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PERIOD CHANGES OF RR LYRAE VARIABLES IN THE GLOBULAR CLUSTER MESSIER 5

By Christine M. Coutts and Helen Sawyer Hogg

Abstract

The purpose of this investigation is to study period changes in RR Lyrae variables in the globular cluster M5. The study is based mainly on a collection of 167 plates taken between 1936 and 1966 at the David Dunlap Observatory. Some 64 photographs taken by Dr. Harlow Shapley in 1917 with the 60-inch telescope on Mount Wilson have also been measured.

Studies of this type which have been carried out for other globular clusters are briefly discussed. The methods for studying period changes using a phase-shift diagram are explained.

A total of 66 RR Lyrae variables has been studied in M5. Of these, 16 have irregular periods, 18 have been constant, 20 have shown increases (median rate 0.05 ± 0.02 days per million years) and 12 decreases (median 0.075 ± 0.02 days per million years) in period during an interval of about seventy years. It seems not possible at present to attach any evolutionary significance to these changes.

Introduction

Messier 5 is in third place among the globular clusters which are richest in variable stars (ω Centauri and Messier 3 supersede it). The only study of period changes of the RR Lyrae variables in this cluster was made 27 years ago by Oosterhoff (1941), based on observations obtained up to the year 1935. Messier 5 is therefore a cluster very suitable for a study of changes in period. One of us (Sawyer Hogg) has taken a series of 136 photographs of this cluster with the 74-inch telescope between 1936 and 1964 inclusive.

An additional series of 31 plates was taken by Coutts on four nights in 1966 with the 74-inch telescope at the David Dunlap Observatory, after this investigation was begun. Dr. H. W. Babcock kindly lent us some plates taken by Dr. Harlow Shapley with the 60-inch telescope at Mount Wilson Observatory in 1917. Although these plates were studied previously (Shapley 1927), the individual observations were never published and so these plates were remeasured. The measures of the David Dunlap and Mount Wilson plates form the basis for the present investigation.

In addition, a number of published observations of the variables in M5 are available, from 123 photographs taken between 1889 and 1912 by Bailey (1917), and from 81 photographs with the 60-inch Mount

Wilson telescope in 1934 and 1935 by Oosterhoff (1941). When all this material is considered, M5 can be studied over an interval of more than seventy years. It is important to find what characteristics of the period changes of the RR Lyrae variables in M5 are similar to those in the other clusters which have been studied already.

Other Studies of the Period Changes of RR Lyrae Variables in Globular Clusters

About ten globular clusters have been investigated for period changes. The results, on the whole, do not indicate any particular trend in changes in period of the RR Lyrae stars. Some variables have constant periods. Some have periods which are secularly decreasing and others which are secularly increasing. In most clusters, there appears to be no preference for periods to increase or decrease. The clusters which have been investigated specifically for period changes are listed in Table I, in order of decreasing number of variables.

TABLE I

Cluster	No. of RR Lyrae Variables	Investigators
NGC 5272 = M3	173:	Martin (1942) Hett (1942) Belserene (1952) Ozsvath (1957) Szeidl (1965) Kheylo (1966)
NGC 5139 = ω Centauri	140:	Martin (1938) Belserene (1961, 1964)
NGC 5904 = M5	93	Oosterhoff (1941)
NGC 7078 = M15	88	Izsak (1956) Mannino (1956a, 1956b) Grubissich (1956) Nobili (1957) Notni and Oleak (1958) Bronkalla (1959) Fritze (1962) Makarova and Akimova (1965)
NGC 6402 = M14	69:	Sawyer Hogg and Wehlau (1968)
NGC 6121 = M4	41	Wilkens (1964)
NGC 5024 = M53	38:	Margoni (1964, 1965a, 1965b, 1967) Wachmann (1965)
NGC 5466	18	Bartolini, Biolchini and Mannino (1965)
NGC 7089	13	Mantegazza (1961) Kulikov (1961)
NGC 6341 = M92	12	Kheylo (1964, 1965) Bartolini, Battistini and Nasi (1968)
NGC 5053	10	Mannino (1963)

The RR Lyrae stars in ω Centauri exhibit a distinct tendency for the periods to increase. For about 70 per cent of the stars investigated in this cluster, the periods show secular increases while the others decrease, remain constant or fluctuate. The median rate of change of period for 47 variables classed as RR *a, b* types investigated by Belserene (1964) is an increase of 0.11 days per million years.

The RR Lyrae variables in M3, on the other hand, do not exhibit such a tendency. Szeidl (1965) has studied 112 variables. Of these, 22 have periods which are increasing at an average rate of 0.18 days per million years and 25 have periods which are decreasing at an average rate of 0.20 days per million years. Of the other periods, 7 have remained constant and the rest are fluctuating. The average rate of change of period of all the stars is a decrease of 0.02 days per million years, but the median rate is zero. Thus the RR Lyrae variables in M3 behave in a different manner from those in ω Centauri. Belserene (1964) has pointed out, however, that the period-amplitude relations for these two clusters are also different, and therefore she notes that conclusions based on the observations of RR Lyrae variables in one cluster are not necessarily applicable to the class of variables as a whole.

In M15, there are a few more stars with increasing periods than with decreasing, but the tendency to increase is not as marked as that in ω Centauri.

In the other clusters investigated, there are approximately equal numbers of stars with increasing and decreasing periods. Margoni (1967) in his work on M53 has suggested that sine curves can be fitted to the phase-shift diagrams for five of the stars on the basis of the present observations. This implies that the period changes are periodic and if this be true, we can not attach any evolutionary significance to the values of β computed for other stars. The quantity β is the rate of change in the period in days per day as defined by Martin (1938).

For M5, Oosterhoff (1941) used observations from 1895, 1896, 1897, 1912, 1917, 1934 and 1935. He considered 41 stars of RR Lyrae types *a, b* and found that the average period change was an increase of 0.05 days per million years, with 25 periods increasing and 15 decreasing, and 1 remaining constant. The tendency for periods to increase is therefore not as marked as in ω Centauri.

Theory of Investigation of Period Changes

To investigate changes in period among RR Lyrae stars, a reasonably accurate period is needed, i.e., it must satisfy the observations over an interval of one or two years. The light curve is derived by reducing all the observations of the star to one cycle of light variation.

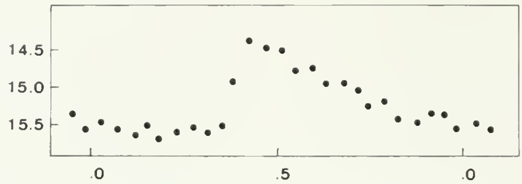

FIG. 1—Light curve of an RR Lyrae variable (phase in fractions of period).

A certain period, P, is assumed and a reference epoch at time E is adopted. All the observations at the different times, t, are reduced to one cycle of period, P, at epoch E, such that: phase $= (t - E)/P$. This is the number of cycles of length P, which have elapsed between epoch E and time t. The phase adopted at time t is the fractional part of this number. When phases are computed at a series of times t, a light curve can then be plotted. If the period is constant and correct, the scatter on the light curve should be that expected from the accuracy of the observations. However, if the scatter is larger than this, the assumed period is incorrect or varying or both. The method used to examine the behaviour of the period is to plot a phase-shift diagram.

There are five cases of the phase-shift diagram, described below.

Case 1: Assumed period incorrect

Suppose that the true period is α, and that an incorrect value P has been assumed in computing the phase for the light curve. Then the resulting displacement in phase is given by:

$$\begin{aligned} \Delta \text{ phase} &= \frac{t-E}{P} - \frac{t-E}{\alpha}, \\ &= (t-E)\left(\frac{\alpha - P}{P\alpha}\right), \\ &\simeq \frac{(t-E)}{P^2} \cdot \Delta P, \end{aligned}$$

where $\Delta P = \alpha - P$.

If Δ phase is plotted against t, a straight line results, and the true period can be determined from the slope of this line, $\Delta P/P^2$.

Case 2: Period changing at a uniform rate

Suppose that the period is not constant, but instead, changes at a constant rate β. If the period at time E is α, then the period at time t is

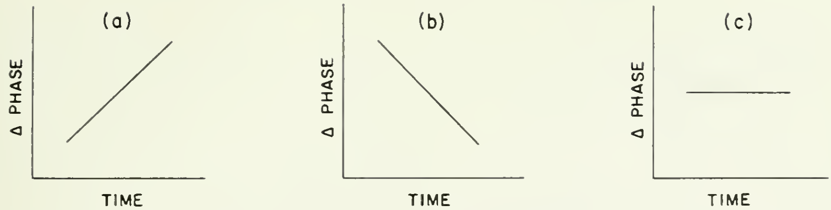

FIG. 2—Phase-shift diagrams for a star of constant period: (a) α, the true period, $>$ P, the assumed period (b) $\alpha < P$, (c) $\alpha = P$.

given by: $P = \alpha + \beta(t - E)$. Since the period is changing at a constant rate, the true phase at time t should be given by:

$$\frac{t - E}{\alpha + \frac{\beta}{2}(t - E)}.$$

The phase calculated assuming a constant period, α, is: $(t - E)/\alpha$. Hence, the displacement in phase (or phase-shift) at time t is:

$$\begin{aligned} \Delta \text{ phase} &= \frac{t - E}{\alpha} - \frac{t - E}{\alpha + \frac{\beta}{2}(t - E)}, \\ &\simeq \frac{t - E}{\alpha}\left[1 - \left\{1 - \frac{\beta}{2\alpha}(t - E)\right\}\right], \\ &= \frac{\beta(t - E)^2}{2\alpha^2}, \end{aligned}$$

where $\frac{\beta}{2\alpha} \cdot (t - E) \ll 1$.

In this case, if Δ phase is plotted against t, the result is a parabola with a vertical axis, with equation:

$$\Delta \text{ phase} = A + Bt + Ct^2,$$

where $C = \beta/2P^2$ day^{-2}. If the parabola is concave upward, β is positive, and the period is increasing. If the parabola is concave downward, the period is decreasing.

Case 3: Assumed period incorrect and period changing at a uniform rate

Suppose that the assumed period is not the true period at time E and that the period is changing at a constant rate. Indeed, if the

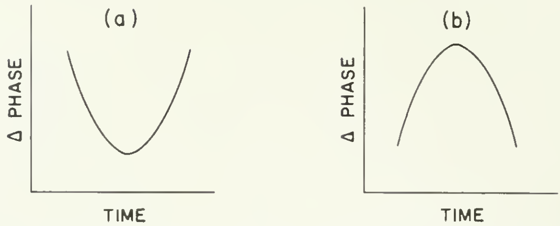

FIG. 3—Phase-shift diagrams for a star with period changing at a uniform rate: (a) $\beta > 0$, period increasing; (b) $\beta < 0$, period decreasing.

period is changing, it is very difficult to determine the period precisely at any given moment. In this case, the phase shift at time t is given by:

$$\Delta \text{ phase} = \frac{t-E}{P} - \frac{t-E}{\alpha + \frac{\beta}{2}(t-E)},$$

$$= \frac{t-E}{P} - \frac{t-E}{\alpha} - \frac{t-E}{\alpha + \frac{\beta}{2}(t-E)} + \frac{t-E}{\alpha},$$

$$\cong \frac{\Delta P}{P^2}(t-E) + \frac{\beta}{2\alpha^2}(t-E)^2,$$

$$\cong \frac{\Delta P}{P^2}(t-E) + \frac{\beta}{2P^2}(t-E)^2.$$

Thus, a plot of Δ phase against time once again results in a parabola with a vertical axis (see figure 3). The value of β is again determined from the coefficient of the t^2 term $\beta/2P^2$.

Case 4: An abrupt change in period

If the period changes abruptly, rather than gradually, the phase-shift diagram consists of two straight lines with different slopes. If the

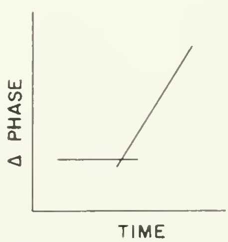

FIG. 4—Phase-shift diagram for a star whose period changes abruptly.

slope of the second line is greater than that of the first, an increase in period is indicated. The amount of change in the period is related to the difference in slope between the two lines: $\Delta P = (\Delta \text{ slope}) P^2$.

Case 5: Irregular changes in period

Many phase-shift diagrams have a more complicated form than those described above. In such cases, it is difficult to predict long-range period changes. An increase in slope indicates an increase in period and a decrease in slope, a decrease in period. However, if these changes occur in an irregular manner, it must be assumed that the period changes are random.

Obviously the phase-shift diagram can give important information regarding the behaviour of the period of a star. In the past, most investigators have assumed a parabolic form for the phase-shift diagram (rather than a more complicated curve) to determine the period change. According to Belserene (1964), β is a useful parameter for describing the extent of the variation in period. She adds, "It is the average rate of period change if the true rate has varied." However, Makarova and Akamova (1965) in a study of RR Lyrae variables of M15 find that for about 50 per cent of the stars they studied, the period changes are abrupt, i.e., the phase-shift diagram is represented better by two intersecting straight lines than by a parabola. This is also a simple assumption, but it is difficult to determine the rate of period change when the observed quantity is its amount.

In the present investigation, the period change is determined by both methods.

Present Investigation

The globular cluster M5 has a total of 98 variables (but the variability of one, no. 51, is questionable). There are two W Virginis variables (nos. 42 and 84), one irregular (no. 50), one SS Cygni (no. 101) and 93 RR Lyrae. Of the RR Lyrae stars, 91 have periods determined (Bailey 1917, Shapley 1927, and Oosterhoff 1941). Sixty-eight are of type *a*, *b* and twenty-three are type *c*.

The plates used with the 74-inch reflector were Eastman Kodak 103aO. Sixty-six RR Lyrae stars (50 of type *a*, *b* and 16 of type *c*) and the two W Virginis stars could be studied on these plates. Most of the stars were measured with a Cuffey iris astrophotometer, but the magnitudes of variables 6, 13, 14, 27, 33, 34, 38, 45, 63, 67, 69, 83 and 98 were estimated by eye.

A sequence of photoelectric *B*, *V* standards determined by Arp

TABLE II

PHASE SHIFTS (IN FRACTIONS OF THE PERIOD)

Year	No. 1	No. 3	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 15	No. 16	No. 19
1889													
1895–96	−.025	.00	−.01	.01	−.04	.00	−.02	−.01	−.33	.03	.04	−.05	−.04
1897–99	−.06	.00	−.01	−.05	−.04	.00	−.01	.00	−.30	−.03	−.01	−.06	−.03
1901–02	−.04	.00			−.04	.02	−.01	.00		.02?	−.05	−.08	.01
1904–05	−.055	−.01	−.02		−.07	−.01	−.01	−.01		.00?	−.07	−.10	−.04?
1912	−.02?	−.02	.00	.02	−.07	.05?	−.01	.02	−.10	.00	−.20	−.07	−.07?
1917	−.01?	−.04	−.01	−.09	−.07	−.02	−.04	−.01	−.09		−.16?	−.06	−.06
1934	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1936–38	.03?	.00		−.01	.00	−.03	.00	−.02	.00	.00	.00	.04	
1940–42	.03	.01	.03	.06	.05	.00?	.00	−.02	.04	.00	.01	.03	.00
1943–44	.01	.02	.00	.21	.02	.00	.00	.00	.00	.02	.11	.01	.02
1946–49	.00	.01	−.02	.20	.04	.00	.00?	.02	−.01	.05	.19	.06	.04
1950–53	.04	.02	−.02	.21	.11	.01	−.03?	.00	.01		.24	.10	.25
1954–56	.06	.045	−.06	.29?	.14	.05	−.04	.00	−.02	.15	.20?	.11	.44
1959–60	.07	.08	−.05		.15	.03	−.02	.03	−.10	.13	.35?	.16?	.68
1963–64		.08		.38	.17	.03	−.06	.03	−.10		.35?	.16?	1.02
1966	.065	.06	−.07	.53	.25	.02	−.07	.03	−.15	.12	.47	.17	1.09

Year	No. 20	No. 21	No. 27	No. 28	No. 29	No. 30	No. 31	No. 32	No. 33	No. 34	No. 36	No. 38	No. 39
1889													
1895–96	.00	−.04	−.06	−.01	−.19	.00	.01	−.12	−.03	.00	.04?	.03	−.01
1897–99	−.02	−.01	.02	.11	−.10	.05	−.02	−.14	−.04	−.01	.00	.04	.00
1901–02	.01	−.01		.12	−.08?	.01	.06	−.12	−.02	.01			.00
1904–05	−.01	−.03	.06		−.10	.04	.04	−.14	−.02			.03	−.03
1912	.00	−.05	.08	.11	−.09	.00	.01	−.06					.06
1917	.00	−.01		.11	.08?	−.01	−.01	−.08	.00			.62?	−.01
1934	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1936–38	−.01	−.04	.02	−.05	.04	−.02	.03	.00	.00	−.02	−.06?	−.05	
1940–42	−.01	.00		−.06	.09	.00	.00	.01	.00	.09?	.02?	−.09	.00
1943–44	.00	−.01	.17	−.12	.04	.01	−.04	.00	.04	.04	.00?	−.12	.00
1946–49	.01	.00	.25	−.15	−.08	−.01	−.05	.00	.05	.01	−.09?	−.15	.02
1950–53	.00	.00	.20	−.27	−.32	.01	−.05	.04	.06	−.10?	−.06	−.20	.06
1954–56	.02	−.02	.23	−.25	−.40	.01	−.04	.03	.03	.01	.03?	−.29	.07
1959–60	.01	−.01	.26	−.31	−.49?	.00	−.03	.01		.00			.05
1963–64	.01	−.01		−.31		.00	−.03	.01	.16	.00			.05
1966	.01	.00	.29	−.54	−.58	−.02	−.05	.07	.14	.04	−.07	−.55	.07

TABLE II—*continued*

Year	No. 40	No. 41	No. 43	No. 45	No. 47	No. 55	No. 59	No. 61	No. 62	No. 63	No. 64	No. 69	No. 70
1889												−.08	
1895–96	−.01	.02	.00	−.03	−.02	.05	−.02	−.05	−.02	−.03	−.01	−.01	−.07
1897–99	−.04	.01	.01	−.02	−.01	−.01	−.02	.00	−.06	−.02	.00	−.01	−.15?
1901–02	−.01	.03	−.02	−.05	−.05	.00	−.05	−.08	−.15		.00	−.01	−.15
1904–05	.05?	.05	−.01	.01	.05	−.03		−.08	−.27?		.02	.00	−.20?
1912	−.01	.10		−.04	.00	−.04	−.04	−.09	−.25	−.02	.06		
1917	−.05	.02	−.02	−.05	.04	−.05	−.04	−.09	−.04?	−.05	.02	−.01	−.20
1934	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1936–38	.04	−.04	.00	−.05	−.11?	.04	−.04	.02	−.01	.04	.00	.00	.04
1940–42	.02	−.07	.00	−.01	.01?	.05	−.02	.05	.13	.02	−.01	−.08	.14
1943–44	.05	−.07	.01	.04?	.09	.05	−.04	.08	.23	.02	−.07	−.02	.18
1946–49	.11	−.09	.01	.06?	.04?	.09	.01	.14	.33	.05	−.10	−.03	.25
1950–53	.11	−.10	.03	.03	.02	.14	.03	.16	.40		−.12	.00	.33
1954–56	.13	−.12	.02	.03	.01	.16	.02	.23	.35	.10	−.18	−.06	.49
1959–60	.10	−.15?	.05	.00?	−.04	.14	.02		.35			−.05	
1963–64	.10	−.15?	.05	.00?	−.04	.14	.02		.52		−.28	−.05	
1966	.13	−.19	.02	.10	−.08	.14	.01	.33	.51	.12	−.28	−.02	.87

Year	No. 71	No. 73	No. 74	No. 75	No. 76	No. 77	No. 78	No. 79	No. 80	No. 81	No. 83	No. 87	No. 98
1889			−.06						.00				
1895–96	−.01	−.04	−.04	.00	.00	−.02	−.02	−.04	.10	−.05	−.03	.00	
1897–99	−.03	−.06	.01	−.03	−.04	−.01	−.01	−.01	.03	−.02	−.02	.02	
1901–02	−.02?	.03	.08	−.04	.11?	−.09	.00	−.10	.10	.04	.02?	.02	
1904–05			.05			−.04	−.03	−.10		.10	−.01	.01	
1912		−.01			−.02	−.07?	−.02	−.04	.02	.09?	.02	−.01	
1917	−.03	−.05	.01	−.04	−.04	−.10	.00	.03	.10	.09	−.04	−.12?	
1934	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1936–38	.06?	−.03	.01?	−.02	.09	.01	−.04	−.03	−.01	−.05	.00	.05	.02
1940–42	.05	−.09	.01	.02	.01	.02	.00	.10?	.04	−.10	.00	.05	−.05
1943–44	−.04?	−.12	−.03	.00	.02	.00	.00	.08	−.05	−.14	−.05	.04	
1946–49	.08	.00	.01	.05	−.01	.02	.00	.08	−.12	−.16	−.03	.00?	
1950–53	.09	.10	−.08	.07		.08	−.04			−.26	.00	.05	−.09
1954–56	.09	.14	−.12	.02	−.04	.12	−.01	.12		−.34	−.01	.02	−.23
1959–60	.15?	.36		.08	.04	.15	−.01		−.05	−.60	.00	.01?	
1963–64		.36		.08	.04	.15	−.01	.00	−.05	−.60	.00	.01?	
1966	.21	.36	−.19	.06	.22	.16	.02	.07	−.07	−.72	.00	−.01?	−.91

(1962) was used to reduce the data. Arp's B magnitudes were converted to photographic magnitudes by his relations:

$$B = m_{pg} + 0.23 - 0.16\, CI$$
$$V = m_{pv}$$
$$CI = m_{pg} - m_{pv}.$$

In addition, each plate was examined for the visibility of an SS Cygni star discovered by Oosterhoff (1941), but it was not detected. The limiting magnitude of many of the David Dunlap plates, whose exposure times average only 3 minutes, is at a brighter magnitude than the maximum, $m_{pg} = 17.16$, at which Oosterhoff observed this star. The observations (photographic magnitudes) are listed in Table III where the first column gives the plate number (for variables 1–27), and the second column the heliocentric Julian day with the first two digits (24) omitted. In subsequent sections of the table the plate numbers are not repeated. Measures could be made on 157 plates.

