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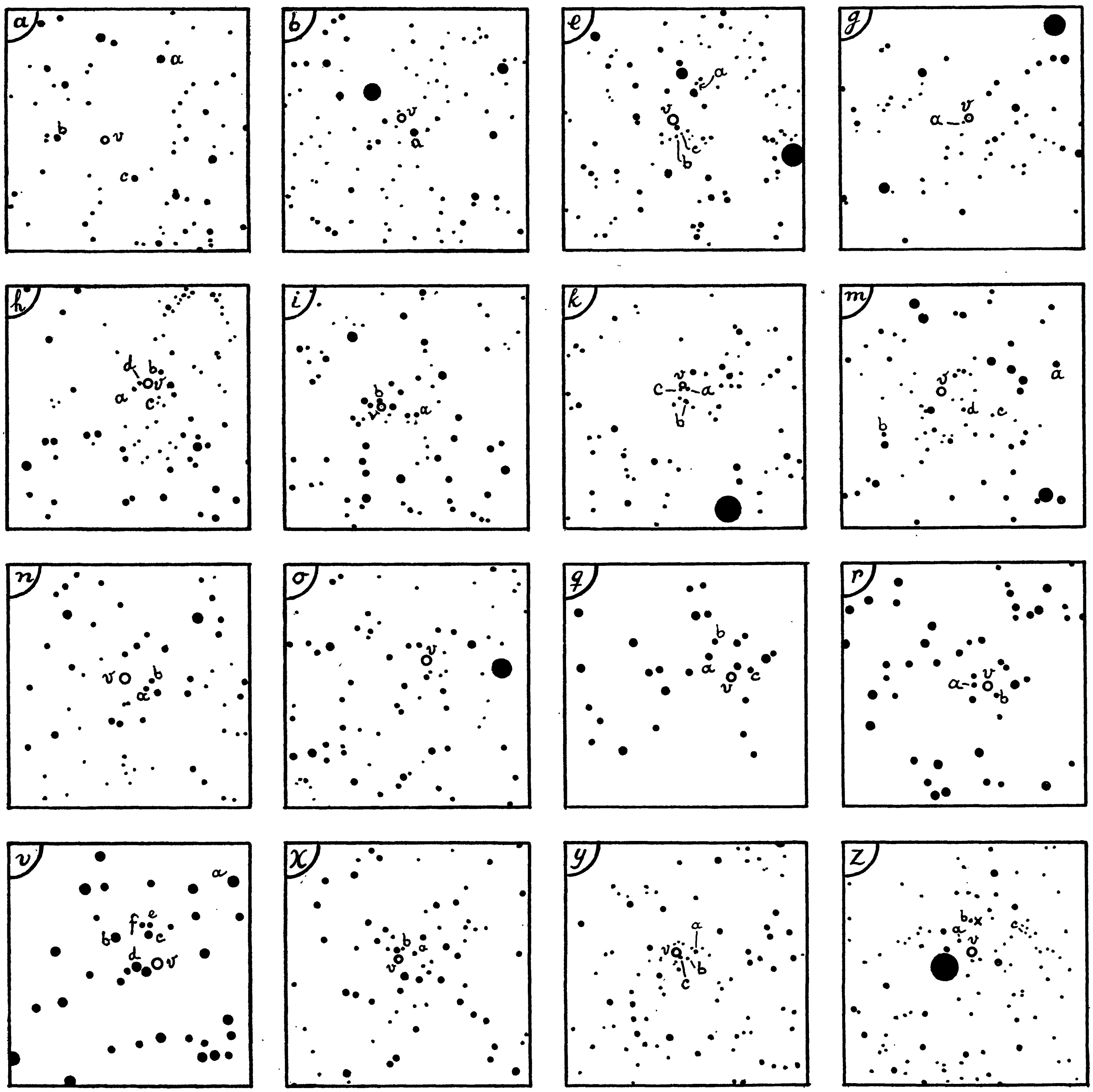
COMMUNICATIONS FROM THE OBSERVATORY AT LEIDEN

Photographic estimates of 25 southern variable stars, by *Ejnar Hertzsprung*.



The size of the squares is 20′ × 20′.

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

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

The period given in Table 1 does not always agree exactly with the reciprocal period used, as the period has sometimes been improved afterwards by the aid of a more refined treatment of the observations. The mean errors of period and epoch are indicated in units of the last decimal.

TABLE 1.

	designation	α (1875)	δ (1875)	found by	type	reciprocal period used	period	m.e.	numb. of plates	epoch J. D. hel. — 2420000	m.e.	kind of epoch	approximate limits of pg magnitude	
		h m s	° ′			d^{-1}	d	±		d	±		m	m
a	AY Pup	7 33 23	—24 12·3		W UMa	4·264755	2 × ·23447993	10	360	6371·4070	6	min	11·6	12·5
b	D 4	7 35 45	—25 21·9	Hzg	Algol	1·493	2 × ·6697912	11	342	6263·5471	16	min	12·1	12·9
c	WX Pup	7 36 48	—25 35·0		δ Ceph	·111865	8·9393	2	350	6147·41	2	↗ ·5	9·1	10·1
d	B 57	7 36 50	—20 57·5	Hzg	Algol	·929464	1·0758889	8	359	6378·5404	8	min	11·3	12·3
e	D 3	7 41 19	—23 54·8	Hzg	Algol	·583637	1·713393	3	350	6561·069	2	min	13·7	15·1
f	ZZ Pup	7 42 54	—18 59·0		Algol	·157774	6·33818	2	361	7239·464	3	min	9·3	11·7
g	D 2	7 46 44	—20 59·1	Hzg	Algol	1·1587	·8630358	12	327	6274·5349	13	min	13·6	14·2
h	D 1	7 50 16	—24 2·5	Hzg	W UMa	1·25619	·796057	9	352	6161·4919	9	min	13·9	14·6
i	D 5	7 52 16	—23 47·0	Hzg	Algol	·370492	2·69911	4	345	6471·67	2	min	14·0	14·6
k	—	7 56 10	—21 49·5	v. Gent	RR Lyr	1·953482	·5119070	5	342	6401·0060	11	↗ ·3	13·3	14·6
l	AA Pup	7 56 19	—24 22·2		Algol	·141493	7·0671		362	5652·59		min	10·4	11·6
m	B 34	8 9 52	—42 11·3	Hzg	δ Ceph	·02019	49·53	3	281	6214·91	14	↗ ·5	12·5	13·6
n	vG 1	8 25 20	—40 48·4	v. Gent	δ Ceph	·13887	7·2008	5	271	6180·06	10	↗ ·25	13·1	13·5
o	vG 64	10 34 44	—54 27·3	v. Gent	Algol	2·384173	·4194326	17	—	4374·217	3	min	13·5	13·9
p	—32°4551	17 20 51	—32 53·9	Hzg	Algol	·857163	2 × 1·16664	5	298	8339·229	9	min	8·0	8·4
q	V386 Sco	17 32 35	—34 36·8		Algol	·56277	1·776925	7	292	8161·0303	14	min	13·0	14·6
r	—	17 34 3	—28 14·2	Hzg	Algol	·03592	27·84	1	278	8325·3	2	min	14·2	15
s	V393 Sco	17 40 27	—35 ·6		Algol	·129656	7·71272	13	301	8321·118	7	min	7·7	8·7
t	—30°4911	17 40 36	—30 25·7	Hzg	δ Ceph	·107342	9·3163	4	300	8260·57	3	↗ ·7	9·7	10·4
u	RY Sco	17 42 37	—33 39·9		δ Ceph	·049235	20·3109	6	289	8254·78	10	↗ ·3	8·2	9·5
v	BS Sco	17 46 57	—31 36·9		Algol	·131191	7·62247	7	298	8508·185	5	min	11·5	13·2
w	V453 Sco	17 48 6	—32 27·1		β Lyr	·0833041	12·0063	16	308	8357·65	6	min	6·5	7·0
x	C 80	17 58 54	—33 27·7	Hzg	δ Ceph	·04321	23·140	8	549	8277·14	15	↗ ·55	13·9	15·1
y	C 82	18 2 46	—31 56·6	Hzg	δ Ceph	·02304	43·39	4	280	8322·5	4	↗ ·4	13·5	14·3
z	C 83	18 12 50	—29 51·3	Hzg	δ Ceph	·06597	15·156	8	280	8325·5	2	↗ ·6	13·2	14·3

The five variables *b*, *e*, *g*, *h* and *i* were found during a week's stay in Groningen by the aid of the blinkmicroscope at the Astronomical Laboratory Kapteyn.

All the measures in the Schilt photometer were made by C. J. KOOREMAN. His results for each plate concerning the stars *a*, *b*, *c* and *g* will, together with the hel. J. D. with four decimals, be published in a later issue of this Bulletin.

The provisional magnitudes, which are designated by m', were derived from the galvanometer readings by the aid of the table given by WESSELINK in *B.A.N.* No. 318. In the first column of that table read 4·072 instead of 4·062.

