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COMMUNICATION FROM THE OBSERVATORY AT LEMBANG

A study of the variable stars in Messier 4, by *A. de Sitter* †.

(Partly discussed and prepared for publication by *P. Th. Oosterhoff*).

The globular cluster M₄ has been investigated on 107 plates taken with the 60-cm refractor of the Bosscha Observatory. Ten new variables of the cluster type have been discovered. The plates have been measured in a Hartmann photometer. The resulting magnitudes have been collected in Table 2. The main data about the variables are to be found in Table 1. New periods have been derived for 20 variables, whereas the periods of six others could be corrected. For 25 variables periods have been determined from the combined material of Miss SAWYER and of Lembang. Mean light-curves arranged according to period are shown in Figure 1. The frequency-distribution of the periods and the ratio between the number of *c*-type variables and the total number of cluster-type variables are similar to those of M₃ and M₅.

1. Introduction.

During the years in which Dr A. DE SITTER was director of the Bosscha Observatory at Lembang he took more than a hundred plates of the globular cluster M₄ with the 60-cm photographic refractor for an investigation of its variable stars. The measurement of these plates and the reduction connected therewith was first interrupted when Dr DE SITTER was imprisoned by the Japanese and was definitely brought to an end through his tragic death in 1944.

A considerable and probably the most essential part of his work has been saved and was eventually sent to the Leiden Observatory. In this article the results of this investigation are presented, although they are not as complete as they no doubt were intended to be by the author. Several details about the reduction of the measurements remained obscure. No record has been found of the comparison stars which were used, but a quite complete list of the resulting magnitudes of the individual variables is available. For several plates and variables two values of the magnitude were found entered in this list. Their weighted mean value, as given by DE SITTER, has been adopted. As a consequence of the uncertainty about the photometric system, these magnitudes have only been used for the derivation of periods and mean light-curves and not for the determination of the distance-modulus. Dr DE SITTER indicated the variables in his papers by a provisional serial number, which however could be identified with certainty with the official numbering by means of the periods in all but one case.

The treatment of the material has been completely independent of the work done by DE SITTER, of

which only disconnected data were at hand. From a list by DE SITTER of provisional reciprocal periods it is however clear that the results presented here fully agree with those derived by him. In a few cases only, which will be mentioned explicitly below, there seems to be a discordance. For a number of variables provisional results derived from estimates have been published by Dr DE SITTER himself. This article "Note on variable stars in the globular cluster Messier 4" is to be found in *Natuurwetenschappelijk Tijdschrift voor Ned. Indië*, **101**, 51, 1941. The important data of this article have been included in the present paper.

2. Plates and measures.

The cluster Messier 4 or N.G.C. 6121 is a bright, but rather loose globular cluster in the constellation Scorpio. Its equatorial co-ordinates are:

$$\alpha (1900) = 16^{\text{h}} 17^{\text{m}} \cdot 5, \quad \delta (1900) = -26^{\circ} 17'.$$

In 1904 the discovery of 33 variables was announced by Miss LEAVITT¹⁾. For twenty of these variables periods have been determined by HELEN B. SAWYER²⁾. She also published a map on which the variables have been marked.

From 1939 June 20 until 1940 August 4, 107 plates have been taken of this cluster with the 60-cm photographic refractor of the Bosscha Observatory. On these plates ten new variables have been discovered. Their rectangular co-ordinates expressed in seconds of arc with respect to the zeropoint used by Miss SAWYER in her catalogue of variable stars in globular clusters³⁾ are:

¹⁾ *H.C.* No. 90, 1904; *A.N.* **167**, 161, 1904.

²⁾ *H.C.* No. 366, 1931.

³⁾ *Publ. David Dunlap Obs.*, 1, No. 4, 1939.

Variable	GREENSTEIN number	x	y
34	—	— 820	+ 416
35	420	— 377	+ 62
36	519	— 208	— 259
37	166	— 39	+ 2
38	252	— 23	— 92
39	222	+ 1	— 80
40	118 B	+ 25	+ 49
41	540	+ 65	— 150
42	303	+ 377	+ 558
43	—	+ 1263	+ 332

In the second column the numbers are given of GREENSTEIN's catalogue of photographic and red magnitudes ¹⁾. Variable V 35 was already suspected by GREENSTEIN. No variation was found in the suspected stars 219 and 520 of his catalogue, but the latter is a close companion to the variable V 36 or GREENSTEIN 519.

The plates have been measured in a Hartmann microphotometer. The resulting magnitudes are given in Table 2. The stars V 4, V 13 and V 40 have not been measured, the last variable being badly blended with a 13^m.5 star. The first figure of the magnitudes in Table 2 is always equal to one and has therefore been omitted in that table. The identification of V 17 is still somewhat uncertain. All the variables were identified with the aid of their periods. Only for one this proved to be impossible. It could therefore only be identified with either V 4, V 13 or V 17. As it has a very small range and a median magnitude which is perfectly normal for a cluster-type variable in M 4, the identification with V 17 is most probably correct.

¹⁾ *Ap. J.* 90, 387, 1939.

3. The periods.

The periods have been derived from the material of Table 2 exclusively. After a provisional value of the period had been determined, a second approximation was obtained from a least-squares solution with the aid of those observations which yield the most accurate epochs. For most variables these observations cover the rising branch of the light-curve. In this case the slope of the rising branch has been included in the equation as an unknown. The resulting equations are tabulated in Table 3. The rising and the descending branches, the maximum and the minimum have been indicated by (r.b.), (d.b.), (max.) and (min.) respectively. The errors are mean errors throughout. The epochs used in these solutions are given in Table 4, together with their residuals.

The observations published by Miss SAWYER (*l.c.*) have been used for 25 variables. The periods, which were derived for the combined material from epochs of maximum or minimum, have been computed only when the counting of periods within the large intervals seemed reasonably well established. The periods and their mean errors as derived from the Lembang plates only are given in the third column of Table 1, whereas the periods derived from all available observations are given in the last. The mean errors refer to the last decimal place of the periods.

The period of V 40 has been copied from *Natuurwetenschappelijk Tijdschrift voor Ned. Indië*, where the variable has been classified as belonging to subclass *a* according to Figure 1. Its period is however rather uncertain, as it has been derived from estimates, the star being badly blended.

If this period is disregarded, Table 1 contains 20 new periods as compared with Miss SAWYER's list and 6 corrected periods, namely for the variables 7, 10, 15, 24, 29 and 30.

TABLE I

var.	number DE SITTER	period Lembang plates	m.e.	reciprocal period	number of obs.	phase of max.	epoch of max.	range	median magn.	period Harvard Mt Wilson m.e. Lembang plates
1	14	d .288872	6	d ⁻¹ 3'46174	97	P .54	d 9706'315	m .51	m 13'72	d
2	15	.535654	12	1'8669	95	.96	9676'448	1'05	13'58	.5356817 13
3	57	.506651	14	1'97381	97	.99	9723'221	1'16	13'50	
4										
5	30	.622455	35	1'60654	96	.33	9522'035	.42	13'78	.622401 3
6	73	.320504	4	3'12009	96	.45	9705'377	.55	13'82	
7	175	.498760	15	2'00497	95	.31	9748'231	1'29	13'64	.4987743 7
8	4	.5081814	21	1'96781	89	.63	9676'458	1'34	13'55	.5081753 16
9	5	.571892	7	1'74858	95	.44	9676'332	1'41	13'46	.5718921 24
10	19	.490693	8	2'03794	98	.26	9717'391	1'50	13'43	.4907161 8
11	20	.493067	17	2'02812	95	.47	9496'021	.82	13'73	.4930763 14
12	61	.446118	4	2'241557	93	.17	9676'323	1'34	13'71	.4461309 15
13										

TABLE I (continued)

var.	number DE SITTER	period Lembang plates	m.e.	reciprocal period	number of obs.	phase of max.	epoch of max.	range	median magn.	period Harvard Mt Wilson Lembang plates	m.e.
14	6	d .463528	5	d ⁻¹ 2'15737	92	P .20	d 9717'295	m 1'44	m 13'68	d .4635292	21
15	7	.443773	4	2'25341	96	.66	9496'035	1'27	13'62	.4437854	15
16	22	.542536	5	1'843195	91	.81	9705'381	1'13	13'62	.5425452	25
17 ¹⁾	72	.855469	15	1'16895	105	.54	9708'319	.34	13'57		
18	64	.478793	5	2'088585	95	.78	9676'446	1'36	13'52	.4787915	20
19	8	.4678120	24	2'13761	95	.17	9511'075	1'42	13'47	.4678119	11
20	162	.309405	4	3'23201	97	.36	9676'381	.36	13'42	.3094164	8
21	82	.471986	4	2'11869	93	.61	9705'436	1'37	13'42		
22	47	.603070	18	1'65818	96	.83	9676'410	.58	13'69	.6030634	23
23	84	.298545	7	3'34958	97	.44	9676'389	.51	13'52	.2985478	9
24	23	.546786	16	1'82887	97	.37	9676'450	.94	13'59	.5467733	15
25	40	.612713	9	1'63206	97	.17	9723'276	1'00	13'58	.6127352	21
26	10	.541226	6	1'84765	96	.72	9538'993	1'34	13'47	.5412200	6
27	115	.612015	17	1'63395	95	.32	9723'260	1'19	13'50	.6120184	25
28	25	.522322	7	1'91453	95	.38	9676'411	1'42	13'31		
29	42	.522484	6	1'91394	96	.29	9705'367	1'14	13'45	.5224857	19
30	12	.269745	5	3'70721	97	.86	9676'458	.58	13'58	.2697501	4
31	26	.505304	7	1'979008	96	.58	9676'272	1'31	13'38	.5053135	12
32	120	.579089	14	1'72685	96	.85	9705'446	.98	13'47	.579109	4
33	178	.614834	15	1'62646	88	.38	9676'340	1'26	13'33	.6148277	12
34	180	.554843	11	1'80231	92	.67	9723'338	1'20	13'76		
35	13	.627042	12	1'59479	96	.94	9705'441	.71	13'80		
36	2	.541310	11	1'84739	96	.83	9676'370	.92	13'72		
37	21	.247352	6	4'04282	97	.39	9522'064	.30	13'61		
38	35	.577848	14	1'73054	96	.10	9496'053	.71	13'74		
39	52	.623980	18	1'60263	96	.39	9676'463	.44	13'84		
40	9	.40151 ²⁾									
41	24	.2517311	31	3'97249	98	.21	9676'402	.44	13'75		
42	45	.303708	5	3'29264	97	.03	9526'164	.45	13'56		
43	173	.320637	8	3'11879	87	.53	9748'245	.56	13'20		

¹⁾ Identification uncertain.

²⁾ Badly blended with 13^m.5 star s.f.; no photometric measures.

4. The light-curves.

Phases have been computed according to the formula:

$$\text{phase} = \text{reciprocal period} \times (\text{J.D.} - 2420000).$$

The values actually adopted for the reciprocal periods are given in the fourth column of Table I. Normal points have then been formed, the details of which are given in Table 5. The resulting mean light-curves are shown in Figure 1, where the variables have been arranged according to period.

The phase of maximum, given in the sixth column of Table I, was read from these curves. The corresponding mean epochs of maximum, expressed in Julian Days, are given in the next, whereas data about range and median magnitude have been collected in the eighth and ninth columns of the same table.

5. Remarks about individual variables.

V 3. It has not been possible to combine the observations of Lembang and of Miss SAWYER into a single light-curve by means of a constant period. No

quadratic term is given here on account of the uncertainties involved.

