Provisional ephemerides of 25 new variable stars in or near the constellation Crux

Bruna, P.P.

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COMMUNICATIONS FROM THE OBSERVATORY AT LEIDEN.

Provisional ephemerides of 25 new variable stars in or near the constellation Crux,

by *P. P. Bruna*.

Of the 25 new variable stars published in the present paper, 15 are to be found in the constellation Crux, 8 in Centaurus, 2 in Musca. They were discovered by comparing 7 pairs of plates in the blink microscope. The estimates were made on the same plates as used by P. TH. OOSTERHOFF (*B. A. N.* 148) and in the course of the work supplemented by new ones, taken by H. VAN GENT at Johannesburg. The ordinary centre of the plates is $11^h 51^m$, $-61°30'$ (1875), The normal exposuretime is 30 min.

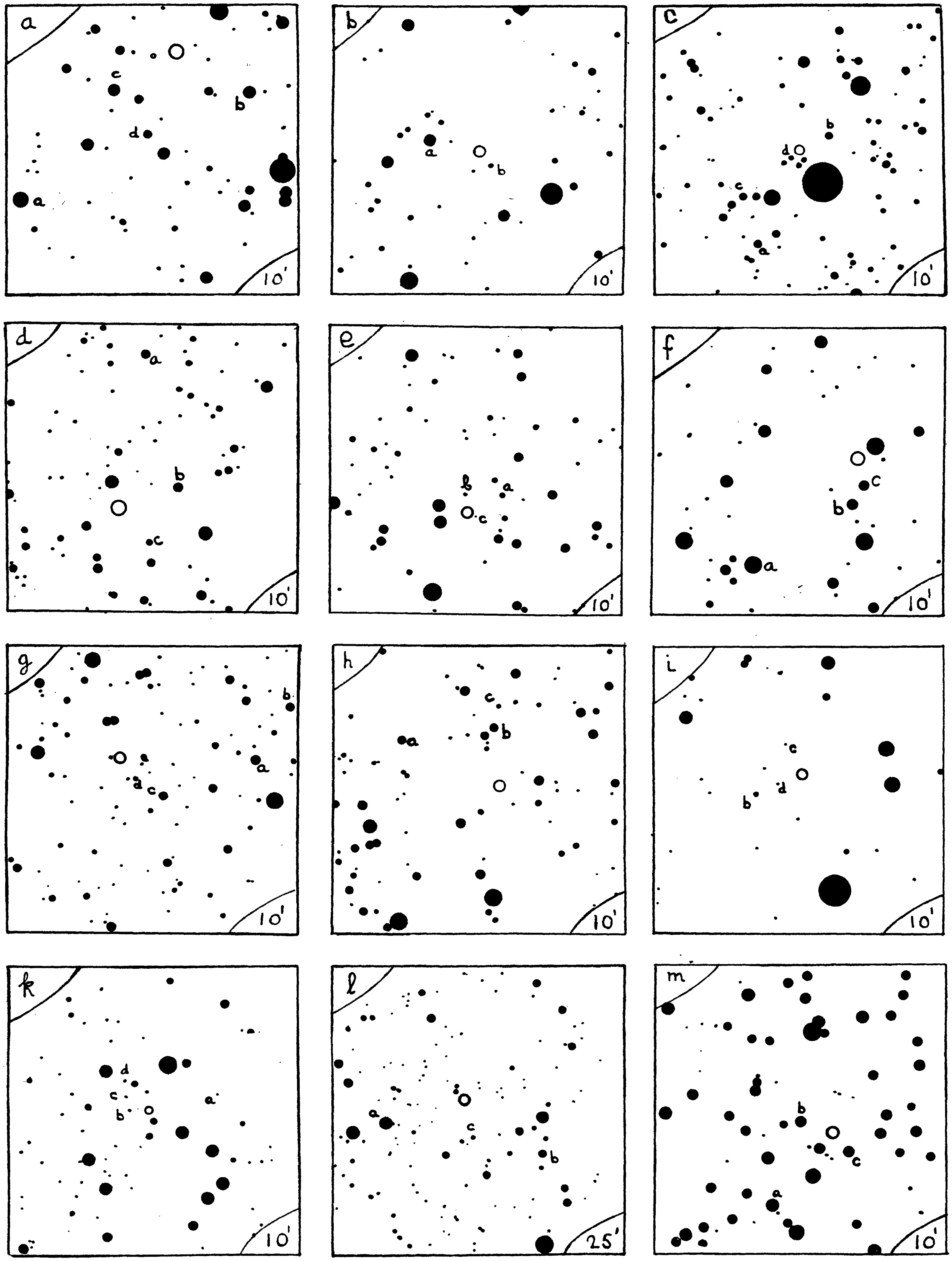
The variable stars are listed in Table 1 together with observational data for each object. Of these 25 variables only *x* occurs in the *C. P. D.* viz: $-62°2817$ ($9^m{\cdot}5$) = *H. D.* 109176 ($10^m{\cdot}2$; Ko).

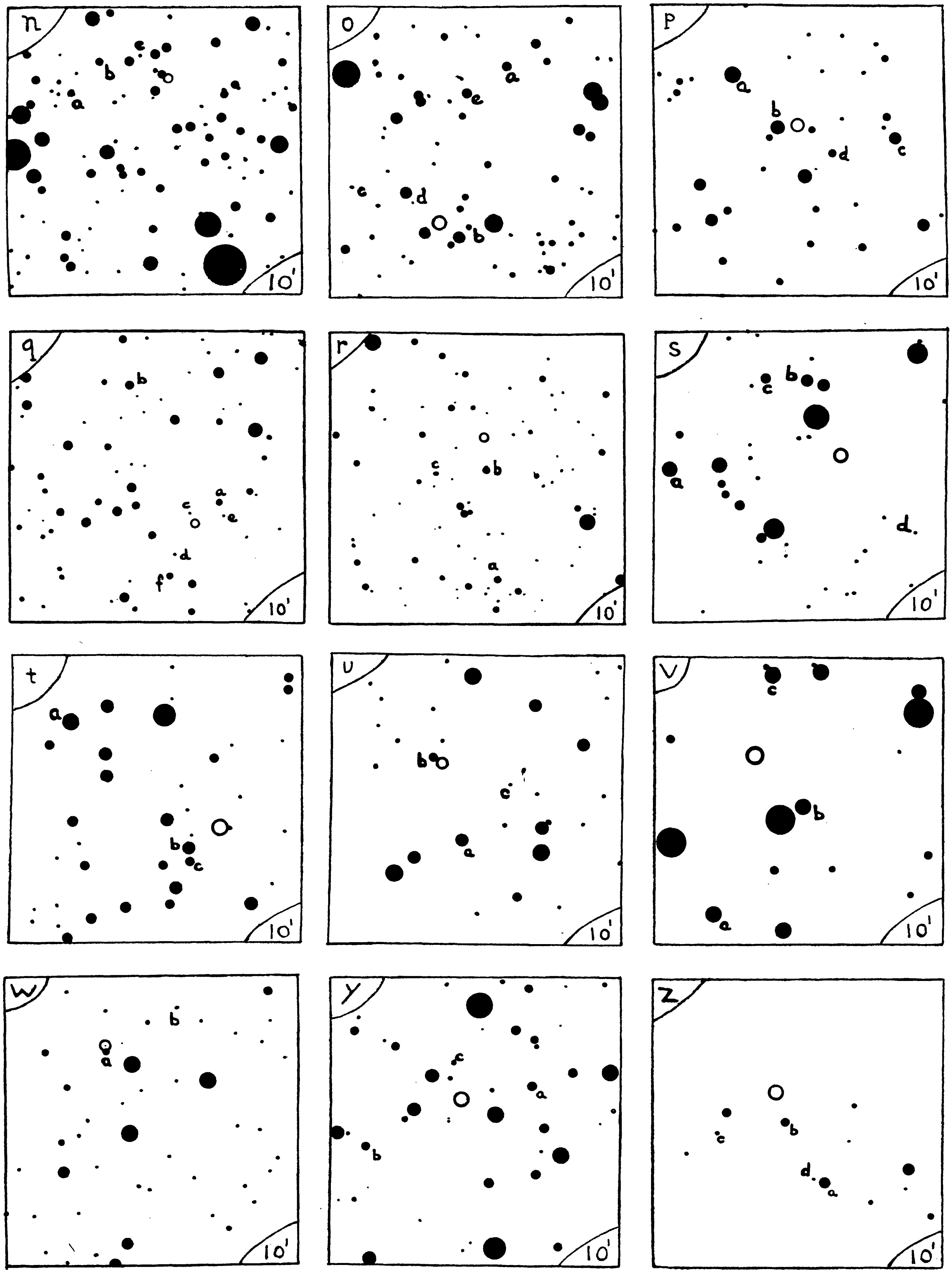
TABLE 1.