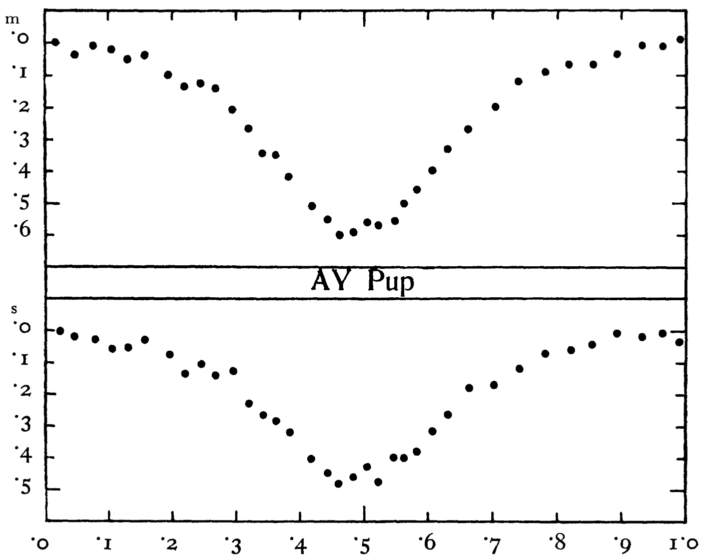
For most of the variables a special table gives mean values of phase and brightness for groups each containing a number n of observations, which is either the same for all groups or indicated separately for each of them. Several of the calculations were made with a decimal more than the rounded off values given in the tables.

In case the variable has been both measured in the Schilt photometer by C. J. KOOREMAN and estimated by the writer a difference in zeropoint between the two scales is frequently noted. This feature may partly be explained by a systematic error in the estimates, of the same kind as the hour angle error in visual estimates and partly by a difference in colour between the stars compared. The penumbra of the photographic image has a larger effect on the measures in the Schilt photometer than on the estimates of the total intensity of the image, in which latter case relatively more attention is paid to the nucleus. Difference in colour between the two stars to be compared will affect the measures and the estimates in a different way. A white and a yellow star, faint images of which give the same reading in the Schilt photometer will be very different if stronger images are measured in which case the image of the white star will appear relatively bright owing to the out of focus light of short wavelength.

On the lightcurves of stars of the δ Ceph type two points are chosen separated by a certain fraction of the period in such a way that the brightness on the rising and decreasing branch is the same. The epoch of the former of these two points is given in Table 1.

I am indebted to Messrs C. J. KOOREMAN and L. PLAUT for the star counts used in an approximate determination of the necessary magnitudes.

The following remarks refer to the individual objects.



a = AY Pup. This known variable of the W UMa type was also measured by C. J. KOOREMAN in the Schilt photometer, which measures have about four times the weight of my estimates.

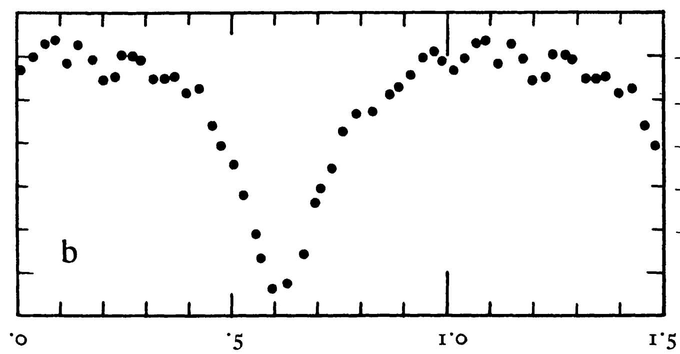
The period was derived from 56 observations on the descending and 64 on the ascending branch of the lightcurve, respectively between the phases ·30 to ·44 and ·54 to ·68. The slope of the branches, d/m', was included as an unknown in the least squares solution and found to be ·073 ± ·004 (m.e.). The mean error of a single epoch of this kind is ± ^{d}·005. In these calculations no difference was made between even and odd minima. The mean error of a single plate is ± ·056 for the measures of m' and ± ^{s}·082 for the estimates. The range is ·58 in m' and ·43 in s. The comparison star a = CPD — 24°2646 being taken as zeropoint, b was found to be ·91 in the scale of m' and ^{s}·52 in steps. It will be noted that the proportion $\Delta m'/\Delta s$ is ·58/·43 = 1·35 in the case of the range and ·91/·52 = 1·75 in the case of the difference between a and b. The discrepancy may in the main be due to the yellowness of the star b. In fact b is photovisually about ^{m}·6 brighter than a. KOOREMAN used a third comparison star c for which $m'_c - m'_a$ = ·75. Mean values of 1·68 $(m'_v - m'_a)/(m'_b + m'_c - 2m'_a)$ are given in the second column of Table 2.

TABLE 2.

AY Pup

mean phase and mean brightness in provisional magnitudes and in steps

P	m′	s	P	m′	s	P	m′	s
·019	·003	·003	·342	·343	·265	·605	·400	·315
·047	·033	·020	·360	·354	·287	·630	·332	·263
·078	·010	·027	·382	·418	·322	·662	·273	·182
·104	·024	·058	·417	·511	·406	·703	·202	·171
·129	·051	·056	·443	·551	·448	·740	·122	·122
·156	·040	·032	·460	·600	·480	·780	·094	·073
·193	·101	·080	·482	·594	·463	·817	·069	·058
·219	·133	·138	·504	·564	·429	·854	·069	·045
·245	·128	·106	·523	·573	·475	·893	·038	·010
·265	·144	·141	·548	·558	·398	·931	·010	·020
·295	·208	·128	·562	·504	·403	·963	·014	·008
·319	·267	·232	·582	·461	·382	·990	—·009	·037



b. Only one comparison star taken as zeropoint was used. The apparent period, ^{d}·67, of this eclipsing variable evidently has to be doubled though no difference between even and odd minima has been noted. The period was derived from 40 measures on the descending and 38 on the ascending branch of the lightcurve, respectively in the intervals of phase ·48 to ·58 and ·65 to ·75. The slope of the branches was taken to be ·214 d/m'. The mean error

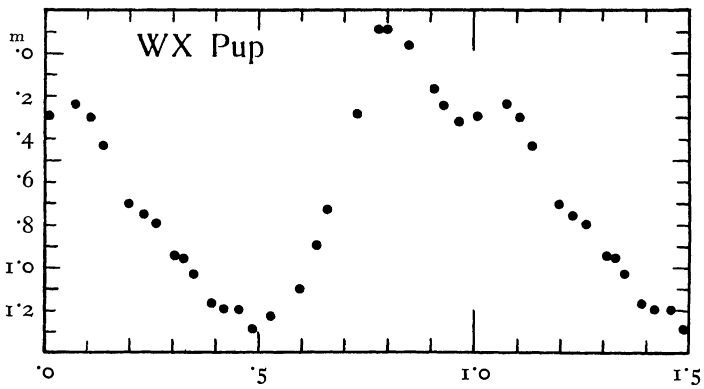
TABLE 3.

star *b*

mean phase and mean brightness in steps *s*, in provisional magnitudes m' and in steps reduced to the scale of m'

P	s	m′	s′	P	s	m′	s′
·010	—·168	—·466	—·444	·505	—·010	—·247	—·234
·036	—·224	—·496	—·518	·528	·014	—·174	—·203
·064	—·253	—·527	—·557	·553	·099	—·089	—·090
·087	—·236	—·535	—·534	·569	·132	—·033	—·046
·114	—·188	—·482	—·471	·596	·143	·040	—·031
·143	—·212	—·524	—·503	·627	·184	·028	·023
·173	—·208	—·490	—·497	·662	·179	—·041	·016
·200	—·186	—·444	—·468	·693	·090	—·161	—·102
·226	—·182	—·452	—·463	·706	·056	—·190	—·147
·243	—·162	—·502	—·436	·729	·000	—·236	—·221
·272	—·179	—·498	—·459	·755	—·118	—·322	—·378
·290	—·183	—·491	—·464	·790	—·093	—·366	—·345
·317	—·167	—·446	—·443	·829	—·189	—·363	—·472
·341	—·216	—·446	—·508	·862	—·178	—·408	—·457
·365	—·177	—·451	—·456	·884	—·132	—·427	—·396
·395	—·179	—·413	—·459	·914	—·150	—·454	—·420
·426	—·104	—·424	—·359	·942	—·206	—·496	—·495
·453	—·017	—·337	—·244	·965	—·250	—·509	—·553
·479	—·052	—·293	—·290	·985	—·230	—·482	—·526

of a single of the 78 epochs mentioned is $\pm$ ^{d}·014. The mean error of a single observation is $\pm$ ·064 in m' and $\pm$ ·087 in s. The range is ·52 in m' and ·38 in s. The proportion of weight between m' and s is therefore 3·5. If account is taken of the plate errors this proportion will be still larger. The relation between m' and s was found to be $m' = -{\cdot}022 + 1{\cdot}327\ s = s'$.



c= WX Pup = CPD — 25°2705. The comparison stars used are a = CPD — 25°2710, ^{s}·00, —$^{m'}$·18·, b = —25°2703, ^{s}·26, $^{m'}$·18· and c at 7^{h}36^{m}·6, —25°34′ (1875), ^{s}·48, 1$^{m'}$·09. The difference in magnitude between c and the mean of a and b was assumed to be 1^{m}·4 as found from two plates taken with a grating in front of the objective. The magnitudes interpolated according to the formula $m_v = 1{\cdot}4\,(2m'_v - m'_a - m'_b)/(2m'_c - m'_a - m'_b)$ have been designated by m in spite of the remaining uncertainty of the scale.

