PUBLICATIONS OF
THE DAVID DUNLAP OBSERVATORY
UNIVERSITY OF TORONTO

VOLUME II NUMBER 17

A STUDY OF THE VARIABLE STARS IN THE GLOBULAR CLUSTER MESSIER 14

I. PERIODS AND LIGHT CURVES OF TWENTY VARIABLES

HELEN SAWYER HOGG
AND
AMELIA WEHLAU

1966
TORONTO, CANADA

PRINTED AT
THE UNIVERSITY OF TORONTO PRESS

A STUDY OF THE VARIABLE STARS IN THE GLOBULAR CLUSTER MESSIER 14

I. Periods and Light Curves of Twenty Variables

By Helen Sawyer Hogg and Amelia Wehlau

The globular cluster Messier 14, NGC 6402, (R.A. $17^h\ 35^m.0$, Dec. $-03°\ 15'$, 1950) is one of the clusters very rich in variable stars. It is exceeded in number of variables by only seven other clusters at present. Seventy-two variables were discovered by H. B. Sawyer (1938) from a series of plates taken with the 72-inch reflector of the Dominion Astrophysical Observatory at Victoria. A preliminary report of work on their periods appeared at the same time (Sawyer 1937), but circumstances delayed publication of further work until now.

For the past three years we have been making a study of the variables in the cluster to determine their periods and the form of their light curves. A total of 258 plates is now available, virtually all of which have been taken by one of us (H.S.H.). Of these, 31 were taken with the 72-inch reflector of the Dominion Astrophysical Observatory, 211 with the 74-inch reflector and 9 with the 19-inch of the David Dunlap Observatory, 2 with the 36-inch Steward Observatory reflector, and 5 early Mount Wilson plates were taken by F. G. Pease and H. Shapley. These plates span an interval of 52 years.

Four additional variables have now been found by Amelia Wehlau, bringing the total to 76. These are indicated on figure 1, and are given in Table I of this paper. The first 72 variables were identified in the original paper. One of the first results of the renewed study was the discovery of a nova (by A.W.) on the plates of 1938 taken with the David Dunlap Observatory 74-inch (Sawyer Hogg and Wehlau 1964).

All the available plates have been measured (by A.W.) with the Becker iris photometer at the Hume Cronyn Memorial Observatory of the University of Western Ontario. The magnitudes of the sequence previously published have now been revised from five plates taken with superimposed exposures on both the cluster and Kapteyn Area 61, one of the areas where the magnitude values have been standarized to the fainter magnitudes (Stebbins, Whitford and Johnson 1950). The comparison stars are identified on figure 1, and their revised magnitudes are given in Table II, which includes four auxiliary stars added to the original sequence.

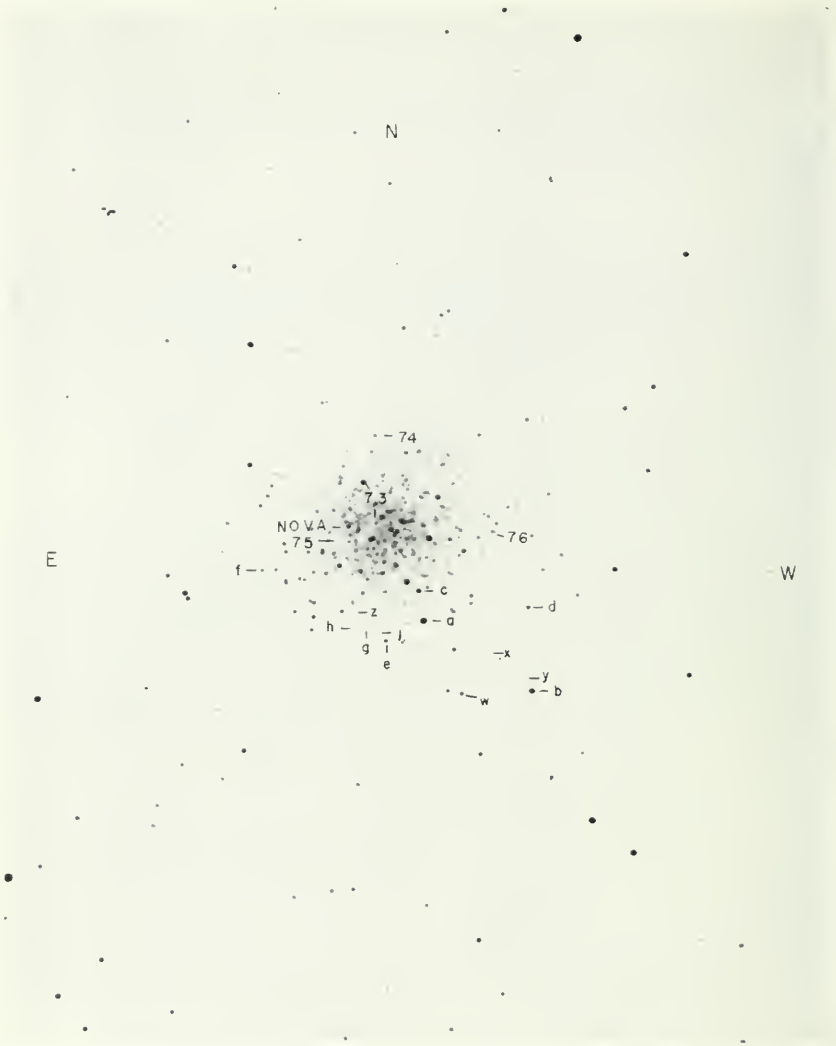

FIG. 1—The globular cluster Messier 14, photographed with the 74-inch reflector of the David Dunlap Observatory on June 23, 1938, when the nova was visible. (Plate 3263, exp. 40 min.) Four new variables, and comparison stars are also identified. Scale of the figure, 7″.0/mm.

The variables in this paper are mainly those for which preliminary results were given in 1937, with many additional observations obtained since. They have large ranges, and three bright Cepheids with periods over one day are among them. Many of the preliminary periods derived

TABLE I

NEW VARIABLE STARS

Variable No.	Co-ordinates x″	y″	Magnitudes Max.	Min.	Mean	Remarks
73	+05	+07	16.5	18.0	17.25	Bright irregular?
74	+07	+91	16.5	17.2	16.85	Bright irregular?
75	+35	−12	16.7	18.5	17.60	RR Lyrae
76	−105	+03	16.1	17.0	16.55	Short period Cepheid
Nova	+30	+04	16 (observed)			Found only on plates of 1938

TABLE II

MAGNITUDES OF SEQUENCE STARS

Star	Co-ordinates x″	y″	Mean Mag. (pg)
a	−43	−86	14.52
b	−146	−150	14.70
c	−39	−57	15.35
d	−141	−71	15.85
e	−9	−104	16.17
f	+110	−42	16.71
g	+11	−92	17.46
h	+21	−93	17.98
j	+2	−99	18.42
w	−80	−152	16.20
x	−105	−115	17.40
y	−139	−138	17.55
z	+24	−79	17.56

some years ago are being brought up to date with the help of the IBM 7040 at the University of Western Ontario. Even though the magnitudes have been determined with the photometer it will be difficult to get periods for many of the stars with small ranges, located in the congested central region of the cluster, where background corrections are large; the congestion in the central region, even on a scale of 22″.43 to the millimetre, is severe. Although the cluster has a relatively large angular diameter of 6′.7, the stars are faint, with the RR Lyrae stars ranging mostly from the 17th magnitude at maximum to the 18th at minimum. Since the twenty stars which appear in this paper have been selected for large ranges and unobscured position, this

material alone is not suitable for a discussion of the frequency of periods in this cluster.

Table III gives the observations on all available plates for the following twenty variables, numbers 1, 2, 4, 5, 7, 9, 10, 11, 15, 16, 19, 22, 23, 24, 25, 30, 32, 33, 36 and 43, giving the number of the plate, the Julian Date, and the observation derived from photometer readings. There are fewer plates listed in the second section of Table III for the stars with numbers 19 to 43 since on some of the poorer quality plates none of these stars could be measured.

Table IV gives for these variables the maximum, minimum and mean magnitudes, the epoch of maximum (chosen as the nearest maximum just before J.D. 2438200 in the 1963 series of observations), and the period, followed by remarks when pertinent.

The light curves of these twenty variables, in order of decreasing length of period, are shown in figures 2 and 3. The points are the computed weighted means of all observations at intervals in phase of 0.04 of the period of the star. Observations with colons in Table III have been assigned half weight. A filled circle represents at least three good observations, but averages about ten such. Open circles represent mean points derived from observations which are few in number or of low weight.

Of this first group of stars, three are Cepheids with periods longer than one day. Sixteen are type *ab* RR Lyrae stars with periods between 0.48 and 0.68 days, and one is a type *c* with period 0.36 days. A period change is noticeable only for Var. 1, the Cepheid with longest period in the cluster, 18.730 days, whose period seems to be steadily shortening at the rate of $\beta = 14 \times 10^{-7}$ days/day.

In figure 2 two light curves are given for this star to illustrate graphically the change in period from an earlier to a later interval. In the case of this star, the figure shows many open circles which do not represent uncertainty in the magnitudes, but rather fewer observations in the means because of the division of material.

Joy (1949) studied spectroscopically variables 1, 2, 7, and 17 in this cluster. For Var. 1, his classification from two spectrograms was G2 and G0, with an average radial velocity of -115 km/sec, indicating cluster membership.