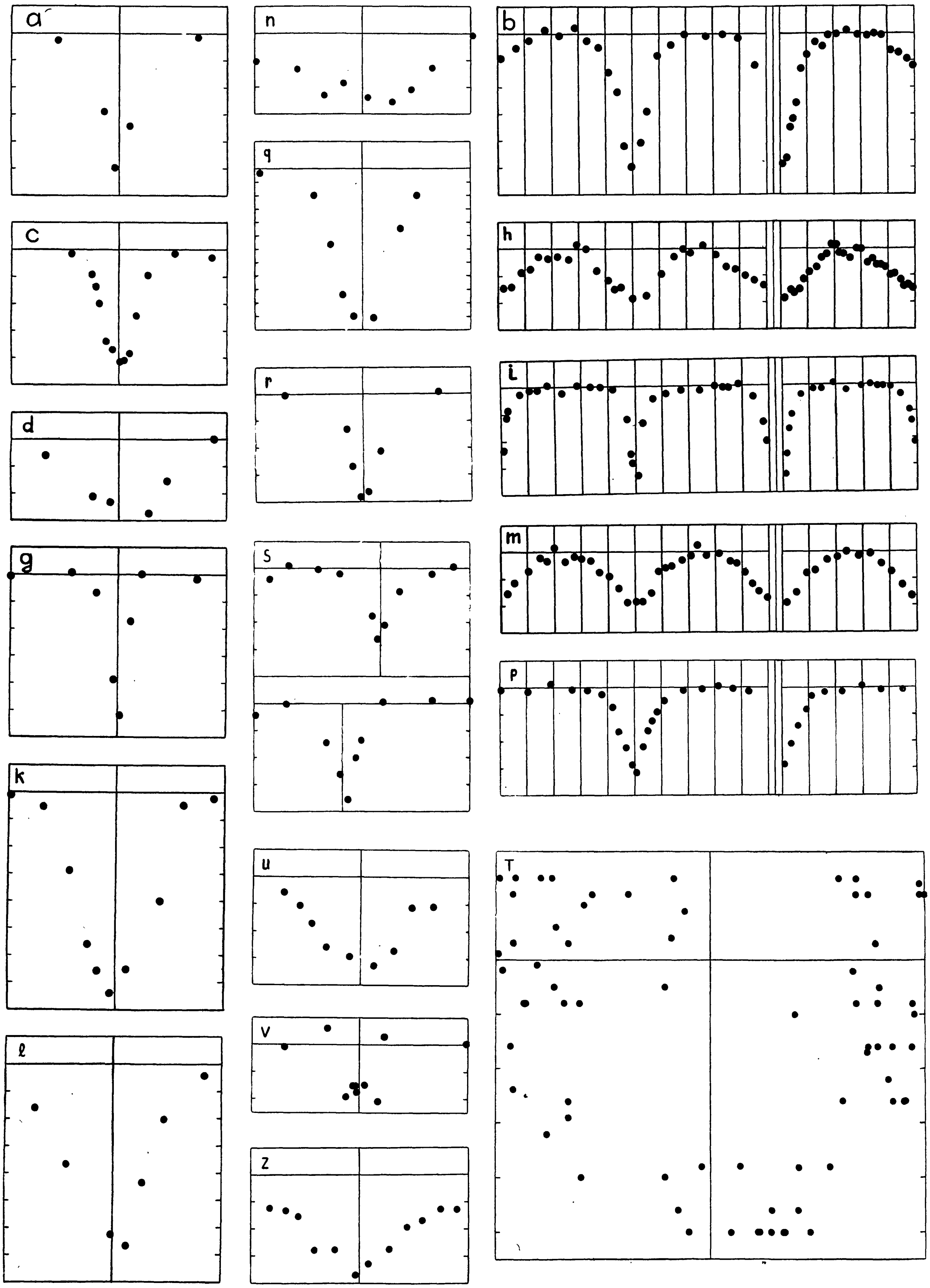
	α (1875)	δ (1875)	number of plates	period	m. e.	reciprocal period	phase of epoch	epoch 2420000+	fraction of period occupied by min.	max.	min.	range	m. e. of single estimate	max.	min.
	h m s	° ′		d	d	d^{-1}	P	d	P	s	s	s	s	m	m
a	11 22 30	−59 28·8	334	19·138	± ·003	·052253	·29	4464·62	·11	3·0	8·0	5·0		11·4	12·1
b	11 27 34	59 8·2	337	1·132963	± ·000015	·882641	·580	4776·098		1·8	6·8	5·0	± ·92	12·0	12·4
c	11 31 48	60 46·4	383	9·0904	± ·0004	·110006	·539	4950·085	·09	1·7	5·9	4·2		12·6	13·8
d	11 32 17	62 24·4	329	20·461	± .004	·048873	·70	4679·48	·18	2·1	4·5	2·4		12·0	12·5
e	11 35 25	61 34·2	305	5·89192		·169724	·104*	4773·067		2·0	5·0	3·0	± ·52	13·4	13·8
f	11 36 48	58 18·0	334	12·1822	± ·0010	·082087	·406*	4780·367		−1·1	12·2	13·3	± 1·01	11·3	12·3
g	11 40 0	62 3·2	324	5·29654		·188802	·971	4708·483	·045	3·5	8·7	5·2		12·3	13·6
h	11 43 12	61 22·3	324	·773320	± ·000006	1·293125	·552	4775·681		0·2	2·0	1·8	± ·57	13·0	13·4
i	11 54 5	65 19·0	307	3·705654	± ·00006	·2698579	·081	4776·888	·11	1·8	5·1	3·3		13·5	14·1
k	11 54 51	63 2·5	303	1·615336	± ·000008	·619066	·459	4691·679	·14	−0·7	6·7	7·4		13·5	14·4
l	11 55 1	65 11·0	329	3·11175	± ·00005	·321362	·527	4775·073	·18	7·3	14·0	6·7		11·0	11·7
m	11 56 53	62 14·5	312	·3881358	± ·000002	2·576418	·378	4776·1574		1·8	3·8	2·0	± ·45	12·4	12·9
n	11 57 20	60 18·1	348	61·50		·01626	·504	5381·56	·20	1·5	4·0	2·5		13·6	14·1
o	12 0 10	61 54·5	302	4·9898	± ·0003	·20041	·770*	4774·063		2·7	7·2	4·5	± ·68	12·5	13·2
p	12 3 18	60 7·3	315	1·045570	± ·000004	·956416	·232	4791·045	·15	2·3	5·4	3·1		11·8	12·4
q	12 5 45	62 30·3	303	3·55272	± ·00005	·281474	·698	4834·187	·11	1·4	12·5	11·1		13·4	14·3
r	12 5 58	61 57·3	309	16·120		·062035	·845	4478·843	·06	1·8	5·5	3·7		13·0	14·0
s	12 7 25	63 59·3	374	6·35447	± ·00014	·157370	·849	4949·157	·07	3·5	7·0	3·5		12·3	13·1
t	12 11 20	62 0·4	328	4·0987		·24398	·36	4776·46		6·7	11·4	4·7		11·7	12·1
u	12 14 38	63 40·2	313	1·40443	± ·00002	·71203	·317	4917·373	·15	2·7	6·0	3·3		12·7	13·5
v	12 14 40	57 8·3	375	56·252		·017777	·882	4943·58	·05	1·2	2·9	1·7		11·1	11·6
w	12 16 36	63 46·7	245	6·1217		·163353	·662*	4778·988		−1·0	6·7	7·7	± 1·25	13·0	13·6
x	12 26 12	62 48·9	333	5·26485		·189939	·332*	4776·965		0·4	7·7	7·3	± 1·00	10·3	11·3
y	12 27 20	60 32·6	324	12·2144	± ·0017	·081870	·723*	4772·481		2·4	13·0	10·6	± 1·16	12·2	13·7
z	12 30 53	63 12·1	305	·562905	± ·000002	1·776498	·380	4775·902	·23	2·5	6·2	3·7		12·9	14·0

