\pi P - \cdot066 \cos 2\pi P$$
$$\pm \cdot010 \quad \pm \cdot015 \qquad \pm \cdot015 \quad \text{(m.e.)}$$

TABLE 7a.

star *d*

number of plates	mean phase	mean brightness	O—C	number of plates	mean phase	mean brightness	O—C
	P	s	s		P	s	s
10	·010	·32	+ ·06	10	·469	·42	+ ·02
10	·040	·21	— 2	10	·499	·39	— 4
10	·065	·18	— 3	10	·521	·34	— 11
10	·084	·26	+ 6	10	·553	·50	+ 3
10	·108	·15	— 4	10	·570	·47	— 1
10	·134	·21	+ 3	10	·584	·50	+ 1
10	·154	·16	— 2	10	·613	·47	— 3
10	·175	·21	+ 3	10	·635	·55	+ 4
10	·198	·18	0	10	·661	·52	+ 1
10	·216	·17	— 2	10	·696	·53	+ 2
10	·236	·20	+ 1	10	·727	·54	+ 4
10	·260	·19	— 1	10	·765	·52	+ 4
10	·281	·20	— 2	10	·812	·43	— 2
10	·315	·30	+ 6	10	·855	·43	+ 2
10	·346	·26	— 1	10	·884	·37	— 1
10	·371	·29	— 1	10	·920	·25	— 9
10	·394	·32	0	10	·955	·25	— 6
10	·423	·37	+ 2	10	·988	·32	+ 4
10	·444	·38	+ 1				

TABLE 7b.

star *d*

number of plates	mean phase	mean brightness	O—C	number of plates	mean phase	mean brightness	O—C
	P	s	s		P	s	s
10	·035	·18	— ·09	10	·507	·49	+ ·05
10	·094	·19	— 3	10	·570	·48	— 2
10	·147	·22	+ 3	10	·632	·52	— 2
10	·233	·24	+ 5	10	·684	·49	— 6
10	·303	·23	+ 0	10	·736	·58	+ 3
10	·344	·28	+ 2	10	·797	·55	+ 3
10	·384	·31	+ 1	10	·851	·52	+ 5
10	·421	·31	— 3	12	·894	·46	+ 4
10	·462	·37	— 2	12	·951	·33	— 3

TABLE 7c.

star *d*

number of plates	mean phase	mean brightness	O—C	number of plates	mean phase	mean brightness	O—C
	P	s	s		P	s	s
10	·071	·51	— ·01	10	·623	·23	+ ·02
10	·168	·53	— 0	10	·690	·21	— 1
10	·223	·51	+ 0	10	·764	·27	+ 1
10	·313	·47	+ 3	10	·849	·36	+ 2
10	·460	·26	— 3	10	·943	·42	— 2
10	·569	·20	— 2				

m.e. for all 3 groups $^{s}\pm\cdot04$

The maximum occurs at the phase $^{P}\cdot192 \pm {}^{P}\cdot012$ (m.e.) or at J.D. 2424225·639 ± ·005 (m.e.) and the range is $^{s}\cdot370 \pm {}^{s}\cdot030$ (m.e.).

Finally a group of 110 plates between J.D. 2425377 and 5777 gave the values contained in Table 7c, which are represented by the sinusoid:

$$s = \cdot371 + \cdot119 \sin 2\pi P + \cdot114 \cos 2\pi P$$
$$\pm \cdot007 \pm \cdot009 \qquad \pm \cdot010 \quad \text{(m.e.)}$$

with its maximum at $^{P}\cdot628 \pm {}^{P}\cdot009$ or J.D.2425640·903 ± ·004 (m.e.) and a range of $^{s}\cdot330 \pm {}^{s}\cdot019$ (m.e.).

The light curves belonging to each of these three groups are shown in Figure 2.

FIGURE 2.

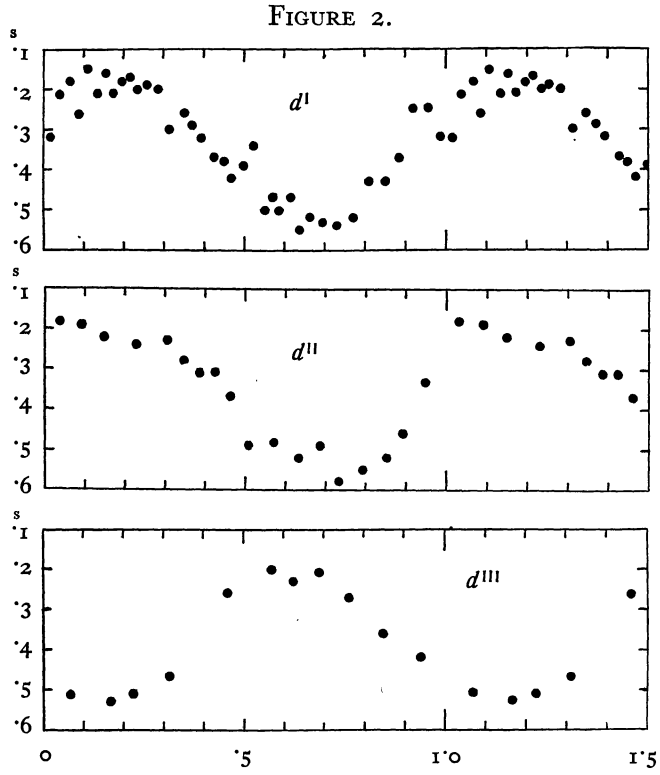


TABLE 8.

star *e*

min. at J.D.— 2420000	epoch E	O—C	min. at J.D.— 2420000	epoch E	O—C
d		d	d		d
3814·427	0	—·013	3943·244	161	—·032
78·465	80	+ 7	63·234	186	— 47
79·247	81	— 11	67·241	191	— 41
99·295	106	+ 32	4976·367	1452	+ 3
3903·261	111	— 4	5329·278	1893	+ 16
07·297	116	+ 31	5564·558	2187	+ 30
11·278	121	+ 11	5641·413	2283	+ 64
15·268	126	0	5709·370	2368	+ 2
27·243	141	— 28	6118·295	2879	+ 13
31·290	146	+ 18	26·283	2889	— 2
35·288	151	+ 14	7664·316	4811	+ 3
39·258	156	— 17	8341·253	5657	— 49

m.e. ± ·028

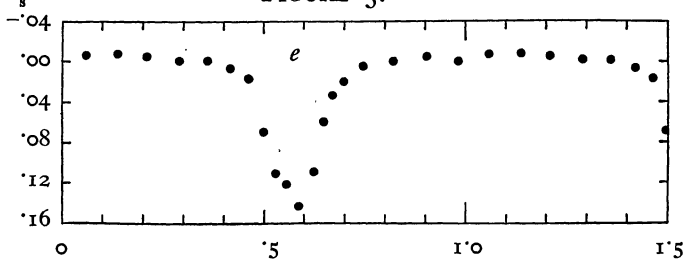
e = CPD—56°3131 = H.D. 89714, Sp. B2. Only comparison star: a $^{s}\cdot00$ (—57°3008). The form of the light curve, shown in Figure 3, requires doubling of the period. The 24 minima used for the determination of the period are listed in Table 8 and mean values of phase and brightness of 808 plates are given in Table 9.

TABLE 9.

star *e*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
66	·060	—·007	20	·587	+·144
66	·138	—·008	20	·623	+·110
66	·210	—·005	20	·650	+·061
66	·291	—·001	20	·675	+·034
66	·360	—·001	20	·699	+·020
50	·420	+·007	50	·746	+·006
20	·462	+·017	66	·820	·000
20	·499	+·070	66	·904	—·005
20	·530	+·112	66	·983	·000
20	·559	+·122			

FIGURE 3.



f = CPD—58°2109. Comparison stars: a $^{s}\cdot00$ (—58°2118), b $^{s}\cdot17$ (—58°2097). The period of this variable of the δ Cephei type was determined by the aid of 126 plates taken in 44 nights on the ascending branch of the light curve. The time of observation of each of the 44 normal values, listed in Table 10, has been reduced to that point on the ascending branch of the light curve (viz. at $^{s}\cdot92$) which is separated by $^{P}\cdot44$ from the same brightness on the descending branch. The mean epoch of this point is E = 949, the J.D. of which is 2424937·923 ± ·044 (m.e.).