Thirty-three plates taken by Shapley in 1917 with the 60-inch Mount Wilson telescope were also measured. Some of the plates had two exposures of the cluster so that there were 64 photographs altogether, with exposures usually 2 or 3 minutes. All the variable stars except variables 6, 33, and 38 were measured with the iris photometer, while the others were estimated visually. Some of the stars measured on the David Dunlap plates (variables 13, 27, 84 and 98) could not be measured on the Mount Wilson plates owing to the double exposures on the latter. The presence of two exposures on one plate has the effect of crowding the field, particularly in the nuclear region of the cluster. The observations (photographic magnitudes) from the Mount Wilson plates are listed in Table IV. The first column gives the Mount Wilson plate number for the 32 plates whose quality permitted measures, and the second column gives the heliocentric Julian day with the first two digits (24) omitted. From these two columns the plates with two exposures can be identified. We made every effort to determine which exposure was made first, but we cannot guarantee that the decision is always correct. The time difference between the two exposures is so small that we used the means of the times and of the magnitudes.

On both series of plates, no correction was made for background light which has the effect of making the stars in dense regions of the cluster appear too bright. There are no photoelectric standards in these regions, and correction for background intensity without such standards could introduce additional uncertainties into the results.

These two series, totalling 200 plates, along with the values from 123

TABLE III

Photographic Magnitudes from the David Dunlap Plates

TABLE III. PHOTOGRAPHIC MAGNITUDES FR

Plate	Julian Day	No. 1	No. 2	No. 3	No. 6	No. 7	No. 8	No. 9	No.
819	28308.736								
828	8309.651								
829	.661	15.3	15.17	14.74	15.05	15.3	15.6	14.80	14.9
830	.670	15.25	15.19	14.76	15.0	15.0:	15.48	14.89	14.8
831	.677	15.28	15.29	14.86	14.85	14.96	15.42	14.97	14.6
838	.796		15.43	15.11	14.85	14.76	14.65	15.18	15.1
1107	8365.608	15.45	15.43	15.17	15.25	14.53	15.20	15.02	15.3
1122	8366.608	15.4	15.39	15.39	14.9	14.66	14.76	15.36	15.2
1285	8399.596	15.39	14.81	15.38	14.85	15.56	15.40	15.36	15.2
1976	8688.640				14.6				
1990	8689.640								
2005	8692.632	15.3	15.48	14.97	14.9	15.35	15.35	14.82	15.5
2012	8693.730	15.4	15.5?	15.21	14.85	15.45	15.35	15.31	15.5
2029	8696.631	14.55	14.77	15.51	15.05	15.50	15.21	15.54	15.1
2108	8715.638								
3246	9071.660	15.47	15.51	15.41	14.5	14.78	15.43	15.3	15.6
3259	9072.698	15.42	15.47	15.3	15.05	15.27	15.44	15.25	15.4
3269	9073.605	15.34	15.23	15.33	15.05	14.74	15.3	15.01	15.5
3284	9076.603				14.6:				
3296	9077.600								
3310	9078.600								
3325	9079.602	14.68	15.42	15.31	15.15:		15.21	15.45	15.6
5706	9786.609	14.56	15.5	15.45	15.25	15.01	15.51	15.27	15.1
5720	9787.608	15.45	15.62	15.43	15.25	15.12	15.54	15.63	14.4
5804	9813.610	15.4	15.58	15.45	15.25	15.43	14.95	14.65	14.5
5817	9814.612	15.41		15.45	15.3	15.31	15.13	15.36	15.3
5832	9815.613	15.48	15.47	15.05	15.15	15.01	15.56	15.36	15.5
5839	9816.611	15.44	15.44	15.44	14.85	14.75	15.5	15.23	15.4
6855	30171.617	15.52	15.6	15.21	14.6	14.4	15.5	15.1	15.6
6868	0172.615	15.44	15.58	14.96	14.5	14.41	15.4	15.39	15.5
7852	0519.606	15.53	15.25	14.84	14.9	15.40	15.28	14.74	15.5
7867	0520.606	15.41	15.58	15.39	14.55	15.41	15.42	15.37	15.3
7935	0550.608	14.97	15.37	15.47	15.25	15.37	15.23	15.44	15.5
7952	0553.604	15.06	15.4	15.41	14.85	15.43	15.5	15.49	15.7
7971	0554.614	15.32	15.81	15.15	14.4	15.66	15.75	15.27	15.1
7989	0555.629	15.39	15.44	14.92			15.56	15.45	15.2
8008	0556.620	15.39	15.21	15.45	15.25	15.45	15.40	14.87	14.9
8115	0586.572	14.75	15.02	15.3	15.0	15.28	15.05	14.56	15.
8801	0880.592								
8804	.623	15.49	15.53	15.43	14.4	14.57	15.5	15.42	15.
8807	.659	15.22	15.54	15.33	14.6	14.55	15.43	15.27	15.
8810	.690	15.4		15.36	14.85	15.0	15.49	15.45	15.
8813	.730	15.36	14.15	15.43	14.9	14.92	15.50	15.35	14.
8816	.760	15.1	14.46	15.44	14.95	15.11	15.55	15.0	14.
8819	.788								
8827	0883.593								
8830	.630	15.29	15.54	15.31	15.1	14.71	14.67	14.55	15.
8833	.664	15.47	15.66	15.41	15.25	15.05	14.9	14.74	15.
8836	0884.622								
8839	.651								
8842	.680	15.41	15.64	15.35	15.25	15.19	14.80	15.32	15.

THE DAVID DUNLAP PLATES

No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 18	No. 19	No. 20	No. 21	No. 25	No. 27
		14.55	15.45								
		15.15	15.25								15.5
15.24	15.62	15.1	15.2	15.38	14.97	14.65	15.6	15.35	15.6	14.66	
15.22:	15.42	15.05	15.2	15.3	14.94	14.68:	15.51	15.24	15.49	14.61	15.6
15.24	15.35	15.0	15.3	15.33	14.96	14.91:	15.44	15.29	15.48:	14.61	15.5
15.37	15.55	14.6	15.4	14.97	15.04	15.17:	15.52	15.34	14.58	14.22	14.85
15.31	14.85	15.15	14.85	15.31	15.12	15.47:	15.54	15.16	15.28	15.28	15.6
14.88	15.19	14.85	14.95	15.28	15.0	15.31:	15.50	14.67	15.16	14.21	15.55
15.31	15.44	14.25	15.1	15.35	15.23	15.15	15.46	14.94	15.34	14.41	15.2
			15.0:								
15.18	15.30	14.65	15.3	15.17	15.28:	15.06	15.24	15.35	15.44	14.74	15.35
14.94	15.50	14.8	15.25	15.01	15.13	15.31	15.55	15.40	15.40	14.77	14.85
14.35	15.61	15.0	15.35	15.43	14.12	14.97	15.64	15.32	15.53	14.63	15.4
15.3	15.52	15.05	15.0	15.05	14.4	14.56	15.51	15.32:	15.44	14.56	15.55
14.88	15.31	15.1	15.2	15.22	15.34	15.32	14.91	15.35	15.23	14.80	14.35
15.46		14.85	14.9	15.08	14.51	15.34	14.77	14.82	15.49	14.38	15.65
			14.9	15.1							
			15.25								15.3:
15.32	15.44	14.95	15.3		15.04	14.88	15.35	15.34	15.48	14.12	15.5
14.93	15.36	14.9	15.25	15.08	14.14	15.18	14.92	15.35	15.40	14.4	15.55
15.57	15.63	14.45	15.3	15.0	15.2	15.31	15.28	15.33	14.81	14.27	14.8
15.37:	14.38		14.6?	15.25	15.24	15.34	15.54	14.90	14.75	14.59	15.2
14.82	15.04	15.2	15.3	15.3	14.98	15.57:	15.53	15.25	15.69	14.66	15.3
15.48	15.34	14.95	15.35	15.17	15.46	14.98	15.65	15.30	15.39	14.64	15.45
15.38	15.54	14.95	15.45	15.15	15.21	14.77	14.64	14.83	14.65	14.65	
15.25	15.5	15.0	14.95	15.27	15.3	14.50	15.38	15.35	15.12	14.71	15.0
14.37	15.57	14.95	14.95	15.29	14.35	14.92	15.54	15.02	15.45	14.67	15.55
15.17	15.57	15.3	15.25	14.93	15.16	14.45	15.24	15.33	14.75	14.58	14.95
14.51	15.71	14.95	15.5	15.16	14.99	14.97	14.41	14.99	15.56	14.66	15.5
15.17	15.34		15.55	15.08	15.28	14.97	15.48	15.11	15.47	14.51	14.85
15.26	15.02	15.25	14.75	15.16	14.85	15.11	14.88	14.98	15.42	14.48	15.3
14.26	15.52	15.4	14.9	15.21	13.82	15.56	15.56	14.93	14.84	14.16	15.7
15.38	15.56	15.35	15.2	15.20	14.69	15.26	15.72	15.33	15.58	14.39	15.2
15.23	15.64	15.3	15.0	15.30	13.97	15.03	15.72	14.92	15.36	14.39	14.9
15.67	15.51	14.8	15.35	15.25	14.85	15.22	15.28	15.2	15.06	14.63	15.6
		14.8	14.6								15.4
14.69	15.44	14.9	14.8	15.04	14.87	15.05	14.44	15.45	14.56	14.43	14.85
14.70	15.4	14.85	14.8	14.90	14.73	15.09	14.81	15.07:	14.83	14.15	14.75
14.95	15.6	14.85	14.9	15.00	14.89	15.10	15.1	14.88	14.95	13.87	14.75
14.94	15.47	14.9	15.25	14.92	14.91	15.10	15.3	14.42	15.09	14.0	14.95
15.18	15.54	14.9	15.25	15.06	15.08	15.20	15.4	14.65	15.29	14.26	15.1
		14.95	14.95								
14.80	15.49	14.5	15.2	15.19	13.85	15.20	15.46	15.38	14.50	14.57	14.95
15.02	15.62	14.65	15.25	15.08	14.05	15.26	15.56	15.54	14.76	14.54	15.25
		14.6	15.15								15.3
			15.2								
14.80	14.44	14.75	15.3	15.05	15.25	14.95	15.55	15.34	15.55	14.43	15.55

Plate	Julian Day	No. 1	No. 2	No. 3	No. 6	No. 7	No. 8	No. 9	No. 10
8846	30884.721	15.43	15.60	15.47	14.95	15.41	14.85	15.47	15.55
8851	.771		15.58	15.26	14.95	15.41	14.99	15.26	15.44
8887	0899.602	14.62	15.50	15.22	15.25	15.21	15.17	15.48	15.72
8891	.647	14.8	15.21	15.17	14.95	15.38	15.37	14.85	15.55
8897	.701	15.16	14.73	15.37	15.05	15.55	15.59	14.58	15.69
8912	0900.604	14.76	15.38	15.25		15.45	14.9	15.22	15.50
8916	.638	14.62:	15.5	14.98	14.95:	15.4	15.15	15.18	15.50
8935	0901.632								
8938	.676	14.55	15.77	15.44	15.05	15.44	15.01	15.42	15.42
9001	0932.604	15.24	15.54	15.03	15.05	15.16	15.55	14.66	15.63
9021	0933.589	14.97			15.05	14.85			
10098	1257.634	14.93:	14.50	15.51	14.35	15.23	15.45	14.86	15.29
10108	1258.625								
10121	1259.604	14.55	15.74	14.77	15.05	15.42	15.2	14.62	15.16
12043	1969.736	14.52	15.21	15.17	15.25	14.16	15.34	14.72	15.15
12063	1970.698								
12109	1976.641	14.93	15.28	15.42	14.45	14.26	14.74	14.74	14.96
12138	1977.690	14.93	15.26	15.49	14.75	14.65	14.55	15.33	14.75
12276	2000.641	15.07	15.55	15.37	15.15	15.35	14.6	15.1	15.40
12323	2004.652	15.63	15.57	15.38	14.95	15.41	15.37	14.55	15.09
12357	2006.599	15.31	14.62	15.27			15.33	15.72	15.23
13326	2326.715	14.46	15.52	14.53	14.9	14.27	14.96	15.47	15.60
13340	2328.739	14.51	15.21	15.82	15.25	14.5	15.55	15.46	15.54
13392	2354.604	15.54	15.62	15.48	15.15	15.65	15.03	15.63	15.46
13415	2355.607	15.37	15.51	14.96	15.25	15.12	15.77	14.9	14.84
13439	2356.605	15.26	15.63	15.32	15.2	15.25	15.25	15.15	14.86
13454	2357.604	15.29	15.17	15.9	14.95	15.36	15.50	14.67	14.51
13504	2361.704	14.84	15.15	15.23	15.05	15.3	14.75	15.18	15.41
14506	2733.605				15.15				
14530	2734.604	15.5	15.16	15.5		14.02	15.55	15.35	15.57
14578	2740.608	15.28	15.08	15.41	14.55	14.48	15.52	14.65	15.14
14602	2741.607	14.97	15.37	15.18	15.05	15.08	15.7	15.40	15.53
14627	2742.648	14.81	15.25	14.65	15.3	15.02	15.46	14.70	15.6
14750	2770.576	15.49	15.44	15.42	15.4	15.48		14.94	15.28
16016	3068.668	14.37	15.35	15.1	15.35	15.35	15.16	15.23	14.48
16043	3069.654	15.21	15.11	15.37	15.5	15.44	14.57	15.52	15.48
16167	3095.604	15.35	15.77	14.91	15.45	15.25	15.77	14.57	15.17
16196	3096.609	15.54	15.52	15.48	15.45	15.01	15.35	15.34	15.78
17448	3476.602	15.7	15.49	15.03			14.8	14.79	15.28
17472	3477.601	15.38	15.49	15.45	15.25:	15.63	15.7	15.45	15.37
17504	3481.597	15.26	15.0	14.99		14.1	14.98	15.03	15.11
17627	3505.572	15.35	15.6	15.18	15.25	15.3	14.81	15.47	15.23
18162	3823.649	14.5	15.31	14.9		15.0	15.35	15.41	15.65
18273	3858.636	14.3	15.68	15.3	14.7	15.26	15.59	15.42	15.50
18277	3859.590								
18292	3860.589	15.39	15.16	15.44	15.25	15.17:	14.60	15.35	15.34
19147	4180.634	14.76	15.4	15.04	14.9	15.64	14.82	15.36	15.37
19164	4181.607	14.51	15.04	15.54	15.25	15.61	15.71	15.49	
19186	4182.607	15.51	14.98	15.18	15.25	15.37	15.58	15.25	14.82
19191	4183.608								
20072	4538.633	14.87	15.62	15.3	14.85	14.00	15.37	15.4	14.59
20092	4539.634	14.65	15.53	14.83	14.55	14.09	15.15	14.85	14.65

No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 18	No. 19	No. 20	No. 21	No. 25	No. 27
14.21	14.98	14.85	15.55	15.11	15.58	15.05	15.66	15.39	15.66	14.21	15.3
14.58	15.22	14.8	15.3	14.94	15.18	15.0	15.48	15.38	15.35	14.05	15.4
14.2	14.58	15.0	14.5	15.10	15.22	14.97	15.58	14.55	15.41	14.56	15.25
14.3	14.44	14.85	14.8	15.10	15.13	15.04	15.65	14.58	15.40	14.48	15.15
14.66	14.94	15.2	15.0	15.39	15.41	15.25	15.83	14.82	15.62	15.62	15.3
15.06:	14.75	14.8	14.65	15.05	14.68	15.0	15.71	15.3	14.86	14.42	
15.41	15.04	14.65	14.8	15.12	14.79	15.26	15.54	15.3	14.95	14.67	15.2
15.35	15.45	14.95	15.25	15.21	15.42	15.32	15.65	15.35	15.67	14.67	15.5
15.29	15.86	14.95	15.6	14.68	15.15	15.17	15.82	14.67	14.55	14.29	15.3
14.1		14.95	15.5		14.20					13.97	15.6
15.45	15.53	15.2		15.12	14.89	14.56	15.19	15.12	15.27	14.52	15.25
14.71	15.66	15.25	15.5	14.89	15.07	15.16	15.48	15.45	15.32	14.56	15.5
15.35	14.30	15.25	14.6	15.06	13.78	15.31	15.6	15.39	15.58	14.45	15.5
			14.4								
15.24	15.63	14.7	15.2	15.17	15.06	15.27	15.01	14.77	14.79	14.52	15.2
14.7	14.18	15.0	15.4	15.4	14.81	15.52	15.63	15.49	15.59	14.45	15.45
15.44	14.37	15.25	15.5	15.31	15.25	15.11	15.16	15.31	15.46	14.7	15.3
15.30	15.7	15.2	15.4	15.4	14.40	15.64	15.75	14.62	15.20	14.53	15.5
	15.81	15.4	15.5	14.95	14.32:	14.32:	15.55		15.25	14.43	15.15
15.26	15.02	14.85	15.0	14.90	14.38	15.24	14.48	15.27	15.50	14.35	15.6
14.95	15.51	15.25	14.95	14.96	14.75	14.96	15.54	15.41	14.61	14.35	15.45
15.59	15.74	15.1	14.45	15.33	14.9	15.05	15.63	15.1	15.82	14.48	15.6
15.27	14.17	15.4	14.85	15.36	15.16	14.64	15.87	15.00	15.42	14.48	14.9
14.53	14.86	15.3	14.8	15.1	14.77	14.93	15.40	15.51	14.59	14.28	14.55
15.30	15.21	15.3	14.95	15.35	15.22	15.1	15.61	14.92	15.51	14.29	15.0
15.35	14.40	15.3	15.5	15.02	14.67	14.99	15.56	15.13	15.40	14.64	15.55
		14.95	14.4								15.6
15.48	15.38	14.95	14.6	14.92	13.97	15.29	14.63	15.59	14.63	13.84	15.15
15.39	14.83	14.55	15.2	14.84	14.69	15.23	15.56	15.26	15.02	13.75	15.55
14.72	15.42	14.9	15.25	15.01	15.25	15.60	15.86	15.12	15.56	14.33	15.5
15.33	15.7	14.75	15.25	14.79	14.71	14.49	14.60	14.66	15.17	13.57	15.6
15.36	15.12	15.15	15.2	14.87	15.20	14.98	15.52	15.49	15.46	14.19	15.15
14.17	15.50	15.15	15.5	14.93	15.01	15.35	15.60	15.30	15.24	14.51	14.55
15.26	15.62	14.85	15.45	14.79	14.58	15.44	15.78	15.28	15.39	14.34	14.75
14.8	14.93		14.8	14.9	14.73	15.68	14.75	14.74	15.65	14.65	15.25
15.35	15.18	15.25	14.9	14.96	14.01	15.38	15.09	15.34	15.48	14.51	15.6
	15.46		14.85	15.2			15.60		15.51	14.06	
15.14	15.67	14.9	14.75	15.31	14.76	15.59	15.43	15.50	15.30	14.1	15.6
14.34	15.46		15.1?	14.91	14.76	14.65	15.27	15.25	15.07	14.18	
14.94	15.58		15.25	15.32	15.14	14.96	15.5	15.43	15.60	14.40	14.6
14.07	15.59		15.5	14.85	14.7	14.75	15.17	15.24	15.41	14.07	
15.26	15.70	15.3	15.3	15.01	14.75	14.92	15.74	14.47	15.07	14.42	15.6
14.2	15.62		15.4	15.44	15.06	14.83	15.57	15.09	15.44	14.68	
14.32	14.32	14.9	15.35	14.98	15.31	15.57	15.63	15.25	15.42	14.73	15.5
15.49	14.69	15.05	15.55	15.16	15.11	15.59	15.78	14.7	15.09	14.58	15.6
15.31	15.13	14.9	15.2	15.04	14.91	15.27	14.48	15.35	15.62	14.33	15.5
			15.2								
15.39	15.51	14.7	14.85	14.86	14.89	14.95	15.59	15.11	15.35	14.33	
15.33	15.59	14.9	15.2	14.88	14.30	15.11	15.67	15.11	14.69	14.33	15.7