V 6. From his estimates DE SITTER classified this variable as an eclipsing binary of the W UMA-type with a total period of .641030 days. The apparent period has been fully confirmed, but the measures hardly permit classification as an eclipsing variable. Figure 1 shows that the light-curve is not unusual at all for a cluster-type variable of subclass *c*, the rising branch being slightly steeper than the descending one. Its median magnitude of 13.82, though a quarter of a magnitude fainter than the mean value for all the cluster-type variables, is not extreme and it is certainly not in conflict with the assumption that we have to do with an ordinary cluster-type variable. There is no noticeable difference in depth between successive minima, as might be expected if the star were an eclipsing binary. If it is considered as a W UMA-type variable with equal minima, a reflected light-curve can be computed, in which phase has been reckoned without regard to sign from the phase of minimum. Such a mean light-curve is shown in Figure 2. It seems however rather unsatisfactory and

FIGURE I

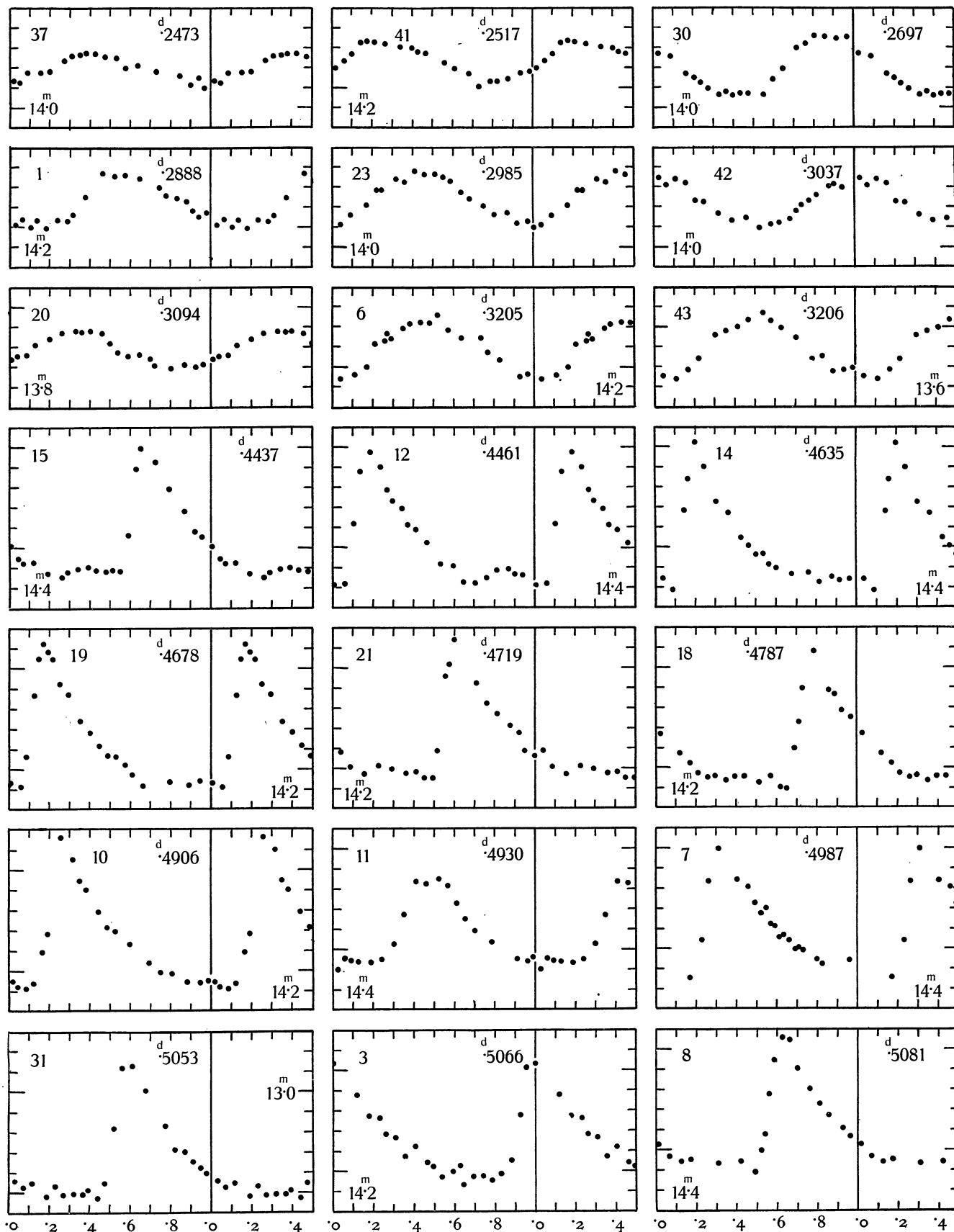
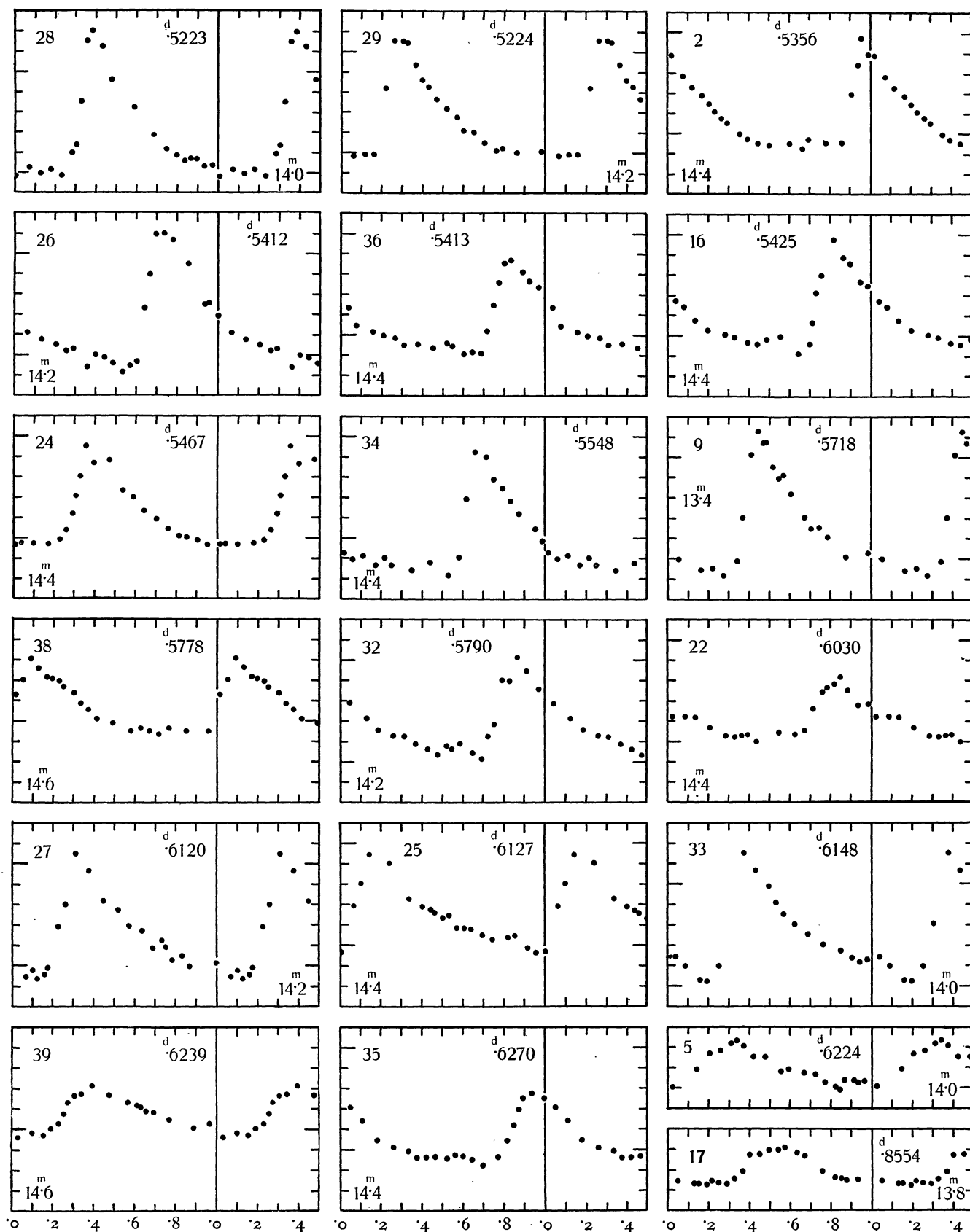
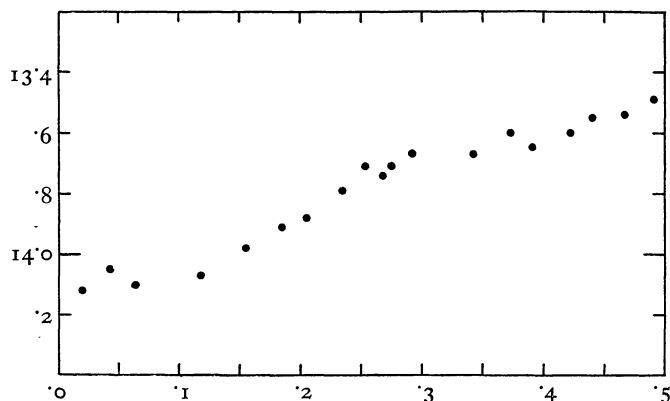


FIGURE I (continued)



the variable must therefore be classified as an ordinary cluster-type variable.

FIGURE 2
Var 6 considered as W UMA-type variable
Reflected light-curve



V 8. The observation at J.D. 2429791.308 deviates about half a magnitude from the mean light-curve. It has not been included in the normal points.

V 11. The dispersion of the observations near maximum is so large that it must be considered real. The unusual character of the light-curve is probably due to the same fact.

V 17. It has already been stated that the identification of this variable is somewhat uncertain. The period which has been derived is the largest in this cluster. It is the same as that found by DE SITTER, who probably has felt some hesitation about it, as he apparently has not treated the star any further.

V 20. The counting of periods in the large intervals of the combined observations is slightly different from that adopted by DE SITTER, who gave a period of 309388 days.

V 21. The observation at J.D. 2429705.370 is one magnitude too bright. It has not been included in the normal points. All available epochs of maximum are well represented by the quadratic formula:

$$\text{max.} = 2417443.532 + .4719646E + 41 \times 10^{-11} E^2 \\ \pm \quad 20 \quad \pm 7 \quad (\text{m.e.})$$

V 24. There are some large deviations from the light-curve shortly after maximum.

V 25. The observation on the rising branch at J.D. 2429758.175, which differs by half a magnitude from the neighbouring observations, has been omitted from the least-squares solution of the period and also from the normal points.

V 30. The observation at J.D. 2429739.373 is more than half a magnitude too faint. It is not included in the normal points. The period of 269503 days given by DE SITTER is materially shorter than

that adopted here. The difference amounts to one period per year.

V 37. The observations at J.D. 2429748.343 and 2429758.150 show considerable deviations from the light-curve. Nevertheless the period is believed to be correct.

V 40. The period given by DE SITTER has been derived from estimates, the variable being badly blended with a 13^m.5 star. It must be considered as tentative.

6. Discussion of the results.

If the median magnitudes of Table 1 are plotted against the distance of the variables from the centre of the cluster, it is seen that no correlation exists between them up to a distance of 1000". The two variables 33 and 43, which are situated at a still larger distance, have a median magnitude which is .3 magnitudes brighter than the mean value for all variables.

The mean median magnitude and its mean dispersion are shown for all variables and for the two subclasses separately in the following table:

subclass	number	$m_{\text{med.}}$	dispersion
<i>c</i>	9	13.58	$\pm .19$
<i>a</i> and <i>b</i>	31	13.58	$\pm .14$
all	40	13.58	$\pm .15$

The mean dispersion, especially for the *c*-type variables, is considerably larger than the values derived by MARTIN¹⁾ and by OOSTERHOFF²⁾ for the clusters ω Cen and M 5. The values derived by them for subclass *c* are $\pm .085$ and $\pm .06$ respectively.

In this connection it may be worth mentioning that M 4 has a galactic latitude of + 14°, which is nearly the same as that of ω Cen, but which is much smaller than the value for M 5. In the neighbourhood of M 4 however there is evidence of heavy interstellar absorption. The cluster has according to STEBBINS and WHITFORD³⁾ a considerable colour-excess and no extra-galactic nebulae have been recorded in this field. The apparent star density on the other hand is quite normal, although at some distance dark material and nebulosity are very conspicuous.

The frequency distribution of the periods is of the usual type and it is comparable with that of M 3 and

¹⁾ *Annalen Leiden*, 17, part 2, 39, 1938.

²⁾ *Ibidem*, 17, part 4, 22, 1941.

³⁾ *Ap. J.* 84, 132, 1936; *Mt W. Contr.* No. 547.

