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COMMUNICATION FROM THE OBSERVATORY AT LEIDEN.

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

by *W. E. Kruytbosch.*

Among the plates taken by H. VAN GENT with the Franklin-Adams instrument at Johannesburg are about 250 with the centre at 16^h4^m, $-54°45'$ (1875) and covering $10° \times 10°$. The 25 variables forming the subject of the present note were found by comparing selected pairs of these plates in the blinkmicroscope here in Leiden.

The 25 stars are listed in Table 1. Of these 6 occur in the C. P. D., viz. *d*, *l*, *n*, *q*, *r* and *u* with the numbers $-54°6774$ ($9^m{\cdot}6$), $-56°7432$ ($10^m{\cdot}0$), $-53°7773$ ($10^m{\cdot}4$), $-52°9843$ ($9^m{\cdot}9$), $-53°8005$ ($9^m{\cdot}7$) and $-53°7734$ ($9^m{\cdot}8$) respectively.

The total number of observations used here (not counting repetitions) is 5575 and the average number for each star thus 223. The extreme dates of the plates used are J. D. 2425381 and 5864. The normal exposure time of a plate is 30 min.

For 18 of the 25 periods a mean error has been indicated in Table 1. Owing to the generally small number of epochs these mean errors are often rather uncertain.

The phases have in all cases been computed according to the formula

$$\text{phase} = \text{recipr. period} \times (\text{J. D. hel. M. astr. T. Grw} - 2420000)$$

The reciprocal periods actually used for this computation are given in Table 1.

For eclipsing variables the corresponding phase of the minimum has been given, while for 6 other variables of δ Cep- or RR Lyr-type the phase, taken as normal, is marked with an asterisk in Table 1 and explained in the remarks below.

The normal epochs given in J. D. have been chosen near to the mean date of the observations.

My scale of steps, in which the estimates were made, has proved to vary considerably from star to star and even for the same star, when the estimates were repeated later. An attempt was therefore made to estimate the magnitudes of the comparison stars by comparison with plates of the Crux region containing the Selected Area No. 193. The magnitudes thus found are given in Table 3. They are naturally rather uncertain but may still be used to obtain some idea of the magnitudes of the variables at different phases.

The dates of the two plates, by the comparison of which the variability of the star was found in the blinkmicroscope, are given in Table 2 together with the interval in days and the difference in steps between the two images of the variable as derived from the mean lightcurve.

The surroundings of each variable with indication of the comparison stars are shown on the diagrams on the pages 220 and 221. The brightness assigned to each comparison star is given in Table 3. The size of each square is indicated in the right hand bottom corner. The stars *q* and *r* are on the same diagram.

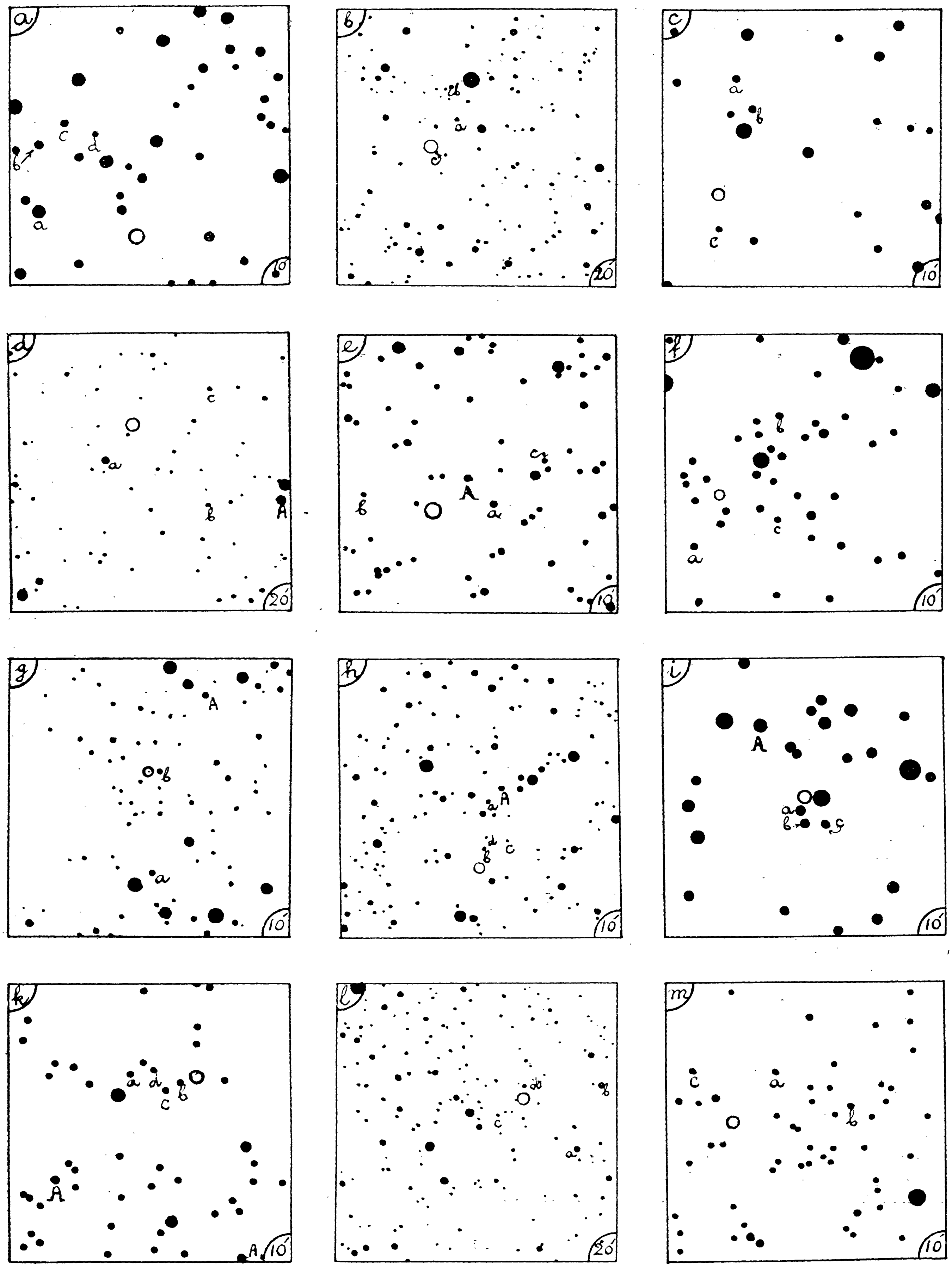
For 17 variables the epochs of minimum and for one (*t*) the epochs of maximum used for computing the period according to least squares are indicated in Table 4 together with the counting of epochs and the residuals $O-C$.

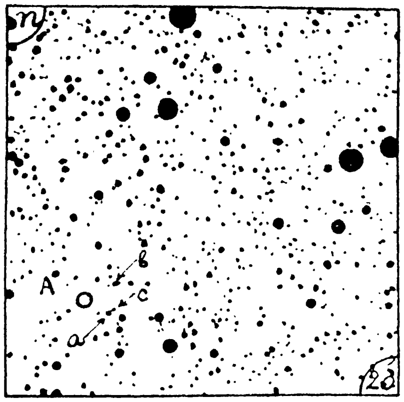
For each variable the observations were arranged according to phase and divided into groups as indicated in Table 5, where mean values of phase and brightness are given for each group. In case only some of the mean values are shown on the diagrams on the pages 222 and 223, these mean values are marked with an asterisk. In 7 cases, concerning variables of the eclipsing type, mean values were computed anew, taking the phase of the minimum as zeropoint and disregarding the sign of the phase.