Though the light curve appears to be slightly asymmetrical in the ordinary sense a least squares solution was made to determine the constants of the sinusoid representing the 29 mean values of phase and brightness given in Table 11. The result for these 866 plates is:

$$s = \cdot110 + \cdot045 \sin 2\pi P + \cdot128 \cos 2\pi P$$
$$\pm \cdot005 \pm \cdot007 \qquad \pm \cdot007 \quad \text{(m.e.)}$$

The range of the sinusoid is $^{s}\cdot272 \pm {}^{s}\cdot013$ (m.e.) and the phase of its maximum $^{P}\cdot554 \pm {}^{P}\cdot008$ (m.e.) corresponding to J.D. 2424485·563 ± ·032 (m.e.).

TABLE 10.

star *f*

number of plates	J.D.— 2420000	epoch E	O—C
	d		d
1	0991·07	0	+ ·01
3	3831·48	683	— 16
3	43·98	686	— 13
9	77·90	694	+ 52
6	81·61	695	+ 7
2	85·46	696	— 24
4	3902·05	700	— 29
2	19·17	704	+ 20
2	27·54	706	+ 25
4	31·32	707	— 13
3	43·88	710	— 5
5	48·08	711	— 1
1	68·67	716	— 21
1	72·91	717	— 13
2	77·21	718	+ 1
4	4168·71	764	+ 19
5	72·55	765	— 12
3	76·82	766	— 1
3	4264·17	787	0
4	85·48	792	+ 52
4	88·91	793	— 21
4	93·03	794	— 25
4	97·69	795	+ 25
3	4538·61	853	— 5
4	59·17	858	— 29
2	4642·31	878	— 33
1	51·27	880	+ 32
1	5025·09	970	— 17
2	5320·56	1041	+ 1
2	91·95	1058	+ 70
2	5562·07	1099	+ 30
6	5686·32	1129	— 22
2	5732·30	1140	+ 1
1	52·60	1145	— 48
4	61·64	1147	+ 24
2	5923·48	1186	— 12
2	6123·00	1234	— 23
2	64·14	1244	— 68
2	6826·53	1403	+ 43
2	55·61	1410	+ 41
1	84·40	1417	+ 8
3	7533·55	1573	+ 43
1	9105·18	1951	— 4
2	9424·04	2027	— 39

m.e. of unit weight ± ·29

FIGURE 4.

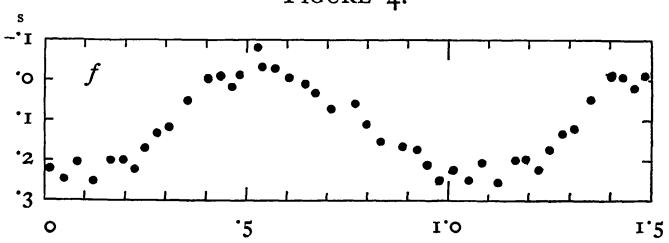


TABLE 11.

star *f*

number of plates	mean phase	mean brightness	O—C
	P	s	s
30	·0131	·224	—·019
30	·0476	·249	+ 2
30	·0819	·206	— 38
30	·1195	·253	+ 18
30	·1641	·200	— 15
30	·1963	·200	+ 5
30	·2235	·222	+ 45
30	·2492	·172	+ 16
30	·2799	·135	+ 5
30	·3103	·120	+ 15
30	·3545	·052	— 16
30	·4049	—·005	— 34
30	·4339	—·008	— 18
30	·4619	·019	+ 22
30	·4848	—·011	+ 3
30	·5140	—·080	— 58
30	·5408	—·036	— 10
30	·5678	—·026	— 1
30	·6006	—·005	+ 15
30	·6442	·008	+ 13
30	·6716	·036	+ 26
30	·7057	·077	+ 46
30	·7676	·060	— 20
30	·7985	·111	+ 5
30	·8306	·155	+ 22
29	·8860	·164	— 13
29	·9230	·176	— 28
29	·9515	·213	— 6
29	·9792	·250	+ 18

m.e. ± ·025

g. Comparison stars: a $^{s}\cdot00$, b $^{s}\cdot53$, c $1^{s}\cdot00$, d $1^{s}\cdot50$. This variable of the δ Cephei type is only about 135″ distant from EW Car.

The period was determined in two different ways, viz.

1°: from 83 observations on the ascending branch of the light curve. These observations yielded the 20 normal epochs at which the brightness $1^{s}\cdot00$ was reached on the ascending branch. This point is separated by $^{P}\cdot39$ from the same brightness on the descending branch. The corresponding data are listed in Table 12.

2°: from the 17 observations of maximum light given in Table 13.

The two periods thus found are $14^{d}\cdot0749 \pm {}^{d}\cdot0023$ and $14^{d}\cdot0709 \pm {}^{d}\cdot0016$ respectively or in the mean $14^{d}\cdot0722 \pm {}^{d}\cdot0013$.

The change in sign of O—C in the latter solution is not satisfactorily frequent, but it would be premature to conclude from this material that the period is variable. Mean values of phase and brightness for 609 plates divided into 17 groups are given in Table 14.

TABLE 12.

star *g*

number of plates	J.D.— 2420000	epoch E	O—C
	d		d
3	3799·16	0	+ ·27
12	3812·89	1	— ·07
3	41·41	3	+ ·30
3	82·77	6	— ·57
1	96·93	7	— ·48
4	3911·15	8	— ·34
5	39·16	10	— ·48
2	67·42	12	— ·37
2	4207·35	29	+ ·29
5	63·34	33	— ·02
10	91·68	35	+ ·17
4	4559·58	54	+ ·65
4	5038·48	88	+ 1·00
6	66·49	90	+ ·86
1	5318·84	108	— ·14
2	5614·10	129	— ·45
1	5738·80	138	— 2·42
10	6120·27	165	— ·97
2	6826·37	215	+ 1·38
3	6882·05	219	+ ·76

m.e. of unit weight ± 1·40

TABLE 13.

star *g*

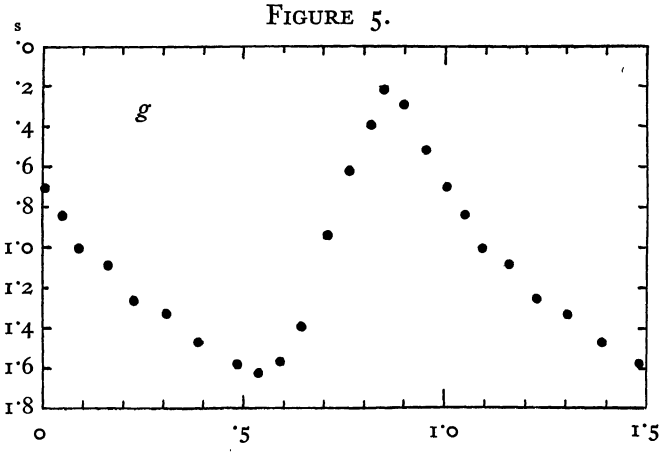
max. J.D.— 2420000	epoch E	O—C	max. J.D.— 2420000	epoch E	O—C
d		d	d		d
0327·25	0	+ 1·22	5686·35	381	— ·69
3814·53	248	— 1·08	6449·29	435	+ 2·42
85·41	253	— ·56	76·31	437	+ 1·29
3913·34	255	— ·77	6828·28	462	+ ·49
41·28	257	— ·97	84·23	466	+ 1·16
5320·37	355	— ·83	9105·21	624	— 1·07
77·31	359	— ·17	9345·37	641	— ·11
91·39	360	— ·17	9401·23	645	— ·53
5447·21	364	— ·63			m.e. ± 1·05

TABLE 14.

star *g*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
39	·003	·70	30	·595	1·57
40	·046	·84	30	·642	1·39
40	·094	1·01	30	·713	·94
40	·160	1·09	30	·763	·62
50	·228	1·26	30	·817	·40
40	·303	1·33	30	·849	·22
40	·389	1·47	40	·900	·29
30	·482	1·58	40	·951	·52
30	·536	1·62			

FIGURE 5.



h. Comparison stars: a s·00, b s·66, c 1s·16. The period of this variable of the δ Cephei type was determined from 75 plates taken on the rising branch of the light curve. The last two plates were made simultaneously with the new Rockefeller instrument at Johannesburg and have been counted as a single observation in the solution according to least squares. The 28 dates given in Table 15 represent the point on the ascending branch of the light curve where the brightness s·33 is reached. This point is separated by P·27 from the same brightness on the descending

