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COMMUNICATIONS FROM THE OBSERVATORY AT LEIDEN

Photographic observations of RS Bootis, an RR Lyrae-type variable with long secondary period, by *P. Th. Oosterhoff* [1]).

During the years 1938–1944 2418 photographic observations have been obtained with the 33 cm Leiden refractor. The plates were measured in a Schilt microphotometer. The internal mean error of a magnitude determination is $\pm$ ^{m}·036, but there is a strong indication of the existence of systematic plate errors with a mean dispersion of at least $\pm$ ^{m}·032. The individual magnitudes are given in Table 9. Epochs, 33 in number, have been derived by least squares for a point on the rising branch of brightness $\Delta m =$ ·00. They clearly show that RS Bootis has a secondary period during which the form of the light-curve changes considerably. The most probable elements for these epochs are:

$$\begin{array}{lllll} \text{Epoch} = 2428972^{d}{\cdot}6633 & +^{d}{\cdot}37733657\ t & -^{d}{\cdot}0038 \sin 2\pi\psi & +^{d}{\cdot}0086 \cos 2\pi\psi & \\ \pm\ 7 & \pm\ 18 & \pm\ 4 & \pm\ 4 & \text{m.e.} \end{array}$$

where ψ is the phase of the secondary period. This period is very long, namely (1424 $\pm$ 10) P or 537 days. For five other stars of similar character the secondary period varies between 64 P and 160 P.

Mean light-curves for different values of the phase ψ are shown in the Figures 4a and 4b. When the rising branch begins early, its slope is small and the range of the light-variation is a minimum. After half the secondary period the rising branch is steep, but comes 27 minutes later and the range is a maximum. The extreme values of minimum and maximum brightness are about 11^{m}·02—11^{m}·22 and 9^{m}·86—9^{m}·71 respectively. Figure 5 represents the variation in brightness for a point of given phase during a secondary period. Sufficient material is only available for the part of the light-curve from minimum to maximum. The older observations are too few in number to permit the determination of improved periods from the combined material, but they indicate that the ordinary period increases in a secular or long period manner.

This variable was put on the program of the 33 cm Leiden refractor for the following reasons. According to *Geschichte und Literatur des Lichtwechsels der Veränderlichen Sterne* by R. PRAGER the light-curve of this star is subject to considerable variations, especially near maximum brightness, which may be an indication that its light-variation is of a complicated character similar to that of RR Lyrae. It seems probable that accurate observations will reveal this two-period-type of light-variation for many more cluster type variables and a detailed study of this phenomenon is much to be desired. An important step in this direction has already been made by JULIA BALÁZS and L. DETRE, who have published extensive series of observations for RW Draconis [2]), AR Herculis [3]) and RR Lyrae [4]). As the position and brightness of RS Bootis are quite favourable for the photographic refractor of the Leiden Observatory observations have been started in 1938.

The plates used are mainly Eastman 40, although in 1939 a number of observations were made on plates of the brand Guilleminot La Superguil. The exposure time, which usually was 90 seconds, varies from thirty seconds to two and a half minutes. As a rule about 44 exposures were made on a single plate. They were taken one millimetre inside the best focus. The total number of plates and exposures is 75 and 2418 respectively.

Some data about the comparison stars have been collected in Table 1. The last three stars play only a secondary role in the reduction. It is seen from the fourth and fifth column that the position of the comparison stars relative to the variable is not very satisfactory, as they are all situated on its preceding side. Their distance in minutes of arc from the mean position of the first three comparison stars is given in the last column. These figures will be used later. The photographic magnitudes in the third column have

TABLE 1

star	B.D.	m_{pg}	$\Delta\alpha \cos\delta$	$\Delta\delta$	r
var.	+ 32° 2489	—	0'·0	0'·0	15'·9
1	+ 32 2485	9^{m}·76	− 15·3	− 7·2	1·8
2	—	10·60	− 15·6	− 7·3	2·0
3	+ 32 2487	11·10	− 13·9	− 1·8	3·7
4	+ 31 2627	9·79	− 22·6	− 26·5	22·4
5	+ 32 2481	10·15	− 53·0	+ 7·7	40·3
6	+ 32 2484	11·08	− 23·4	− 15·9	13·4

1) Received in July 1944.
2) *Mitteilungen der Sternwarte Budapest-Svábhegy, Nr* 5, 1938.
3) *Mitteilungen der Sternwarte Budapest-Svábhegy, Nr* 8, 1939.
4) *Mitteilungen der Sternwarte Budapest-Svábhegy, Nr* 17, 1943.

TABLE 2

plate	n	relative gradation	star 1	star 2	star 3	star 4	star 5	star 6
			m	m	m	m	m	m
4348	10	1·11	9·76	10·59	11·10	9·77	10·00	11·08
4349	10	1·13	·76	·59	·10	·71	9·91	·01
4350	10	1·24	·76	·59	·10	·87	10·07	·08
4362	17	1·18	·76	·59	·11	·80	·24	·05
4363	17	1·16	·77	·59	·11	·78	·16	·08
4364	17	1·21	·76	·59	·10	·89	·26	·11
4764	32	1·06	·76	·60	·10	·84	·11	·05
4765	32	1·07	·76	·60	·10	·83	·08	·06
4766	11	1·26	·76	·59	·11	·85	·09	·01
4825	32	1·26	·75	·62	·09	·83	·11	·10
4826	31	1·34	·76	·60	·10	·74	·06	·07
4827	30	1·27	·75	·62	·09	·72	·12	·09
4837	3	1·35	·77	·56	·12	·77	·16	·07
4838	32	1·28	·77	·58	·11	·80	·18	·03
4839	20	1·29	·76	·59	·10	·87	·11	·10
5297	44	1·21	·77	·58	·11	·74	·13	·09
5320	18	1·26	·77	·58	·11	·81	·29	·08
5330	50	1·27	·76	·59	·11	·78	·22	·10
5331	44	1·13	·76	·60	·10	·73	·14	·06
5349	48	1·25	·77	·58	·11	·83	·21	·11
5354	32	1·23	·76	·59	·11	·81	·03	·10
5359	44	1·20	·76	·59	·11	·82	·10	·09
5360	45	1·33	·77	·58	·11	·81	·14	·11
5361	45	1·37	·77	·58	·11	·82	·10	·09
5362	34	1·25	·76	·58	·11	·76	·07	·07
5363	19	1·36	·76	·59	·11	·81	·08	·10
5553	11	1·15	·77	·58	·11	·80	·21	·08
5554	11	1·14	·76	·59	·11	·75	·22	·01
5555	11	1·15	·77	·59	·11	·83	·15	·12
5556	11	1·09	·76	·60	·10	·83	·09	·08
5580	45	1·27	·76	·59	·11	·77	·17	·10
5581	45	1·22	·76	·61	·10	·77	·13	·09
5582	45	1·22	·76	·60	·10	·82	·17	·11
5583	27	1·17	·76	·60	·10	·77	·10	·06
5590	45	1·24	·76	·59	·11	·75	·19	·09
5620	11	1·21	·77	·59	·11	·76	·24	·06
5621	34	1·19	·77	·58	·11	·71	·14	·05
5622	23	1·20	·76	·59	·11	·77	·17	·09
5669	47	1·33	9·77	10·58	11·11	9·76	9·98	11·09
5677	45	1·31	·76	·59	·10	·84	10·24	·08
5714	11	1·00	·76	·59	·11	·73	·11	·07
5726	34	1·22	·76	·59	·10	·80	·09	·07
5945	44	1·05	·77	·59	·11	·74	·20	·05
5946	25	1·11	·77	·58	·11	·76	·19	·06
5947	42	1·15	·77	·59	·11	·70	·20	·04
5948	44	1·17	·76	·60	·10	·79	·13	·07
5949	44	1·16	·76	·59	·10	·86	·20	·08
5980	44	1·20	·76	·59	·10	·75	·23	·08
5981	43	1·29	·77	·59	·11	·78	·16	·09
5982	44	1·32	·76	·59	·11	·77	·19	·07
5983	44	1·28	·77	·59	·11	·80	·19	·07
5984	18	1·22	·76	·59	·11	·78	·16	·10
5988	44	1·15	·77	·58	·11	·85	·16	·09
5989	22	1·17	·76	·59	·10	·79	·19	·09
6006	44	1·30	·77	·58	·11	·80	·22	·08
6015	42	1·20	·76	·59	·11	·81	·21	·08
6045	36	1·40	·76	·59	·11	·79	·14	·07
6047	43	1·26	·77	·58	·11	·74	·21	·07
6067	39	1·31	·76	·60	·10	·81	·33	·05
6097	44	1·29	·76	·59	·11	·83	·15	·08
6121	22	1·20	·76	·59	·11	·80	·24	·08
6294	39	1·24	·76	·60	·10	·76	·10	·12
6296	13	1·36	·76	·59	·11	·81	·08	·09
6297	44	1·34	·77	·58	·11	·82	·07	·12
6304	44	1·23	·77	·59	·11	·81	·12	·11
6305	44	1·20	·77	·58	·11	·79	·22	·08
6319	7	1·22	·77	·59	·11	·84	·32	·11
6354	44	1·25	·76	·59	·10	·85	·22	·08
6393	43	1·26	·77	·59	·11	·73	·22	·05
6394	41	1·31	·76	·60	·10	·89	·16	·13
6562	44	1·16	·77	·58	·11	·75	·15	·03
6565	43	1·11	·76	·59	·10	·75	·14	·11
6583	44	1·08	·76	·59	·11	·78	·24	·07
6587	35	1·02	·76	·59	·11	·69	9·99	·02
6593	22	1·17	·76	·59	·11	·80	10·22	·05

been taken from SEARES and SHAPLEY [1]) for the first three stars. Their colour-index is according to the same authors $+^{m}\cdot5$, which value does not differ much from that of the variable, which according to SEARES and SHAPLEY varies between $-^{m}\cdot1$ and $+^{m}\cdot5$. The remaining magnitudes of Table 1 are derived below. In order to test the scale of these magnitudes a plate has been taken with three exposures with a coarse grating in front of the objective. The resulting magnitudes differ by 2·5 per cent from the scale of SEARES and SHAPLEY in such a manner that the range of the variable would be increased if these magnitudes were adopted. This difference of a few per cent is however too small to be considered as ascertained and the magnitudes of the table have been used.

The plates have been measured in the Schilt microphotometer partly by Mr C. J. KOOREMAN but mainly by the writer. As some of the stars are several centimetres apart on the plates, much care has been taken to perform the measurement of the different stars on the same plate at the same focus of the photometer.

[1]) *Ap. J.* **48**, 229, Table VII, 1918; *Mt Wilson Contr.* No. 159.

This is important as a slight change in this focus may cause a considerable difference in the resulting measure. It forms the main reason why the photometric results obtained with such a photometer usually decrease in accuracy with increasing distance between the stars. The galvanometer readings have been reduced to magnitudes by means of the following reduction method. The readings were first turned into provisional magnitudes by means of WESSELINK's table [1]). Then for each exposure differences were computed from the mean provisional magnitude of the six comparison stars and the mean values of these differences for all exposures of each plate were formed. These mean differences were finally reduced with least squares to the scale and zeropoint of SEARES and SHAPLEY by means of the first three comparison stars. The resulting mean magnitudes are given for each plate in Table 2. In the third column the mean relative gradations are given. These are the figures by which the mean provisional magnitudes must be divided in order to reduce them to the correct photo-

[1]) *B.A.N.* No. 318, 333, 1939.

metric scale. The mean magnitudes of the first three comparison stars necessarily agree closely with the values from Table 1. The magnitudes of the remaining stars have been derived from Table 2. The mean magnitude and its dispersion for each comparison star as derived from Table 2 is found to be:

star	mean magnitude	mean dispersion	r
1	9·763	± ·0053	1′·8
2	10·590	± ·0089	2·0
3	11·106	± ·0056	3·7
4	9·790	± ·044	22·4
5	10·154	± ·076	40·3
6	11·078	± ·026	13·4

In this computation equal weight has been given to all plates. From these figures it is clear that systematic plate errors occur. They are probably caused by systematic variations in the thickness of the photographic emulsion over the plate, whereas the above mentioned effect of changes in the photometer focus may also be partly responsible. It is interesting to notice that the dispersions are practically proportional to the distance r of the stars from the mean position of the first three comparison stars, the magnitudes of which were adjusted by means of least squares. As for RS Bootis this distance is 15′·9 one should expect a mean systematic plate error for the variable of $\pm$ ^{m}·032. Later we shall compare this value with another derived from the light-curve.

For some plates the gradation is evidently not the same for all exposures, which fact probably is due to variations in the seeing conditions and to guiding errors. I therefore decided that the relative gradation of each individual exposure should be taken into account in the determination of the magnitude of the variable. The gradation has been determined by means of the six comparison stars and for each plate the magnitudes which are given in Table 2 have been used. In this manner the systematic plate errors do not enter the determination of the gradation. The gradation-factor having been applied, which reduces the photometric scale to that of SEARES and SHAPLEY, the zeropoint was chosen in such a way that for each exposure it is given by the mean magnitude of the first three comparison stars.

The reduction which has just been described can be summarized as follows. For each exposure the magnitude of RS Bootis has been derived with the aid of the first three comparison stars. The photometric scale is that of SEARES and SHAPLEY; the zeropoint coincides with the mean magnitude of these three comparison stars. The remaining comparison stars have only been used in order to obtain a more accurate determination of the relative gradation for each exposure.

The magnitudes Δm have been listed in Table 9 at the end of this article. They are transformed into apparent magnitudes by addition of 10·49. In the first column of this table the heliocentric Julian Day is given. The reduction to the sun has been made by the formula:

$$\text{Reduction} = + {}^{d}\!\cdot\!00387\ X + {}^{d}\!\cdot\!00167\ Y$$

where X and Y are rectangular equatorial coordinates of the sun. The last column of Table 9 will be explained below.

From a preliminary discussion of the present observations it became soon clear that the variable shows the characteristic features of the complicated light-variation of the type of RR Lyrae itself. Therefore two periods must be determined, namely in the first place the ordinary period P of about ^{d}·37 and in addition the secondary period P′. The best method to determine these periods seems to be with the aid of epochs for points on the steep ascending branch, which can be derived with a greater accuracy than for any other point of the light-curve. This method has however a drawback, namely the fact that in this case a certain amount of interlocking exists between the two periods. On the other hand one could derive a value for the secondary period quite independent from the ordinary period by using for example the steepness of the rising branches, but this would mean a considerable loss in accuracy. A third possibility is offered by the existence of several old series of observations, which in combination with the present material would probably yield a value of the ordinary period, which on account of the long time interval covered by them would be accurate enough for the short series presented here. But in this case a secular or long period change of the period, as has been found to exist in the case of RR Lyrae, RW Draconis and AR Herculis, would make the result too uncertain. In the following discussion we shall therefore make use of our own observations only, which form a homogeneous material and which cover a sufficiently long time interval for a satisfactory determination of both periods. The first method of epochs for a point on the steep rising branch will be applied.

The epoch for a point on the ascending branch of brightness Δm = ·00 has been derived with the assumption that for a small part of this branch near the point in question the magnitude is a linear function of the time and accordingly an equation of the type: $\Delta m = a + b\,t$ has been solved by least squares for all observed rising branches. The correct way to do this would be to include only those observations which fall within a certain interval of phase. In the present case this cannot be done as the two periods and consequently also the phase have not yet been determined. Therefore those observations have been used which fall within an interval of ^{d}·0140 around a provisional epoch, which had been derived when only a preliminary reduction of the observations had been carried out. For the derivation of this first epoch the observations were selected between certain limits of brightness.

The relations computed by least squares have been tabulated in Table 3. The unit of t is ^{d}·0001 and its zeropoint is given by the Julian Day in the first column. The mean error of one observation as derived from the residuals of these formulae is given in the third column, whereas the computed time at which Δm equals zero is tabulated in the last. The observations which were used in the computation and their residuals $(O-C)$ have been listed in Table 4.