Plate	Julian Day	No. 1	No. 2	No. 3	No. 6	No. 7	No. 8	No. 9	No. 10
20110	34540.613	14.33	15.49	15.37	15.25	14.20	14.67	15.44	15.53
20227	4572.602	15.09	14.96	14.81	14.6	15.05	15.49	15.32	14.94:
20240	4573.635	15.1	14.85	15.3	14.65	15.15	15.37	15.38	14.51
20255	4574.602	14.5	15.6	15.25	15.3	16.0	15.69	15.17:	15.17
20274	4575.603	14.43	15.58	14.7	15.25	15.48	14.76	15.46	15.26
21394	4929.623	15.33	15.80	15.38		15.61	14.82	14.74	15.55
22336	5273.612	15.44	14.82	14.69	14.9	14.69	15.6	15.11	14.72
22356	5274.609	15.51	14.61	15.42	14.85	15.29	15.53	15.48	14.46
22373	5275.610	15.16	15.86	14.91	14.5	15.15	15.69	14.85	15.22
22470	5307.600	15.10	15.62	15.38	15.0	15.13	14.91	14.81	14.98
22491	5308.599	15.5	15.65	15.24	14.7	15.07	14.8	15.26	14.56
22514	5309.600	15.54	15.7	14.92	14.95	15.39	15.57	15.55	15.36
22538	5310.600	15.49	15.52	15.38	15.0	15.31	15.6	14.99	15.54
23203	5658.601		15.56		15.0				
23215	5661.602	15.27	14.93	15.5	15.05	15.12		15.56	14.98
23293	5685.588	15.08	15.08	15.26	14.65	15.44	14.92	15.44	15.6
23313	5687.592	14.63	15.85	15.30	15.4	15.06	15.52	15.28	14.81
23327	5688.590	14.55	15.52	15.31	15.25	14.65	15.55	14.72	14.76
24782	6752.607	14.87	15.48	15.01	14.8	14.46	15.68	15.31	14.85
24803	6753.602	14.55	15.63	15.16	14.7	14.59	15.52	14.78	14.02
25182	7113.610	14.62	15.57	15.4	14.95	14.92	15.52	14.61	15.52
25209	7115.636	14.23	15.43	14.83	15.1	15.15	14.91	14.75	15.29
25231	7116.640	15.10	15.30	15.34		15.23	14.78	15.15	15.02
26824	8198.614	15.37	14.96	15.3	15.2	15.44	15.43	15.33	15.11
26845	8199.629	15.29	15.35	15.02			15.5	14.70	14.53
27544	8584.628	15.28	15.38	15.35	15.1	15.25	15.42	15.43	15.37
27551	8586.605	14.92	15.53	15.15	15.05	15.47	14.82	15.44	15.1
29082	9262.772								
29083	.779	14.42	14.72	15.28		14.82	14.75	14.85	15.48
29084	.785	14.38	14.91	15.41	15.25	15.15	14.49	14.95	15.61
29087	9265.585				14.75				
29092	.620								
29097	.680	15.15	15.7	15.2		13.95?	15.27	15.05	14.88
29098	.684								
29099	.772	15.27	15.60	15.31		14.44?	15.41	15.22	14.92
29103	.816	15.4	15.47	15.31	15.05	15.31	15.61	15.28	14.95
29104	.819	15.65	15.63	15.43	14.9	15.24	15.38	15.31	15.11
29106	.847	15.53	15.34	15.50	14.95	15.47	15.65	15.39	15.30
29138	9270.772	15.10	15.35	15.30	15.05	15.2	15.49	15.27	15.44
29139	.776	15.22	15.35	15.31		15.35	15.42	15.28	15.58
29141	.798	15.03	15.62	14.93	15.25	15.36	15.43	15.27	15.45
29142	.803	15.28	15.6	14.96		15.26	15.5	15.31	15.56
29148	9271.615	15.11	15.56	15.11	14.95	14.71	14.83	15.32	15.00
29149	.619	15.02	15.66	15.16	14.8	14.84	14.90	15.5	14.91
29151	.647	14.43	15.27	15.12	14.6	14.82	14.97	15.38	15.00
29152	.651	14.49	15.07	15.27	14.55	14.88	14.98	15.49	15.00
29155	.697	14.33	14.79	15.15	14.65	15.12	15.06	14.92	14.92
29156	.701	14.60	14.60	15.44	14.6	15.05	15.22	14.88	15.20
29158	.722	14.72	14.72	15.34	14.9	15.16	15.3	14.91	15.18
29159	.725	14.82	14.81	15.38	14.65	15.22	15.24	14.72	15.44
29164	.771	15.08	15.14	15.34	15.1	15.48	15.41	14.51	15.48
29165	.776				14.9				
29169	.817	15.10	15.23	15.27	14.95	15.48	15.5	14.69	15.36
29170	.820	15.07	15.32	15.35		15.37	15.45	14.76	15.45

No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 18	No. 19	No. 20	No. 21	No. 25	No. 27
14.51	15.5	15.25	15.25	14.95	14.84	15.30	15.80	14.53	15.57	14.47	15.8
15.63	14.69	14.95	14.85	15.18	14.20	15.11	15.52	15.5	15.33	14.37	15.6
15.55	15.2	14.95	14.75	15.06	15.03	15.03	14.37	14.93	15.17	14.48	14.6
14.82	15.7	14.95	14.7	15.28	14.49	15.55	15.00		15.78	14.78	14.85
15.4	15.79	14.9	14.85	15.08	15.11	14.8	15.15	15.16	15.46	14.51	15.15
14.12	15.69	14.65	14.5	14.68	14.49	14.83	15.59	15.09	15.52	14.39	
15.03	15.63	14.95	14.65	15.31	15.20	14.68	15.45	15.53	15.32	14.58	15.4
14.94	14.32	15.15	14.65	15.25	14.14	15.05	15.76	14.98	14.90	14.48	15.6
14.98	14.87	14.95	14.55	15.28	14.72	15.09	15.70	15.20	15.46	14.21	15.5
14.96	15.63	15.2	15.5	15.24	13.88	15.15	15.65	15.23	15.55	14.59	15.6
14.48	15.64		15.2	15.2	14.81	15.24	15.49	14.59	15.20	14.5	
15.65	15.9	15.15	15.6	15.2	14.16	15.39	15.00	15.50	14.95	14.5	15.6
15.21	14.23	15.15	15.4	15.14	15.12	15.49	14.51	15.19	15.41	14.37	14.95
			14.95							14.24	
15.22	15.33	15.2	15.3	15.58	15.22	15.09		14.89	15.66	14.51	15.25
15.29	15.77	14.8	15.5	15.01	14.92	15.39	14.97	15.34	15.43	14.26	15.3
14.07	14.3	14.85	15.65	15.02	14.75	14.81	15.0	15.59	15.55	14.06	15.4
15.19	14.82	14.9	15.6	15.21	14.49	15.07	15.38	15.27	15.4	14.06	
14.75	14.61	14.95	15.0	15.04	14.13	15.24	15.16	15.09	15.16	14.48	15.4
15.46	15.07	15.15	15.0	14.95	14.77	14.29	15.41	14.99	14.85	14.55	14.2
14.23	14.73	15.0	14.65	15.15	15.23	14.68	15.36	15.34	15.32	14.42	15.6
15.4	15.27	14.95	14.7	15.1	15.26	15.18	15.45	14.80	15.48	14.41	15.25
14.59	15.57	14.85	14.8	15.08	14.84	15.18	15.58	15.55	15.21	14.89:	
15.5	15.48	15.4	14.8	14.81	13.75	15.06	15.51	15.49	14.60	14.42	15.6
15.32	14.81		14.9	14.83	14.76	14.96	14.55	15.35	15.38	14.35	
15.36	14.82	14.8	15.35	15.17	14.26	15.23	15.21	14.97	15.02	14.36	14.95
14.98	15.43		15.2	15.15	14.41	15.45	15.33	15.5	15.34	14.45	
15.35	14.48			14.8	14.58	15.15:	14.88	15.05	15.1	14.42	
15.55	14.45	15.25	15.5	14.9	14.65	15.29	14.89	15.27	15.17	14.31	14.8
			14.7								
			15.0								
14.8	15.12		15.35	15.35	14.88	15.38	15.34	15.13	14.65	14.54	
15.41	15.43:		15.6	14.84	15.22	15.03:	15.45	15.32	15.01	14.05	
15.42	15.60	15.15	15.65	14.93	15.22	14.77	15.67	15.37	15.17	14.25	15.5
15.63	15.72	15.25	15.5	14.93	15.35	14.65	15.47	15.6	15.15	14.18	15.25?
15.7	15.73	15.3	15.6	15.07	15.13	14.97	15.78	15.17	15.29	14.30	15.6
14.36	14.87	14.8	15.55	15.09	14.82	15.34	14.93	14.48	15.28	14.25	14.8
14.54	14.98		15.5	15.0	15.05	15.17	14.89	14.46	15.22	14.22	
14.82	15.14	14.9	15.3	14.92	14.88	15.22	15.05	14.76	15.31	13.97	14.85
14.73	15.05	14.9	15.25	14.88	15.18	15.14	14.98	14.55	15.31	13.92	14.8
15.33	14.95	15.2	15.65	14.97	15.11	15.22	14.91	15.25	15.22	14.63	15.5
15.32	14.72	15.15	15.45	15.15	15.34	15.36	14.83	15.39	15.51	14.67	15.5
15.36	14.40	14.7	15.65	15.06	15.09	15.12	14.39	15.26	14.98	14.57	15.35
15.39	14.36	14.5	15.55	15.25	15.31	15.23	14.47	15.31	14.88	14.62	15.4
15.25	14.97	14.55	15.4	15.19	14.03	14.97	14.63	15.55	14.31	14.41	14.65
15.59	14.76	14.5	15.55	15.4	14.33	15.19	14.72	15.35	14.45	14.52	14.55
15.37	14.9	14.85	15.5	15.25	13.90	15.28	14.93	15.22	14.59	14.47	14.7
15.50	14.89	14.8	15.55	15.27	13.98	15.42	14.81	15.58	14.50	14.66	14.6
15.58	15.3	14.95	15.35	15.14	13.93	14.92	15.2	15.4	14.83	14.39	15.2
		14.85	15.25								
15.45	15.33	14.85	14.4	14.99	14.40	14.96	15.36	15.41	14.99	14.01	15.3
15.45	15.32		14.35	14.95	14.37	14.81	15.25	15.32	14.98	14.02	

Julian Day	No. 28	No. 29	No. 30	No. 31	No. 32	No. 33	No. 34	No. 35	No. 36
28308.736						15.3?	15.25		
8309.651						15.4			14.9
.661	15.33	15.6	15.6	15.1	15.6	15.5	15.20	15.13	14.85
.670	15.25	15.5	15.43	14.99	15.49	15.3	15.05	15.10	14.95
.677	15.35		15.42	15.09	15.43		14.85?	15.10	14.9
.796	15.27	15.4	14.89	15.09	15.36	15.0	14.80	14.70	14.95
8365.608	15.1	15.53	15.34	14.96	15.57	14.9	15.20	14.75	15.05
8366.608	14.62	15.65	14.83	15.18	14.34	15.0	15.1	14.98	15.25
8399.596	15.56	15.52	15.44	15.00	14.7	14.4	14.8	15.17	14.9
8688.640							14.9:		
8689.642									
8692.632	15.29	15.3	15.35	14.87	14.97	15.1	14.65	15.10	14.7
8693.730	15.30	15.42	15.37	15.29	15.48	15.3	14.95	14.77	14.7
8696.631	15.47	15.6	15.35	15.15	15.40	15.2	14.55	15.18	15.15
8715.638									
9071.660	15.02	15.47	15.33	14.92	14.8	15.05		15.08	14.7
9072.698	15.02	15.42	15.35	15.32	15.38	15.1	14.9	14.99	14.9
9073.605	15.50	15.75	15.21	15.19	15.25	14.9	15.5	14.89	14.75?
9076.603							15.4		
9077.600						14.4			
9078.600						14.4	15.1		14.55:
9079.602	15.27	14.64	14.69	15.10	15.32		14.7	14.95:	15.30
9786.609	15.39	15.19	15.06	15.42	15.46	15.75	15.35	15.12	14.9
9787.608	15.39	15.55	15.53	15.17	14.61	15.55	15.1	15.20	15.25
9813.610	15.26	14.96	15.46	15.19	15.57	15.25		14.66	15.1
9814.612	14.87	15.20	15.25	15.49	14.65	15.5	15.35	14.94	15.25
9815.613	15.11	15.34	15.13		15.23	15.4	15.1	15.23	14.65
9816.611	15.42	15.52	15.38	15.19	15.44	15.15	15.2	15.15	14.95
30171.617	15.36	14.78	14.97	15.24	15.30	15.4	14.95	15.22	14.7
0172.615	15.23	15.26	15.53	15.43	14.75	15.6		15.13	14.9
0519.606	14.88	15.33	15.31		14.30	15.55	15.5	15.13	15.3
0520.606			15.33	15.26	15.15	15.6	15.35	14.85	15.25
0550.608	14.95	15.28	14.90	14.91	15.35	15.5		14.64	14.85
0553.604	15.25	14.87	14.98	14.90	15.12	15.25	15.5	14.71	15.35
0554.614	15.36	15.66	15.56	15.56	15.45	15.2	15.5	14.50	14.7?
0555.629	15.59	15.70	15.52	14.96	15.57	15.35		14.96	
0556.620	15.00	15.43	15.24	15.03	14.92	15.25	15.45	15.03	15.55
0586.572	15.19	15.04	15.39	14.81	15.26	14.55	15.25	14.75	15.3
0880.592						15.05	14.65		15.2:
.623	15.37	15.70	15.37	14.85	15.50	15.3	14.8	14.66	15.05
.659	14.61	15.49	15.33	15.1	15.41	15.05	14.8	14.60	15.15?
.690	14.51	15.70	15.50	15.3	15.58	15.4	14.9	14.70	15.05
.730	14.79	15.50	15.50	15.39	15.31	15.3	15.1	14.81	15.0
.760	14.97	15.37	15.46	15.44	14.22	15.5	14.95	15.05	15.0:
0880.788									
0883.593						15.05			
.630	15.28	15.22	15.42	14.95	15.10	15.05	15.2	15.11	15.1
.664	15.50	15.45	15.42	15.14	15.39	15.40	15.2	15.00	14.9
0884.622						15.30			
.680	15.32	15.61	15.25	15.42	15.60	15.55	14.95	14.70	15.0

No. 38	No. 39	No. 40	No. 41	No. 42	No. 43	No. 44	No. 45	No. 47	No. 52	No. 55
14.75							15.1			
14.85				12.4			14.6			
14.85	15.00	15.17	15.13	12.4	15.08	14.92	14.65	14.96	14.46	15.34
14.85	15.02	15.21	15.22	12.4	15.15	14.91	14.7	14.99	14.37	15.23
14.9	15.15	15.27	15.26	12.3	15.20	14.71	14.7	14.70	14.29	15.20
15.05	15.26	15.11	15.60	12.4	15.08	14.82	14.95	14.28	14.69	15.02
14.6	14.90	15.37	15.54	10.7	15.10	15.09	15.2	15.15	15.12	15.36
14.9	15.61	15.07	15.60	10.7	15.39	15.15	15.25	15.0	15.12	15.35
15.05	15.65	15.21	15.35	11.8	15.31	15.25	14.4	15.40	15.02	15.15
				11.9						
				12.1						
14.9	15.17	15.09	14.87	12.6	15.25	15.15	14.7	15.11	15.04	15.00
15.15	15.02	15.35	15.45	12.4	15.21	14.88	14.55	15.20	15.05	15.05
15.25	14.8	15.13	15.35	12.1	15.35	14.97	15.2	15.33	15.08	14.95
				12.4						
14.4	15.42	15.33	15.49	11.9	15.33	15.10	15.15	15.17	14.85	15.01
14.9	15.42	15.07	14.51	12.1	15.17	15.00	15.25	15.40	15.15	15.30
14.6	14.88	15.20	15.44	12.2	15.43	15.07	14.65	14.94	14.81	14.92
					15.20	15.02				
							14.7			
15.05	14.95	15.27	14.9	12.6			15.5	15.14	14.83	15.06
15.15	15.39	15.31	15.25	11.6	15.20	15.11	15.15	14.91	14.97	14.95
15.4	15.18	15.37	15.35	11.7	15.54	15.10	15.3	14.64	15.04	14.94
15.4	15.34	15.28	15.53	11.9	14.98	15.11	14.9	15.00	15.18	15.02
15.15	14.82	15.04	15.63	11.7	15.49	15.17	15.25	14.76	15.28	15.09
15.15	15.43	15.01	15.60	11.8	15.15	15.13	14.95	14.41	15.40	15.10
15.15	15.32	15.02	15.48	11.7	15.46	15.12	14.75	15.37	15.28	15.06
14.6	15.04	14.95	15.28	11.5	15.42	14.93	15.1	15.50	15.15	15.31
14.9	15.35	14.93	15.35	11.7	15.40	14.85	14.9	15.20	15.16	15.30
15.35	14.25	15.28	15.55	12.6						
14.15	15.52	15.24	15.57	12.7	15.53	15.24	14.75	15.21	14.37	15.10
14.8	15.38	15.06	14.37	11.7	15.24	15.57	14.95	14.99	14.41	15.25
14.5	15.37	15.34	15.03		15.38	15.06	14.65	15.20	14.33	14.88
14.9	15.47	14.78	15.02	11.7	15.18	14.90	14.7	14.90	14.35	14.78
15.4	14.76	14.88	15.27		15.60	14.40	15.25	14.80?	13.50	14.95
15.4	15.65	14.95	15.28	11.3	14.79	14.54	15.2	14.15	13.75	14.98
14.85	15.42	15.30	15.54	11.9	15.49	14.62	14.65	14.64	14.20	14.99
14.6					15.46	14.97	15.25	15.34	15.16	15.05
15.0	15.55	14.97	15.59	12.6			15.0			
15.1	14.85	15.10	15.47	12.4	15.29	14.76	14.95	14.90	14.78	15.05
15.05	14.31	15.25	15.54	12.4	15.17	14.61	14.95	14.69	13.95	15.16
15.15	14.50	15.31	15.50	12.4	15.32	14.70	15.15	14.95	13.98	15.36
15.3	14.77	15.32	15.58	12.4	15.25	15.39	14.9	14.93	14.26	15.34
				12.4	15.40	15.05	14.95	15.21	14.55	15.30
				12.4			14.8			
15.35	14.21	15.25	15.55	12.6	15.49	14.66	14.95	15.17	14.90	15.24
15.15	14.39	15.15	15.62	12.5	15.50	14.80	14.95	15.37	14.50	15.35
				12.2			14.9			
15.15	15.60	14.85	15.58	12.2	15.38	14.85	14.15	15.23	14.17	15.35