TABLE 15.

star *h*

number of plates	J.D. — 2420000	epoch E	O—C
	d		d
1	3788·800	0	+ ·019
3	3814·229	5	— 13
2	29·556	8	+ 38
8	80·403	18	— 36
8	85·511	19	— 20
1	3926·421	27	+ 153
4	31·353	28	— 7
4	36·494	29	+ 42
1	41·608	30	+ 64
2	72·198	36	+ 102
1	77·173	37	— 15
1	87·480	39	+ 107
2	4196·102	80	— 46
4	4201·149	81	— 91
8	06·343	82	+ 10
2	57·192	92	— 61
4	62·312	93	— 34
2	4537·438	147	+ 120
1	4649·244	169	— 100
2	5377·500	312	— 13
2	5652·516	366	+ 30
2	5759·410	387	— 10
3	6126·171	459	+ 120
1	6421·376	517	— 16
1	7618·063	752	+ 30
2	8341·104	894	— 6
1	9104·796	1044	— 127
2	9344·234	1091	— 18

m.e. of unit weight ± ·094

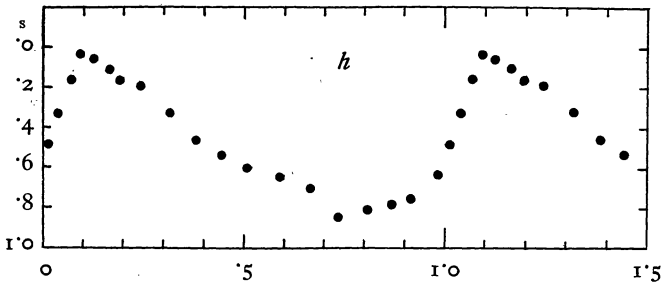
branch. The mean epoch is 157 and the corresponding J.D. 2424588·239 ± ·011 (m.e.). Mean values of phase and brightness for 730 plates divided into 19 groups are given in Table 16.

TABLE 16.

star *h*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
20	·0126	·484	50	·4421	·535
20	·0394	·335	50	·5097	·605
20	·0686	·160	50	·5888	·654
20	·0970	·034	50	·6666	·715
20	·1260	·065	50	·7389	·842
20	·1662	·112	50	·8066	·805
40	·1964	·162	50	·8663	·792
50	·2425	·196	50	·9191	·758
50	·3187	·329	20	·9819	·636
50	·3831	·468			

FIGURE 6.



i = VW Car. This variable proved to be of the Mira type. It is only visible on the plates when near maximum light. The approximate dates of 11 maxima are listed in Table 17.

TABLE 17.

star *i* = VW Car

max. at J.D.— 2420000	epoch E	O—C
d		d
3828	0	+ 2
3928	1	— 7
4160	3	+ 7
4262	4	0
4586	7	— 3
4916	10	0
5031	11	+ 6
5447	15	—14
5570	16	0
5686	17	+ 7
5791	18	+ 3
		m.e. ± 7

k = CPD—60°2116 = H.D. 92490, Sp. Ko. Comparison stars: a = —60°2141, b = —60°2103. The difference in magnitude between the two comparison stars was determined by C. J. KOOREMAN, who measured the stars on 7 plates taken with a grating in front of the objective. The result was $m_b - m_a$ = 1^m·007 ± ^{m}·038 (m.e.). A difference of 1^m·00 was finally adopted. From 372 plates the same difference expressed in steps was found to be ^{s}·468 ± ^{s}·008 (m.e.). In this case therefore 1^s = 2^m·15.

The minima are sharper than the maxima and the period was determined by the aid of the 20 epochs of minimum given in Table 18.

Mean values of phase and brightness expressed in $m_v - m_a$ as given in Table 19 have been derived for 20 groups from 830 plates.

TABLE 18.

star *k*

number of plates	min. at J.D.— 2420000	epoch E	O—C
	d		d
1	3788·48	0	+ ·05
2	3816·42	3	+ 40
3	43·66	6	+ 3
2	71·82	9	+ 60
2	79·88	10	— 54
2	3908·26	13	+ 24
3	35·64	16	+ 1
2	44·74	17	— 8
3	63·23	19	0
1	4202·43	45	— 1
1	38·31	49	— 93
1	57·31	51	— 33
1	85·29	54	+ 5
1	94·27	55	— 17
1	4560·47	84	— 77
4	5067·52	139	+ 27
1	5379·37	173	— 69
2	5923·06	232	+ 20
1	50·56	235	+ 9
1	6125·20	254	— 7
			m.e. of unit weight ± ·61

TABLE 19.

star *k*

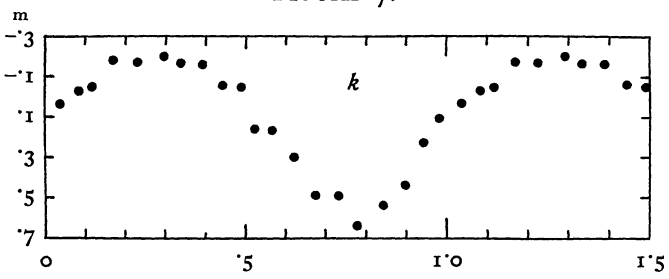
number of plates	mean phase	mean $m_v - m_a$	number of plates	mean phase	mean $m_v - m_a$
	P	m		P	m
40	·0375	+·032	40	·5276	+·163
40	·0840	—·033	40	·5715	+·170
40	·1188	—·053	40	·6201	+·297
50	·1723	—·186	40	·6769	+·489
50	·2277	—·174	40	·7355	+·491
50	·2974	—·202	40	·7797	+·652
40	·3392	—·169	40	·8436	+·540
40	·3917	—·165	40	·8964	+·446
40	·4428	—·062	40	·9414	+·229
40	·4922	—·047	40	·9811	+·114

The form of the light curve cannot be said to be abnormal for stars of the δ Cephei type with periods of about 9 days, but it does not show any sensible asymmetry and reminds of the variables of β Lyrae type showing equal depth of even and odd minima. The density corresponding to a rotation period of $18^d.4$ for two equal stars in contact is about 1/7000 times that of our sun.

Supposing perfect symmetry of the light curve the phase of the minimum is found to be $^P.773$.

The star is just bright enough for examination on Harvard plates of the AM series, thus covering a time interval of about 40 years, which may be sufficient to show change in the period.

FIGURE 7.



l. Comparison stars: a $^s.00$, b $^s.58$. This faint Algol variable is situated in the η Carinae nebula. Its period was derived from the 12 epochs of minimum given in Table 20. The first of these minima was found on an old plate during my stay at the Cape Observatory. Mean values of phase and brightness for 790 plates divided into 16 groups are contained in Table 21. The method described in *B.A.N.* No. 147, 4, 180 gives the phase of the minimum to be $^P.687$.

TABLE 20.

star *l*

number of plates	min. at J.D.— 2400000	epoch E	O—C
	d		d
1	16999·27	0	·00
2	23874·32	2120	0
1	77·50	2121	— 7
2	87·32	2124	+ 2
4	3900·26	2128	— 1
3	13·28	2132	+ 4
1	26·21	2136	0
2	39·22	2140	+ 4
2	4263·42	2240	— 6
1	89·38	2248	— 4
2	6423·28	2906	0
1	9105·21	3733	+ 1

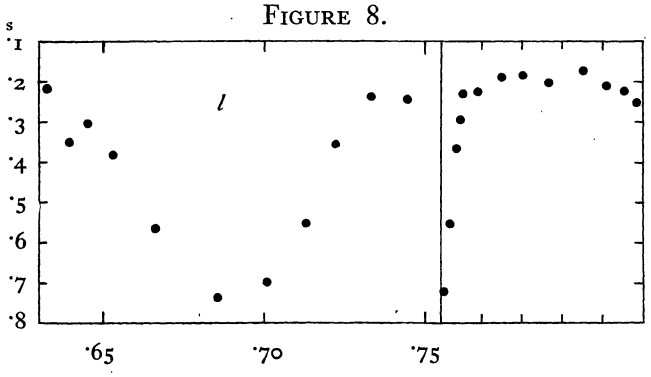
m.e. of unit weight ± ·04

TABLE 21.

star *l*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s	or counted from min.:		
100	·0636	·193			
100	·1947	·237		P	s
100	·2992	·198	20	·0077	·718
100	·4739	·190	20	·0234	·558
100	·5871	·222	20	·0346	·368
10	·6393	·354	20	·0472	·296
10	·6454	·305	20	·0561	·231
10	·6530	·384	90	·0892	·225
10	·6664	·564	100	·1455	·189
10	·6858	·740	100	·2018	·185
10	·7012	·697	100	·2657	·202
10	·7133	·551	100	·3525	·178
10	·7222	·353	90	·4145	·211
10	·7336	·238	50	·4527	·221
100	·8110	·190	50	·4846	·254
100	·9246	·198			

FIGURE 8.



m. Comparison stars: a $^s.00$, b $^s.68$. The period of this variable of the RR Lyrae type was derived from 71 plates taken on the ascending branch of the light curve and listed in Table 22. All the observations were reduced to that point on the rising branch where the brightness is $^s.21$ and which is separated by $^P.25$ from the same brightness on the descending branch.