TABLE 4.

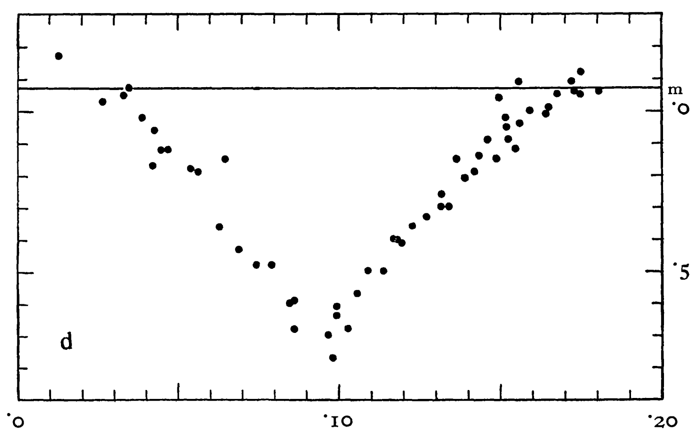
WX Pup

P	m	s	P	m	s
·006	·299	·103	·485	1·289	·539
·073	·241	·093	·528	1·233	·542
·105	·305	·090	·595	1·108	·461
·137	·435	·179	·634	·900	·356
·196	·709	·264	·660	·735	·261
·228	·759	·294	·730	·283	·074
·260	·799	·293	·778	— ·101	— ·020
·305	·950	·362	·799	— ·108	— ·015
·326	·960	·371	·848	— ·032	— ·015
·349	1·035	·429	·906	·171	·037
·389	1·171	·505	·928	·246	·046
·419	1·198	·488	·964	·324	·110
·455	1·201	·531			

The lightcurve is very similar to that of S Sge (*A.N.* 4916), the period of which is 8^{d}·38 or only ^{d}·56 less than that of WX Pup. With increasing period the secondary wave on the descending branch of the lightcurve climbs nearer to and eventually surpasses the maximum which to start with was the principal one. If this consideration is carried through the hesitation on the ascending branch of the lightcurve at periods of about two weeks (e.g. SV Vel) represents the rest of the maximum at periods of about one week.

On both the Franklin-Adams charts, J. D. 2416473·3 and 9512·3, WX Pup is near minimum brightness. The period was determined from a combination of these two dates with 16 later epochs of minimum.

The range is 1·4 in the scale of m' and ·58 in steps. The mean errors of a single observation are respectively $\pm$ $^{m'}$·080 and $\pm$ ^{s}·062. The corresponding proportion of weight is 3·5 in favour of the measures. A plot of the individual values of m' according to phase tends to show that the large deviations from the mean lightcurve mostly indicate the variable too bright. This would be the case if some of the plates have been taken in so great hour angles that the selective extinction in the atmosphere would weaken the yellow variable less than the whiter comparison stars. But this explanation does not seem to hold in the present case.



d. This variable of the eclipsing type has been measured in the Schilt photometer on 60 plates by C. J. KOOREMAN. The comparison stars used are a = CPD —20°2845, 9^{m}·5, ^{s}·00, b = —20°2852, 9^{m}·9, ^{s}·30 and c at 7^{h}36^{m}35^{s}, —20°58′·4 (1875), ^{s}·82. The value of $(m'_v - m'_b)/(m'_c - m'_b)$ is entered in the third column of Table 5. The difference between the comparison stars b and c was thus taken to be 1^{m}.

Table 5 contains 60 individual observations during or near eclipse. The fourth column gives my estimates reduced to the scale of the measures by KOOREMAN. The period was determined from 15 measures on the descending and 25 on the ascending branch of the lightcurve. The residuals O—C are given in the last column of Table 5. The mean error of a single observation of this kind is $\pm$^{d}·005. The slope of the two branches of the lightcurve was assumed to be ·09 d/m'. The constancy of the brightness outside

TABLE 5.
star *d*

J. D. — 2420000	brightness Hzg	Koo	$S_{m'}$	phase	epoch E	O—C
d	s	m′	m′	P		d
5507·612	·47	·33	·32	·1272	0	— ·000
62·506	45	15	28	·1487	51	7
·526	32	— 5	7	·1674		
5616·269	56	41	47	·1195	101	— 1
44·277	39	9	18	·1522	127	5
·299	29	— 6	2	·1728		
45·258	50	15	37	·0644	128	16
·280	51	60	38	·0846		
46·387	62	50	57	·1135	129	1
·409	35	30	12	·1338	129	4
73·272	63	68	58	·1026	154	5
·294	52	36	40	·1228	154	— 2
87·303	30	14	3	·1432	167	0
·325	30	1	3	·1641		
5714·212	31	12	5	·1544	192	10
·234	29	— 5	2	·1748		
15·299	26	— 1	— 3	·1647		
58·186	29	— 3	2	·0265		
·208	30	12	3	·0468	233	— 0
5971·301	56	50	47	·1090	431	— 4
72·317	34	18	10	·0537	432	2
·339	60	48	53	·0743	432	— 3
·406	40	15	20	·1367	432	— 6
·420	29	— 4	2	·1495	432	— 9
73·440	68	77	67	·0978		
·462	49	40	35	·1182	433	— 4
74·437	29		2	·0241		
·459	29	12	2	·0447	434	— 2
6000·382	33	21	8	·1389	458	2
·404	30	0	3	·1591		
02·476	67	68	65	·0857		
14·265	30	6	3	·0424	471	0
·286	48	36	33	·0627	471	— 5
·360	31	26	5	·1316	471	— 2
·382	30	5	3	·1518	471	1
·404	26	— 9	— 3	·1721		
·427	25		— 5	·1930		
15·436	39	30	18	·1316	472	2
·458	30	2	3	·1518	472	— 1
28·309	66	70	63	·0964		
·331	56	40	47	·1166	484	— 5
29·388	68	61	67	·0992		
·449	30	— 9	3	·1559	485	— 7
42·386	25	— 6	— 5	·1803		
83·243	28	4	0	·1556	535	4
84·226	56	43	47	·0689	536	— 4
97·250	28	— 12	0	·1747		
99·259	39	17	18	·0419	550	— 10
6273·522	28	— 17	0	·0126		
·544	30	— 5	3	·0328	712	0
99·414	60	48	53	·0790	736	2
·436	71	64	72	·0993		
7717·504	30	19	3	·1420	2054	3
·525	26		— 3	·1618		
7802·438	68	59	67	·0856	2133	— 1
·460	61	57	55	·1053	2133	— 2
8965·424	30	2	3	·0385	3214	— 0
9400·198	30	9	3	·1457	3618	— 2
02·230	32	— 7	7	·0345	3620	4
·253	41	19	22	·0558	3620	3

eclipse leaves the question, whether the period should be doubled or not, unanswered.

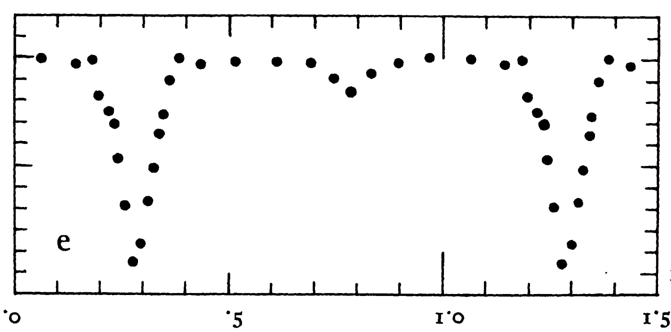
The fact that this variable is not in the C.P.D. invited the suggestion that the star was photographed during eclipse on the main CPD plate. I am indebted to Messrs L. PLAUT and A. BLAAUW for the following estimates.

C. P. D. plate no.	PLAUT	BLAAUW
2231	b 4 v 3 c	b 4 v 2 c
2275	a 4 v 3 b	a 3 v 1 b

TABLE 6.
star *d*

n	P	s	*n*	P	s
9	·0153	·278	50	·2288	·236
10	·0454	·343	50	·3439	·231
10	·0836	·614	50	·4881	·233
10	·1134	·573	50	·6103	·247
10	·1402	·342	50	·7447	·234
10	·1571	·300	50	·9024	·233

Consequently the variable was near minimum, viz. in the scale of KOOREMAN $^{m'}$·57 (PLAUT) and $^{m'}$·67 (BLAAUW) on the plate 2231 taken at J. D. 2411101·342 hel. M. astr. T. Grw. If this date is taken as a time of minimum a coefficient of about $-^{d}$·0000004 to E^2 is indicated.



e. The three comparison stars used are a ^{s}·00, b ^{s}·45 and c ^{s}·89. The period was determined from

TABLE 7.
star *e*

bright- ness	J. D. — 2420000	reduced to ^{s}·89	epoch E	kind of branch	O—C
s	d	d			d
1·10	5644·407	·432	0	+ 1	— ·000
·89	·429	·429	0	+ 1	— 4
·52	·498	·453	0	+ 1	+ 21
·64	87·303	·273	25	+ 1	+ 6
·81	5997·402	·392	206	+ 1	+ 1
·89	6002·476	·476	209	— 1	+ 2
·58	14·427	·464	216	— 1	— 4
·72	·448	·469	216	— 1	+ 1
·89	·470	·470	216	— 1	+ 2
·99	·492	·480	216	— 1	+ 12
·81	·514	·505	216	+ 1	— 21
·75	·536	·520	216	+ 1	— 6
·73	93·261	·280	262	— 1	— 4
·89	·283	·283	262	— 1	— 2
·48	6117·216	·266	276	— 1	— 6
·89	7748·474	·474	1228	+ 1	— 5
·73	·496	·476	1228	+ 1	— 3
·60	7803·351	·316	1260	+ 1	+ 9
·86	9400·198	·194	2192	+ 1	+ 5
·62	·220	·187	2192	+ 1	— 8