The two periods P and P′ have then been derived in the following manner. I have assumed that the epochs for a point on the rising branch can be represented by the equation:

$$\text{Epoch} = A + B\,t + C \sin 2\pi\psi + D \cos 2\pi\psi.$$

Here B is identical with the period P, t is the number of periods elapsed and it has therefore a meaning

TABLE 3

J. D.	relation between Δm and t	m.e. of one observation	t_0	J. D.	relation between Δm and t	m.e. of one observation	t_0
2428972·6600	$\Delta m = +\,{}^{m}\!\cdot562 - \cdot00461\,t$ ± 30	$\pm\,{}^{m}\!\cdot027$	122	2430462·3800	$\Delta m = +\,\cdot684 - \cdot00500\,t$ ± 16	$\pm\,{}^{m}\!\cdot020$	137
2428977·5700	$\Delta m = +\,\cdot336 - \cdot00373\,t$ ± 16	$\pm\,\cdot028$	90	2430465·4000	$\Delta m = +\,\cdot652 - \cdot00558\,t$ ± 23	$\pm\,\cdot029$	117
2429326·5900	$\Delta m = +\,\cdot581 - \cdot00450\,t$ ± 33	$\pm\,\cdot057$	129	2430466·5300	$\Delta m = +\,\cdot625 - \cdot00470\,t$ ± 29	$\pm\,\cdot036$	133
2429373·3900	$\Delta m = +\,\cdot280 - \cdot00441\,t$ ± 17	$\pm\,\cdot033$	63	2430486·5300	$\Delta m = +\,\cdot625 - \cdot00499\,t$ ± 35	$\pm\,\cdot039$	125
2429694·4900	$\Delta m = +\,\cdot331 - \cdot00333\,t$ ± 22	$\pm\,\cdot028$	99	2430488·4200	$\Delta m = +\,\cdot554 - \cdot00461\,t$ ± 17	$\pm\,\cdot019$	120
2429726·5600	$\Delta m = +\,\cdot423 - \cdot00319\,t$ ± 29	$\pm\,\cdot037$	133	2430514·4600	$\Delta m = +\,\cdot426 - \cdot00511\,t$ ± 20	$\pm\,\cdot027$	83
2429730·3400	$\Delta m = +\,\cdot178 - \cdot00309\,t$ ± 27	$\pm\,\cdot034$	58	2430517·4800	$\Delta m = +\,\cdot333 - \cdot00498\,t$ ± 18	$\pm\,\cdot020$	67
2429751·4700	$\Delta m = +\,\cdot353 - \cdot00358\,t$ ± 35	$\pm\,\cdot044$	99	2430531·4400	$\Delta m = +\,\cdot622 - \cdot00524\,t$ ± 21	$\pm\,\cdot024$	119
2429752·6000	$\Delta m = +\,\cdot281 - \cdot00347\,t$ ± 50	$\pm\,\cdot054$	81	2430790·6500	$\Delta m = +\,\cdot248 - \cdot00337\,t$ ± 51	$\pm\,\cdot064$	74
2430066·5600	$\Delta m = +\,\cdot482 - \cdot00515\,t$ ± 34	$\pm\,\cdot045$	94	2430812·5400	$\Delta m = +\,\cdot344 - \cdot00369\,t$ ± 28	$\pm\,\cdot031$	93
2430071·4600	$\Delta m = +\,\cdot805 - \cdot00525\,t$ ± 19	$\pm\,\cdot028$	153	2430849·5200	$\Delta m = +\,\cdot213 - \cdot00347\,t$ ± 20	$\pm\,\cdot022$	61
2430092·5900	$\Delta m = +\,\cdot464 - \cdot00367\,t$ ± 22	$\pm\,\cdot028$	126	2431144·6100	$\Delta m = +\,\cdot428 - \cdot00399\,t$ ± 34	$\pm\,\cdot043$	107
2430114·4800	$\Delta m = +\,\cdot271 - \cdot00530\,t$ ± 21	$\pm\,\cdot027$	51	2431172·5300	$\Delta m = +\,\cdot517 - \cdot00487\,t$ ± 20	$\pm\,\cdot024$	106
2430117·5000	$\Delta m = +\,\cdot239 - \cdot00431\,t$ ± 24	$\pm\,\cdot030$	55	2431200·4500	$\Delta m = +\,\cdot425 - \cdot00381\,t$ ± 35	$\pm\,\cdot039$	112
2430162·4000	$\Delta m = +\,\cdot158 - \cdot00411\,t$ ± 63	$\pm\,\cdot055$	38	2431223·4700	$\Delta m = +\,\cdot246 - \cdot00373\,t$ ± 25	$\pm\,\cdot028$	66
2430168·4300	$\Delta m = +\,\cdot309 - \cdot00328\,t$ ± 29	$\pm\,\cdot033$	94	2431240·4500	$\Delta m = +\,\cdot180 - \cdot00337\,t$ ± 40	$\pm\,\cdot044$	53
2430443·5200	$\Delta m = +\,\cdot255 - \cdot00400\,t$ ± 21	$\pm\,\cdot027$	64				

TABLE 4

t	Δm	O−C
2428972·6600		
76	+·21	·00
90	+·12	−·03
104	+·07	−·01
118	+·05	+·03
132	−·02	+·03
145	−·08	+·03
159	−·19	−·02
173	−·26	−·02
2428977·5700		
35	+·18	−·03
44	+·20	+·03
52	+·16	+·02
61	+·15	+·04
70	+·08	+·01
78	+·01	−·04
87	−·04	−·05
96	−·03	−·01
130	−·15	·00
139	−·15	+·03
148	−·21	+·01
156	−·24	+·01
165	−·27	+·01
173	−·33	−·02
2429326·5900		
75	+·25	+·01
82	+·29	+·08
89	+·11	−·07
96	+·03	−·12
103	+·19	+·07
151	−·09	+·01
158	−·11	+·02
165	−·10	+·06
172	−·21	−·02
179	−·20	+·02
186	−·26	·00
193	−·31	−·02
200	−·37	−·05
207	−·34	+·01
2429373·3900		
16	+·13	−·08
23	+·21	+·03
29	+·15	·00
36	+·13	+·01
43	+·14	+·05
50	+·05	−·01
57	+·03	·00
64	−·02	−·02
71	−·03	·00
78	−·04	+·02
85	−·13	−·04
92	−·08	+·05
99	−·15	+·01
106	−·18	+·01
113	−·21	+·01
120	−·24	+·01
126	−·30	−·02
133	−·26	+·05
140	−·34	·00
147	−·42	−·05
154	−·41	−·01

t	Δm	O−C
2429694·4900		
60	+·13	·00
74	+·10	+·02
88	+·04	·00
102	+·03	+·04
115	−·11	−·06
129	−·11	−·01
143	−·16	−·01
157	−·19	·00
171	−·23	+·01
185	−·27	+·02
2429726·5600		
98	+·10	−·01
112	+·13	+·06
126	+·02	·00
140	−·03	−·01
154	−·13	−·06
167	−·12	−·01
181	−·15	·00
195	−·24	−·04
209	−·20	+·04
223	−·27	+·02
2429730·3400		
21	+·15	+·04
35	+·05	−·02
49	+·04	+·01
63	−·01	+·01
77	−·06	·00
91	−·13	−·03
104	−·20	−·06
118	−·20	−·01
132	−·22	+·01
146	−·22	+·05
2429751·4700		
47	+·16	−·02
61	+·14	+·01
75	+·09	+·01
89	+·02	−·01
103	−·02	·00
117	·00	+·07
131	−·08	+·04
144	−·19	−·03
158	−·29	−·08
172	−·23	+·03
2429752·6000		
43	+·04	−·09
56	+·14	+·05
70	+·09	+·05
84	−·01	·00
98	−·06	·00
112	−·05	+·06
126	−·22	−·06
140	−·20	·00
153	−·26	−·01
2430066·5600		
38	+·26	−·03
52	+·16	−·05
66	+·14	·00
80	+·10	+·03
93	+·06	+·06

t	Δm	O−C
107	−·06	+·01
121	−·09	+·05
163	−·42	−·06
176	−·43	−·01
2430071·4600		
99	+·26	−·03
113	+·19	−·02
127	+·15	+·01
141	+·09	+·03
155	+·02	+·03
168	−·10	−·02
182	−·12	+·03
196	−·23	−·01
210	−·27	+·03
224	−·39	−·02
238	−·47	−·03
2430092·5900		
85	+·16	+·01
99	+·06	−·04
113	+·06	+·01
127	+·01	+·01
141	−·02	+·03
155	−·13	−·03
168	−·12	+·03
182	−·22	−·02
196	−·29	−·03
210	−·29	+·02
2430114·4800		
10	+·27	+·05
23	+·12	−·03
37	+·04	−·03
51	−·01	−·01
65	−·06	+·01
79	−·16	−·01
93	−·21	+·01
107	−·30	·00
120	−·33	+·03
134	−·46	−·02
2430117·5000		
4	+·23	+·01
18	+·10	−·06
32	+·14	+·04
46	+·05	+·01
60	−·01	+·01
73	−·09	−·01
87	−·11	+·03
101	−·19	+·01
115	−·26	·00
129	−·34	−·02
2430162·4000		
4	+·20	+·06
25	+·03	−·03
45	−·05	−·02
66	−·17	−·06
87	−·21	−·01
108	−·23	+·06
2430168·4300		
56	+·12	−·01
73	+·02	−·05

t	Δm	O−C
90	+·05	+·04
108	−·01	+·04
125	−·10	·00
142	−·15	+·01
159	−·22	−·01
177	−·29	−·02
2430443·5200		
16	+·19	·00
30	+·12	−·02
44	+·09	+·01
57	+·02	−·01
71	+·01	+·04
85	−·08	·00
99	−·14	·00
113	−·25	−·05
127	−·26	−·01
141	−·28	+·03
2430462·3800		
87	+·25	·00
101	+·19	+·01
115	+·12	+·01
129	−·01	−·05
143	−·02	+·01
157	−·08	+·02
170	−·17	·00
184	−·24	·00
198	−·30	+·01
212	−·38	·00
2430465·4000		
61	+·34	+·03
75	+·22	−·01
89	+·13	−·03
103	+·06	−·02
117	−·01	−·01
131	−·06	+·02
145	−·14	+·02
158	−·18	+·05
172	−·34	−·03
186	−·40	−·01
2430466·5300		
85	+·23	·00
98	+·17	+·01
112	+·08	−·02
126	·00	−·03
140	−·02	+·01
154	−·08	+·02
168	−·17	−·01
181	−·15	+·08
195	−·33	−·04
209	−·38	−·02
2430486·5300		
88	+·18	−·01
105	+·06	−·04
122	+·07	+·05
140	−·03	+·04
157	−·18	−·02
174	−·29	−·05
192	−·32	+·01
209	−·41	+·01

t	Δm	O−C
2430488·4200		
80	+·21	+·02
97	+·11	·00
115	−·02	−·04
132	−·06	−·01
149	−·12	+·01
166	−·21	·00
184	−·29	·00
201	−·37	·00
2430514·4600		
22	+·28	−·03
39	+·21	−·02
57	+·17	+·04
74	+·08	+·03
91	−·04	·00
109	−·11	+·02
126	−·24	−·02
143	−·30	·00
160	−·41	−·02
2430517·4800		
19	+·22	−·02
36	+·17	+·02
54	+·08	+·02
71	−·01	+·01
88	−·12	−·01
105	−·22	−·03
123	−·25	+·03
140	−·37	−·01
2430531·4400		
73	+·20	−·04
91	+·16	+·01
108	+·10	+·04
125	−·02	+·01
143	−·13	·00
160	−·24	−·02
177	−·33	−·02
195	−·38	+·02
2430790·6500		
39	+·22	+·10
53	·00	−·07
67	·00	−·02
81	−·02	·00
95	−·18	−·11
109	−·11	+·01
123	−·11	+·06
136	−·17	+·04
150	−·27	−·01
164	−·31	−·01
2430812·5400		
51	+·16	·00
71	+·05	−·03
92	+·05	+·05
113	−·08	−·01
134	−·18	−·03
154	−·20	+·02
175	−·31	−·01

t	Δm	O−C
2430849·5200		
22	+·17	+·03
43	+·05	−·01
64	−·03	−·02
84	−·09	−·01
105	−·17	−·02
126	−·20	+·02
147	−·29	+·01
2431144·6100		
62	+·11	−·07
76	+·19	+·07
89	+·08	+·01
103	·00	−·02
117	−·03	+·01
131	−·05	+·04
145	−·16	−·01
159	−·24	−·03
172	−·23	+·03
186	−·34	−·03
2431172·5300		
61	+·20	−·02
75	+·15	·00
103	+·03	+·01
116	−·03	+·02
130	−·10	+·02
144	−·18	·00
158	−·25	·00
172	−·37	−·05
186	−·37	+·02
2431200·4500		
63	+·20	+·02
80	+·07	−·05
97	+·06	·00
115	·00	+·01
132	−·04	+·04
149	−·11	+·03
167	−·27	−·06
184	−·27	+·01
2431223·4700		
45	+·06	−·02
66	+·04	+·04
87	−·07	+·01
107	−·19	−·04
128	−·24	−·01
149	−·30	+·01
170	−·38	+·01
2431240·4500		
13	+·09	−·05
34	+·06	−·01
55	+·05	+·06
75	−·04	+·03
96	−·13	+·01
117	−·26	−·05
138	−·29	−·01

different from the discussion given above, and ψ is the phase computed with the secondary period P′. A preliminary investigation had already proved that the secondary period is very long, namely about 1400 times the ordinary period. The four constants of the equation have therefore been determined by the method of least squares for three different sets of ψ, which correspond with values of the secondary period of 1390, 1430 and 1470 P. The results obtained are:

$$\begin{array}{llllll}
\mathrm{P}' = 1390\ \mathrm{P}: \mathrm{Epoch} = & 2428972^{d}\cdot6626 & + \;^{d}\cdot37733683\, t & - \;^{d}\cdot0001 \sin 2\pi\psi_1 & + \;^{d}\cdot0091 \cos 2\pi\psi_1 & \\
 & \pm 8 & \pm 21 & \pm 5 & \pm 5 & \mathrm{m.e.} \\
\mathrm{P}' = 1430\ \mathrm{P}: \mathrm{Epoch} = & 2428972\cdot6634 & + \cdot37733652\, t & - \cdot0043 \sin 2\pi\psi_2 & + \cdot0084 \cos 2\pi\psi_2 & \\
 & \pm 7 & \pm 18 & \pm 4 & \pm 4 & \mathrm{m.e.} \\
\mathrm{P}' = 1470\ \mathrm{P}: \mathrm{Epoch} = & 2428972\cdot6646 & + \cdot37733613\, t & - \cdot0073 \sin 2\pi\psi_3 & + \cdot0061 \cos 2\pi\psi_3 & \\
 & \pm 9 & \pm 24 & \pm 5 & \pm 6 & \mathrm{m.e.}
\end{array}$$

TABLE 5

Epoch on rising branch $\Delta m =$ ·00	t	ψ_1	$O-C_1$	Epoch − $(A_1 + B_1 t)$	ψ_2	$O-C_2$	Epoch − $(A_2 + B_2 t)$	ψ_3	$O-C_3$	Epoch − $(A_3 + B_3 t)$
d			d	d		d	d		d	d
2428972·6722	0	·000	+ ·0005	+ ·0096	·000	+ ·0004	+ ·0088	·000	+ ·0015	+ ·0076
77·5790	13	·009	+ 19	+ 110	·009	+ 20	+ 102	·009	+ 34	+ 90
9326·6029	938	·675	+ 23	− 16	·656	− 10	− 22	·638	− 46	− 30
73·3963	1062	·764	+ 10	+ 20	·743	− 24	+ 15	·722	− 53	+ 7
9694·4999	1913	1·376	− 15	− 81	1·338	− 3	− 83	1·301	+ 2	− 87
9726·5733	1998	1·437	+ 2	− 83	1·397	+ 8	− 85	1·359	+ 5	− 89
30·3458	2008	1·445	− 5	− 92	1·404	− 2	− 94	1·366	− 2	− 98
51·4799	2064	1·485	+ 32	− 59	1·443	+ 33	− 61	1·404	+ 27	− 65
52·6081	2067	1·487	− 6	− 97	1·445	− 5	− 99	1·406	− 12	− 103
2430066·5694	2899	2·086	− 5	+ 73	2·027	− 2	+ 74	1·972	+ 1	+ 73
71·4753	2912	2·095	+ 3	+ 79	2·036	+ 7	+ 79	1·981	+ 10	+ 79
92·6026	2968	2·135	− 16	+ 43	2·076	− 12	+ 44	2·019	− 8	+ 44
0114·4851	3026	2·177	− 26	+ 13	2·116	− 21	+ 14	2·059	− 16	+ 14
17·5055	3034	2·183	− 7	+ 29	2·122	− 1	+ 31	2·064	+ 3	+ 31
0162·4038	3153	2·268	− 7	− 18	2·205	+ 1	− 17	2·145	+ 5	− 16
68·4394	3169	2·280	− 17	− 36	2·216	− 11	− 35	2·156	− 7	− 34
0443·5264	3898	2·804	+ 17	+ 48	2·726	+ 23	+ 52	2·652	+ 31	+ 56
62·3937	3948	2·840	+ 2	+ 53	2·761	+ 9	+ 57	2·686	+ 17	+ 61
65·4117	3956	2·846	− 7	+ 46	2·766	− 1	+ 50	2·691	+ 7	+ 54
66·5433	3959	2·848	− 12	+ 42	2·769	− 6	+ 46	2·693	+ 2	+ 50
86·5425	4012	2·886	− 24	+ 45	2·806	− 19	+ 50	2·729	− 11	+ 53
88·4320	4017	2·890	+ 2	+ 73	2·809	+ 8	+ 78	2·733	+ 16	+ 82
0514·4683	4086	2·940	− 11	+ 74	2·857	− 7	+ 79	2·780	− 0	+ 83
17·4867	4094	2·945	− 15	+ 71	2·863	− 11	+ 76	2·785	− 5	+ 80
31·4519	4131	2·972	+ 19	+ 108	2·889	+ 21	+ 113	2·810	+ 27	+ 117
0790·6574	4818	3·466	− 51	− 141	3·369	− 45	− 134	3·278	− 44	− 127
0812·5493	4876	3·508	+ 14	− 77	3·410	+ 24	− 70	3·317	+ 29	− 63
49·5261	4974	3·578	− 19	− 99	3·478	− 2	− 92	3·384	+ 10	− 84
1144·6207	5756	4·141	+ 17	+ 73	4·025	+ 6	+ 83	3·916	+ 5	+ 93
72·5406	5830	4·194	+ 13	+ 43	4·077	− 3	+ 53	3·966	− 11	+ 64
1200·4612	5904	4·247	+ 19	+ 19	4·129	+ 2	+ 30	4·016	− 12	+ 41
23·4766	5965	4·291	+ 23	− 2	4·171	+ 5	+ 9	4·058	− 10	+ 20
40·4553	6010	4·324	+ 26	− 17	4·203	+ 11	− 6	4·088	− 8	+ 5

The epochs and their residuals from these three solutions are given in Table 5. They are graphically shown in Figure 1.

The figure clearly shows that the assumption of a sine-curve is fully justified. The second solution seems to give the best representation of the observations. The sum of the squares of the residuals for the three solutions is:

	$\Sigma\,(O-C)^2$
P′ = 1390 P	·00010637
P′ = 1430 P	·00007527
P′ = 1470 P	·00013481

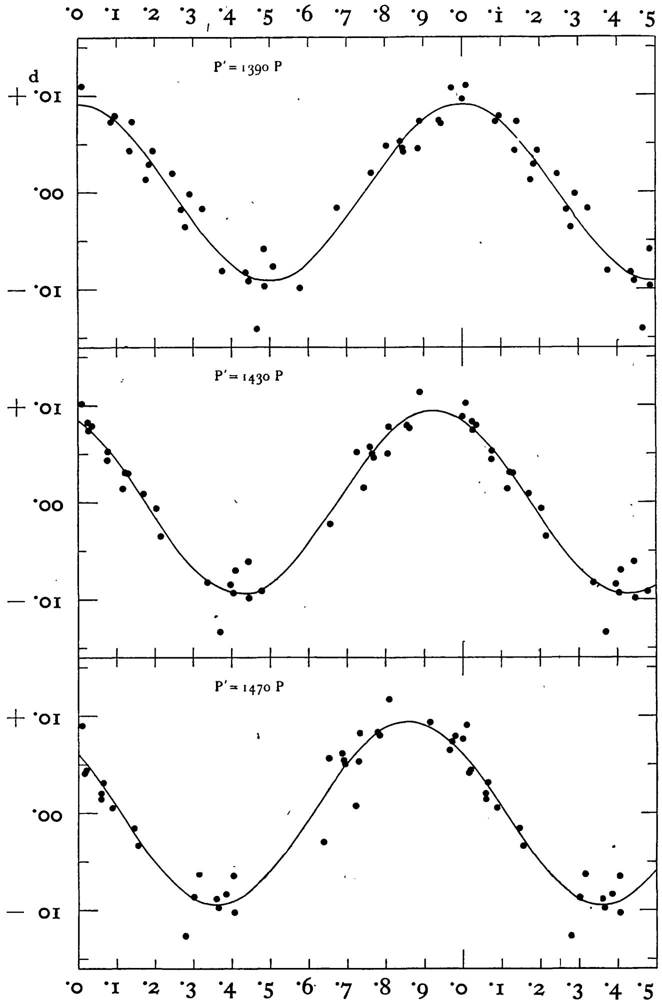
These three values can be represented by a parabola and the most probable value of P′ must correspond with its top. In this way we find the following value with its mean error computed according to the formula derived by PANNEKOEK and ELSA VAN DIEN[1]):

$$\mathrm{P}' = 1424\ \mathrm{P}$$
$$\pm 10 \quad \mathrm{m.e.}$$

I am convinced that a much shorter period is out of the question. This is well illustrated by Figure 2, where the residuals computed from the first two terms of the second solution have been plotted not against ψ_2 as in Figure 1, but against the number of periods elapsed since the first epoch. During the third,

1) *B.A.N.* No. 297, 142, 1937.