M 5. Therefore M 4 belongs to the globular clusters with relatively short mean periods. If V 40 is omitted, the mean period of the *c*-type variables is .29 days, that of the *a*- and *b*-type variables .55 days. These values may be compared with those collected by OOSTERHOFF for other clusters¹⁾. It is an interesting fact that the ratio between the number of *c*-type

variables and the total number of cluster-type variables is about the same as for M 3 and M 5, namely .22, whereas this ratio equals about .5 for the clusters with relatively long mean periods.

¹⁾ *The Observatory*, 62, 104, 1939.
B.A.N. No. 365, 58, 1944.

TABLE 2

J.D. hel. - 2420000	V 1	V 2	V 3	V 5	V 6	V 7	V 8	V 9	V 10	V 11	V 12	V 14	V 15	V 16	V 17	V 18	V 19
9435'135	3'74	4'09	3'79	4'05	3'61	3'80	3'36	3'66	4'08	4'05	4'09	4'09	4'07	4'14	3'65	2'84	4'05
36'093	4'11	3'86	3'62	3'69	3'74	3'43	2'92	3'90	4'15	4'04	4'25	4'12	3'74	4'04	3'71	2'88	4'15
'128	3'83	3'88	3'71	3'50	3'57	3'50	3'37	2'83	4'18	3'99	4'23	4'44	3'10	4'06	3'60	3'33	4'12
'156	3'90	4'08	3'97	3'57	3'53	3'87	—	2'86	4'17	4'04	4'12	4'36	3'12	—	3'37	3'38	4'08
59'152	3'93	3'91	4'10	3'57	3'93	4'11	3'95	3'64	4'11	3'72	3'83	3'42	4'26	3'56	3'70	3'51	2'85
'180	3'97	3'94	4'11	3'61	3'72	4'01	3'91	3'69	4'17	3'87	3'95	3'51	3'49	3'60	3'70	3'68	3'02
60'216	3'43	3'89	3'97	4'05	3'50	4'10	4'17	3'33	3'92	4'14	4'37	4'15	3'90	3'39	3'42	3'95	3'71
62'046	3'89	4'13	3'90	3'97	3'72	3'70	3'17	3'67	4'12	3'31	4'49	4'12	4'20	4'06	3'49	3'60	3'54
66'048	3'64	3'63	3'85	3'57	3'77	3'60	3'15	3'71	4'19	3'72	4'36	3'20	4'18	4'20	3'68	4'12	4'15
'081	3'94	3'84	4'00	3'68	3'95	3'90	2'76	3'81	4'16	3'93	4'30	3'18	4'26	3'58	3'46	4'07	4'14
'194	3'75	4'14	4'13	3'81	3'93	4'24	3'64	3'94	3'05	4'08	2'99	3'99	4'20	3'45	3'40	4'14	2'96
67'025	4'04	3'24	3'81	3'93	3'86	3'54	4'21	2'57	4'16	3'84	4'39	3'34	4'24	4'06	3'41	4'11	4'15
'181	3'68	3'87	4'00	3'58	3'67	4'11	3'64	3'75	3'17	4'06	3'93	4'14	3'12	3'43	3'45	3'56	3'50
68'209	4'18	3'62	4'18	4'10	3'66	4'16	—	3'14	3'43	4'04	—	—	3'75	—	3'75	3'31	3'60
74'061	3'50	3'64	3'44	3'55	3'70	3'82	4'09	3'74	3'14	4'16	4'21	3'99	4'24	4'11	3'61	3'90	4'18
75'044	4'05	3'17	3'36	3'96	3'87	3'66	4'13	2'93	3'21	4'04	4'41	4'15	4'20	3'99	3'67	3'96	2'89
'064	4'18	3'17	3'31	3'80	3'92	3'87	—	3'14	3'43	4'04	4'47	4'15	4'24	—	3'75	3'96	2'82
'096	3'85	3'34	3'46	3'92	4'05	3'86	4'13	3'23	3'67	4'03	3'70	4'26	4'28	3'98	3'74	4'07	3'27
77'134	3'90	3'92	3'74	3'72	3'76	4'09	—	4'13	3'84	4'17	4'24	4'58	4'24	—	3'75	4'11	4'08
78'091	3'40	4'13	3'37	3'82	3'64	4'00	4'17	3'82	3'73	4'05	4'22	3'51	4'18	3'37	3'44	4'11	4'09
85'068	3'49	4'00	3'45	3'94	4'02	3'97	3'91	3'92	4'00	4'05	3'91	2'68	3'89	3'64	3'40	3'78	4'02
88'115	4'15	4'06	3'22	4'09	3'62	4'12	3'99	4'09	4'15	3'42	3'52	4'33	3'49	4'06	3'70	4'05	3'81
'164	3'65	4'13	3'03	3'89	3'75	4'12	4'07	2'89	4'11	3'60	3'84	4'35	3'90	4'09	3'76	4'13	2'84
89'046	3'44	3'54	4'06	3'56	3'56	3'88	3'68	3'89	4'15	3'77	3'78	4'27	3'80	3'73	3'66	4'10	3'92
'071	3'51	3'62	4'04	3'56	3'66	3'86	3'72	4'01	4'12	3'27	3'85	4'29	3'85	3'79	3'71	4'12	3'14
90'039	3'66	2'95	4'21	4'04	3'57	3'80	3'49	3'60	4'10	3'81	4'17	4'34	4'22	3'32	3'65	4'17	2'78
92'028	3'65	4'05	4'02	3'97	3'89	3'81	3'15	4'03	4'10	3'62	4'25	3'19	3'13	4'12	3'58	4'13	3'72
'076	3'86	4'09	3'86	3'73	4'13	3'91	3'50	4'13	4'17	3'28	3'14	3'55	3'32	—	3'64	3'53	3'87
93'111	3'59	4'05	4'18	4'02	3'93	4'14	3'58	4'04	3'70	3'54	3'90	4'09	4'14	4'08	3'68	3'28	4'11
95'026	4'12	3'76	4'09	4'08	3'97	3'86	2'68	2'88	4'14	2'94	4'33	4'34	4'24	3'71	3'72	3'33	4'11
'054	4'03	3'95	4'02	3'94	3'75	4'08	2'84	2'76	4'07	3'03	4'20	4'26	4'28	3'96	3'76	3'42	4'15
'070	3'80	3'97	3'97	3'98	3'65	3'94	3'15	2'94	3'49	3'07	3'92	—	4'24	3'94	3'73	3'49	3'92
96'003	3'53	3'61	4'09	3'80	3'63	3'78	3'90	4'04	4'24	2'90	4'30	4'38	3'86	3'15	3'68	3'37	4'14
'055	3'51	3'75	4'03	3'89	3'65	4'09	2'95	4'17	3'36	3'29	3'94	4'39	3'01	3'63	3'49	3'75	4'15
'103	3'74	3'90	4'07	3'89	3'50	4'12	3'21	4'16	2'76	3'56	3'06	4'47	3'44	3'60	3'42	3'84	2'76
9511'070	3'51	3'75	3'71	3'89	3'80	4'12	4'09	2'89	4'09	4'18	4'34	3'63	4'24	4'14	3'68	4'12	2'71
12'059	3'91	3'50	3'72	3'56	3'72	4'04	4'02	4'09	4'02	4'16	4'34	4'00	3'42	3'98	3'73	4'08	3'17
22'042	3'48	3'98	3'63	3'55	3'51	4'11	3'49	3'50	4'02	4'06	3'68	4'37	4'26	3'29	3'71	3'95	4'04
26'066	3'56	3'80	4'11	4'04	4'12	4'12	3'17	3'69	3'24	3'63	3'63	—	4'24	3'93	3'44	3'81	2'98
39'006	3'72	4'00	3'80	3'81	3'65	4'16	4'01	4'20	4'11	3'63	3'70	4'10	4'31	3'93	3'38	3'36	4'18
42'016	3'55	3'31	3'97	3'72	3'72	4'10	4'12	3'25	4'11	3'76	3'67	4'21	4'18	4'19	3'72	3'40	3'38
9676'351	3'71	—	3'84	3'67	4'10	—	—	2'84	3'72	4'18	3'30	—	3'96	4'10	3'71	4'15	3'95
'368	3'71	4'08	3'99	3'64	4'09	3'88	3'99	2'88	3'68	4'03	3'38	4'33	4'03	4'10	3'82	4'22	4'00
'385	3'80	4'24	4'07	3'78	4'09	3'36	4'15	3'08	3'88	4'11	3'61	4'24	4'03	3'95	3'73	4'19	4'05
'403	3'81	4'12	3'98	3'46	4'10	2'92	4'00	3'17	3'90	4'00	3'68	4'24	4'14	4'11	3'71	3'80	3'88
'419	3'80	3'63	3'91	3'56	4'10	2'96	3'56	3'38	3'99	3'78	3'76	4'36	4'18	4'11	3'71	3'17	4'08
9705'353	3'98	3'32	4'16	3'99	3'55	3'08	4'24	4'12	4'16	4'08	3'18	4'08	4'19	3'38	3'69	3'95	3'74
'370	3'99	3'04	3'95	3'90	3'53	3'24	4'05	3'98	4'11	4'08	3'56	4'00	4'11	2'90	3'74	4'09	3'80
'388	3'95	3'10	4'22	3'90	3'52	3'26	3'49	4'20	4'01	4'04	3'58	4'20	4'29	2'96	3'79	4'09	3'82
'410	3'60	3'38	4'03	3'87	3'55	3'48	2'81	4'29	4'05	4'13	3'66	4'10	4'12	3'18	3'72	4'14	4'06

TABLE 2 (continued)