Variable 2, with period 2.79468 days, is the type of short period Cepheid in clusters mentioned by Joy and C. Payne Gaposchkin (1954). Joy gives the spectrum from one plate as F8, and the radial velocity as -129 km/sec.

Variable 7 seems to be a typical W Virginis star with period 13.596

TABLE III

OBSERVATIONS OF VARIABLE STARS IN NGC 6402

Plate	Julian Day*	No. 1	No. 2	No. 4	No. 5	No. 7	No. 9	No. 10	No. 11	No. 15	No. 16
103	19536.939	16.0	16.45			15.0					
2617	20725.811	15.05				16.05:					
2637	26.750	15.05	16.05	18.7	18.7	16.15	18.15	18.9	18.0	18.6	18.2
2649	48.705	15.15	15.8	18.15	18.5	15.7	18.4	18.1	18.2	18.9:	18.2
4397	1690.895	15.85	16.0			16.3			18.1:		17.2:
20544	6915.824	15.1	16.85	18.4	16.9	15.85	17.1	17.2	17.1	18.3:	17.8
20559	21.824	15.95	15.85	17.6	17.9	15.55	17.7	18.0	16.6	17.45	17.5
20571	23.785	16.9:	17.0:			15.7:					
20584	24.758	16.2	15.9			16.4	18.8:	18.2:	18.4:		
20587	.824	16.8:	15.8		18.0:	16.5:	18.2:		16.85:		
20597	25.776	16.05	16.5	17.6:		16.55		17.6:		17.9:	
20647	44.781	15.95	15.95	17.75:		15.45		17.9:	16.5	18.35:	
20675	46.742	15.5	16.9:			15.4	17.8:		17.8:	18.5:	
21377	7272.784	15.1	16.65	17.8:	18.5:	15.6	18.5	17.8	18.1	18.2	
21380	.864	15.0	16.9:	17.95:	18.9	15.5	18.1	18.4	18.6	18.05	
21386	73.788	15.0	16.4	18 4	17.7	15.55	18.0	17.7	17.7	17.8	17.9
21399	74.776	15.1	16.0:	17.45	17.5	15.4	18.05	18.3:	16.35	17.15	16.9
21406	.891	15.1	16.25	18.5	18.4	15.55	18.8	18.8:	17.4	18.1	17.7
21412	75.768	15.15	16.7	18.75	18.85	15.7	17.3	17.9:	18.45	18.95:	17.85
21416	.856	15.25	17.1	18.6	17.35	15.6	17.6	18.9	18.2	17.45	18.7
21515	306.776	14.7	16.9	18.1:	18.5	16.15	18.0:		16.6		
21538	07.799	14.85	15.85	18.0:	18.4	16.2	18.1	17.0	18.5:	18.1	17.5
21556	08.800	14.85	16.3:			15.9			17.2:		
23178	639.790	16.05	16.95	18.6	18.45	15.55	18.4	18.15	18.0	18.8	18.7
23237	58.749	15.65	16.85	18.9	19.1:	16.4	18.9	17.25	17.45	18.35	17.55

*Heliocentric

Plate	Julian Day	No. 1	No. 2	No. 4	No. 5	No. 7	No. 9	No. 10	No. 11	No. 15	No. 16
23240	27658.811	15.65	16.75:	18.55	19.0:	16.3	18.3	17.6	17.5	18.8	18.1
23252	59.760	15.1	15.95	17.9	18.7	16.5	18.5	18.4	16.5	18.55	17.15
23255	.823	15.15	15.95	18.3	18.6	16.5	18.3	18.3	16.65	18.1	17.05
23256	.840	15.05	15.85	17.7:	18.5:	16.8	17.7:	18.25:	16.5	18.4	17.5
23306	64.765	14.85	16.9	18.7	18.85	15.45	17.2	18.0	17.4	18.1	17.95
23308	.802	14.75	17.1	18.5	18.25	15.45	17.0	18.5	17.45	18.1	17.7
23309	85.730	15.15:				16.0:					
23522	713.649	16.0	16.45:			16.5:			16.9:		
23529	14.663	15.95	17.1	18.45		16.6	18.65	18.4	18.3	18.4:	17.9
23538	15.661	15.65	15.75:	17.1:		16.45		17.1:			17.2:
23600	28.630	15.85	16.8:			16.3			17.2:		
91	8015.608	15.35	16.3	18.05	17.3	16.0	17.4	17.4	18.0	17.85	18.0
92	.677	15.3	16.35			16.05			17.7:		17.6
100	16.610	14.9	16.9	17.55		15.95	17.65	18.5	17.75	17.5	16.9
101	.628	15.0	17.0	17.25	19.0:	15.9	17.2		17.8	17.6	17.1
102	.674	14.55:	17.1		17.8:	15.9	17.0:		17.55:		17.4
103	.693	14.7	17.2		17.5:	15.8	17.2		17.8:		
104	.711	14.75	17.25		17.25:	15.9	17.55:	18.3:	18.3:		18.0:
105	.732	14.7:	17.4:			16.0					17.7:
169	37.599	14.7	16.05			15.6	17.9:	18.0:	16.6		16.8
170	.617	14.5	16.1			15.6					
185	38.569	14.85	16.7	19.5:	19.5:	15.75	18.25	18.0	17.85	19.0:	18.3
186	.582	14.9	16.75	18.7	18.5	15.8	18.3		17.85		18.2
187	.608	14.75	16.7		18.6:	15.75	18.6:	17.9:			19.5:
189	.644	14.75	16.95:		17.2:	15.9					
192	.701	14.75	17.0:		17.6:	15.85			17.3:		17.3:
217	43.571	15.05	16.35		17.9	15.9	17.0	18.6:	16.45	19.0:	17.1
219	.610	15.05	16.3	18.7	17.05	16.0	16.95	19.0	16.5	18.45	16.9
223	.677	15.05	16.4	18.7	17.5	16.1	17.3	17.15	16.55	18.5	16.8
820	308.751	15.4:	16.1			15.6					

Plate	Julian Day	No. 1	No. 2	No. 4	No. 5	No. 7	No. 9	No. 10	No. 11	No. 15	No. 16
821	28308.769	15.15:	16.2			15.6					
824	.843	15.7:	16.1:			15.3					
836	09.767	15.85	17.15	17.85	17.0	15.65	17.2	17.45	17.45		17.2
837	.781	15.7	17.5:			15.5	16.7:		18.0:		
840	.835	15.75	17.05		18.05:	15.6	17.2	17.9:	17.45:		
1109	65.737	15.35	17.0	18.5:	18.3:	15.9		18.05:	18.3:	17.65:	17.3:
1110	.656	15.4	16.95		19.0:	16.1				17.1:	
1112	.706	15.45	16.9	17.2	18.0	16.0	18.35	18.45	17.4	17.5	17.9
1113	.723	15.5	17.0:	17.6:	17.35:	16.0	18.7:		16.9:	17.5:	18.1:
1115	.770	15.45	17.2	18.15:	17.5:	15.95	17.75:	18.15:	16.65	17.4:	
1123	66.631	15.6	16.05		18.15:	16.35	18.6:	17.25	17.5	18.4:	17.9:
1124	.658	15.45	15.95		19.0:	16.15	17.9:	17.9	17.8	18.6:	
1127	.729	15.55	15.85		19.0:	16.4	18.2:		19.0:	18.5:	
1226	91.592	15.05	17.0:		17.5:	15.6	18.7:		17.6:		
1227	.613	15.05	16.5		17.9:	15.65			19.0:		
1229	.678	14.9	16.5	18.2:	19.0:	15.7	16.75		18.0:		
1230	.699	15.1	16.2			15.8	16.9:		17.2:		
1240	92.603	14.55	16.15	18.2	17.85	15.8	18.8	19.0:	17.85	17.8	17.2
1241	.623	14.65	16.15	18.0	17.7:	15.9	17.95	18.05	17.5	18.1:	17.7
1244	.695	14.65	16.05	18.3:	17.65	15.95	17.85:	17.85:	17.65	18.5:	17.6
1257	93.623	14.7:				16.1:					
1267	98.587	14.8	16.25			15.65	18.05:		17.5:	17.0:	16.7
1268	.609	14.95	16.3			15.75	18.0:		17.6:	17.15:	16.9
1271	.653	14.95	16.5		17.8:	15.7	18.2:	18.0:	17.4:	18.0:	
1272	.679	15.0	16.4:		17.15	15.7	17.5:	18.9:	18.1:	17.95:	17.5
1284	99.582	14.95	17.25	17.25	18.8	15.4	18.4	18.35	16.5	18.5	18.2
1287	.630	15.05	17.05	17.35	19.0:	15.5	18.15	18.3:	16.55	18.8:	18.2
1290	.695	15.15	16.8:			15.7				16.8:	
1980	688.713	15.8	15.95			15.55	17.9:		17.6:	18.6:	17.3
1982	.759	15.85	16.05	17.2:	19.5:	15.45	18.8:	17.7:			17.5