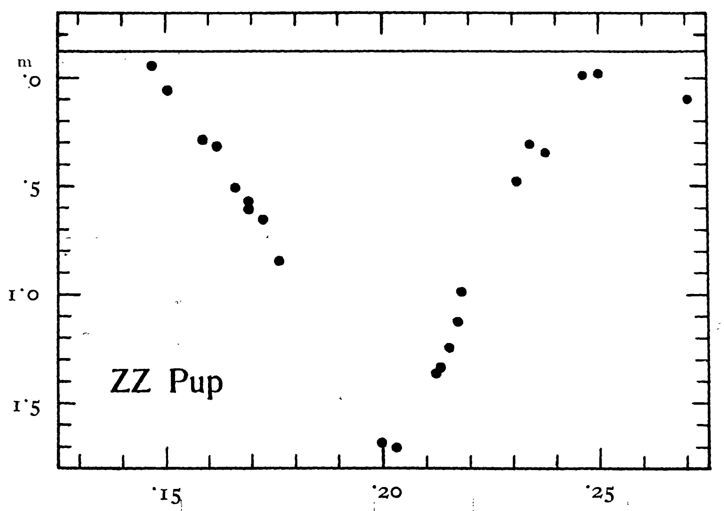
8 estimates on the descending and 12 on the rising branch of the lightcurve as given in Table 7. The dates of observation were reduced to the time at

TABLE 8.

star *e*

n	P	s	*n*	P	s
30	·0612	·003	5	·3457	·268
30	·1432	·028	5	·3591	·110
5	·1808	·008	5	·3808	·006
5	·1950	·178	30	·4314	·035
5	·2176	·252	30	·5126	·018
5	·2305	·306	30	·6092	·021
5	·2392	·472	20	·6872	·025
5	·2545	·694	20	·7449	·098
5	·2765	·958	20	·7827	·161
5	·2972	·868	20	·8324	·067
5	·3110	·672	20	·8972	·026
5	·3255	·518	30	·9658	— ·001
5	·3376	·356			

which the brightness of the variable was found equal to that of the comparison star b, ^{s}·89, assuming the slope of the branches to be equal to ·12 *d/s*.



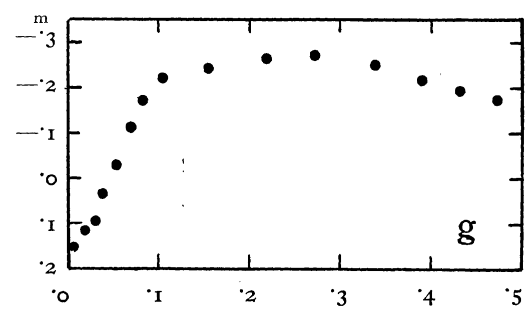
f = ZZ Pup = CPD — 18°169. The three comparison stars used are a = — 19°2697, ^{s}·00, ^{m}·0, b = — 19°2694, ^{s}·63, 1^m·2 and c at 7^{h}42^{m}56^s, — 18°58′·5 (1875), 1^s·17, 2^m·0. In Table 9 the brightness of the variable is given for 23 plates both in estimated steps and in magnitude as derived from the measures of KOOREMAN. The period was determined by the aid of 7 observations on the decreasing and 8 on the rising branch of the lightcurve as indicated in Table 9. The slope of the branches was introduced as an unknown into the equations of condition and found to be ·15 ± ·01 (m.e.) *d/m*. The semiwidth of the lightcurve at v = b is ^{d}·1025 ± ^{d}·0006 (m.e.). The maximum brightness is —^{m}·12.

TABLE 9.

ZZ Pup

J. D. — 2420000	brightness		epoch E	kind of branch	phase	O—C
d	s	m			P	d
5653·494	·00	·05			·9744	
5705·294	·00	— ·05			·1470	
·315	·00	·06			·1504	
5997·270	·82	1·34	0	+ 1	·2132	+ ·007
·294	·66	1·13	0	+ 1	·2170	+ 0
·402	·24	·31	0	+ 1	·2341	— 13
·424	·00	·35	0	+ 1	·2376	+ 15
6086·213	·01	— ·01			·2462	
·236	·00	— ·02			·2497	
92·256	1·02	1·69			·1996	
·278	1·03	1·71			·2031	
6269·464	·02	·29	43	— 1	·1585	— 20
·486	·16	·32	43	— 1	·1619	— 3
·553	·40	·66	43	— 1	·1725	+ 14
·575	·55	·85	43	— 1	·1759	+ 7
6333·305	·30	·48	53	+ 1	·2308	— 8
·557	·00	·10			·2706	
7803·351	·36	·51	285	— 1	·1659	— 6
·373	·36	·57	285	— 1	·1693	+ 7
9394·256	·33	·61	536	— 1	·1693	+ 1
9407·203	·78	1·37	538	+ 1	·2121	+ 5
·223	·76	1·25	538	+ 1	·2152	+ 7
·242	·63	·99	538	+ 1	·2182	— 12

g. Four comparison stars a, b, c and d were used for the measures made by KOOREMAN. The difference between the provisional magnitudes of v and of the mean of the four comparison stars was formed without regard to differences in gradation between different plates. If the star a is taken as zeropoint the mean provisional magnitudes as derived from 342 plates are of b ·38, of c ·63 and of d ·45. For the estimates only the comparison star d at a distance of about 40″ from the variable was used and taken as zeropoint. The period was derived



from 24 measures on the descending and 28 on the ascending branch of the lightcurve. The mean error of one epoch of this kind is ± ^{d}·0093. The lightcurve was assumed to be symmetrical and the phase of minimum has been taken as zeropoint in Table 10. There is a marked indication of ellipticity of the components. The mean error of a single measure is ± ^{m}·056.

TABLE 10.

star *g*

n	phase	brightness	
	P	m′	s
10	·0051	·154	·105
10	·0165	·118	·140
10	·0309	·095	·086
10	·0374	·036	·068
10	·0546	—·029	·004
10	·0679	—·109	—·107
10	·0839	—·170	—·136
20	·1036	—·220	—·136
40	·1526	—·242	—·202
40	·2171	—·265	—·236
40	·2727	—·271	—·244
40	·3372	—·252	—·204
30	·3892	—·218	—·173
29	·4307	—·194	—·163
18	·4728	—·173	—·183

h. The four comparison stars used are a ^{s}·00, b ^{s}·18, c ^{s}·59 and d ^{s}·94. The period was derived from the 14 most pronounced epochs of minimum given in Table 11. The mean error of a single epoch is ± ^{d}·046.

TABLE 11.

star *h*

min. at J. D. — 2420000	epoch E	O—C	min. at J. D. — 2420000	epoch E	O—C
d		d	d		d
5524·58	0	—·06	6040·46	648	—·03
64·52	50	8	64·36	678	— 1
5650·42	158	0	6266·54	932	— 3
54·42	163	2	6309·52	986	— 3
5974·46	565	5	25·43	1006	— 4
6013·37	614	— 5	8219·32	3385	3
29·41	634	7	9402·23	4871	0

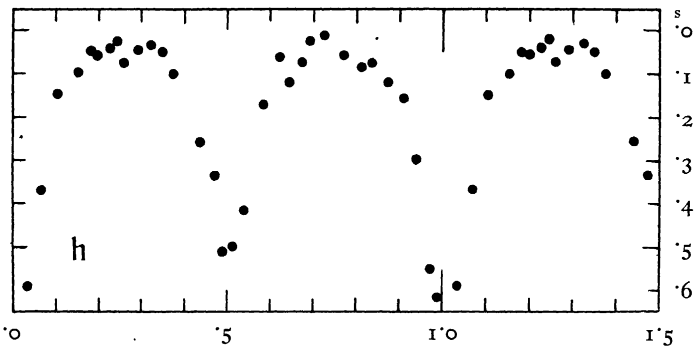
A smooth curve was drawn through the 32 points contained in Table 12. This curve was read off on 100 equidistant places and the phase of the minimum derived in the usual way as described in *B.A.N.* No. 147. The sum of the squares of the 50 differences between the two parts of the lightcurve following and preceding the phases ·995 ($x = -1$), ·005 ($x = 0$) and ·015 ($x = +1$) are respectively $y_{-1} = {}^{s2}·2422$, $y_0 = {}^{s2}·0794$ and $y_{+1} = {}^{s2}·2844$. The phase of the minimum therefore is ·0045 ± ·0017 (m.e.).

TABLE 12.