J.D. hel. - 2420000	V ₁	V ₂	V ₃	V ₅	V ₆	V ₇	V ₈	V ₉	V ₁₀	V ₁₁	V ₁₂	V ₁₄	V ₁₅	V ₁₆	V ₁₇	V ₁₈	V ₁₉
97°06'320	3'53	4'08	3'94	3'70	3'57	3'19	4'09	3'97	4'01	4'02	3'75	4'01	4'26	3'87	3'73	3'87	3'82
08'426	3'82	4'20	3'87	3'96	4'17	3'64	3'88	3'15	4'07	4'20	3'22	4'32	4'40	4'09	3'42	4'07	4'20
17'394	3'88	4'16	4'00	3'78	4'08	3'44	4'12	4'14	2'58	3'40	3'12	3'73	4'26	3'50	3'75	4'14	2'79
419	3'90	4'16	4'06	3'66	4'09	3'67	4'07	4'12	2'74	3'58	3'44	4'00	4'07	3'56	3'76	4'12	3'18
23'376	3'50	4'16	3'57	3'90	3'64	3'50	3'98	3'68	3'32	3'48	4'38	3'73	3'86	3'40	3'76	2'87	4'12
421	3'51	4'28	3'71	3'90	3'72	3'75	4'10	3'84	3'72	3'70	4'38	3'86	4'10	3'68	3'74	3'14	3'90
24'226	3'36	3'58	2'98	3'77	—	—	3'00	—	3'86	—	—	3'52	3'64	—	3'75	—	—
378	3'97	3'98	3'54	3'62	3'68	3'58	3'84	2'84	3'46	3'47	4'15	4'05	4'32	3'09	3'68	3'19	3'30
394	3'80	4'12	2'73	3'61	3'76	3'90	3'68	3'90	2'72	3'58	3'58	4'20	4'02	2'88	3'68	3'50	2'66
25'247	—	—	3'09	—	—	—	3'11	—	2'75	—	—	—	—	—	—	—	—
28'395	3'78	3'52	3'42	3'96	3'78	3'52	3'68	2'72	3'96	3'80	4'41	3'79	4'33	4'11	3'67	3'98	4'15
39'373	3'81	4'15	4'09	3'62	3'44	3'64	4'28	3'73	4'20	4'24	4'22	4'49	3'99	4'07	3'72	4'06	2'75
398	3'96	4'12	3'20	3'86	3'62	3'84	4'23	3'84	4'23	4'14	4'12	4'32	4'04	4'02	3'70	4'05	3'05
418	4'04	4'22	2'73	3'87	3'70	3'90	4'00	3'74	4'14	4'15	4'17	4'29	4'00	3'94	3'69	4'07	3'20
48'268	3'79	3'34	3'88	4'06	3'59	3'29	3'80	4'07	3'47	4'06	3'90	4'32	4'05	3'41	3'74	2'82	2'86
296	3'70	3'39	3'90	4'04	3'53	3'22	3'98	4'14	2'64	4'18	4'18	4'42	4'10	3'18	3'75	3'01	3'07
343	3'97	3'62	4'15	3'88	3'34	3'54	4'20	3'84	2'96	4'13	4'41	2'92	4'31	3'56	3'71	3'39	3'61
373	3'87	3'60	4'22	4'00	3'68	3'78	4'20	3'07	3'25	4'23	4'34	3'15	4'38	3'70	3'71	3'58	3'73
49'285	3'93	3'36	3'82	3'68	3'50	3'38	3'78	3'90	2'62	4'26	4'45	3'28	4'38	3'52	3'49	3'34	3'58
384	3'54	3'55	3'87	3'84	3'78	4'00	4'14	4'16	3'54	3'65	4'29	3'86	4'16	3'40	3'40	3'63	3'98
419	3'64	3'73	3'98	3'88	4'04	4'08	4'14	4'16	3'54	3'41	4'33	4'10	3'04	3'39	3'46	4'05	4'22
52'355	3'72	4'04	3'94	3'57	4'14	3'85	3'78	3'54	3'59	3'69	4'17	4'30	4'26	4'04	3'70	4'07	4'29
58'150	3'73	4'05	3'71	3'75	4'21	4'27	4'26	3'14	3'06	4'10	4'26	3'47	4'16	3'61	3'52	4'02	3'33
175	3'97	—	2'95	3'98	4'10	3'44	—	3'34	3'29	3'86	—	3'91	4'22	3'80	3'69	—	3'60
199	3'92	4'13	2'78	3'76	3'75	3'04	4'32	3'40	3'40	3'94	4'49	3'87	4'26	3'98	3'69	4'23	3'68
63'326	3'72	3'58	3'21	3'86	3'77	3'71	3'29	3'03	3'97	3'65	2'95	4'04	3'99	4'07	3'66	4'25	3'63
352	3'99	3'68	3'34	4'00	3'57	3'89	2'80	3'27	4'01	3'74	3'34	4'19	4'15	4'33	3'64	4'13	3'68
378	4'03	3'84	3'46	3'94	3'68	4'04	2'92	3'49	4'06	3'92	3'64	4'22	4'07	4'02	3'74	4'24	3'75
76'148	3'85	3'34	3'98	3'74	3'78	3'06	3'45	4'00	4'05	3'55	4'33	3'26	3'48	3'93	3'67	3'81	4'11
78'356	3'91	3'73	3'87	3'76	3'97	3'95	4'12	4'05	3'76	4'23	4'32	4'30	3'69	3'97	3'50	4'25	4'10
79'110	3'36	4'08	3'66	3'42	3'48	4'05	3'02	4'16	4'17	3'51	4'22	4'22	4'31	3'95	3'79	4'01	3'10
210	3'65	4'10	4'03	3'67	3'85	3'42	3'61	4'17	2'81	4'06	4'25	4'31	3'47	3'40	3'46	3'96	3'42
254	4'00	3'89	3'90	3'82	3'92	3'68	3'79	3'08	3'06	4'09	4'24	4'24	3'83	3'47	3'48	4'19	4'02
278	3'89	3'08	4'09	3'76	4'11	3'83	3'72	2'76	3'04	4'25	4'23	4'32	3'90	3'58	3'39	3'96	3'87
326	3'82	3'27	4'06	3'81	4'06	3'93	4'00	3'18	3'42	4'29	4'43	4'38	3'97	3'85	3'39	4'35	4'06
355	3'81	3'42	—	—	3'72	3'83	—	3'32	3'59	—	3'53	—	—	3'78	3'44	3'57	—
80'044	3'68	4'19	3'16	3'93	3'46	4'10	—	3'74	4'28	3'35	4'34	4'26	2'80	4'11	3'50	3'98	3'40
81'040	4'05	3'92	3'51	3'71	3'58	4'16	4'13	3'19	4'09	3'28	4'12	4'17	3'68	3'87	3'40	4'09	3'24
064	3'93	3'79	3'48	3'74	3'74	4'31	—	3'23	3'99	3'43	—	4'29	4'08	4'01	3'44	4'16	3'23
113	3'43	4'01	3'56	3'93	3'84	3'83	3'38	3'48	4'14	3'81	4'42	4'25	4'28	4'18	3'45	4'22	3'57
212	3'60	4'11	3'87	3'82	4'18	3'29	3'45	3'90	2'86	4'14	3'47	4'30	4'28	4'03	3'68	4'09	4'03
235	3'74	4'01	3'92	4'00	4'08	3'56	3'54	4'12	3'20	4'17	3'54	3'61	4'11	4'15	3'68	4'16	4'18
281	3'80	4'19	4'01	4'01	3'75	3'71	3'76	3'91	3'54	4'35	3'98	3'12	4'24	3'78	3'65	3'10	4'25
305	4'00	4'13	4'17	4'02	3'65	3'95	3'97	4'01	3'77	4'25	4'10	3'43	4'29	3'41	3'72	2'77	4'15
350	3'93	4'10	4'16	3'89	3'54	4'12	3'90	4'08	3'70	4'22	4'16	3'81	4'03	3'24	3'66	3'33	4'19
87'201	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
91'244	3'53	3'94	3'72	3'93	3'69	3'74	3'99	3'35	3'93	4'14	4'29	4'13	3'58	3'81	3'40	4'20	4'22
308	3'52	3'82	3'61	3'96	3'68	3'98	3'50	3'06	4'22	3'41	4'26	4'36	3'98	3'81	3'46	3'81	2'95
94'312	3'92	2'97	3'71	3'83	4'08	4'22	3'76	3'71	4'20	3'55	4'27	3'58	3'30	3'80	3'75	3'35	4'22
98'16'084	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3'41	—	—
18'064	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3'69	—	—
22'124	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3'32	—	—
198	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3'41	—	—
34'180	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3'41	—	—
43'160	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3'75	—	—
46'062	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3'37	—	—
153	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3'45	—	—

TABLE 2 (continued)

J.D. hel. - 2420000	V ₂₀	V ₂₁	V ₂₂	V ₂₃	V ₂₄	V ₂₅	V ₂₆	V ₂₇	V ₂₈	V ₂₉	V ₃₀	V ₃₁	V ₃₂	V ₃₃	V ₃₄	V ₃₅	V ₃₆
9435'135	3'38	3'73	3'39	3'24	4'08	4'01	3'03	3'53	2'65	4'05	3'74	4'07	3'45	3'77	4'23	3'75	3'98
36'093	3'54	3'81	3'92	3'36	3'89	3'76	4'06	4'11	3'81	3'94	3'33	4'10	3'72	3'38	3'89	4'08	3'51
'128	3'55	3'74	3'93	3'41	4'00	3'75	3'38	4'11	2'55	4'01	3'38	4'01	3'25	3'39	4'17	4'05	3'61
'156	3'56	—	3'93	3'58	4'08	3'74	2'71	3'98	2'53	4'08	3'58	3'85	3'27	—	4'27	4'08	3'80
59'152	3'20	3'49	4'05	3'57	4'07	3'36	3'96	4'02	3'00	4'04	3'79	3'70	3'85	3'95	4'32	3'92	4'01
'180	3'15	3'50	4'00	3'66	4'00	3'10	4'04	3'98	3'18	3'97	3'80	3'74	3'86	3'83	4'18	3'95	3'99
60'216	3'54	4'06	4'07	3'43	4'10	3'99	3'77	3'52	3'05	4'04	3'74	3'97	3'84	3'88	4'30	3'53	4'12
62'046	3'48	3'96	3'89	3'26	4'02	3'92	4'13	3'52	3'97	3'71	3'35	2'79	3'81	3'51	3'30	4'01	3'42
66'048	3'48	3'89	3'70	3'70	3'61	3'80	3'48	4'12	3'49	3'03	3'38	2'77	3'86	—	3'95	3'94	3'99
'081	3'46	4'06	3'75	3'76	3'64	3'68	3'58	4'10	3'64	2'72	3'37	2'59	3'81	—	4'07	3'93	4'18
'194	3'54	3'20	3'88	3'31	3'98	3'88	4'01	2'89	3'83	3'55	3'87	3'60	3'95	3'31	3'99	4'09	4'17
67'025	3'51	4'02	3'89	3'65	2'94	3'99	2'71	3'85	3'22	4'09	3'91	3'82	3'61	3'93	3'17	4'12	3'94
'181	3'40	3'50	3'58	3'51	3'90	3'16	3'68	4'01	3'85	3'28	3'46	3'40	3'86	4'04	4'14	3'53	4'15
68'209	3'49	—	3'81	3'58	3'49	3'94	3'62	3'68	3'95	3'21	3'34	3'78	3'64	—	—	4'04	3'98
74'061	3'29	4'12	3'96	3'45	4'09	3'62	2'77	4'12	3'86	3'60	3'74	3'96	3'78	2'57	—	3'57	3'81
75'044	3'52	4'01	3'67	3'70	3'99	3'98	4'05	3'82	3'84	3'55	3'69	3'96	3'25	3'81	4'26	4'12	3'35
'064	3'55	—	3'67	3'73	4'03	3'54	4'10	3'98	3'92	3'53	3'76	4'03	3'27	—	4'27	4'04	3'41
'096	3'55	2'77	3'80	3'49	4'07	3'22	3'24	3'98	3'78	3'67	3'85	4'03	3'52	3'77	4'31	4'06	3'63
77'134	3'20	—	3'87	3'73	3'96	3'74	3'89	4'01	3'95	3'46	3'32	3'78	3'95	—	3'83	3'92	3'54
78'091	3'25	3'63	3'68	3'50	3'60	4'02	3'79	3'81	3'73	3'00	3'96	4'09	3'80	3'72	3'24	4'01	4'01
85'068	3'51	3'13	3'90	3'43	3'15	3'69	3'78	4'21	3'94	3'80	3'88	4'07	3'76	3'59	4'29	4'05	4'13
88'115	3'58	4'11	3'91	3'77	4'09	3'58	2'67	4'06	3'85	3'58	3'57	3'79	3'87	3'94	3'41	4'10	3'91
'164	3'48	3'99	3'83	3'72	4'13	3'72	3'08	4'02	3'79	3'67	3'31	4'04	3'94	3'19	3'65	4'11	3'94
89'046	3'56	3'98	3'79	3'77	3'63	3'99	3'96	3'59	3'65	2'76	3'43	3'82	3'64	3'65	4'32	3'85	3'35
'071	3'53	3'96	3'85	3'81	3'84	3'99	4'00	3'82	3'70	2'81	3'61	3'83	3'80	3'66	—	3'49	3'22
90'039	3'42	4'11	3'59	3'54	2'96	3'74	3'99	3'40	3'36	4'10	3'34	3'86	3'00	—	4'32	4'05	4'20
92'028	3'48	4'06	3'70	3'74	4'07	3'93	3'43	3'58	2'65	3'95	3'75	3'78	3'78	3'42	3'59	4'08	4'03
'076	3'50	3'27	3'83	3'70	3'98	3'88	3'73	3'70	2'94	4'08	3'79	3'97	3'95	3'59	3'83	4'12	4'01
93'111	3'54	3'39	3'60	3'30	4'13	3'76	3'47	3'46	2'99	3'94	3'60	3'89	3'66	2'75	3'16	3'97	4'01
95'026	3'28	3'48	3'76	3'73	3'63	3'96	4'03	3'10	3'98	3'79	3'74	3'72	3'84	—	4'27	4'04	3'21
'054	3'08	3'53	3'70	3'75	3'59	4'06	4'13	3'32	3'98	3'97	3'88	3'76	3'80	3'19	4'26	4'07	3'25
'070	3'28	3'53	3'72	3'70	3'66	3'93	4'04	3'42	3'95	3'88	3'84	3'78	3'78	3'42	4'18	4'05	3'30
96'003	3'25	3'63	3'83	3'39	2'99	3'16	3'96	3'98	3'82	3'68	3'33	3'60	3'64	3'69	3'94	3'34	4'21
'055	3'39	3'73	3'59	3'26	3'09	3'48	4'09	4'12	3'88	3'88	3'59	3'76	3'77	3'95	4'17	3'60	3'95
'103	3'50	4'00	3'50	3'29	3'43	3'62	3'97	4'10	3'95	4'02	3'72	3'79	3'81	3'81	4'24	3'57	3'21
9511'070	3'50	3'42	3'90	3'52	4'03	3'91	3'99	3'58	3'75	3'38	3'34	3'05	3'72	3'38	4'24	3'49	4'05
12'059	3'28	3'68	3'83	3'79	3'82	3'72	3'48	3'54	3'69	2'98	3'94	2'77	3'09	3'97	3'67	4'05	4'02
22'042	3'40	3'82	3'29	3'32	4'14	4'02	4'00	3'54	3'80	3'27	3'88	3'98	3'57	3'02	3'77	4'10	3'94
26'066	3'48	2'94	4'00	3'73	3'29	3'48	3'11	4'13	3'34	4'02	3'87	4'01	3'53	3'67	4'18	3'56	3'89
39'006	3'22	3'91	3'69	3'38	4'09	3'62	2'86	3'34	3'60	3'90	3'86	3'74	3'90	3'71	4'27	4'04	3'87
42'016	3'50	4'08	3'66	3'34	3'36	3'57	4'10	4'00	3'98	3'73	3'80	3'62	3'74	3'70	3'83	4'08	4'21
9676'351	3'19	4'01	3'68	3'46	4'05	3'84	—	3'93	3'90	3'93	3'94	3'20	3'85	2'87	3'87	4'03	3'46
'368	3'28	3'84	3'71	3'26	4'06	3'86	4'36	3'86	3'64	3'94	3'88	3'40	3'87	2'81	4'19	4'08	3'40
'385	3'42	4'00	3'35	3'26	3'92	3'86	4'12	3'77	3'38	3'98	3'69	3'43	3'90	2'95	3'95	4'10	3'41
'403	3'18	4'10	3'32	3'26	3'88	3'94	4'05	3'86	2'90	3'96	3'58	3'60	4'00	3'06	4'35	4'05	3'53
'419	3'34	4'08	3'37	3'38	3'62	3'80	3'64	3'92	2'68	3'98	3'35	3'54	3'75	3'07	4'09	4'11	3'66
9705'353	3'48	4'08	3'42	3'20	4'09	4'09	3'79	4'02	3'72	3'01	3'30	3'96	4'05	3'27	4'34	3'93	4'18
'370	3'50	2'89	3'21	3'28	4'08	4'10	3'76	4'02	3'82	2'90	3'56	4'04	3'73	3'21	4'39	3'83	4'04
'388	3'42	4'07	3'38	3'34	3'72	4'12	3'87	4'14	3'88	3'04	3'53	4'07	3'64	3'41	4'54	3'78	4'17
'410	3'34	3'14	3'56	3'57	3'28	4'02	3'90	4'02	3'85	3'17	3'69	3'98	3'09	3'58	4'20	3'52	4'12
06'320	3'43	4'27	4'09	3'73	4'19	3'76	3'02	3'62	3'37	4'10	3'99	3'99	3'75	4'00	4'01	3'91	3'87
08'426	3'60	3'82	3'80	3'71	4'00	4'08	2'68	4'18	3'33	3'96	3'83	4'07	3'39	3'11	3'67	4'09	3'89
17'394	3'46	3'78	3'46	3'53	3'80	3'92	4'10	3'71	3'97	2'84	3'75	3'78	3'94	3'93	3'99	3'53	4'30
'419	3'60	3'80	3'46	3'78	3'71	3'80	3'95	3'84	3'83	3'07	3'39	3'85	3'68	4'02	4'18	3'56	4'13
23'376	3'34	2'71	3'70	3'83	4'19	3'40	3'99	3'28	3'94	4'04	3'13	3'29	3'16	3'56	3'34	4'08	4'24