FIGURE 1



fourth, fifth and last opposition in which the variable has been observed too many observations have been obtained at intervals varying from a few days to some months to leave a short period undetected.

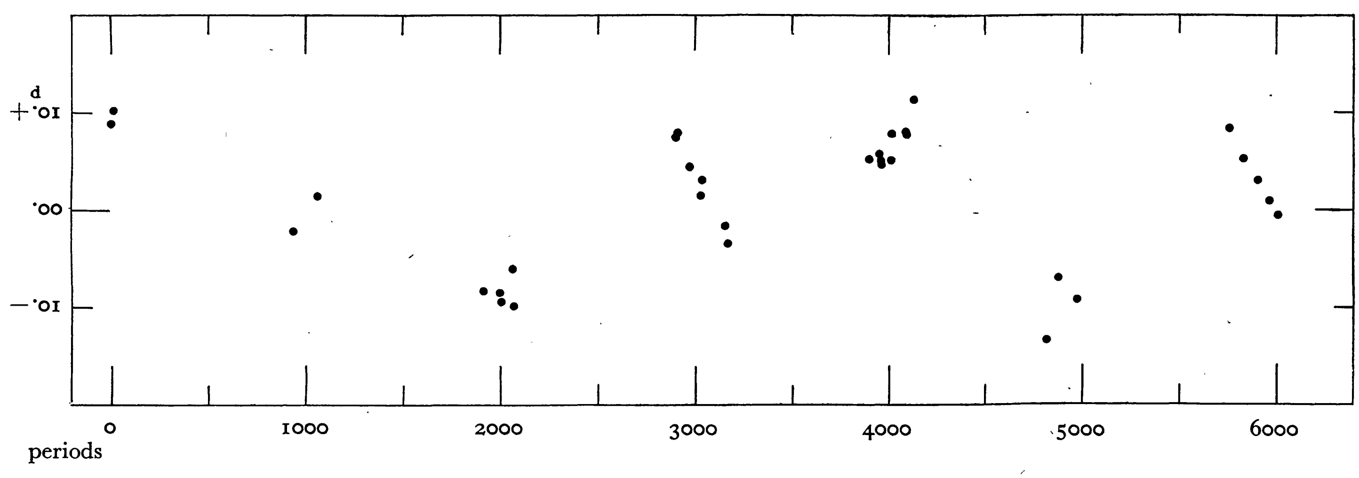
It may be interesting to compare the ratio between secondary and ordinary period as found here for RS Bootis with the same ratio for other variables of the RR Lyrae type. As far as I know the following data have been published:

variable	P	P′	P′/P
	d	d	
RS Bootis	·377	537	1424
RW Draconis	·443	41·6	94
AR Herculis	·470	31·5	67
XZ Draconis	·476	76	160 [1])
Y Leonis Minoris	·522	33·4	64 [2])
RR Lyrae	·567	41·0	72

For RR Lyrae the figures given by BALÁZS and DETRE have been quoted here, although A. DE SITTER derived a somewhat different value for the secondary period [3]). The value of P′/P for RS Bootis is very different from that of the other four variables, but as we will see below the characteristic features of the secondary light-variation are of exactly the same type. From the point of view of the observer this large value is rather unpleasant, as it will take many years to collect observations which cover more or less all values of the phase ψ of the secondary period.

The most probable value of the ordinary period P, which corresponds with P′ = 1424 P, is: ^{d}·37733657 ± ^{d}·00000018 m.e. for the mean epoch J.D. 2430168·4405. The phases in the third column

FIGURE 2



of Table 9 have therefore been computed by means of the formula:

$$\text{Phase} = 2^{d-1}\cdot 650154\ (\text{J.D.} - 2400000)$$

The phase ψ of the secondary period, which has been given in italics for each plate in Table 9 on the same line as the plate number, was computed by the formula:

$$\psi = {}^{d-1}\cdot 001861\ (\text{J.D.} - 2400000)$$

1) *A.N.*, **271**, 231, 1940.
2) *Harvard Reprint* No. 231, 32, 1941.
3) *B.A.N.* No. 234, 1932.

TABLE 6

incli-nation ris. br.	t	phase ψ	$O-C$	incli-nation ris. br.	t	phase ψ	$O-C$	incli-nation ris. br.	t	phase ψ	$O-C$
460	0	·000	− 16	367	2968	·084	− 73	511	4086	·869	+ 14
373	13	·009	− 100	530	3026	·125	+ 111	498	4094	·875	0
450	938	·659	+ 20	431	3034	·131	+ 15	524	4131	·901	+ 27
441	1062	·746	− 29	411	3153	·214	+ 36	337	4818	·383	+ 3
333	1913	·343	− 3	328	3169	·225	− 43	369	4876	·424	+ 33
319	1998	·403	− 15	400	3898	·737	− 66	347	4974	·493	− 6
309	2008	·410	− 26	500	3948	·772	+ 21	399	5756	·042	− 61
358	2064	·449	+ 18	558	3956	·778	+ 77	487	5830	·094	+ 52
347	2067	·452	+ 5	470	3959	·780	− 12	381	5904	·146	− 28
515	2899	·036	+ 53	499	4012	·817	+ 8	373	5965	·189	− 14
525	2912	·045	+ 67	461	4017	·821	− 31	337	6010	·221	− 35

where $({}^{d-1}{\cdot}001861)^{-1} = 1424 \times {}^{d}{\cdot}37733657 = 537^{d}{\cdot}3$.

Some remarks should still be made regarding the second solution of Table 5. This solution, which was carried out with the adopted value P′ = 1430 P, is practically identical with the best possible solution with P′ = 1424 P, as we are near the top of the parabola. The mean error for a single epoch is found to be $\pm\, {}^{d}{\cdot}0016$. On the ascending branch an increase of ${}^{d}{\cdot}0001$ in time corresponds on the average with an increase of ${}^{m}{\cdot}0042$ in brightness, as is seen from Table 3. The uncertainty of an epoch therefore corresponds with a mean error of $\pm\, {}^{m}{\cdot}067$, which is considerably larger than should be expected, as about 10 observations were used on each rising branch [1]). In order to see how this discrepancy can be explained it is necessary to form an idea about the accuracy of the observations.

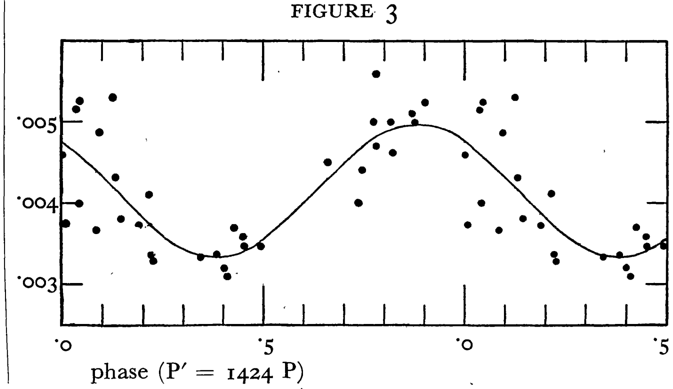
The accidental errors are easily determined. With the aid of the figures in the third column of Table 3 the mean accidental error is found to be $\pm\, {}^{m}{\cdot}036$, a value which has been derived from the residuals of the least squares solutions of the observations on the steep rising branch. This value has been confirmed in the following manner from a much larger material. The differences in magnitude were formed between consecutive observations for each plate and the mean accidental error has then been derived from the relation: $(\text{m.e.})^2 = \dfrac{\Sigma\Delta^2}{2n}$. This has been carried out separately for the observations between the phases ·10 and ·95 and for the remaining observations, with the following result:

phase	n	m.e.
·10—·95	1144	± ·036
·95—·10	1215	± ·047

The last figure must be too large, because the observations cover the steep rising branch and consequently a correction should be applied for the genuine change in brightness. The interval between two consecutive observations is on the average about ${}^{d}{\cdot}0016$, which corresponds with a change in brightness of ${}^{m}{\cdot}068$ on the steepest part of the light-curve. As the observations cover also a part of the minimum and maximum the correction has been computed on the rather arbitrary assumption that one third of the observations must be corrected for the full amount, whereas the remaining two thirds do not need a correction. The mean error which results in this way is $\pm\, {}^{m}{\cdot}038$. Taking all evidence together we conclude that the mean accidental error is $\pm\, {}^{m}{\cdot}036$. This value, combined with a probable mean systematic plate error of $\pm\, {}^{m}{\cdot}032$, is too small to explain the mean error of a single epoch, as derived from the least squares solution. Therefore the systematic plate errors must be larger than has been anticipated or there must exist real fluctuations in the light-variation of the variable which have not been taken into account. It may be that the secondary light-variation has a more complicated character than the assumed sine-curve, that a secular or long period change of the period still makes itself felt in the six years of observation or that other minor variations of unknown type have remained undiscovered.

The existence of real variations in the light-curve,

FIGURE 3



[1]) The corresponding figures derived from the observations by the writer for RR Leonis are: $\pm\, {}^{d}{\cdot}0009$ and $\pm\, {}^{m}{\cdot}046$. (See *B.A.N.* No. 293, 124, 1937.)

apart from those which are due to the secondary period of 537 days, can be tested by means of the inclination or slope of the rising branch. It is seen that the coefficient of t in the second column of Table 3 is closely correlated with the phase ψ of the secondary period. A least squares solution yields the following relation:

$$\text{inclination} = +\,416 - 55 \sin 2\pi\psi + 61 \cos 2\pi\psi$$
$$\pm\ \ 8 \pm 11 \qquad\qquad \pm 12 \quad \text{m.e.}$$

TABLE 7

n	mean phase	mean brightness
P′ = ·006	n = 111	
	P	m
10	·9249	+ ·688
10	·9565	+ ·639
10	·9786	+ ·527
10	·9970	+ ·416
5	·0106	+ ·280
5	·0200	+ ·180
5	·0302	+ ·046
5	·0400	− ·112
5	·0494	− ·284
5	·0584	− ·412
5	·0678	− ·542
5	·0766	− ·630
5	·0864	− ·684
6	·1043	− ·740
5	·1250	− ·730
5	·1434	− ·654
5	·1616	− ·554
5	·1802	− ·488
P′ = ·052	n = 136	
10	·9349	+ ·690
10	·9525	+ ·669
10	·9655	+ ·614
10	·9787	+ ·548
10	·9918	+ ·425
10	·0050	+ ·288
5	·0148	+ ·184
5	·0212	+ ·060
5	·0280	− ·036
5	·0342	− ·112
5	·0410	− ·270
5	·0476	− ·388
5	·0540	− ·454
5	·0606	− ·572
5	·0670	− ·604
5	·0740	− ·696
5	·0802	− ·730
5	·0868	− ·812
5	·0948	− ·772
5	·1068	− ·712
6	·1312	− ·615
P′ = ·128	n = 102	
10	·9596	+ ·584
10	·9788	+ ·384
5	·9908	+ ·272
5	·9972	+ ·186
5	·0036	+ ·168
5	·0102	+ ·074
5	·0168	− ·010
5	·0234	− ·078
5	·0298	− ·208
5	·0366	− ·280
5	·0426	− ·372
5	·0502	− ·456
5	·0588	− ·504
5	·0674	− ·656
6	·0778	− ·693
	P	m
5	·0910	− ·764
5	·1038	− ·764
6	·1197	− ·710
P′ = ·261	n = 44	
5	·9544	+ ·506
5	·9726	+ ·306
5	·9910	+ ·098
5	·0094	− ·160
5	·0276	− ·322
5	·0460	− ·510
5	·0644	− ·608
4	·0808	− ·678
5	·0976	− ·658
P′ = ·314	n = 347	
10	·5297	+ ·447
10	·5663	+ ·432
10	·6271	+ ·508
10	·6664	+ ·512
10	·7032	+ ·484
10	·7398	+ ·492
10	·8669	+ ·602
10	·8877	+ ·629
10	·9077	+ ·683
10	·9312	+ ·612
10	·9451	+ ·529
10	·9531	+ ·466
10	·9608	+ ·396
10	·9690	+ ·347
10	·9766	+ ·240
10	·9850	+ ·091
10	·9949	− ·003
10	·0049	− ·140
10	·0148	− ·260
10	·0245	− ·351
10	·0321	− ·424
10	·0403	− ·490
10	·0500	− ·550
10	·0598	− ·585
10	·0700	− ·631
10	·0805	− ·595
10	·0940	− ·606
10	·1107	− ·537
9	·2580	− ·107
9	·2911	− ·038
9	·3241	+ ·050
10	·3590	+ ·163
10	·4028	+ ·233
10	·4562	+ ·321
10	·4928	+ ·388
P′ = ·382	n = 351	
10	·5154	+ ·425
10	·5522	+ ·427
10	·5888	+ ·439
10	·6260	+ ·462
10	·6616	+ ·498
10	·6837	+ ·499
	P	m
10	·7057	+ ·548
10	·7277	+ ·553
10	·7498	+ ·538
10	·7718	+ ·560
10	·7939	+ ·562
10	·8184	+ ·600
11	·8455	+ ·643
10	·8686	+ ·636
10	·8948	+ ·610
10	·9140	+ ·617
10	·9279	+ ·564
10	·9411	+ ·558
10	·9515	+ ·524
10	·9647	+ ·387
10	·9786	+ ·221
10	·9921	+ ·084
10	·0062	− ·101
10	·0230	− ·329
10	·0451	− ·564
10	·0669	− ·704
10	·0835	− ·721
10	·0972	− ·693
10	·1109	− ·688
10	·1299	− ·648
10	·3172	+ ·003
10	·3538	+ ·111
10	·3924	+ ·212
10	·4309	+ ·277
10	·4743	+ ·354
P′ = ·577	n = 75	
6	·9548	+ ·553
6	·9657	+ ·463
5	·9760	+ ·442
5	·9850	+ ·416
5	·9940	+ ·300
5	·0034	+ ·174
5	·0236	− ·142
5	·0330	− ·344
5	·0420	− ·420
5	·0510	− ·550
5	·0604	− ·636
6	·0703	− ·737
6	·0905	− ·728
6	·1033	− ·752
P′ = ·677	n = 692	
20	·5518	+ ·444
20	·6302	+ ·480
20	·7066	+ ·534
20	·7616	+ ·602
20	·8020	+ ·630
20	·8388	+ ·705
20	·8766	+ ·713
20	·9082	+ ·728
20	·9288	+ ·698
20	·9419	+ ·680
20	·9522	+ ·660
20	·9612	+ ·651
20	·9718	+ ·614
	P	m
20	·9818	+ ·544
10	·9893	+ ·506
10	·9953	+ ·472
10	·0001	+ ·385
10	·0056	+ ·343
10	·0105	+ ·287
10	·0155	+ ·251
10	·0213	+ ·138
10	·0276	+ ·047
10	·0335	− ·050
10	·0398	− ·170
10	·0457	− ·283
10	·0522	− ·373
10	·0599	− ·475
10	·0676	− ·576
10	·0742	− ·662
10	·0797	− ·704
10	·0855	− ·724
10	·0903	− ·757
10	·0963	− ·766
10	·1022	− ·773
10	·1101	− ·802
10	·1188	− ·763
10	·1300	− ·691
10	·1422	− ·648
10	·1553	− ·610
10	·1680	− ·557
10	·1804	− ·502
10	·1924	− ·466
10	·2046	− ·434
10	·2169	− ·369
10	·2290	− ·318
10	·2424	− ·285
10	·2589	− ·225
10	·2724	− ·180
10	·2977	− ·082
10	·3178	− ·047
10	·3362	+ ·003
10	·3610	+ ·086
11	·3995	+ ·191
11	·4398	+ ·227
10	·4967	+ ·346
P′ = ·737	n = 79	
5	·9658	+ ·674
5	·9790	+ ·650
5	·9906	+ ·574
5	·0018	+ ·464
5	·0134	+ ·346
5	·0248	+ ·192
5	·0366	− ·010
5	·0478	− ·200
5	·0592	− ·420
5	·0708	− ·536
5	·0824	− ·690
5	·0936	− ·762
5	·1052	− ·822
5	·1166	− ·834
5	·1314	− ·784
4	·1510	− ·710
P′ = ·796	n = 105	
	P	m
10	·9634	+ ·694
10	·9881	+ ·625
10	·0057	+ ·552
5	·0170	+ ·448
5	·0250	+ ·306
5	·0324	+ ·170
5	·0400	+ ·078
5	·0478	− ·074
5	·0554	− ·258
5	·0628	− ·376
5	·0710	− ·522
5	·0782	− ·588
5	·0858	− ·650
5	·0938	− ·740
5	·1046	− ·766
5	·1160	− ·790
5	·1276	− ·758
5	·1416	− ·726
P′ = ·953	n = 376	
10	·5201	+ ·381
10	·5623	+ ·451
10	·5990	+ ·467
10	·8088	+ ·577
10	·8455	+ ·651
10	·8822	+ ·724
10	·9146	+ ·725
10	·9337	+ ·707
10	·9472	+ ·742
10	·9598	+ ·734
10	·9694	+ ·713
10	·9779	+ ·650
10	·9849	+ ·632
10	·9914	+ ·603
10	·9980	+ ·522
10	·0066	+ ·470
10	·0145	+ ·403
10	·0221	+ ·324
10	·0286	+ ·218
10	·0352	+ ·134
10	·0419	+ ·018
10	·0486	− ·101
10	·0582	− ·288
10	·0660	− ·406
10	·0741	− ·545
10	·0820	− ·653
10	·0900	− ·760
10	·1013	− ·797
10	·1285	− ·739
10	·1768	− ·566
6	·2062	− ·442
10	·2355	− ·332
10	·2722	− ·205
10	·3119	− ·071
10	·3603	+ ·073
10	·3971	+ ·190
10	·4338	+ ·253
10	·4705	+ ·338