The total number of estimates is 8095. The phases have been computed with J. D. 2420000 as zeropoint and with the reciprocal period given in Table 1. For the Algol stars the epoch of the phase of the principal minimum has been given, for the δ Cep. stars the character of the epoch given in Table 1 is explained in the remarks. The normal epoch has been chosen near to the mean date of all the observations, or of the observations in the minimum.

The steps used are very different from star to star. In each case the magnitudes of the comparison stars were determined by comparison with the Harvard



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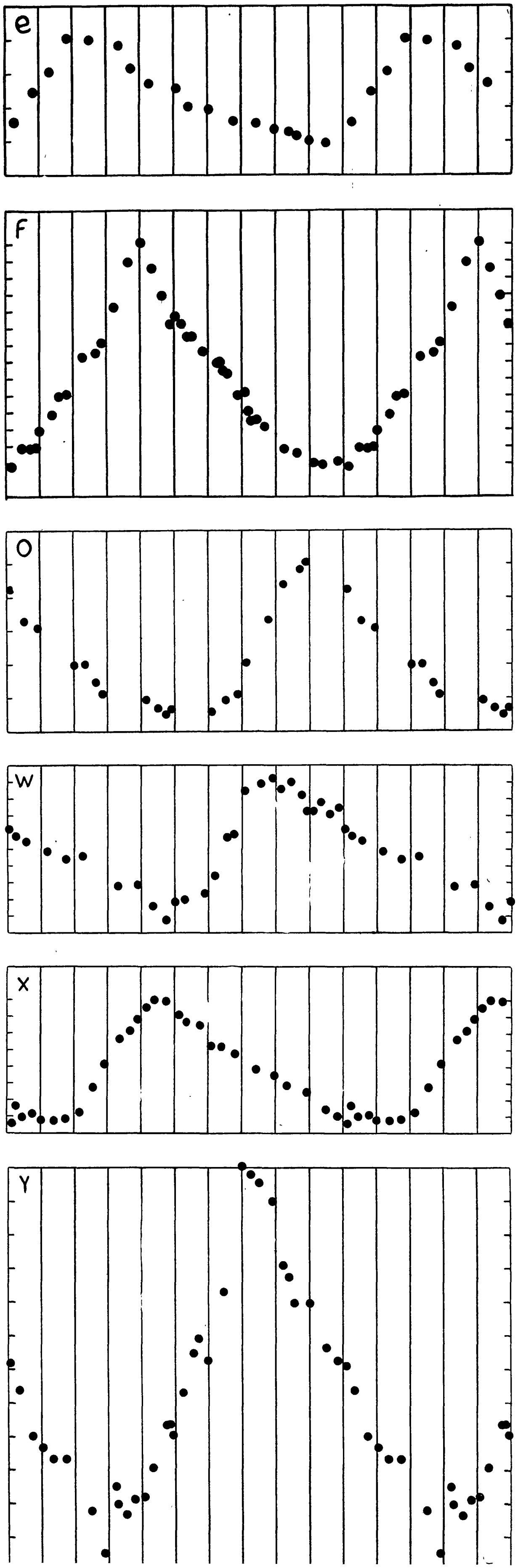

sequence of the Selected Area 193, which is in the field of the plates used. The results have been given in Table 3. The corresponding magnitudes of the variables at maximum and minimum have been given in Table 1.

In Table 2 the types of the variables have been indicated with the J. D.'s of the plates by the comparison of which the variability was discovered. Of the 25 variables 19 are eclipsing systems, 6 are δ Cep stars. Of the eclipsing variables 2 are of the W UMa type, one of them shows a notable excentricity of the orbit.

Table 4 gives for each of 21 variables the epochs used for computing the period, together with the counting of epochs and the residuals $O-C$. For the eclipsing variables epochs of minimum were used, or a fixed brightness on the descending or the ascending branch of the lightcurve. For two of the δ Cep stars with sharp maximum (f and y) epochs of maximum were used. The periods of the four other δ Cep stars have been determined in the following way. Using a provisional period, the observations on the ascending branch of the lightcurve were plotted separately for the years 1924, 1925 and 1928. The shifting of the phase of a fixed brightness on the ascending branch gave a correction to the provisional period.

The estimates of each variable have been arranged according to phase and divided into groups, the means of which are given in Table 5. For the eclipsing variables only those mean values are shown on the diagrams which are marked with an asterisk in Table 5. In addition new phases have been computed for 5 eclipsing variables, taking the principal minimum as zeropoint and disregarding the sign of the phase.

On all the diagrams of the lightcurves vertical lines have been drawn for each tenth of the period. For eclipsing variables the principal minimum has for convenience been placed in the middle of the diagram. The brightness is indicated in steps, counted from the maximum light.

The size of the diagrams of the surroundings of each of 23 variables is $10' \times 10'$. For the variable l the size is $25' \times 25'$. On each of these diagrams the variable and the comparison stars used have been indicated. For the variable x no diagram of the surroundings has been given, since the variable and the 2 comparison stars occur in the *C. P. D.* The *C. P. D.* numbers of these stars are given below.