TABLE 2 (continued)

J.D. hel. - 2420000	V 20	V 21	V 22	V 23	V 24	V 25	V 26	V 27	V 28	V 29	V 30	V 31	V 32	V 33	V 34	V 35	V 36
9723'421	3'36	3'02	3'53	3'72	3'82	3'60	4'18	3'60	2'47	4'06	3'38	3'61	3'07	3'58	3'62	4'08	3'64
24'226	3'50	—	3'70	3'44	3'90	3'96	3'60	—	—	3'33	3'07	—	3'78	—	—	3'54	—
'378	3'28	3'40	3'88	3'52	4'12	4'07	4'00	4'12	4'05	3'78	3'74	3'39	4'01	2'87	4'21	3'76	4'10
'394	3'54	3'41	4'02	3'46	4'07	4'02	3'78	4'02	4'10	3'82	3'70	3'47	3'72	3'18	4'14	3'80	4'18
25'247	—	2'68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28'395	3'32	4'01	3'80	3'31	3'32	3'69	3'00	3'78	—	3'00	3'95	3'05	3'97	3'67	3'59	4'03	3'45
39'373	3'66	3'78	3'90	3'18	3'26	3'60	3'48	3'68	4'04	3'10	4'31	4'12	3'89	3'52	4'49	3'55	3'97
'398	3'47	2'87	4'01	3'22	3'54	3'76	3'54	3'76	4'05	3'28	3'75	3'54	4'08	3'76	3'75	3'74	4'15
'418	3'54	2'75	4'01	3'22	3'65	3'75	3'76	3'76	4'19	3'34	3'82	2'78	4'02	3'91	3'20	3'89	4'18
48'268	3'58	4'11	3'61	3'38	3'80	4'10	4'16	4'04	4'09	3'29	3'54	4'00	2'94	2'68	3'50	4'01	4'21
'296	3'72	4'12	3'87	3'42	3'96	4'15	3'97	3'48	4'14	3'43	3'63	4'00	3'09	2'65	3'08	4'05	4'18
'343	3'71	3'90	3'89	3'30	4'06	3'52	4'07	2'89	4'04	3'63	3'82	4'08	3'20	3'17	3'35	4'17	3'28
'373	3'40	2'70	3'77	3'22	4'18	3'21	4'10	2'87	4'08	3'92	3'82	4'05	3'22	3'30	3'34	4'00	3'06
49'285	3'52	3'82	3'86	3'44	3'57	3'80	3'90	3'83	3'90	3'00	3'33	3'87	3'87	3'78	4'29	3'63	4'11
'384	3'35	3'35	3'41	3'81	3'88	3'85	4'12	3'92	4'08	3'73	3'65	4'02	3'84	3'98	3'54	3'62	3'71
'419	3'19	3'39	3'48	3'88	3'98	3'99	4'18	4'10	4'00	3'77	3'93	3'93	3'48	3'86	2'93	3'65	3'46
52'355	3'63	3'86	3'52	3'75	4'10	3'80	3'46	4'01	3'69	3'44	3'74	4'03	3'01	3'78	4'06	4'07	4'00
58'150	3'51	3'95	3'86	3'28	4'20	3'59	3'44	2'96	3'75	2'94	3'42	2'89	3'00	2'92	4'24	3'52	3'41
'175	3'70	4'05	4'12	3'37	3'85	3'69	2'63	3'08	3'96	3'30	3'22	2'96	3'05	3'00	—	3'59	3'45
'199	3'56	4'12	3'88	3'28	3'76	2'96	2'94	3'32	3'99	3'27	3'25	3'10	3'32	2'96	4'40	3'65	3'63
63'326	3'20	4'04	3'55	3'49	3'94	3'62	3'84	3'97	3'64	3'17	3'18	3'64	3'27	3'72	3'55	3'98	4'19
'352	3'20	4'02	3'54	3'50	3'56	3'84	3'93	3'91	2'75	3'27	3'60	3'37	3'81	3'57	4'02	3'91	—
'378	3'43	3'94	3'63	3'63	3'16	3'86	3'96	4'04	3'87	2'74	3'35	3'76	2'99	3'68	3'72	4'06	4'27
76'148	3'63	4'22	3'95	3'29	3'77	3'60	3'28	3'70	3'24	4'00	3'81	3'83	3'28	3'56	3'60	4'24	4'01
78'356	3'56	3'79	3'48	3'65	3'77	3'42	3'69	3'18	3'18	3'99	3'74	2'74	3'81	3'39	3'59	3'85	3'98
79'110	3'24	3'18	3'88	3'31	4'17	3'34	4'20	3'52	4'06	3'36	3'96	4'02	3'45	3'30	4'26	4'15	4'14
'210	3'60	3'79	4'05	3'54	3'51	3'63	4'25	3'84	4'03	3'83	3'34	4'04	3'63	3'43	4'16	4'12	3'22
'254	3'60	3'93	4'05	3'89	3'41	3'80	3'53	3'83	3'85	3'92	3'42	3'99	3'86	3'57	4'17	4'14	3'40
'278	3'54	3'90	4'00	3'70	3'49	3'84	3'08	3'97	3'27	3'94	3'41	4'10	3'77	3'64	4'42	4'19	3'52
'326	3'38	4'11	3'84	3'34	3'51	3'76	2'94	4'00	2'60	4'08	3'77	3'34	3'79	3'76	4'37	4'12	3'61
'355	3'26	3'78	—	3'18	3'66	3'77	3'06	—	3'03	—	3'90	2'75	—	3'84	3'67	3'93	4'12
80'044	3'30	3'12	4'00	3'51	4'03	3'98	3'84	3'96	4'12	3'46	3'14	3'78	4'17	3'55	3'74	3'49	4'05
81'040	3'53	3'40	3'91	3'90	3'86	3'74	3'58	3'76	3'81	3'94	3'87	3'72	3'82	3'65	3'13	4'15	4'10
'064	3'48	3'58	3'90	3'77	3'87	3'70	3'54	3'87	3'82	4'00	3'66	3'75	3'95	3'44	3'38	—	3'98
'113	3'54	3'78	4'02	3'46	4'04	3'85	3'88	4'03	3'96	2'92	3'30	4'06	3'95	3'56	3'41	4'08	4'15
'212	3'27	4'01	4'00	3'27	3'86	3'94	3'93	3'94	4'01	3'44	3'69	3'96	3'92	3'74	4'07	4'11	4'26
'235	3'27	4'04	3'88	3'39	3'97	3'92	4'01	4'06	3'98	3'38	3'86	4'11	3'87	3'87	4'12	3'98	4'06
'281	3'16	4'07	3'55	3'69	3'84	3'77	4'11	4'05	3'94	3'69	3'86	4'08	3'17	3'80	4'14	3'43	4'16
'305	3'32	4'05	3'45	3'64	4'00	3'98	4'06	4'09	4'06	3'88	3'86	4'04	2'92	3'85	4'19	3'34	4'12
'350	3'48	4'15	3'49	3'76	3'96	4'13	4'24	3'49	3'78	4'08	3'43	3'22	3'13	4'04	4'14	3'34	3'63
87'201	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
91'244	3'45	3'93	3'83	3'65	3'69	3'40	2'90	3'13	4'03	3'82	3'82	3'87	3'45	3'75	4'30	4'10	3'61
'308	3'59	3'27	4'06	3'43	3'21	3'12	3'35	3'47	2'64	3'96	3'64	4'02	3'57	2'64	4'35	3'50	4'12
94'312	3'43	3'58	3'89	3'12	4'19	3'26	4'06	3'20	3'97	3'62	3'43	3'96	3'61	3'68	4'09	4'18	4'21
9816'084	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18'064	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22'124	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
'108	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
34'180	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
43'160	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
46'062	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
'153	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

TABLE 2 (continued)