FIGURE 4a

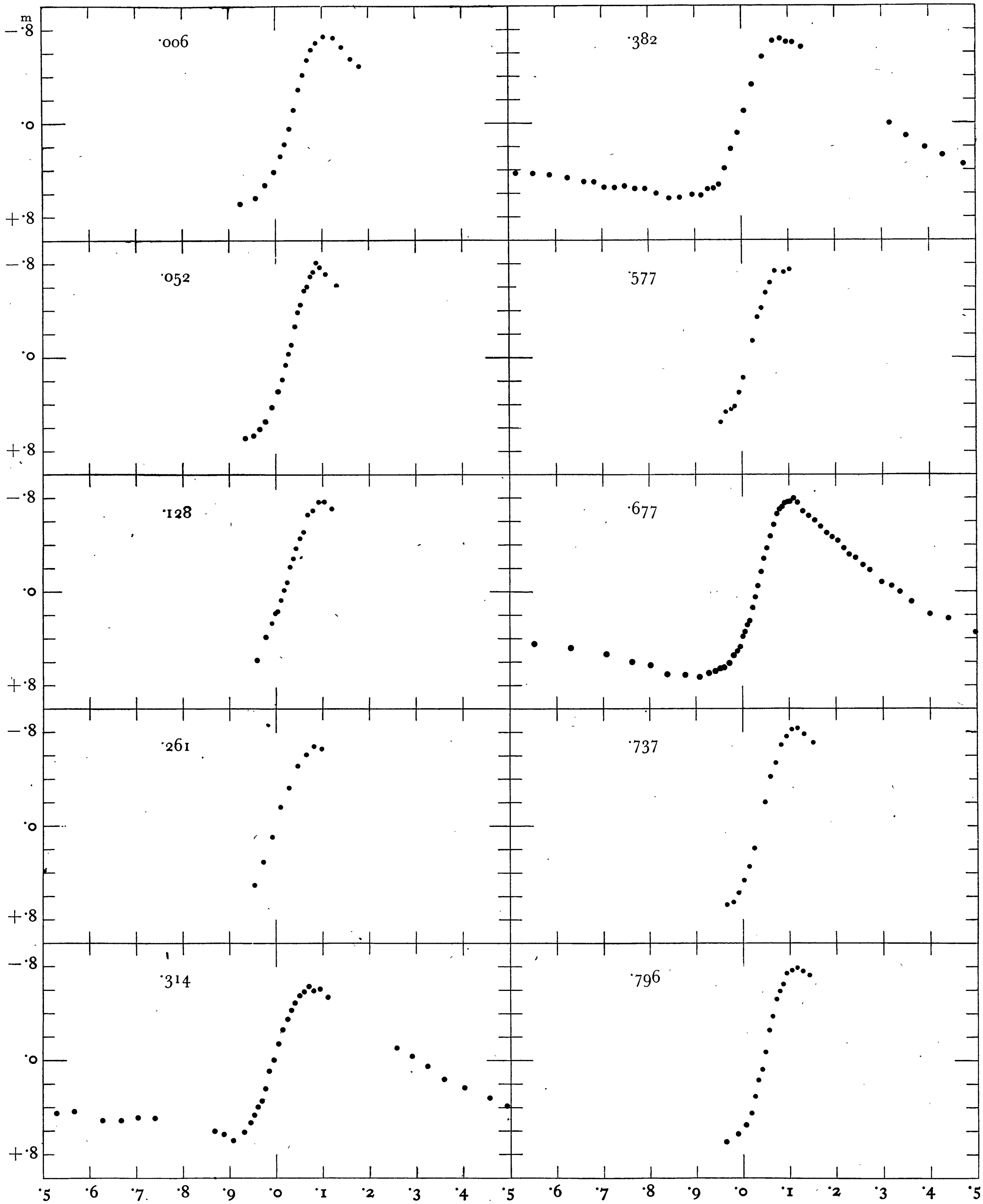
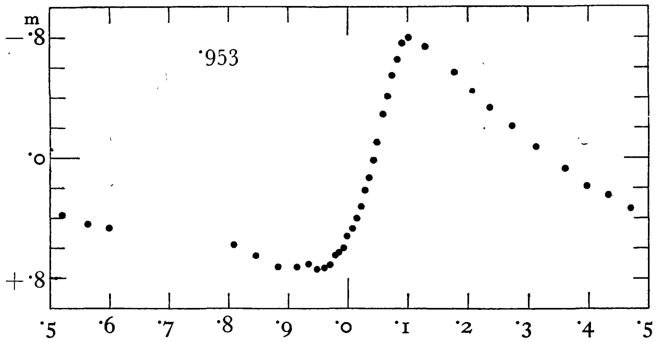

m
−·8
·0
+·8
·006
·382
·052
·577
·128
·677
·261
·737
·314
·796
·5
·6
·7
·8
·9
·0
·1
·2
·3
·4
·5
·6
·7
·8
·9
·0
·1
·2
·3
·4
·5

FIGURE 4b



The details are given in Table 6 and the relation is shown in Figure 3. The figures in the first column have been taken from Table 3 after multiplication with the factor 10^5. The phase ψ is the product of t and $(1424)^{-1}$. In order to compare this phase with that of Table 9, which has been used further below, ·918 should be added. The deviations of the individual points from the sine-curve are considerable as compared with the amplitude of 41. The mean error is found to be $\pm$ 46. When the second Fourier terms are included in the solution, their coefficients appear to be much smaller than their mean error, which indicates that the sine-curve is a sufficient approximation. It is noteworthy that the mean error of the inclinations, as computed from the individual observations, is considerably smaller than the figure derived here from the deviations of the sine-curve. In the second column of Table 3 the mean error has been given for the inclination of every rising branch. The mean error derived from the figures in this table is $\pm$ 30. As the inclinations have been computed with one or two exceptions only from observations taken on the same plate, it seems unlikely that systematic plate errors should have any influence on this result. Still this indication that the variable should show variations in the light-curve, which are not accounted for by the secondary period of 537 days, is in itself quite weak and needs further confirmation.

Next mean light-curves have been formed for different values of the phase ψ of the secondary period. The observations have been divided into eleven groups, the phase limits of which are:

group	n	phase	group	n	phase
1	111	·002—·012	7	75	·577
2	136	·043—·064	8	692	·653—·698
3	102	·107—·143	9	79	·735—·739
4	44	·261	10	105	·787—·819
5	347	·301—·342	11	376	·918—·965
6	351	·367—·411			

For each group a mean light-curve has been computed. The number of observations, the mean phase and the mean magnitude of each normal point have been listed in Table 7. The mean light-curves are shown in the Figures 4a and 4b. The dots are of different size corresponding with 5, 10 and 20 observations respectively. All normal points are independent of each other and are direct mean values of observed quantities. The writer has preferred this form of representation over the method chosen by BALÁZS and DETRE [1]) for AR Herculis, in which a considerable amount of smoothing has been done. Between the phases ·95 and ·10 of the ordinary period the observations cover the phase of the secondary period more or less uniformly. For the remaining part of the light-curve the observations are far less complete and the whole light-curve has practically been obtained for the four following values of ψ only, ·314, ·382, ·677 and ·953. Accidentally more than a quarter of all observations falls within an interval of ·045 of the phase ψ around ·677. It is a happy circumstance that two of these light-curves nearly represent the extreme forms which are reached during the course of a secondary period. The figures show clearly that the variations in the shape of the light-curve are of the usual type. When the rising branch begins early its slope is small and the range of the light-variation is a minimum. This is caused as well by a high minimum brightness as by a low maximum. When on the other hand the rising branch comes late, it is steep and the light-range is largest. The light-curve has a rather smooth appearance and the sudden dip just in front of the rising branch in the light-curve for ψ = ·314 is certainly not real, but it is caused by the systematic deviation of the observations of plate 6354, which starts at phase ·874. When the individual observations of these mean light-curves are plotted, it is evident that there exist systematic differences between several plates. They can hardly be interpreted as differences in the phase ψ, the effect of which usually should be very small.

The mean dispersion of these systematic differences has been determined in the following manner. For each of the mean light-curves those parts have been selected, which are covered by the observations of three or more plates. Then the sum of the squares has been formed of the differences in magnitude between successive observations. After a correction for accidental errors had been applied, the mean dispersion of the systematic plate errors was found to be $\pm$ ^{m}·067. This figure is twice as large as that derived from the comparison stars, but in the latter case the assumption that the dispersion increases proportionally with the distance from the mean position of the three main comparison stars may not be fulfilled. On the other

[1]) L.c. Figure 6.

hand part of the dispersion found here must be due to differences in the phase ψ, although this effect should be small and is difficult to estimate, whereas also the possibility exists that the light-curve is subject to variations of a still unknown character. The present material is however not sufficient to allow a final decision with regard to this question.

On page 106 we have found that a point on the ascending branch of brightness $\Delta m =$ ·00 oscillates with a period of 537 days and with an amplitude of $(\cdot 0043^2 + \cdot 0084^2)^{1/2} = {}^d\cdot 0094$, or about 13·5 minutes. We shall now investigate in which manner the magnitude varies for a point of given phase. Due to the distribution of the observations over the phase ψ this can only be done for that part of the light-curve which is comprised between the phases ·95 and ·10. Practically this covers the minimum, the rising branch and the maximum. The magnitude at certain equidistant phases has been read from the mean light-curves. The results are given in Table 8. A better picture of these variations can be obtained from Figure 5. Starting at the top of the figure, which means near the minimum of the light-curve, the range is about two tenths of a magnitude, the maximum being near phase ·35, the minimum near ·85. Progressing towards larger phase values we find an increasing range, which reaches a maximum in the neighbourhood of phase ·025, when it amounts to nearly three quarters of a magnitude. Thereafter it rapidly decreases, while the form of the curve begins to deviate from a simple sine-curve, the minimum being clearly sharper than the maximum. The phases of minimum and maximum however remain unchanged. This is no longer the case in the last two diagrams of Figure 5. In the first of these the minimum near phase ·85 is still present, but instead of the maximum near phase ·35 there is now an indication of a second minimum. In the last diagram, which practically represents the maximum of the light-curve, this second minimum has become a minimum in the absolute sense, whereas that near ·85 has disappeared altogether. Thus the smallest brightness of the variable near minimum occurs at the same phase ψ as the largest value near maximum. The range of maximum brightness has not been determined very well, but it seems to be about ^{m}·15. This means that the range of the light-curve varies to an amount of about one third of a magnitude, its extreme values being 1^m·50 and 1^m·20.

These are the main features, which can be derived from the present material. Before some remarks will be made about the older observations, it should be emphasized that RS Bootis is an interesting variable, not only on account of its secondary period and the phenomena related therewith, but also because of the fact that its light-curve should be classified as type *a* or

Figure 5

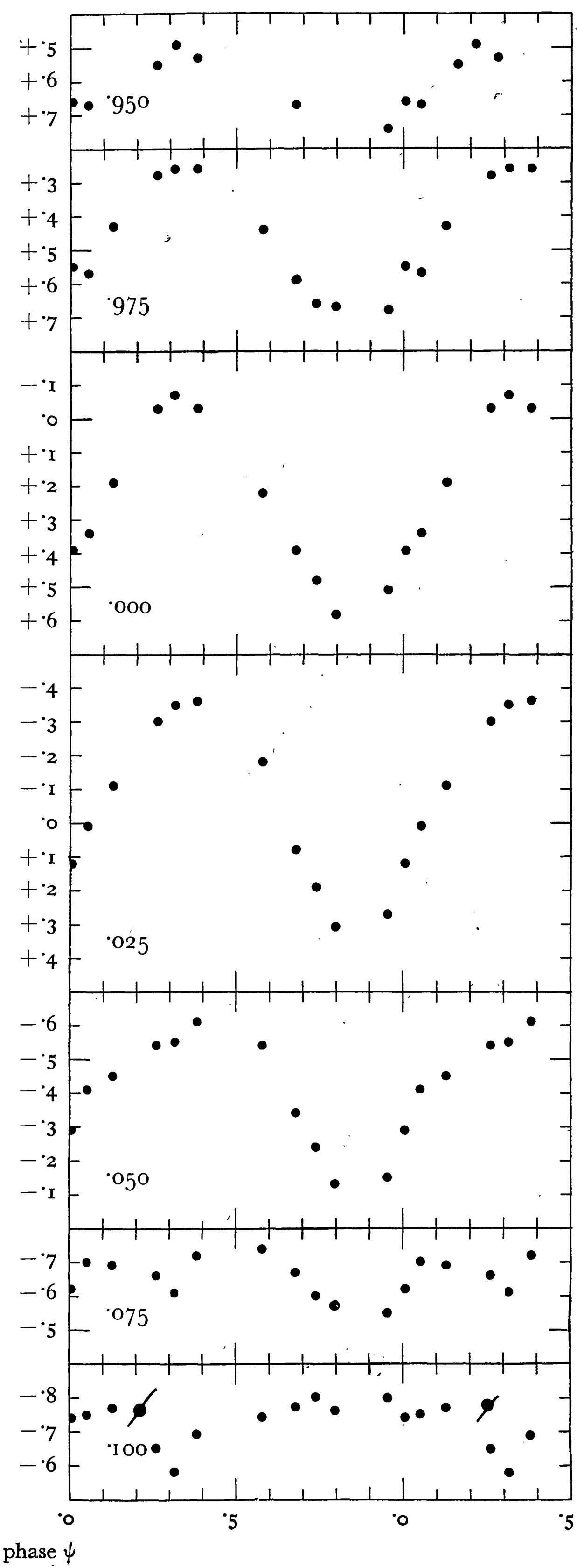


TABLE 8

P \ P′	·006	·052	·128	·261	·314	·382	·577	·677	·737	·796	·953
	m	m	m	m	m	m	m	m	m	m	m
·950	+ ·66	+ ·67	—	+ ·55	+ ·49	+ ·53	—	+ ·67	—	—	+ ·74
·975	+ ·55	+ ·57	+ ·43	+ ·28	+ ·26	+ ·26	+ ·44	+ ·59	+ ·66	+ ·67	+ ·68
·000	+ ·39	+ ·34	+ ·19	− ·03	− ·07	− ·03	+ ·22	+ ·39	+ ·48	+ ·58	+ ·51
·025	+ ·12	+ ·01	− ·11	− ·30	− ·35	− ·36	− ·18	+ ·08	+ ·19	+ ·31	+ ·27
·050	− ·29	− ·41	− ·45	− ·54	− ·55	− ·61	− ·54	− ·34	− ·24	− ·13	− ·15
·075	− ·62	− ·70	− ·69	− ·66	− ·61	− ·72	− ·74	− ·67	− ·60	− ·57	− ·55
·100	− ·74	− ·75	− ·77	− ·65	− ·58	− ·69	− ·74	− ·77	− ·80	− ·76	− ·80

b in BAILEY's scheme notwithstanding the short period of ·38 days. No such star is known in any of the globular clusters and although RS Bootis does not stand alone in this respect among the RR Lyrae-type variables, which are scattered among the stars of our galaxy, this combination of period and type seems to be very rare.

The older observations consist of different series, obtained visually or photographically, which are all rather limited in number as well as in the time interval covered by them. Consequently they are of little help in the derivation of a more accurate value for the two periods in question. The oldest and most extensive series of observations, which covers somewhat over three years, consists of visual measures by SEARES, HAYNES and SHAPLEY [1]). When mean light-curves are computed for different phases of the secondary period, some characteristic differences are evident, especially with regard to the phase of the rising branch, but the material seems insufficient to improve the secondary period by the combination of these old observations with the present data. Of the intermediate observations some are of considerable accuracy, such as the photographic and photovisual series by SEARES and SHAPLEY [2]) and the photographic observations of JORDAN [3]). It must therefore be regretted that these observations cover a very short time interval and consequently they provide information about the light-curve for a single value of the phase ψ of the secondary period only. The observations clearly indicate that this phase ψ has a different value for both series of observations.

[1]) *Ap. J.* **48**, 215, 1918; *Mt Wilson Contr.* No. 159.
[2]) L.c.
[3]) *Allegheny Publ.* **7**, 25, 1929.

While the existing material would be hardly sufficient for the determination of improved values of both periods, if the assumption of their constancy proved to be correct, the situation is still complicated by a possible secular or long period variation of the ordinary period. Amongst others the following values have been derived:

	d	
SEARES and SHAPLEY	·37733506 ± 52 m.e.	1907—1914
DOMBROWSKI [1])	·37733530 ± 11	1907—1932
OOSTERHOFF	·37733657 ± 18	1938—1944

In the determination of the first two figures and of their mean errors the secondary period has not been taken into account, but the difference between the old and new values of the period seems to be too large to be explained by the omission of the influence of the secondary period. A secular or long period change in period is therefore rather probable. Additional observations will be necessary to determine this secular increase of the period with some accuracy.

[1]) NISHNI-NOVGOROD, *Veränderliche Sterne*, **4**, No. 4, 1933.