Plate	Julian Day	No. 1	No. 2	No. 4	No. 5	No. 7	No. 9	No. 10	No. 11	No. 15	No. 16
1984	28688.822	15.7	16.25	17.9:	19.5:	15.35	18.0:	17.35:	18.0:		18.0
1994	89.720	15.75	16.7		18.6	15.45	17.9	18.6	16.55	17.1	18.6
1997	.804	15.8	16.95	18.8	18.7	15.4	18.2	18.8	17.0	17.75	17.5
2013	93.746	14.7	15.9		18.5:	16.3					
2021	95.759	14.85	16.95	18.5:	18.5:	16.15	17.7:	18.1:	16.4	17.9:	17.7
2033	96.679	14.9	16.0	17.6:	17.0:	16.05	17.45:		17.5:	17.9:	
2035	.722	14.85	15.85	18.2:	17.6	15.95	17.8	18.2	18.1	19.0:	18.7:
2037	.776	14.85	15.9	18.05:	18.0	16.1	17.7	18.6	18.0		18.1
2111	715.675	14.85	17.0:	18.3:	19.0:	15.3	17.8:		16.8	18.3:	16.75
2114	.747	15.0	16.8	18.8:	19.0:	15.35	17.8:	17.0	16.7	18.8:	17.1
2115	.770	15.0	16.6	18.8	18.8	15.4	18.2	17.05	17.15	18.6	17.4
3249	9071.710	14.75	16.2	17.4:	18.1	15.7	17.25	17.95	16.5	18.05	18.0
3252	.798	14.95	16.1	17.8	18.35	15.95	17.75	18.1	17.05	17.4	18.1
3263	72.780	14.95	17.0	18.25	18.3	16.15	17.5	18.05	18.1	18.45	18.3
3275	73.709	14.85	16.0	17.3	17.6	16.35	18.3	18.1	17.55	18.5	17.35
3278	.783	14.95	15.95	18.0	17.8	16.45	18.0	17.2	17.7	18.7	17.6
3290	76.742	15.1	15.9		19.5:	15.8	18.1	17.75	17.4	18.2	17.1
3303	77.702	15.35	16.5	17.9	18.6	15.75	17.4		17.35		17.3
3318	78.722	15.55	17.1	18.3	18.0	15.55	17.4	18.65	18.0	18.6	17.8
4209	405.920	14.6	16.55:			15.5			17.1:		17.3:
4228	06.956	14.7	16.05	18.65:	17.8:	15.2:	17.9:		18.05:	16.9:	
4584	30.738	15.1	16.9	18.4	18.6	15.8	18.2	18.05	16.6	18.7	18.1
4684	62.653	14.8	16.05	17.7	18.7:	15.4	18.05	18.3:	17.9	18.1:	
4693	63.648	14.7	16.65	19.0	19.0:	15.15	18.0		18.05	18.4	
4703	64.653	14.8	16.85	18.5:	18.8:	15.6	17.9:	17.5:	17.0	18.8:	16.8
4795	87.614	15.1	15.9	18.0:	18.6:	15.35	18.0:		17.8:	19.0:	
4807	89.702	15.6	16.85	18.8	17.35	15.4	18.8	18.1	17.9	19.0	18.3
4819	90.657	15.65	15.95	18.05	18.35	15.4	18.25	18.45	17.1	17.35	17.8
4973	519.568	14.65	16.65		18.5	15.55	18.0	18.3	16.35	18.6	17.9
5702	785.764	15.05	16.95	17.9:	17.7	15.45	17.8	17.85	17.35	17.6	17.7

Plate	Julian Day	No. 1	No. 2	No. 4	No. 5	No. 7	No. 9	No. 10	No. 11	No. 15	No. 16
5717	29786.812	15.0	15.9	17.8:	17.7:	15.25	17.65	17.4	16.85	17.3	
5728	87.784	15.3	16.55	18.3	17.75	15.4	17.35	18.3	18.05	18.85	16.75
5729	.810	15.4	16.6	18.5	18.2	15.4	17.5	18.2	18.05	18.9	17.1
5808	813.677	15.75	17.0	18.3	19.0:	15.25	17.15	18.8	18.6:	18.8	17.15
5812	.784	15.9	16.85	18.8	19.0:	15.5	18.3	17.15	18.3	18.6	
5820	14.672	15.5	15.9	19.5:	17.45	15.3	18.5	19.2:	17.4	16.9	17.7
5825	.770	15.7	16.05		18.4	15.4	17.25	18.4	17.9	17.55	17.1
5835	15.657	15.15	16.4:			15.55					
5836	.711	14.9	16.45	18.5:	17.8	15.25	18.25	18.05	16.8	18.9	17.7
5840	16.631	14.65	16.65	18.15	19.0	15.45	18.7	18.25	18.7	18.8	16.9
5843	.690	14.65	16.7	18.45	18.65	15.35	18.75	17.05	18.2	18.7	17.15
5846	.733	14.65	16.8	19.0	17.65	15.45	18.85	17.45	18.3	18.75	17.5
5848	.780	14.8	16.95	18.2	17.35	15.45	18.4	17.7	17.95	18.45	17.7
5948	41.688	15.05	16.8:	17.8	18.7	15.5	17.1	18.5	16.65	18.4	18.2
5964	42.703	15.2	15.95		18.3:	15.55	18.3:		18.5:	18.1:	
5974	43.623	15.3	16.4	17.8:	17.35	15.45	18.3	17.0	16.95	17.55	16.6
5980	.732	15.25	16.45	18.4:	17.45	15.45	18.8:	18.1:	17.9:	17.5:	17.3
6836	30169.693	15.6	16.05	18.6:	17.2:	15.35		19.0:	17.8:	18.6:	17.8:
6837	.722	15.7	16.0		17.9	15.4	18.4	18.4:	17.5:	19.0:	17.6
6838	.751	15.8	16.0		17.8	15.35	18.4	18.6:	18.8:	19.0:	16.85
6839	.789	15.65	16.05	18.4:	18.4	15.4	18.0	18.6	18.2	18.3:	16.9
6847	70.715	15.5	16.75	18.45:	17.45	15.4	18.5	18.25	17.7	18.3	17.7:
6861	71.730	15.05	17.0	18.5	18.6	15.3	18.35	17.6	16.4	18.05	17.8
6864	.797	15.0	16.9	17.65	17.95	15.5	18.4	17.7	17.0	18.3	18.0
6870	72.642	14.55	16.0	17.9	18.7	15.65	17.6	18.2	18.05	18.6	18.0:
6875	.747	14.6	16.0	18.1	18.5	15.65	17.9	18.2	18.0	17.3	17.1
6930	97.722	14.9:	15.5:			15.5:					
6938	99.705	15.35	16.8:			15.65	18.1:		18.3:		
6951	200.696	15.55:	16.0			15.7					
7923	549.662	14.9	15.8	17.75	18.35	15.35	17.8	16.8	17.5	18.7	17.5:

Plate	Julian Day	No. 1	No. 2	No. 4	No. 5	No. 7	No. 9	No. 10	No. 11	No. 15	No. 16
7927	30549.750	14.95	15.85	18.0	18.6	15.35	17.2	17.4	17.6	16.85	
7937	50.686	14.95	16.4	18.5	18.05	15.65	18.05	18.45	16.55	18.25	17.6
7940	.727	15.05	16.45	18.85	18.15	15.35	17.9	18.55	16.55	18.4	17.8
7943	.806	15.05	16.45	18.15	18.85	15.45	17.5	17.65	17.35	18.2	17.9
7949	52.679	15.0	15.9	18.6	17.1	15.6	17.9	17.4	17.4	17.8	18.6:
7955	53.644	15.1	16.65	18.0	18.55	15.55	18.0	18.5	18.15	16.8	17.35
7961	.720	15.05	16.75	18.05	18.3	15.65	18.0	17.7	16.35	17.35	17.8
7964	.779	14.95	16.65	17.85	17.05	15.65	17.95	17.25	17.0	17.4	17.9
7974	54.656	15.05	16.6	18.9	18.6	15.9	17.55	18.35	18.05	18.75	18.2
7979	.739	15.0	16.35	17.5	18.25	15.75	17.55	18.1	17.5	16.95	17.1
8014	56.686	15.3	16.85	17.55	18.0	16.3	17.25	17.05	17.9	18.35	17.25
8020	.748	15.35	16.85	17.35	18.5	16.5	17.2	17.6	16.25	18.45	18.05
8117	86.604	14.8	16.05	18.4	18.25	15.9	18.2	17.3	17.7	17.1	17.0
8895	899.685	16.15	16.2	18.35	18.0	15.95	18.25	18.2	17.7	18.25	17.6
8902	.754	16.3	16.3	18.6	18.55	15.85	18.55	18.55	17.9	18.4	18.2
8907	.811	16.35	16.35	18.7	19.0	15.85	18.4	18.5	18.1	19.0	17.9:
8919	900.675	16.05	16.9	17.7	17.45	15.65	18.4	17.3	16.55	17.95	17.55
8926	.766	16.0	17.1	17.75	17.9	15.7	18.4	17.85	17.15	18.15	17.3
8930	.813	16.0	17.05:	17.8:	17.55:	15.65	17.95:	17.7:	17.4:	18.1:	17.0
9002	32.617	15.75	15.9	17.95	18.4	15.45	18.25	18.4	17.85	18.8	17.3
9003	.627	15.6	15.95	18.35	18.65	15.35	18.4	18.6	17.95	18.55	17.6
9005	.652	15.65	15.8	18.25	18.35	15.45	18.3	18.1	17.15	18.65	17.35
9006	.661	15.7	15.85	18.25	18.25	15.55	18.15	18.25	16.75	18.3	17.4
9008	.685	15.7	15.8	18.3	18.35	15.55	18.45	18.3	16.4	18.65	17.65
9009	.694	15.6	15.9	18.3	18.55	15.45	18.65	18.55	16.4	18.65	17.55
9011	.714	15.8	15.85	18.7	18.75	15.45	18.7	18.2	16.4	18.85	17.95
9012	.724	15.75	15.8	18.45	18.35	15.5	18.4	18.3	16.65	18.65	17.75
9013	.734	15.75	15.85	18.45	18.7	15.5	18.35	18.7	16.75	18.95	18.05
9022	33.600	15.95	16.5	18.45	17.4	15.55	18.55	18.0	17.65	18.2	18.2
9023	.610	15.8	16.5	18.1	17.4	15.6	18.0	17.9	17.6	17.9	18.2