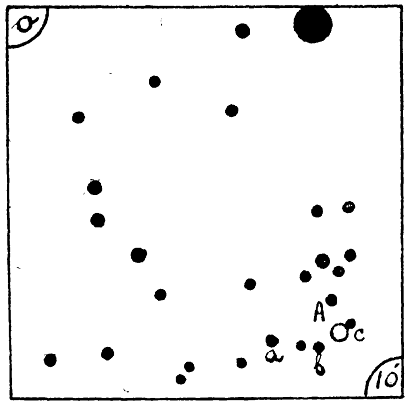
On all the diagrams vertical lines have been drawn for each tenth of the period. The phases have in case of eclipsing variables been counted from minimum and the brightness in steps from maximum light.

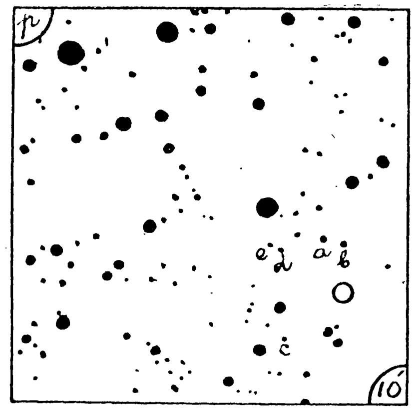
The individual objects give rise to the following remarks.

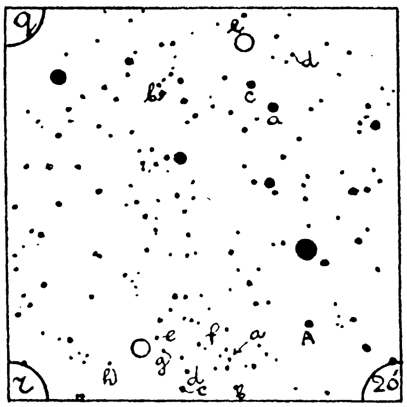
a. The descending branch of the lightcurve is

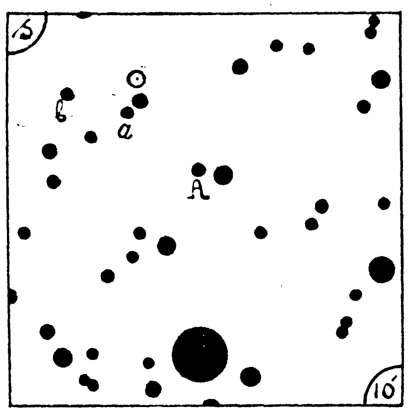


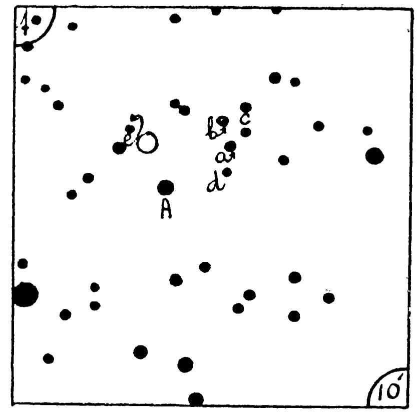

n
A
a
b
c
20'

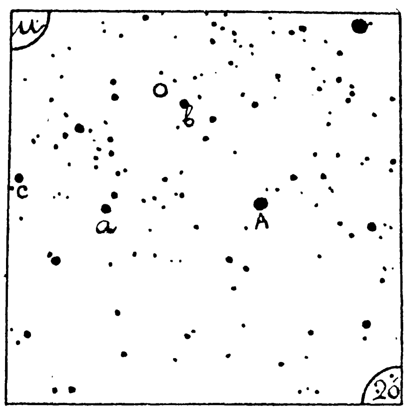

o
A
a
b
c
10'

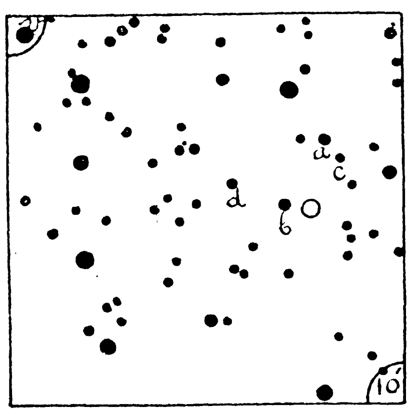

p
e
d
a
b
c
10'

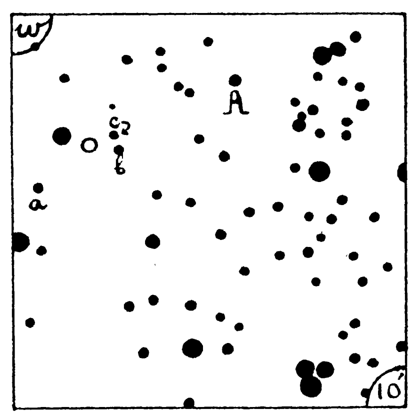

q
k
d
b
c
a
e
f
a
A
h
g
d
c
r
20'

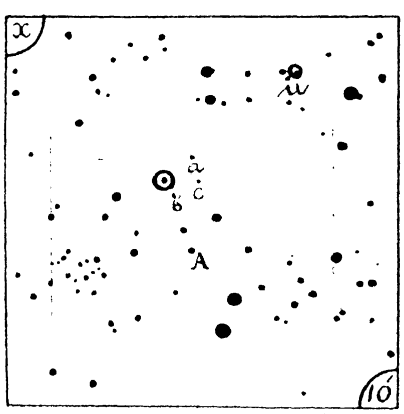

s
b
a
A
10'

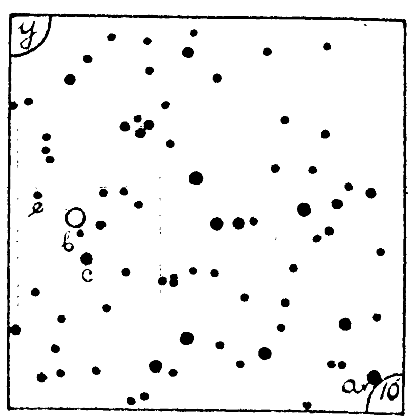

t
b
c
a
d
A
10'

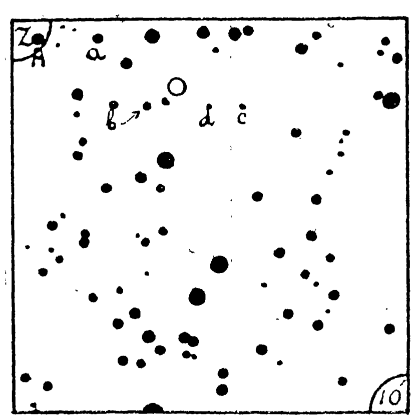

u
b
c
a
A
20'