The following remarks relate to the individual objects.

a. The comparison star *a* is *C. P. D.* — 59°3509 ($10^m \cdot 0$).

e. At two phases differing by ·35 the brightness is the same on the ascending and the descending

TABLE 2.

	type	variable found bright	variable found faint	Δ *d*	Δ *s*		type	variable found bright	variable found faint	Δ *d*	Δ *s*
		d	d	d	s			d	d	d	s
a	Algol	2423963·273	2423967·282	4	2·1	*o*	δ Cep	2425393·286	2425386·415	7	4·7
b	β Lyr	5383·434	5391·266	8	1·6	*p*	Algol	5386·415	5393·286	7	3·1
c	Algol	5393·286	5386·415	7	4·5	*q*	Algol	5386·270	5381·290	5	10·4
d	Algol	3967·282	3963·273	4	2·0	*r*	Algol	5386·270	5381·313	5	2·0
e	δ Cep	3967·282	3963·273	4	2·7	*s*	Algol	5714·329	5702·365	12	3·4
f	δ Cep	5391·266	5383·434	8	8·6	*t*	Algol	5383·434	5391·266	8	2·8
g	Algol	5393·286	5386·415	7	4·0	*u*	Algol	5393·286	5386·415	7	2·0
h	WUMa	3967·282	3963·273	4	1·9	*v*	Algol	5386·415	5393·286	7	1·8
i	Algol	5393·286	5386·415	7	2·2	*w*	δ Cep	5391·266	5383·434	8	5·5
k	Algol	—	4294·316	—	—	*x*	δ Cep	5383·434	5391·266	8	5·6
l	Algol	5383·434	5391·266	8	4·2	*y*	δ Cep	5383·434	5391·266	8	8·2
m	WUMa	3963·273	3967·282	4	1·7	*z*	Algol	4287·414	4282·249	5	2·1
n	Algol	3963·273	3967·282	4	2·3						

TABLE 3. Comparison stars.

var.	star	s	m
a	a	·0	10·9
	b	3·1	11·4
	c	6·0	11·8
	d	8·3	12·1
b	a	·0	11·8
	b	7·6	12·5
c	a	·0	12·2
	b	2·0	12·7
	c	5·1	13·5
	d	6·7	13·9
d	a	·0	11·5
	b	4·4	12·4
	c	6·7	12·9
e	a	0·	13·2
	b	3·2	13·6
	c	6·4	14·0
f	a	·0	11·4
	b	6·7	11·9
	c	12·4	12·3
g	a	·0	11·5
	b	2·8	12·2
	c	5·5	12·8
	d	8·2	13·5
	e	9·7	13·9
h	a	—2·8	12·4
	b	·0	13·0
	c	3·7	13·7
i	b	·0	13·2
	c	3·6	13·8
	d	6·6	14·3
k	a	·0	13·6
	b	2·0	13·9
	c	5·0	14·2
l	a	·0	10·1
	b	7·6	11·0
	c	15·2	11·9
m	a	·0	12·0
	b	1·3	12·3
	c	4·4	13·0
n	a	·0	13·2
	b	1·9	13·7
	c	3·9	14·1
o	e	·0	12·0
	a	3·0	12·5
	b	5·6	13·0
	c	7·7	13·3
	d	10·7	13·8
p	a	·0	11·4
	b	3·1	12·0
	c	5·9	12·5
	d	7·6	12·8
q	f	·0	13·3
	a	1·5	13·4
	b	4·5	13·7
	c	6·6	13·9
	d	8·6	14·0
	e	10·9	14·2
r	a	·0	12·4
	b	2·2	13·0
	c	5·0	13·8
s	a	·0	11·6
	b	2·5	12·1
	c	6·2	12·9
	d	8·7	13·4
t	a	·0	11·2
	b	7·3	11·7
	c	15·2	12·4
u	a	·0	12·0
	b	2·7	12·7
	c	4·9	13·2
	d	6·8	13·7
v	a	·0	10·8
	b	1·9	11·4
	c	3·7	11·8
w	a	·0	13·1
	b	9·1	13·8
x	a	·0	10·3
	b	8·1	11·3
y	a	·0	11·9
	b	7·9	13·0
	c	13·4	13·8
z	a	·0	12·2
	b	3·3	13·2
	c	5·7	13·8
	d	7·3	14·3

branches. The epoch of the first of these two phases has been given in Table 1.

f, The maximum is sharp. The lightcurve resembles that of Z Lacertae, the period of which is 11^d. The epoch of the maximum has been given in Table 1.

g. The minimum of this eclipsing star covers ·045 of the period only.

h. The period of this W UMa star was found from 75 epochs of minimum. The even and odd minima show a slight difference in depth.

m. The even and odd minima show a slight difference in depth.

n. The apparent period of this star is $61^d·50$. A much shorter period of, say, one day does not seem to be excluded, taking into account that the star has not been observed near minimum for more than $^d·064$ in one night, further the faintness of the object and the small range of the light-variation. If the period is really long, the duration of the minimum of about ·2 of the period indicates a very low density.

o. The period is 5·003 sideral days. At the phases between ·1 and ·2, ·3 and ·4, ·5 and ·6, ·9 and ·0 no observations occur; between ·7 and ·8 (the ascending branch) only 9. At two phases, differing by ·3, the brightness is the same on the ascending and the descending branches. The epoch of the first of these two phases has been given in Table 1.

p. The period has probably to be doubled, judging from the form of the lightcurve. The period has been computed both from epochs of minimum and from points on the ascending branch only.

s. This system has a notable excentricity. The phase of the primary minimum is ·849; that of the secondary min. is ·385 the difference being ·5 ± ·036. Between the two minima is a difference in depth of $^m·2$.

In 1930 new plates were taken during minimum, so that a good period could be derived separately for even and odd minima, which two values agreed within the m. e.

t. This Algol star of four days period presented some difficulties. The nights in which more than one observation near minimum was made, and two nights in which only one plate is taken, on which the star is in minimum, gave an apparently satisfactory period. But on a few nights the star was estimated faint between two bright estimates. And in the minimum some estimates of maximum brightness occur. The explanation of this lies probably in the fact that the star is one component of a double star, so that the two components are never completely separated on the plate. The individual estimates near minimum have been given on the diagram.

u. The period has been obtained both from the epochs of minimum and from points on the descending branch.

v. An eclipsing variable of long period: 56 days, and small range: ^{m}·5. The duration of the minimum is 3 days. Of this star 10 plates in one night are taken near minimum, covering ·2 days, so that a shorter period seems to be excluded. The descending and ascending branches of the lightcurve are probably steep. The comparison star *a* is *C. P. D.* — 57°5417 (9^{m}·9).

w. At two phases differing by ·4 the brightness is the same on the ascending and the descending branches. The epoch of the first of these two phases has been given in Table 1.

x. This δ Cep. star is *C. P. D.* — 62°2817 (9^{m}·5) = H. D. 109176 (10^{m}·2; Ko). The comparison stars are: *a* = *C. P. D.* — 62°2813 (9^{m}·4) and *b* = — 62°2820 (10^{m}·0). At two phases, differing by ·3, the brightness is the same on the ascending and the descending branches. The epoch of the first of these two phases has been given in Table 1.