Plate	Julian Day	No. 1	No. 2	No. 4	No. 5	No. 7	No. 9	No. 10	No. 11	No. 15	No. 16
9025	30933.635	15.9	16.55	19.0	17.5	15.7	18.5	18.15	18.1	18.25	18.1
9027	.658	15.9	16.5	18.65	17.6	15.65	18.15	18.25	18.15	18.25	18.05
9030	.687	15.9	16.5	18.8	18.15	15.65	18.25	18.5	18.1	18.65	18.25
9033	.717	15.85	16.6	18.35	18.0	15.6	18.0	18.25	18.05	18.35	17.4
10134	1259.731	14.8	16.0		18.9	15.6	19.0:	18.1:	16.7	17.05	18.0
12045	969.756	15.95	16.1			16.65					
12051	.817	15.8	16.15	18.5:	17.7:	16.4	17.8:	17.7:	17.25:	17.6:	16.55
12070	70.779	15.55:	16.85:			16.05		18.3:			
12143	77.736	15.15	16.0	18.75:	18.45	15.6	17.85	17.95:	16.2	18.25	17.3
12260	99.693	15.35	15.95	17.9	19.2:	15.9	17.6	17.8	17.35	18.9	18.4
12345	2005.706	16.0	15.85	18.5	18.6	15.5	17.45	17.55	17.45	18.35	18.2
12349	.758	16.2	15.8	18.45	18.55	15.55	17.7	17.55	17.5	18.5	18.35
12361	06.641	16.1	16.45	17.85	18.4	15.75	18.7	18.85	18.0	17.95	18.05
12364	.677	16.05	16.45	17.8	18.65	15.65	17.9	18.35	17.8	18.15	18.05
12370	.747	16.05	16.7	18.15	18.6	15.6	17.05	18.5	16.4	18.4	17.95
13424	355.697	15.45	16.25	17.25	18.2	15.45	18.2	18.7	17.2	17.2	18.1
13431	.756	15.2	16.15	17.75	18.35	15.45	18.15	18.15	17.55	17.75	18.15
13436	.828	15.55	16.1	18.0:	18.25	15.35	18.1:		17.8:	18.5:	
13445	56.657	15.8	16.85	18.3	17.65	15.4	17.8	17.25	17.1	18.9	17.25
13448	.710	15.6	17.0	18.4	17.95	15.45	18.05	17.65	16.2	18.8	17.45
13460	57.655	15.95	15.75	17.55	17.55	15.55	17.8	18.6	17.9	18.55	18.05
13464	.701	15.75	15.45	17.9	17.25	15.5	18.25	18.75	17.9	18.95	18.7
13488	60.659	16.15	15.95	18.4:	18.5	15.7	18.45	17.6	17.9	17.05	18.15:
13492	.723	16.1	15.85	18.9	18.75	15.55	17.4	17.15	17.8	17.5	18.2
13497	.793	16.15	16.0	18.5	18.7	15.75	17.45	17.35	17.8	17.9	17.2
14580	740.637	14.6	15.75	17.35	18.5	15.9	17.45	17.95	17.1	17.9	17.85
14584	.683	14.7	15.85	17.7	18.6	15.75	17.55	18.2	17.45	18.1	17.95
14591	.762	14.65	15.85	17.95	17.05	15.7	17.6	18.6	17.6	18.45	18.15
14604	41.638	14.6	16.35	18.5	18.5	15.95	17.8	17.25	17.75	17.15	17.15
14609	.692	14.8	16.45	18.5	18.9	15.75	17.3	17.6	16.35	17.7	17.4

Plate	Julian Day	No. 1	No. 2	No. 4	No. 5	No. 7	No. 9	No. 10	No. 11	No. 15	No. 16
14624	32742.621	14.95	17.0	17.7	18.5	16.15	18.3	18.55	18.0	18.65	18.1
14629	.673	14.95	16.95	17.9	18.7	16.25	18.4	18.65	17.9	18.3	18.35
14638	.779	14.95	16.75	18.25	18.55	16.1	17.25	17.15	17.6	17.5	17.6
14756	70.616	15.95	16.75	17.7	18.5	16.4	18.1	18.2	18.05	17.2	17.85
14764	.697	16.05	16.8	17.8	18.6	16.45	18.3	18.2	16.5	17.85	18.05
21395	4929.638	15.65	16.25	17.4	18.6	15.5	17.6	18.1	17.65	17.7	17.05:
21402	.752	15.85	16.35	18.05	18.2	15.6	17.8	18.4	16.6	17.95	17.45
21426	31.665	15.2	15.8	17.95	18.55	16.05		18.25	17.25	18.8	17.3:
21431	.719	15.0	15.95	17.65	17.85	16.25	17.55	16.9	17.5	19.0	18.5:
22343	5273.697	14.95	16.5	18.3	19.0	16.45	17.05	18.55	16.8	17.25	18.3:
22348	.765	14.9	16.55	18.2	18.4	16.45	17.8	18.4	17.1	17.8	18.05
22363	74.691	14.95	16.85	18.9	18.25	16.1	17.95:	18.3	18.0	18.8	18.0:
22371	.796	15.0	16.95	17.7:	19.0:	16.25	17.1:	18.6:	16.9	16.9	18.7
22380	75.701	14.95	16.0	17.9	17.9	16.1	18.05	17.45	17.6	18.45	17.6
22385	.814	15.1	16.05	18.2:	18.6:	16.0	16.8	18.0	17.5:	18.8	17.7:
22516	309.632	14.85	16.05	18.7	18.4	15.45	18.5	17.15	17.75	18.9	18.2
22521	.679	14.8	16.15	18.45	17.25	15.4	18.0	17.4	17.65	18.55	18.25
22540	10.624	14.8	17.05	17.65	18.6	15.55	18.5	18.45	17.05	18.15	17.85
23295	685.610	14.9	16.75	18.6	17.0	15.9	18.05	18.05	17.5	18.05	18.05:
23315	87.621	14.8	16.65	18.65	18.55	15.55	17.75	17.35	16.7	17.7	17.05
23332	88.633	14.95	16.2	17.95	18.6	15.35	17.3	19.0	18.1	16.75	17.8
23909	6044.661	15.0	16.2	17.95	18.6	15.5	17.95	18.35	17.65	18.4	18.25:
23913	.697	15.05	16.3	17.2	18.15	15.45	17.15	18.2	17.65	18.5	17.8
B1691	49.660	15.7:				16.6:					
B1705	51.660	15.9:				16.2:					
B1715	52.669	15.55:	15.9:			16.15:		18.0:	17.6:		
B1722	53.640	16.2:				15.8:					
B1742	67.646	15.8			17.55:	15.4			18.25:		
B1752	68.663	15.65:				15.5:					
B1765	70.652	15.95	16.7:		17.8:	15.5	17.2:	17.9:	17.45:	17.5:	

Plate	Julian Day	No. 1	No. 2	No. 4	No. 5	No. 7	No. 9	No. 10	No. 11	No. 15	No. 16
B1782	36072.686	15.75	16.15:	17.4:	17.9:	15.7	17.8:	18.5:	16.35	18.15:	
B1789	73.640	15.4				15.6		17.1:	17.5:	18.1:	
24773	750.679	14.6	16.05	17.95	18.3	15.35	17.25	18.05	17.35	17.8	
24779	.739	14.8	16.0	16.65	18.4:	15.35	17.9	18.45	17.8	18.2	17.05
24785	52.640	14.85	16.95	17.75	18.45	15.55	17.95	18.5	16.3	18.9	17.6
24793	.733	14.9	17.05	17.7	18.7	15.45	17.3	17.0	16.95	17.35	17.85
24808	53.648	14.95	15.9	18.45	17.9	15.65	18.05	18.4	17.6	18.55	18.2:
24813	.762	14.9	15.85	18.4	18.3	15.6	17.75	18.3	17.95	18.55	17.1
26203	7849.648	16.1	15.85	18.15	18.65	15.25	18.65	17.45	16.25	19.0:	18.15:
26204	.661	16.1	15.9	18.05	18.05	15.35	18.0	17.6	16.3	18.3:	18.0
26205	.682	16.15	16.0	18.2	18.35	15.25	18.3	17.55	16.4	18.4	18.3
26207	.707	16.2	16.15	18.5	18.2	15.3	18.3	18.35	16.65	18.6	18.2
26210	.750	16.0	16.15	18.2	18.3	15.3	17.6	18.0	17.15	18.0	18.1:
26222	50.672	16.05	16.65	18.5	17.55	15.4	18.05	17.95	17.6	18.3	17.9:
26225	.700	16.0	16.8	18.1	17.8	15.4	18.35	18.25	17.85	18.15:	18.5:
26227	.733	15.9	16.65	17.8	18.5	15.35	17.85	17.2	17.7	19.0:	18.15:
26829	8198.704	14.95	15.8	17.75	18.5	16.1	18.05	18.5	17.8	18.65	
26835	.763	15.15	15.65	17.75	18.5	16.15	18.2	17.15	17.55	18.25	
26837	.783	15.1	15.8	18.0	18.1	16.15	18.45	16.9	17.75	18.6	18.2:
26851	99.690	15.15	16.4	18.9	17.6	16.1	18.05	18.6	16.9	18.75	18.1
26853	.712	15.15	16.25	18.2	17.45	15.9	18.15	18.2	17.05	18.4	18.1
26857	.754	15.2	16.5	18.7	17.25:	15.85	18.35	18.5	17.1	18.35	17.8
27559	587.693	14.85	16.1	18.4:	17.65	15.45	18.0	18.8:	16.8	17.3	