Julian Day	No. 28	No. 29	No. 30	No. 31	No. 32	No. 33	No. 34	No. 35	No. 36
30884.721	15.53	15.65	15.43	15.38	15.61	15.40	14.8	14.94	14.9
.771	15.44	15.52	15.38	14.90	15.41	15.30	15.1	15.06	14.9
0899.602	15.45	15.45	15.39	15.19	14.78	15.20		15.12	14.85
.647	15.50	15.67	15.48	15.31	15.14	15.15	15.35	15.14	14.7
.701	14.65	15.42	15.58	15.5	15.46	15.40	15.35	14.84	14.8
0900.604	15.37		14.91	15.41	15.20	15.20	15.2	14.90	15.2:
.638	15.4	15.21	15.31	15.41	15.41		14.95	14.77	
0901.632					15.60				
.676	15.32	15.43	15.08	15.15	15.60	15.30	14.7	14.87	14.9
0932.604	15.17	15.64	15.12	14.75	15.04	14.85	15.3	14.78	15.05
0933.589		14.90				14.85	15.4	14.80	15.25
1257.634	14.40	15.60	14.75	15.31	15.06	15.2	15.25	14.55	14.95
1259.604	15.25	15.14	15.25	14.77	15.5	14.7	14.8	15.15	15.3
1969.736	14.98	15.28	15.49	15.34		15.15	14.4	14.90	15.3
1970.698									
1976.641	15.47	15.48	15.11	15.34	15.55	14.45	14.8	14.65	15.35
1977.690	15.67	15.19	14.55	14.85	14.82	14.55	14.6	14.90	15.3
2000.641	14.56	15.56	15.46	15.16	15.23	15.25	15.5	14.99	14.85
2004.652	15.83	15.70	15.48	15.43	14.36	15.25	15.4	14.70	15.3
2006.599	14.66	14.99	15.41	14.87	15.17			14.01	15.3
2326.715	15.38	14.79	15.48	14.85	15.60	14.9	15.25	14.95	15.2
2328.739	14.98	15.54	15.6	15.06	14.18	15.15	14.85	14.90	15.35
2354.604	15.8	15.52	15.57	15.17	15.60	15.4	15.6	14.90	14.65
2355.607	15.46	14.67	15.34	15.17	15.70	15.4	15.15	15.22	15.6
2356.605	15.16	15.52	15.28	15.18	15.27	15.3	14.55	14.92	14.95
2357.604	15.2	15.26	15.37	14.88	14.37	15.45	15.3	14.69	15.3
2361.704	15.4	15.61	15.46	15.37	14.19	15.25	14.6	14.90	15.15
2733.605						15.5	15.6		15.6
2734.604	15.16	15.80	14.96	14.82	15.53	15.4	15.6	14.53	15.15
2740.608	15.13	14.89	15.03	14.84	15.45	15.35	15.4	14.83	15.2
2741.607	15.16	15.20	14.86	15.44	15.84	15.4	15.5	14.75	15.35
2742.648	14.75	15.73	15.60	14.86	14.68	15.4	15.5	14.66	15.2
2770.576	15.39	15.43	14.96	15.21	14.80	14.95	15.4	14.63	15.3
3068.668	15.35	15.55	15.30	15.27	15.26	15.4	15.1	14.73	15.5
3069.654	15.12	15.22	14.64	15.25	15.53	15.4		14.87	14.85
3095.604	14.68	16.02	15.74		15.10	15.3	15.45	15.35	15.4
3096.609	15.45	15.51	15.32	15.31	15.25	15.2	15.35	14.70	14.7
3476.602		15.36	15.13	15.44	15.36		15.45	14.54	
3477.601	15.34	15.68	15.48	15.01	15.80		15.35	14.69	14.95
3481.597		15.57	15.28	14.98	15.12	14.85	15.2	14.43	
3505.572	15.43	15.6	14.96	14.81	15.36	14.85	15.25	14.85	15.25
3823.649	15.09	15.16	15.09	14.98	15.57	15.15	15.25	14.16	
3858.636	15.40	15.76	15.36	15.46	15.03	14.45	15.35	15.12	14.95
3860.589	15.15	14.75	15.45	14.89	14.96	15.55	15.35	14.72	
4180.634	15.55	14.68	14.98	14.95	15.29	14.6	15.35	15.05	14.85
4181.607	15.59	14.95	15.67	15.01	15.64	14.45	15.25	15.31	15.25
4182.607	15.27	15.41	15.27	15.30	15.55	14.35	15.1	15.00	14.95
4538.633	14.49	14.76	15.47	15.02	15.29	14.5	15.55	14.59	
4539.634	15.49	15.28	15.29	15.04	15.67	14.45	15.45	14.57	15.3

No. 38	No. 39	No. 40	No. 41	No. 42	No. 43	No. 44	No. 45	No. 47	No. 52	No. 55
14.2	15.57	15.07	15.60	12.2	15.43	15.18	14.65	15.45	14.34	15.34
14.2	15.19	15.11	14.76		15.41	15.20	14.7	15.05	14.63	15.02
15.25	14.70	14.99	15.38	12.2	14.97	15.05	14.8	15.00	15.17	14.85
15.15	14.85	14.95	15.41	12.1	14.92	15.15	14.95	15.19	15.19	14.98
15.25	15.11	15.22	15.66	12.1	15.04	14.87	15.25	15.29	15.25	15.24
15.45	15.31	15.05	15.52	12.2	15.33	14.99	15.3?	15.14	15.19	14.84
	15.55:	15.25	15.44		15.46	15.21	14.95	15.14	15.25	15.06
14.2	15.52	15.27	15.52		15.15	15.19	15.35	15.07	15.45	15.36
15.25	14.78	14.77	15.80	12.9:	14.81	14.94	15.25	15.10	14.94	15.34
15.25				12.8:		14.95	15.2	14.82	15.07	
15.4	15.00	15.13	14.78	11.7	15.25	14.92	15.25	15.10	15.02	15.28
15.3	15.29	15.29	14.91	12.0	15.42	15.10	14.65	15.10	15.02	15.20
15.05	15.59	15.08	15.56	11.3	15.47	14.44	15.1	14.12	14.47	15.23
				11.4						
14.2	15.48	14.86	15.51	11.9	15.28	14.79	15.3	14.77	13.84	15.24
14.65	15.33	15.30	15.44	12.0	15.24	14.92	15.3	15.35	14.34	14.93
14.25	15.75	15.27	15.51	11.6	15.42	14.84	15.25	15.20	14.73	15.30
15.25	14.66	15.27	14.65	12.0	15.61	14.75	14.9	15.33	14.34	14.99
	15.18	15.27	14.82	12.3	15.33	14.72	15.25	15.29	15.21	15.18
14.6	15.69	14.97	15.15	11.1	15.46	14.67	15.25	14.92	13.93	14.81
15.4	15.21	15.32	15.54	10.5?	15.37	14.82	15.45	14.63	14.25	15.05
15.3	15.02	14.98	15.36	11.0	15.60	14.77	15.5	14.77	15.32	15.12
15.4	15.05	15.07	15.48	11.0	15.15	14.68	15.05	14.25	15.12	15.03
15.15	15.46	15.17	15.55	11.5	15.69	14.80	14.55	15.00	14.92	14.78
15.2	15.18	16.2	15.68	11.7	15.11	14.68	15.25	15.17	14.92	14.95
15.3	15.33	15.25	15.40	11.7	15.35	15.05	14.95	15.20	15.01	15.32
14.4							14.95			
14.9	15.18	15.43	15.03	12.3	15.31	14.92	14.6	14.80	14.25	14.96
14.3	15.16	15.39	15.73		15.48	14.57	15.3	14.89	14.13	15.08
14.3	15.21	15.33	15.63	11.5	14.86	14.66	14.95	14.89	14.10	15.4
14.85	14.15	14.80	15.77	11.7	15.56	14.53	14.55	14.37	14.06	15.21
15.25	15.35	14.92	15.63	11.7	15.57	14.65	14.9	14.8	14.34	15.32
15.05	15.40	15.22	15.39	12.5:	15.27	14.83	15.0	14.51	14.31	14.98
15.2	14.70	15.30	15.02	12.6	15.60	14.63	15.2	14.01	13.95	14.87
	15.21	14.83	14.23	12.5	15.10	14.65		14.53	14.09	15.13
15.2	15.07	15.31	14.82	12.4	15.52	14.70	14.55	14.34	14.35	14.91
	14.31	14.82	15.53			14.50		13.98		15.06
15.25	15.59	14.82	15.42	11.6	15.56	14.61	14.65	15.23	15.09	15.14
	15.21	15.12	14.75	12.0	15.50	14.80	15.1	14.63	14.59	15.10
14.35	15.08	15.13	14.91		14.96	14.90	14.85	15.33	14.79	15.11
14.9	14.78	15.27	15.06		15.31	14.25	14.7:	13.60	14.00	15.11
15.25	15.66	14.94	15.66	12.2	15.48	14.52	15.6	15.0	14.32	15.23
15.45	15.26	14.95	15.59	12.1	15.55	14.65		14.90	14.23	15.20
14.1	15.12	15.40	15.62	10.7	15.34	14.78	14.55	15.29	14.66	15.11
14.35	15.50	15.75	15.41	10.7	14.75	14.65	15.2	14.87	14.50	15.41
14.8	15.41	15.33	15.56	11.3	15.49	14.64	14.9	14.57	14.38	15.02
14.4	14.26	15.29	15.6	11.6	15.49	14.55	15.25	14.77	14.93	15.07
14.6	15.48	15.65	15.65	10.8	15.16	14.51	14.95	14.84	14.86	15.1

Julian Day	No. 28	No. 29	No. 30	No. 31	No. 32	No. 33	No. 34	No. 35	No. 36
34540.613	15.39	15.58	14.95	15.48	15.63	15.2	15.25	14.86	15.35
4572.602	15.25	15.38	14.75	14.77	15.50	15.3	15.25	14.68	15.05
4573.635	15.07	15.41	15.35	15.08	15.40	15.5	15.25	15.16	14.7
4574.602	15.12	15.84	15.74	16.01		15.5	14.65	15.52	15.25
4575.603	14.78	14.93	14.91	14.92	14.57	15.6	15.45	14.64	15.15
4929.623	15.28	15.39	15.52	15.35	15.41	15.6	15.45	14.95	
5273.612	15.11	15.22	15.55	14.87	15.53	15.5	14.75	14.81	14.95
5274.609	14.60	15.43	15.33	15.33	14.36	15.55	14.95	14.61	15.25
5275.610	15.48	15.93	15.15	15.41	14.97	15.5	15.5	14.65	14.95
5307.600	15.40	15.56	15.13	14.95	14.57	15.4	14.8	14.69	14.95
5308.599	15.21	15.70	15.53	15.35	15.09		15.6	14.95	
5309.600	15.37	15.18	15.60	15.26	15.49	15.4	15.25	15.27	15.15
5310.600	15.03	15.01	15.19	14.90	15.53	15.25	14.95	14.69	14.9
5658.601						15.15	15.35		15.15
5661.602			14.65	15.16	15.42	15.1	14.8	15.04	15.0
5685.588	15.34	15.48	15.55	15.43	15.54	14.85	15.2	15.12	15.2
5687.592	15.02	15.48	15.66	15.17	14.68	14.85	14.95	14.53	15.3
5688.590	14.62	15.55	15.46	15.49	15.27	14.9	15.3:	14.76	
6752.607	15.26	15.74	15.49	15.47	15.65	15.7	15.4	15.07	15.15
6753.602	14.80	15.87	15.01	15.34	15.30	15.6	14.95	15.27	15.2
7113.610	14.73	15.05	15.07	15.38	14.98	15.4	15.15	14.65	14.9
7115.636	15.36	15.70	15.28	14.95	15.47	15.6	15.25	15.04	15.15
7116.640	15.36	15.55	14.95	15.38	15.43	15.6	15.15	14.72	14.95?
8198.614	15.39	15.57	15.15	14.90	15.19	15.3	15.4	14.87	15.5
8199.629	15.12	15.56	15.15	15.39	15.45	15.4	15.4	14.92	
8584.628	15.24	15.45	14.84	15.25	15.50		14.9	14.94	15.5
8586.605	14.59	15.08	15.34	14.92	15.44	14.55	15.7	15.41	
9262.779	15.15:	14.60	15.20	15.28	15.41			14.65	
.785	15.29	14.62	15.21	15.4	15.48	15.4	15.25	14.69	14.9
9265.585						14.55	15.5		
.680	15.48	15.48	15.16	14.96	15.13	14.9:		14.83	
.684									
.772	15.35:	15.61:	15.14	15.28	15.32			14.97:	
.816	15.40	15.61	15.38	15.40	15.55	15.6	14.5	14.70	14.85
.819	15.37	15.63	15.37	15.35	15.51	15.3	14.5	14.64	14.85
.847	15.55	15.63	15.51	15.48	15.67	15.65	14.65	14.64	14.7
9270.772	15.27	15.67	15.54	14.87	15.22	15.4	15.5	14.62	15.3
.776	15.35	15.62	15.49	14.87	15.28	15.3	15.4	14.73	
.798	15.07	15.81	15.49	14.93	15.31	15.5		14.41	15.2
.803	15.31	15.79	15.58	14.94	15.29	15.25	15.5	14.61	14.9
9271.615	15.11	15.58	15.03	14.83	14.76	14.55	14.95	15.03	14.95
.619	15.45	15.74	15.06	14.80	14.90	14.4	14.95	15.17	15.0
.647	15.10	15.61	15.10	14.73	14.93	14.6	15.05	14.80	15.15
.651	15.31	15.69	15.09	14.83	15.10	14.65	14.95	14.81	15.15
.697	14.95	15.85	15.37	14.78	15.18	15.05	15.4	14.30	15.4
.701	15.40	15.71	15.17	14.86	15.31	14.9	15.05	14.57	15.0
.722	15.32	15.36	15.36	15.01	15.32	15.25	15.3	14.52	15.05
.725	15.43	15.42	15.27	14.93	15.43	14.95	15.3	14.62	15.15
.771	15.36	15.03	15.40	15.27	15.53	15.5	15.25	14.67	15.3
.776						15.25	15.15		
.817	15.38	14.73	15.45	15.38	15.58	15.4	15.25	15.00	15.3
.820	15.32	14.77	13.37	15.30	15.47			14.93	

No. 38	No. 39	No. 40	No. 41	No. 42	No. 43	No. 44	No. 45	No. 47	No. 52	No. 55
14.9	15.33	14.90	15.64		15.44	14.56	15.4	14.73	14.79	15.13
14.8	15.38	15.42	14.86	11.7	15.30	14.90	15.3	15.20	15.20	15.23
15.15	15.30	14.84	15.12	11.6	15.42	15.02		15.16	15.21	15.14
15.15	14.76	14.95	15.00	11.7	15.24	14.95	14.7	15.05	15.09	
15.25	15.84	15.01	15.15		15.51	14.84		14.75	15.05	15.30
14.6	15.77	14.89	15.63	11.3	14.88	14.90	15.25	15.25	14.42	14.78
15.15	15.57	15.03	14.45		14.96	14.83	14.95	15.35	14.62	14.95
15.4	15.35	14.96	14.31	12.2	15.40	14.62	14.65	14.83	14.48	14.91
15.05	14.98	14.64	14.25	12.5	14.67	14.35	15.15	15.10	13.92	14.95
15.25	15.37	14.95	15.55	12.5	15.49	14.77	15.1	15.17	14.31	15.15
	14.98	14.92	15.65	12.2	15.00	14.82		14.84	14.13	15.19
15.25	15.70	15.17	15.63	12.4	15.51	15.00	14.95	14.95	14.24	15.28
14.15	15.51	15.23	15.69	11.9	14.85	14.88	15.0	14.26	14.25	15.16
15.2				12.2		14.98	15.25			
14.6	15.15	15.50		12.9	15.32	14.81	15.4	14.90	15.26	15.31
14.6	14.96	14.83	14.97	12.1	14.82	14.67	15.25	14.98	14.84	15.39
15.1	15.62	15.13	15.16		14.74	14.60	15.25	14.95	14.58	15.37
	15.15	15.27	15.37		15.39	14.62		14.73	14.81	15.30
14.85	15.59	15.20	14.77	11.4	14.87	14.67	14.6	15.60	14.73	15.13
15.15	15.56	15.06	14.77		15.57	14.78	15.15	15.39	14.18	15.39
15.25	15.48	14.93	14.33	11.0	15.25	15.07	15.0	15.59	15.13	15.32
15.05	14.45	15.39	15.06	10.9	14.98	15.10	15.25	15.15	15.15	15.26
	15.53	15.05	15.18	11.2	15.51	15.10		15.05	15.04	15.25
14.6	15.41	15.19	15.65	10.8:	15.22	14.93	14.6	15.30	14.29	15.02
	15.03	15.25	15.62		15.38	14.94		15.55	14.14	15.10
15.3	15.56	15.05	15.45	11.5	15.10	15.23	14.7	14.78	15.16	15.10
15.25	15.1	14.95	14.92	11.6	15.21	15.23		15.51	15.35	14.94
	14.87	14.87	15.35	12.1	14.76	14.70		15.00	14.55	15.10:
15.15	14.82	14.92	14.96	12.4	14.93	14.65	15.25	15.16	14.65	15.1
14.8:										
15.4:	14.81	14.70	15.55	12.2	15.22	14.58		14.09	14.82	15.37
				12.4						
	14.93	15.15?	14.6:	12.2	15.48	14.77		14.62?	14.73	14.96:
15.25	15.22	15.25	14.79	12.8	15.42	14.71	15.5	14.56	14.28	14.94
15.25	15.27	15.33	14.90	12.5	15.46	14.89	15.1	14.83	14.37	14.79
15.3	15.41	15.41	14.95	12.8	15.61	15.00	15.2	14.92	14.09	14.90
14.9	15.54	14.85	15.20	12.6	15.17	14.83	15.4	14.89	14.74	14.89
14.9	15.50	14.92	15.35	12.6	15.21	14.92		15.10	14.95	14.90
14.9	15.58	14.83	15.31		15.24	14.84	15.3	14.79	14.40	14.91
14.9	15.60	14.88	15.41	12.5	15.22	14.96	14.9	14.90	14.73	14.87
14.2	14.77	15.17	14.51	12.6	15.42	14.76	14.5	14.45	14.96	15.20
14.15	14.63	15.15	14.27	12.6	15.48	14.80	14.7	14.48	15.08	15.40
14.5	14.95	14.93	14.73	12.5	15.49	14.66	14.85	14.15	14.87	15.10
14.45	14.91	15.0	14.65	12.6	15.55	14.70	14.75	14.37	15.14	15.09
14.9	15.36	14.75	14.85		15.48	14.67	14.95	14.21	14.71	14.92
14.75	15.05	14.81	14.90	12.8	15.60	14.63	14.75	14.49	15.12	14.83
14.9	15.22	14.93	15.10	12.8	15.37	14.46	14.85	14.41	14.97	14.90
14.95	15.15	14.85	15.10	12.8	15.55	14.78	14.95	14.74	15.28	14.81
15.15	15.35	15.05	15.42	12.6	15.55	14.90	15.15	14.78	14.91	14.91
15.05				12.5			14.85			
15.25	15.44	15.15	15.30	12.5	15.47	15.02	15.25	14.90	14.58	15.13
	15.42	15.22	15.50	12.4	15.53	14.97		15.12	14.55	15.02

Julian Day	No. 58	No. 59	No. 61	No. 62	No. 63	No. 64	No. 65	No. 66	No. 67
28308.736					15.25	15.05			
8309.651									
.661	14.65	14.93	15.51	15.60	15.35	15.1	15.15	15.40	
.670	14.76	15.02	15.42	15.36	15.45	14.85	15.15	15.36	
.677	14.86	15.01	15.38	15.36	15.5	14.85	15.10		
.796	15.41	15.32	15.51	14.97	15.45	15.05	14.86	15.17	
8365.608	15.46	15.27	14.62	15.51	14.95	15.6	14.41	15.05	
8366.608	15.16	15.13	15.47:	14.98	14.8	15.5	14.57	15.10	
8399.596	15.02	14.94	15.46	15.30	14.95	14.9	15.25	14.90	
8688.640					14.65	14.7			
8692.632	15.55	15.30	14.96	15.30	14.65	15.05	15.05	15.45	15.25
8693.730	15.44	15.37	14.91	15.35	14.95	15.05	15.2	15.48	
8696.631	15.60	14.90	15.03	15.32	14.65	15.6	15.22	15.20	15.05
9071.660	15.09	14.62	15.42	15.29	15.45	15.15	14.68	15.29	
9072.698	15.23	14.60	15.40	15.17	15.2	15.25	14.65	15.11	15.7
9073.605	15.18	15.42	15.00	15.36	15.25	15.0	14.53	15.5	15.15
9076.603					15.25				
9078.600					15.1	15.0			14.85
9079.602	15.30	15.20	15.34	15.20	15.35	14.85	14.92	15.35	14.9
9786.609	15.65	14.78	14.69	14.98	15.25	15.7	14.92	15.42	14.5
9787.608	15.60	14.64	15.60	15.51	15.25	15.35	14.95	15.50	14.6
9813.610	15.56	15.01	15.48	14.97	15.25	15.65	15.16	15.36	
9814.612	15.53	15.33	15.23	15.43	15.35	15.75	15.31	15.62	15.15
9815.613	15.51	15.37	14.68	14.90	15.25	15.7	15.30	15.47	
9816.611	15.32	15.40	15.42	15.41	15.35	15.5	15.18	15.25	
30171.617	15.15	15.30	15.0	15.00	15.25	15.5	15.01	15.5	14.95
0172.615	15.14	15.11	15.55	15.44	15.25	15.4	15.08	15.4	15.05
0519.606	15.64	15.24	15.02	15.18	14.5	15.55	15.04	15.44	14.75
0520.606	15.50	15.24	15.71	15.04	14.5	15.7	15.11	15.52	15.15
0550.608	15.28	15.20	15.37	15.08	15.25	14.55	14.95	14.94	15.05
0553.604	15.51	14.81	15.44	15.13	15.35	14.65	14.00	15.75	
0554.614		14.47	15.77	14.83	15.45	15.75	13.96	15.57	
0555.629	15.21	15.20	15.40	15.55	15.35	15.7	14.75	15.23	
0556.620		15.33	15.06	15.03	15.35	15.65	14.68	15.01	
0586.572	15.58	14.38	15.56	15.31	15.35	15.65	15.07	15.33	15.05
0880.592					15.25	15.55			14.9
.623	15.70	15.38	14.59	15.40	15.25	15.55	14.98	14.90	14.9
.659	15.45	15.30	14.70	15.38	15.35	15.55	14.96	15.02	14.95
.690	15.70	15.35	14.88	15.45	15.45	15.55	15.2	15.10	15.2
.730	15.57	15.34	14.89	15.07	15.35	15.55	15.10	15.28	15.15
.760	15.65?	15.37	15.08	14.99	15.35	15.7	15.22	15.44	15.6
.788									
30883.630	15.59	14.42	15.21	15.01	15.25	15.0	15.15	15.45	15.45
.664	15.69	14.75	15.35	15.23	15.35	15.1	15.31	15.53	15.6
0884.622						14.7			15.15
.651						14.6			15.4
.680	15.66	14.45	14.95	14.92	15.35	14.75	15.26	15.46	15.75
.721	15.65	14.64	15.23	15.05	15.45	15.05	15.27	15.50	15.35
.771	15.5	14.90	15.30	15.10	15.35	15.15	14.03	15.11	15.1