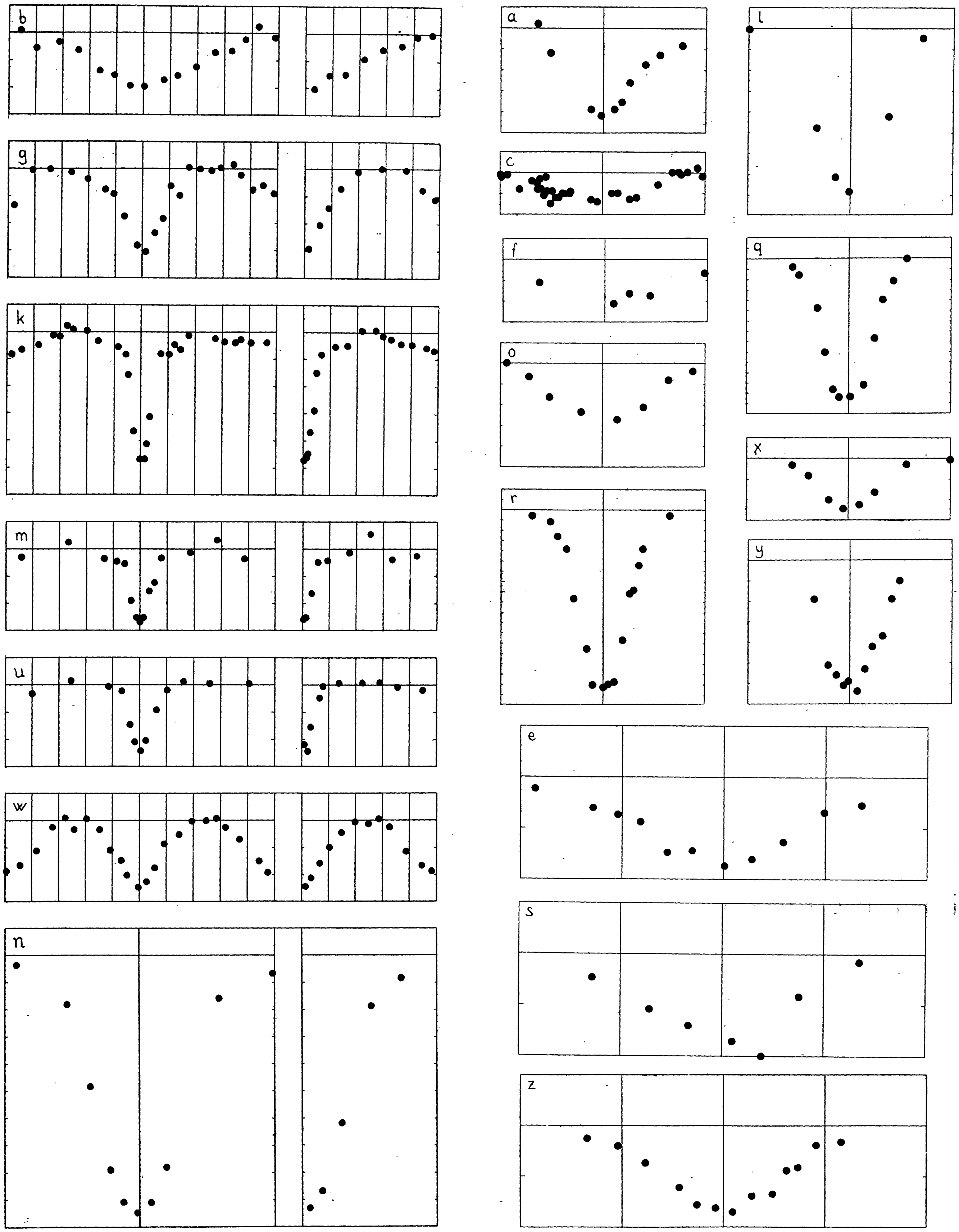

v
a
c
d
b
10'


w
A
c
b
a
10'


x
u
a
b
c
A
10'


y
a
b
c
a
10'


z
A
a
b
d
c
10'


b
g
k
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u
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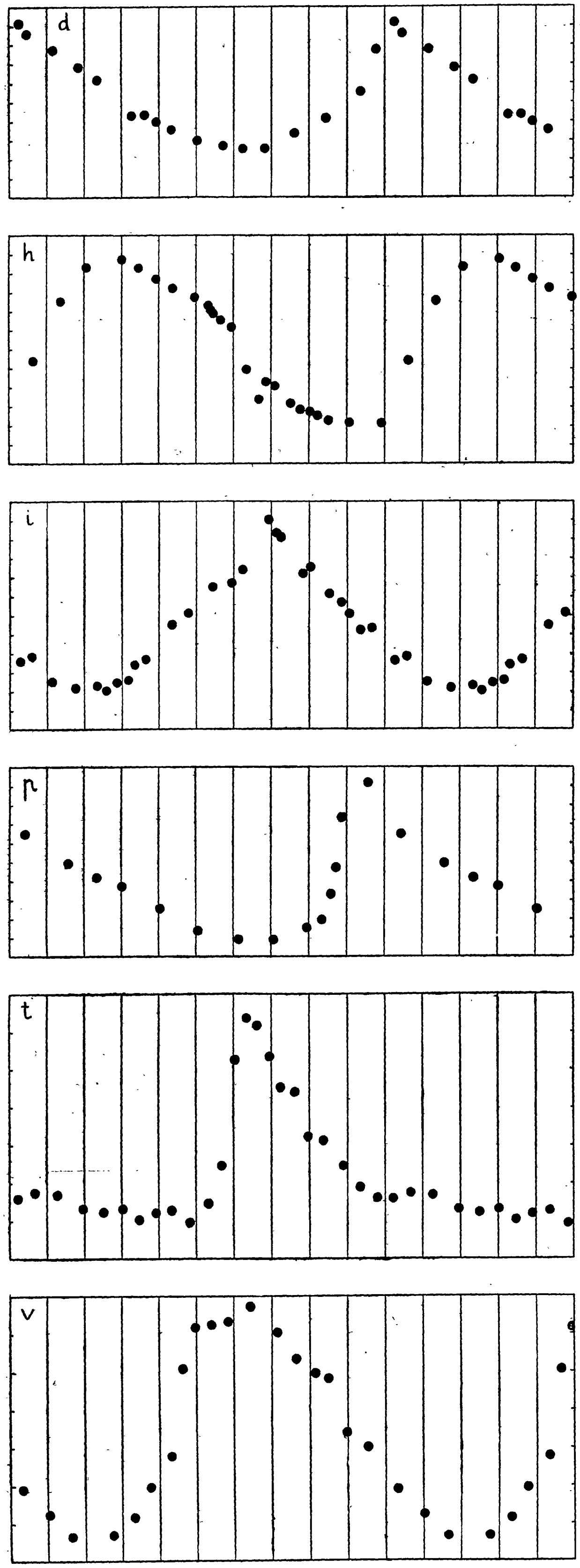
n
a
c
f
o
r
l
q
x
y
e
s
z



incompletely observed. The period has been derived from observations on the ascending branch only.

b. This star is most probably of the W UMa-type, though in the mean lightcurve the minimum hardly appears sharper than the maximum. Eventually the apparent period will have to be doubled.