Plate	Julian Day	No. 19	No. 22	No. 23	No. 24	No. 25	No. 30	No. 32	No. 33	No. 36	No. 43
2637	20726.750	18.5	18.4	17.8	19.0:		18.9:	18.3	18.0	18.3	18.1
2649	48.705	19.0:	18.15	18.7:	16.85		16.9	17.0	18.2:	17.5	17.7
4397	1690.895				18.1:		19.0:	17.45			
20544	6915.824	18.4	18.1:	18.65	17.9	18.3	17.0	18.65:	17.8:	18.3	18.2:
20559	21.824	18.05	18.5	18.7	18.6	18.7	17.6	18.4	17.4	17.25	18.4

Plate	Julian Day	No. 19	No. 22	No. 23	No. 24	No. 25	No. 30	No. 32	No. 33	No. 36	No. 43
20571	26923.785						17.9:				
20584	24.758		17.8:	17.45:			18.0:				18.2:
20587	.824		17.3:	17.0:							18.0:
20597	25.776			17.7:	17.7:		18.6:				17.7:
20647	44.781		18.2:	18.05:	19.0:		17.8	18.2:		16.45:	17.75:
20675	46.742			18.0:	18.3:		18.3:				18.0:
21377	7272.784	18.0	17.8:	18.3:	19.0:	18.25:	17.7	18.5:		18.0:	17.8:
21380	.864	17.3	18.55:	18.8	18.8	18.05:	17.9	18.55:	18.1		18.55:
21386	73.788	18.6	17.45	17.55	18.25	17.5	17.45	17.5	18.0	17.8	17.65
21399	74.776	18.8	18.7	18.8	19.0:	18.0	17.4	18.25	18.7	18.35	18.05
21406	.891	19.5:	18.5	17.7	18.8	18.8:	17.4	18.3		17.4	18.3:
21412	75.768	18.3	17.9	18.7	18.9	18.0:	18.15	17.9	18.15	18.25	17.85
21416	.856	19.0:	18.0	18.9	19.2:	17.6	16.9	18.2	18.4	18.5	17.55
21515	306.776		18.1:		18.3		18.1:	18.3:		17.25	17.7:
21538	07.799	17.6		18.8:	17.5:		17.9:		18.2:	18.1	17.75:
21556	08.800						18.5:				
23178	639.790	18.65	18.0	18.6	18.45	17.7	18.2	17.7	17.8:	18.0	18.1
23237	58.749	17.9	17.2	18.4:	17.65	18.5	18.3	17.1	18.3	17.75	17.2
23240	.811	18.15	17.65	16.95	18.15	18.55	18.6	17.45	18.6	17.85	17.6
23252	59.760	17.3	18.55	18.5	17.3	18.3	18.15	18.1	18.1	18.25	17.4
23255	.823	17.9	18.7	18.7	17.8	18.05	17.8:	18.05	17.9:	18.2:	17.85
23256	.840	18.6		18.2:	17.9:	17.9:	18.8	17.9:	18.8:	17.9:	17.9:
23306	64.765	17.95	18.0	18.55	18.55	17.9	16.95	17.6	17.6	17.4	17.85
23308	.802	17.9		18.3	19.0:	17.9	17.15	17.45	17.65	17.35	17.8
23522	713.649						18.0:				
23529	14.663	18.7	18.15:	17.65	18.4	18.6:	18.1	18.1	17.6	18.6	18.0
23538	15.661			18.0:			17.6			16.95:	17.35:
23600	28.630		19.0:	18.0:							
91	8015.608	17.6	17.35	16.95	18.2	17.95	18.1	17.0	17.8	18.15:	17.55
92	.677	17.8:									17.5:

Plate	Julian Day	No. 19	No. 22	No. 23	No. 24	No. 25	No. 30	No. 32	No. 33	No. 36	No. 43
100	28016.610	16.95	18.1	18.3	18.5	18.3	18.1	17.8	17.0	17.3	17.35
101	.628	17.25	17.8	18.6:	19.0:	18.2	17.9	17.8	17.2	17.55	17.45
102	.674	17.6:					18.3			17.2:	
103	.693	17.8:		17.65:			17.9:				
104	.711			17.55:	18.5:		18.0:	18.5:		17.7:	
105	.732	17.7:		17.15:							
169	37.599						17.9:			17.4:	17.5:
170	.617						18.5:				
185	38.569	18.4	17.6	19.0:	19.5:		18.5	17.2	18.5	18.3	17.35
186	.582	18.0	17.75	18.3:	18.5	18.05	18.4	17.3	18.0:	17.8	17.65
187	.608	17.7	17.6:				17.9	17.1:		18.0:	17.1:
189	.644	17.6					17.9				17.3:
192	.701						18.0				17.4:
217	43.571	18.3	19.0:	19.0:	18.6:		16.9	18.8:	18.7	17.75:	18.8:
219	.610	18.2	19.0	19.0:	18.7	19.0:	17.2	17.9	17.8:	19.0	17.6
223	.677	18.5	17.65	19.0:	18.15:	17.65	17.6	17.5:		17.2:	16.5:
836	309.767	17.4	17.85:				17.7				16.75:
837	.781						18.4:				
840	.835		17.75:				18.1:	17.75:			16.9:
1109	65.637	18.5:		17.9:			17.4:		17.6:		16.9:
1110	.656				17.9:		17.5:				17.5:
1112	.706	18.1	18.35	18.55	17.25	19.0:	16.8	17.9:	17.8:	18.7:	17.3
1113	.723		19.0:	19.0:	17.0:		16.7:	19.0:		18.5:	17.95:
1115	.770		17.5:	17.6:	17.3:		17.7:			17.75:	17.45:
1123	66.631	18.1:	18.15:	19.0:	19.5:	17.4	18.3:	17.9:		17.9	17.0:
1124	.658	19.0:	17.7	18.8:	18.8:	17.9:		17.55		17.4:	17.05
1127	.729			18.0:	17.8:		17.2:				17.2:
1226	91.592	17.5:	18.2:		19.0:		17.8			17.8:	17.4:
1227	.613	18.0:		19.0:	19.0:		18.0:			17.45:	16.95:
1229	.678		17.8:				17.9:				17.05:

Plate	Julian Day	No. 19	No. 22	No. 23	No. 24	No. 25	No. 30	No. 32	No. 33	No. 36	No. 43
1230	28391.699				18.5:						17.2:
1240	92.603	17.8	18.1	18.3:	18.5	18.05	17.8	17.85	17.9:	18.3	17.65
1241	.623	17.7	18.0:	18.4:	18.7:		17.9	18.0:	18.5:		
1244	.695	18.4	17.35:	19.0:	18.6		17.6	17.2:	18.2:	17.85	17.9
1267	98.587	17.5	17.3:	18.05:	17.65:	19.0:	18.0	17.4:	17.3	19.0:	17.15:
1268	.609	17.4	17.05:	18.5	18.5:	17.9	17.9:	17.3:	17.2	18.1:	17.75
1271	.653	18.0:		18.6:		17.6:	18.4:				17.35:
1272	.679	18.0	17.9	19.0:	18.9:	17.35	18.0	17.65	17.7:	18.1:	18.0
1284	99.582	18.6	18.7	18.0:	17.5	18.25	18.1	18.15		18.35:	17.3
1287	.630	17.7	17.8	17.95	17.5:		17.9	18.0:		17.3	17.65
1980	688.713	18.0:	17.8:	18.4:	17.8:		19.5:	17.5:		18.8:	18.6:
1982	.759	18.0:	17.5:	19.0:	18.8:	17.2:	18.0:				17.6:
1984	.822	18.0:	18.0	19.0	19.5:	17.65	19.0:	17.9:		17.6:	17.9
1994	89.720	18.3	19.5:	18.8	17.8	19.0:	17.9	18.9	18.1:	18.3	
1997	.804	18.5	17.4	18.8	18.55	17.6	18.3	18.4	18.5	17.6	17.75
2013	93.746	17.3:	16.85:		18.3:		17.0:				16.85:
2021	95.759	18.0:	17.5:	18.5	18.2:		18.5:	17.15:	17.4:		17.55:
2033	96.679	18.5:		17.2:			18.3:			17.2:	17.4:
2035	.722	17.9	18.8	17.55	18.2	18.0	18.0	18.0	17.5:	17.7	17.5:
2037	.776	18.0	18.5	17.7	19.0:	18.05	18.0	17.8	17.35	17.85	17.95
2111	715.675	17.8	18.3:	18.2:	17.5:		17.0		18.2:	17.75:	16.95:
2114	.747	18.7:	18.5:	18.5	19.0:	18.2:	17.6	18.1		17.8	17.7:
2115	.770	18.3	18.45	18.2	18.0	18.05:	17.9	18.05	17.9:	17.9	17.95
3249	9071.710	17.5	17.5	17.3	18.35	18.25	17.9	17.15	17.7	18.0	17.65
3252	.798	18.5:	18.0	17.8	17.8	17.6	18.1	17.65	17.9	17.85	17.7
3263	72.780	18.6	18.35	17.7	17.25	18.15	18.1	18.0	18.3	18.15	18.1
3275	73.709	18.5	18.3	18.5	19.0	17.9	17.8	17.95	18.2	17.75	17.7
3278	.783	18.3	18.15	18.7	18.7	18.35	18.2	17.7	18.3:	18.10	18.0
3290	76.742	18.6:	17.45:	17.45	19.5:	18.1:	16.75			18.3	17.05:
3303	77.702	18.6	17.4	18.2	18.5	18.0	18.3	17.4:	17.5	17.6	18.7