No. 68	No. 69	No. 70	No. 71	No. 72	No. 73	No. 74	No. 75	No. 76	No. 77	No. 78
	15.15									
	14.95									
	15.0	14.63	15.7		15.30	14.26	15.17	15.10	14.84	15.20
	15.05	14.78	15.51	15.48	15.31	14.30	15.07	14.99	14.84	15.22
		14.79			15.33	14.34	14.95	15.20	14.96	15.20
	15.55	15.45	15.45	14.51	15.17	14.35	15.05	14.66	14.82	14.95
	15.15	15.24	14.85	15.53	14.98	14.42	15.40	14.97	14.94	15.00
	15.35	15.12	14.53	15.01	15.01	14.35	15.10	15.24	15.01	15.26
		14.64			14.87	14.40	15.30	15.12	15.23	15.20
	14.7									
15.25	14.9	15.62	15.61	15.5	15.47	14.14	15.35	15.16	14.80	15.14
14.9	15.15	15.59	14.84	15.5	15.42	14.33	15.28	14.83	15.18	15.0
15.45	15.15	15.8	15.80	15.85	15.08	14.45	15.45	15.00	15.29	15.02
15.65	15.25	15.47	15.38	15.16	15.17	14.36	15.32	14.84	15.20	15.01
15.3	15.0	15.18	15.48	15.67	15.02	14.06	15.25	15.22	15.30	15.06
15.4	15.8		15.15	15.52	15.63	13.96	15.35	15.21	15.16	15.29
	14.7									
15.25	14.65	15.47	14.77	15.15	15.28	14.42	15.25	15.01	14.66	15.06
15.4	15.9	15.60	15.13	15.59	14.90	14.45	15.42	15.11	15.20	15.04
15.7	15.7	14.92	14.85	15.51	14.85	14.28	15.35	15.17	15.39	15.40
15.05	15.75	15.68	15.75	15.63	15.39	13.84	15.37	14.98	15.15	15.06
15.3	15.6	15.74	15.87	15.56	15.37	14.38	15.65	14.95	15.37	15.33
		15.15		14.63	15.03	14.35	15.10	15.23	14.92	15.28
		14.85	15.34	15.07	15.11	14.41	15.25	14.95	14.82	15.11
15.2	15.75	15.8	15.44	15.22	14.85	14.46	15.42	15.03	14.91	15.22
15.05	15.75	15.65	15.49	15.11	14.95	14.37	14.95	14.81	15.10	15.30
14.65	15.3	15.39	15.25	14.49	14.87	13.94	15.02	14.97	14.9	15.15
15.15	15.4	15.63	15.61	15.55	14.90	14.30	15.46	15.02	14.78	15.28
15.05	15.35	14.78	15.38	15.00	14.90	14.50	15.31	14.76	15.11	15.04
15.15	15.5		15.70	15.35	14.65	14.0	15.24	14.57	14.74	15.11
		15.29			14.77	14.03	15.33	15.27	15.15	14.77
		14.90			14.80	14.30	15.69	14.93	15.22	14.95
		15.60			14.78	14.78	15.24	14.74	15.33	15.26
15.05	15.25	15.47	14.84	15.08	14.75	14.22	14.96	14.97	14.75	15.26
	15.3?									
15.55	15.55	14.90	15.44	15.23	15.49	14.30	14.87	15.05	14.63	14.92
15.5	15.55	14.86	15.51	15.35	15.26	14.27	15.06	15.22	14.83	14.94
15.5	15.55	15.0	15.58	15.49	14.98	14.27	15.19	15.35	14.99	15.11
15.25	15.6	15.2	15.60	15.42	14.95	14.34	15.23	15.29	14.95	15.21
15.2	15.65	15.45	15.60	15.58	15.03	14.37	15.29	15.28	15.03	15.33
15.35	15.65	15.46	15.34	15.42	15.44	13.55	15.30	15.00	15.28	15.24
15.5	15.70	15.69	15.58	15.52	15.59	13.80	15.39	15.18	15.40	15.4
	15.5?									
	15.35									
15.6	15.7	14.50	15.65	15.55	15.49	14.20	15.30	15.12	15.02	15.26
15.4	15.4	15.61		15.66	15.45	14.38	15.22	15.08	15.00	15.40
15.05	15.5	15.36	15.43	15.39	15.05	14.28	15.06	14.92	14.77	15.17

Julian Day	No. 58	No. 59	No. 61	No. 62	No. 63	No. 64	No. 65	No. 66	No. 67
30899.602	14.78	15.37	15.33	14.92	15.35	15.65	15.05	15.22	15.25
.647	15.42	15.34	15.52	14.90	15.45	15.5	14.04	15.07	
.701	15.56	15.38	15.60	15.24	15.5	15.55	14.3	15.40	
0900.604	14.95	15.16	14.75	15.31	15.25	15.35	14.1	14.87	14.95
.638	15.46	15.35	15.12	15.42	15.5	15.55	14.35	15.18	
0901.676	15.69	15.21	14.77	15.36	15.55	15.3	14.93	14.99	
0932.604		15.15	15.42	15.12	15.55	14.9	14.75	15.10	
0933.589		14.85	14.90		15.5	15.5			
1257.634	15.36	14.39	14.46	14.95	14.4	14.35	15.07	15.55	14.7
1258.625					14.5	15.4			14.9
1259.604	15.56	15.25	15.53	14.99	14.6	15.5	15.25	15.33	15.3
1969.736	15.56	15.16	15.33	15.45	15.65	15.8	14.64	15.30	15.25
1976.641	15.56	15.32	15.45	14.94	15.5	15.5	15.21	15.08	15.4
1977.690	15.71	15.33	15.31	14.91	15.5	15.5	15.15	15.12	15.45
2000.641	15.41	15.40	15.46	15.30	14.85	15.65	15.18	15.25	15.05
2004.652	15.95:	15.00	15.54	15.43	14.5	14.9	15.10	15.65	15.2
2006.599	15.29	15.63	14.73	15.23		15.3	14.78	14.85	14.7?
2326.715	14.60	15.20	14.86	15.05	14.5	15.5	15.18	14.82	
2328.739	14.78	14.63	15.38	15.25	14.95	15.05	14.00	15.11	
2354.604	15.60	15.53	15.10	15.12	14.95	15.6	14.38	15.38	14.95
2355.607	15.09	15.32	14.97	15.47	15.15	15.4	13.78	14.98	14.9
2356.605	15.59	15.37	15.57	15.07	15.0	15.3	14.36	15.03	14.9
2357.604	14.78	15.21	15.35	14.91	15.25	14.95	14.36	14.93	14.9
2361.704	15.35	14.48	15.49	15.34	15.4	15.6	15.20	15.08	15.25
2733.605					15.5	15.4			
2734.604	15.90	14.85	15.48	15.35	15.3	15.5	15.05	15.27	15.15
2740.608	15.79	14.31	14.48	14.75	15.4	15.35	14.42	15.48	15.0
2741.607	15.75	15.70	15.74	15.51	15.4	15.6	14.85	15.06	15.0
2742.648	16.0	15.32	15.60	14.87	15.4	15.4	14.23	14.93	14.85
2770.576	15.64	15.12	15.45	15.28	14.25	15.3	14.69	15.34	15.05
3068.668	15.55	14.98	14.97	15.46	14.5	14.65	14.95	15.2	15.25
3069.654	15.65	14.40	15.49	14.97	14.65	15.6	14.71	15.4	
3095.604	14.85	14.45	15.27	15.58	14.5	15.6	15.18	15.33	14.9
3096.609	15.12	15.36	14.74	14.81	14.5	15.25	15.08	15.69	15.2
3476.602	15.56			15.21	15.2	15.05	14.09	14.81	14.9
3477.601	15.51	15.30	14.80	15.35	15.5	14.75	14.43	14.92	15.05
3481.597	14.95	14.62	14.93	14.81	15.5	15.5	15.10	15.20	14.95
3505.572	15.88	15.25	15.39	14.93	15.5	15.4	15.08	15.36	15.15
3823.649	15.36	14.46	15.39	15.39	15.0	15.4	14.10	15.65	15.3
3858.636	15.53	15.32	15.05	15.32	15.25	15.55	15.13	15.08	15.5
3860.589	15.56	15.21	15.44	15.27	14.9	15.4	14.96	15.31	14.95
4180.634	15.28	15.45	15.48	14.87	14.95	14.95	15.35	15.39	15.05
4181.607	15.24	15.34	14.84	15.55	14.8	14.75	15.11	14.00?	14.95
4182.607	15.20	15.14	14.78	14.91	14.95	15.6	14.98	14.84	15.6
4538.633	15.75	14.95	14.69	15.07	15.45	15.6	14.92	15.00	15.4
4539.634	15.80	14.53	15.62	15.35	15.5	15.55	14.88	14.96	15.55
4540.613	15.82	15.05	15.5	15.19	15.5	15.25	14.85	15.15	14.95
4572.602	15.77	15.10	15.67	14.90	15.5	14.75	14.61	14.83	15.05
4573.635	15.70	15.32	15.46	15.26	15.45	14.65	15.01	14.88	15.1

No. 68	No. 69	No. 70	No. 71	No. 72	No. 73	No. 74	No. 75	No. 76	No. 77	No. 78
15.0	15.8	15.45	15.17	15.21	15.65	14.16	15.32	14.82	15.20	15.34
15.25	15.7	14.82	15.20	15.05	15.47	14.18	15.57	15.10	15.30	14.88
15.6	15.7	15.18	15.63	15.4	15.31	14.15	15.67	15.29	15.29	14.96
15.15	15.6	15.92	15.39	15.77	15.60	14.40	15.05	15.27	15.31	15.41
					15.58	14.35	15.30	15.25	15.35	15.26
					15.44	14.42	15.63	14.86	14.72	15.18
		14.82			15.58	14.14	15.72	15.36	15.37	15.16
						13.85				
15.15		15.21	15.82	15.61	15.25	14.13	14.90	14.88	14.83	15.20
15.15	15.5	15.75	15.58	14.91	15.08	13.92	15.20	14.95	15.25	15.04
15.25	15.25	15.80	15.85	15.39	15.26	14.41	15.23	14.95	15.39	15.06
15.05	14.95	15.31	15.60	15.51	14.92	14.23	14.89	14.74	14.71	14.96
15.15	15.5	14.90	15.85	15.60	14.91	14.33	15.58	15.10	14.81	15.12
14.9	15.65	15.41	15.42	15.25	15.39	14.32	15.05	15.20	15.18	15.26
14.85	15.7	15.98:	15.66	15.49	15.63	14.05	15.18	15.03	14.70	15.37
14.85?		15.51	15.18	15.60	14.95	14.44	15.18	14.58	14.80	14.80
15.1	15.6	14.48	15.32	14.60	15.12	14.12	15.50	15.32	14.89	15.00
15.35	15.6	15.70	15.45	15.70	15.22	13.92	15.57	14.79	15.18	15.18
15.05	15.6	14.99	15.51	15.48	14.90	13.83	15.82	14.85	14.91	14.87
14.9	15.5	15.40	15.02	14.91	14.85	13.97	15.36	15.18	15.25	14.83
14.9	15.4	15.33	14.98	14.56	14.83	14.35	15.16	14.94	15.28	15.19
15.05	15.35	15.04	15.14	14.43	14.90	14.36	15.10	14.80	15.35	15.36
14.85	15.25	15.59	15.31	15.30	15.05	14.29	15.56	15.18	15.38	14.88
15.2	15.55									
14.9	15.3?	14.86	14.42	15.21	15.33	13.90	15.33	14.94	15.26	14.90
14.95	15.6	14.78	14.24	14.66	15.05	14.25			14.74	15.32
15.05	15.6	15.83	14.16	15.26	14.82	14.13	15.07	14.89	14.85	15.36
14.9	14.6	15.85	14.48	15.65	14.98	14.13	15.44	14.98	15.02	15.25
15.25	15.5	15.85	15.83	15.55	15.36	14.16	15.20	14.85	15.08	15.00
15.05	15.55	15.52	15.13	15.65	15.22	14.05	15.30	15.20	14.80	15.20
15.05	15.7	14.83	15.92	15.48	15.25	13.93	15.54	15.13	14.92	15.04
15.05	15.0	15.39	15.64	15.69	14.75	13.89			15.02	14.87
15.2	15.25	16.02	15.90	15.43	14.95	14.40	14.73	14.64	14.76	15.00
15.2	14.75	15.19	15.41	15.37	14.77	14.25	15.55	15.10	15.43	14.72
15.4	14.9	15.43	15.69	14.81	14.42	14.16	15.42	14.80	14.71	15.10
15.15	14.9	15.78	15.59	14.88	15.17	14.30	15.30	14.90	15.29	14.94
14.95	15.4?	15.53	15.67	15.73	15.29	14.28	15.29	14.93	14.73	15.31
14.85	15.5	15.0	15.8	15.32	15.35	14.20	15.59	15.05	15.17	15.12
15.3	14.9	15.61	14.5	15.41	15.3	13.52	15.62	15.18	15.45	15.26
15.0	14.55	15.10	14.79	14.68	14.94	14.24	15.30	14.79	14.84	15.01
14.95		15.02	15.52	15.20	14.98	14.19	15.44	14.76	15.39	15.37
15.25	15.4	14.30	15.42	15.04		14.20	14.95	15.15	14.66	15.01
15.3	15.65	15.12	15.68	15.59	14.58	14.43	15.36	15.11	14.71	15.00
15.25	14.9	14.91	15.53	14.81	14.90	14.27	15.31	14.85	15.15	15.36
15.05	15.05	15.35	15.58	15.69	15.25	13.79	15.37	14.86	15.25	15.40
15.25	14.85	16.10	15.62	15.75	15.25	14.01	15.65	15.29	15.39	14.85
15.25	15.6	14.60	14.00	15.33	15.15	14.20	15.45	15.20	15.38	15.26
15.15	15.5	15.56	14.73	15.32	15.20	14.30	15.06	14.89	15.19	15.18

Julian Day	No. 58	No. 59	No. 61	No. 62	No. 63	No. 64	No. 65	No. 66	No. 67
34574.602	15.85	15.55	15.60	14.85	15.4	15.7	15.03	14.92	15.45
4575.603	15.76	15.26	14.69	15.45	15.55	15.55	15.00	15.23	15.25
4929.623	16.0	15.39	15.70	15.49	14.9	15.45	14.59	15.09	15.4
5273.612	15.95	15.07	15.61	14.84	15.2	15.45	15.31	14.87	14.85
5274.609	15.68	14.53	15.28	15.40	15.1	15.45	14.94	15.13	14.9
5275.610	15.93	14.85	14.81	15.13	15.25	14.9	14.99	15.06	15.3
5307.600	15.08	14.85	15.45	15.28	15.45	14.7	14.99	15.07	14.95
5308.699	15.21	15.47	14.91	15.18	15.35	15.55	15.10	15.08	14.9
5309.600	15.13	15.55	15.60	14.96	15.3	15.45	15.27	15.45	14.9
5310.600	14.98	15.29	15.59	15.30	15.15	15.5	15.13	15.42	14.85
5658.601		15.45				15.45			14.9
5661.602	14.94	14.37	14.66	15.12	14.3	14.95	15.09	15.15	
5685.588	15.57	15.18	14.92	14.89	14.8	14.85	15.19	15.21	14.95
5687.592	15.77	14.30	15.70	14.91	14.7	15.7	14.89	15.25	15.3
5688.590	15.57	15.34	15.28	15.41	14.9	15.7	13.84	15.49	
6752.607	15.51	15.27	15.43	15.53	14.9	15.6	14.88	15.10	15.55
6753.602	15.82	15.43	15.37	15.15	14.7	15.55	15.03	14.70	
7113.610	15.43	15.16	15.62	15.46	15.4	15.6	15.12	15.40	15.4
7115.636	15.8	15.41	14.63	15.8:	15.15	15.6	15.12	15.50	15.6
7116.640	15.84	15.30	15.16	15.09	15.4	15.3	14.13	15.23	15.25
8198.614	15.27	15.33	15.49	14.90	15.5	15.4	15.00	15.66	15.3
8199.629	15.00	15.30	15.24	15.36	15.5	15.25	14.52	15.28	15.25
8584.628	15.51	15.43	15.73:	15.37	15.05	15.6	15.37	14.95	15.25
8586.605	15.76	15.31	15.40	15.35	15.05	14.85	14.56	15.25	14.85
9262.772					14.85				
.779	14.63	14.45	14.55	15.38	14.7	15.55	15.01	15.38	14.85
.785	14.89	14.36	14.61	15.37	14.7	15.5	15.06	15.30	14.9
9265.585					15.35	14.8			14.8
.620						14.85			14.85
.680	14.75	14.97	15.23	15.34		15.35	14.97	14.97	15.15
.772	15.2	15.26?	15.31	14.92		15.6	15.29:	15.29:	15.3?
.816	15.31	15.28	15.30	15.22	14.45	15.4	14.06	15.34	15.2
9265.819	15.46	15.38	15.51	15.07	14.55	15.55	14.20	15.37	
.847	15.35	15.41	15.57	15.37	14.55	15.6	14.13	15.57	14.85
9270.772	15.62	15.35	14.72	14.92	14.6	15.6	14.84	15.37	14.9
.776	15.62	15.33	14.83	14.86	14.65	15.55	15.02	15.40	14.8
.798	15.80	15.30	15.08	14.93	14.45	15.55	14.86	15.50	14.9
.803	15.80	15.41	14.92	14.77	14.4	15.6	14.95	15.55	14.9
9271.615	14.74	15.06	15.55	14.72	15.5	14.85	14.21	15.05	
.619	14.78	15.19	15.72	14.86	15.4	14.85	14.44	14.94	15.15
.647	14.94	15.09	15.38	14.77	15.5	15.05	14.25	14.97	15.4
.651	14.99	15.11	15.62	14.84	15.5	14.9	14.54	14.95	15.9
.697	15.38	15.46	15.69	14.95	15.55	15.1	14.66	14.84	15.4
.701	15.32	15.28	15.72	14.94	15.4	14.95	14.74	15.07	15.6
.722	15.33	15.21	15.47	15.05	15.6	15.25	14.61	15.12	15.3?
.725	15.50	15.35	15.68	15.02	15.4	15.15	14.91	15.15	
.761	15.70	15.33	15.67	15.33	14.55	15.4	14.95	15.45	14.9
.776					14.25	15.5			15.15
.817	15.56	15.28	15.27	15.45	14.45	15.6	15.07	15.32	
.820	15.53	15.32	15.18	15.35	14.6	15.5	14.97	15.58	14.85