The maxima indicate a slightly smaller value of the period than do the minima given in Table 4. Finally the reciprocal period 5$^{\mathrm{d}^{-1}}$·3175 was adopted.

c. It was found that an interval of nearly 14$^{\mathrm{d}}$·96 should contain a whole number of periods. A least square solution using the 4 epochs 2425391·446, 5451·297, 5720·530 and 5825·325 gave 14·$^{\mathrm{d}}$9603 for this interval. The individual estimates were then plotted according to the phase computed by the formula given above, using the reciprocal $^{\mathrm{d}^{-1}}$·0668435. As 14·$^{\mathrm{d}}$9603 is equal to 15·0013 sidereal days, 15 well separated groups of observations were shown on the plot, which, however, gave sufficient evidence to see that the real period is 14·$^{\mathrm{d}}$96/4 = 3·$^{\mathrm{d}}$74. Hence the final phases were computed with a reciprocal period of ·267374$^{\mathrm{d}^{-1}}$.

On the diagram of page 222 the individual observations in and near minimum have been plotted. The range is small and not much can be said with certainty about the shape of the minimum. But as far as the present evidence goes, the star appears to be in constant minimum for an extraordinary large fraction of the period, viz. about one tenth.

The following remarks concerning this star were made by Professor HERTZSPRUNG.

If a system consists of two identical stars in contact and one of these components contracts to a white dwarf without other changes in the dimensions of the couple taking place, the total eclipse may last for as much as ·167 of the period and a lightcurve of the kind found for the present star may be obtained.

But it is more likely, that we have here to do with a triple system, the total light of which is observed, the third component being so bright, that practically all the light observed during the constant minimum is due to it.

Accurate observations on the descending and ascending branches of the lightcurve are much wanted. In case one of the components is a white dwarf, the transition from maximum to minimum and inversely should be extremely quick.

d. The shape of the lightcurve as far as revealed by these few observations, bears some similarity to the curves normal for a period of about 14 days (*B. A. N.* 96).

The value of 1$^{\mathrm{s}}$ was in this case found to be $^{\mathrm{m}}$·27, corresponding to a total range of 1$^{\mathrm{m}}$·8. The mean error of a single estimate is ± $^{\mathrm{m}}$·17. Two phases, different by ·2, at which the variable reaches the same brightness on the ascending and descending branch of the lightcurve are ·968 and ·168. The mean epoch of the first of these phases is given in Table 1.

e. This star had already been estimated before on the first 84 plates then available. A comparison between the old and the new estimates on these plates showed that $1^s{\cdot}17$ on my new scale of steps was equal to $2^s{\cdot}70$ on the old one. This is an example of the considerable variations in the value of my step. The mean between the new estimates and the old ones multiplied by $1{\cdot}17/2{\cdot}70 = {\cdot}433$ has been used.

There is no trace of a secondary minimum and the period has, in view of the long duration of the minimum (·35 of the period), probably to be doubled.

f. It does not seem possible to represent the observations by a shorter period of about a day or less, as the star remained in full minimum on 7 plates, taken from J. D. 2425448·21 to ·45, thus for $^d{\cdot}24$. Assuming the period to be correct, the variable is of more than usual interest. Long periods like this are mostly found among eclipsing stars showing a large range and an extended constant minimum. If the present object only differs from systems of this kind by its inclination, it would not be expected that the minimum occupies about ·25 of the period.

There is nothing in the lightcurve excluding a doubling of the period.

h. This δ Cep-variable of rather long period has a lightcurve, which remains nearly unchanged, when turned upside down. In fact, both maximum and minimum are very shallow and it is difficult to give their epoch accurately. There happen to be only few observations on the ascending branch of the lightcurve. At the two phases ·125 and ·525, differing by ·4, the variable shows the same brightness on the ascending and descending branch of the lightcurve. The mean epoch of the phase ·125 is J. D. 2425654·82. Drawing a smooth curve representing the observations and computing a sinusoid fitting this curve according to least squares, the result is $3^s{\cdot}60 - 3^s{\cdot}72 \sin 2\pi P + 2^s{\cdot}43 \cos 2\pi P$. The maximum of this sinusoid is at the phase ·343, which has been entered in Table 1.

i. The lightcurve of this variable of the ζ Gem-type is very nearly symmetrical with the maximum slightly sharper than the minimum. The phase of the maximum given in Table 1 is that of the sinusoid $4^s{\cdot}42 + 3^s{\cdot}46 \sin 2\pi P + {}^s{\cdot}85 \cos 2\pi P$, which has been computed by least squares to fit the 25 normal points.

k. There is a slight indication of the variable being fainter near secondary minimum than midway between the two minima, suggesting ellipticity of the star.

m. There is a slight indication of ellipticity of the star.

n. Here again there seems to be a trace of ellipticity of the star. Though this behaviour of the lightcurve may not have much weight in an individual case, the fact, that this diminution of brightness near the secondary minimum is so often indicated by the observations makes its generality probable.

o. The minimum may be constant for as much as ·07 of the period, but more observations are needed for an accurate lightcurve.

p. This variable of the δ Cep-type shows the rather unusual combination of a short period ($2^d{\cdot}4$) and remarkable range. The rising branch of the lightcurve is very steep. The epoch of maximum is not well fixed by my observations. At the two phases ·872 and ·172, separated by $^P{\cdot}3$, the star shows the same brightness ($5^s{\cdot}2$) on the ascending and descending branch of the lightcurve. The mean epoch of the phase ·872 is given in Table 1.

q. The minimum seems to be constant for about ·025 of the period.

r. The 3 brightest comparison stars are *A*: C. P. D. — 53°7989, *a*: 7995 and *b*: 7994. The minimum seems to be constant for about ·02 of the period.

s. The range is small and the representation of the observations by the elements here given is not very satisfactory, but I have not been able to find any better.

t. This variable had already been estimated before on the first 113 plates used here. A comparison between the old and new estimates showed that one of my steps was later double as much expressed in magnitudes as it was before, similar to what was found above in the case of the variable *e*. This is a change in the unexpected direction, as ordinarily the value of one step decreases with accumulating experience.

The maximum occurs at about the phase ·63, the mean epoch of which is J. D. 2425587·945. At the phases ·585 on the rising and ·785 on the descending branch of the lightcurve the variable shows the same brightness ($3^s{\cdot}3$). The mean epoch of the phase ·585 is given in Table 1.

u. Here again there is an uncertain indication of the star being darker near the secondary minimum than between the two minima.

v. The lightcurve of this variable of the RR Lyr-type is rather different from that of the above variable *t* of the same class. The star *t* shows a very marked difference between the sharp maximum and the flat minimum, while in the case of *v* the lightcurve does not appear very different, when turned upside down.

The variable shows the same brightness ($3^s{\cdot}8$) on the ascending and descending branch of the lightcurve at the phases ·45 and ·85 respectively. The mean epoch of the phase ·45 is J. D. 2425535·166. The maximum is ill defined and no accurate epoch of it can be given from the present observations.