TABLE 9

J. D. Hel. − 2400000	Δm	phase
plate *4348*		*·918*
d	m	P
28972·6330	+ ·72	·939
·6344	+ ·79	·943
·6358	+ ·77	·947
·6371	+ ·72	·950
·6385	+ ·73	·954
·6399	+ ·65	·958
·6413	+ ·69	·961
·6427	+ ·66	·965
·6441	+ ·71	·969
·6455	+ ·66	·972
plate *4349*		*·918*
28972·6489	+ ·64	·981
·6503	+ ·66	·985
·6517	+ ·70	·989
·6531	+ ·66	·993
·6545	+ ·55	·996
·6558	+ ·61	·000
·6572	+ ·57	·003
·6586	+ ·46	·007
·6600	+ ·45	·011
·6614	+ ·38	·014
plate *4350*		*·918*
28972·6648	+ ·32	·024
·6662	+ ·25	·027
·6676	+ ·21	·031
·6690	+ ·12	·035
·6704	+ ·07	·038
·6718	+ ·05	·042
·6732	− ·02	·046
·6745	− ·08	·049
·6759	− ·19	·053
·6773	− ·26	·057
plate *4362*		*·927*
28977·5480	+ ·76	·965
·5489	+ ·73	·967
·5498	+ ·74	·970
·5506	+ ·77	·972
·5515	+ ·70	·974
·5524	+ ·62	·976
·5532	+ ·65	·979
·5541	+ ·66	·981
·5550	+ ·65	·983
·5558	+ ·70	·985
·5567	+ ·64	·988
·5576	+ ·58	·990
·5584	+ ·61	·992
·5593	+ ·56	·995
·5602	+ ·51	·997
·5610	+ ·54	·999
·5619	+ ·48	·002
plate *4363*		*·927*
28977·5657	+ ·46	·012
·5666	+ ·40	·014
·5674	+ ·39	·016
·5683	+ ·37	·019
·5692	+ ·35	·021
·5700	+ ·33	·023
·5709	+ ·28	·025
·5718	+ ·27	·028
·5726	+ ·31	·030
·5735	+ ·18	·032

J. D. Hel. − 2400000	Δm	phase
d	m	P
28977·5744	+ ·20	·035
·5752	+ ·16	·037
·5761	+ ·15	·039
·5770	+ ·08	·042
·5778	+ ·01	·044
·5787	− ·04	·046
·5796	− ·03	·048
plate *4364*		*·927*
28977·5830	− ·15	·057
·5839	− ·15	·060
·5848	− ·21	·062
·5856	− ·24	·064
·5865	− ·27	·067
·5873	− ·33	·069
·5882	− ·36	·071
·5891	− ·39	·074
·5899	− ·40	·076
·5908	− ·50	·078
·5917	− ·49	·081
·5925	− ·59	·083
·5934	− ·61	·085
·5943	− ·65	·087
·5951	− ·67	·090
·5960	− ·79	·092
·5969	− ·82	·094
plate *4764*		*·577*
29326·5788	+ ·60	·950
·5795	+ ·53	·952
·5802	+ ·62	·954
·5809	+ ·54	·956
·5816	+ ·56	·958
·5823	+ ·47	·959
·5830	+ ·54	·961
·5836	+ ·43	·963
·5843	+ ·44	·965
·5850	+ ·49	·967
·5857	+ ·47	·968
·5864	+ ·41	·970
·5871	+ ·57	·972
·5878	+ ·46	·974
·5885	+ ·44	·976
·5892	+ ·40	·978
·5899	+ ·34	·980
·5906	+ ·41	·981
·5913	+ ·34	·983
·5920	+ ·47	·985
·5927	+ ·48	·987
·5933	+ ·38	·989
·5940	+ ·29	·990
·5947	+ ·38	·992
·5954	+ ·30	·994
·5961	+ ·30	·996
·5968	+ ·23	·998
·5975	+ ·25	·000
·5982	+ ·29	·002
·5989	+ ·11	·003
·5996	+ ·03	·005
·6003	+ ·19	·007
plate *4765*		*·577*
29326·6051	− ·09	·020
·6058	− ·11	·022
·6065	− ·10	·024
·6072	− ·21	·025
·6079	− ·20	·027
·6086	− ·26	·092

J. D. Hel. − 2400000	Δm	phase
d	m	P
29326·6093	− ·31	·031
·6100	− ·37	·033
·6107	− ·34	·035
·6114	− ·44	·037
·6120	− ·36	·038
·6127	− ·44	·040
·6134	− ·42	·042
·6141	− ·44	·044
·6148	− ·44	·046
·6155	− ·56	·047
·6162	− ·52	·049
·6169	− ·56	·051
·6176	− ·55	·053
·6183	− ·56	·055
·6190	− ·59	·057
·6197	− ·70	·059
·6204	− ·63	·060
·6210	− ·65	·062
·6217	− ·61	·064
·6224	− ·69	·066
·6231	− ·74	·068
·6238	− ·66	·069
·6245	− ·76	·071
·6252	− ·80	·073
·6259	− ·77	·075
·6266	− ·66	·077
plate *4766*		*·577*
29326·6314	− ·72	·090
·6321	− ·75	·091
·6328	− ·79	·093
·6335	− ·74	·095
·6342	− ·71	·097
·6349	− ·74	·099
·6356	− ·77	·101
·6363	− ·75	·102
·6370	− ·74	·104
·6377	− ·82	·106
·6384	− ·69	·108
plate *4825*		*·664*
29373·3604	+ ·75	·929
·3611	+ ·73	·930
·3618	+ ·80	·932
·3625	+ ·80	·934
·3632	+ ·79	·936
·3639	+ ·72	·938
·3646	+ ·76	·940
·3652	+ ·75	·941
·3659	+ ·67	·943
·3666	+ ·70	·945
·3673	+ ·68	·947
·3680	+ ·68	·949
·3687	+ ·66	·951
·3694	+ ·78	·952
·3701	+ ·69	·954
·3708	+ ·56	·956
·3715	+ ·60	·958
·3722	+ ·63	·960
·3729	+ ·71	·962
·3736	+ ·76	·964
·3743	+ ·64	·965
·3749	+ ·59	·967
·3756	+ ·70	·969
·3763	+ ·55	·971
·3770	+ ·60	·973
·3777	+ ·67	·974
·3784	+ ·55	·976
·3791	+ ·53	·978

J. D. Hel. − 2400000	Δm	phase
d	m	P
29373·3798	+ ·52	·980
·3805	+ ·52	·982
·3812	+ ·63	·984
·3819	+ ·42	·986
plate *4826*		*·664*
29373·3860	+ ·39	·996
·3867	+ ·40	·998
·3874	+ ·43	·000
·3888	+ ·34	·004
·3895	+ ·26	·006
·3902	+ ·30	·008
·3909	+ ·21	·009
·3916	+ ·13	·011
·3923	+ ·21	·013
·3929	+ ·15	·015
·3936	+ ·13	·017
·3943	+ ·14	·018
·3950	+ ·05	·020
·3957	+ ·03	·022
·3964	− ·02	·024
·3971	− ·03	·026
·3978	− ·04	·028
·3985	− ·13	·030
·3992	− ·08	·031
·3999	− ·15	·033
·4006	− ·18	·035
·4013	− ·21	·037
·4020	− ·24	·039
·4026	− ·30	·040
·4033	− ·26	·042
·4040	− ·34	·044
·4047	− ·42	·046
·4054	− ·41	·048
·4061	− ·42	·050
·4068	− ·44	·052
·4075	− ·43	·053
plate *4827*		*·664*
29373·4116	− ·58	·064
·4123	− ·56	·066
·4137	− ·65	·070
·4144	− ·78	·072
·4151	− ·72	·074
·4158	− ·71	·075
·4165	− ·78	·077
·4172	− ·71	·079
·4179	− ·79	·081
·4186	− ·75	·083
·4193	− ·74	·085
·4200	− ·76	·087
·4207	− ·83	·088
·4213	− ·80	·090
·4220	− ·79	·092
·4227	− ·71	·094
·4234	− ·81	·096
·4241	− ·83	·097
·4248	− ·76	·099
·4255	− ·79	·101
·4262	− ·83	·103
·4269	− ·86	·105
·4276	− ·87	·107
·4283	− ·83	·109
·4290	− ·82	·110
·4297	− ·76	·112
·4303	− ·76	·114
·4310	− ·86	·116
·4317	− ·79	·118
·4324	− ·80	·119

TABLE 9 (*continued*)

J. D. Hel. − 2400000	Δm	phase
plate *4837*		·*677*
d	m	P
29380·5082	+ ·72	·871
·5096	+ ·74	·875
·5121	+ ·79	·882
plate *4838*		·*677*
29380·5219	+ ·77	·908
·5226	+ ·71	·909
·5233	+ ·65	·911
·5240	+ ·76	·913
·5247	+ ·79	·915
·5254	+ ·81	·917
·5261	+ ·65	·919
·5268	+ ·70	·921
·5275	+ ·57	·922
·5282	+ ·64	·924
·5288	+ ·67	·926
·5295	+ ·64	·928
·5302	+ ·67	·930
·5309	+ ·67	·931
·5316	+ ·61	·933
·5323	+ ·66	·935
·5330	+ ·60	·937
·5337	+ ·67	·939
·5344	+ ·58	·941
·5351	+ ·59	·943
·5358	+ ·64	·944
·5365	+ ·64	·946
·5372	+ ·72	·948
·5378	+ ·58	·950
·5385	+ ·70	·952
·5392	+ ·55	·953
·5399	+ ·68	·955
·5406	+ ·68	·957
·5413	+ ·61	·959
·5420	+ ·57	·961
·5427	+ ·58	·963
·5434	+ ·63	·965
plate *4839*		·*677*
29380·5475	+ ·66	·975
·5482	+ ·63	·977
·5489	+ ·54	·979
·5496	+ ·61	·981
·5503	+ ·48	·983
·5510	+ ·50	·985
·5517	+ ·42	·987
·5524	+ ·50	·988
·5531	+ ·48	·990
·5538	+ ·49	·992
·5545	+ ·48	·994
·5552	+ ·39	·996
·5559	+ ·42	·998
·5565	+ ·33	·999
·5572	+ ·30	·001
·5579	+ ·31	·003
·5600	+ ·27	·009
·5607	+ ·24	·010
·5614	+ ·22	·012
·5621	+ ·19	·014
plate *5297*		·*261*
29694·4808	+ ·59	·947
·4822	+ ·55	·951
·4835	+ ·54	·954
·4849	+ ·53	·958
·4863	+ ·32	·962

J. D. Hel. − 2400000	Δm	phase
d	m	P
29694·4877	+ ·38	·965
·4891	+ ·33	·969
·4905	+ ·29	·973
·4919	+ ·29	·976
·4932	+ ·24	·980
·4946	+ ·19	·984
·4960	+ ·13	·987
·4974	+ ·10	·991
·4988	+ ·04	·995
·5002	+ ·03	·998
·5015	− ·11	·002
·5029	− ·11	·006
·5043	− ·16	·009
·5057	− ·19	·013
·5071	− ·23	·017
·5085	− ·27	·020
·5099	− ·27	·024
·5112	− ·33	·028
·5126	− ·37	·031
·5140	− ·37	·035
·5154	− ·44	·039
·5168	− ·46	·042
·5182	− ·50	·046
·5196	− ·58	·050
·5209	− ·57	·053
·5223	− ·56	·057
·5237	− ·60	·061
·5251	− ·60	·064
·5265	− ·62	·068
·5279	− ·66	·072
·5292	− ·61	·075
·5306	− ·70	·079
·5320	− ·70	·083
·5334	− ·70	·086
·5348	− ·70	·090
·5362	− ·60	·094
·5376	− ·64	·098
·5389	− ·69	·101
·5403	− ·66	·105
plate *5320*		·*310*
29720·5121	+ ·66	·934
·5135	+ ·63	·938
·5162	+ ·57	·945
·5176	+ ·58	·949
·5190	+ ·48	·952
·5204	+ ·43	·956
·5218	+ ·32	·960
·5232	+ ·44	·963
·5246	+ ·37	·967
·5259	+ ·35	·971
·5273	+ ·31	·974
·5287	+ ·30	·978
·5301	+ ·23	·982
·5460	− ·33	·024
·5474	− ·34	·028
·5488	− ·36	·031
·5502	− ·45	·035
·5516	− ·45	·039
plate *5330*		·*321*
29726·5532	+ ·61	·944
·5546	+ ·56	·948
·5560	+ ·48	·951
·5574	+ ·51	·955
·5587	+ ·39	·958
·5601	+ ·42	·962
·5615	+ ·39	·966
·5629	+ ·38	·970

J. D. Hel. − 2400000	Δm	phase
d	m	P
29726·5643	+ ·31	·973
·5657	+ ·24	·977
·5670	+ ·25	·980
·5684	+ ·19	·984
·5698	+ ·10	·988
·5712	+ ·13	·992
·5726	+ ·02	·995
·5740	− ·03	·999
·5754	− ·13	·003
·5767	− ·12	·006
·5781	− ·15	·010
·5795	− ·24	·014
·5809	− ·20	·017
·5823	− ·27	·021
·5837	− ·31	·025
·5851	− ·29	·028
·5864	− ·35	·032
·5878	− ·36	·036
·5892	− ·37	·039
·5906	− ·39	·043
·5920	− ·43	·047
·5934	− ·40	·050
·5947	− ·44	·054
·5961	− ·46	·058
·5975	− ·41	·061
·5989	− ·47	·065
·6003	− ·47	·069
·6017	− ·49	·072
·6031	− ·48	·076
·6044	− ·54	·080
·6058	− ·53	·083
·6072	− ·50	·087
·6086	− ·54	·091
·6100	− ·58	·094
·6114	− ·61	·098
·6128	− ·54	·102
·6141	− ·55	·105
·6155	− ·58	·109
·6169	− ·57	·113
·6183	− ·49	·116
·6197	− ·43	·120
·6211	− ·43	·124
plate *5331*		·*328*
29730·3269	+ ·45	·945
·3283	+ ·50	·948
·3297	+ ·41	·952
·3310	+ ·48	·956
·3324	+ ·39	·959
·3338	+ ·37	·963
·3352	+ ·38	·967
·3366	+ ·33	·970
·3380	+ ·20	·974
·3394	+ ·19	·978
·3407	+ ·13	·981
·3421	+ ·15	·985
·3435	+ ·05	·989
·3449	+ ·04	·992
·3463	− ·01	·996
·3477	− ·06	·000
·3491	− ·13	·004
·3504	− ·20	·007
·3518	− ·20	·011
·3532	− ·22	·014
·3546	− ·22	·018
·3560	− ·28	·022
·3574	− ·37	·026
·3587	− ·41	·029
·3601	− ·40	·033
·3615	− ·42	·036

J. D. Hel. − 2400000	Δm	phase
d	m	P
29730·3629	− ·47	·040
·3643	− ·56	·044
·3657	− ·57	·048
·3671	− ·57	·051
·3684	− ·62	·055
·3698	− ·62	·058
·3712	− ·58	·062
·3726	− ·60	·066
·3740	− ·60	·070
·3754	− ·66	·073
·3768	− ·60	·077
·3781	− ·58	·080
·3795	− ·63	·084
·3809	− ·61	·088
·3823	− ·62	·092
·3837	− ·62	·095
·3851	− ·63	·099
·3864	− ·57	·102
plate *5349*		·*367*
29751·4567	+ ·71	·942
·4581	+ ·70	·946
·4595	+ ·69	·949
·4609	+ ·60	·953
·4623	+ ·56	·957
·4637	+ ·46	·961
·4651	+ ·44	·964
·4664	+ ·36	·968
·4678	+ ·34	·971
·4692	+ ·26	·975
·4706	+ ·29	·979
·4720	+ ·28	·983
·4734	+ ·27	·986
·4747	+ ·16	·990
·4761	+ ·14	·993
·4775	+ ·09	·997
·4789	+ ·02	·001
·4803	− ·02	·005
·4817	·00	·008
·4831	− ·08	·012
·4844	− ·19	·015
·4858	− ·29	·019
·4872	− ·23	·023
·4886	− ·34	·027
·4900	− ·31	·030
·4914	− ·40	·034
·4928	− ·48	·038
·4941	− ·49	·041
·4955	− ·56	·045
·4969	− ·58	·049
·4983	− ·64	·052
·4997	− ·64	·056
·5011	− ·69	·060
·5024	− ·63	·063
·5038	− ·65	·067
·5052	− ·64	·071
·5066	− ·61	·074
·5080	− ·64	·078
·5094	− ·68	·082
·5108	− ·65	·085
·5121	− ·66	·089
·5135	− ·67	·093
·5149	− ·68	·096
·5163	− ·65	·100
·5177	− ·65	·104
·5191	− ·63	·107
·5204	− ·69	·111
·5218	− ·68	·115

TABLE 9 (*continued*)

J. D. Hel. − 2400000	Δ*m*	phase
plate *5354*		*·370*
d	m	P
29752·5724	+ ·60	·899
·5738	+ ·59	·902
·5752	+ ·65	·906
·5766	+ ·66	·910
·5779	+ ·65	·913
·5793	+ ·61	·917
·5807	+ ·56	·921
·5821	+ ·52	·924
·5835	+ ·53	·928
·5849	+ ·53	·932
·5863	+ ·60	·936
·5876	+ ·51	·939
·5890	+ ·50	·943
·5904	+ ·57	·946
·5918	+ ·50	·950
·5932	+ ·45	·954
·5946	+ ·42	·958
·5959	+ ·40	·961
·5973	+ ·31	·965
·5987	+ ·34	·968
·6001	+ ·21	·972
·6015	+ ·19	·976
·6029	+ ·21	·980
·6043	+ ·04	·983
·6056	+ ·14	·987
·6070	+ ·09	·990
·6084	− ·01	·994
·6098	− ·06	·998
·6112	− ·05	·002
·6126	− ·22	·005
·6140	− ·20	·009
·6153	− ·26	·012
plate *5359*		*·375*
29755·3654	− ·05	·301
·3668	− ·01	·304
·3682	+ ·01	·308
·3696	+ ·03	·312
·3709	+ ·03	·315
·3723	− ·02	·319
·3737	+ ·01	·323
·3751	+ ·01	·326
·3765	+ ·03	·330
·3779	− ·01	·334
·3793	+ ·06	·337
·3806	+ ·09	·341
·3820	+ ·06	·345
·3834	+ ·14	·348
·3848	+ ·13	·352
·3862	+ ·07	·356
·3876	+ ·09	·359
·3890	+ ·12	·363
·3903	+ ·17	·367
·3917	+ ·18	·370
·3931	+ ·23	·374
·3945	+ ·20	·378
·3959	+ ·14	·381
·3973	+ ·17	·385
·3986	+ ·27	·389
·4014	+ ·20	·396
·4028	+ ·20	·400
·4042	+ ·21	·403
·4056	+ ·26	·407
·4070	+ ·24	·411
·4083	+ ·21	·414
·4097	+ ·25	·418
·4111	+ ·27	·422
·4125	+ ·24	·425

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
29755·4139	+ ·27	·429
·4153	+ ·29	·433
·4167	+ ·31	·437
·4180	+ ·34	·440
·4194	+ ·33	·444
·4208	+ ·26	·447
·4222	+ ·32	·451
·4236	+ ·30	·455
·4250	+ ·31	·459
·4263	+ ·34	·462
plate *5360*		*·375*
29755·4319	+ ·37	·477
·4333	+ ·35	·481
·4347	+ ·43	·484
·4360	+ ·41	·488
·4374	+ ·36	·491
·4388	+ ·35	·495
·4402	+ ·36	·499
·4416	+ ·40	·503
·4430	+ ·41	·506
·4444	+ ·43	·510
·4457	+ ·41	·513
·4471	+ ·45	·517
·4485	+ ·44	·521
·4499	+ ·48	·525
·4513	+ ·42	·528
·4527	+ ·45	·532
·4541	+ ·41	·536
·4554	+ ·45	·539
·4568	+ ·45	·543
·4582	+ ·38	·547
·4596	+ ·43	·550
·4610	+ ·39	·554
·4624	+ ·44	·558
·4637	+ ·47	·561
·4651	+ ·42	·565
·4665	+ ·43	·569
·4679	+ ·45	·572
·4693	+ ·47	·576
·4707	+ ·39	·580
·4721	+ ·44	·583
·4734	+ ·44	·587
·4748	+ ·40	·591
·4762	+ ·44	·594
·4776	+ ·37	·598
·4790	+ ·46	·602
·4804	+ ·53	·605
·4818	+ ·45	·609
·4831	+ ·45	·613
·4845	+ ·44	·616
·4859	+ ·45	·620
·4873	+ ·46	·624
·4887	+ ·44	·627
·4901	+ ·48	·631
·4914	+ ·44	·635
·4928	+ ·48	·638
plate *5361*		*·375*
29755·4984	+ ·52	·653
·4998	+ ·43	·657
·5011	+ ·51	·660
·5025	+ ·48	·664
·5039	+ ·44	·668
·5053	+ ·50	·671
·5067	+ ·43	·675
·5081	+ ·48	·679
·5095	+ ·51	·683
·5108	+ ·54	·686