J.D. hel. - 2420000	V 37	V 38	V 39	V 41	V 42	V 43	J.D. hel. - 2420000	V 37	V 38	V 39	V 41	V 42	V 43
9435'135	3'71	4'06	3'72	3'98	3'73	3'40	9723'421	3'31	4'20	3'78	3'75	3'79	3'57
36'093	3'67	3'69	4'05	3'77	3'76	3'37	24'226	3'59	—	—	3'50	3'55	3'04
'128	3'81	3'96	4'01	3'90	3'67	3'59	'378	3'48	3'45	4'01	3'97	3'71	3'56
'156	3'67	3'94	3'74	3'84	3'67	3'43	'394	3'44	3'77	3'97	3'97	3'69	3'51
59'152	3'77	3'59	4'10	3'51	3'75	—	25'247	—	—	—	3'62	—	3'19:
'180	3'63	3'63	4'07	3'48	3'89	3'46	28'395	3'61	3'56	3'75	4'02	3'40	3'00
60'216	3'57	3'36	4'03	3'57	3'40	3'40	39'373	3'77	3'67	3'89	3'64	3'37	3'23
62'046	3'65	3'65	3'88	3'85	3'29	3'42	'398	3'73	3'76	3'83	3'70	3'50	3'42
66'048	3'68	3'52	4'14	3'79	3'31	2'96	'418	3'61	3'72	3'71	3'77	3'46	3'54
'081	3'71	3'59	4'05	4'04	3'50	—	48'268	3'58	4'09	3'76	3'98	3'72	3'00
'194	3'43	4'06	3'59	3'53	3'80	3'36	'296	3'72	4'14	3'64	3'94	3'84	3'10
67'025	3'79	4'18	3'87	3'68	3'68	—	'343	3'88	4'22	3'65	3'86	3'86	3'38
'181	3'43	3'57	4'10	3'72	3'52	3'39	'373	3'64	3'92	3'64	3'69	3'78	3'44
68'209	3'62	4'11	3'85	3'51	3'67	3'37	49'285	3'71	3'78	3'85	3'88	3'70	3'27
74'061	3'43	3'64	4'01	3'51	3'67	3'05	'384	3'58	3'99	3'76	3'46	3'40	3'46
75'044	3'57	4'09	3'74	3'62	3'55	3'02	'419	3'57	4'07	3'71	3'57	3'31	3'42
'064	3'42	4'18	3'85	3'62	3'45	2'83	52'355	3'52	4'17	4'14	4'01	3'52	3'02
'096	3'45	4'11	3'87	3'68	3'45	3'06	58'150	3'41	4'16	3'64	3'70	3'38	2'90
77'134	3'69	3'94	3'85	3'84	3'67	3'27	'175	3'69	4'18	3'65	3'69	3'41	2'85
78'091	3'58	3'63	3'70	3'54	3'52	3'49	'199	3'77	4'09	3'59	3'65	3'27	3'01
85'068	3'77	3'31	3'82	3'53	3'62	—	63'326	3'64	4'08	3'85	3'70	3'37	2'94
88'115	3'63	3'95	3'67	3'61	3'53	—	'352	3'79	4'02	3'88	3'81	3'28	3'05
'104	3'48	4'01	3'82	3'75	3'27	—	'378	3'83	4'06	3'82	4'13	3'18	3'12
89'046	3'78	4'09	4'05	3'77	3'51	3'45	76'148	3'60	3'97	4'07	3'55	3'12	2'85
'071	3'76	3'72	4'02	3'73	3'37	3'41	78'356	3'53	3'99	3'93	3'55	3'61	3'06
90'039	3'78	4'13	3'87	3'95	3'43	—	79'110	3'52	4'16	4'16	3'54	3'38	3'32
92'028	3'78	3'51	3'98	3'95	3'74	3'42:	'210	3'86	3'51	4'16	3'91	3'53	3'48
'076	3'74	3'57	3'91	3'83	3'56	—	'254	3'61	3'71	4'03	3'86	3'65	3'13
93'111	3'43	3'93	3'75	3'67	3'49	—	'278	3'48	3'60	4'09	3'96	3'53	3'06
95'026	3'67	3'70	3'80	3'78	3'75	—	'326	3'55	3'76	3'91	3'77	3'76	2'88
'054	3'64	3'88	3'82	4'03	3'81	3'60:	'355	3'68	3'71	3'60	3'55	3'74	2'91
'070	3'50	3'95	3'77	3'73	3'65	3'58:	80'044	3'36	4'11	3'57	3'92	3'44	3'12
96'003	3'74	3'70	4'06	3'72	3'59	3'12	81'040	3'64	3'70	3'92	3'92	3'44	3'37
'055	3'59	3'54	3'75	3'95	3'43	—	'064	3'51	3'77	4'05	3'95	3'60	3'46
'103	3'42	3'58	3'63	3'80	3'40	—	'113	3'65	4'03	4'14	3'56	3'97	3'48
9511'070	3'65	3'34	3'64	3'70	3'72	—	'212	3'68	3'98	3'69	3'77	3'38	3'11
12'059	3'70	4'10	3'97	3'64	3'85	—	'235	3'60	4'09	3'75	3'91	3'32	3'05
22'042	3'43	3'59	3'89	3'80	3'71	—	'281	3'36	4'10	3'54	3'90	3'28	2'93
26'066	3'57	3'63	3'65	3'85	3'66	—	'305	3'53	4'13	3'60	3'84	3'33	2'98
39'006	3'76	3'98	4'09	3'62	3'64	3'44	'350	3'65	4'13	3'59	3'58	3'52	3'33
42'016	3'76	4'12	4'00	3'69	3'51	—	87'201	—	—	—	—	—	—
9676'351	3'63	3'38	3'83	3'81	3'75	3'02	91'244	3'52	4'15	3'73	3'59	3'38	2'96
'368	3'66	3'58	3'86	3'77	3'82	3'04	'308	3'95	3'52	3'64	3'76	3'40	3'46
'385	3'59	3'52	3'95	3'56	3'77	3'03	94'312	3'72	3'63	4'02	3'70	3'47	3'36
'403	3'53	3'50	3'58	3'61	3'65	2'86	9816'084	—	—	—	—	—	3'53
'419	3'49	3'64	3'73	3'48	3'51	2'88	18'064	—	—	—	—	—	3'11
9705'353	3'46	3'87	3'96	3'48	3'31	3'16	22'124	—	—	—	—	—	—
'370	3'42	3'98	3'74	3'51	3'26	3'27	'198	—	—	—	—	—	3'43
'388	3'54	3'94	3'77	3'55	3'32	3'38	34'180	—	—	—	—	—	—
'410	3'52	3'86	4'07	3'69	3'53	3'46	43'160	—	—	—	—	—	2'83
06'320	3'44	4'00	3'94	3'68	3'53	3'32	46'062	—	—	—	—	—	2'83
08'426	3'66	4'02	3'62	3'62	3'31	3'00	'153	—	—	—	—	—	3'57
17'394	3'61	3'44	3'89	3'74	3'75	3'11							
'419	3'50	3'54	4'05	3'53	3'63	3'04							
23'376	3'50	4'04	3'89	3'98	3'81	3'47							

TABLE 3
Least-squares solutions

V 1 (r.b.)	2429436.166	+ .288872	$E - \pm .085$	(m — 13.75)	V 23 (r.b.)	2429676.334	+ .298545	$E - \pm .154$	(m — 13.44)
V 2 (r.b.)	9475.019	+ .535654	$E - \pm .045$	(m — 13.50)	V 24 (r.b.)	9466.998	+ .546786	$E - \pm .055$	(m — 13.53)
V 3 (r.b.)	9724.207	+ .506651	$E - \pm .038$	(m — 13.37)	V 25 (r.b.)	9705.453	+ .612713	$E - \pm .082$	(m — 13.52)
V 5 (r.b.)	9676.323	+ .622455	$E - \pm .31$	(m — 13.72)	V 26 (r.b.)	9436.118	+ .541226	$E - \pm .037$	(m — 13.50)
V 6 (r.b.)	9676.459	+ .320509	$E - \pm .109$	(m — 13.83)	V 27 (r.b.)	9539.007	+ .612015	$E - \pm .061$	(m — 13.34)
„	(d.b.)	9676.305	$E + \pm .180$	(m — 13.81)	V 28 (r.b.)	9676.380	+ .522322	$E - \pm .032$	(m — 13.33)
V 7 (r.b.)	9758.179	+ .498760	$E - \pm .24$	(m — 13.50)	V 29 (r.b.)	9705.336	+ .522484	$E - \pm .041$	(m — 13.26)
V 8 (r.b.)	9466.035	+ .5081814	$E - \pm .032$	(m — 13.50)	V 30 (r.b.)	9488.128	+ .269745	$E - \pm .085$	(m — 13.50)
V 9 (r.b.)	9436.101	+ .571892	$E - \pm .037$	(m — 13.50)	V 31 (r.b.)	9739.390	+ .505304	$E - \pm .041$	(m — 13.59)
V 10 (r.b.)	9460.235	+ .490693	$E - \pm .038$	(m — 13.50)	V 32 (r.b.)	9676.439	+ .579089	$E - \pm .067$	(m — 13.52)
V 11 (max.)	9489.101	+ .493067	$E - \pm .03$	(m — 13.50)	V 33 (r.b.)	9676.297	+ .614834	$E - \pm .070$	(m — 13.30)
V 12 (r.b.)	9542.015	+ .446118	$E - \pm .031$	(m — 13.61)	V 34 (r.b.)	9724.420	+ .554843	$E - \pm .039$	(m — 13.63)
V 14 (r.b.)	9466.040	+ .463528	$E - \pm .029$	(m — 13.50)	V 35 (r.b.)	9435.125	+ .627042	$E - \pm .112$	(m — 13.75)
V 15 (r.b.)	9436.103	+ .443773	$E - \pm .027$	(m — 13.50)	V 36 (r.b.)	9477.135	+ .541310	$E - \pm .056$	(m — 13.50)
V 16 (r.b.)	9705.336	+ .542536	$E - \pm .044$	(m — 13.70)	V 37 (max.)	9466.169	+ .247340	$E - \pm .08$	
V 18 (r.b.)	9676.418	+ .478793	$E - \pm .045$	(m — 13.45)	„	(min.)			
V 19 (r.b.)	9475.025	+ .4678120	$E - \pm .0304$	(m — 13.50)	V 38 (r.b.)	9526.065	+ .577848	$E - \pm .088$	(m — 13.65)
V 20 (r.b.)	9705.387	+ .309396	$E - \pm .22$	(m — 13.42)	V 39 (r.b.)	9676.372	+ .623980	$E - \pm .157$	(m — 13.86)
„	(d.b.)	9676.435	$E + \pm .147$	(m — 13.40)	V 41 (r.b.)	9676.368	+ .2517311	$E - \pm .106$	(m — 13.69)
V 21 (r.b.)	9705.402	+ .471986	$E - \pm .0308$	(m — 13.44)	V 42 (r.b.)	9496.021	+ .303708	$E - \pm .155$	(m — 13.54)
V 22 (r.b.)	9676.353	+ .603070	$E - \pm .125$	(m — 13.64)	V 43 (r.b.)	9676.331	+ .320637	$E - \pm .120$	(m — 13.25)