A smooth curve representing the observations was drawn and read off on 20 points, equidistant in phase. A least square solution of a sinusoid, fitting these 20 points, gave the result $4^s{\cdot}555 + 2^s{\cdot}68 \sin 2\pi P - 1^s{\cdot}45 \cos 2\pi P$. The maximum of this sinusoid occurs at the phase ·671, the mean epoch of which is given in Table 1.

w. The resemblance of this variable to TY Pup = C. P. D. — 20°2574 (period $^{d}{\cdot}58071564$) is very close. Of the 33 epochs, given in Table 4, 24 are of the primary and 9 of the secondary minimum. The apparent period thus found was accordingly doubled.

y. This variable was found in a curious way. A nearby star was suspected of variability in the blink-microscope, but by closer examination of the plate the film was found to be defect. However, at that occasion the variability of the star *y* was noted under the magnifying glass.

Owing to the small range it was difficult to get reliable results. Therefore the plates were also estimated by HERTZSPRUNG, who used the comparison stars, *c*, *b* and *e*. Our two scales of steps (Table 3) proved to be different only in zeropoint, the mean difference being $K - H = 3^s{\cdot}01$.

As the results were not yet satisfactory, 30 plates near minimum were measured by HERTZSPRUNG in the Schilt microphotometer. These measures were reduced to a provisional scale of magnitudes by the aid of a "normal" table derived from other material. The mean magnitude of the comparison stars *c* and *b* was taken as zeropoint and that of *e* to be $^{m}{\cdot}8$. The relation between the two scales of HERTZSPRUNG was found to be: provisional magnitude = — ·3 + ·165. Hence both our steps are in this case equal to about $^{m}{\cdot}16$.

The estimates *K* and *H* have both been reduced to the provisional scale of magnitudes by the aid of the formulae given above. If measures with the microphotometer were available, these have been used and the estimates neglected in forming the mean values given in Table 4.

The mean error of a plate measured in the microphotometer is found to be about ± $^{m}{\cdot}074$.

I want to express my thanks to Prof. HERTZSPRUNG for all the help he gave me in preparing this paper.

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	15 34 27	— 58 29·3	232	1·68639	± ·00006	·593	·11	5789·393	·15	·6	4·8	4·2		11·9	13·1
b	15 35 3	59 25·4	224	·188058	± ·000005	5·3175	·550	5598·599		·2	2·2	2·0	± ·65	12·0	12·6
c	15 43 3	51 33·0	228	3·74008		·267374	·575	5582·349	·13	1·5	2·5	1·0		12·1	12·2
d	15 45 2	54 11·5	238	12·642		·0791	·01 *	5600·632		·8	7·5	6·7	± ·64	10·0	11·8
e	15 45 36	56 21·2	233	·73728	± ·00003	1·35633	·612	5600·121	·35	1·8	3·3	1·5	± ·37	12·3	12·6
f	15 48 21	54 2·8	233	37·246	± ·060	·02685	·27	5596·648	·25	2·3	4·2	1·9	± ·83	12·6	12·9
g	15 50 44	55 6·0	229	1·6712	± ·0001	·59838	·048	5603·543		3·6	6 6	3·0	± ·81	12·4	12·7
h	15 54 13	55 43·8	227	32·11	± ·10	·031146	·343*	5597·605		— ·7	7·9	8·6	± ·70	12·5	13·9
i	15 55 27	51 36·4	225	10·782		·09275	·712*	5603·364		·0	7·8	7·8	± ·83	11·9	13·5
k	15 55 47	54 55·3	233	3·03049	± ·00007	·32998	·515	5601·900	·16	1·6	6·3	4·7		12·2	13·5
l	16 4 2	56 30·6	236	3·5204	± ·0002	·28406	·985	5586·795	·15	1·6	9·6	8·0		11·6	12·2
m	16 5 49	57 24·4	233	4·2273	± ·0004	·23655	·773	5608·848	·13	2·6	5·3	2·7		12·0	12·7
n	16 10 35	53 26·4	232	3·14825	± ·00018	·317664	·708	5574·154	·15	·6	10·0	9·4		11·6	14·3
o	16 11 47	55 22·8	217	·87414	± ·00004	1·14395	·624	5597·818	·16	2·7	5·4	2·7		13·4	13·7
p	16 17 29	56 29·7	168	2·38572	± 00008	·41916	·872*	5534·574		·6	9·2	8·6	± ·71	12·1	13·5
q	16 17 49	52 46·3	238	3·13580		·318898	·245	5601·305	·11	2·1	15·4	13·3	± ·77	11·2	12·3
r	16 18 24	53 2·2	238	3·19603		·312889	·788	5576·380	·13	2·8	19·8	17·0		11·2	13·4
s	16 20 44	52 2·8	231	1·10175	± ·00012	·90765	·20	5594·888	·23	1·1	2·8	1·7		12·1	12·3
t	16 21 2	58 17·6	223	·618025	± ·000010	1·61806	·585*	5587·917		·4	5·9	5·5	± ·54	12·3	13·4
u	16 21 26	54 16·2	235	2·08256	± ·00018	·48018	·138	5589·858	·16	2·4	4·8	2·4		11·2	11·5
v	16 21 39	53 41·8	171	·375305		2·6645	·671*	5535·249		1·3	7·5	6·2	± ·81	12·1	12·8
w	16 21 47	51 46·1	227	·543853	± ·000008	1·83873	·695	5599·895		2·0	4·4	2·4	± ·53	12·7	13·2
x	16 21 51	54 18·7	226	1·08904	± ·00005	·91824	·859	5608·402	·12	·7	3·2	2·5		13·3	13·7
y	16 26 39	56 2·6	173	1·5999		·62504	·572	5534·961	·10	— $^{m}{\cdot}29$	$^{m}{\cdot}32$	$^{m}{\cdot}61$		11·4	12·4
z	16 27 26	52 55·3	225	1·00937	± ·00004	·990717	·750	5598·723	·22	$^{s}{\cdot}3$	$1^{s}{\cdot}7$	$1^{s}{\cdot}4$	± ·26	13·2	13·8

TABLE 2.

	type	variable found		Δd	Δs
		bright	faint		
		d	d	d	s
a	Algol	2425720·541	2425713·528	7	3·8
b	WU Ma	5438·443	5441·353	3	1·0
c	Algol	5448·423	5451·330	3	1·0
d	δ Cep	5423·504	5445·446	2	6·0
e	Algol	5444·315	5448·233	4	1·5
f	Algol	5442·462	5448·292	6	1·9
g	β Lyr	5444·315	5448·233	4	1·9
h	δ Cep	5445·446	5423·504	22	4·0
i	ζ Gem	5442·462	5448·292	6	5·5
k	Algol	5438·391	5441·353	3	2·1
l	Algol	5448·292	5442·462	6	8·0
m	Algol	5444·315	5448·233	4	2·2
n	Algol	5442·462	5448·292	6	8·5
o	Algol	5438·391	5441·353	3	2·7
p	δ Cep	5713·528	5720·541	7	5·2
q	Algol	5438·391	5441·353	3	11·7
r	Algol	5423·504	5445·446	22	6·2
s	Algol	5442·462	5448·292	6	1·2
t	RR Lyr	5438·443	5441·353	3	3·5
u	Algol	5442·462	5448·292	6	2·2
v	RR Lyr	5713·528	5720·541	7	4·3
w	β Lyr	5448·313	5445·446	3	2·5
x	Algol	5445·446	5448·313	3	2·5
y	Algol	5713·528	5720·541	7	^{m}·61
z	Algol	5448·423	5451·330	3	1^{s}·1