Plate	Julian Day	No. 19	No. 22	No. 23	No. 24	No. 25	No. 30	No. 32	No. 33	No. 36	No. 43
3318	29078.722	18.8:	17.8	18.25	18.2	18.0	18.6	18.0	17.7	17.9	18.0
4209	405.920			18.3:			17.3:				18.0:
4228	406.956	17.2:	17.9:	17.9:			17.1:				18.2:
4584	30.738	18.1	18.5	17.15	18.4	17.7:	18.0	18.05	18.1	18.6	17.85
4684	62.653	17.3	17.2	17.85	18.5:	18.0:	17.6:		17.7:	18.1:	18.0:
4693	63.648	18.7	18.4	19.0:	18.65	18.5	17.6	17.75	17.1	18.0	18.2:
4703	64.653	19.0:	18.3:	19.0:	18.9:	17.9	17.15	17.4		18.5:	17.8:
4795	87.614		18.6:	17.0:	19.0:		17.1	17.3:		19.0:	18.8:
4807	89.702		18.9	18.7	18.5	18.7:	16.85	17.8	17.7	18.9:	18.0
4819	90.657	18.15	17.35	18.35	18.4	17.95	18.6	18.3	17.9:	17.65	17.7
4973	519.568	18.6	17.7	18.9	18.25	18.25	18.6	18.2	18.3	18.5	17.75
5702	785.764	18.1	17.9	17.7	18.0:	17.75:	17.1	17.55	17.0	17.6	17.1
5717	86.812	18.0:		18.5:	18.9:	18.0:	16.8:	17.3:		17.25:	17.1:
5728	87.784	18.2	17.4	18.2	18.1	17.75	17.05	17.95	17.95	18.25	18.2
5729	.810	17.5	17.55	18.5	17.9	18.05	16.8	18.2	18.3	18.3	18.2
5808	813.677	18.6	19.0	18.15	17.2	18.4:	18.2	17.45	17.7	18.9	18.0
5812	.784	18.5	18.4	18.7	18.2	18.0	17.9	17.9	18.4		17.9
5820	14.672	17.6	17.7	17.4	17.1	18.9	17.9	18.15	17.65	17.6	18.5
5825	.770	18.5	17.7	17 65	17.6	17.75	18.2	17.9	17.9	17.9	18.0
5835	15.657						17.0:				
5836	.711	17.2	18.7	17.4	17.5	18.5	18.0	18.05	18.0:	18.25	17.8
5840	16.631	18.3	18.05	18.7	18.9	18.0	17.15	18.55	18.2:	17.65	17.2
5843	.690	18.5	17.65	19.1:	18.75	17.7	16.95	18.05	18.2:	17.6	17.45
5846	.733	17.25	17.95	18.85	18.25	18.1	17.4	18.5	18.6	17.85	18.1
5848	.780	17.25	18.0	18.15	17.15	18.1	17.7	18.15	18.3:	17.7	18.05
5948	41.688	18.7	17.45	17.05	17.75	18.2	18.3	17.65	17.5:	17.6:	17.4
5964	42.703				19.5:		18.5:				17.4:
5974	43.623	18.1	17.6	18.6	18.2	18.2	18.3	18.05	18.1:	18.5	18.3
5980	.732	18.3	18.0:	18.0:	18.8:	18.0:	18.1:	17.6:	17.1	18.2:	17.4:
6836	30169.693	18.5:	18.2:	18.6:	19.0:		18.2:	17.4:	17.8:	17.6:	18.2:

Plate	Julian Day	No. 19	No. 22	No. 23	No. 24	No. 25	No. 30	No. 32	No. 33	No. 36	No. 43
6837	30169.722	19.0:	19.0:	18.8	19.0:	18.0	18.8:	17.8	17.5:	18.1	17.4
6838	.751	18.7	18.0	18.0		18.2:	16.9	17.35	18.2:		18.0
6839	.789	17.1	17.6	17.2	17.0	17.9	16.9	16.95	17.9:	18.4:	17.0
6847	70.715	18.8:	18.2:	18.7	18.9	18.45	18.6	17.65	17.7:	18.05	18.0
6861	71.730	18.5	18.1	18.4	18.5	18.15	18.15	17.1	18.1:	18.3	17.75
6864	.797	18.2	18.35	18.6	18.85	18.4	18.4	17.4	18.2:	18.5	18.25
6870	72.642	17.9	18.15	17.85	18.4	17.85	17.75	17.7		17.5	
6875	.747	18.4	17.95	18.15	18.6:	17.85	18.0	17.9	18.1:	17.8	18.15
6938	99.705			17.6:	18.5:	17.6:	16.9			17.1:	18.3:
7923	549.662	17.75	17.95	18.2	18.7	17.9	17.2	17.0	18.25:	17.5	17.7
7927	.750	18.2	18.1	17.4	18.2	18.05	18.1	17.6	17.65:	17.8	17.7
7937	50.686	16.9	17.45	18.4	18.4	17.55	16.75	17.65	18.0:	18.25	17.3
7940	.727	17.3	17.8	18.15	18.3	17.7	17.25	17.9	17.7	18.3	17.5
7943	.806	18.0	18.0	18.55	18.7	18.25	17.85	17.6	17.35	18.6	17.8
7949	52.679	18.9:	17.55	17.45	18.6	18.35	18.4	17.8	17.3	18.05	18.0
7955	53.644	18.5	18.3	17.05	18.1	17.85	18.25	17.3	17.2	17.25	17.75
7961	.720	18.6	18.2	17.05	18.25	18.2	18.25	17.45	17.4	17.6	17.45
7964	.779	18.4:	18.8	17.5	18.0:	18.1:	18.3	17.7	17.7:	17.85	17.15
7974	54.656	18.05	17.7	18.4	17.9		18.05	18.05	17.3	18.4	17.8
7979	.739	18.5	17.9	17.0	18.0:	17.85	18.35	17.8	17.6:	17.95	18.1
8014	56.686	16.9	17.65	18.05	18.0	18.5	17.55	17.85	17.6:	18.1	17.65
8020	.748	17.45	18.25	18.4	18.0	17.85	17.85	17.3	18.15:	18.4	18.05
8117	86.604	18.5	18.3	18.05	18.25	18.15	17.9	17.55	18.15	18.15	17.8
8895	899.685	18.25	17.7	18.7	17.9	18.2	17.9	17.85	17.0	18.1	17.15
8902	.754	18.5	18.3	18.7	17.2	17.9	18.2	18.3	17.5	18.15	17.2
8907	.811	18.3	17.9	18.65	17.9	18.0	18.4	17.35	17.75	18.5	17.5
8919	900.675	18.6	18.35	17.9	18.55	18.25	17.3	17.7	17.3	18.7	17.5
8926	.766	18.6	19.0	18.1	16.9	18.8:	17.7	17.5	17.85	17.25	17.1
8930	.813		17.95:	18.1:	17.6:		18.0:	17.35:		17.2:	17.45:
9002	32.617	17.85	18.6	17.55	18.3	17.65	17.75	17.6	18.05:	17.25	17.15