Mean values of phase and brightness for 711 plates divided into 18 groups are given in Table 23. The light curve is quite normal for variables of this period.

FIGURE 9.

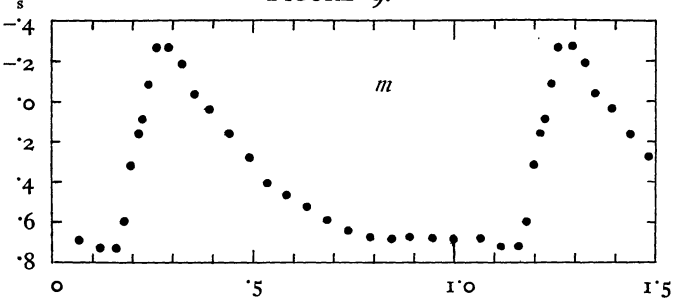


TABLE 22.

star *m*

J.D.— 2420000	epoch E	O—C	J.D.— 2420000	epoch E	O—C
d		d	d		d
3813·346	0	—·011	4538·495	1423	—·009
14·370	2	— 6	58·366	1462	— 12
17·421	8	— 13	59·405	1464	+ 8
·427	8	— 7	·398	1464	0
87·244	145	— 4	5327·343	2971	— 7
3913·231	196	— 6	28·386	2973	+ 17
15·281	200	+ 6	77·266	3069	— 24
16·286	202	— 9	79·308	3073	— 21
38·204	245	— 2	81·364	3077	— 3
39·233	247	+ 8	83·412	3081	+ 7
·244	247	+ 18	·389	3081	— 16
40·254	249	+ 9	5746·225	3793	— 8
·230	249	— 15	73·249	3846	+ 7
41·262	251	— 2	·229	3846	— 13
·264	251	0	74·251	3848	— 10
42·277	253	— 7	·253	3848	— 9
43·312	255	+ 9	75·270	3850	— 10
63·184	294	+ 8	·275	3850	— 5
64·193	296	— 3	76·306	3852	+ 6
·182	296	— 14	·298	3852	— 1
65·218	298	+ 3	5922·567	4139	+ 14
66·242	300	+ 8	23·593	4141	+ 22
·229	300	— 6	·599	4141	+ 28
89·184	345	+ 18	50·568	4194	— 11
4141·552	644	+ 19	6120·270	4527	— 3
·538	644	+ 5	·265	4527	— 8
69·560	699	— 1	23·327	4533	— 4
4240·405	838	+ 12	24·326	4535	— 24
58·227	873	— 2	26·385	4539	— 3
64·351	885	+ 6	6269·578	4820	— 5
82·188	920	+ 7	6413·302	5102	+ 14
85·242	926	+ 4	·286	5102	— 2
·232	926	— 6	20·446	5116	+ 24
86·275	928	+ 18	7533·364	7300	— 3
87·285	930	+ 8	9365·355	10895	+ 10
92·376	940	+ 4			m.e. ± ·011

TABLE 23.

star *m*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
36	·0654	·69	36	·4433	·16
36	·1184	·73	36	·4886	·28
27	·1573	·73	36	·5350	·41
9	·1781	·60	36	·5831	·46
9	·1976	·32	36	·6342	·53
9	·2147	·16	36	·6809	·59
9	·2219	·09	36	·7361	·64
9	·2399	—·09	36	·7930	·67
18	·2599	—·27	36	·8439	·68
27	·2920	—·27	36	·8900	·67
27	·3211	—·19	36	·9413	·68
27	·3517	—·04	36	·9989	·69
36	·3954	·04			

n. Comparison stars: a ^{s}·0, b ^{s}·8. This faint Algol star, situated in the η Carinae nebula, is of special interest as it is of less than normal brightness on 1/80 of the plates only.

Of the 7 minima given in Table 24 and used for the determination of the period the four even ones have been found on Johannesburg plates and the three odd ones on Harvard plates, which Miss HOFFLEIT has been kind enough to examine for this purpose. The period found from the combined material is $38^{d}\cdot3594 \pm {}^{d}\cdot0004$ (m.e.). The results of the examination of 26 plates taken in or near minimum are collected in Table 25 in chronological order. The only date at which the variable was estimated to be distinctly between the two comparison stars is J.D. 2424198·325.

The shape of the minimum is still very uncertain. It may be that the variable just goes below the plate limit and that the minimum is constant for as much as ^{P}·08, but conclusions of this kind are premature.

The variable is at constant light nearly equal to the comparison star a.

TABLE 24.

star *n*

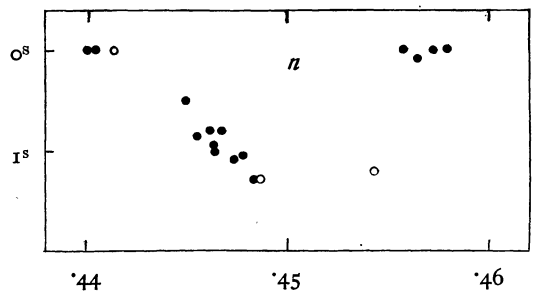
min. at J.D.— 2420000	epoch E	O—C
d		d
3968·24	0	—·06
4198·48	6	+ 3
5771·23	47	+ 4
6423·35	64	+ 5
7842·54	101	— 6
8341·25	114	— 2
8993·39	131	+ 1
		m.e. ± ·05

TABLE 25.

star *n*

J.D.— 2420000	phase	brightness	J.D.— 2420000	phase	brightness
d	P	s	d	P	s
3814·538	·4401	·0	4198·439	·4479	1·07
·551	·4405	·0	·453	·4483	1·3
3930·219	·4558	·0	·467	·4487	invis.
·246	·4565	·08	·481	·4490	invis.
·272	·4572	·0	·495	·4494	invis.
·299	·4579	·0	·509	·4498	invis.
68·215	·4463	1·0	·522	·4501	invis.
·239	·4469	invis.	4543·432	·4415	·0:
4198·325	·4450	·5	6423·270	·4464	·95
·349	·4456	·86	·292	·4470	invis.
·372	·4462	·8	·352	·4486	1·3:
·396	·4468	·8	·373	·4491	invis.
·419	·4474	1·1	·572	·4543	1·2:

FIGURE 10.



o. Comparison stars: a $^{s}\cdot00$, b $^{s}\cdot39$, c $^{s}\cdot83$, d $1^{s}\cdot31$. This variable of the δ Cephei type has the unusually long period of 64 days. The variable is found both brighter and fainter than the comparison star b, which is only about 17″ distant. The 148 plates taken on the ascending branch of the light curve were used for the determination of the period. In Table 26 are given 20 mean epochs when that point on the ascending branch is reached which is separated by half a period from the same brightness, $^{s}\cdot566$, on the descending branch. The frequency of change in sign of O—C is not quite satisfactory, but it is premature to conclude that the period is systematically changing.

The light curve is remarkably symmetrical with respect to either of the two points separated by half the period, the maxima and minima being very similar in shape.

Mean values of phase and brightness for 747 plates divided into 30 groups are given in Table 27.