In the course of the work this star was found to be previously marked on one of the plates.

y. The period of this δ Cep star is nearly the same as that of the star *f*. The lightcurves are very similar, but the range of this variable is larger. The epoch of maximum has been given in Table 1.

z. The duration of the minimum is ·23 of the adopted period, but the period has probably to be doubled. The period has been obtained both from epochs of minimum and from points on the ascending branch.

I want to thank Prof. E. HERTZSPRUNG for his help and advice in preparing this paper.

TABLE 4.

d	ε	d
	a	
2423967·3	0	+ ·2
86·2	1	0
4292·3	17	— 2
4560·5	31	+ 1
5383·4	74	0
	b	
2423791·539	0	+ ·015
99·528	7	+ 43
3943·337	134	— 34
68·265	156	— 31
76·254	163	+ 27
4258·351	412	+ 16
59·445	413	— 23
91·204	441	+ 13
·227	441	+ 36
92·295	442	— 29
·319	442	— 5
4566·504	684	+ 3
5332·360	1360	— 24
·384	1360	0
·407	1360	+ 23
	c	
2424259·075	0	+ ·027
86·292	3	— 27
5386·277	124	+ 12
6013·504	193	— 3
95·313	202	— 8
	d	
2423942·8	0	— ·2
63·8	1	+ 3

d	ε	d
2424290·8	17	0
5354·7	69	+ 1
5415·9	72	0
	f	
2420991·27	0	— ·43
3940·34	242	+ 54
64·28	244	+ 12
76·25	245	— 9
88·22	246	— 30
·24	246	— 28
89·22	246	+ 70
4000·21	247	— 50
4281·23	270	+ 33
93·20	271	+ 12
·22	271	+ 14
·29	271	+ 21
·39	271	+ 31
·41	271	+ 33
4560·52	293	— 57
5206·53	346	— 22
5816·21	396	+ 35
6010·42	412	— 35
·45	412	— 32
·56	412	— 21
	g	
2423887·5	0	— ·25
3972·3	16	+ 27
4258·3	70	0
5386·5	283	— 10
5418·3	289	+ 9
	h	
2423883·52	0	+ ·07

d	ε	d
2423886·24	7	+ 8
3940·34	147	+ 5
45·34	160	+ 2
59·28	196	+ 4
64·28	209	+ 1
67·28	217	— 8
71·25	227	+ 2
74·26	235	— 6
76·25	240	0
90·21	276	+ 4
98·21	297	— 8
4259·26	972	— 3
·28	972	— 1
·31	972	+ 2
60·40	975	— 5
62·29	980	— 9
·32	980	— 6
63·47	983	— 7
64·37	985	+ 5
86·27	1042	— 9
·39	1042	+ 3
·42	1042	+ 6
89·40	1050	— 5
90·22	1052	0
91·35	1055	— 3
·40	1055	+ 2
·42	1055	+ 4
92·20	1057	+ 4
·22	1057	+ 6
93·29	1060	— 3
·39	1060	+ 7
94·39	1063	— 9
·41	1063	— 7
96·39	1068	— 2
97.21	1070	+ 3
·23	1070	+ 5
98·37	1073	+ 3

d	ε	d
2423898·40	1073	+ 6
4586·51	1818	+ 10
·54	1818	+ 13
5329·49	3740	— 8
·52	3740	— 5
5330·32	3742	— 2
·39	3742	+ 5
31·43	3745	— 7
·55	3745	+ 5
50·40	3794	— 5
54·31	3804	— 1
·57	3805	— 13
57·35	3812	— 6
·37	3812	— 4
62·32	3825	— 12
·48	3825	+ 4
81·31	3874	— 7
85·23	3884	— 2
86·37	3887	— 4
·44	3887	+ 3
88·35	3892	+ 1
93·35	3905	— 2
·38	3905	+ 1
5415·34	3962	— 7
·36	3962	— 5
17·39	3967	+ 5
41·30	4029	— 1
53·25	4060	— 5
5702·41	4704	+ 10
14·26	4735	— 4
·33	4735	+ 3
5807·21	4975	+ 11
·26	4975	+ 16
32·21	5040	— 2
36·23	5050	+ 13
6007·42	5493	+ 3
10·45	5501	— 3

TABLE 4 (*continued*).

d	ε		d
	i		
2423550·272	0	+	·020
3991·212	119	—	28
·236	119	—	4
4291·399	200	—	9
·421	200	+	13
5351·271	486	+	11
·295	486	+	35
62·302	489	—	76
·325	489	—	53
88·354	496	+	36
·376	496	+	58
5414·211	503	—	48
·296	503	+	37
	k		
2423945·387	0	—	·011
4260·392	195	+	4
86·237	211	+	3
89·460	213	—	4
94·323	216	+	13
5331·352	858	—	4
·348	858	—	8
86·287	892	+	10
5420·198	913	—	1
	l		
2423788·56	0	—	·08
3944·33	50	+	10
72·26	59	+	2
97·22	67	+	9
4000·21	68	—	3
4286·42	160	—	11
5391·27	515	+	5
5702·36	615	—	5
·39	615	—	2
·41	615		0
·43	615	+	2
5836·20	658	—	1
·23	658	+	2
6007·40	713	+	4
·42	713	+	6
10·42	714	—	6
·45	714	—	3
	m		
2423887·483	0	—	·035
3916·417	149	—	17
67·282	411	+	2
74·257	447	—	9
75·257	452	+	20
88·243	519	+	4
4259·330	1916	—	22
60·350	1921	+	28
61·288	1926	—	5
62·268	1931	+	5
89·237	2070	—	1
·425	2071	—	8
90·220	2075	+	11
91·388	2081	+	15
97·208	2111	+	13
·392	2112	+	3
98·372	2117	+	12
5331·379	7440	—	4

d	ε		d
2425350·399	7538	—	3
53·321	7553	+	8
54·290	7558	+	7
56·383	7569	—	35
91·359	7749	+	9
93·286	7759	—	5
5452·294	8063	+	7
53·253	8068	—	5
5714·282	9413	+	3
	n		
2423970·7	0	+	·1
5384·4	23	—	7
6123·7	35	+	6
	p		
2423883·521	0	+	·028
3992·209	104	—	23
·232	104		0
4290·220	389	+	2
92·295	391	—	15
·319	391	+	9
94·385	393	—	16
·408	393	+	7
5329·517	1383	+	5
30·558	1384	+	1
50·399	1403	—	24
·422	1403	—	1
51·468	1404	—	1
93·263	1444	—	28
·286	1444	—	5
·308	1444	+	17
5414·211	1464	+	8
17·368	1467	+	29
2423990·233	0	+	·042
91·230	1	—	7
4289·218	286	—	7
90·234	287	—	37
91·302	288	—	14
·304	288	—	12
92·371	289	+	9
·370	289	+	8
93·395	290	—	12
·406	290	—	1
94·468	291	+	15
5329·587	1281	+	16
30·629	1282	+	13
48·401	1299	+	10
51·526	1302	—	2
·526	1302	—	2
54·670	1305	+	5
93·346	1342	—	5
·346	1342	—	5
5414·275	1362	+	13
17·401	1365	+	2
5714·317	1649	—	25
	q		
2423942·316	0	—	·016
4560·532	174	+	27
5331·454	391	+	8
·427	391	—	19
·458	391	+	12
·437	391	—	9
5420·283	416	+	19