Plate	Julian Day	No. 19	No. 22	No 23	No. 24	No 25	No 30	No. 32	No. 33	No. 36	No. 43
9003	30932.627	17.7	18.3	17.8	17.9	17.85	17.1	17.4	18.2:	17.2	17.1
9005	.652	16.95	18.6	18.3	18.3	17.45	16.9	17.15		17.3	17.65
9006	.661	17.05	18.6	18.25	18.35	17.25	17.2	17.15	17.65:	17.1	17.35
9008	.685	17.15	18.65	18.2	18.55	17.6	17.3	17.05	17.85	17.3	17.65
9009	.694	17.1	18.75	18.15	18.55	17.6	17.15	17.05	17.95	17.6	17.55
9011	.714	17.45	19.1:	18.6	18.6	17.65	17.6	17.55	17.7	17.4	17.7
9012	.724	17.6	18.55	18.4	18.5	17.65	17.7	17.5	17.55	17.65	17.75
9013	.734	17.7	18.2	18.3	18.25	17.8	17.5	17.35	17.25	17.45	17.85
9022	33.600	18.4	18.4	18.2	17.55	18.35	18.4	17.6	18.3	17.85	17.35
9023	.610	18.6	17.9	17.85	17.4	18.35	18.55	17.5	18.1:	17.8	17.05
9025	.635	18.4	17.85	17.55	17.8	18.35	18.15	17.85	18.0:	18.3	16.85
9027	.658	18.3	17.2	16.9	17.9	18.0	18.25	17.6	18.0	18.3	16.95
9030	.687	18.6	17.2	17.05	18.05	17.95	17.6	17.8	17.6	18.3	17.3
9033	.717	17.7	17.35	17.15	18.3	17.75	16.9	17.75	17.1	18.2	17.55
10134	1259.731	18.4	18.3:	18.1:	18.6:	17.7:	17.5:	18.8:	17.7:	18.5	16.75:
12045	969.756						17.6:				
12051	.817	18.8:	17.4:	17.3:	17.8:	17.3:	18.1	16.8:	17.45	17.3:	16.7:
12070	70.779						17.6:				
12143	77.736	17.8	18.45	17.65	18.6	17.35	17.8	17.25	17.7:	17.8	17.45
12260	99.693	18.3	17.8	17.3	18.5	17.7	18.2	18.25	17.85	18.0	17.7
12345	2005.706	18.1	17.6	17.35		18.2	18.1	18.0	17.75	18.95	17.8
12349	.758	18.8	18.45	17.2	18.6	17.7	18.3	18.05	17.8	18.3	17.55
12361	06.641	18.05	18.7	18.45	17.35	18.3	18.0	17.6	18.35	17.3	18.35
12364	.677	18.1	18.2	18.55	17.7	18.1	18.1	17.55	18.0	17.45	18.35
12370	.747	18.5	17.2	18.45	18.15	18.3	18.3	17.75	17.7	17.85	18.05
13424	355.697	18.5	17.15	18.35	18.45	17.6	18.7	17.6	17.75:	17.25	18.3
13431	.756	17.1	17.7	18.6	18.75	17.75	18.5	17.6	17.55	17.25	18.3
13436	.828	17.5	17.9:	18.4	18.7:	18.4:	17.0	17.75	17.6	17.4	18.25
13445	56.657	18.7	18.15	17.85	18.15	18.15	18.4	17.7	18.15:	17.9	18.25
13448	.710	18.6	18.05	18.1	18.3	17.55	18.7	17.75	17.45	18.15	18.15

Plate	Julian Day	No. 19	No. 22	No. 23	No. 24	No. 25	No. 30	No. 32	No. 33	No. 36	No. 43
13460	32357.655	18.7	17.4	17.5	18.55	18.4	18.3	17.65	17.8:	18.1	18.0
13464	.701	18.4	17.6	17.75	18.45	18.7	18.5	17.75	17.35	17.5	17.9
13488	60.659	17.2	19.0	18.7	17.2	17.45	17.05	17.75		17.3	18.1
13492	.723	17.4	18.75	18.5	17.6	17.55	17.6	17.0	17.6:	17.9	17.8
13497	.793	18.1	18.85	18.9	18.35	17.7	17.5	17.4	17.7:	17.8	18.35
14580	740.637	18.0	18.05	17.95	18.45	17.9	17.7	17.15	17.45	18.1	17.85
14584	.683	18.3	17.45	18.3	17.05	18.1	18.0	17.5	16.85	18.15	18.25
14591	.762	18.4	17.4	18.7	17.4	18.3	18.3	17.5	17.6	17.6	18.35
14604	41.638	17.7	18.2	17.7	18.45	17.5	17.6	17.9	17.0	17.35	18.0
14609	.692	18.0	18.85	18.75	18.25	17.8	17.95	17.9	17.05	17.45	17.95
14624	42.621	17.35	18.1	17.15	18.45	17.9	16.9	17.35	16.95	17.95	17.55
14629	.673	17.1	17.3	17.3	18.75	17.7	17.4	17.45	17.2	18.2	17.5
14638	.779	18.15	17.8	18.6	16.75	17.8	18.1	17.85	18.25	18.2	18.0
14756	70.616	18.0	18.2	18.3	18.4	18.0	18.15	18.0	18.21	17.6	18.15
14764	.697	18.25	18.45	18.0	18.6	17.95	18.5	16.95	18.05	16.9	17.1
21395	4929.638	18.8	17.55	18.5	18.15	17.55	18.5:	17.4		17.5	17.2
21402	.752	17.55	18.1	18.55	18.0	17.8	17.1	17.45	17.9:	17.95	18.0
21426	31.665	18.3	18.25	17.9	18.4	18.7	18.4	17.6		18.0	18.55
21431	.719	18.7:	17.05:	17.85	18.3	18.05	18.3	17.3	18.1:	17.95	17.8
22343	5273.697	18.5	18.3	18.3	17.5	17.8	18.45	17.85	18.25:	18.2	18.3
22348	.765	18.65	18.05	18.3	18.0	17.7	17.3	17.8	18.35:	17.4	18.2
22363	74.691	17.9	17.35	18.2	17.0	18.05	18.6:	17.2	18.1:	17.3	18.2
22371	.796	18.8:	18.1:	18.9	18.5:	17.8:	18.7	17.65:		17.8:	18.5
22380	75.701	17.55	18.2	17.5	17.55	18.05	18.2	17.8	18.1:	18.4	17.6
22385	.814		17.0:	17.9:	17.3:	17.9:	18.2	17.4:		17.2	17.9:
22516	309.632	18.05	18.6	18.65	17.95	18.25	17.5	18.1	17.9:	18.15	18.0
22521	.679	18.2	18.3	18.5	18.15	18.25	17.65	17.95	17.8:	17.75	17.75
22540	10.624	17.7	17.4	18.4	17.6	17.5	17.3	17.2	17.85:	17.5	17.2
23295	685.610	18.2	18.2	17.7	19.1	17.7	18.35	17.65	17.9:	17.5	17.95:
23315	87.621	17.1	18.5	17.65	17.9	18.0	18.35	18.05	17.6	17.75	18.0

Plate	Julian Day	No. 19	No. 22	No. 23	No. 24	No. 25	No. 30	No. 32	No. 33	No. 36	No. 43
23332	88.633	18.35	17.9	18.5	18.0	17.75	18.6:	17.3	17.4:	18.15	18.35
23909	6044.661	18.7	17.9	18.5	17.1	17.65	17.15	17.2	18.2:	17.35	17.35
23913	.697	18.05	17.75	18.1	17.15	17.4	17.45	16.9	17.9:	16.9	17.45
B1715	52.669						16.9:				18.0:
B1742	67.646		17.65:	17.0:	17.3:	18.1:	17.2:	16.35:			17.9:
B1765	70.652		18.9:	17.9:	17.0:	17.6:	18.0:	17.65:		17.15:	17.35:
B1782	72.686		18.2:	17.4:	18.2:			17.5:	17.6:	17.7:	18.15:
24773	750.679	17.6		19.0	17.2	17.8	17.95	17.6	17.05:	17.45	17.2
24779	.739	18.2	18.45	18.7	17.55	18.05	18.5	17.7	17.8:	17.85	18.0
24785	52.640	18.5	18.25	17.35	19.0:	17.9	17.85	17.55	17.15	17.15	17.05
24793	.733	18.3	18.25	18.05	17.9	17.55	18.15	17.9	17.7	17.6	17.45
24808	53.648	18.9	17.6	17.55	18.55	18.1	17.2	18.0	17.4:	17.85	17.25
24813	.762	18.4	17.95	17.55	18.15	17.8	18.05	17.45	17.85:	18.2	17.8
26203	7849.648	17.45	17.5	17.75	19.5:	17.45	18.3		18.35:	17.3	18.2
26204	.661	17.85	17.6	17.75	19.5:	17.75	18.6		18.25	17.65	18.1
26205	.682	17.7	17.5	17.9	18.65	17.75	18.3	17.95	17.95	17.45	18.1
26207	.707	17.8	18.2:	18.2	18.6	17.75	18.6	18.0	17.8:	17.65	18.35
26210	.750	18.35	17.8	18.3	17.5	18.1	18.4	17.85	17.25	17.9	18.3
26222	50.672	16.85	17.9	17.05	18.8	17.4	18.6	17.25	17.6:	18.0	17.9
26225	.700	17.4	18.25	17.35	18.35	17.45	18.4	17.5	17.8:	18.15	
26227	.733	17.8	18.55	17.4	19.5:	17.75	18.5	17.25	17.85:	17.95	18.15
26829	8198.704		17.3	17.0	18.55	18.45:	17.2	17.75		17.0	17.85
26835	.763	17.7	17.85	17.7	18.45	17.55	17.5	18.0	17.2:	17.2	18.1
26837	.783	17.7:	17.7	18.55	18.75	17.85	17.3	18.0	17.9:	17.05	18.5
26851	99.690	18.6	18.55	18.35	17.8	18.55	18.3	17.15	17.8:	18.65	18.35
26853	.742	18.7	18.3	17.45	17.55	18.2	17.1	17.7	17.6:	17.9	18.05
26857	.754	18.3	18.2	16.95	18.8	18.0	17.0	17.95	17.6	17.95	18.3
27559	587.693	18.5:	17.95:	18.2	18.6	17.7	17.4	18.0:		17.85	17.85

NOTES TO TABLE III

Plates 103-4397 taken by F. G. Pease and H. Shapley with Mt. Wilson 60-inch reflector.

Plates 20544-23600 taken by H. Sawyer Hogg with Dominion Astrophysical Observatory, 72-inch reflector.

Plates 4209 and 4228 taken by H. Sawyer Hogg with 36-inch reflector, Steward Observatory, University of Arizona.

Plates B 1691 to B 1789 taken by various observers with 19-inch David Dunlap reflector.

All other plates taken by H. Sawyer Hogg with 74-inch David Dunlap reflector.