TABLE 26.

star *o*

number of plates	J.D.— 2420000	epoch E	O—C
	d		d
1	1720·0	0	— 7·3
4	3783·4	32	— ·5
5	3848·7	33	+ ·5
27	3912·6	34	+ ·2
3	76·0	35	— ·7
17	4170·8	38	+ 1·3
1	4237·8	39	+ 4·0
17	4299·4	40	+ 1·3
6	4555·9	44	+ ·8
7	5069·1	52	— ·2
8	5324·7	56	— 1·6
4	89·8	57	— ·8
4	5647·4	61	— ·2
6	5709·4	62	— 2·6
21	75·1	63	— 1·1
4	6032·1	67	— 1·2
8	6418·4	73	— ·4
2	8156·2	100	+ 2·1
1	8220·1	101	+ 1·7
2	9380·6	119	+ 5·4

m.e. of unit weight ± 2·4

FIGURE 11.

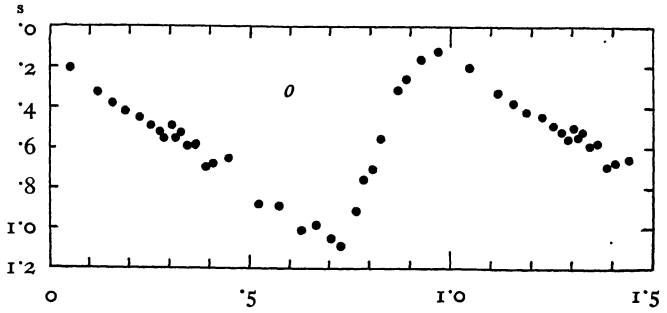


TABLE 27.

star *o*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
25	·050	·204	25	·444	·658
25	·119	·329	25	·525	·886
25	·158	·377	25	·576	·893
25	·193	·424	25	·629	1·017
24	·225	·447	25	·668	·987
24	·255	·492	25	·702	1·058
25	·279	·518	25	·728	1·091
25	·292	·558	25	·761	·920
24	·304	·496	25	·783	·766
25	·315	·550	25	·808	·712
25	·327	·532	25	·833	·562
25	·344	·597	25	·870	·319
25	·364	·594	25	·892	·258
25	·387	·697	25	·933	·159
25	·407	·678	25	·968	·125

p = CC Car. Comparison stars: a $^{s}\cdot00$, b $^{s}\cdot53$. This is an ordinary variable of the δ Cephei type. Its period was determined by the aid of 98 observations on the rising branch of the light curve. The times at which these 98 observations were made have been

TABLE 28.

star *p* = CC Car

number of plates	J.D.— 2420000	epoch E	O—C
	d		d
1	0250·20	0	+ ·25
3	3786·54	743	+ 11
2	3829·37	752	+ 10
4	72·04	761	— 7
3	81·69	763	+ 6
4	86·46	764	+ 7
4	3910·24	769	+ 5
4	29·22	773	— 1
3	43·38	776	— 12
3	48·35	777	+ 9
3	67·13	781	— 17
2	71·94	782	— 12
1	86·31	785	— 3
4	4176·69	825	— 4
6	4200·57	830	+ 4
9	05·26	831	— 3
4	62·43	843	+ 2
1	81·14	847	— 31
5	86·13	848	— 8
2	4538·23	901	— 24
1	4976·36	993	— 1
2	5038·37	1006	+ 13
2	5328·73	1067	+ 14
2	5561·87	1116	+ 6
1	71·30	1118	— 3
4	5709·39	1147	+ 3
2	5923·56	1192	+ 1
2	6123·52	1234	+ 6
4	6423·36	1297	+ 4
2	7427·75	1508	+ 12
4	8308·24	1693	+ 6
2	41·30	1700	— 20
2	9336·25	1909	— 3

m.e. of unit weight ± ·17

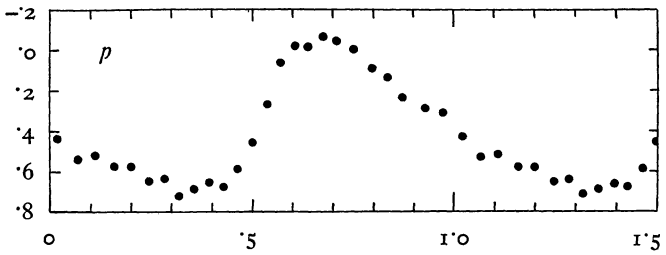
reduced to the brightness $^{s}\cdot29$, which is separated by $^{P}\cdot4$ from the same brightness on the descending branch. The 33 epochs thus obtained are collected in Table 28.

Mean values of phase and brightness for 825 plates divided into 25 groups are given in Table 29.

TABLE 29.
star p = CC Car

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
33	·0209	·439	33	·5384	·270
33	·0675	·545	33	·5751	·062
33	·1101	·525	33	·6079	—·017
33	·1584	·578	33	·6388	—·013
33	·2001	·585	33	·6786	—·068
33	·2432	·645	33	·7102	—·040
33	·2825	·640	33	·7526	—·009
33	·3186	·725	33	·7985	·089
33	·3561	·688	33	·8356	·145
33	·3956	·662	33	·8775	·237
33	·4272	·678	33	·9293	·291
33	·4625	·593	33	·9768	·311
33	·5000	·455			

FIGURE 12.



q. Comparison stars: a $^{s}\cdot00$, b $^{s}\cdot30$. The shape of the light curve of this variable of the δ Cephei type is nearly sinusoidal. The period has been only provisionally determined by the aid of the 12 epochs of minimum given in Table 30.

Mean values of phase and brightness are given in Table 31 for 701 plates divided into 70 groups of 10 or 11 plates each. These values are well represented by the following sinusoid determined by least squares:

$$s = \cdot0513 + \cdot0907 \sin 2\pi P - \cdot0544 \cos 2\pi P$$
$$\pm \cdot0029 \quad \pm \cdot0041 \quad \pm \cdot0041 \quad \text{(m.e.)}$$

The range is only $^{s}\cdot21 \pm {}^{s}\cdot01$ (m.e.).

FIGURE 13.

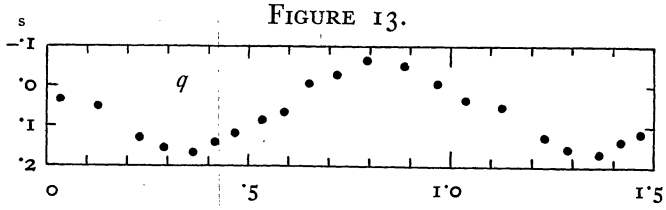


TABLE 30.
star q

min. at J.D.— 2420000	epoch E	O—C
d		d
3814	0	0
84	5	+ 2
3908	7	— 1
36	9	— 1
49	10	— 1
4141	24	0
69	26	+ 1
4263	33	0
90	35	0
5068	92	+ 2
5759	143	— 1
73	144	0
		m.e. ± 1

TABLE 31.
star q

mean phase	mean brightness	O—C	mean phase	mean brightness	O—C
P	s	s	P	s	s
·0141	·044	+·039	·5073	·071	—·030
·0301	·010	— 5	·5181	·099	+ 4
·0390	·024	+ 4	·5339	·084	— 2
·0470	·018	— 7	·5534	·092	+ 20
·0589	·079	+ 45	·5645	·095	+ 29
·0895	·024	— 29	·5777	·073	+ 16
·1037	·037	— 26	·5831	·080	+ 27
·1139	·056	— 14	·5897	·074	+ 25
·1580	·082	— 16	·6015	·029	— 11
·1766	·069	— 40	·6156	·077	+ 45
·1927	·113	— 5	·6287	·004	— 20
·2042	·114	— 9	·6351	·022	+ 3
·2377	·152	+ 14	·6496	·008	— 2
·2520	·143	0	·6638	—·034	— 36
·2631	·138	— 8	·6731	—·016	— 12
·2732	·155	+ 6	·6793	—·035	— 28
·2843	·164	+ 12	·6998	—·028	— 10
·2917	·138	— 16	·7255	·009	+ 39
·3054	·150	— 5	·7349	—·050	— 16
·3213	·172	+ 16	·7528	—·053	— 13
·3386	·202	+ 45	·7657	—·083	— 38
·3529	·183	+ 26	·7754	—·016	+ 31
·3636	·139	— 17	·7905	—·036	+ 14
·3736	·155	+ 1	·8080	—·098	— 45
·3828	·150	— 2	·8275	—·093	— 39
·3903	·128	— 23	·8507	—·044	+ 10
·4017	·153	+ 5	·8676	—·044	+ 8
·4102	·135	— 11	·8871	—·075	— 26
·4327	·166	+ 28	·8999	—·014	+ 32
·4425	·119	— 15	·9134	—·055	— 12
·4502	·091	— 40	·9390	—·013	+ 20
·4565	·110	— 18	·9553	—·011	+ 15
·4626	·143	+ 18	·9680	—·034	— 14
·4810	·099	— 17	·9744	·032	+ 49
·4943	·132	+ 23	·9873	—·002	+ 8
					m.e. ± ·024

r = CF Car. As this variable of ordinary δ Cep type according to the mean light curve is always brighter than the only comparison star used, the character of the estimates is rather provisional. The

period was determined by the aid of the 44 epochs of maximum listed in Table 32. Mean values of 755 plates divided into 15 groups are given in Table 33. The shape of the light curve is quite normal for δ Cep stars of similar periods. At the phases $^{P}\cdot425$ and $^{P}\cdot825$ ($\Delta P = \cdot4$) the brightness is $-\,^{s}\cdot25$. The maximum occurs at the phase $^{P}\cdot564$.