TABLE 3.

a

	s	m
a	·00	11·7
b	1·79	12·4
c	3·50	12·7
d	4·85	13·1

b

	s	m
a	·00	11·9
b	·73	12·2
c	2·31	12·5

c

	s	m
a	·00	11·9
b	1·79	12·1
c	2·54	12·2

d

	s	m
A	·00	·00
a	2·71	·38
b	5·65	1·32
c	8·31	2·04

e

	s	m
A	·00	12·0
a	1·42	12·3
b	2·59	12·5
c	3·85	12·6

f

	s	m
a	·00	12·3
b	·26	12·7
c	·55	13·0

g

	s	m
A	·00	12·0
a	4·20	12·3
b	6·56	12·8

h

	s	m
A	·00	12·6
a	2·52	13·1
b	4·37	13·4
c	5·75	13·5
d	7·68	13·8

i

	s	m
A	·00	11·9
a	3·22	12·3
b	5·73	13·2
c	8·07	13·4

k

	s	m
A′	·00	11·8
A	1·66	12·1
a	3·01	12·3
b	3·63	12·6
c	5·55	13·3
d	6·33	13·7

l

	s	m
a	·00	11·4
b	3·00	11·7
c	6·81	12·0
d	10·30	12·3

m

	s	m
a	·00	11·4
b	2·73	12·0
c	5·54	12·9

n

	s	m
A	·00	11·6
a	3·16	12·3
b	5·06	12·9
c	7·83	13·3

o

	s	m
A	·00	13·1
a	2·29	13·3
b	3·78	13·5
c	5·06	13·7

p

	s	m
a	·00	12·0
b	3·46	12·5
c	7·18	13·2
d	9·20	13·6
e	10·49	13·7

q

	s	m
a	·00	10·9
b	4·96	11·4
c	8·30	11·7
d	12·86	12·0
e	15·84	12·3

r

	s	m
A	·00	10·8
a	·27	11·2
b	·48	11·4
c	·77	11·7
d	1·02	12·0
e	1·30	12·3
f	1·58	13·0
g	1·83	13·3
h	2·05	13·6

s

	s	m
A	·00	12·0
a	1·93	12·2
b	2·91	12·4

t

	s	m
A	·00	12·2
a	1·64	12·5
b	2·60	12·8
c	4·14	13·1
d	5·34	13·2
e	6·35	13·4

u

	s	m
A	·00	10·9
a	2·37	11·2
b	4·14	11·4
c	5·42	11·5

TABLE 3 (*continued*).

v

	s	m
a	·00	12·0
b	3·41	12·4
c	5·92	12·7
d	8·39	12·9

w

	s	m
A	·00	12·3
a	2·15	12·6
b	4·04	13·2
c	4·86	13·4

x

	s	m
A	·00	13·2
a	1·46	13·4
b	2·45	13·6
c	3·03	13·7

y

K

	s	m
a	·0	10·9
b	4·9	11·8
e	9·5	12·8

H

	s	m_{pr}
c	·00	—·10
b	2·09	·10
e	6·95	·80

z

	s	m
A	·00	13·1
a	·40	13·2
b	·89	13·5
c	1·30	13·7
d	1·64	13·8

TABLE 4.

b

d	ε	d
2425442·484	0	—·012
43·445	5	+ 9
44·365	10	— 11
53·232	57	+ 16
5738·489	1574	— 21
39·466	1579	+ 16
·633	1580	— 5
64·471	1712	+ 8
89·286	1844	— 1
93·227	1865	— 10
95·304	1876	— 1
5822·210	2019	+ 11
33·302	2078	+ 8
50·213	2168	— 7
52·289	2179	0

e

d	ε	d
2425391·446	0	—·021
5411·369	27	— 5
48·233	77	— 5
53·410	84	+ 11
76·298	115	+ 43
5646·533	346	— 33
5745·368	480	+ 6
5824·221	587	— 30
35·333	602	+ 23
52·278	625	+ 11

f

d	ε	d
2425411	0	+·2
48	1	·0
5745	9	—1·0
5821	11	+·5
58	12	+·3

g

d	ε	d
2425406·306	0	—·048
·329	0	— 25
11·358	3	— 10
·380	3	+ 12
·402	3	+ 54
41·480	21	+ 31
5740·598	200	+ 7
92·410	231	+ 12
97·442	234	+ 30
5864·215	274	— 44

l

d	ε	d
2425442·473	0	+·041
5646·538	58	— 81
5713·517	77	+ 10
20·530	79	— 18
94·462	100	— 16
5833·290	111	+ 87
54·302	117	— 24

m

d	ε	d
2425448·255	0	+·039
52·404	1	— 40
5714·576	63	+ 42
31·401	67	— 42
65·249	75	— 12
5803·315	84	+ 9
58·264	97	+ 3

n

d	ε	d
2425391·48	0	—·05
5410·42	6	0
48·23	18	+ 3
51·38	19	+ 3
5646·54	81	0
5791·38	127	+ 2
94·46	128	— 5
5832·29	140	0
51·23	146	+ 1
54·28	147	— 4

o

d	ε	d
2425413·382	0	+·002
20·376	8	+ 3
41·331	32	— 21
·353	32	+ 1
76·321	72	+ 3
5739·466	373	+ 32
89·286	430	+ 26
5824·221	470	— 5
58·277	509	— 40

s

d	ε	d
2425382·31	0	+·07
5415·28	30	— 1
38·39	51	— 4
48·31	60	— 3
5719·39	306	+ 2
2425720·52	307	+·05
41·35	326	— 6
74·48	356	+ 2
95·30	375	— 9
5858·26	432	+ 7

t

d	ε	d
2425415·518	0	—·008
35·300	32	— 3
38·391	37	— 2
41·480	42	— 3
43·335	45	— 2
·353	45	+ 16
48·292	53	+ 11
53·210	61	— 16
82·286	108	+ 13
5651·605	382	— 7
5797·464	618	— 1
5833·302	676	— 9
51·242	705	+ 8
64·215	726	+ 3

u

d	ε	d
2425448·212	0	—·032
·233	0	— 10
·255	0	+ 12
·292	0	+ 48
·313	0	+ 70
52·375	2	— 34
75·281	13	— 36
5731·401	136	— 71
5850·213	193	+ 35
52·278	194	+ 18

w

d	ε	d
2425393·493	0	—·009
5406·306	47	+ 24
15·244	80	— 12
·266	80	+ 10
·543	81	+ 15
17·417	88	— 14
·439	88	+ 8
18·220	91	— 27
·242	91	— 5
20·432	99	+ 10
38·391	165	+ 22
2425442·462	180	+·014
44·342	187	— 10
·365	187	+ 13
45·423	191	— 16
·446	191	+ 7
51·406	213	— 16
·429	213	+ 7
53·322	220	— 3
5713·528	1177	— 31
40·463	1276	— 16
45·357	1294	— 17
65·217	1367	— 8
·238	1367	+ 13
74·482	1401	+ 12
92·410	1467	— 7
97·283	14[illegible]5	— 29
5803·304	1507	+ 10
21·250	1573	+ 8
25·314	1588	— 06
34·307	1621	+ 13
58·255	1709	+ 31
64·215	1731	+ 9

x

d	ε	d
2425411·288	0	—·001
·311	0	+ 22
48·292	34	— 24
5646·527	216	+ 6
5719·476	283	— 11
90·282	348	+ 8

z

d	ε	d
2425443·30	0	+·01
44·32	1	+ 2
48·31	5	— 2
51·37	8	+ 1
52·37	9	0
53·37	10	— 1
5685·54	240	0
5764·27	318	0
65·24	319	— 4
90·49	344	— 2
92·52	346	— 1
5864·24	417	+ 5