d	ε		d
2425420·254	416	—	10
52·222	425	—	16
	r		
2423963·27	0	+	·21
95·22	2	—	8
4285·32	20	—	10
4559·48	37	+	6
5381·35	88	—	10
	s		
2424285·318	0	+	·007
5702·284	223	—	44
6007·400	271	+	64
6096·291	285	—	6
·278	285	—	19
2424288·240	0		·000
·251	0	+	11
5330·334	164	—	49
62·168	169	+	12
6010·320	271	+	2
29·405	274	+	24
	t		
2423940·3	0		·0
77·2	9		0
89·2	12	—	3
4260·2	78	+	2
5350·4	344	+	1
54·4	345		0
91·4	354	+	2
	u		
2423799·529	0	+	·081
3941·341	101	+	46
86·226	133	—	10
4000·210	143	—	71
4285·315	346	—	64
·338	346	—	41
88·200	348	+	12
·223	348	+	35
92·389	351	—	12
5330·297	1090	+	27
·325	1090	+	55
5351·295	1105	—	42
86·415	1130	—	32
·438	1130	—	9
93·443	1135	—	26
5417·368	1152	+	24
·390	1152	+	46
5702·431	1355	—	12
2424288·103	0	—	·018
92·349	3	+	15
5330·262	742	+	30
51·299	757		0
86·402	782	—	9
93·424	787	—	9
5702·408	1007	—	7
	v		
2423930·3	0	—	·4
87·8	1	+	8

d	ε		d
2425393·4	26	—	3
6013·4	37	+	8
6124·3	39	—	8
	y		
2423991·21	0	+	·46
4259·21	22	—	26
·24	22	—	23
·26	22	—	21
·31	22	—	16
·33	22	—	14
·35	22	—	12
·37	22	—	10
·42	22	—	5
·44	22	—	3
96·21	25	+	10
·23	25	+	12
·35	25	+	24
·37	25	+	26
·39	25	+	28
4918·49	76	—	56
5383·46	114	+	26
5835·23	151	+	10
	z		
2423788·564	0		·000
3884·273	170	+	15
3991·212	360	+	2
4000·210	376	—	6
4287·297	886	—	1
88·412	888	—	12
4566·504	1382	+	5
5330·393	2739	+	31
31·476	2741	—	12
·499	2741	+	11
54·544	2782	—	23
57·371	2787	—	11
88·354	2842	+	10
93·398	2851	—	10
5415·362	2890	+	1
5702·431	3400	—	12
14·259	3421	—	5
·282	3421	+	18
2423987·238	0	—	·007
91·188	7	+	3
4260·250	485	—	4
82·208	524	+	1
86·155	531	+	8
87·272	533	—	1
88·396	535	—	3
91·223	540	+	10
96·281	549	+	1
5331·467	2388	+	6
54·516	2429	—	24
57·353	2434	—	2
61·293	2441	—	2
88·316	2489	+	2
93·377	2498	—	4
5414·217	2535	+	9
15·333	2537	—	1
5702·430	3047	+	15
14·234	3068	—	2

TABLE 5.

n	phase	brightness
	P	s
	a	
20	·039	3·12
20	·104	3·14
20	·172	3·32
20	·233	3·26*
2	·276	5·90*
6	·286	7·98*
5	·300	6·44*
20	·363	3·14*
20	·431	2·98
20	·480	2·98
20	·536	3·10
20	·570	2·82
20	·597	2·68
20	·627	2·81
20	·706	3·00
20	·784	3·18
20	·836	2·92
20	·918	3·16
21	·975	3·05
	*b**	
20	·037	2·99
20	·092	2·72
20	·150	2·34
20	·198	2·06
20	·256	1·66
20	·309	1·86
20	·368	1·58
20	·411	2·26
16	·455	2·37
5	·492	3·24
5	·523	3·98
5	·548	6·00
10	·575	6·77
10	·610	5·87
10	·633	4·71
16	·674	2·62
20	·725	2·22
20	·775	1·82
20	·854	1·90
20	·918	1·83
20	·974	1·97
7	·008	6·67
11	·024	6·45
8	·037	5·31
7	·048	4·99
6	·060	4·40
9	·080	3·12
19	·101	2·60
18	·132	2·13
22	·159	2·28
22	·180	1·86
24	·210	1·83
24	·247	1·69
23	·289	1·85
23	·324	1·87
17	·350	1·81
22	·377	1·87
23	·413	2·43
24	·442	2·51
18	·473	2·74
10	·495	2·99
	c	
22	·022	1·81
22	·076	1·72
22	·160	1·65
22	·258	1·62
22	·296	1·80
22	·362	1·78
21	·428	1·45
20	·495	1·86*
5	·514	2·62*
3	·518	3·07*
4	·521	3·70*
3	·527	5·10*
4	·533	5·40*
4	·540	5·85*
3	·544	5·80*
4	·549	5·55*
2	·555	4·15*
4	·566	2·65*
21	·591	1·85*
21	·625	2·00*
22	·655	1·86
22	·708	1·57
22	·757	1·70
22	·841	1·59
22	·890	1·75
22	·955	1·59
	d	
20	·036	2·15
20	·114	2·12
20	·184	2·19
20	·241	2·39
20	·300	2·29
20	·402	2·00
20	·473	2·14
20	·521	2·12
20	·566	2·27
20	·598	2·29
12	·632	2·70*
10	·676	4·21*
12	·692	4·42*
11	·728	4·84*
5	·746	3·64*
20	·788	2·11*
20	·835	2·17
20	·885	2·12
19	·964	1·98
	*e**	
17	·027	4·44
17	·083	3·54
17	·132	2·94
17	·184	1·95
17	·250	2·01
17	·338	2·18
17	·374	2·85
17	·428	3·29
17	·508	3·44
17	·544	3·99
17	·605	4·06
17	·677	4·41
17	·744	4·47
17	·799	4·64
17	·841	4·72
17	·864	4·85
17	·900	4·99
16	·950	5·06
	*f**	
10	·015	12·22
9	·046	11·10
9	·071	11·13
9	·089	11·04
9	·100	10·08
9	·137	9·12
9	·157	8·03
9	·180	7·91
9	·228	5·70
9	·267	5·46
9	·285	4·87
9	·322	2·77
9	·364	0·09
9	·403	— 1·11
9	·434	0·44
9	·465	2·07
9	·488	3·76
9	·503	3·28
9	·521	3·73
9	·538	4·50
9	·553	4·51
9	·584	5·39
9	·627	6·07
9	·636	6·01
9	·644	6·52
9	·658	6·70
9	·688	7·98
9	·708	7·80
9	·718	8·93
9	·726	9·51
9	·744	9·41
9	·767	9·84
9	·825	11·16
9	·863	11·41
9	·912	11·99
9	·938	12·09
9	·982	11·92
	g	
18	·044	3·54*
18	·144	3·65
18	·179	3·63
18	·214	3·56
18	·258	3·43
18	·311	3·24
18	·352	3·21
18	·382	3·50
18	·424	3·46
18	·487	3·58
18	·565	3·68
18	·609	3·62
18	·691	3·52
18	·759	3·73
18	·813	3·66
18	·871	3·56
18	·928	3·43*
6	·951	4·17*
5	·967	7·38*
2	·973	8·70*
3	·983	5·23*
2	·993	3·50*
	*h**	
12	·006	1·38
12	·042	1·56
12	·072	1·67
12	·101	1·63
12	.139	1·09
12	·172	0·94
12	·201	0·50
12	·237	0·58
12	·273	0·48
12	·314	0·60
12	·344	0·04
12	·380	0·22
12	·419	1·02
12	·461	1·37
12	·485	1·71
12	·509	1·63
12	·552	2·05
12	·603	1·99
12	·659	1·14
12	·706	0·50
12	·741	0·20
12	·768	0·35
12	·815	0·08
12	·863	0·43
12	·901	0·87
12	·936	0·96
12	·972	1·20
12	·015	2·05
12	·039	1·75
12	·051	1·86
12	·071	1·72
12	·086	1·35
12	·108	1·08
12	·135	0·91
12	·153	0·55
12	·173	0·42
12	·190	0·06
12	·208	0·07
12	·219	0·37
12	·235	0·41
12	·260	0·57
12	·285	0·22
12	·303	0·23
12	·323	0·75
12	·343	0·60
12	·357	0·82
12	·374	0·83
12	·390	0·91
12	·410	1·19
12	·423	1·17
12	·447	1·39
12	·459	1·62
12	·476	1·56
12	·491	1·68
	*i**	
7	·050	3·04
5	·063	4·32
6	·069	4·67
5	·090	5·14
5	·109	3·18
15	·147	2·27
15	·195	2·09
15	·253	1·96
15	·322	1·97
15	·380	1·81
15	·410	1·86
15	·430	1·87
15	·467	1·75
15	·521	2·21