TABLE 32.

star r = CF Car

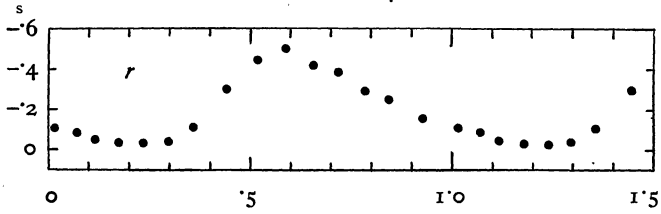
max. at J.D.— 2420000	epoch E	O—C	max. at J.D.— 2420000	epoch E	O—C
d		d	d		d
3789·5	0	+ ·2	4196·4	74	+ ·5
3833·6	8	+ 3	4201·9	75	+ 5
44·3	10	0	06·9	76	0
71·8	15	+ 1	40·4	82	+ 5
76·8	16	— 4	62·2	86	+ 3
87·4	18	— 8	84·2	90	+ 4
3904·4	21	— 3	89·3	91	0
10·3	22	+ 1	94·4	92	— 4
15·8	23	+ 1	4558·4	140	— 2
26·2	25	— 5	86·5	145	+ 5
31·8	26	— 4	4915·4	205	— 3
37·7	27	0	5025·4	225	— 2
43·1	28	— 1	5327·7	280	— 1
48·7	29	0	77·3	289	0
59·6	31	0	82·9	290	+ 1
65·2	32	+ 1	5564·6	323	+ 5
70·7	33	+ 1	5640·9	337	— 1
76·2	34	+ 1	51·6	339	— 4
87·5	36	+ 4	5745·7	356	+ 3
4168·5	69	+ 1	61·4	359	— 5
73·4	70	— 5	73·2	361	+ 3
90·4	73	0	89·2	364	— 2
					m.e. ± ·3

TABLE 33.

star r = CF Car

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
55	·0160	—·108	50	·5186	—·443
50	·0737	—·088	50	·5871	—·496
50	·1145	—·052	50	·6577	—·421
50	·1780	—·034	50	·7207	—·388
50	·2348	—·034	50	·7860	—·290
50	·2983	—·043	50	·8439	—·244
50	·3603	—·111	50	·9312	—·158
50	·4439	—·296			

FIGURE 14.



s. Comparison stars: a $^{s}\cdot00$, b $^{s}\cdot20$, the latter appeared afterwards to be a close double. This faint variable, which is near to the border of the field, was difficult to estimate. The period was determined by the aid of the 18 epochs of maximum collected in Table 34. Mean values of phase and brightness for 508 plates divided into 17 groups are given in Table 35. The form of the light curve shows a halt on the descending branch as is ordinarily found in other cases of δ Cep stars of similar periods. At the phases ·93 and ·23 ($\Delta P = \cdot3$) the brightness is the same, viz. $^{s}\cdot1$.

TABLE 34.

star s

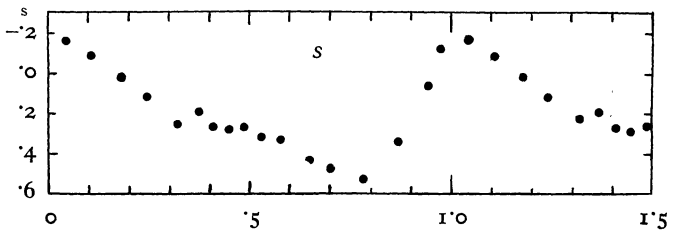
max. at J.D.— 2420000	epoch E	O—C	max. at J.D.— 2420000	epoch E	O—C
d		d	d		d
0605·3	0	— ·4	4558·9	555	+ ·1
3789·5	447	0	66·5	556	+ 6
3817·4	451	— 6	5562·5	696	— 5
82·3	460	+ 2	5791·2	728	+ 2
89·5	461	+ 3	6118·3	774	— 3
3903·8	463	+ 3	6125·2	775	— 5
10·3	464	— 3	8155·5	1060	— 1
32·3	467	+ 3	9096·2	1192	+ 4
46·8	469	+ 6	9423·2	1238	— 2
					m.e. ± ·4

TABLE 35.

star s

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
30	·0430	—·160	30	·5338	·320
30	·1082	—·087	30	·5777	·337
30	·1789	·010	30	·6530	·437
30	·2429	·120	30	·7024	·477
30	·3203	·227	30	·7853	·530
30	·3748	·197	30	·8725	·337
30	·4103	·273	30	·9413	·060
30	·4494	·280	28	·9760	—·121
30	·4913	·267			

FIGURE 15.



t. Comparison stars: a $^{s}\cdot00$, b $^{s}\cdot73$, c $^{1s}\cdot31$. The period was determined by the aid of the 14 epochs of minimum collected in Table 36. In spite of the different numbers of plates all these epochs were given equal weight. There are very nearly 7 periods in 100 days. The estimates are not accurate enough

to decide whether the eclipse is total or not. Mean values of phase and brightness of 751 plates divided into 7 groups outside the eclipse and 7 during eclipse are given in Table 37.

TABLE 36.
star *t*

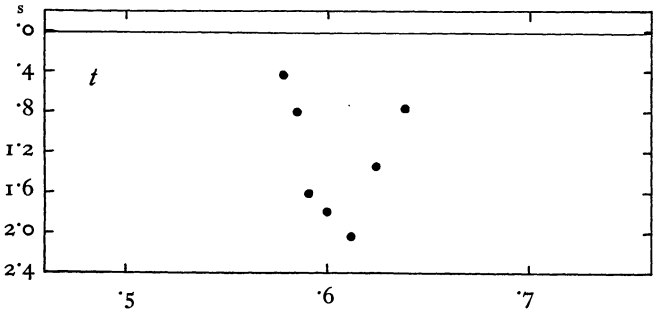
number of plates	min. at J.D.— 2420000	epoch E	O—C
	d		d
1	0623·25	0	+ ·03
8	3880·35	228	— 8
1	3937·33	232	— 24
1	66·23	234	+ 9
1	4266·24	255	+ 9
1	80·19	256	— 25
2	4537·40	274	— 18
2	66·47	276	+ 31
2	5380·26	333	— 20
3	5709·31	356	+ 27
1	5923·56	371	+ 23
2	6123·31	385	— 2
5	6423·42	406	+ 9
2	9423·25	616	— 14

m.e. of unit weight ± ·27

TABLE 37.
star *t*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
103	·0043	·016	4	·5915	1·625
103	·1006	·031	4	·6005	1·785
103	·2143	·018	4	·6122	2·045
103	·3353	·021	4	·6238	1·368
103	·4641	·000	4	·6382	·765
4	·5785	·458	104	·7400	·013
4	·5855	·808	104	·9086	·015

FIGURE 16.



u. Only one comparison star, taken as zero point, was used for this variable of the W UMa type. The 45 epochs of minimum which served for the determination of the period are collected in Table 38. In a case like the present one, where the total range is only ·24/·104 = 2·3 times the mean error of a single estimate, it is only possible to find the correct period if numerous observations well distributed over different hour angles are available. It is particularly valuable to have plates taken both at the beginning and the end of consecutive oppositions.