TABLE 5.

n	phase	brightness
	a	
	P	s
10	·004	·60
1	·046	·4 *
1	·059	1·8 *
3	·098	4·50*
3	·109	4·80*
4	·121	4·50*
4	·128	4·15*
4	·136	3·22*
4	·151	2·35*
4	·165	1·88*
4	·187	1·45*
10	·233	·35
30	·311	·63
30	·425	·69
30	·587	·78
30	·761	·65
30	·863	·44
30	·949	·62
	*b**	
	P	s
14	·035	·38
14	·093	·10
14	·151	·77
14	·238	·53
14	·306	·81
14	·387	1·60
14	·441	1·75
14	·500	2·14
14	·554	2·18
14	·626	1·93
14	·678	1·77
14	·746	1·45
14	·814	·91
14	·876	·85
14	·928	·44
14	·974	—·02
	P	s
28	±·032	2·25
28	±·089	1·75
28	±·148	1·70
28	±·219	1·11
28	±·285	·80
28	±·356	·64
28	±·413	·30
28	±·470	·24
	c	
	P	s
29	·034	1·57
29	·157	1·53
29	·286	1·47
29	·438	1·46
25	·543	2·43*
29	·705	1·49
29	·839	1·34
29	·928	1·46
	*d**	
	P	s
14	·025	·87
14	·049	1·41
14	·119	2·26
14	·185	3·20
	P	s
14	·235	3·86
14	·328	5·74
14	·360	5·71
14	·391	6·04
14	·434	6·44
14	·504	7·01
14	·571	7·35
14	·624	7·52
14	·683	7·51
14	·761	6·66
14	·845	5·89
14	·940	4·47
14	·979	2·30
	e	
	P	s
30	·081	1·79
30	·221	1·80
30	·321	1·82
10	·426	1·83*
7	·484	2·20*
7	·508	2·33*
7	·530	2·47*
7	·557	3·07*
7	·581	3·03*
7	·613	3·33*
7	·640	3·20*
7	·671	2·87*
7	·711	2·29*
10	·748	2·15*
30	·822	1.77
30	·927	1·78
	f	
	P	s
32	·083	2·50
20	·163	2·74
11	·206	3·42*
10	·278	4·44*
10	·294	3·96*
10	·314	4·05*
10	·367	2·98*
10	·395	2·55
30	·416	2·15
30	·495	2·28
30	·614	2·11
30	·816	2·37
	*g**	
	P	s
10	·028	6·42
10	·061	6·66
10	·095	5·97
10	·124	5·45
10	·153	4·25
10	·185	4·59
10	·221	3·56
10	·262	3·61
10	·302	3·68
10	·338	3·57
10	·383	3·44
10	·412	3·84
10	·458	4·37
10	·495	4·21
10	·534	4·52
10	·570	4·96
10	·638	3·67
	P	s
10	·704	3·62
10	·785	3·72
10	·845	3·98
10	·908	4·38
10	·941	4·53
9	·981	5·37
	P	s
20	±·016	6·54
20	±·056	5·68
20	±·090	5·04
30	±·132	4·34
30	±·200	3·71
40	±·283	3·60
30	±·375	3·67
20	±·439	4·38
19	±·483	4·71
	*h**	
	P	s
3	·064	4·60
4	·138	1·45
10	·207	—·32
10	·302	—·74
10	·347	—·23
10	·391	·31
10	·437	·80
10	·496	1·25
10	·532	1·71
10	·540	1·97
10	·547	2·13
10	·567	2·47
10	·596	2·83
10	·635	5·07
10	·670	6·62
10	·687	5·74
10	·710	5·95
10	·750	6·85
10	·777	7·19
10	·802	7·28
10	·824	7·44
10	·853	7·77
10	·910	7·86
10	·992	7·89
	*i**	
	P	s
9	·029	6·40
9	·059	6·19
9	·111	7·52
9	·177	7·82
9	·233	7·73
9	·259	7·99
9	·287	7·58
9	·318	7·42
9	·332	6·62
9	·365	6·36
9	·435	4·53
9	·480	3·90
9	·544	2·56
9	·595	2·34
9	·622	1·61
9	·691	—1·01
9	·712	—·32
9	·727	—·11
9	·782	1·81
9	·802	1·48
	P	s
9	·853	2·88
9	·885	3·37
9	·906	3·96
9	·937	4·80
9	·969	4·70
	*k**	
	P	s
10	·033	2·45
10	·070	2·26
10	·132	2·09
10	·187	1·72
10	·213	1·78
10	·238	1·39
10	·261	1·51
10	·314	1·56
10	·355	1·93
5	·427	2·18
5	·458	2·44
5	·467	3·20
5	·487	5·28
5	·511	6·30
5	·526	6·30
5	·535	5·74
5	·549	4·74
5	·588	2·42
5	·617	2·44
10	·639	2·09
10	·663	2·26
10	·731	1·73
10	·787	1·84
10	·823	1·97
10	·862	1·99
10	·883	1·89
12	·918	1·99
11	·979	1·99
	P	s
5	±·003	6·34
5	±·012	6·22
5	±·018	6·08
5	±·025	5·30
5	±·039	4·50
5	±·048	3·12
13	±·067	2·45
20	±·119	2·14
20	±·161	2·10
20	±·216	1·54
20	±·267	1·53
20	±·294	1·74
20	±·326	1·84
20	±·360	2·01
20	±·401	2·06
20	±·455	2·18
10	±·483	2·29
	l	
	P	s
5	·023	5·82*
6	·055	2·07*
40	·130	1·60
40	·307	1·59
40	·509	1·72
40	·672	1·54
40	·808	1·66
10	·886	1·64*
5	·952	6·40*

TABLE 5 (*continued*).