No. 68	No. 69	No. 70	No. 71	No. 72	No. 73	No. 74	No. 75	No. 76	No. 77	No. 78
15.15	15.7	15.21	14.51	14.45	15.15	13.42	15.63	15.01	14.91	15.07
15.15	15.55	15.23	14.72	15.47	15.25	14.19	15.64	15.19	14.95	14.79
15.25	15.05	15.06	15.90	15.4	15.23	13.50	15.35	14.73	14.75	14.66
15.4	15.4	14.75	14.95	15.05	15.43	14.29	15.06	15.20	14.79	14.97
15.45	15.35	15.77	14.93	15.74	15.50	14.20	15.30	14.83	14.91	15.33
15.15	15.4	15.13	14.69	15.57	15.25	13.79	15.20	14.89	15.28	15.01
15.05	14.8	15.69	15.66	15.57	15.51	14.39	15.39	14.79	15.02	15.07
14.85	14.6	15.52	15.47	15.15	15.49	14.34	15.28	15.15	15.34	14.86
14.85	14.7	15.54	15.55	14.77	15.59	13.57	15.49	15.09	15.43	15.25
14.9	15.05	15.16	15.51	15.34	15.40	13.96	15.15	14.71	15.01	15.34
15.25?	15.25				15.25	14.28				
14.95	15.2	15.35	15.34	14.91	15.23	14.57	14.85	14.79	14.82	15.13
14.4	15.5	15.63	14.27	15.53	14.87	13.88	15.49	15.30	15.38	15.23
14.55	15.3	14.73	14.16	15.30	14.69	14.05	15.17	14.86	14.78	14.75
14.5	14.9	15.21	14.51	15.16	14.85	14.32	15.48	14.81	14.84	14.86
14.8	14.15	15.73		14.57	14.85	14.02	15.07	15.17	14.88	14.87
14.7	14.4	15.19	15.10	14.62	14.95	13.88	15.64	14.85	15.30	14.97
15.05	15.6	15.21	14.25	15.55	15.28	14.15	15.48	15.28	15.10	14.82
14.8	15.6	15.73	14.35	15.12	15.56	13.85	15.39	14.89	15.34	15.29
14.85	15.4	15.46	14.36	14.87	15.28	14.10	14.99	15.16	15.07	15.21
14.75	14.8	15.75	15.48	15.25	16.0	14.34	15.47	15.22	14.78	14.96
14.7	14.4	15.7	15.28	14.74	15.56	14.28	15.16	14.79	15.07	14.75
14.9	14.85	15.54	15.44	15.45	15.28	14.36	15.42	14.95	15.03	15.03
15.05	14.8	15.60	15.38	15.03	15.43	14.08	15.40	15.20	15.12	15.12
15.25		15.28	14.63	15.03	15.74	14.42	15.35	15.06	15.13	15.31
15.2	15.4	15.36	15.0	15.13	15.63	14.32	15.30	15.05	15.05	15.34
14.9	14.5									
14.85	14.5									
15.25	14.85	15.00	15.05	14.55	14.85	13.78	15.60	15.00	15.46	15.07
		15.31	14.97	15.12	15.27:	14.23	15.35:	14.76:	15.23	14.92:
15.15	15.7	15.43	15.07	15.26	15.34	14.08	15.57	15.14	14.90	14.81
15.2	15.7	15.65	15.16	15.20	15.46	14.15	15.47	14.93	14.77	14.90
15.25	15.6	15.46	15.26		15.51	14.03	15.56	15.25	14.90	15.06
15.35	15.7	15.27	14.5	14.73	14.89	14.00	15.23	15.11	15.51	14.95
15.4	15.65	15.35	14.67	14.83	15.06	13.93	15.10	15.04	15.36	15.10
15.4	15.7	15.4	14.79	14.91	15.05	14.03	15.19	14.96	15.55	14.71
15.3		15.35	14.89	14.89	14.73	14.15	15.01	14.85	15.46	14.79
14.95	14.95	15.58	15.25	15.09	15.41	13.84	14.85	15.01	15.39	
14.9	15.25	15.92	15.53	15.42	15.60	13.77	15.09	15.06	15.51	14.80
15.15	15.25	15.58	15.27	15.07	15.55	13.97	15.21	14.83	15.40	14.94
15.15	15.6	15.76	15.41	15.31	15.51	14.02	15.20	14.90	15.38	14.90
15.4	15.6?	15.50	15.37	15.53	15.36	13.72	15.28	14.87	15.32	14.83
15.1	15.6	15.91	15.61	15.78	15.48	14.07	15.15	14.80	15.05	15.15
15.25	15.6	15.05	14.70	15.58	15.11	14.07	15.27	14.90	14.90	15.23
15.2	15.65	15.20	14.60	15.67		14.11	15.16	14.68	14.79	15.27
15.35	15.65	14.73	14.56	15.42	14.95	14.25	15.34	14.77	14.79	15.34
15.3										
15.2	15.7	14.90	14.92	14.89	14.87	14.27	15.55	14.90	14.73	15.06
15.15	15.5	14.93	14.92	14.79	14.73	14.30	15.42	14.87	14.64	15.06

Julian Day	No. 79	No. 80	No. 81	No. 83	No. 84	No. 87	No. 92	No. 98
28309.651					12.2			
.661	15.05	14.97	15.55	15.5?	12.2	14.85	14.44	
.670	15.05	14.97	15.39		12.2	14.84	14.44	
.677	14.97	14.90	15.30		12.1	14.92	14.46	
.796	14.78	14.70	14.67	14.75	11.9	15.02	14.27	15.15?
8365.608	15.17	14.85	15.07	15.05	11.9	14.98	14.23	15.1
8366.608	15.10	14.84	14.58	15.7	11.0	15.03	14.37	15.5
8399.596	15.15	15.07	15.02		11.2	15.12	14.58	15.0
8688.640					10.7			
8692.632	14.86	15.18	14.57	14.4	11.2	15.16	13.93	15.4
8693.730	15.14	15.03	14.92	14.95	11.4	15.12	14.36	15.05
8696.631	14.85	15.29	14.97	15.0	11.6	15.12	14.38	15.6
8715.638					11.3			
9071.660	14.79	14.92	14.73	14.6	11.4	14.99	13.92	15.7
9072.698	14.92	14.96	15.02	15.6	12.1	15.25	14.40	15.05
9073.605	15.20	15.23	15.40	15.55	11.7	15.20	14.25	15.05
9077.600				15.25				
9079.602	15.04	15.15	15.07	15.3	10.8	15.04	14.07	
9786.609	14.84	15.00	14.93	15.0	12.0	15.13	14.18	
9787.608	14.75	15.00	15.42	15.25	11.8	15.21	13.78	15.3
9813.610	14.73	15.17	15.30	15.55	12.5	14.96	14.13	15.5
9814.612	14.82	15.25	15.10	15.45	12.5	15.18	14.39	15.55
9815.613	14.81	15.23	14.60	15.6	12.6	15.31	14.39	15.15
9816.611	14.88	15.32	15.44	15.3	12.5	14.95	14.43	14.6?
30171.617	15.12	15.08	15.42	14.9	11.6	15.25	14.49	
0172.615	15.14	15.11	15.43	15.6	11.8	15.0	14.03	15.05
0519.606	15.07	15.15	14.98	15.3	11.3	14.74	14.38	15.7
0520.606	15.10	15.05	14.63	15.6	11.4	15.10	14.43	14.95
0550.608	14.91	15.10	15.37	15.35	12.2	14.80	14.34	15.4
0553.604	14.85	15.26	15.01	15.35		14.80	13.92	15.55
0554.614	14.76	14.95	14.35	15.05	11.2:	14.76?	13.96	15.2
0555.629	14.84	15.24	15.40	14.85		15.0	14.18	
0556.620	14.93	15.05	15.40	15.55	11.3	14.93	14.30	15.9
0586.572	14.95	15.05	15.18	15.3	11.3	15.18	13.96	14.9
0880.592				15.25				15.4
.623	14.70	14.66	14.65	15.3	10.7:	14.8	14.32	15.0
.659	14.67	14.57	14.55	15.5	10.7:	14.79	14.40	
.690	14.84	14.88	14.77	15.4	10.0:	14.86	14.31	
.730	14.90	14.95	14.92	15.6	10.8	14.85	13.5	
.760	15.07	15.14	15.10	15.5	10.8	14.95	13.7	
.788					11.2			
0883.593				15.5?	11.4			15.4?
.630	14.65	14.66	15.26	15.3	11.2	14.78	14.09	
.664	14.80	14.87	15.41	15.5	11.3	14.92	14.27	14.9
0884.622					11.3			
.680	14.80	14.78	15.14	15.5	11.5	15.20	14.3	15.15
.721	15.10	15.06	15.38	15.3	11.5	15.31	14.57	
.771	15.15	15.18	15.40	15.5	11.6	15.20	14.47	15.3

Julian Day	No. 79	No. 80	No. 81	No. 83	No. 84	No. 87	No. 92	No. 98
30899.602	14.74	15.10	14.52	15.5	12.1	15.17	14.38	15.25
.647	14.72	15.15	14.74	15.3	12.1	15.15	14.35	15.1
.701	14.9	15.12	15.01	15.55	12.1	15.25	13.47	14.95
0900.604	14.77	15.07	15.47	15.5	11.7	15.04	14.2	
.638	14.88	15.18	15.42			14.98	13.5	
0901.676	14.95	15.35	15.54	15.4		15.25	14.29	15.25
0932.604	14.55	15.18	15.15	15.3		14.87	13.60	15.3
0933.589	14.52	14.87	14.45	14.95			13.79	
1257.634	15.00	14.80	15.34	15.3	11.1	15.10	14.12	15.25
1259.604	15.20	14.78	14.47	15.35	11.4	15.02	14.37	14.95
1969.736	14.63	14.59	14.81	15.3	11.3	14.63	13.57	15.5
1970.698					11.6			
1976.641	14.66	14.96	15.35	15.05	12.2	15.00	13.40	15.15
1977.690	14.62	14.75	15.45	14.9	12.0	15.27	13.89	15.3
2000.641	14.83	14.79	15.39	15.4	12.0	15.21	14.50	15.55
2004.652	14.68	14.65	15.61	15.5	12.6	14.95	14.28	15.6
2006.599	14.97	14.66	15.43	15.3	12.4	14.71	14.75	
2326.715	14.73	14.43	15.40	15.25	12.1	14.93	14.17	15.6
2328.739	14.60	14.54	15.71	15.6	10.7?	14.90	14.23	15.6
2354.604	15.08	14.83	15.55	14.9	11.2	14.95	14.40	
2355.607	15.06	14.71	15.53	15.2	10.9	15.29	14.37	15.3
2356.605	15.17	14.95	15.29	14.95	10.8:	14.83	13.81	15.4
2357.604	14.97	14.97	14.97	15.5	11.1	15.03	13.87	15.6
2361.704	14.87	14.65	15.42		11.3	15.21	13.99	
2734.604	14.80	14.75	15.28	14.9	11.4	15.21	14.12	
2740.608	14.59	14.82	15.13	15.1		14.73	14.11	
2741.607	14.85	14.93	15.19	15.6	12.4	15.06	14.34	15.25
2742.648	14.66		14.53	15.6	11.8	15.0	13.5	
2770.576	14.66	14.80	14.95	14.9	11.9	15.13	14.18	
3068.668	14.87	14.98	14.62	15.35		14.81	14.35	
3069.654	14.35	14.92	15.48	15.3	10.6:	14.95	14.08	
3095.604	14.86	15.13	15.56		10.7	15.06	14.47	
3096.609	14.76	15.17	15.00	15.2	11.2	14.81	14.16	15.55
3476.602			14.54			14.93	13.6	
3477.601	15.02	15.06	15.71	15.35	11.3:	14.80	13.9	14.95
3481.597	14.90	14.95	14.38		11.7	14.82	14.32	
3505.572	15.12	14.98	14.57	15.2	11.5	15.05	14.45	15.3 ?
3823.649	14.41	14.11	15.33			15.29	13.96	
3858.636	14.78	14.45	15.46	15.3	11.3	14.64	14.23	15.55
3860.589	14.75	14.97	14.61		12.0	15.20	14.41	
4180.634	15.02	15.16	15.32	15.4	11.2	14.92	14.35	15.25
4181.607	15.01	15.15	14.72	15.3?	10.8	15.24	14.30	15.15
4182.607	14.82	15.23	15.41	14.85	10.9	15.17	14.24	14.9
4538.633	14.89	14.88	15.35		10.9	14.83	14.00	
4539.634	14.84	14.90	15.37	15.3	10.9	14.95	13.80	15.55
4540.613	14.78	14.85	15.12			15.10	13.98	
4572.602	14.97	15.02	15.38	15.05	11.9	15.08	13.92	15.15
4573.635	15.11	15.17	15.41		12.3	15.30	14.47	
4574.602	15.14	15.05	15.53	15.4	12.8	15.45	14.43	15.6

Julian Day	No. 79	No. 80	No. 81	No. 83	No. 84	No. 87	No. 92	No. 98
34575.603	14.94	14.87	14.65	15.25		14.70	14.35	
4929.623	14.60	15.05	15.1		10.8?	14.80	14.16	
5273.612	15.22	15.20	15.5	15.4		15.09	13.75	15.05
5274.609	14.99	14.91	15.23	15.6	10.0:	15.15	13.95	
5275.610	14.99	15.10	14.77	15.3	10.7	14.55	13.95	15.55
5307.600	15.15	15.06	15.45	15.15	10.3:	15.02	14.28	
5308.599	15.15	14.91	15.23		11.3	15.12	14.36	
5309.600	15.24	15.08	14.87	15.15	11.6	14.92	14.44	15.7
5310.600	15.17	14.90	15.46	15.15	11.6	15.04	14.31	15.3
5658.601				15.2	12.0			
5661.602	14.74	15.01	15.36	14.75	12.7			
5685.588	14.95	14.89	15.55	15.25	12.2	14.91	13.70	
5687.592	14.42	14.93	15.32	14.7		14.61	14.10	
5688.590	14.84	14.85	14.82			14.89	14.23	
6752.607	14.58	14.5	15.35	15.5	11.9	15.02	14.26	15.6
6753.602	14.59	14.63	15.00	15.3	12.5	15.17	14.24	15.6
7113.610	14.73	14.88	14.95	15.2	12.2	14.89	14.32	15.6
7115.636	14.72	14.96	15.44	14.65	11.8	14.9	13.50	15.25
7116.640	14.82	14.88	15.38		11.3	14.99	13.89	
8198.614	14.89	14.97	14.50	15.45	10.5:	14.99	13.73	
8199.629	14.73	14.82	15.35			14.70	13.81	
8584.628	15.15	15.13	15.45	15.35	12.7	15.07	13.64	15.5
8586.605	15.16	15.27	15.21		12.4	15.10	14.27	
9262.779	14.66	14.91	15.50		11.6	14.95	14.47	
.785	14.78	14.82	15.45	15.3	10.8:	15.2	14.38	
9265.680	14.66	14.73	15.26		11.5	14.92	14.38	
.684					11.8			
.772	14.72:	15.16:	14.93:		11.6	15.06:	13.85	
.816	14.80	14.70	14.54	14.65	11.0:	15.07	13.80	15.5
.819	14.92	14.89	14.48	14.7	12.0	15.20	13.83	15.55
.847	14.98	14.81	14.68	14.9	11.4	15.00	13.74	15.6
9270.772	14.74	15.04	15.35	14.8	11.9	15.00	14.35	15.7
.776	14.87	14.87	15.27	14.5	12.3	15.10	14.42	15.4
.798	14.66	15.02	14.79	14.55		14.90	14.21	
.803	14.77	15.12	14.73	14.6	12.2	15.12	14.33	14.9
9271.615	15.02	14.66	15.31	15.4		14.95	14.28	15.6
.619	15.21	14.72	15.53	15.3	12.5	15.17	14.36	15.35
.647	14.97	14.69	15.29	15.3	11.4	15.01	14.23	15.55
.651	15.00	14.77	15.36	15.15	12.5	15.23	14.35	15.55
.697	14.80	14.60	15.32	15.5		15.00	14.07	
.701	14.67	14.89	15.45	15.3	12.6	15.07	14.28	15.15
.722	14.57	14.72	15.42	15.4	11.9	15.01	14.21	15.25
.725	14.75	15.11	15.42	15.15	12.7	15.18	14.32	14.95
.771	14.66	15.11	15.44	15.3		14.89	14.26	15.2
.776					12.5			14.9
.817	14.85	14.97	15.42	15.25	11.5	14.9	13.85	15.1
.820	14.81	15.02	15.35		12.4	14.81	13.87	

TABLE IV

PHOTOGRAPHIC MAGNITUDES FROM MOUNT WILSON PLATES

TABLE IV PHOTOGRAPHIC MAGNITUDES

Plate	Julian Day	No. 1	No. 2	No. 3	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11
3686P	21338.885	14.35	15.45	15.37	15.15?	15.32	14.70	14.63	14.30	15.33
	.887	14.42	15.40	15.23		15.30	14.80	14.73	14.32	15.02
3694P	21339.696	15.53	15.04	15.04	14.90	15.68	15.63	15.23	15.68	14.85
	.699	15.50	14.98	14.85		15.67	15.67	15.17	15.61	14.67
3696P	.719	15.53	14.98	14.98		14.95	15.80	15.23	15.87	14.30
	.721	15.60	14.95	14.95		14.90	15.68	15.22	15.65	14.35
3698P	.740	15.45	15.02	14.87	14.75	14.43	15.67	15.30	15.62	14.18
	.742	15.67	15.07	14.90		14.35	15.62	15.35	15.65	14.23
3699P	.765	15.49	15.18	15.02	14.8	14.03	15.60	15.49	15.57	14.33
	.767	15.63	15.10	14.93		14.02	15.71	15.45	15.76	14.35
3701P	.787	15.48	15.35	15.25	14.9	14.80	15.55	15.53	15.60	14.35
	.789	15.51	15.25	15.14		14.83	15.70	15.44	15.66	14.53
3702P	.807	15.41	15.39	15.32	14.8	14.77	15.78	15.76	15.63	14.45
	.809	15.48		15.15		14.87	15.65	15.77	15.70	14.65
3704P	.828	15.75	15.42	15.09	14.85	14.92	15.62	15.48	15.65	14.69
	.830	15.55	15.36	15.10		14.85	15.55	15.33	15.65	14.80
3705P	.848	15.60	15.47	15.20	14.9	14.97	15.61	15.43	15.66	14.97
	.850	15.59	15.42	15.23		15.06	15.48	15.42	15.75	15.02
3707P	.868	15.45	15.53	15.18	14.9	15.17	15.38	15.42		15.00
	.870	15.47	15.40	15.09		15.13	15.24	15.38		14.97
3708P	.889	15.35	15.53	15.42	15.05	15.25	14.98	15.62	15.85	15.24
	.891	15.55	15.58	15.57		15.37	15.01	15.65	15.95	15.47
3710P	.910	14.76	15.76	15.29	15.05	15.42	14.55	15.42	15.65	15.05
	.912	14.82	15.68	15.25		15.44	14.55	15.32	15.58	15.15
3711P	.932	14.63	15.62	15.43	15.0	15.50	14.57	15.50	15.05	15.01
	.934	14.58	15.51	15.35		15.45	14.60	15.39	14.92	15.21
3713P	.954	14.75	15.60	15.43	14.95	15.55	14.73	15.48	14.75	15.20
	.956	14.75	15.52	15.39		15.40	14.62	15.35	14.70	15.34
3714P	.975	14.85	15.60	15.48	14.95	15.60	14.76	15.55	14.85	15.35
	.977	15.12	15.52	15.47		15.54	14.78	15.56	14.86	15.45
3716P	.993	14.93	15.56	15.48	15.15?	15.54	14.87	15.63	14.99	15.32
	.995	15.06	15.60	15.50		15.48	14.79	15.60	14.99	15.42
3717P	21340.010	15.03	15.60	15.47	15.25	15.46	14.92	15.50	14.90	15.28
	.012	15.14	15.66	15.57		15.66	14.94	15.55	15.00	15.50
3718P	.015	15.10	15.37	15.50	15.25	15.50	15.20	15.57	15.17	15.53
3748P	21375.679	15.62?	15.65	15.50?		15.65?	15.85?	15.85?	15.35?	
	.680	15.56?	15.37	15.37?		15.45?	15.62?	15.85?	15.40?	15.20?
3750P	.695	15.42	15.53	15.03	15.5	15.42	15.53	15.50	15.31	14.97
	.697	15.55	15.56	15.05		15.50	15.52	15.40	15.30	15.26
3751P	.718	15.57	15.65	14.86	15.15	15.40	15.29	15.65	15.92	15.27
	.719	15.63	15.67	14.90		15.55	15.39	15.58	15.90	15.47
3754P	.766	15.30	15.64	15.01	15.3	15.52	15.47	15.10	15.78	15.16
	.768	15.36	15.69	14.93		15.84	15.40	15.14	16.00	15.39
3755P	.790	15.44	15.60	14.80	14.95	15.69	15.76	14.90	15.75	15.47
	.791	15.35	15.58	14.85		15.61	15.61	14.98	15.84	15.77
3757P	.807	15.35	15.35	15.17	15.15	14.99	15.57	14.88	16.00	15.31
	.808	15.57	15.68	15.03		14.92	15.50	14.79	16.00	15.60
3758P	.827				15.25					
	.828									
3760P	.845	15.55	15.72	15.02	15.15	14.37	15.28	14.61	15.81	15.45
	.846	15.57	15.67	15.07		14.58	15.23	14.52	16.05	15.75
3761P	.862	15.71	15.55	15.55	15.15	14.89	15.95	15.13	15.8	15.47