From the figures given in Table 39 for the mean light curve the phase of the minimum was found to be ^{P}·689. There is no sensible difference between even and odd minima and the apparent period has been used here.

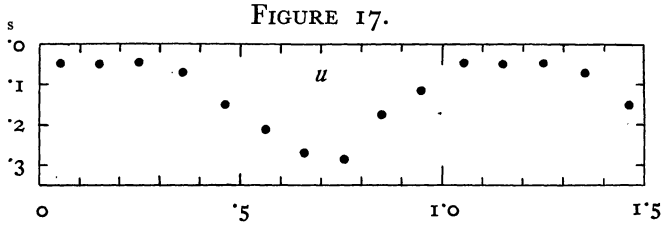
TABLE 38.
star *u*

min. at J.D.— 2420000	epoch E	O—C	min. at J.D.— 2420000	epoch E	O—C
d		d	d		d
3789·51	0	·00	4258·26	2709	+ ·01
3813·51	139	— 5	62·22	2732	— 1
14·41	144	— 1	63·25	2738	— 2
15·47	150	+ 1	85·24	2865	— 1
28·47	225	+ 3	86·32	2871	+ 4
76·38	502	+ 1	88·35	2883	— 1
79·31	519	0	92·35	2906	+ 1
85·38	554	+ 1	96·32	2929	+ 1
3904·38	664	— 2	4553·46	4415	+ 2
07·37	681	+ 3	5614·46	10547	— 1
27·23	796	— 1	41·49	10703	+ 3
29·30	808	— 2	86·28	10962	+ 1
40·21	871	— 1	5745·26	11303	— 2
42·32	883	+ 3	46·31	11309	— 1
45·24	900	+ 1	75·20	11476	— 1
58·20	975	— 1	76·25	11482	0
63·20	1004	— 3	5950·50	12489	+ 1
4172·44	2213	+ 2	6126·29	13505	0
76·42	2236	+ 2	6828·29	17562	+ 1
·57	2237	— 1	7619·20	22133	— 1
90·42	2317	0	8341·25	26306	— 2
98·35	2363	— 3	9096·21	30669	+ 1
4206·31	2409	— 3		m.e.	± ·02

TABLE 39.
star *u*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
70	·0538	·046	70	·5626	·211
70	·1484	·049	70	·6562	·269
70	·2513	·043	71	·7553	·284
70	·3561	·071	70	·8524	·177
70	·4615	·149	72	·9518	·118

FIGURE 17.



v. For this variable of the W UMa type also only one comparison star was used and taken as zero point as in the case of the star *u*. The determination of the period was difficult owing to the small range and the uncertainty of the estimates, but the value of the apparent period adopted here is supposed to be correct, though confirmation is desirable. The two multiples of the apparent period $1^d\cdot944$ and $3^d\cdot004$ are well established and there is evidence for the supposition that the latter interval is equal to an even number of periods. The question is if the two intervals then available, viz. $1^d\cdot502$ and $1^d\cdot944$, contain respectively 10 and 13 or 7 and 9 periods. The latter alternative was adopted as the most probable one. There is no support for the assumption that $\frac{1}{2} \times 1^d\cdot502 = {}^d\cdot751$ should be a multiple of the period.

In Table 40 are collected 62 epochs of minimum which served for the determination of the apparent period according to least squares. Mean values of phase and brightness of 780 plates divided into 26 groups are given in Table 41. The phase of the minimum was found to be $^P\cdot666$.

TABLE 40.

star *v*

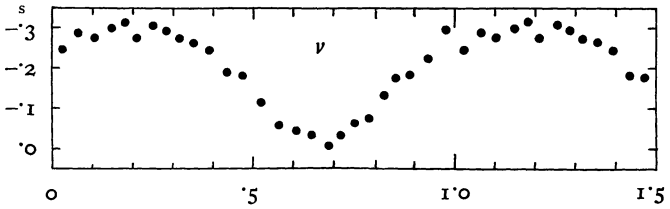
min. at J.D.— 2420000	epoch E	O—C	min. at J.D.— 2420000	epoch E	O—C
d		d	d		d
3787·526	0	—·003	4257·291	2187	—·009
3813·524	121	+ 4	62·244	2210	+ 3
15·448	130	— 5	82·213	2303	— 4
28·362	190	+ 21	85·244	2317	+ 20
57·348	325	+ 9	86·320	2322	+ 22
74·322	404	+ 13	87·343	2327	— 29
76·440	414	— 17	89·272	2336	— 34
77·329	418	+ 13	94·248	2359	+ 2
79·257	427	+ 8	4918·465	5265	+ 5
86·343	460	+ 5	5039·201	5827	+ 23
87·414	465	+ 2	67·273	5958	— 44
3904·384	544	+ 3	5320·370	7136	+ 17
07·364	558	— 24	30·257	7182	+ 23
08·248	562	+ 1	80·258	7415	— 25
15·325	595	— 11	81·348	7420	— 9
16·390	600	— 20	5651·568	8678	— 10
29·290	660	— 8	86·345	8840	— 30
31·249	669	+ 18	5709·359	8947	0
32·300	674	— 5	38·341	9082	— 16
35·328	688	+ 16	60·267	9184	0
37·266	697	+ 20	61·356	9189	+ 15
40·233	711	— 20	75·300	9254	— 3
43·269	725	+ 9	77·214	9263	— 23
46·281	739	+ 14	5950·565	10070	— 16
57·244	790	+ 22	6010·515	10349	+ 4
60·247	804	+ 18	6120·277	10860	+ 2
4141·503	1648	+ 51	6422·322	12266	+ 36
69·440	1778	— 6	6883·233	14412	— 17
4200·372	1922	— 6	7427·564	16946	+ 7
04·433	1941	— 26	8308·262	21046	+ 18
05·508	1946	— 25	9340·372	25851	+ 6
				m.e.	± ·018

TABLE 41.

star *v*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
30	·0236	—·245	30	·5202	—·114
30	·0643	—·287	30	·5640	—·058
30	·1048	—·275	30	·6043	—·043
30	·1455	—·299	30	·6434	—·037
30	·1802	—·316	30	·6875	—·003
30	·2108	—·275	30	·7179	—·031
30	·2512	—·305	30	·7516	—·061
30	·2855	—·294	30	·7856	—·073
30	·3185	—·274	30	·8269	—·133
30	·3531	—·263	30	·8557	—·175
30	·3914	—·245	30	·8926	—·185
30	·4362	—·187	30	·9325	—·226
30	·4741	—·180	30	·9746	—·292

FIGURE 18.



w = CPD—61°2103, $8^m\cdot9$ = H.D. 97485, Sp. K2. Comparison star:
CPD—60°2786, $8^m\cdot8$ = H.D. 98312, Sp. Ko. The period of this variable of the δ Cephei type has been only provisionally determined by the aid of the 11 epochs of minimum collected in Table 42. Mean values of phase and brightness are given in Table 43 for 799 plates divided into 16 groups. As is ordinarily the case with δ Cep variables of similar period there is a marked halt on the descending branch of the light curve.

TABLE 42.

star *w*

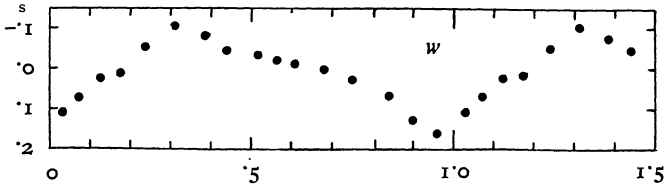
min. at J.D.— 2420000	epoch E	O—C
d		d
3880·4	0	—·1
3902·9	3	—·2
10·8	4	+·2
33·3	7	+·1
40·6	8	—·2
63·7	11	+·3
71·1	12	+·2
5078·2	159	—·5
5379·4	199	—·7
5561·6	223	+·7
5651·6	235	+·2
		m.e. ± ·4

TABLE 43.

star *w*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
50	·0322	·114	50	·5158	—·033
50	·0750	·075	50	·5622	—·020
50	·1240	·025	50	·6089	—·011
50	·1766	·015	50	·6796	·001
50	·2394	—·056	50	·7485	·029
50	·3108	—·102	50	·8410	·071
50	·3841	—·079	50	·8993	·128
50	·4407	—·045	49	·9611	·160

FIGURE 19.



x. Comparison stars: a s·00, b s·15, c s·36, d s·85, e 1s·33. The period of this Algol variable was found to be: from 83 epochs of minimum 3d·313490 ± d·000015 (m.e.) and from 17 epochs of intermediary brightness (s·6): 3d·313514 ± d·000011 (m.e.) or in the mean 3d·313506. The 17 epochs corresponding to the brightness s·6 are given in Table 44. At this brightness the minimum is d·215 ± d·006 (m.e.) broad. The minimum is constant for about 1/30 of the period. There is a marked indication of a secondary minimum about s·094 deep. If the eclipse is supposed to be central the radius of the larger star is about ·24 and of the smaller about ·13 of the distance between their centres. Mean values for 930 plates divided into 29 groups are given in Table 45.