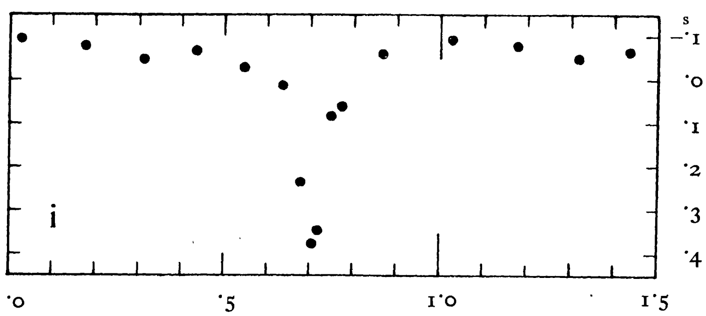
star *h*

P	s	P	s	P	s	P	s
·0331	·591	·2572	·075	·5124	·500	·7702	·057
·0681	·370	·2919	·049	·5369	·419	·8009	·088
·1105	·150	·3202	·033	·5854	·172	·8365	·076
·1525	·102	·3489	·052	·6241	·063	·8710	·123
·1770	·054	·3725	·105	·6461	·123	·9065	·161
·1974	·060	·4386	·257	·6731	·075	·9387	·299
·2224	·045	·4730	·335	·6926	·028	·9677	·551
·2411	·024	·4888	·512	·7244	·015	·9874	·616

The square of the mean error of the phase of minimum is equal to $2\Delta^2 P\ (a - b^2/4c)\,/\,cn$, where a, b and c are the coefficients in the equation $y = a + bx + cx^2 = y_0 - \frac{1}{2}(y_{-1} - y_{+1})\,x + \frac{1}{2}(y_{-1} - 2y_0 + y_{+1})\,x^2 = ·0794 + ·0191\,x + ·1819\,x^2$, where n is the number of points used to draw the lightcurve and



ΔP the shift in phase between two consecutive values of x, in the present case ^{P}·01, which is taken as unit for x. The minimum value of y or $a - b^2/4c = {}^{s2}·0789$ depends on the accuracy of the observations and $y - y_{\min}$ on the character of the lightcurve. The mean error of a single estimate is ± ^{s}·092 or of the mean of 11 observations ± ·028. The square of this, ^{s2}·0008, is in good agreement with the value of $y_{\min}$ found above from 100 readings on the lightcurve, viz. ^{s2}·0789.



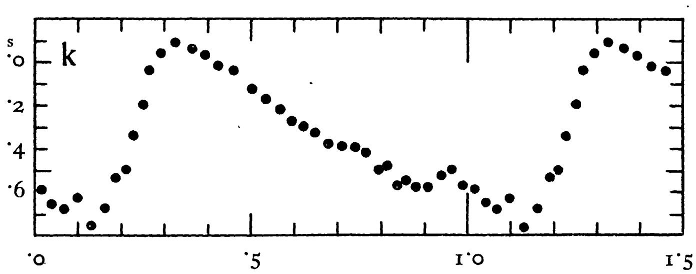
i. The estimates of this variable were made difficult by a close companion nf. For the same reason

TABLE 13.

star *i*

n	P	s	*n*	P	s
50	·0248	— ·090	5	·6731	·236
50	·1764	— ·077	5	·7029	·378
50	·3129	— ·046	5	·7151	·346
50	·4307	— ·063	10	·7459	·087
50	·5438	— ·027	10	·7711	·062
10	·6322	·014	50	·8664	— ·056

the star has not been measured in the Schilt photometer. The two comparison stars used are a ^{s}·00 and b ^{s}·34.



k. The comparison stars used for this variable of the RR Lyr type are a ^{s}·00, b ^{s}·50 and c ^{s}·84. The period was derived from 20 estimates on the rising branch of the lightcurve as given in Table 14. The slope was assumed to be ·068 d/s. The mean error of one such observation is ± ^{d}·0047, while the m.e. of one estimate was found to be ± ^{s}·12.

TABLE 14.

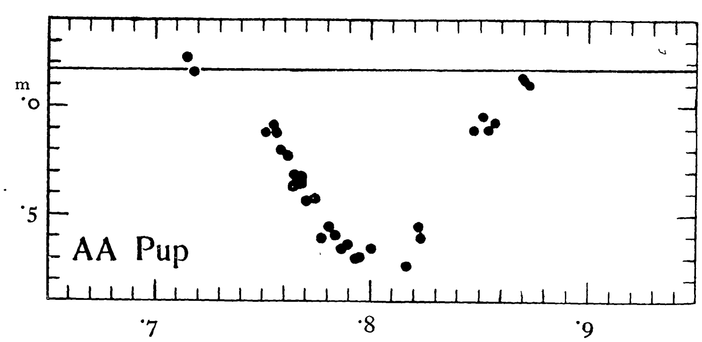
star *k*

J. D. — 2420000	bright-ness	epoch E	O – C	J. D. — 2420000	bright-ness	epoch E	O – C
d	s		d	d	s		d
5562·5056	·25	0	·0062	6014·5364	—·08	883	·0007
5616·2686	·03	105	40	28·3310	·25	910	— 38
44·4071	·12	160	— 62	87·2268	·00	1025	57
·4290	—·05	160	41	89·2665	·02	1029	— 8
85·3482	·31	240	— 48	6269·4644	·00	1381	44
5704·3042	·20	277	32	73·5435	·25	1389	52
05·3153	·33	279	— 8	6476·2610	·00	1785	— 94
5973·5724	·00	803	— 53	8219·3083	·04	5190	— 28
6013·5132	—·07	881	19	9399·2282	·50	7495	27
14·5143	·17	883	— 44	·2483	·17	7495	4

TABLE 15.

star *k*

n	P	s	*n*	P	s	*n*	P	s
10	·017	·59	10	·324	—·09	10	·709	·39
10	·041	·65	10	·362	—·06	10	·740	·40
10	·068	·68	10	·394	—·03	10	·767	·42
10	·097	·63	10	·424	·02	10	·796	·50
10	·131	·76	10	·462	·04	10	·818	·48
10	·162	·68	10	·502	·13	10	·836	·57
10	·192	·53	10	·536	·17	10	·858	·55
6	·208	·50	10	·566	·22	10	·879	·58
5	·226	·34	10	·595	·28	10	·909	·58
5	·252	·20	10	·621	·30	10	·941	·53
6	·268	·04	10	·647	·33	10	·965	·50
10	·294	—·04	10	·676	·38	10	·992	·57

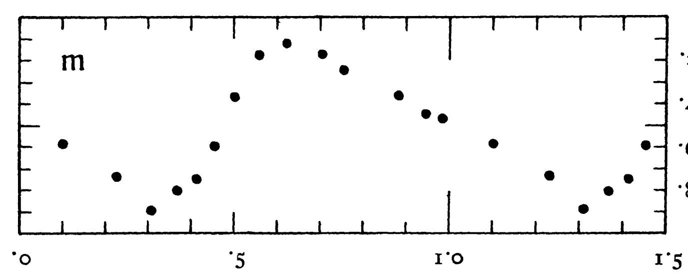


l = AA Pup. This variable of the Algol type was measured by KOOREMAN on 40 selected plates merely near the primary minimum as exhibited in Table 16. There are too few observations during eclipse for a more detailed study.

TABLE 16.

AA Pup

J. D. — 2420000	brightness		phase	J. D. — 2420000	brightness		phase
d	s	m′	P	d	s	m′	P
5532·588	·47	·56	·8225	5652·502	·47	·64	·7894
64·504	·06	—·11	·3384	·523	·49	·71	·7925
·526	·18	—·10	·3415	54·342	·00	—·12	·0498
5644·299	·00	—·19	·6288	5709·232	·47	·74	·8164
45·258	·33	·37	·7645	·278	·47	·61	·8229
·280	·26	·36	·7676	6012·415	—·02	—·22	·7146
46·507	·00	—·12	·9412	13·357	·05	·11	·8479
50·436	·00	—·23	·4971	·379	·05	·05	·8510
51·452	·00	—·16	·6409	·513	·00	—·13	·8700
52·263	·07	·13	·7556	91·256	·00	—·12	·8701
·284	·35	·21	·7587	·278	·03	—·10	·8732
·306	·23	·23	·7617	97·250	·00	—·16	·7183
·328	·33	·32	·7648	6299·414	·02	—·04	·3231
·349	·26	·33	·7678	·436	·19	—·20	·3261
·371	·39	·44	·7709	6309·508	·16	·12	·7513
·392	·40	·43	·7740	·530	·16	·09	·7544
·415	·47	·61	·7771	38·504	·04	·11	·8540
·437	·47	·56	·7802	·523	·29	·08	·8566
·458	·45	·60	·7833	8656·219	·47	·70	·7944
·480	·52	·66	·7864	·258	·47	·66	·7999



m. The comparison stars used for this variable of the δ Ceph type are a ^{s}·00, *b* ^{s}·36, c ^{s}·58 and d ^{s}·98. The period of nearly 50 days is rather unusual for stars of this type. As is also the case with the δ Ceph star *o* of *B.A.N.* No. 327 (Figure 11) with a period of 64 days the lightcurve does not change its appearance materially if turned upside down. Two points, one on the ascending and one on the descending

TABLE 17.