TABLE 4

V 1 (r.b.)	V 6 (r.b.)	V 8 (cont.)	V 15 (r.b.)	V 20 (cont.)	V 22 (cont.)
9436'156 + '003	9435'135 - '004	9676'403 - '001	9436'093 - '003	9542'016 + '008	9752'355 '000
66'194 - 15	36'093 + 6	'419 - 1	59'180 + 1	9705'370 + 1	80'044 + 8
68'209 + 15	59'152 + 9	9705'370 + 1	67'181 + 4	'388 + 1	81'281 - 18
78'091 + 9	'180 + 14	'388 0	92'028 0	'410 + 6	'305 - 6
88'164 - 7	62'046 - 4	08'426 + 2	96'003 + 1	06'320 + 7	
89'046 - 10	66'194 0	39'418 - 1	9749'384 - 5	23'376 + 27	
93'111 + 24	67'181 - 3	63'326 - 2	'419 0	39'398 - 11	V 23 (r.b.)
95'070 - 22	77'134 + 24	81'113 + 1	80'044 - 2	'418 + 24	9435'135 - '006
9539'006 - 1	78'091 + 7	94'312 + 1	81'350 + 6	48'373 - 24	60'216 + 27
9705'388 + 10	93'111 - 6			79'326 - 15	66'194 + 15
'410 + 3	95'026 - 9	V 9 (r.b.)	V 16 (r.b.)	'355 - 12	67'025 + 3
49'285 - 3	'054 - 5	9436'093 + '007	9435'135 + '001	81'212 - 9	68'209 - 18
76'148 - 12	'070 0	88'115 - 6	66'048 - 8	'235 + 14	75'064 - 7
79'326 - 14	96'003 - 31	'164 - 1	'081 - 2	V 20 (d.b.)	'096 - 11
'355 + 14	9511'070 - 9	95'026 - 2	67'181 + 6	9462'046 + '019	78'091 0
81'064 0	12'059 + 9	9748'343 + 2	85'068 - 1	66'048 - 1	90'039 + 12
'113 + 7	9676'419 - 10	'373 + 4	9542'016 + 5	68'209 - 7	95'070 - 8
'350 - 2	9728'395 + 8	52'355 0	9705'353 + 3	74'061 - 5	96'003 - 18
V 2 (r.b.)	48'268 - 11	79'254 + 3	'370 - 2	78'091 + 9	9539'006 - 7
9475'044 + '010	58'150 + 3	91'244 - 7	49'285 - 5	92'028 - 11	42'016 + 11
77'134 - 8	'175 + 16		63'378 + 4	96'055 + 7	9676'351 + 20
90'039 - 3	'199 + 2	V 10 (r.b.)	79'110 0	9522'042 + 2	'368 + 6
9676'385 - 6	63'326 + 3	9460'216 - '003	81'281 - 7	26'066 - 8	9724'378 - 10
'403 + 6	76'148 + 5	93'111 + 7	'305 + 1	9676'403 + 1	'394 - 3
'419 0	78'356 - 9	95'054 + 2	94'312 + 4	'419 - 7	48'268 - 25
9705'353 - 5	79'326 + 9	'070 - 4	V 18 (r.b.)	9724'378 + 3	'296 + 9
28'395 + 13	'355 + 1	96'055 - 5	9435'135 + '001	'394 - 20	58'150 - 10
49'285 + 5	81'212 - 15	9522'042 0	36'093 + 4	28'395 - 8	'175 + 29
79'254 + 1	'281 + 7	9717'394 + 2	66'194 - 3	58'150 + 15	79'326 - 22
'278 - 11	V 6 (d.b.)	24'226 + 12	67'181 0	63'352 + 3	'355 - 17
9466'048 - '006	9466'048 - '006	25'247 + 10	92'076 - 3	'378 - 5	81'113 - 7
'081 - 6	'081 - 6	39'418 + 3	9526'066 + 5	81'040 + 6	91'244 + 2
67'025 - 7	67'025 - 7	48'268 - 4	39'006 - 2	'305 - 7	'308 + 33
74'061 + 7	74'061 + 7	'296 - 8	9676'385 0	'350 + 14	
75'044 - 2	75'044 - 2	49'285 - 1	'403 0	91'244 + 12	V 24 (r.b.)
'064 + 9	'064 + 9	79'210 - 1	'419 - 12	94'312 - 12	9467'025 - '005
88'164 - 1	88'164 - 1	81'113 - 11	9723'376 + 10	V 21 (r.b.)	85'068 + 6
92'028 - 8	92'028 - 8	V 11 (max.)	48'268 + 3	9466'081 - '005	96'003 + 4
9542'016 + 14	9542'016 + 14	9489'09 - '01	79'326 + 8	67'025 - 6	9526'066 + 3
9676'351 - 6	9676'351 - 6	92'06 0	'355 + 2	75'096 + 2	9676'403 + 6
9723'376 - 11	9723'376 - 11	95'03 + 1	81'281 - 8	92'076 + 7	'419 + 8
'421 + 20	'421 + 20	96'00 0	'305 + 1	9526'066 + 3	9705'388 + 3
24'378 + 23	24'378 + 23	9749'45 + 1	91'308 - 4	9705'388 + 6	410 0
'394 - 1	'394 - 1	81'01 + 1	V 19 (r.b.)	'410 - 1	17'394 - 16
39'398 - 15	39'398 - 15	91'33 - 2	9475'044 + '001	06'320 0	'419 + 4
'418 - 14	'418 - 14	V 12 (r.b.)	88'115 + 1	25'247 - 2	23'421 - 3
58'150 + 10	48'373 - 19	9466'194 '000	89'046 0	39'373 - 1	63'326 - 7
'175 + 6	49'384 + 12	75'096 + 1	'071 + 1	'398 - 4	'352 - 2
V 5 (r.b.)	'419 0	92'028 - 2	96'055 - 2	48'343 + 5	79'210 - 3
9436'093 + '028	79'210 + 20	96'055 0	9511'070 - 1	'373 - 2	91'244 + 11
60'216 - 12	81'064 + 29	9542'016 + 2	9723'421 0	49'285 0	V 25 (r.b.)
67'181 - 41	'113 + 2	9708'426 - 4	24'378 + 3	91'308 0	9459'152 - '003
74'061 - 17	V 7 (r.b.)	79'355 + 2	'394 0	V 22 (r.b.)	'180 + 4
77'134 - 3	9676'368 - '002	V 14 (r.b.)	79'110 - 5	9435'135 - '022	75'044 + 9
92'028 + 30	'385 - 1	9466'048 '000	80'044 + 3	88'164 - 8	'064 - 7
'076 + 3	'403 + 3	78'091 0	91'244 0	90'039 + 28	'096 - 1
95'070 - 37	9706'320 + 2	85'068 0	V 20 (r.b.)	96'003 - 9	78'091 - 4
9512'059 + 14	58'150 - 4	9724'226 + 1	9466'194 - '004	'055 + 13	9705'410 - 2
9676'351 + 12	'175 - 6	28'395 + 7	67'181 + 25	9511'070 - 9	48'296 + 3
'368 + 20	'199 + 6	48'343 - 2	85'068 - 9	9676'351 + 3	'343 0
'385 + 81	76'148 0	76'148 + 1	88'164 - 14	'368 + 23	'373 + 5
'403 - 1	79'110 + 1	81'113 + 2	90'039 - 8	'385 0	58'150 + 10
9717'394 + 8	81'113 + 2	V 8 (r.b.)	93'111 - 4	9717'394 + 9	'199 + 7
'419 - 5	V 8 (r.b.)	9466'048 + '001	95'026 - 2	23'376 - 9	78'356 - 18
24'226 - 10	9466'048 + '001	96'003 - 1	9511'070 + 1	'421 + 14	91'244 + 2
63'378 - 20	96'003 - 1	'235 - 1		49'285 - 12	94'312 - 5
78'356 - 37					
79'110 - 12					

TABLE 4 (continued)

V 26 (r.b.)		V 30 (cont.)		V 33 (cont.)		V 36 (cont.)		V 38 (cont.)		V 41 (cont.)	
9436'093 - '005		9490'039 + '010		9496'103 - '011		9781'305 - '011		9522'042 + '017		9758'175 - '006	
'128 + 5		9511'070 + 1		9676'351 + 24		'350 + 6		26'066	0	'199 + 14	
75'064 - 1		9676'385 - 9		9748'268 - 8		94'312 + 9		9706'320 - 2		79'326 + 8	
'096	0	'403	0	78'356 + 3				91'308	0	81'064 + 3	
9676'403	0	'419 - 3		91'244 + 5		V 37 (max.)				'350 - 2	
'419 + 1		9706'320 + 10		'308 - 9				V 39 (r.b.)			
9728'395 - 4		17'394 + 4		94'312 - 6		9466'19 + '02		9436'093 - '002		V 42 (r.b.)	
58'150	0	'419 - 1				67'18 + 2		'128 + 27		9460'216 + '011	
'175 - 5		24'394 + 13		V 34 (r.b.)		74'06 - 2		'156 + 13		62'046 + 2	
79'254 - 1		58'150 + 1		9459'180 - '004		75'08 + 1		59'180	0	67'181 + 10	
'278 + 7		78'356 + 3		78'091 + 6		88'18	0	66'048 + 14		75'044 - 19	
V 27 (r.b.)		81'040 + 1		9724'394 - 6		93'11 - 2		'081 + 33		'064 - 15	
		'064 + 7		39'373 + 6		95'11	0	96'003 + 4		'096 + 17	
9436'156 + '007		'305 - 5		'398 + 2		96'10	0	'055 + 7		78'091 - 14	
66'194 - 10		'350 + 4		'418	0	9522'04 - 3		9511'070 + 28		85'068 - 7	
90'039 - 3		91'308 - 1		48'268 - 15		9676'44 + 3		9676'351 - 26		88'115 - 11	
93'111 + 13		V 31 (r.b.)		'296 - 4		9705'35	0	'368 - 4		'164 - 2	
9512'059 - 7		9466'048 - '006		49'384 - 7		06'32 - 2		'385 + 27		89'046 + 6	
39'006 - 1		67'025 + 3		'419 + 4		23'42 + 2		'403 - 13		'071 + 9	
9748'296 - 11		75'096 - 2		79'326 + 5		24'38 - 1		'419 + 26		92'076 + 7	
'343 - 1		77'134 + 4		'355 + 7		80'04	0	9706'320 + 7		96'003 - 10	
58'150 + 18		9739'373 + 5		81'040 + 6		81'27 - 1		24'378 - 20		'055 + 17	
81'350 - 6		'398 + 6		V 35 (r.b.)		V 37 (min.)		'394 - 11		9526'066 - 3	
V 28 (r.b.)		'418 - 5		9435'135 + '010		9435'14	'00	39'373 - 21		9676'385 - 2	
		79'278 - 10		60'216 - 15		36'13	0	'398 - 5		'403 - 3	
9436'093 - '004		'326 + 7		62'046 - 13		59'15 + 2		'418 - 4		'419 - 9	
'128 - 9		81'305 - 7		77'134 + 16		66'08 + 2		49'384 - 14		9717'394 + 3	
92'028 + 6		'350 + 5		89'046 + 7		67'03 - 2		'419 + 13		'419 + 10	
9539'006 + 5		V 32 (r.b.)		'071 - 9		85'07 - 4		58'150 - 3		24'378 - 4	
9676'368 - 3		9436'093 - '010		9526'066 - 1		89'06	0	79'278 - 21		'394 + 9	
'385 + 6		'128 - 7		9705'353 - 7		90'04 - 1		'326 - 2		48'373 + 8	
'403 + 9		'156 + 22		'370 - 1		92'05 + 2		'355 - 22		49'285 - 3	
9723'376 + 6		'419 - 4		'388 + 11		96'00 + 1		81'212 - 22		52'355 + 2	
76'148 + 1		9676'403 - 4		'410 + 4		9539'01 - 2		'235 + 30		58'150 + 5	
79'254 - 7		'419 - 4		49'285 - 2		42'02 + 2		94'312 + 25		79'355 + 6	
'278 - 2		9705'370 - 9		52'355 - 18		9739'39	0	V 41 (r.b.)		81'212 - 15	
81'350 - 3		'388 + 3		79'326 - 4		48'33 + 3		9466'194 + '004		91'244 - 5	
91'308 - 5		'410 - 12		'355 + 4		49'29	0	67'181 + 4		V 43 (r.b.)	
V 29 (r.b.)		23'376 + 7		81'212	0	58'20 + 1		68'209 + 3		9436'128 - '005	
		48'268 - 17		'235 + 8		63'37 - 1		85'068 - 2		'156 + 4	
9466'048 '000		49'384 + 1		91'244 - 2		79'21 - 1		89'071 - 5		60'216 + 13	
89'046 - 2		'419 + 12		V 36 (r.b.)		91'31 - 3		93'111 + 1		68'209 - 14	
90'039 + 1		63'326 + 7		9477'134 + '001		94'31 + 1		9522'042 - 3		89'046 - 9	
9705'353 + 7		78'356 + 17		89'046 - 6		V 38 (r.b.)		26'066 - 2		'071 + 11	
52'355 + 3		81'212 - 15		96'055	0	9460'216	'000	9676'351 - 5		9676'351 - 8	
63'326 - 9		'235 + 5		9522'042 + 3		74'061 - 2		'368 + 8		9708'426 + 1	
'352 - 1		'281 + 4		9676'351 + 12		78'091 + 14		'385 + 3		17'394 + 5	
80'044 + 1		V 33 (r.b.)		9723'421 - 2		85'068	0	9706'320 - 1		49'419 + 3	
81'064 - 2		9485'068 + '005		48'296 + 3		89'046 + 2		17'394 - 1		52'355 + 5	
'113 + 3		88'115 + 2		'343	0	'071 - 5		'419 + 2		79'254 - 16	
V 30 (r.b.)		'164 - 1		49'384 - 18		93'111 + 8		23'421 - 15		'278	0
		93'111 - 4		'419 + 3		96'003 - 9		48'343 - 2		81'212 + 16	
9488'115 - '007						9511'070 + 2		'373 + 10		94'312	0
								49'384 - 11		9818'064 - 5	