TABLE IV

Var.	Magnitude Max.	Min.	Mean	Epoch of Maximum	Period days
1	14.65	16.1	15.35	38191.8	18.730
2	15.8	17.0	16.4	38198.58	2.79468
4	17.2	18.6	17.9	38199.23	0.651313
5	17.1	18.7	17.9	38199.61	0.548796
7	15.4	16.5	15.95	38189.56	13.596
9	17.0	18.4	17.7	38199.47	0.538831
10	17.1	18.5	17.8	38199.34	0.585914
11	16.4	18.0	17.2	38199.59	0.604417
15	16.9	18.6	17.75	38199.51	0.557727
16	16.8	18.2	17.5	38199.40	0.600617
19	17.0	18.6	17.8	38199.34	0.545671
22	17.3	18.5	17.9	38199.23	0.655916
23	17.1	18.5	17.8	38199.72	0.552342
24	17.0	18.7	17.85	38199.64	0.519901
25	17.65	18.4	18.0	38199.48	0.360707
30	16.9	18.3	17.6	38199.72	0.534226
32	17.0	18.1	17.55	38199.55	0.655975
33	17.3	18.3	17.8	38199.59	0.479946
36	17.2	18.3	17.75	38199.33	0.677990
43	17.0	18.2	17.6	38199.46	0.521747

REMARKS TO TABLE IV

Var. 1 The period seems to be steadily shortening rapidly, and may be expressed as $P = 18^{d}.730 - 14 \times 10^{-7}\ (T - T_0)$, where $T_0 = 2438200.00$, over the interval of 52 years represented by the observations.

Var. 11 This variable, on the outskirts of the cluster, is more than half a magnitude brighter than the average of the other cluster-type variables.

Var. 25 The period of 0.360350 days satisfied our observations almost as well, and it is difficult to determine which is the true period.

Var. 33 The accuracy of measures for this star is less than average because it is a blended double.

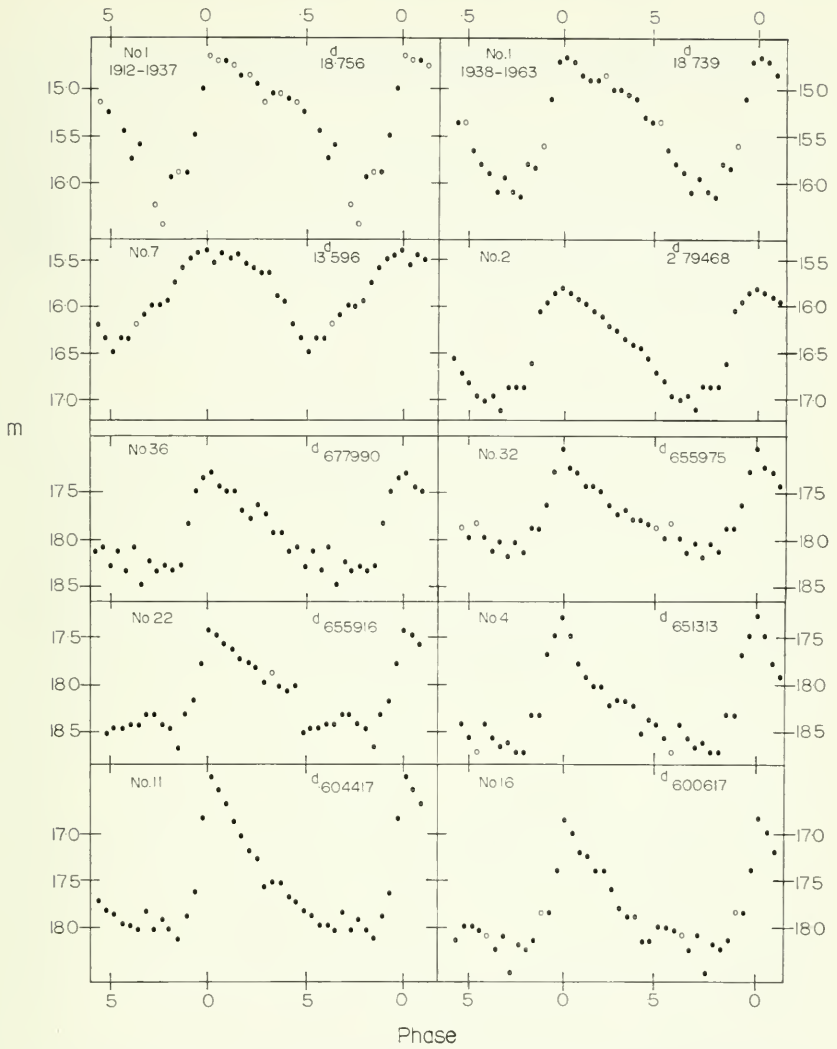

FIG. 2—Mean light curves for the nine stars of longest period in this group of 20. Two curves are given for Var. 1 to show the change in period.

days, very similar to Var. 29 in Omega Centauri (Martin 1938), whose period is comparable. From two plates, Joy gives spectral types of F5 and G2e3, with an average radial velocity of −136 km/sec.

Our comments on the total picture of the variables in this cluster will be reserved till the final paper. The second paper of this series is

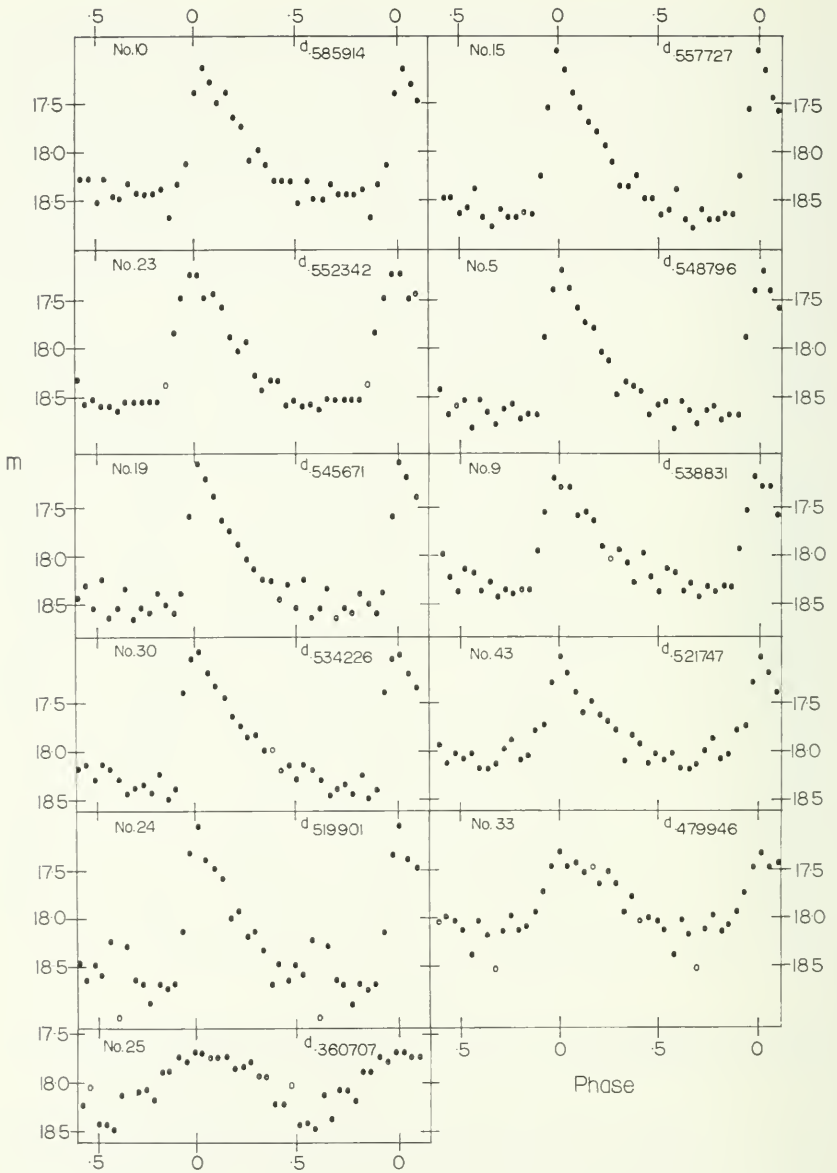

FIG. 3—Mean light curves for 11 variables, arranged by decreasing length of period.

in preparation. A summary of the results for the first forty periods determined in this cluster was presented at the Michigan meetings of the American Astronomical Society in August 1965 (Sawyer Hogg and Wehlau 1965).

It is a pleasure to express our appreciation to the National Research Council of Canada for generous support of this program, and to many observers at the David Dunlap Observatory who assisted with the telescopic part of the program, especially the late Dr. Frank S. Hogg and Mr. G. F. Longworth.

April 27, 1966

References

Joy, A. H. 1949, *Ap. J.*, vol. 110, p. 105.

Martin, W. Chr. 1938, *Leiden Ann.*, vol. 17, pt. 2.

Payne-Gaposchkin, C. 1954, "Variable Stars and Galactic Structure," p. 37. University of London.

Sawyer, H. B. 1937, *R.A.S.C. Jour.*, vol. 31, pp. 57–59.

Sawyer, H. B. 1938, *Dom. Ap. Obs. Pub.*, vol. VII, no. 5.

Sawyer Hogg, H. and Wehlau, A. 1964, *A.J.*, vol. 69, no. 2, p. 141; *R.A.S.C. Jour.*, vol. 58, no. 4, pp. 163–166; *D.D.O. Comm.*, no. 97.

Stebbins, J., Whitford, A. E., and Johnson, H. L. 1950, *Ap. J.*, vol. 112, p. 475.