n	phase	bright-ness
	P	s
5	·971	8·74*
5	·984	9·44*
	*m**	
	P	s
30	·058	2·29
30	·160	2·97
30	·331	2·92
30	·506	2·36
20	·639	2·97
4	·684	3·07
4	·716	3·15
6	·742	4·50
6	·762	5·12
7	·773	5·30
6	·784	5·13
4	·806	4·15
3	·825	3·86
20	·852	2·94
33	·958	2·75
	P	s
10	± ·004	5·19
10	± ·014	5·15
10	± ·035	4·23
10	± ·056	3·10
30	± ·092	3·04
40	± ·175	2·74
40	± ·252	2·08
40	± ·330	2·99
43	± ·423	2·86
	n	
	P	s
40	·078	·66
30	·231	·87
40	·366	·62
30	·536	·57
10	·616	·98*
5	·654	2·42*
5	·672	5·44*
5	·687	8·50*
5	·696	9·68*
4	·706	10·08*
4	·717	9·70*
4	·728	8·40*
5	·767	2·18*
5	·806	1·26*
10	·840	·94
30	·941	·46
	P	s
9	± ·006	9·91*
9	± ·015	9·29*
8	± ·030	6·79*
8	± ·052	2·48*
9	± ·074	1·43*
9	± ·104	1·03
60	± ·178	·54
60	± ·317	·58
60	± ·433	·84
	o	
	P	s
30	·063	2·68
30	·206	2·81
30	·311	2·76

n	phase	bright-ness
	P	s
30	·426	2·47
5	·530	2·70*
5	·552	3·34*
4	·572	4·32*
4	·603	5·10*
4	·638	5·42*
4	·664	4·82*
5	·688	3·52*
6	·712	3·08*
30	·799	2·70
30	·952	2·62
	*p**	
	P	s
15	·042	3·56
15	·159	5·09
15	·235	5·85
15	·301	6·31
15	·404	7·49
15	·506	8·64
15	·614	9·14
15	·708	9·17
15	·795	8·50
6	·836	8·05
4	·858	6·75
4	·871	5·32
4	·886	2·68
15	·957	·89
	q	
	P	s
40	·076	1·95
4	·190	2·95*
3	·196	3·70*
2	·214	6·85*
4	·222	11·18*
4	·230	14·75*
4	·236	15·50*
2	·246	15·45*
2	·260	14·35*
2	·270	9·80*
3	·278	6·03*
4	·289	4·28*
4	·302	2·18*
40	·401	2·12
40	·582	2·05
40	·743	2·04
40	·914	2·10
	r	
	P	s
25	·051	2·35
25	·157	2·51
25	·283	2·91
25	·397	2·65
25	·491	2·92
25	·603	3·05
25	·677	2·82
4	·718	3·35*
2	·736	3·95*
2	·743	5·35*
1	·752	6·6 *
1	·759	11·4 *
1	·772	16·3 *
3	·778	19·83*
4	·788	20·05*
3	·793	19·80*

n	phase	bright-ness
	P	s
3	·799	19·53*
2	·807	15·45*
2	·814	10·95*
3	·818	10·60*
1	·823	8·2 *
1	·827	6·6 *
5	·853	3·20*
25	·922	2·94
	s	
	P	s
20	·072	1·46*
6	·129	2·08*
6	·167	2·40*
7	·210	2·71*
6	·239	3·00*
6	·276	1·83*
20	·335	1·16*
40	·483	1·12
40	·612	1·14
40	·748	1·04
40	·897	1·22
	*t**	
	P	s
10	·020	5·41
10	·070	5·26
10	·128	5·31
10	·198	5·69
10	·251	5·77
10	·302	5·70
10	·348	5·98
10	·393	5·80
10	·436	5·73
10	·486	6·06
7	·533	5·54
8	·568	4·56
8	·603	1·75
10	·637	·65
10	·662	·85
10	·695	1·67
10	·723	2·49
10	·761	2·60
10	·799	3·78
10	·837	3·87
10	·890	4·55
10	·935	5·12
10	·980	5·40
	*u**	
	P	s
20	·022	2·48
5	·072	2·62
5	·106	3·88
5	·122	4·50
5	·144	4·84
5	·161	4·46
5	·199	3·32
5	·238	2·60
20	·300	2·29
40	·397	2·35
40	·542	2·37
40	·738	2·71
40	·884	2·26

n	phase	bright-ness
	P	s
7	± ·009	4·60
7	± ·021	4·83
7	± ·032	3·97
7	± ·065	2·89
7	± ·078	2·46
40	± ·138	2·34
40	± ·225	2·32
40	± ·290	2·30
40	± ·356	2·47
40	± ·449	2·59
	*v**	
	P	s
10	·033	6·10
10	·102	6·78
10	·164	7·35
10	·277	7·31
10	·332	6·87
10	·378	6·06
7	·433	5·24
7	·464	2·94
7	·498	1·84
10	·540	1·78
10	·585	1·69
10	·643	1·29
10	·714	1·97
10	·763	2·68
10	·813	3·06
10	·850	3·20
10	·896	4·60
10	·951	4·99
	*w**	
	P	s
10	·012	2·27
10	·065	2·70
10	·138	3·50
10	·170	3·94
10	·198	3·89
10	·253	3·66
10	·313	3·11
10	·370	2·26
10	·416	1·92
10	·453	2·34
10	·496	1·93
10	·546	2·34
10	·586	3·10
10	·617	3·48
10	·650	4·01
10	·693	4·47
10	·723	4·27
10	·752	3·75
10	·785	2·87
10	·842	2·51
9	·891	2·02
9	·943	2·01
9	·980	1.92
	P	s
10	± ·014	4·45
20	± ·036	4·12
20	± ·067	3·59
20	± ·101	3·00
20	± ·148	2·46
20	± ·199	2·05
20	± ·248	2·11
20	± ·287	1·96

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
20	± ·326	2·24	5	·870	2·96*	2	·573	·30*	10	·616	·25*
20	± ·388	3·13	6	·885	2·33*	2	·580	·35*	5	·646	·40*
19	± ·448	3·66	8	·916	·99*	2	·587	·24*	5	·673	·74*
18	± ·482	3·88	7	·959	·79*	3	·594	·13*	5	·707	1·22*
						3	·604	·08*	5	·724	1·56*
	x			*y*		3	·613	— ·10*	5	·743	1·62*
	P	s		P	m	3	·621	— ·19*	5	·759	1·70*
60	·160	·73	30	·112	— ·30	29	·782	— ·26	5	·778	1·38*
60	·412	·66	29	·287	— ·29	29	·943	— ·28	5	·799	1·34*
60	·652	·65	29	·409	— ·29				5	·812	·88*
5	·803	1·02*	3	·537	— ·10*		*z*		5	·823	·82*
5	·820	1·52*	2	·551	·22*		P	s	5	·842	·38*
5	·840	2·70*	2	·559	·27*	50	·175	·36	10	·866	·32*
5	·854	3·14*	2	·566	·32*	50	·436	·32	50	·980	·27

ERRATA in *B. A. N.* 185.

Page 160, below Figure 1	*for*	Conclation	*read:*	Correlation.
2nd column, last line	„	$\delta(\log d)$	„	0·75 $\delta(\log d)$.
„ 162, 2nd „ , line 15	„	in objects	„	objects.
„ 168, N. G. C. 598, $\log r_d$	„	— ·77	„	— ·02.
„ 171, 2nd column, formula (26)	„	10^{45}	„	10^{27}.

A misidentification has occurred in the case of the nebula, which is mentioned in Table XIII (p. 169) under Nr. 4824. The measured radial velocity belongs to N. G. C. 4884. which, according to REINMUTH, does not exist separately, but is identical to 4889. This latter is probably of type E5, $\log d = 0{\cdot}18$, $m/5 = 2{\cdot}4$. This gives $\log r_m = 1{\cdot}12$, $\log r_d = 0{\cdot}86$, adopted $\log r = 1{\cdot}0$, $r = 10$, which falls almost exactly on the curve. (The correction ΔV is unaltered).