TABLE 5

mean phase magn.			mean phase magn.			mean phase magn.			mean phase magn.			mean phase magn.					
n	phase	magn.	n	phase	magn.	n	phase	magn.	n	phase	magn.	n	phase	magn.			
V 1			V 1 (cont.)			V 1 (cont.)			V 1 (cont.)			V 2 (cont.)			V 2 (cont.)		
5	'028	13'98	5	'285	13'94	5	'646	13'51	5	'942	13'89	5	'075	13'44	5	'294	13'90
5	'065	13'92	4	'313	13'88	5	'745	13'60	5	'982	13'85	5	'118	13'55	5	'354	14'01
5	'105	14'00	4	'376	13'70	5	'780	13'68	V 2			5	'169	13'63	5	'393	14'06
5	'135	13'93	4	'462	13'46	5	'832	13'71	5	'203	13'71	5	'203	13'71	5	'447	14'10
5	'182	14'01	5	'521	13'49	5	'880	13'74	5	'230	13'79	5	'230	13'79	5	'501	14'12
5	'236	13'93	5	'574	13'48	5	'910	13'83	5	'019	13'23	5	'266	13'85	5	'602	14'10

TABLE 5 (continued)

n	mean phase	mean magn.	n	mean phase	mean magn.	n	mean phase	mean magn.	n	mean phase	mean magn.	n	mean phase	mean magn.	n	mean phase	mean magn.
V 2 (cont.)			V 6 (cont.)			V 8 (cont.)			V 11 (cont.)			V 15 (cont.)			V 18 (cont.)		
5	'665	14'15	6	'522	13'48	5	'652	12'91	5	'653	13'70	3	'589	13'88	3	'617	14'20
5	'695	14'06	5	'573	13'63	5	'701	13'20	5	'699	13'82	3	'627	13'22	4	'650	14'21
5	'781	14'09	5	'638	13'71	5	'762	13'40	5	'784	13'93	3	'651	13'01	3	'689	13'81
3	'860	14'09	5	'736	13'71	5	'811	13'55	5	'909	14'10	3	'724	13'15	3	'711	13'55
3	'907	13'61	5	'769	13'85	5	'854	13'66	5	'961	14'12	5	'793	13'42	3	'729	13'21
3	'938	13'32	5	'829	13'93	5	'925	13'79	5	'991	14'08	5	'868	13'64	3	'787	12'84
3	'956	13'05	5	'927	14'10	5	'962	13'87				5	'919	13'84	4	'857	13'23
3	'989	13'22	5	'969	14'07							5	'954	13'89	5	'888	13'27
V 3			considered as W UMa-var.			V 9			V 12			V 16			V 19		
3	'001	12'94				5	'053	14'01	5	'007	14'38						
5	'117	13'25				5	'163	14'12	3	'060	14'37						
5	'176	13'46	5	'020	14'12	6	'222	14'10	3	'103	13'77	5	'041	13'66			
5	'228	13'48	5	'043	14'05	6	'274	14'17	3	'135	13'25	5	'081	13'72	5	'006	14'14
5	'261	13'64	5	'064	14'10	3	'339	14'03	3	'186	13'05	5	'134	13'85	3	'057	14'18
5	'306	13'67	5	'119	14'07	3	'370	13'60	3	'236	13'20	5	'199	13'95	3	'084	13'88
5	'355	13'86	5	'156	13'98	4	'411	12'98	3	'267	13'43	5	'283	13'99	3	'124	13'27
5	'404	13'76	5	'186	13'91	4	'445	12'75	5	'296	13'54	5	'331	14'02	3	'147	12'91
5	'463	13'92	5	'207	13'88	4	'469	12'86	5	'341	13'62	5	'395	14'07	3	'168	12'76
5	'494	13'96	5	'234	13'79	5	'481	12'86	5	'369	13'78	5	'438	14'09	5	'192	12'84
5	'536	14'06	5	'254	13'71	5	'481	12'86	5	'412	13'83	5	'490	14'04	5	'216	12'91
5	'589	14'01	5	'254	13'71	5	'514	13'10	5	'464	13'96	5	'556	14'01	5	'251	13'16
5	'625	13'95	5	'268	13'74	5	'544	13'22	5	'532	14'17	5	'646	14'18	5	'295	13'26
5	'643	14'14	5	'276	13'71	5	'567	13'18	5	'597	14'19	3	'699	14'09	5	'353	13'53
5	'692	14'06	5	'292	13'68	5	'604	13'37	5	'647	14'35	3	'715	13'87	5	'401	13'64
5	'740	14'05	5	'342	13'67	5	'671	13'60	5	'703	14'36	3	'732	13'58	5	'447	13'77
5	'784	14'09	5	'373	13'60	5	'704	13'71	5	'762	14'31	3	'757	13'41	5	'488	13'87
5	'829	14'03	5	'392	13'65	5	'742	13'70	5	'811	14'23	4	'818	13'05	5	'530	13'88
3	'881	13'90	5	'423	13'60	5	'784	13'79	5	'870	14'22	5	'865	13'23	5	'574	13'96
3	'926	13'45	5	'440	13'55	5	'874	13'99	5	'900	14'27	5	'899	13'29	5	'608	14'06
3	'957	12'98	5	'468	13'54	5	'985	13'95	5	'941	14'28	5	'950	13'47	5	'663	14'17
			6	'491	13'49							5	'987	13'51	5	'796	14'13
V 5			V 7			V 10			V 14			V 17			V 20		
4	'024	13'99	2	'169	14'29	5	'017	14'11	5	'038	14'32	5	'049	13'71			
4	'146	13'82	3	'229	13'92	5	'043	14'16	3	'086	14'43	5	'128	13'74			
4	'206	13'67	3	'263	13'33	5	'085	14'18	3	'147	13'64	5	'152	13'74			
4	'259	13'64	5	'310	13'01	5	'122	14'13	3	'163	13'33	5	'190	13'75	5	'010	13'52
5	'311	13'57	5	'404	13'32	3	'190	13'64	5	'200	12'96	5	'215	13'71	5	'040	13'49
5	'341	13'54	5	'459	13'39	5	'256	12'68	5	'244	13'20	5	'249	13'73	4	'085	13'48
5	'373	13'59	5	'491	13'55	5	'256	12'68	5	'304	13'55	5	'288	13'74	4	'127	13'38
5	'422	13'70	5	'523	13'65	5	'317	12'90	5	'366	13'66	5	'325	13'69	4	'200	13'32
5	'480	13'70	5	'547	13'60	5	'348	13'11	5	'426	13'91	5	'366	13'62	5	'261	13'26
5	'556	13'84	5	'568	13'76	5	'379	13'20	5	'464	13'99	5	'401	13'46	5	'332	13'24
5	'596	13'82	5	'591	13'78	5	'439	13'42	5	'498	14'08	5	'449	13'45	5	'372	13'25
5	'667	13'86	5	'613	13'89	5	'485	13'57	5	'534	14'07	5	'496	13'41	5	'401	13'24
5	'723	13'87	5	'633	13'87	5	'526	13'61	5	'564	14'17	5	'540	13'41	5	'458	13'26
5	'770	13'95	5	'661	13'92	5	'597	13'74	5	'602	14'21	5	'570	13'39	5	'500	13'36
5	'822	13'99	5	'688	14'01	5	'691	13'93	5	'679	14'27	5	'631	13'44	5	'539	13'45
5	'845	14'02	5	'707	13'99	5	'749	14'02	5	'761	14'26	5	'671	13'47	5	'589	13'49
5	'864	13'93	5	'732	14'02	5	'807	14'03	5	'816	14'35	5	'756	13'62	5	'644	13'47
5	'912	13'93	5	'799	14'11	5	'883	14'11	5	'878	14'30	5	'818	13'68	5	'697	13'52
5	'933	13'95	5	'826	14'15	5	'946	14'12	5	'917	14'33	5	'847	13'69	5	'721	13'58
5	'964	13'94	5	'961	14'12	5	'985	14'10	5	'967	14'32	5	'874	13'71	5	'801	13'61
V 6			V 8			V 11			V 15			V 18			V 21		
5	'037	14'12	5	'013	13'95	5	'026	14'20	5	'004	13'99						
5	'108	14'08	5	'066	14'07	5	'059	14'09	5	'045	14'11	5	'024	13'66			
5	'170	14'00	5	'124	14'12	5	'089	14'11	5	'072	14'16	5	'121	13'86			
5	'208	13'77	5	'173	14'10	5	'126	14'12	5	'118	14'15	5	'172	13'96	5	'037	13'83
5	'259	13'74	5	'308	14'14	5	'185	14'13	5	'192	14'26	5	'212	14'06	5	'085	13'99
5	'271	13'67	5	'420	14'12	5	'241	14'10	5	'259	14'30	5	'259	14'10	5	'154	14'06
5	'292	13'72	5	'490	14'23	5	'298	13'95	5	'288	14'25	5	'295	14'09	5	'226	13'98
5	'351	13'61	4	'520	14'01	5	'349	13'66	5	'340	14'22	5	'350	14'13	5	'290	14'01
5	'383	13'57	3	'538	13'85	5	'408	13'33	5	'391	14'20	5	'395	14'09	5	'361	14'05
5	'435	13'55	3	'562	13'45	5	'459	13'35	5	'431	14'23	5	'438	14'09	5	'409	14'04
5	'483	13'56	3	'586	13'11	5	'522	13'31	5	'479	14'24	5	'513	14'15	5	'451	14'10
			5	'624	12'89	5	'564	13'37	3	'513	14'23	5	'569	14'09	4	'494	14'10
						5	'610	13'55	4	'548	14'24						

TABLE 5 (continued)

mean phase		mean magn.		mean phase		mean magn.		mean phase		mean magn.		mean phase		mean magn.			
<i>n</i>		<i>n</i>		<i>n</i>		<i>n</i>		<i>n</i>		<i>n</i>		<i>n</i>		<i>n</i>			
V 39 (cont.)			V 41			V 41 (cont.)			V 42 (cont.)			V 42 (cont.)			V 43 (cont.)		
5	'342	13'66	4	'017	13'80	5	'609	13'81	5	'110	13'32	4	'734	13'58	4	'303	13'08
5	'393	13'58	5	'062	13'73	5	'681	13'86	5	'162	13'36	4	'772	13'54	5	'357	13'04
5	'476	13'67	4	'100	13'66	5	'729	13'99	5	'207	13'54	4	'809	13'48	5	'415	13'00
5	'567	13'74	5	'142	13'55	5	'786	13'94	5	'251	13'55	5	'874	13'39	5	'469	12'93
5	'612	13'77	5	'176	13'53	5	'821	13'94	5	'322	13'67	5	'897	13'37	5	'542	12'86
5	'629	13'79	5	'212	13'54	5	'876	13'91	5	'391	13'73	5	'939	13'40	5	'580	12'94
5	'655	13'83	5	'264	13'56	5	'938	13'85	5	'460	13'71	V 43			5	'629	13'01
5	'692	13'84	5	'339	13'59	5	'984	13'84	5	'524	13'81	5	'043	13'49	5	'704	13'11
5	'767	13'91	5	'398	13'60	V 42			5	'585	13'77	5	'112	13'52	5	'785	13'32
5	'886	13'99	5	'427	13'64	5	'024	13'31	5	'625	13'75	5	'170	13'43	5	'835	13'29
5	'965	13'95	5	'466	13'66	5	'064	13'38	5	'678	13'72	5	'222	13'32	5	'887	13'44
			5	'558	13'75				5	'707	13'64	4			5	'943	13'43
															5	'984	13'41