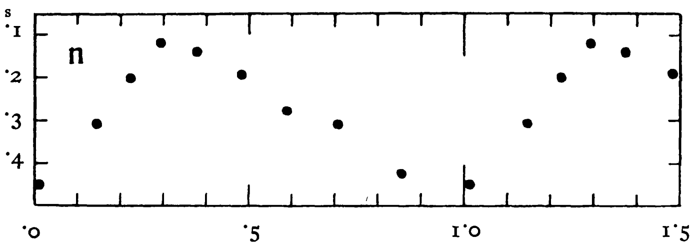
star *m*

n	P	s	*n*	P	s
20	·1003	·588	20	·5606	·180
20	·2278	·736	20	·6204	·122
20	·3081	·894	20	·7040	·175
20	·3650	·805	20	·7527	·251
20	·4118	·752	20	·8814	·366
20	·4522	·598	20	·9448	·450
20	·5002	·367	21	·9857	·469

branch, may therefore be indicated, in regard to which the lightcurve is practically symmetrical. The brightness of the variable at these two points is $^{s}\cdot 47$ and the phase of that on the ascending branch is indicated in Table 1.

For the determination of the period 45 observations on the rising branch of the lightcurve between the phases $^{P}\cdot 42$ and $^{P}\cdot 53$ were used. The interval in time thus covered is from J. D. 2425719 to 6514. The period of nearly 50 days thus found satisfies the 45 epochs with a mean error of $\pm\ ^{d}\cdot 94$, corresponding to $\pm\ ^{s}\cdot 094$, while the m.e. of a single estimate, as derived from the differences between two observations following each other in phase, is found to be $\pm\ ^{s}\cdot 102$ or practically the same.

So far it seems that this variable is of regular δ Ceph type with a rather unusually long period. But the fact that later observations near J. D. 2428000 fall approximately a quarter of a period earlier than the prediction still leaves the question open as to the true character of this object. On the Franklin-Adams chart photographed on J. D. 2419513 the star is near maximum brightness.



n. The comparison stars used for this faint variable of the δ Ceph type are a $^{s}\cdot 00$ and b $^{s}\cdot 27$. The star was found near maximum on the Franklin-Adams chart photographed on J. D. 2419513·3.

TABLE 18.

star *n*

n	P	s	*n*	P	s
31	·0108	·451	30	·4799	·194
30	·1467	·309	30	·5897	·277
30	·2223	·202	30	·7049	·310
30	·2916	·122	30	·8541	·427
30	·3774	·144		m.e.	± ·019

The period derived from this approximate epoch of maximum in connection with 19 newer epochs of the same kind is only to be considered as preliminary. The present estimates are not accurate enough to guarantee the hesitation on the descending branch of the lightcurve, which is ordinarily found for δ Ceph stars with similar periods. The mean error of a single estimate is $\pm\ ^{s}\cdot 103$.

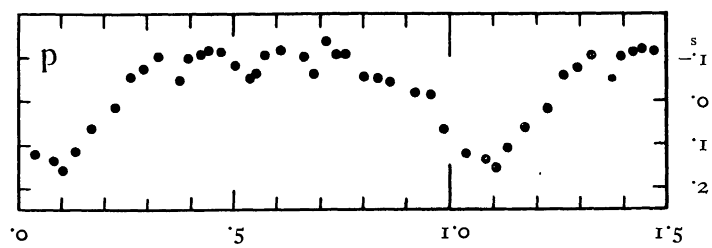
o. In the case of this faint Algol variable of small range I confined myself to the selection of the most pronounced epochs of minimum given in Table 19, from which the period was determined.

TABLE 19.

star *o*

J. D. — 2420000	E	O—C	J. D. — 2420000	E	O—C
d		d	d		d
3828·47	0	·00	4172·42	820	·02
58·25	71	0	77·45	832	2
71·26	102	1	98·40	882	— 1
76·28	114	0	4292·35	1106	— 1
86·34	138	— 1	5745·26	4570	— 1
3928·27	238	— 2	76·32	4644	1
36·26	257	0	6120·25	5464	0
44·23	276	0			

p = CPD $-32°4551$. Only one comparison star, viz. CPD $-32°4529$, $8^{m}\cdot 2$, was used. The period was finally determined by the aid of 34 estimates on the



descending and 40 on the ascending branch of the lightcurve. The mean error of one such epoch was found to be $\pm\ ^{d}\cdot 033$. The width of the minimum

TABLE 20.

star *p*

n	P	s	*n*	P	s	*n*	P	s
10	·038	·12	10	·396	— ·10	10	·687	— ·06
10	·083	·14	9	·424	— ·11	10	·713	— ·13
10	·105	·16	10	·446	— ·12	10	·737	— ·11
10	·135	·11	10	·472	— ·11	10	·759	— ·10
10	·172	·06	10	·504	— ·08	10	·801	— ·05
10	·226	·01	10	·534	— ·05	10	·833	— ·05
10	·260	— ·06	10	·554	— ·06	10	·860	— ·04
10	·294	— ·07	10	·572	— ·10	10	·918	— ·01
10	·325	— ·10	10	·609	— ·11	10	·956	— ·01
10	·375	— ·04	10	·663	— ·10	9	·985	·07

indicates that the period has to be doubled. The star is bright enough for the determination of radial velocities and doubling of the lines may be expected.

q = V 386 Sco. The three comparison stars used are a $^{s}\cdot 00$, b $^{s}\cdot 55$ and c $1^{s}\cdot 10$. The period was determined from 14 estimates on the descending and 9 on the ascending branch of the lightcurve as indicated in Table 21. The mean error of one

TABLE 21.
V 386 Sco

J. D. hel. — 2420000	bright-ness	fraction of day red. to ^{s}·55	epoch E	descen-ding or rising branch	O — C
d	s	d			d
7681·305	·55	·305	0	+ 1	— ·007
7713·221	1·10	·194	18	— 1	2
·264	1·12	·291	18	+ 1	— 5
·285	·59	·288	18	+ 1	— 8
·306	·45	·299	18	+ 1	3
7949·522	·55	·522	151	— 1	— 1
·544	·93	·524	151	— 1	1
7981·491	·40	·503	169	— 1	— 5
·513	·55	·513	169	— 1	5
·534	1·15	·505	169	— 1	— 3
·600	1·07	·626	169	+ 1	14
·621	·55	·621	169	+ 1	9
8015·257	·40	·268	188	— 1	— 2
·278	·55	·278	188	— 1	9
8342·331	·42	·321	372	+ 1	— 7
97·388	1·10	·415	403	+ 1	3
8461·267	·52	·269	439	— 1	— 9
8642·544	·90	·526	541	— 1	2
58·503	·46	·510	550	— 1	— 6
·526	·57	·525	550	— 1	9
99·413	·98	·391	573	— 1	5
8749·240	·57	·241	601	+ 1	— 2
72·236	·58	·234	614	— 1	— 5

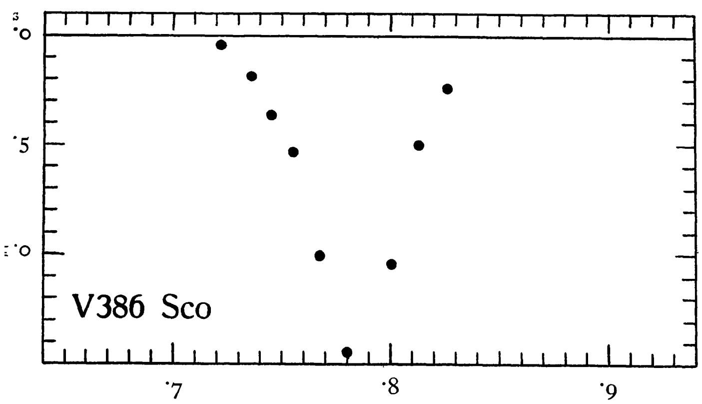


TABLE 22.
V 386 Sco

n	phase	bright-ness
	P	
60	·145	·009
60	·396	·020
60	·607	·026
5	·722	·042
5	·736	·190
6	·745	·370
6	·755	·532
5	·767	1·012
7	·780	1·444
5	·800	1·046
5	·813	·508
8	·826	·250
60	·959	·007

epoch is ± ^{d}·0065. The form of the lightcurve is rather unusual for a period of less than two days. Another example of this kind is UW Vrg.

***r*.** The two comparison stars used are a ^{s}·0 and b ^{s}·3. The eclipse of this faint Algol star lasts for only 1/20 of the period. The total range is still unknown. The star was measured by KOOREMAN on 7 plates taken during eclipse. If the provisional magnitude at maximum brightness is chosen as zeropoint m' was found to be ·90 at J. D. hel. 2427685·332. On six consecutive plates taken on J. D. 2427713 the values of m' were ·84, 1·02, ·60, ·64, ·46 and ·22 respectively, at the fractions of the day ·221, ·242, ·264, ·285, ·306 and ·328. The large m.e. of the epoch of minimum is due to the fact that nearly all the observations during eclipse are on the rising branch of the lightcurve.