FROM MOUNT WILSON PLATES

No. 12	No. 14	No. 15	No. 16	No. 18	No. 19	No. 20	No. 21	No. 25	No. 28	No. 29	No. 30
15.70	15.20	15.00	14.56	14.67	15.70	14.93	15.60	14.50	14.43	14.90	15.50
15.55	15.20	15.00	14.65	14.80	15.75	14.87	15.75	14.62	14.46	14.91	15.65
15.53	15.41	15.41	14.53	15.63	15.40	15.53	15.06	14.55	15.68	15.02	15.60
15.50	15.40	15.37	14.40	15.51	15.40	15.48	14.87	14.35		14.80	15.68
15.87	15.38	15.25		14.22	15.56	15.45	15.22	14.10	15.64	14.43	15.66
15.73	15.50:	15.25	14.60	14.17	15.48	15.48	15.19	14.08		14.38	15.63
15.69	15.32	15.30	14.85	14.15	15.69	15.35	15.17	14.10	15.71	14.62	15.45
15.52	15.40	15.32	14.92	14.17	15.67	15.10:	15.28	14.10		14.63	15.72
15.75	15.41	15.23	14.96	14.40	15.63	15.40	15.40	14.10	15.65	14.90	15.45
15.77	15.45	15.20	14.97	14.49	15.90	15.40	15.35	14.04		14.86	15.57
15.83	15.17	15.30	15.13	14.80	15.90	15.44	15.72	14.16	15.75	15.08	15.30
15.65	15.17	15.20	14.98	14.75	15.83	15.33	15.58	14.25		15.10	15.34
15.85	15.50	15.18	15.26	14.90	16.05	15.62	15.62	14.02	15.70	15.25	14.99
15.65	15.40	15.10	15.00	14.80	16.00	15.70	15.69	14.15		15.24	15.02
15.80	15.35	14.96	15.03	14.88	15.80	15.58	15.40	14.18	15.60	15.25	14.63
15.72	15.40	14.80	14.88	14.76	15.80	15.47	15.20	14.22		15.25	14.65
15.81	15.42	15.00	15.05	15.02	15.72	15.63	15.40	14.22	15.60	15.38	14.53
15.65	15.48	14.92	15.15	14.98	15.65	15.64	15.31	14.19		15.36	14.60
15.65	15.18	15.02	15.10	15.10	15.75	15.51	15.38	14.32	15.65	15.45	14.65
15.45	15.13	15.00	14.80	14.80	15.55	15.50	15.21	14.22		15.35	14.63
15.81	15.19	15.19	15.19	15.40	15.83	15.60	15.58	14.27	15.75	15.57	14.76
15.73	15.34	15.42	15.15	15.47	15.83	15.58	15.65	14.40		15.54	14.96
15.95	14.90	15.15	15.33	15.47	15.82	15.44:	15.44	14.30	15.25	15.71	14.85
15.68	15.00	15.17	15.13	15.47	15.76	15.48	15.37	14.50		15.68	14.97
15.53	14.77		15.25	15.53	15.77	14.90	15.53	14.36	14.79	15.55	14.95
15.39	14.79	15.42	15.23	15.55	15.78	14.81	15.39	14.39		15.57	15.00
14.73	14.83	15.38	15.40	15.67	15.70	14.65	15.60	14.43	14.48	15.66	14.95
14.52	14.67:	15.25	15.17	15.57	15.75	14.64	15.40	14.38		15.54	14.95
14.44	14.91	15.44	15.52	15.74	15.74	14.55	15.54	14.42	14.60	15.66	15.09
14.30	14.95	15.45	15.32	15.59	15.62		15.41	14.42		15.56	15.01
14.66	14.97	15.52	15.34	15.63	15.26	14.69	15.53	14.50	14.75	15.65	15.08
14.50	15.00	15.45	15.28	15.72	15.08		15.50	14.40		15.65	15.07
14.72	14.98	15.34	15.25	15.70	14.25	14.68	15.53	14.53	14.77	15.59	15.08
14.97	15.06	15.40	15.19	15.72	14.33	14.70	15.54	14.52		15.65	15.18
14.80	15.00	15.45	15.24	15.57	14.30	14.67	15.60	14.57	14.80	15.30	15.20
15.45?	15.48?	15.78?	15.42?	15.75?	16.05?	15.52?	15.90?	14.66	15.85?	15.66?	15.40?
15.24?	15.43?	15.80?	15.20?	15.70?	15.8?			14.50		15.57?	15.30?
15.45	15.19	15.62	15.37	15.58	15.73	15.33	15.40	14.45	15.51	15.66	15.35
15.31	15.30	15.52	15.26	15.60	15.68		15.26	14.43		15.68	15.33
15.80	15.37	15.4	15.27	15.48	15.02	15.48	15.69		15.34	15.76	15.27
15.60	15.60	15.31	15.21	15.55	14.85	15.37	15.53	14.99		15.70	15.36
15.75	15.35	15.50	15.17	15.62	14.45	15.58	15.75	13.75	15.61	15.64	15.43
15.85	15.37	15.29	14.98	15.81	14.29	15.62	15.66	13.87		15.69	15.33
16.05	15.69	15.24	14.53	15.76	14.90	15.72	15.69	13.80	15.85	15.30	15.09
15.97	15.62	15.07	14.59	15.84	14.74	15.77	15.18?	14.07		15.32	15.10
16.00	15.44	15.10	14.60	15.86	14.88	15.65	16.00	14.08	15.35	15.22	15.31
15.85	15.57	15.13	14.29	15.77	14.92	15.61	15.77	13.90		15.16	15.10
			14.21					14.12			
			13.95								
16.05	15.39	14.80	13.80		15.25	15.72	14.90	14.32	14.40	14.64	15.72
15.87	15.50	14.66	13.71		15.05	15.95:	14.60	14.18		14.82	15.52
15.75	15.67		14.07	15.95	15.65	15.47	14.97	14.20	14.83	14.47	15.72

Plate	Julian Day	No. 1	No. 2	No. 3	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11
3761P	21375.863	15.85	15.34	14.95		14.48	15.85	14.92	16.0	15.45
3763P	.886	15.43	15.28	15.24	15.0	14.87	15.56	14.80	15.38	15.96
	.887	15.55	15.47	15.20		14.94	15.43	14.82	15.47	15.88
3764P	.905	14.50	15.68	15.35	14.9	15.35	15.62	14.85	15.70	15.62
	.907	14.81	15.53	15.22		15.40	15.62	14.91	15.62	15.48
3766P	.926	14.38	15.18	15.46	14.85	15.01	15.40	15.20	15.60	15.31
	.928	14.32	15.20	15.42		15.24	15.35	15.22	15.66	15.53
3767P	.946	14.31	15.03	15.40	14.75	15.13	15.09	15.12		15.50
	.948	14.38	14.97	15.45		15.23	15.01	15.26		15.66
3849P	21435.746	15.45	15.62	14.82	14.65?	15.05	15.45	15.35	15.53	14.57

Plate	Julian Day	No. 31	No. 32	No. 33	No. 34	No. 35	No. 38	No. 39	No. 40	No. 41
3686P	21338.885	14.75	15.65	14.55	15.80	14.90	14.6	14.30	15.10	15.58
	.887	14.70	15.75		15.90	14.85		14.37	15.10	15.75
3694P	21339.696	15.43	15.30	15.25	15.88		15.5	15.35	14.83	15.36
	.699	15.43	15.25		15.87	15.19		15.34	14.76	15.27
3696P	.719	15.40	15.43	15.3	15.25	14.90	15.5	15.40	14.90	15.53
	.721	15.32	15.51			15.22		15.43	14.90	15.48
3698P	.740	15.12	15.53	15.4	16.00		15.2	15.48	14.92	15.54
	.742	15.06	15.58		15.88	15.12:		15.50	14.95	15.64
3699P	.765	15.02	15.60	15.5	15.95		14.55	15.52	15.02	15.57
	.767	14.95	15.74		16.05	14.85		15.48	14.95	15.77
3701P	.787	14.97	15.83	15.5	16.05	14.80	14.55	15.57	15.12	15.82
	.789	15.00	15.80		16.05	14.77		15.50	15.04	15.62
3702P	.807	15.01	15.90	15.5	16.05		14.65	15.60	15.30	
	.809	14.83	15.95			14.40		15.55	15.17	15.77
3704P	.828	14.86	15.72	14.9	14.70		14.7	15.48	15.06	15.70
	.830	14.75	15.72			14.60		15.51	15.06	15.62
3705P	.848	14.89	15.66	14.55	14.77		14.75	15.49	15.20	15.53
	.850	14.95	15.67			14.66		15.48	15.10	15.70
3707P	.868	15.00	15.61	14.45	14.80		15.05	15.57	15.15	15.70
	.870	14.96	15.55			14.62		15.42	15.07	15.56
3708P	.889	15.25	15.76	14.45	15.02		14.85	15.53	15.31	15.83
	.891	15.36	15.72			14.88		15.58	15.55	15.95
3710P	.910	15.32	15.70	14.6	15.10		14.9	15.66	15.35	15.82
	.912	15.24	15.62			14.99		15.60	15.20	15.76
3711P	.932	15.43	15.65	14.7	15.13		14.95	15.62	15.24	15.72
	.934	15.39	15.59			14.96		15.57	15.26	15.66
3713P	.954	15.38	15.73	14.95	15.09		15.05	15.57	15.19	15.73
	.956	15.30	15.66			15.04		15.47	15.07	15.68
3714P	.975	15.48	15.67	14.95	15.25		15.15	15.74	15.20	15.74
	.977	15.32	15.56			15.10		15.56	15.15	15.70
3716P	.993	15.35	15.26	14.95	15.35		15.5	15.63	15.00	15.14
	.995	15.30	15.06			15.06		15.61	14.95	15.09
3717P	21340.010	15.27	14.30	15.25	15.12		15.35	15.63	14.85	14.59
	.012	15.28	14.30			15.10		15.57	14.90	14.57
3718P	.015	15.32	14.25	15.35	15.26	15.28	15.05	15.40	15.12	14.60
3748P	21375.679	15.60?	15.90?		15.32?			15.48?	15.48?	14.14?
	.680	15.45?	15.70?			14.91?		15.37?	15.24?	14.17?
3750P	.695	15.45	15.37	15.3	15.05		15.2	15.32	15.07	14.30
	.697	15.44	15.37			14.95		15.40	15.12	14.29
3751P	.718	15.45	14.44	15.5	14.82	14.13	15.4	15.35	15.23	14.44
	.719	15.41	14.33			14.10		15.36	15.27	14.42

No. 12	No. 14	No. 15	No. 16	No. 18	No. 19	No. 20	No. 21	No. 25	No. 28	No. 29	No. 30
15.25	15.53		13.85	16.05	15.70	15.40	14.66	14.09		14.17	15.60
16.05	15.67	14.73	14.22	15.25	15.05	15.19	14.50	14.16	14.55	14.73	15.19
15.80	15.70	14.75	14.15	15.37	15.60	15.26	14.46	14.31		14.65	15.26
16.05	15.30	15.15	14.46	15.20	15.75	15.03	14.46	14.35	14.70	14.70	15.30
16.00	15.40	15.09	14.01	15.35	15.57	14.96	14.65	14.28		14.85	15.57
15.73	15.11	14.70:	14.55	14.10	15.76	14.62	14.88	14.65	15.04	15.13	15.11
15.65	15.15	14.55:	14.20	14.02	15.75	14.49	14.55	14.29		15.06	14.96
15.65	14.81	15.68:	14.47	14.17	15.91	14.45	14.92	14.45	15.12	15.39	14.95
15.42	15.01	15.60:	14.40	14.20	15.89	14.40	15.02	14.45		15.70	14.88
15.70	15.39	14.91	15.13	15.75	15.56	14.89	14.73	14.43	14.82	15.41	14.96

No. 42	No. 43	No. 44	No. 45	No. 47	No. 52	No. 55	No. 58	No. 59	No. 61	No. 62	No. 63
11.7	14.80	15.10	15.22	15.15	14.85		15.53	15.32	15.50	15.32	14.64
11.5	14.80	14.95	15.20	15.30	14.97	15.00	15.50	15.27	15.35	15.20	14.62
11.3	15.32	14.80	14.90		15.10		15.28	14.65	15.10	15.55	15.58
11.3	15.25	14.72	14.79	14.46	15.20	15.67	15.28	14.67	15.00	15.62	15.67
11.4	15.28	14.87	14.56		14.10	15.35:	15.10	14.83	14.73	15.50	15.70
11.3	15.27	14.90	14.55	14.40	13.90	15.32	15.10	14.92	14.68	15.50	15.65
11.4	15.29	14.75	14.26	14.09	14.10		15.30	14.82	14.53	15.38	15.69
	15.35	14.96	14.28	14.51	14.05	15.45	15.26	14.93	14.60	15.27	15.82
11.4	15.37	14.88	14.23:		14.20		15.40		14.75	15.27	15.72
11.4	15.42	14.93	14.17	14.53	14.30	15.28	15.28	14.95	14.64	14.90	16.05
11.5	15.32	14.92:	14.10:		14.46		15.72		14.90	15.04	15.85
11.5	15.36	15.10	14.23	14.61	14.65	15.26	15.55	15.15	14.85	15.07	15.85
11.4	15.45	14.95	14.05		14.35		15.72		14.91	14.77	15.95
11.5	15.35	14.98	14.20	14.78	14.26	15.18	15.57	15.20	14.89	14.95	16.05
11.5	15.49	15.22	14.58	14.85	14.63		15.63	15.40	15.10	14.90	15.70
	15.40	15.17	14.65	14.88	14.66	14.85	15.55	15.36	15.10	14.83	15.80
11.6	15.60	15.27	14.92		14.66		15.65	15.27	15.20	15.00	15.19
	15.53	15.18	14.77	15.03	14.76	14.86	15.60	15.31	15.20	14.95	15.31
11.6	15.50	15.00	14.66		14.80		15.65	15.07	15.17	15.05	15.17
	15.55	14.83	14.62	14.83	14.75	14.80	15.59	15.25	15.17	14.98	15.00
11.7	15.67	15.08	14.96		14.83		15.73	15.58	15.31	15.22	14.85
11.8	15.68	15.17	15.21	15.51	15.17	14.88	15.75	15.63	15.50	15.40	15.03
11.8	15.67	14.79	14.82	15.06	14.94		15.85	15.20	15.40	15.24	14.30
	15.57	14.80	14.75		14.97	15.00		15.35	15.40	15.32	14.39
11.7	15.53	14.79	14.75		15.00		15.82	15.26	15.38	15.41	14.54
	15.50	14.75	14.89	15.12	15.25	15.01	15.74	15.32	15.45	15.51	14.58
11.7	15.57	14.75	14.87		15.14		15.78	15.27	15.45	15.48	14.65
	15.54	14.74	14.95	15.26	15.20	15.18	15.62	15.38	15.45	15.45	14.72
1.7	15.62		15.05		15.30		15.86	15.34	15.50	15.40	14.87
	15.61	14.70	15.12	15.33	15.09	15.41	15.77	15.36	15.47	15.27	14.89
1.7	15.67	14.69	15.14		15.35		15.79	15.19	15.48	15.34	15.07
	15.70	14.65	15.04	15.32	15.39	15.25	15.79	15.37	15.60	15.30	14.97
1.7	15.60	14.92	15.19		15.15		15.60	15.52	15.60	15.18	15.00
	15.69	14.90	15.23	15.27	15.34	15.29	15.60	15.60	15.57	15.25	15.06
1.8	15.55	14.98	15.06	15.30	15.17	15.25	15.49	15.25	15.37	15.26	15.17
2.2?	15.75?	14.89?					15.80?		15.17?	15.75?	15.60
	15.70?	14.92?		15.15?		15.20?	15.56?		15.16?	15.70?	15.40
2.1	15.63	14.80	14.60		15.20		15.75	15.10	15.16	15.49	14.84
	15.56	14.95	14.65	15.07	15.25	14.89	15.55		15.15	15.52	15.02
2.3	15.63	15.18			14.86		15.85		15.33	15.42	14.52
	15.69	15.17	15.03	15.43	15.17	14.88	15.90	15.53	15.46	15.47	14.62

Plate	Julian Day	No. 31	No. 32	No. 33	No. 34	No. 35	No. 38	No. 39	No. 40	No. 41
3754P	21375.766	15.50	14.57	15.55	14.71		15.35	15.53	15.27	14.88
	.768	15.33	14.62			14.90		15.55	15.31	14.87
3755P	.790	15.44	14.95	15.4	14.98		15.3	15.40	15.10	15.10
	.791	15.35	14.98			15.19		15.35	15.25	14.97
3757P	.807	15.03	14.91	15.6	15.06		15.2	15.40	15.21	15.10
	.808	14.95	14.88			14.98		15.35	15.30	15.10
3758P	.827			15.25			15.3			
3760P	.845	14.85	15.17	15.3	14.90		15.3	15.57	15.22	15.22
	.846	14.75	15.08			14.70		15.38	15.23	15.23
3761P	.862	15.07	15.35	15.25	15.35		15.15	15.75	15.13	15.68
	.863	14.72	15.58			14.40		15.62	14.91	15.30
3763P	.886	14.85	14.90	15.25	15.24		15.3	15.25	14.73	15.58
	.887	14.72	15.07			14.59		15.26	14.82	15.70
3764P	.905	14.97	15.66	15.5	15.10		15.25	15.86	14.80	15.27
	.907	15.03	15.79			14.82		15.70	14.71	15.31
3766P	.926	15.23	15.67	15.2	15.23		15.4	15.76	15.05	15.68
	.928	15.21	15.85			14.80		15.69	14.92	15.75
3767P	.946	15.20	15.82	14.7	15.27		15.3	15.85	14.92	15.82
	.948	15.37	15.75			14.91		15.67	15.01	15.65
3849P	21435.746	15.03	14.62	14.95	14.57	15.07	14.4	15.25	15.34	15.35

Plate	Julian Day	No. 64	No. 65	No. 66	No. 67	No. 68	No. 69	No. 70	No. 71	No. 72
3686P	21338.885	15.45	14.43	15.20	14.5	15.65		15.70	15.80	15.55
	.887	15.25	14.57	15.12		15.75		15.50	15.90	15.50
3694P	21339.696	15.53	15.38	15.07	15.75?	15.27		14.85	15.41	15.80
	.699	15.52	15.41	14.93		15.22		14.67	15.43	15.72
3696P	.719	15.76	15.65	14.98	15.5	15.15	16.05	14.62	15.66	15.77
	.721	15.67	15.58	15.02		15.13	15.87	14.50	15.57	15.67
3698P	.740	15.69	15.39	15.01	15.35	15.00	14.93?	14.70	15.67	15.33
	.742	15.62	15.45	14.92		15.02	14.88?	14.80	15.70	15.43
3699P	.765	15.65	15.45	15.08	15.25	15.33	14.32	15.11	15.77	15.29
	.767	15.75	15.50	15.02		15.28	14.26	15.02	16.00	15.28
3701P	.787	15.87	15.34	15.15	14.9	15.22	14.40	15.20	15.20	15.32
	.789	15.62	15.30	15.13		15.35	14.49	15.16	15.16	15.26
3702P	.807	15.74	14.94	15.58	14.55	15.48	14.90	15.57	15.57	15.37
	.809	15.62	15.07	15.48		15.61	14.92	15.53	15.53	15.30
3704P	.828	15.70	14.70	15.30	14.45	15.35	14.76	15.18	15.18	15.03
	.830	15.45	14.77	15.29		15.22	14.62	15.22	15.22	14.86
3705P	.848	15.55	14.90	15.33	14.55	15.37	14.87	15.28	15.28	15.00
	.850	15.44	14.90	15.27		15.44	14.90	15.27	15.27	14.95
3707P	.868	15.55	14.53	15.40	14.45	15.58	15.07	15.30	15.83	15.12
	.870	15.35	14.75	15.37		15.50	14.89	15.25	15.72	14.93
3708P	.889	15.58	14.76		14.55	15.85	15.46	15.71	16.05	15.35
	.891	15.60	15.10			15.75	15.40	15.72	15.95	15.36
3710P	.910	15.87	15.20	15.44	14.8	15.58	15.04	15.34	15.70	15.00
	.912	15.69	15.10	15.47		15.62	15.15	15.36	15.70	15.10
3711P	.932	15.76	15.20	15.52	14.9	15.58	15.47	15.53	15.25	15.15
	.934	15.66	15.25	15.47		15.57	15.33	15.58	15.66	15.10
3713P	.954	15.66	15.28	15.55	15.0	15.55	15.63	15.63	15.73	15.15
	.956	15.43	15.00	15.45		15.50	15.52	15.54	15.77	15.14
3714P	.975	15.26	15.40	15.44	15.25	15.65	15.55	15.53	15.85	15.25
	.977	15.05	15.34	15.45		15.47	15.45	15.47	15.76	15.14
3716P	.993	14.74	15.26	15.28	15.25	15.45	15.60	15.50	15.70	15.17