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
29755·5122	+ ·48	·690
·5136	+ ·51	·693
·5150	+ ·54	·697
·5164	+ ·55	·701
·5178	+ ·52	·705
·5191	+ ·57	·708
·5205	+ ·56	·712
·5219	+ ·56	·715
·5233	+ ·54	·719
·5247	+ ·53	·723
·5261	+ ·57	·727
·5275	+ ·61	·730
·5288	+ ·52	·734
·5302	+ ·50	·737
·5316	+ ·57	·741
·5330	+ ·52	·745
·5344	+ ·55	·749
·5358	+ ·53	·752
·5372	+ ·48	·756
·5385	+ ·50	·759
·5399	+ ·55	·763
·5413	+ ·53	·767
·5427	+ ·51	·771
·5441	+ ·56	·774
·5455	+ ·55	·778
·5468	+ ·51	·781
·5482	+ ·50	·785
·5496	+ ·56	·789
·5510	+ ·51	·793
·5524	+ ·55	·796
·5538	+ ·57	·800
·5552	+ ·59	·804
·5565	+ ·54	·807
·5579	+ ·54	·811
·5593	+ ·58	·815
plate *5362*		*·375*
29755·5649	+ ·60	·829
·5662	+ ·64	·833
·5676	+ ·53	·836
·5690	+ ·57	·840
·5704	+ ·71	·844
·5718	+ ·64	·848
·5732	+ ·62	·851
·5746	+ ·64	·855
·5759	+ ·63	·858
·5773	+ ·58	·862
·5787	+ ·55	·866
·5801	+ ·63	·870
·5815	+ ·62	·873
·5829	+ ·57	·877
·5842	+ ·61	·880
·5856	+ ·58	·884
·5870	+ ·66	·888
·5884	+ ·65	·892
·5898	+ ·62	·895
·5912	+ ·60	·899
·5926	+ ·54	·903
·5939	+ ·54	·906
·5953	+ ·62	·910
·5967	+ ·62	·914
·5981	+ ·58	·917
·5995	+ ·53	·921
·6009	+ ·54	·925
·6023	+ ·51	·928
·6036	+ ·56	·932
·6050	+ ·48	·936
·6064	+ ·45	·939
·6078	+ ·45	·943
·6092	+ ·42	·947

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
·6106	+ ·41	·950
plate *5363*		*·382*
29759·4313	− ·77	·076
·4327	− ·78	·080
·4340	− ·79	·083
·4354	− ·73	·087
·4368	− ·72	·090
·4382	− ·68	·094
·4396	− ·72	·098
·4410	− ·69	·102
·4424	− ·72	·105
·4437	− ·68	·109
·4451	− ·68	·112
·4465	− ·68	·116
·4479	− ·68	·120
·4493	− ·61	·124
·4507	− ·60	·127
·4521	− ·65	·131
·4534	− ·66	·134
·4548	− ·65	·138
·4562	− ·59	·142
plate *5553*		*·954*
30066·5222	+ ·77	·914
·5236	+ ·71	·918
·5250	+ ·81	·921
·5264	+ ·67	·925
·5278	+ ·70	·929
·5292	+ ·67	·933
·5306	+ ·66	·936
·5319	+ ·64	·940
·5333	+ ·70	·943
·5347	+ ·74	·947
·5361	+ ·68	·951
plate *5554*		*·954*
30066·5403	+ ·78	·962
·5416	+ ·69	·965
·5430	+ ·66	·969
·5444	+ ·73	·973
·5458	+ ·62	·977
·5472	+ ·59	·980
·5486	+ ·63	·984
·5499	+ ·54	·987
·5513	+ ·47	·991
·5527	+ ·55	·995
·5541	+ ·46	·999
plate *5555*		*·954*
30066·5583	+ ·43	·010
·5596	+ ·44	·013
·5610	+ ·38	·017
·5624	+ ·36	·021
·5638	+ ·26	·024
·5652	+ ·16	·028
·5666	+ ·14	·032
·5680	+ ·10	·035
·5693	+ ·06	·039
·5707	− ·06	·043
·5721	− ·09	·046
plate *5556*		*·954*
30066·5763	− ·42	·057
·5776	− ·43	·061
·5790	− ·56	·065

TABLE 9 (*continued*)

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
30066·5804	− ·58	·068
·5818	− ·63	·072
·5832	− ·73	·076
·5846	− ·72	·079
·5860	− ·72	·083
·5873	− ·81	·087
·5887	− ·83	·090
·5901	− ·82	·094
plate *5580*		*·963*
30071·4519	+ ·65	·979
·4533	+ ·63	·982
·4547	+ ·58	·986
·4561	+ ·60	·990
·4575	+ ·60	·993
·4588	+ ·49	·997
·4602	+ ·51	·001
·4616	+ ·48	·004
·4630	+ ·43	·008
·4644	+ ·40	·012
·4658	+ ·44	·015
·4672	+ ·37	·019
·4685	+ ·30	·023
·4699	+ ·26	·026
·4713	+ ·19	·030
·4727	+ ·15	·034
·4741	+ ·09	·037
·4755	+ ·02	·041
·4768	− ·10	·045
·4782	− ·12	·048
·4796	− ·23	·052
·4810	− ·27	·056
·4824	− ·39	·059
·4838	− ·47	·063
·4852	− ·57	·067
·4865	− ·58	·070
·4879	− ·64	·074
·4893	− ·62	·078
·4907	− ·74	·081
·4921	− ·78	·085
·4935	− ·75	·089
·4949	− ·77	·092
·4962	− ·79	·096
·4976	− ·75	·100
·4990	− ·72	·103
·5004	− ·72	·107
·5018	− ·77	·111
·5032	− ·79	·114
·5046	− ·79	·118
·5059	− ·76	·122
·5073	− ·76	·125
·5087	− ·74	·129
·5101	− ·74	·133
·5115	− ·71	·136
·5129	− ·67	·140
plate *5581*		*·963*
30071·5191	− ·66	·157
·5205	− ·68	·160
·5219	− ·65	·164
·5233	− ·66	·168
·5246	− ·59	·171
·5260	− ·51	·175
·5274	− ·52	·179
·5288	− ·54	·182
·5302	− ·52	·186
·5316	− ·47	·190
·5329	− ·52	·193
·5343	− ·41	·197

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
30071·5357	− ·49	·201
·5371	− ·46	·204
·5385	− ·41	·208
·5399	− ·44	·212
·5413	− ·44	·215
·5426	− ·37	·219
·5440	− ·35	·223
·5454	− ·35	·226
·5468	− ·38	·230
·5482	− ·36	·234
·5496	− ·32	·237
·5510	− ·31	·241
·5523	− ·32	·245
·5537	− ·27	·248
·5551	− ·29	·252
·5565	− ·26	·256
·5579	− ·26	·259
·5593	− ·23	·263
·5607	− ·24	·267
·5620	− ·17	·270
·5634	− ·20	·274
·5648	− ·20	·278
·5662	− ·16	·281
·5676	− ·19	·285
·5690	− ·14	·289
·5703	− ·08	·292
·5717	− ·11	·296
·5731	− ·13	·300
·5745	− ·11	·303
·5759	− ·10	·307
·5773	− ·09	·311
·5787	− ·09	·315
·5800	− ·07	·318
plate *5582*		*·963*
30071·5870	·00	·337
·5884	+ ·07	·340
·5897	+ ·01	·344
·5911	+ ·02	·347
·5925	+ ·04	·351
·5939	+ ·07	·355
·5953	+ ·05	·359
·5967	+ ·10	·362
·5980	+ ·13	·366
·5994	+ ·10	·369
·6008	+ ·10	·373
·6022	+ ·11	·377
·6036	+ ·16	·381
·6050	+ ·18	·384
·6064	+ ·18	·388
·6077	+ ·15	·391
·6091	+ ·16	·395
·6105	+ ·20	·399
·6119	+ ·17	·403
·6133	+ ·25	·406
·6147	+ ·21	·410
·6161	+ ·24	·414
·6174	+ ·24	·417
·6188	+ ·19	·421
·6202	+ ·21	·425
·6216	+ ·25	·428
·6230	+ ·32	·432
·6244	+ ·30	·436
·6258	+ ·28	·439
·6271	+ ·27	·443
·6285	+ ·20	·447
·6299	+ ·27	·450
·6313	+ ·29	·454
·6327	+ ·32	·458
·6341	+ ·36	·461

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
30071·6354	+ ·34	·465
·6368	+ ·34	·469
·6382	+ ·38	·472
·6396	+ ·31	·476
·6410	+ ·38	·480
·6424	+ ·36	·483
·6438	+ ·30	·487
·6451	+ ·35	·491
·6465	+ ·40	·494
·6479	+ ·42	·498
plate *5583*		*·963*
30071·6562	+ ·35	·520
·6576	+ ·35	·524
·6590	+ ·37	·527
·6604	+ ·41	·531
·6618	+ ·40	·535
·6632	+ ·36	·539
·6645	+ ·40	·542
·6659	+ ·40	·546
·6673	+ ·44	·549
·6687	+ ·44	·553
·6701	+ ·43	·557
·6715	+ ·41	·561
·6728	+ ·47	·564
·6742	+ ·42	·568
·6756	+ ·45	·571
·6770	+ ·49	·575
·6784	+ ·46	·579
·6798	+ ·46	·583
·6812	+ ·52	·586
·6825	+ ·44	·590
·6839	+ ·48	·593
·6853	+ ·47	·597
·6867	+ ·47	·601
·6881	+ ·47	·605
·6895	+ ·48	·608
·6909	+ ·45	·612
·6922	+ ·43	·615
plate *5590*		*·965*
30072·5136	+ ·57	·792
·5150	+ ·59	·796
·5164	+ ·53	·800
·5178	+ ·56	·803
·5192	+ ·53	·807
·5206	+ ·65	·811
·5219	+ ·57	·814
·5233	+ ·57	·818
·5247	+ ·61	·822
·5261	+ ·59	·825
·5275	+ ·61	·829
·5289	+ ·61	·833
·5303	+ ·63	·836
·5316	+ ·63	·840
·5330	+ ·61	·844
·5344	+ ·67	·847
·5358	+ ·67	·851
·5372	+ ·70	·855
·5386	+ ·69	·858
·5399	+ ·69	·862
·5413	+ ·67	·866
·5427	+ ·71	·869
·5441	+ ·79	·873
·5455	+ ·72	·877
·5469	+ ·69	·880
·5483	+ ·71	·884
·5496	+ ·69	·888
·5510	+ ·67	·891

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
30072·5524	+ ·79	·895
·5538	+ ·80	·899
·5552	+ ·76	·902
·5566	+ ·70	·906
·5580	+ ·75	·910
·5593	+ ·67	·913
·5607	+ ·69	·917
·5621	+ ·75	·921
·5635	+ ·64	·924
·5649	+ ·73	·928
·5663	+ ·76	·932
·5677	+ ·77	·936
·5690	+ ·75	·939
·5704	+ ·77	·943
·5718	+ ·73	·946
·5732	+ ·73	·950
·5746	+ ·79	·954
plate *5620*		*·002*
30092·5563	+ ·67	·908
·5577	+ ·73	·912
·5591	+ ·68	·916
·5604	+ ·67	·919
·5618	+ ·70	·923
·5632	+ ·69	·927
·5646	+ ·64	·930
·5660	+ ·68	·934
·5674	+ ·72	·938
·5688	+ ·70	·942
·5701	+ ·63	·945
plate *5621*		*·002*
30092·5778	+ ·57	·965
·5791	+ ·55	·969
·5805	+ ·55	·973
·5819	+ ·57	·976
·5833	+ ·50	·980
·5847	+ ·46	·984
·5861	+ ·46	·987
·5875	+ ·42	·991
·5888	+ ·40	·995
·5902	+ ·39	·998
·5916	+ ·37	·002
·5930	+ ·36	·006
·5944	+ ·31	·009
·5958	+ ·22	·013
·5971	+ ·23	·017
·5985	+ ·16	·020
·5999	+ ·06	·024
·6013	+ ·06	·028
·6027	+ ·01	·031
·6041	− ·02	·035
·6055	− ·13	·039
·6068	− ·12	·042
·6082	− ·22	·046
·6096	− ·29	·050
·6110	− ·29	·053
·6124	− ·36	·057
·6138	− ·44	·061
·6152	− ·47	·065
·6165	− ·53	·068
·6179	− ·56	·072
·6193	− ·56	·075
·6207	− ·63	·079
·6221	− ·61	·083
·6235	− ·68	·087

TABLE 9 (*continued*)

J. D. Hel. − 2400000	Δ*m*	phase
plate *5622*		*·002*
d	m	P
30092·6311	− ·78	·107
·6325	− ·78	·110
·6339	− ·74	·114
·6352	− ·74	·118
·6366	− ·72	·121
·6380	− ·73	·125
·6394	− ·71	·129
·6408	− ·75	·132
·6422	− ·67	·136
·6435	− ·66	·140
·6449	− ·66	·143
·6463	− ·64	·147
·6477	− ·64	·151
·6491	− ·58	·154
·6505	− ·57	·158
·6519	− ·56	·162
·6532	− ·58	·165
·6546	− ·48	·169
·6560	− ·53	·173
·6574	− ·49	·176
·6588	− ·48	·180
·6602	− ·47	·184
·6616	− ·47	·188
plate *5669*		*·043*
30114·4463	+ ·64	·920
·4477	+ ·81	·924
·4491	+ ·68	·928
·4505	+ ·59	·931
·4519	+ ·77	·935
·4533	+ ·64	·939
·4546	+ ·68	·942
·4560	+ ·61	·946
·4574	+ ·69	·950
·4588	+ ·59	·953
·4602	+ ·54	·957
·4616	+ ·62	·961
·4630	+ ·60	·965
·4643	+ ·72	·968
·4657	+ ·49	·972
·4671	+ ·60	·975
·4685	+ ·57	·979
·4699	+ ·61	·983
·4713	+ ·51	·987
·4726	+ ·43	·990
·4740	+ ·40	·994
·4754	+ ·33	·997
·4768	+ ·30	·001
·4782	+ ·28	·005
·4796	+ ·24	·009
·4810	+ ·27	·012
·4823	+ ·12	·016
·4837	+ ·04	·019
·4851	− ·01	·023
·4865	− ·06	·027
·4879	− ·16	·031
·4893	− ·21	·034
·4907	− ·30	·038
·4920	− ·33	·041
·4934	− ·46	·045
·4948	− ·46	·049
·4962	− ·52	·053
·4976	− ·62	·056
·4990	− ·66	·060
·5003	− ·73	·063
·5017	− ·75	·067
·5031	− ·78	·071
·5045	− ·86	·075

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
·5059	− ·83	·078
·5073	− ·84	·082
·5087	− ·90	·086
·5100	− ·90	·089
plate *5677*		*·049*
30117·4727	+ ·69	·941
·4741	+ ·76	·944
·4755	+ ·75	·948
·4769	+ ·74	·952
·4783	+ ·73	·956
·4796	+ ·73	·959
·4810	+ ·74	·963
·4824	+ ·67	·966
·4838	+ ·65	·970
·4852	+ ·62	·974
·4866	+ ·55	·978
·4880	+ ·61	·981
·4893	+ ·48	·985
·4907	+ ·50	·988
·4921	+ ·46	·992
·4935	+ ·44	·996
·4949	+ ·36	·000
·4963	+ ·36	·003
·4976	+ ·34	·007
·4990	+ ·26	·010
·5004	+ ·23	·014
·5018	+ ·10	·018
·5032	+ ·14	·022
·5046	+ ·05	·025
·5060	− ·01	·029
·5073	− ·09	·032
·5087	− ·11	·036
·5101	− ·19	·040
·5115	− ·26	·044
·5129	− ·34	·047
·5143	− ·41	·051
·5157	− ·45	·055
·5170	− ·51	·058
·5184	− ·58	·062
·5198	− ·57	·066
·5212	− ·63	·069
·5226	− ·65	·073
·5240	− ·68	·077
·5254	− ·73	·080
·5267	− ·76	·084
·5281	− ·82	·088
·5295	− ·84	·091
·5309	− ·80	·095
·5323	− ·82	·099
·5337	− ·83	·102
plate *5714*		*·132*
30162·3942	+ ·28	·990
·3962	+ ·17	·995
·3983	+ ·21	·001
·4004	+ ·20	·006
·4025	+ ·03	·012
·4045	− ·05	·017
·4066	− ·17	·023
·4087	− ·21	·028
·4108	− ·23	·034
·4129	− ·37	·039
·4149	− ·43	·044
plate *5726*		*·143*
30168·4217	+ ·48	·963
·4234	+ ·47	·968

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
30168·4252	+ ·36	·973
·4269	+ ·38	·977
·4286	+ ·32	·982
·4304	+ ·35	·986
·4321	+ ·17	·991
·4338	+ ·17	·996
·4356	+ ·12	·000
·4373	+ ·02	·005
·4390	+ ·05	·009
·4408	− ·01	·014
·4425	− ·10	·019
·4442	− ·15	·023
·4459	− ·22	·028
·4477	− ·29	·032
·4494	− ·30	·037
·4511	− ·44	·041
·4529	− ·45	·046
·4546	− ·50	·051
·4563	− ·43	·055
·4581	− ·54	·060
·4598	− ·68	·064
·4615	− ·78	·069
·4633	− ·74	·074
·4650	− ·72	·078
·4667	− ·78	·083
·4685	− ·75	·087
·4702	− ·80	·092
·4719	− ·81	·096
·4736	− ·73	·101
·4754	− ·87	·106
·4771	− ·87	·110
·4788	− ·82	·115
plate *5945*		*·653*
30442·4121	− ·66	·080
·4135	− ·66	·084
·4149	− ·67	·088
·4163	− ·71	·091
·4176	− ·70	·095
·4190	− ·72	·098
·4204	− ·72	·102
·4218	− ·72	·106
·4232	− ·76	·110
·4246	− ·76	·113
·4260	− ·73	·117
·4273	− ·72	·120
·4287	− ·72	·124
·4301	− ·68	·128
·4315	− ·67	·132
·4329	− ·70	·135
·4343	− ·70	·139
·4357	− ·65	·143
·4370	− ·64	·146
·4384	− ·64	·150
·4398	− ·68	·154
·4412	− ·62	·157
·4426	− ·58	·161
·4440	− ·60	·165
·4453	− ·56	·168
·4467	− ·49	·172
·4481	− ·52	·176
·4495	− ·51	·179
·4509	− ·47	·183
·4523	− ·41	·187
·4537	− ·47	·190
·4550	− ·43	·194
·4564	− ·41	·198
·4578	− ·44	·201
·4592	− ·42	·205
·4606	− ·45	·209