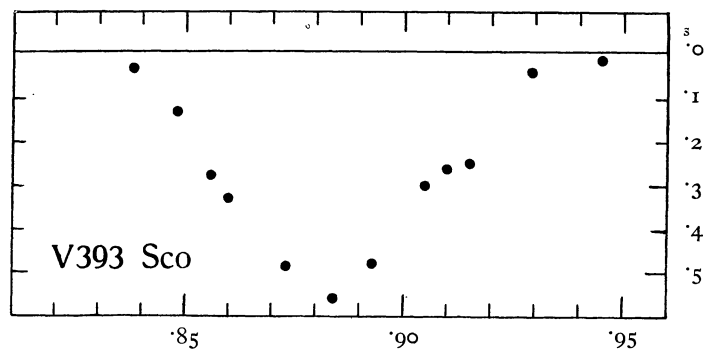


TABLE 23.
V 393 Sco

J. D. hel. — 2420000	bright-ness	fraction of day reduced to ^{s}·27	kind of branch	epoch E	O—C
d	s	d			d
7596·346	·27	·346	+ 1	0	·020
·367	·25	·357	+ 1		30
7665·340	·27	·340	— 1	9	6
·361	·24	·376	— 1		42
7981·534	·27	·534	— 1	50	— 21
·556	·30	·541	— 1		— 14
·577	·27	·577	— 1		22
·600	·43	·520	— 1		— 35
·621	·49	·511	— 1		— 44
8398·316	·49	·426	+ 1	104	— 23
·339	·42	·414	+ 1		— 35
8429·245	·27	·245	+ 1	108	— 55
8714·270	·27	·270	— 1	145	7
·292	·37	·242	— 1		— 22
22·263	·45	·353	+ 1	146	— 30
·470	·22	·445	+ 1		62
45·230	·48	·125	— 1	149	11
·255	·45	·165	— 1		51
·477	·39	·537	+ 1		16
·499	·29	·509	+ 1		— 12
53·237	·27	·237	+ 1	150	· 3
·258	·27	·258	+ 1		24

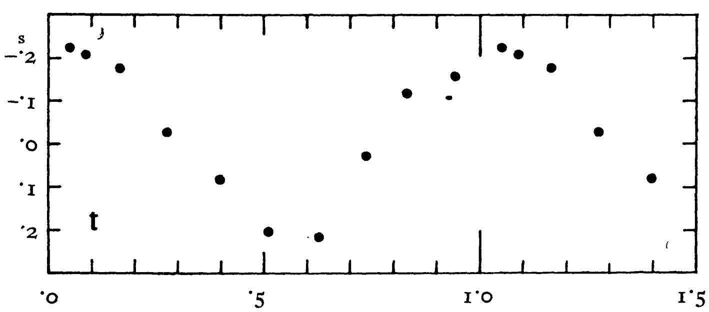
s = V 393 Sco = CPD $-35°7282$, $7^m{\cdot}8$. The three comparison stars used are a $^s{\cdot}00 = -35°7251$, b $^s{\cdot}27 = -35°7314$ and c $^s{\cdot}68 = -34°7119$. The

TABLE 24.

V 393 Sco

n	P	s	*n*	P	s
20	·035	·01	4	·848	·13
20	·127	—·01	4	·856	·28
20	·208	—·00	4	·860	·33
20	·287	—·00	4	·873	·49
20	·378	·02	4	·884	·56
20	·443	·00	4	·893	·48
20	·499	·00	4	·905	·30
20	·568	—·01	4	·910	·26
20	·635	—·01	4	·915	·25
20	·687	·00	4	·929	·04
20	·739	·00	5	·945	·01
20	·801	·03	10	·978	·02
6	·838	·03			

period was derived from 11 estimates on the descending and 11 on the ascending branch of the lightcurve as indicated in Table 23. The mean error of one epoch is $\pm\,^d{\cdot}033$.



t = CPD $-30°4911$. The two comparison stars used are a $^s{\cdot}00 = -30°4903$ and b $^s{\cdot}25 = -30°4907$. This variable of the δ Ceph type was found near maximum brightness on the Franklin-Adams chart taken on J. D. 2418882·33. By the aid of this epoch

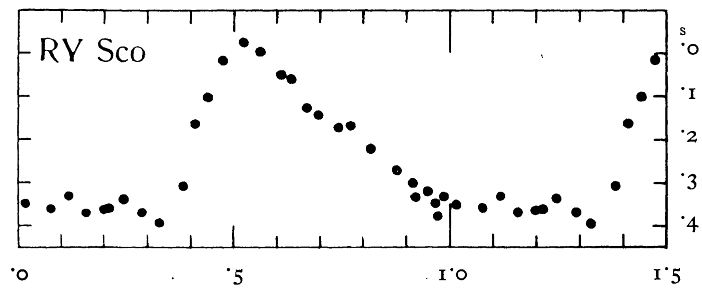
TABLE 25.

star *t*

n	P	s	*n*	P	s
39	·086	—·21	48	·623	·22
40	·272	—·03	48	·736	·03
39	·398	·08	33	·832	—·12
23	·508	·21	30	·942	—·15

of maximum in connection with 10 newer ones the period was found to be $9^d{\cdot}3160 \pm\,^d{\cdot}0005$ (m.e.) and from 51 estimates on the rising branch $9^d{\cdot}3168 \pm\,^d{\cdot}0006$. The form of the lightcurve is nearly symmetrical and very similar to that of the star *k* of *B.A.N.* No. 327 (Figure 7), the period of which is $9^d{\cdot}2$. The mean error of a single estimate is $\pm\,^s{\cdot}055$.

u = RY Sco = CPD $-33°4644$. The two comparison stars used are a $^s{\cdot}00 = -33°4651$ and b $^s{\cdot}41 =$



$-33°4633$. The period was derived from the 10 epochs of maximum collected in Table 26. The minimum is nearly constant for about one third of

TABLE 26.

RY Sco

J. D.	E	O—C
d		d
2413836·5	0	·3
15034·5	59	·0
15928·3	103	·1
19664·6	287	—·8
27688·3	682	·1
28095·5	702	1·1
28419·3	718	—·1
28642·5	729	—·3
28723·8	733	—·3
28744·2	734	—·2

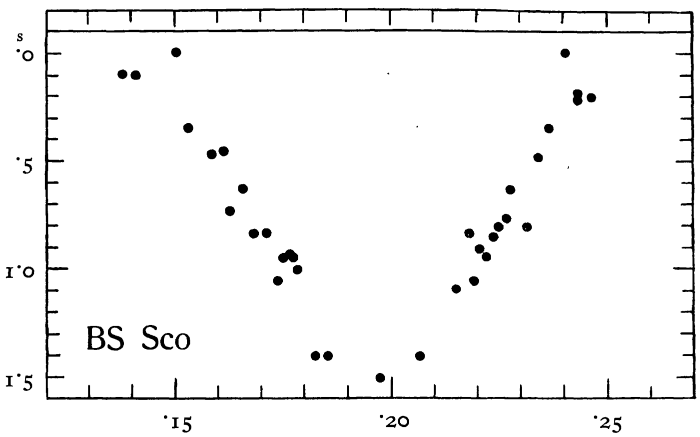
the period, a feature also found in the case of other δ Ceph variables of similar period, e.g. WZ Car (*B.A.N.* No. 146). RY Sco has a companion $9^m{\cdot}6$ at a distance of about 15″ (Hd 280).

TABLE 27.

RY Sco

n	P	s	*n*	P	s
10	·016	·35	10	·608	·05
10	·073	·36	10	·631	·06
10	·114	·34	10	·670	·13
10	·155	·37	10	·698	·14
10	·199	·36	10	·742	·17
10	·213	·36	10	·770	·17
10	·244	·34	10	·819	·22
10	·291	·37	10	·879	·27
10	·326	·39	10	·913	·30
10	·381	·31	10	·921	·34
10	·410	·16	10	·948	·32
10	·442	·10	10	·962	·35
10	·475	·02	10	·970	·38
10	·523	—·02	9	·985	·33
10	·561	—·00		m.e.	± ·02

v = BS Sco = CPD $-31°5087$. The variability of this star was announced by Miss ANNIE J. CANNON (*H.B.* 825), who found the variable particularly faint on 5 dates, which are unfortunately given without the decimal of the day. This latter had therefore to be assumed. The value adopted is $^d{\cdot}6$. The star was estimated on 298 Franklin-Adams plates, from which 7 additional epochs of minimum were derived.



The combined 12 minima gave the period to be $7^d{\cdot}62245 \pm {}^d{\cdot}00011$ (m.e.).

The comparison stars used are a $^s{\cdot}00 = -31°5078$, b $^s{\cdot}24 = -31°5092$, c $^s{\cdot}49$, d $^s{\cdot}84$, e $1^s{\cdot}06$ and f $1^s{\cdot}41$. In Table 28 are collected 22 estimates made in this scale during decreasing or increasing light. By means of a provisional lightcurve the times of observation

TABLE 28.
BS Sco

J. D. hel. — 2420000	bright-ness	fraction of day red. to $^s{\cdot}84$	epoch E	kind of branch	O—C
d	s	d			d
7715·225	·84	·225	0	— 1	— ·021
·248	·84	·248	0	— 1	1
7723·236	1·06	·281	1	+ 1	9
·258	·95	·280	1	+ 1	8
8066·290	·81	·285	46	+ 1	2
·311	·64	·268	46	+ 1	— 15
8096·276	·47	·357	50	— 1	— 13
·297	·46	·381	50	— 1	11
8401·303	·95	·280	90	— 1	11
·324	1·01:	·289	90	— 1	20
8660·455	1·06	·410	124	— 1	— 23
·477	·94	·455	124	— 1	22
8714·270	·49	·194	131	+ 1	1
8721·461	·95	·438	132	— 1	25
8744·219	·74	·241	135	— 1	— 39
·240	·63	·285	135	— 1	5
9156·230	1·10	·283	189	+ 1	— 13
·252	·84	·252	189	+ 1	— 44
·273	·91	·288	189	+ 1	— 8
·295	·86	·301	189	+ 1	5
·317	·77	·302	189	+ 1	6
·353	·81	·348	189	+ 1	52

were reduced to the moments at which the variable passed the brightness of the comparison star d or $^s{\cdot}84$. The 22 epochs of this kind gave the following solution according to least squares: v = d at

$$\text{J. D. hel. } 2428508^d{\cdot}185 + 7^d{\cdot}62247 \times E \pm {}^d{\cdot}2015$$
$$\pm {\cdot}005 \pm {\cdot}00007 \qquad \pm {\cdot}0049$$

At v = d the width of the minimum is therefore $^d{\cdot}403 \pm {}^d{\cdot}010$ (m.e.). The mean error of a single epoch is $\pm {}^d{\cdot}022$. The minimum may be constant for about 3 per cent of the period.