TABLE 44.

star *x*

brightness s·6 J.D.— 2420000	kind of branch	epoch E	O—C
d			d
2084·305	+ 1	0	—·021
3830·534	+ 1	527	— 13
80·251	+ 1	542	+ 1
·476	— 1	542	+ 11
3900·351	— 1	548	+ 5
10·285	— 1	551	— 2
33·285	+ 1	558	+ 19
33·286	+ 1	558	+ 20
4238·320	— 1	650	— 5
61·317	+ 1	657	+ 13
91·340	— 1	666	— 1
4559·516	+ 1	747	— 4
5351·437	+ 1	986	— 13
61·386	+ 1	989	— 5
81·276	+ 1	995	+ 4
5686·334	— 1	1087	+ 4
6120·389	— 1	1218	— 12
			m.e. ± ·012

TABLE 45.

star *x*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
10	·0130	·210	50	·3096	·078
10	·0202	·186	50	·3513	·083
10	·0260	·385	50	·4032	·090
10	·0336	·643	50	·4579	·081
10	·0417	·815	30	·5128	·127
10	·0524	1·029	40	·5668	·172
10	·0627	1·024	40	·6137	·124
10	·0699	1·118	50	·6601	·072
10	·0778	·973	50	·7121	·070
10	·0859	·944	50	·7606	·083
10	·0972	·579	50	·8326	·082
10	·1133	·173	50	·8852	·051
50	·1542	·089	50	·9397	·070
50	·1999	·081	50	·9843	·070
50	·2574	·087			

FIGURE 20.

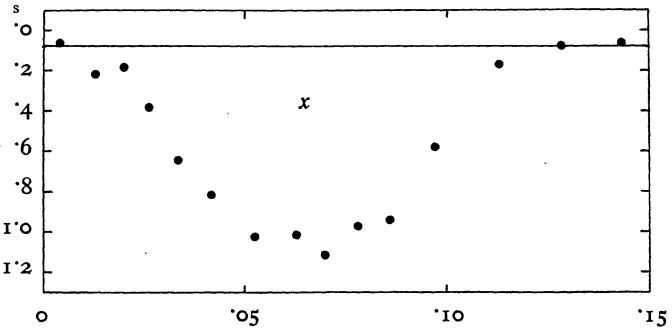


TABLE 46.

star *y*

J.D.— 2420000	epoch E	O—C	J.D.— 2420000	epoch E	O—C
d		d	d		d
1722·268	0	—·016	4169·503	1210	+ ·002
3526·320	892	— 28	71·512	1211	— 11
3813·536	1034	— 6	77·584	1214	— 6
17·569	1036	— 18	4238·297	1244	+ 32
74·262	1064	+ 45	5320·313	1779	+ 14
76·235	1065	— 4	5686·353	1960	— 17
78·252	1066	— 10	5759·192	1996	+ 12
80·273	1067	— 11	61·196	1997	— 6
84·357	1069	+ 28	73·333	2003	— 4
86·343	1070	— 9	75·341	2004	— 19
3955·143	1104	+ 27	6855·366	2538	— 5
59·170	1106	+ 9			
					m.e. ± ·019

y. Comparison stars: a $^{s}\cdot00$, b $^{s}\cdot61$, c $1^{s}\cdot06$. The 23 epochs of minimum used for the determination of the period of this Algol star are collected in Table 46 and mean values for 690 plates divided into 20 groups are given in Table 47. The phase of the minimum is found to be $^{P}\cdot5604$. There is no sign of a secondary minimum and it is not excluded that the period has to be doubled.

TABLE 47.

star *y*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
80	·0445	·126	10	·5499	·779
80	·1668	·088	10	·5605	·937
80	·2777	·130	10	·5719	·772
80	·4084	·134	10	·5892	·631
10	·4869	·173	10	·6036	·433
10	·4985	·236	10	·6161	·203
10	·5090	·263	10	·6342	·122
10	·5192	·512	80	·7185	·113
10	·5306	·562	80	·8149	·100
10	·5406	·656	80	·9215	·103

FIGURE 21.

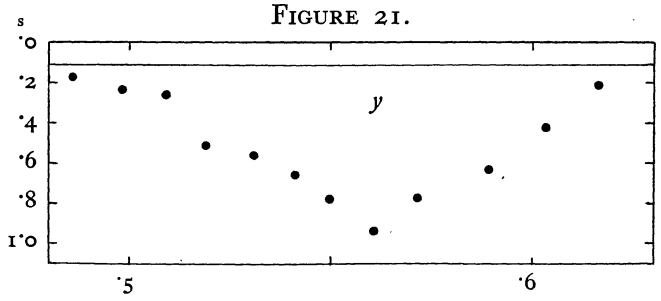
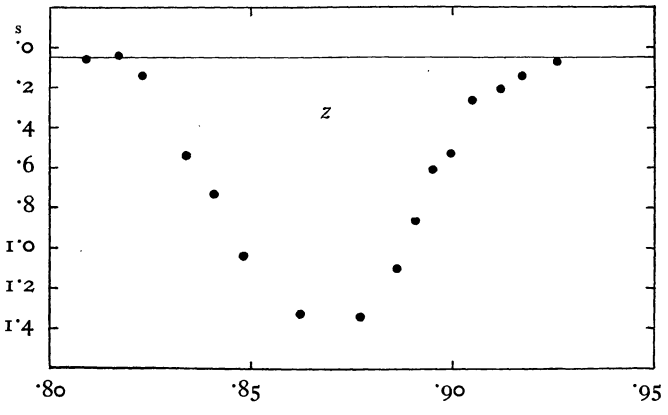


FIGURE 22.



z. Comparison stars: a $^{s}\cdot00$, b $^{s}\cdot38$, c $1^{s}\cdot03$. The period of this Algol star was determined by the aid of 60 observations made at 24 epochs on the descending or ascending branch of the light curve. These have all been reduced to the epochs of minimum, which are listed in Table 48. Mean values of phase and brightness for 170 plates taken at or near minimum and divided into 16 groups are given in Table 49. The minimum appears to be constant for about 1/40 of the period.

TABLE 48.

star *z*

number of plates	min. at J.D.— 2420000	epoch E	O—C
	d		d
2	3831·720	0	+ ·019
1	40·583	1	— 11
6	76·153	5	— 13
4	85·123	6	+ 64
4	3929·517	11	— 7
1	38·385	12	— 32
2	73·976	16	— 13
5	4169·640	38	+ 5
5	4205·223	42	+ 16
3	58·542	48	— 23
5	94·128	52	— 9
1	5379·080	174	— 4
2	5761·444	217	— 39
5	6126·076	258	— 21
1	6472·898	297	— 26
1	6882·006	343	+ 4
1	6926·475	348	+ 8
1	7593·474	423	+ 31
2	8287·093	501	— 4
2	8669·490	544	— 6
1	87·286	546	+ 4
2	8713·983	549	+ 22
2	9043·022	586	+ 19
1	96·360	592	— 1

m.e. of unit weight ± ·032

TABLE 49.

star *z*

number of plates	mean phase	mean brightness	number of plates	mean phase	mean brightness
	P	s		P	s
12	·809	·07	9	·886	1·10
11	·817	·05	11	·891	·86
13	·823	·14	13	·895	·61
8	·834	·54	12	·900	·53
8	·841	·73	10	·905	·27
9	·848	1·04	11	·912	·20
10	·862	1·33	10	·917	·14
11	·877	1·34	12	·926	·07

brightness at maximum ·053