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
30442·4620	− ·35	·212
·4634	− ·38	·216
·4647	− ·39	·220
·4661	− ·36	·223
·4675	− ·32	·227
·4689	− ·28	·231
·4703	− ·29	·234
·4717	− ·31	·238
plate *5946*		*·653*
30442·4793	− ·23	·258
·4807	− ·21	·262
·4821	− ·19	·266
·4834	− ·19	·269
·4848	− ·17	·273
·4862	− ·16	·277
·4876	− ·12	·280
·4890	− ·10	·284
·4904	− ·12	·288
·4917	− ·11	·291
·4931	− ·08	·295
·4945	− ·02	·299
·4959	− ·03	·302
·4973	− ·01	·306
·4987	− ·06	·310
·5001	− ·01	·313
·5014	− ·03	·317
·5028	− ·07	·321
·5042	− ·04	·324
·5056	− ·05	·328
·5070	− ·01	·332
·5084	+ ·04	·335
·5098	− ·02	·339
·5111	+ ·04	·343
·5125	− ·02	·346
plate *5947*		*·655*
30443·4253	+ ·63	·765
·4267	+ ·66	·769
·4281	+ ·63	·773
·4295	+ ·60	·776
·4309	+ ·63	·780
·4322	+ ·64	·784
·4336	+ ·59	·787
·4350	+ ·65	·791
·4364	+ ·67	·795
·4378	+ ·70	·798
·4392	+ ·66	·802
·4406	+ ·68	·806
·4419	+ ·65	·809
·4433	+ ·64	·813
·4447	+ ·68	·817
·4461	+ ·67	·820
·4475	+ ·73	·824
·4489	+ ·72	·828
·4503	+ ·73	·832
·4516	+ ·74	·835
·4530	+ ·79	·839
·4544	+ ·73	·842
·4558	+ ·70	·846
·4572	+ ·76	·850
·4586	+ ·72	·854
·4599	+ ·69	·857
·4613	+ ·72	·861
·4627	+ ·73	·864
·4641	+ ·74	·868
·4655	+ ·72	·872
·4669	+ ·73	·876
·4683	+ ·79	·879

Table 9 (*continued*)

J. D. Hel. − 2400000	Δm	phase
d	m	P
30443·4696	+ ·71	·883
·4710	+ ·74	·886
·4724	+ ·81	·890
·4738	+ ·77	·894
·4752	+ ·76	·898
·4766	+ ·69	·901
·4780	+ ·78	·905
·4793	+ ·81	·908
·4807	+ ·76	·912
·4821	+ ·73	·916
plate *5948*		*·655*
30443·4883	+ ·76	·932
·4897	+ ·68	·936
·4911	+ ·75	·940
·4925	+ ·71	·943
·4939	+ ·76	·947
·4953	+ ·72	·951
·4967	+ ·68	·955
·4980	+ ·72	·958
·4994	+ ·67	·962
·5008	+ ·71	·965
·5022	+ ·64	·969
·5036	+ ·61	·973
·5050	+ ·55	·977
·5063	+ ·58	·980
·5077	+ ·60	·984
·5091	+ ·58	·987
·5105	+ ·50	·991
·5119	+ ·50	·995
·5133	+ ·38	·999
·5147	+ ·38	·002
·5160	+ ·29	·006
·5174	+ ·35	·009
·5188	+ ·33	·013
·5202	+ ·26	·017
·5216	+ ·19	·021
·5230	+ ·12	·024
·5244	+ ·09	·028
·5257	+ ·02	·031
·5271	+ ·01	·035
·5285	− ·08	·039
·5299	− ·14	·043
·5313	− ·25	·046
·5327	− ·26	·050
·5341	− ·28	·054
·5354	− ·38	·057
·5368	− ·42	·061
·5382	− ·48	·065
·5396	− ·54	·068
·5410	− ·55	·072
·5424	− ·61	·076
·5437	− ·63	·079
·5451	− ·73	·083
·5465	− ·68	·087
·5479	− ·75	·090
plate *5949*		*·655*
30443·5555	− ·79	·110
·5569	− ·81	·114
·5583	− ·79	·118
·5597	− ·78	·122
·5611	− ·72	·125
·5624	− ·71	·129
·5638	− ·75	·132
·5652	− ·72	·136
·5666	− ·70	·140
·5680	− ·65	·144
·5694	− ·57	·147

J. D. Hel. − 2400000	Δm	phase
d	m	P
30443·5708	− ·64	·151
·5721	− ·62	·154
·5735	− ·62	·158
·5749	− ·63	·162
·5763	− ·61	·166
·5777	− ·56	·169
·5791	− ·56	·173
·5805	− ·51	·177
·5818	− ·49	·180
·5832	− ·57	·184
·5846	− ·50	·188
·5860	− ·52	·191
·5874	− ·50	·195
·5888	− ·46	·199
·5901	− ·49	·202
·5915	− ·42	·206
·5929	− ·42	·209
·5943	− ·39	·213
·5957	− ·37	·217
·5971	− ·35	·221
·5985	− ·34	·224
·5998	− ·30	·228
·6012	− ·34	·231
·6026	− ·30	·235
·6040	− ·24	·239
·6054	− ·30	·243
·6068	− ·30	·246
·6082	− ·23	·250
·6095	− ·20	·253
·6109	− ·25	·257
·6123	− ·17	·261
·6137	− ·22	·265
·6151	− ·22	·268
plate *5980*		*·690*
30462·3597	+ ·72	·944
·3610	+ ·71	·948
·3624	+ ·73	·952
·3638	+ ·61	·955
·3652	+ ·62	·959
·3666	+ ·67	·963
·3680	+ ·53	·966
·3693	+ ·62	·970
·3707	+ ·59	·974
·3721	+ ·56	·977
·3735	+ ·66	·981
·3749	+ ·53	·985
·3763	+ ·59	·988
·3777	+ ·51	·992
·3790	+ ·45	·996
·3804	+ ·41	·999
·3818	+ ·44	·003
·3832	+ ·36	·007
·3846	+ ·40	·010
·3860	+ ·35	·014
·3874	+ ·27	·018
·3887	+ ·25	·021
·3901	+ ·19	·025
·3915	+ ·12	·029
·3929	− ·01	·032
·3943	− ·02	·036
·3957	− ·08	·040
·3970	− ·17	·043
·3984	− ·24	·047
·3998	− ·30	·051
·4012	− ·38	·054
·4026	− ·46	·058
·4040	− ·53	·062
·4054	− ·53	·066
·4067	− ·59	·069

J. D. Hel. − 2400000	Δm	phase
d	m	P
30462·4081	− ·62	·073
·4095	− ·67	·076
·4109	− ·67	·080
·4122	− ·75	·084
·4137	− ·75	·088
·4151	− ·71	·091
·4164	− ·77	·095
·4178	− ·75	·098
·4192	− ·74	·102
plate *5981*		*·691*
30462·4261	− ·68	·120
·4275	− ·72	·124
·4289	− ·69	·128
·4303	− ·63	·132
·4317	− ·64	·135
·4331	− ·63	·139
·4344	− ·62	·142
·4358	− ·60	·146
·4372	− ·55	·150
·4400	− ·57	·157
·4414	− ·58	·161
·4428	− ·53	·165
·4441	− ·53	·168
·4455	− ·50	·172
·4469	− ·54	·176
·4483	− ·53	·179
·4497	− ·47	·183
·4511	− ·44	·187
·4525	− ·45	·190
·4538	− ·47	·194
·4552	− ·47	·197
·4566	− ·39	·201
·4580	− ·41	·205
·4594	− ·44	·209
·4608	− ·36	·212
·4621	− ·40	·216
·4635	− ·35	·219
·4649	− ·35	·223
·4663	− ·34	·227
·4677	− ·31	·231
·4691	− ·30	·234
·4705	− ·34	·238
·4718	− ·27	·241
·4732	− ·30	·245
·4746	− ·26	·249
·4760	− ·26	·253
·4774	− ·26	·256
·4788	− ·24	·260
·4802	− ·21	·264
·4815	− ·15	·267
·4829	− ·20	·271
·4843	− ·23	·275
·4857	− ·17	·278
plate *5982*		*·691*
30462·4940	− ·11	·300
·4954	− ·11	·304
·4968	− ·13	·308
·4982	− ·08	·311
·4995	− ·07	·315
·5009	− ·04	·319
·5023	− ·03	·322
·5037	− ·04	·326
·5051	·00	·330
·5065	− ·03	·333
·5079	·00	·337
·5092	+ ·01	·341
·5106	+ ·05	·344

J. D. Hel. − 2400000	Δm	phase
d	m	P
30462·5120	+ ·04	·348
·5134	+ ·02	·352
·5148	+ ·05	·355
·5162	+ ·11	·359
·5176	+ ·09	·363
·5189	+ ·10	·366
·5203	+ ·15	·370
·5217	+ ·18	·374
·5231	+ ·14	·377
·5245	+ ·14	·381
·5259	+ ·12	·385
·5272	+ ·13	·388
·5286	+ ·15	·392
·5300	+ ·16	·396
·5314	+ ·17	·399
·5328	+ ·25	·403
·5342	+ ·25	·407
·5356	+ ·21	·411
·5369	+ ·23	·414
·5383	+ ·29	·418
·5397	+ ·22	·421
·5411	+ ·19	·425
·5425	+ ·25	·429
·5439	+ ·27	·433
·5453	+ ·20	·436
·5466	+ ·18	·440
·5480	+ ·21	·443
·5494	+ ·20	·447
·5508	+ ·24	·451
·5522	+ ·24	·455
·5536	+ ·30	·458
plate *5983*		*·691*
30462·5619	+ ·35	·480
·5633	+ ·32	·484
·5646	+ ·32	·487
·5660	+ ·36	·491
·5674	+ ·38	·495
·5688	+ ·33	·499
·5702	+ ·36	·502
·5716	+ ·36	·506
·5730	+ ·37	·510
·5743	+ ·31	·513
·5757	+ ·35	·517
·5771	+ ·34	·521
·5785	+ ·43	·524
·5799	+ ·40	·528
·5813	+ ·37	·532
·5827	+ ·46	·535
·5840	+ ·47	·539
·5854	+ ·50	·543
·5868	+ ·43	·546
·5882	+ ·46	·550
·5896	+ ·46	·554
·5910	+ ·51	·557
·5923	+ ·46	·561
·5937	+ ·45	·565
·5951	+ ·45	·568
·5965	+ ·45	·572
·5979	+ ·46	·576
·5992	+ ·44	·579
·6007	+ ·48	·583
·6020	+ ·51	·587
·6034	+ ·43	·590
·6048	+ ·47	·594
·6062	+ ·47	·598
·6076	+ ·47	·601
·6090	+ ·51	·605
·6104	+ ·39	·609
·6117	+ ·44	·612

TABLE 9 (*continued*)

J. D. Hel. − 2400000	Δm	phase
d	m	P
30462·6131	+ ·45	·616
·6145	+ ·50	·620
·6159	+ ·51	·623
·6173	+ ·52	·627
·6187	+ ·51	·631
·6200	+ ·51	·634
·6214	+ ·48	·638
plate *5984*		*·691*
30462·6291	+ ·47	·658
·6304	+ ·47	·662
·6318	+ ·51	·666
·6332	+ ·50	·669
·6346	+ ·51	·673
·6360	+ ·47	·677
·6374	+ ·44	·680
·6387	+ ·46	·684
·6401	+ ·54	·688
·6415	+ ·48	·691
·6429	+ ·48	·695
·6443	+ ·52	·699
·6457	+ ·53	·702
·6471	+ ·58	·706
·6484	+ ·49	·710
·6498	+ ·55	·713
·6512	+ ·50	·717
·6526	+ ·50	·721
plate *5988*		*·692*
30463·4005	+ ·60	·703
·4019	+ ·55	·706
·4033	+ ·52	·710
·4047	+ ·59	·714
·4061	+ ·53	·718
·4075	+ ·65	·721
·4089	+ ·58	·725
·4102	+ ·58	·728
·4116	+ ·60	·732
·4130	+ ·64	·736
·4144	+ ·58	·740
·4158	+ ·56	·743
·4172	+ ·56	·747
·4186	+ ·63	·751
·4199	+ ·57	·754
·4213	+ ·58	·758
·4227	+ ·58	·762
·4241	+ ·62	·765
·4255	+ ·58	·769
·4269	+ ·57	·773
·4282	+ ·56	·776
·4296	+ ·62	·780
·4310	+ ·66	·784
·4324	+ ·57	·787
·4338	+ ·60	·791
·4352	+ ·53	·795
·4366	+ ·57	·798
·4379	+ ·67	·802
·4393	+ ·60	·806
·4407	+ ·63	·809
·4421	+ ·68	·813
·4435	+ ·57	·817
·4449	+ ·59	·820
·4463	+ ·63	·824
·4476	+ ·63	·828
·4490	+ ·69	·831
·4504	+ ·73	·835
·4518	+ ·60	·839
·4532	+ ·66	·842
·4546	+ ·71	·846

J. D. Hel. − 2400000	Δm	phase
d	m	P
30463·4559	+ ·72	·850
·4573	+ ·68	·853
·4587	+ ·76	·857
·4601	+ ·65	·861
plate *5989*		*·693*
30463·4656	+ ·62	·875
·4670	+ ·64	·879
·4684	+ ·63	·883
·4698	+ ·74	·886
·4712	+ ·68	·890
·4726	+ ·67	·894
·4740	+ ·66	·897
·4753	+ ·68	·901
·4767	+ ·69	·905
·4781	+ ·71	·908
·4795	+ ·67	·912
·4809	+ ·64	·916
·4823	+ ·73	·919
·4836	+ ·73	·923
·4850	+ ·75	·927
·4864	+ ·65	·930
·4878	+ ·73	·934
·4892	+ ·75	·938
·4906	+ ·62	·941
·4920	+ ·62	·945
·4933	+ ·63	·949
·4947	+ ·61	·952
plate *6006*		*·696*
30465·3812	+ ·69	·952
·3826	+ ·63	·956
·3840	+ ·61	·959
·3854	+ ·61	·963
·3868	+ ·57	·967
·3881	+ ·66	·970
·3895	+ ·62	·974
·3909	+ ·58	·978
·3923	+ ·50	·981
·3937	+ ·50	·985
·3951	+ ·55	·989
·3965	+ ·46	·992
·3978	+ ·51	·996
·3992	+ ·40	·000
·4006	+ ·39	·003
·4020	+ ·37	·007
·4034	+ ·39	·011
·4048	+ ·32	·014
·4061	+ ·34	·018
·4075	+ ·22	·022
·4089	+ ·13	·025
·4103	+ ·06	·029
·4117	− ·01	·033
·4131	− ·06	·036
·4145	− ·14	·040
·4158	− ·18	·044
·4172	− ·34	·047
·4186	− ·40	·051
·4200	− ·44	·055
·4214	− ·48	·058
·4228	− ·59	·062
·4242	− ·62	·066
·4255	− ·63	·069
·4269	− ·67	·073
·4283	− ·66	·077
·4297	− ·71	·080
·4311	− ·76	·084
·4325	− ·76	·088
·4339	− ·85	·092

J. D. Hel. − 2400000	Δm	phase
d	m	P
30465·4352	− ·80	·095
·4366	− ·82	·099
·4380	− ·79	·102
·4394	− ·81	·106
·4408	− ·81	·110
plate *6015*		*·698*
30466·5135	+ ·59	·953
·5149	+ ·71	·956
·5163	+ ·60	·960
·5177	+ ·69	·964
·5191	+ ·63	·967
·5204	+ ·68	·971
·5218	+ ·62	·975
·5232	+ ·57	·978
·5246	+ ·52	·982
·5260	+ ·54	·986
·5274	+ ·49	·989
·5288	+ ·53	·993
·5301	+ ·54	·997
·5315	+ ·43	·000
·5329	+ ·39	·004
·5343	+ ·37	·008
·5357	+ ·33	·011
·5371	+ ·29	·015
·5385	+ ·23	·019
·5398	+ ·17	·022
·5412	+ ·08	·026
·5426	·00	·030
·5440	− ·02	·033
·5454	− ·08	·037
·5468	− ·17	·041
·5481	− ·15	·044
·5495	− ·33	·048
·5509	− ·38	·052
·5523	− ·42	·055
·5537	− ·42	·059
·5551	− ·47	·063
·5565	− ·55	·067
·5578	− ·61	·070
·5592	− ·64	·074
·5606	− ·65	·077
·5620	− ·68	·081
·5634	− ·66	·085
·5648	− ·71	·089
·5662	− ·74	·092
·5675	− ·75	·096
·5689	− ·72	·099
·5703	− ·80	·103
plate *6045*		*·735*
30486·5163	+ ·68	·963
·5180	+ ·59	·968
·5197	+ ·63	·972
·5215	+ ·62	·977
·5232	+ ·59	·981
·5249	+ ·50	·986
·5267	+ ·57	·991
·5284	+ ·53	·995
·5301	+ ·41	·000
·5318	+ ·42	·004
·5336	+ ·35	·009
·5353	+ ·29	·013
·5370	+ ·24	·018
·5388	+ ·18	·023
·5405	+ ·06	·027
·5422	+ ·07	·032
·5440	− ·03	·037
·5457	− ·18	·041