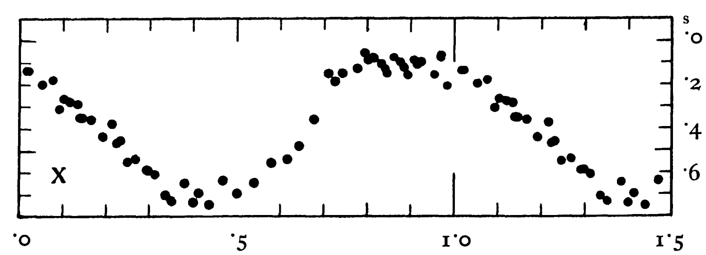
The comparison stars were measured on 9 plates in the Schilt photometer by C. J. KOOREMAN. The differential provisional magnitudes, m', (*B.A.N.* No. 318) were thus found to be a ·00, b ·39, c ·55, d 1·00, e 1·20 and f 1·72. The approximate linear relation with the scale of steps used above is $m' = {\cdot}02 + 1{\cdot}17\,s$.

w = V 453 Sco = CPD $-32°4970$. The only comparison star used was $-32°4977$. The β Lyr character of the lightcurve found by GAPOSCHKIN (*H.B.* 909) is confirmed. The mean error of a single estimate is $\pm {}^s{\cdot}062$. The 41 radial velocities given

TABLE 29.
V 453 Sco

n	P	s
38	·0286	— ·095
44	·1139	— ·082
38	·2000	— ·025
37	·2796	·060
33	·3547	·093
53	·3812	·005
26	·4428	— ·017
39	·4654	— ·076

in *Ap. J.* **67**, 342 were used for a least squares solution of the first and second Fourier terms. The results are respectively 192 km/s and 21 km/s ± 3 km/s (m.e.), corresponding to an eccentricity of ·11. The lightcurve of the variable so far does not reveal any sensible eccentricity.



***x*.** The two comparison stars used are a $^s{\cdot}00$ and b $^s{\cdot}46$. The period was determined by the aid of 51 points on the straight part of the descending branch of the lightcurve. The mean error of one such epoch is $\pm 1^d{\cdot}0$. The mean error of a single estimate is $\pm {}^s{\cdot}107$. A sinusoid was determined according to least squares to fit the lightcurve. The result is:

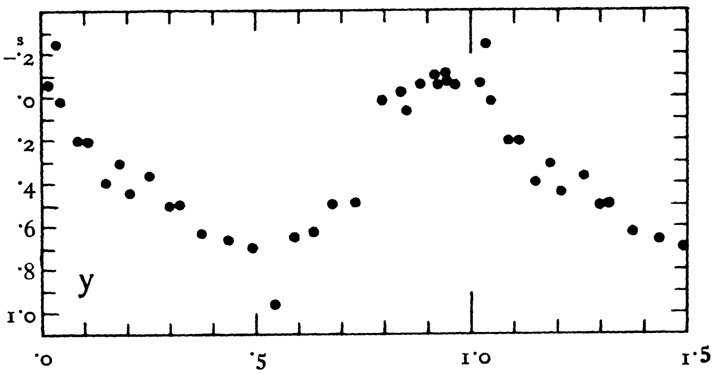
$$s = {\cdot}366 + {\cdot}159 \sin 2\pi P - {\cdot}214 \cos 2\pi P$$

This variable was estimated on two overlapping sets of plates.

TABLE 30.

star *x*

n	P	s	*n*	P	s	*n*	P	s
10	·014	·14	10	·312	·61	10	·800	·09
10	·024	·14	10	·333	·71	10	·811	·08
10	·050	·20	10	·347	·74	10	·832	·11
10	·074	·18	10	·380	·65	10	·839	·13
10	·090	·31	10	·399	·74	10	·843	·15
10	·100	·27	10	·411	·70	10	·858	·08
10	·116	·28	10	·435	·75	10	·876	·10
10	·132	·29	10	·466	·64	10	·883	·12
10	·138	·35	10	·501	·70	10	·892	·16
10	·144	·35	10	·539	·65	10	·904	·09
10	·165	·36	10	·579	·56	10	·913	·11
10	·190	·44	10	·617	·54	10	·920	·11
10	·211	·38	10	·645	·48	10	·926	·10
10	·221	·47	10	·676	·36	10	·954	·16
10	·230	·46	10	·706	·15	10	·965	·08
10	·247	·55	10	·723	·19	10	·970	·07
10	·267	·54	10	·742	·15	9	·983	·21
10	·292	·59	10	·776	·13			
10	·298	·59	10	·794	·06		m.e. ±	·03·



y. The three comparison stars used are a ^{s}·00, b ^{s}·36 and c ^{s}·78. The period was derived from 18 points on the ascending branch of the lightcurve. The mean error of each such epoch is ± 1^{d}·6. The mean error of a single estimate is ± ^{s}·161. From the differences between two plates taken after each other on the same night the m.e. is found to be ± ^{s}·11 or considerably less. The star is suspected of being semiregular.

TABLE 31.

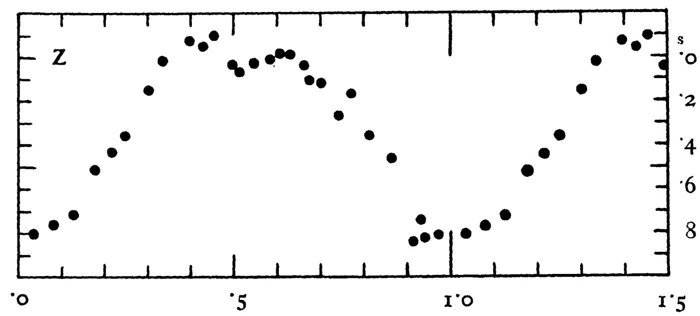
star *y*

P	s	P	s	P	s
·017	—·06	·320	·50	·837	—·02
·031	—·24	·371	·63	·851	·06
·045	·02	·431	·66	·880	—·06
·085	·20	·488	·70	·914	—·10
·108	·21	·539	·96	·922	—·06
·147	·40	·587	·65	·937	—·10
·182	·31	·633	·63	·941	—·06
·204	·44	·677	·50	·963	—·06
·260	·37	·728	·49		
·297	·50	·795	·02	m.e.	±·05

z. The three comparison stars used are a ^{s}·00, b ^{s}·36 and c ^{s}·80. The slope of the straight part of the ascending branch of the lightcurve between the phases ·15 and ·35 was assumed to be 5 *d/s*. Mean values for 21 nights of at least two estimates on this part of the lightcurve were then used for the derivation of as many epochs at which the star had the brightness ^{s}·4 on the ascending branch. At this brightness the difference in phase between the ascending and descending branch is ·60. The sinusoid fitting the observations as well as possible is:

$$s = \cdot 33 + \cdot 036 \sin 2\pi P + \cdot 429 \cos 2\pi P$$

The second order terms are $+ \cdot 040 \sin 4\pi P + \cdot 081 \cos 4\pi P$. The maximum of the sinusoid occurs at the phase ·513 or J. D. 2428344·90. The upper part of the lightcurve appears to be somewhat broader than the lower one, which latter may in



reality be still more pointed as the variable is probably estimated systematically too bright in minimum owing to the presence of a few faint disturbing stars near to the variable. In fact the lightcurve has some

TABLE 32.

star *z*

P	s	P	s	P	s
·033	·81	·452	—·09	·740	·27
·079	·77	·492	·04	·768	·17
·123	·72	·509	·07	·814	·36
·179	·52	·542	·04	·861	·46
·214	·44	·584	·02	·911	·84
·250	·36	·603	—·01	·927	·75
·302	·16	·628	—·00	·940	·83
·335	·02	·660	·04	·970	·81
·398	—·07	·675	·11		
·424	—·04	·699	·13	m.e.	±·04·

resemblance to that of W Vrg, the period of which is similar, viz. 17^{d}·3.

The mean error of a single estimate is ± ^{s}·14. The bright star near the variable is δ Sgr.

Preceding the comparison star b at a distance of 25″ is, marked with a cross on the diagram of the surroundings of the principal variable, a faint long-period variable star, which from J. D. 2428686 to 8722 was found nearly equal to and from J. D. 2427632 to 7635 about ^{s}·15 or ^{m}·25 fainter than the comparison star b. On half of the plates this variable, the position of which is 18^{h}12^{m}47^{s}, —29°48′·9 (1875), is invisible.