Table 5 (*continued*).

n	phase	bright-ness	*n*	phase	bright-ness	*n*	phase	bright-ness	*n*	phase	bright-ness
	P	s		P	s		P	s		P	s
5	·557	3·18	14	·436	7·55*	31	·198	1·84	43	·299	2·23
4	·571	3·88	5	·466	8·90*	27	·309	1·49	43	·371	2·40
2	·592	4·15	5	·495	10·96*	3	·406	2·53*	43	·452	2·40
4	·603	2·95	5	·524	13·56*	6	·445	2·83*			
3	·608	2·67	5	·538	13·98*	5	·469	3·80*		*q*	
14	·653	2·07	5	·553	11·64*	8	·486	3·35*	21	·024	1·25
14	·689	1·92	6	·573	9·32*	5	·509	3·90*	21	·082	1·74
14	·718	1·92	14	·610	7·73*	5	·532	4·04*	21	·114	1·37
14	·755	1·74	15	·642	7·53	4	·549	3·60*	21	·164	1·83
14	·809	2·04	15	·671	7·81	6	·568	2·78*	21	·269	1·55
14	·866	1·77	15	·706	7·06	31	·608	1·57*	21	·333	1·50
14	·916	1·79	15	·740	7·45	31	·674	1·39	21	·381	1·45
14	·952	1·82	15	·774	7·77	31	·702	1·28	21	·430	1·53
14	·998	1·91	15	·857	7·48	31	·753	1·22	21	·504	1·42
			15	·939	7·05	31	·808	1·52	20	·604	1·76*
7	.009	5·13	15	·976	7·28	31	·895	1·41	5	·653	3·38*
7	·015	4·37					*o**		4	·669	7·00*
7	·024	3·44		*m**					7	·680	10·76*
7	·035	2·91				17	·011	3·45	4	·690	12·40*
23	·070	2·17	10	·027	2·02	17	·054	4·40	4	·709	12·50*
27	·114	1·93	10	·052	2·14	18	·092	4·62	5	·732	5·88*
21	·146	1·95	10	·078	1·64	15	·202	5·71	3	·747	3·40*
22	·191	1·74	10	·119	2·17	16	·234	5·69	20	·811	1·14
27	·238	2·00	10	·154	1·97	16	·266	6·26	21	·879	1·74
29	·296	1·85	10	·181	2·04	16	·285	6·58	21	·932	1·42
20	·329	1·80	10	·214	2·13	17	·415	6·76			
26	·354	1·87	10	·247	2·56	17	·450	6·99		*r*	
21	·376	1·86	10	·283	2·70	17	·473	7·19	20	·068	1·76
21	·402	1·90	10	·318	3·16	17	·488	7·02	20	·135	1·83
23	·440	2·17	10	·349	3·67	17	·610	7·12	20	·173	1·89
6	·473	2·77	10	·381	3·64	18	·650	6·76	20	·221	1·76
6	·479	3·18	10	·406	3·66	18	·686	6·59	20	·271	1·69
6	.490	3·97	10	·439	3·33	4	·713	5·65	22	·328	2·07
			10	·465	2·53	5	·778	4·36	18	·418	1·85
	k		10	·493	2·39	19	·822	3·32	20	·498	1·74
20	·040	— 0·60	10	·515	2·34	19	·870	2·87	20	·552	1·56
20	·138	— 0·78	10	·555	2·11	19	·889	2·64	20	·592	1·66
20	·199	— 0·73	10	·588	1·95				20	·647	1·85
20	·295	— 0·70	10	·612	1·56		*p**		20	·714	1·64
20	·361	— 0·59*	10	·646	1·94	21	·001	2·38	19	·772	1·81*
6	·391	— 0·17*	10	·694	1·87	20	·058	2·42	2	·827	3·09*
6	·416	2·17*	10	·735	2·14	20	·112	2·57	2	·835	4·50*
5	·433	4·90*	10	·759	2·23	7	·152	3·03	3	·843	5·62*
4	·442	5·88*	10	·790	2·57	8	·175	3·95	3	·849	5·43*
5	·454	6·70*	10	·817	2·99	10	·201	4·54	1	·862	3·93*
5	·469	5·82*	10	·840	3·27	9	·225	5·18	20	·916	1·72*
5	·500	3·30*	19	·872	3·52	7	·239	5·46	19	·976	1·55
7	·521	— 0·22*	10	·905	3·34	10	·264	4·50			
20	·551	— 0·48*	11	·932	2·94	8	·282	3·91		*s*	
20	·604	— 0·71	11	·983	2·50	7	·299	3·56	11	·016	3·55
20	·653	— 0·68				8	·317	3·21	11	·032	3·39
20	·728	— 0·66	24	·016	3·71	20	·353	2·80	11	·086	3·75
20	·773	— 0·83	24	·054	3·32	20	·416	2·41	11	·114	3·73
20	·817	— 0·69	24	·091	2·60	20	·487	2·39	11	·152	3·77
20	·884	— 0·53	24	·122	2·50	20	·546	2·26	11	·172	3·56
20	·950	— 0·49	24	·167	2·11	20	·601	2·36	11	·213	3·17
	l		24	·206	2·00	20	·660	2·46	11	·261	3.62
			24	·240	1·80	20	·741	2·42	11	·282	3·92*
15	·015	8·16	24	·284	1·96	20	·836	2·46	11	·300	3·40*
15	·052	7·54	24	·328	1·88	20	·925	2·18	11	·326	3·54*
15	·096	8·09	24	·369	2·25				10	·348	3·71*
15	·144	7·80	24	·406	2·54	20	·011	5·17	3	·377	5·27*
15	·211	7·12	24	·447	3·01	20	·036	4·38	6	·383	6·13*
15	·240	6·99	24	·481	3·45	20	·061	3·73	5	·389	5·60*
15	·280	7·29				20	·088	3·11	5	·402	4·36*
15	·326	7·53		*n*		20	·114	2·62	12	·432	3·71*
15	·354	7·24	31	·021	1·41	43	·159	2·47	11	·452	3·45*
15	·407	7·93	31	·099	2·00	43	·227	2·47	11	·480	3·39