J. D. Hel. − 2400000	Δm	phase
d	m	P
30486·5474	− ·29	·046
·5492	− ·32	·050
·5509	− ·41	·055
·5526	− ·48	·059
·5544	− ·55	·064
·5561	− ·63	·069
·5578	− ·68	·073
·5596	− ·70	·078
·5613	− ·77	·082
·5630	− ·77	·087
·5647	− ·82	·091
·5665	− ·82	·096
·5682	− ·86	·101
·5699	− ·87	·105
·5717	− ·82	·110
·5734	− ·89	·114
·5751	− ·92	·119
·5769	− ·87	·124
plate *6047*		*·739*
30488·4020	+ ·72	·961
·4038	+ ·75	·965
·4072	+ ·73	·974
·4089	+ ·67	·979
·4107	+ ·64	·984
·4124	+ ·66	·988
·4141	+ ·61	·993
·4159	+ ·54	·997
·4176	+ ·52	·002
·4193	+ ·43	·006
·4211	+ ·47	·011
·4228	+ ·38	·016
·4245	+ ·29	·020
·4263	+ ·22	·025
·4280	+ ·21	·029
·4297	+ ·11	·034
·4315	− ·02	·039
·4332	− ·06	·043
·4349	− ·12	·048
·4366	− ·21	·052
·4384	− ·29	·057
·4401	− ·37	·061
·4418	− ·39	·066
·4436	− ·47	·071
·4453	− ·51	·075
·4470	− ·57	·080
·4488	− ·64	·085
·4505	− ·68	·089
·4522	− ·73	·094
·4540	− ·76	·098
·4557	− ·81	·103
·4574	− ·75	·107
·4592	− ·80	·112
·4609	− ·78	·117
·4626	− ·78	·121
·4644	− ·79	·126
·4661	− ·79	·130
·4678	− ·77	·135
·4695	− ·70	·139
·4713	− ·71	·144
·4730	− ·71	·149
·4747	− ·71	·153
·4765	− ·71	·158
plate *6067*		*·787*
30514·4362	+ ·78	·955
·4380	+ ·81	·960
·4397	+ ·69	·964
·4414	+ ·63	·969

TABLE 9 (*continued*)

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
30514·4431	+ ·67	·973
·4466	+ ·62	·983
·4483	+ ·64	·987
·4501	+ ·62	·992
·4518	+ ·61	·996
·4535	+ ·60	·001
·4553	+ ·52	·006
·4570	+ ·47	·010
·4587	+ ·45	·015
·4605	+ ·43	·020
·4622	+ ·28	·024
·4639	+ ·21	·029
·4657	+ ·17	·033
·4674	+ ·08	·038
·4691	− ·04	·042
·4709	− ·11	·047
·4726	− ·24	·052
·4743	− ·30	·056
·4760	− ·41	·061
·4778	− ·42	·065
·4795	− ·50	·070
·4812	− ·62	·074
·4830	− ·60	·079
·4847	− ·65	·084
·4864	− ·69	·088
·4882	− ·63	·093
·4899	− ·79	·097
·4916	− ·74	·102
·4934	− ·74	·107
·4951	− ·81	·111
·4968	− ·75	·116
·4986	− ·75	·121
·5003	− ·72	·125
·5020	− ·70	·130
·5037	− ·72	·134
plate *6097*		*·793*
30517·4542	+ ·67	·953
·4559	+ ·72	·958
·4577	+ ·70	·963
·4594	+ ·59	·967
·4611	+ ·68	·972
·4628	+ ·63	·976
·4646	+ ·71	·981
·4663	+ ·60	·985
·4680	+ ·57	·990
·4698	+ ·58	·995
·4715	+ ·66	·999
·4732	+ ·62	·004
·4750	+ ·49	·008
·4767	+ ·48	·013
·4784	+ ·42	·017
·4802	+ ·30	·022
·4819	+ ·22	·027
·4836	+ ·17	·031
·4854	+ ·08	·036
·4871	− ·01	·041
·4888	− ·12	·045
·4905	− ·22	·050
·4923	− ·25	·054
·4940	− ·37	·059
·4957	− ·48	·063
·4975	− ·52	·068
·4992	− ·59	·073
·5009	− ·63	·077
·5027	− ·69	·082
·5044	− ·71	·086
·5061	− ·76	·091
·5079	− ·80	·096
·5096	− ·78	·100

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
30517·5113	− ·79	·105
·5131	− ·78	·109
·5148	− ·84	·114
·5165	− ·80	·118
·5183	− ·79	·123
·5200	− ·74	·128
·5217	− ·84	·132
·5234	− ·73	·137
·5252	− ·73	·141
·5269	− ·71	·146
·5286	− ·74	·150
plate *6121*		*·819*
30531·4318	+ ·67	·996
·4335	+ ·59	·001
·4352	+ ·62	·005
·4370	+ ·47	·010
·4387	+ ·48	·014
·4404	+ ·46	·019
·4422	+ ·42	·024
·4439	+ ·31	·028
·4456	+ ·22	·033
·4473	+ ·20	·037
·4491	+ ·16	·042
·4508	+ ·10	·046
·4525	− ·02	·051
·4543	− ·13	·056
·4560	− ·24	·060
·4577	− ·33	·065
·4595	− ·38	·070
·4612	− ·44	·074
·4629	− ·58	·079
·4647	− ·56	·083
·4664	− ·64	·088
·4681	− ·72	·092
plate *6294*		*·301*
30790·5189	+ ·46	·617
·5203	+ ·51	·621
·5217	+ ·53	·624
·5230	+ ·47	·628
·5244	+ ·48	·631
·5258	+ ·55	·635
·5272	+ ·58	·639
·5286	+ ·46	·643
·5300	+ ·49	·646
·5314	+ ·60	·650
·5327	+ ·55	·653
·5341	+ ·45	·657
·5355	+ ·54	·661
·5369	+ ·58	·665
·5383	+ ·41	·668
·5397	+ ·51	·672
·5411	+ ·52	·676
·5424	+ ·51	·679
·5438	+ ·45	·683
·5452	+ ·55	·687
·5466	+ ·54	·690
·5480	+ ·33	·694
·5494	+ ·42	·698
·5507	+ ·54	·701
·5521	+ ·51	·705
·5535	+ ·54	·709
·5549	+ ·48	·712
·5563	+ ·51	·716
·5577	+ ·42	·720
·5591	+ ·43	·723
·5604	+ ·45	·727

J. D. Hel. − 2400000	Δ*m*	phase
d	m	P
30790·5618	+ ·60	·731
·5632	+ ·48	·734
·5646	+ ·55	·738
·5660	+ ·53	·742
·5674	+ ·48	·745
·5688	+ ·31	·749
·5701	+ ·44	·753
·5715	+ ·65	·756
plate *6296*		*·301*
30790·6075	+ ·57	·852
·6089	+ ·62	·855
·6103	+ ·63	·859
·6117	+ ·52	·863
·6131	+ ·48	·866
·6145	+ ·56	·870
·6158	+ ·51	·874
·6172	+ ·60	·877
·6186	+ ·54	·881
·6200	+ ·56	·885
·6214	+ ·56	·888
·6228	+ ·61	·892
·6242	+ ·55	·896
plate *6297*		*·301*
30790·6332	+ ·67	·920
·6346	+ ·57	·923
·6359	+ ·65	·927
·6373	+ ·50	·931
·6387	+ ·65	·934
·6401	+ ·55	·938
·6415	+ ·47	·942
·6429	+ ·44	·945
·6442	+ ·44	·949
·6456	+ ·40	·953
·6470	+ ·32	·956
·6484	+ ·33	·960
·6498	+ ·30	·964
·6512	+ ·29	·967
·6526	+ ·19	·971
·6539	+ ·22	·975
·6553	·00	·978
·6567	·00	·982
·6581	− ·02	·986
·6595	− ·18	·989
·6609	− ·11	·993
·6623	− ·11	·997
·6636	− ·17	·000
·6650	− ·27	·004
·6664	− ·31	·008
·6678	− ·31	·011
·6692	− ·35	·015
·6706	− ·48	·019
·6719	− ·49	·022
·6733	− ·52	·026
·6747	− ·56	·030
·6761	− ·59	·033
·6775	− ·58	·037
·6789	− ·60	·041
·6803	− ·62	·045
·6816	− ·71	·048
·6830	− ·75	·052
·6844	− ·71	·055
·6858	− ·76	·059
·6872	− ·78	·063
·6886	− ·79	·067
·6900	− ·73	·070
·6913	− ·71	·074
·6927	− ·79	·077

J. D. Hel. − 2400000	Δ*m*	phase
plate *6304*		*·303*
d	m	P
30791·5100	− ·17	·243
·5114	− ·10	·247
·5127	− ·23	·251
·5141	− ·14	·254
·5155	− ·12	·258
·5169	− ·04	·262
·5183	− ·13	·265
·5197	− ·01	·269
·5211	− ·02	·273
·5224	− ·10	·276
·5238	− ·07	·280
·5252	− ·04	·284
·5266	− ·03	·287
·5280	− ·05	·291
·5294	− ·01	·295
·5308	− ·05	·299
·5321	+ ·02	·302
·5335	− ·01	·306
·5349	− ·03	·309
·5363	+ ·07	·313
·5377	− ·01	·317
·5391	+ ·05	·321
·5404	+ ·06	·324
·5418	+ ·07	·328
·5432	+ ·04	·331
·5446	+ ·10	·335
·5460	+ ·10	·339
·5474	+ ·08	·343
·5488	+ ·09	·346
·5501	+ ·09	·350
·5515	+ ·18	·353
·5529	+ ·17	·357
·5543	+ ·23	·361
·5557	+ ·12	·365
·5571	+ ·22	·368
·5585	+ ·24	·372
·5598	+ ·21	·375
·5612	+ ·19	·379
·5626	+ ·27	·383
·5640	+ ·22	·387
·5654	+ ·14	·390
·5668	+ ·20	·394
·5681	+ ·22	·397
·5695	+ ·20	·401
plate *6305*		*·303*
30791·5799	+ ·29	·429
·5813	+ ·27	·432
·5827	+ ·33	·436
·5841	+ ·26	·440
·5855	+ ·35	·443
·5869	+ ·42	·447
·5882	+ ·24	·451
·5896	+ ·29	·454
·5910	+ ·27	·458
·5924	+ ·41	·462
·5938	+ ·44	·465
·5952	+ ·29	·469
·5965	+ ·24	·473
·5979	+ ·33	·476
·5993	+ ·34	·480
·6007	+ ·35	·484
·6021	+ ·39	·487
·6035	+ ·44	·491
·6049	+ ·45	·495
·6062	+ ·37	·498
·6076	+ ·43	·502
·6090	+ ·38	·506

TABLE 9 (*continued*)

J. D. Hel. − 2400000	Δm	phase
d	m	P
30791·6104	+ ·40	·509
·6118	+ ·42	·513
·6132	+ ·52	·517
·6146	+ ·50	·521
·6159	+ ·46	·524
·6173	+ ·37	·528
·6187	+ ·43	·531
·6201	+ ·40	·535
·6215	+ ·50	·539
·6229	+ ·41	·543
·6242	+ ·46	·546
·6256	+ ·46	·550
·6270	+ ·48	·553
·6284	+ ·42	·557
·6298	+ ·35	·561
·6312	+ ·40	·565
·6326	+ ·47	·568
·6339	+ ·45	·572
·6353	+ ·43	·575
·6367	+ ·40	·579
·6381	+ ·46	·583
·6395	+ ·55	·587
plate *6319*		*·310*
30795·5238	+ ·67	·881
·5259	+ ·69	·886
·5280	+ ·67	·892
·5300	+ ·73	·897
·5321	+ ·68	·903
·5342	+ ·67	·908
·5363	+ ·56	·914
plate *6354*		*·342*
30812·5014	+ ·78	·874
·5035	+ ·75	·879
·5056	+ ·74	·885
·5077	+ ·70	·891
·5097	+ ·75	·896
·5118	+ ·75	·901
·5139	+ ·72	·907
·5160	+ ·67	·913
·5181	+ ·63	·918
·5201	+ ·66	·923
·5222	+ ·65	·929
·5243	+ ·60	·935
·5264	+ ·68	·940
·5284	+ ·57	·945
·5305	+ ·57	·951
·5326	+ ·55	·957
·5347	+ ·45	·962
·5368	+ ·48	·968
·5388	+ ·38	·973
·5409	+ ·31	·979
·5430	+ ·26	·984
·5451	+ ·16	·990
·5471	+ ·05	·995
·5492	+ ·05	·001
·5513	− ·08	·006
·5534	− ·18	·012
·5554	− ·20	·017
·5575	− ·31	·023
·5596	− ·33	·028
·5617	− ·43	·034
·5638	− ·44	·039
·5658	− ·51	·045
·5679	− ·50	·050
·5700	− ·50	·056
·5721	− ·56	·061
·5741	− ·62	·067

J. D. Hel. − 2400000	Δm	phase
d	m	P
30812·5762	− ·64	·072
·5783	− ·63	·078
·5804	− ·67	·083
·5825	− ·58	·089
·5845	− ·66	·094
·5866	− ·61	·100
·5887	− ·57	·105
·5908	− ·64	·111
plate *6393*		*·411*
30849·3948	+ ·53	·647
·3969	+ ·55	·653
·3989	+ ·51	·658
·4010	+ ·54	·663
·4031	+ ·50	·669
·4052	+ ·49	·675
·4072	+ ·52	·680
·4093	+ ·47	·685
·4114	+ ·56	·691
·4135	+ ·53	·697
·4156	+ ·58	·702
·4176	+ ·54	·707
·4197	+ ·53	·713
·4218	+ ·54	·719
·4239	+ ·58	·724
·4259	+ ·54	·729
·4280	+ ·60	·735
·4301	+ ·52	·741
·4322	+ ·56	·746
·4343	+ ·55	·752
·4363	+ ·60	·757
·4384	+ ·60	·763
·4405	+ ·54	·768
·4426	+ ·64	·774
·4446	+ ·61	·779
·4467	+ ·58	·785
·4488	+ ·61	·790
·4509	+ ·56	·796
·4530	+ ·59	·801
·4550	+ ·59	·807
·4571	+ ·58	·812
·4592	+ ·61	·818
·4613	+ ·61	·823
·4633	+ ·71	·829
·4654	+ ·68	·834
·4675	+ ·64	·840
·4696	+ ·71	·845
·4717	+ ·66	·851
·4737	+ ·67	·856
·4758	+ ·71	·862
·4779	+ ·65	·867
·4800	+ ·71	·873
·4820	+ ·71	·878
plate *6394*		*·411*
30849·4952	+ ·70	·913
·4973	+ ·63	·919
·4994	+ ·68	·924
·5014	+ ·63	·930
·5035	+ ·61	·935
·5056	+ ·61	·941
·5077	+ ·55	·946
·5097	+ ·57	·952
·5118	+ ·49	·957
·5139	+ ·44	·963
·5160	+ ·36	·968
·5181	+ ·29	·974
·5201	+ ·27	·979
·5222	+ ·17	·985

J. D. Hel. − 2400000	Δm	phase
d	m	P
30849·5243	+ ·05	·990
·5264	− ·03	·996
·5284	− ·09	·001
·5305	− ·17	·007
·5326	− ·20	·012
·5347	− ·29	·018
·5368	− ·38	·023
·5388	− ·44	·029
·5409	− ·56	·034
·5430	− ·61	·040
·5451	− ·59	·045
·5471	− ·65	·051
·5492	− ·71	·056
·5513	− ·76	·062
·5534	− ·78	·067
·5554	− ·80	·073
·5575	− ·74	·078
·5596	− ·76	·084
·5617	− ·78	·089
·5638	− ·73	·095
·5658	− ·74	·100
·5679	− ·76	·106
·5700	− ·72	·111
·5721	− ·64	·117
·5741	− ·72	·122
·5762	− ·68	·128
·5783	− ·64	·133
plate *6562*		*·960*
31144·5871	+ ·79	·952
·5885	+ ·78	·956
·5899	+ ·74	·960
·5912	+ ·73	·963
·5926	+ ·72	·967
·5940	+ ·75	·970
·5954	+ ·72	·974
·5968	+ ·62	·978
·5982	+ ·67	·981
·5995	+ ·65	·985
·6009	+ ·67	·989
·6023	+ ·59	·992
·6037	+ ·49	·996
·6051	+ ·50	·000
·6065	+ ·47	·003
·6079	+ ·50	·007
·6092	+ ·43	·011
·6106	+ ·43	·014
·6120	+ ·31	·018
·6134	+ ·30	·022
·6148	+ ·28	·025
·6162	+ ·11	·029
·6176	+ ·19	·033
·6189	+ ·08	·036
·6203	·00	·040
·6217	− ·03	·044
·6231	− ·05	·047
·6245	− ·16	·051
·6259	− ·24	·055
·6272	− ·23	·058
·6286	− ·34	·062
·6300	− ·38	·066
·6314	− ·45	·069
·6328	− ·48	·073
·6342	− ·62	·077
·6356	− ·65	·081
·6369	− ·73	·084
·6383	− ·75	·088
·6397	− ·76	·091
·6411	− ·78	·095
·6425	− ·82	·099

J. D. Hel. − 2400000	Δm	phase
d	m	P
31144·6439	− ·92	·103
·6453	− ·82	·106
·6466	− ·83	·110
plate *6565*		*·012*
31172·5070	+ ·70	·944
·5084	+ ·69	·948
·5098	+ ·66	·952
·5112	+ ·64	·955
·5126	+ ·65	·959
·5139	+ ·66	·962
·5153	+ ·64	·966
·5167	+ ·63	·970
·5181	+ ·50	·974
·5195	+ ·50	·977
·5209	+ ·53	·981
·5222	+ ·57	·984
·5236	+ ·52	·988
·5250	+ ·45	·992
·5264	+ ·50	·996
·5278	+ ·35	·999
·5292	+ ·40	·003
·5306	+ ·37	·007
·5319	+ ·30	·010
·5333	+ ·20	·014
·5347	+ ·25	·018
·5361	+ ·20	·021
·5375	+ ·15	·025
·5403	+ ·03	·032
·5416	− ·03	·036
·5430	− ·10	·040
·5444	− ·18	·043
·5458	− ·25	·047
·5472	− ·37	·051
·5486	− ·37	·054
·5499	− ·41	·058
·5513	− ·48	·062
·5527	− ·56	·065
·5541	− ·59	·069
·5555	− ·63	·073
·5569	− ·65	·076
·5583	− ·68	·080
·5596	− ·69	·084
·5610	− ·73	·087
·5624	− ·71	·091
·5638	− ·74	·095
·5652	− ·78	·098
·5666	− ·62	·102
plate *6583*		*·064*
31200·4303	+ ·64	·945
·4320	+ ·65	·950
·4338	+ ·66	·954
·4355	+ ·61	·959
·4372	+ ·51	·963
·4390	+ ·53	·968
·4407	+ ·42	·973
·4424	+ ·55	·977
·4442	+ ·47	·982
·4459	+ ·39	·987
·4476	+ ·36	·991
·4494	+ ·43	·996
·4511	+ ·33	·000
·4528	+ ·20	·005
·4546	+ ·21	·010
·4563	+ ·20	·014
·4580	+ ·07	·019
·4597	+ ·06	·023
·4615	·00	·028