TABLE 5 (*continued*).

n	phase	bright-ness
	P	s
11	·515	3·73
11	·550	3·65
11	·002	3·37
11	·633	3·50
11	·649	3·75
11	·674	3·84
11	·695	3·65
11	·711	3·58
11	·746	3·51
11	·769	3·95*
12	·797	3·53*
4	·834	4·95*
6	·847	6·13*
5	·855	7·00*
4	·861	5·50*
6	·867	4·87*
10	·888	3·43*
11	·930	3·40*
11	·967	3·42*
11	·996	3·58
	t	
24	·049	6·65
24	·151	6·68
24	·207	6·40
12	·239	6·15
1	·256	6·6 *
1	·257	5·2 *
1	·258	6·9 *
1	·262	8·3 *
1	·263	9·1 *
1	·263	6·4 *
1	·263	5·5 *
1	·264	5·2 *
1	·268	7·5 *
1	·269	7·5 *
1	·274	6·8 *
1	·276	5·2 *
1	·279	9·9 *
1	·281	5·2 *
1	·282	7·2 *
1	·283	6·1 *
1	·287	7·5 *
1	·289	6·4 *
1	·289	9·3 *
1	·289	9·6 *
1	·294	7·5 *
1	·295	10·7 *
1	·296	5·7 *
1	·300	5·5 *
1	·317	5·5 *
1	·334	7·2 *
1	·334	10·7 *
1	·337	6·3 *
1	·338	5·2 *
1	·340	11·3 *
1	·343	5·8 *
1	·345	11·7 *
1	·361	10·5 *
1	·365	11·7 *
1	·369	10·5 *
1	·378	11·7 *
1	·378	11·7 *
1	·384	11·3 *
1	·384	11·7 *
1	·390	11·7 *
1	·390	11·7 *
1	·394	7·7 *

n	phase	bright-ness
	P	s
1	·396	10·5 *
1	·396	11·3 *
1	·402	11·7 *
1	·411	10·5 *
1	·415	5·2 *
1	·417	9·3 *
1	·422	6·9 *
1	·423	7·5 *
1	·423	5·5 *
1	·423	5·2 *
1	·428	8·4 *
1	·429	8·3 *
1	·429	5·5 *
1	·432	6·4 *
1	·433	7·5 *
1	·433	8·3 *
1	·434	7·2 *
1	·438	8·9 *
1	·440	9·3 *
1	·440	8·3 *
1	·446	9·3 *
1	·446	9·3 *
1	·449	7·5 *
1	·449	8·3 *
1	·450	7·7 *
1	·453	5·5 *
1	·453	5·8 *
1	·455	5·2 *
26	·487	6·83
24	·578	6·48
24	·691	7·32
24	·749	7·34
25	·823	6·75
25	·906	6·37
25	·986	6·45
	u	
19	·048	2·60
19	1·07	2·60
19	·151	2·73
22	·197	2·74
5	·246	3·26*
6	·261	3·76*
5	·272	4·42*
5	·288	5·28*
4	·307	5·63*
4	·329	5·98*
4	·348	5·13*
5	·365	3·84*
6	·384	3·80*
19	·421	2·82
19	·479	2·81
19	·547	2·66
19	·605	2·85
19	·665	2·79
19	·722	2·94
19	·764	2·77
19	·826	2·87
19	·893	2·73
19	·961	2·80
	v	
25	·097	1·22
24	·174	1·24
25	·215	0·97
24	·259	1·22
25	·308	1·43
24	·349	1·33

n	phase	brixht-ness
	P	s
25	·388	1·25
24	·554	1·37
25	·661	1·32
24	·722	1·29
25	·746	1·30
24	·772	1·32
25	·812	1·30*
4	·852	0·60*
4	·869	3·12*
4	·876	2·72*
4	·878	2·72*
4	·880	2·95*
4	·887	2·68*
4	·900	3·32*
4	·905	0·90*
24	·981	1·17*
	*w**	
9	·006	1·83
9	·026	2·23
9	·056	2·53
5	·118	3·13
9	·173	3·62
9	·224	3·43
9	·331	5·23
9	·390	5·12
9	·435	6·44
9	·473	7·27
9	·498	6·16
9	·532	6·04
9	·580	5·66
9	·622	4·63
9	·657	2·32
9	·678	2·17
9	·708	— 0·44
9	·757	— 0·89
9	·790	— 1·22
9	·814	— 0·56
9	·845	— 1·01
9	·877	— 0·22
9	·893	0·80
9	·913	0·76
9	·935	0·22
10	·959	0·90
10	·987	0·54
	*x**	
12	·014	7·64
12	·026	6·77
12	·046	7·43
12	·078	7·32
12	·102	7·62
12	·140	7·65
12	·176	7·57
12	·217	7·16
12	·256	5·66
12	·292	4·24
12	·338	2·76
12	·369	2·27
12	·389	1·57
12	·414	0·88
12	·441	0·44
12	·475	0·50
12	·514	1·32
12	·535	1·76
12	·577	1·94
12	·610	3·19
12	·642	3·25

n	phase	bright-ness
	P	s
12	·678	3·62
12	·742	4·56
12	·796	4·92
12	·834	5·54
11	·893	5·95
11	·950	6·97
11	·986	7·38
	*y**	
10	·008	8·22
10	·034	9·03
10	·073	10·40
10	·103	10·75
10	·137	11·08
10	·173	11·07
10	·251	12·63
10	·291	13·89
10	·323	11·91
10	·332	12·43
10	·357	12·76
10	·381	12·28
10	·408	12·21
10	·436	11·35
10	·476	10·07
10	·486	10·05
10	·496	10·37
10	·526	9·12
10	·555	7·94
10	·569	7·51
10	·598	8·15
10	·647	6·11
10	·699	2·38
10	·727	2·62
10	·752	2·87
10	·791	3·42
10	·821	5·33
10	·840	5·66
11	·857	6·43
11	·900	6·45
11	·949	7·77
11	·985	8·15
	z	
21	·037	2·55
20	·107	2·62
20	·178	2·56
22	·243	2·60
5	·297	3·74*
5	·313	3·82*
5	·324	4·04*
5	·339	5·28*
5	·358	5·26*
5	·371	6·20*
5	·388	5·78*
5	·408	5·24*
5	·424	4·44*
5	·437	4·18*
5	·454	3·78*
5	·471	3·80*
20	·517	2·33
20	·585	2·62
21	·653	2·56
20	·717	2·48
20	·801	2·54
22	·858	2·54
19	·906	2·47
20	·972	2·43