No. 42	No. 43	No. 44	No. 45	No. 47	No. 52	No. 55	No. 58	No. 59	No. 61	No. 62	No. 63
12.2	15.25	14.75			14.95	15.30	15.83		15.62	15.19	14.89
	15.14	14.75	14.75	15.02	15.17	15.22	15.95	15.45	15.69	15.28	15.08
12.6	15.09	15.32	15.35:		15.17		15.50		15.72	14.63	14.93
	15.02	15.42	15.40:	15.65	15.33	15.18	15.50	15.65	15.76	14.85	15.13
12.4	14.91		15.37		15.26		15.41		15.73	15.07	15.21
	14.77	15.16	15.52	15.49	15.13	15.30	15.75	15.75	15.68	14.83	15.02
12.4										14.40	
12.3	15.00	14.82	15.45	14.85	14.00		15.51		15.79	14.85	15.06
	15.00	14.90	15.60		13.92	15.23	15.61	15.90	15.90	14.90	15.08
12.2	15.13	14.10	15.35		13.75		15.80		15.55	15.55	15.65
	14.85	14.29	15.12	14.05	13.88	15.45	15.68	15.10	15.30	15.40	15.49
12.5	15.25	15.05	16.05	14.52	13.93		15.52		15.85	14.94	15.10
	15.19	15.15	15.75		14.07	15.10	15.53	15.63	15.60	15.10	15.19
12.4	14.77	15.41	15.20		13.72		14.85		16.05	15.55	15.48
	14.65	15.13	15.52	14.30	13.95	15.62	15.22	15.53	16.0	15.31	15.40
12.3	15.07	14.40	15.13		14.57		15.51		15.53	15.42	15.60
	15.21	14.39	15.20		14.52	15.57	15.42	14.26	15.75	15.56	15.78
12.1	15.12	14.33	15.07		14.50		14.78		15.70	15.68	15.75
	15.20	14.54	15.23	14.40	14.62	15.48	14.60	14.34	15.69	15.82	15.90
12.9	15.28	15.26	15.23	15.10	15.07		15.64:	15.16	15.68	14.91	15.42

No. 73	No. 74	No. 75	No. 76	No. 77	No. 78	No. 79	No. 80	No. 81	No. 83	No. 87	No. 92
14.46	13.62	15.33	15.33	15.32	15.15	14.75	15.07		15.45	15.15	
14.52	13.55	15.25	15.23	15.20	15.10	14.75	15.13	14.82	15.43	15.27	
15.03	14.25	15.03	15.32	15.35	15.20	15.03			14.90	15.23	14.05
15.00	14.15	15.08	15.27	15.37	15.17	14.92	14.70	15.45	14.70	15.17	14.00
15.14	14.16	15.08	15.23	15.32	15.03	15.02			14.70	15.15	14.01
15.25	14.13	15.10	15.28	15.38	15.02	15.23	14.45	15.57	14.82	15.15	
15.30	13.81	15.08	15.27	15.35	14.95	14.87			14.50	15.25	14.10
15.38	13.81	15.18	15.32	15.45	14.95	14.96	14.86	15.52	14.45	15.45	
15.45	13.60	15.23	15.28	15.37	14.90				14.70	15.17	14.22
15.43	13.63	15.17	15.35	15.35	14.83	14.92	14.92	15.38	14.62	15.26	14.18
15.46	13.85	15.35	15.32	15.40	15.00	15.05			14.75	15.17	14.25
15.42	13.85	15.26	15.32	15.45	14.97		15.00	15.30	14.65	15.11	14.17
15.57	14.04	15.37	15.10	15.57	14.96	14.74			14.80	14.96	14.0
15.57	14.00	15.30	15.17	15.45	15.05	15.06	15.05	15.46	14.80	14.83	
15.35	13.93	14.89	14.86	15.36	15.11	15.05			15.07	14.70	14.27
15.30	14.00	15.12	14.85	15.30	15.07	14.95	15.33	15.33	14.77	14.80	14.18
15.30	13.97	15.19	14.75	15.19	15.25	14.91			15.00	14.65	14.21
15.25	14.01	15.23	14.85	15.39	15.25	14.89	15.22	15.31	14.95	14.85	14.15
15.12	13.95	15.25	14.79	15.24	15.30	14.67			15.00	14.74	14.36
15.05	14.00	15.17	14.77	15.28	15.16	14.75	14.98	15.30	14.87	14.75	14.13
14.98	14.23	15.42	14.67	15.13	15.56	14.70			15.13	14.71	14.12
15.20	14.35	15.38	14.86	15.38	15.65	14.92	15.45	15.25	15.12	15.08	14.23
14.98	13.95	15.37	14.72	15.10	15.58	14.57			15.19	14.76	14.15
14.95	14.08	15.42	14.79	15.15	15.50	14.80	15.05	14.95		14.95	14.30
14.84	14.18	15.50	14.69	14.82	15.43	14.79			15.27	14.73	14.20
14.80	14.22	15.39?	14.70	14.89	15.39	14.58	15.01	14.43		14.89	14.20
14.92	14.21	15.38	14.59	14.69	15.30	14.65			15.36	14.75	14.23
14.80	14.19	15.34	14.58	14.77	15.32	14.78	14.96	14.52		14.85	14.37
14.79	14.19	15.42	14.60	14.65	15.31				15.29	14.91	14.10
14.95	14.25	15.34	14.57	14.75	15.32	14.84	14.90	14.63		14.98	
14.93	14.25	15.36	14.65	14.55	15.17	14.89			15.39	14.97	14.10

Plate	Julian Day	No. 64	No. 65	No. 66	No. 67	No. 68	No. 69	No. 70	No. 71	No. 72
3716P	21339.995	14.64	15.35	15.25		15.28	15.60	15.48	15.70	15.19
3717P	21340.010		15.45	15.10	15.3	15.10	15.67	15.55	15.70	15.16
	.012	14.40	15.38	15.05		15.15	15.58	15.60	15.48	15.28
3718P	.015	14.52	15.23	15.35	15.5	15.10	15.65	15.75	15.47	15.37
3748P	21375.679	15.73		15.70	14.9?	16.0?		15.80	15.90?	15.95
	.680	15.39		15.50		15.66?		15.54	15.80?	15.80
3750P	.695	15.51	15.73	15.65	15.05	15.65	16.00	15.80	15.13	15.65
	.697	15.47	15.65	15.60		15.70	16.00	15.85	15.15	15.80
3751P	.718	15.46	15.76	15.66	15.05	15.52	16.05	16.00	14.36	15.35
	.719	15.35	15.82	15.81		15.53	16.05	15.92	14.50	15.44
3754P	.766	15.75	15.64	15.12	14.55	15.12	15.85	15.79	14.50	14.33
	.768	15.59	15.45	14.96		15.05	16.05	15.95	14.41	14.27
3755P	.790	15.43	15.72	15.09	14.55	14.75	15.85	15.85	14.58	14.40
	.791	15.25	15.80	15.05		15.02	15.80	15.80	14.79	14.50
3757P	.807	15.35	15.84	15.03	14.5	15.40	16.05	16.05	15.31	14.91
	.808	15.35	15.60	15.13		15.35	16.05	15.95	15.30	15.16
3758P	.827				14.35					
3760P	.845	15.67	15.75	14.85	14.45	14.93	15.65	15.55	15.22	14.85
	.846	15.53	15.45	14.90		14.79	15.83	15.50	15.08	14.88
3761P	.862	15.68	14.70	15.08	14.7	14.73	14.95	15.85	15.60	15.05
	.863	15.40	14.58			14.76	14.53	15.63	15.25	15.25
3763P	.886	15.70	14.35	14.95	15.1?	14.67	13.70	15.75	15.10	15.02
	.887	15.32	14.39	14.77		14.77	13.85	15.60	15.19	15.00
3764P	.905	15.85	14.45	14.67	15.15	14.90	13.90	15.95	16.00	15.70
	.907	15.53	14.65	15.02		15.21	13.85	15.62	15.67	15.48
3766P	.926	15.17	14.95	15.13	15.25	14.85	13.93	15.79	15.60	15.31
	.928	14.96	14.67	15.14		15.12	13.90	15.78	15.72	15.35
3767P	.946	14.56	14.53	15.30	15.25	15.60	14.53	15.97	16.15	15.71
	.948	14.59	14.62	15.30		15.64	14.45	15.82	16.0	15.73
3849P	21435.746		15.41?	15.07				15.19		

No. 73	No. 74	No. 75	No. 76	No. 77	No. 78	No. 79	No. 80	No. 81	No. 83	No. 87	No. 92
14.90	14.16	15.42	14.53	14.60	15.05	14.84	14.91	14.57		15.11	13.93
14.85	14.24	15.32	14.53	14.49	14.99	15.02			15.37	14.81	14.06
14.82	14.35	15.32	14.72	14.63	15.05	15.00	14.94	14.63		14.98	14.15
15.20	14.40	15.30	14.60	14.60	15.25	14.87	15.10	14.82		15.25	14.17
15.15?	13.93?	15.66?	15.43?	14.88?	15.52?				14.98		14.32
14.93?	14.10?	15.50?	15.30?	14.91?	15.32?		14.70	15.12?		15.70?	14.10
14.88	13.88	15.42	15.10	14.89	15.15	14.90			14.69	15.25	14.35
14.93	13.78	15.47	15.12	14.95	15.24		14.70	14.83		15.35	14.20
15.07	13.79	15.40	14.88	14.84	15.16	15.00			14.47	14.89	14.07
15.12	13.88	15.39	15.04	14.90	15.30		14.85	14.57		15.09	14.05
15.17	13.75	15.50	15.04	15.01	14.75	14.85			14.95	15.25	13.43
15.40	13.90	15.45	15.00	15.05	14.87		14.69	14.79		15.32	13.39
15.21	13.60	15.43	14.80	14.90	14.98	14.90			15.55	15.25	13.52
15.19	13.90	15.45	14.94	15.02	14.86		15.22	15.02		15.02	13.48
15.50	14.05	15.65	14.80	15.25	14.88	14.83			15.35	15.21	13.59
15.57	14.00	15.61	14.75	15.10	15.25		15.10	15.91		15.02	13.53
	14.17		14.23								13.77
15.40	13.95	15.47	14.77	15.22	15.00	14.70			15.48	15.05	13.79
15.32	14.01	15.45	14.72	15.17	15.18		15.23	15.17		15.00	13.80
15.40	14.25	15.80	14.78	15.17	15.60				15.29	15.84	13.86
15.17	14.15	15.61	14.85	15.10	15.33		14.72	15.53		16.00	
15.15	14.00	15.15	14.51	15.05	15.44	14.67			15.85	14.87	14.00
15.19	14.18	15.20	14.69	15.03	15.27		15.56	15.46		15.07	14.07
	13.95	15.02	14.85	15.15	15.20				16.05	15.21	14.0
	13.88	15.45	15.03	15.35	15.21		15.27	15.70		15.40	
15.00	14.13	15.18	15.18	15.28	15.25	14.54			15.28	15.35	14.00
	14.17	15.12	15.12	15.42	15.50		14.83	15.18		15.66	14.02
	14.21	15.17	15.18	15.30	15.27	14.63			15.52	15.33	14.15
	14.25	15.17	15.23	15.41	15.48		14.67	15.33		15.53	14.02
15.28	14.08	15.20	15.10	14.91	15.28	15.23	15.16	15.41	15.53	15.05	14.13

plates published by Bailey (1917) and from 81 by Oosterhoff (1941) were used to investigate the period changes of the RR Lyrae stars in M5.

The reciprocal periods given by Oosterhoff (1941) were used in determining the light curves. The phases for the light curves were computed from the formula:

$$\text{phase} = \frac{\text{Julian Date of Observation} - 2400000}{P}.$$

Separate light curves were plotted for the following epochs: 1889, 1895–96, 1897–99, 1901–02, 1904–05, 1908, 1912, 1917, 1934–35, 1936–38, 1940–42, 1943–44, 1946–49, 1950–53, 1954–56, 1959–60, 1963–64, 1966. Figure 5 shows the light curves of variable 7 at the various epochs. The light curve for each variable given by the 1934–35 observations of Oosterhoff was drawn on tracing paper. Each was then fitted to the other curves by a horizontal shift. Thus the phase-shifts relative to the epoch 1934–35 were determined. (A positive phase-shift implies that the features on the light curve in question occur at later

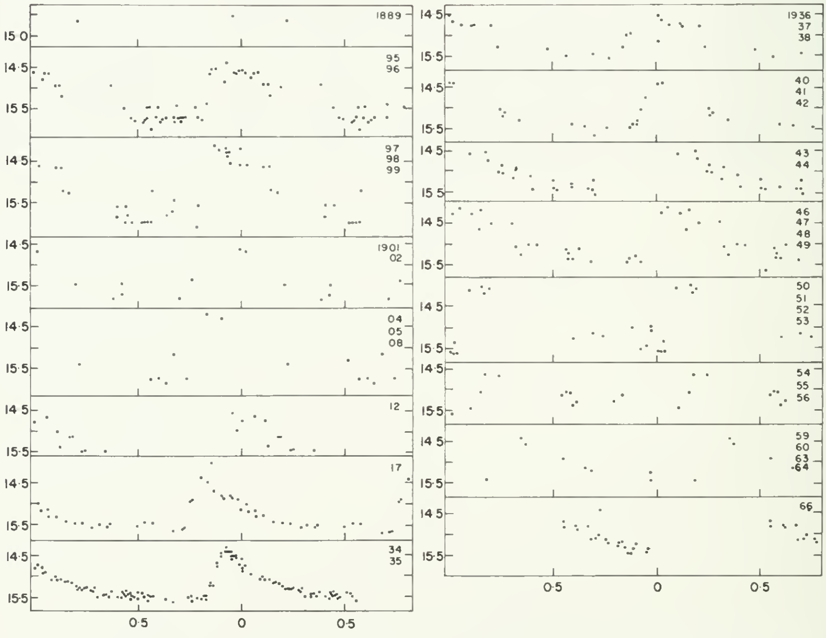

FIG. 5—Illustration of light curves for determination of phase-shift diagram (variable 7).

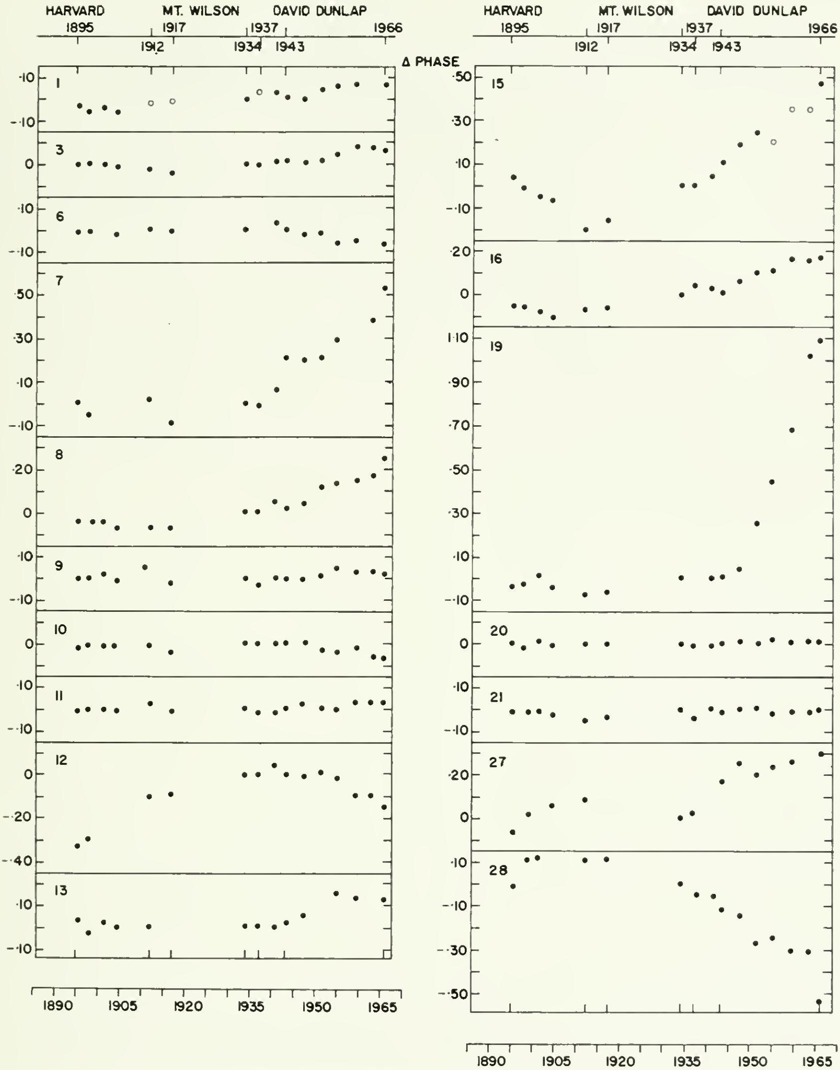

FIG. 6—Phase-shift diagrams (phase-shift in fraction of a period).

phases than on the 1934–35 curve.) Then a phase-shift diagram was plotted.

No phase-shift diagrams were plotted for variables 2, 14, 18, 25, 35, 44, 52, 58, 65, 66, 67, 68, 72, and 92 because their light curves were too irregular. The phase-shifts for the other 52 stars are listed in Table II and their phase-shift diagrams are shown in figure 6.

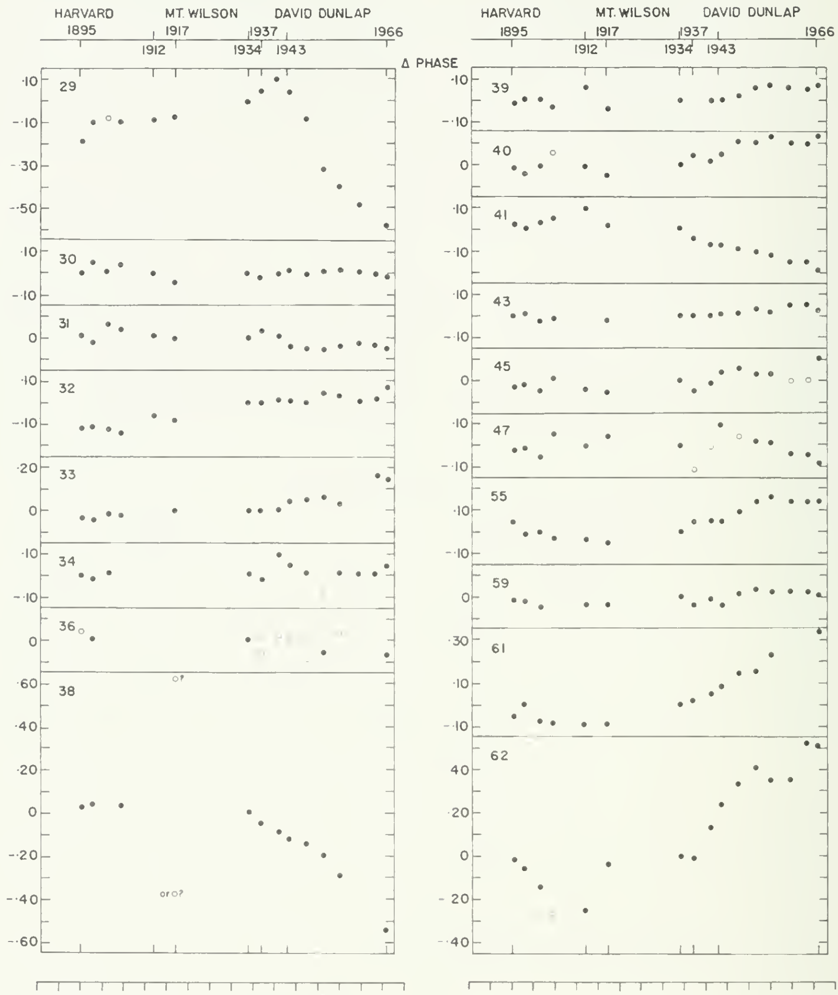

FIG. 6—Phase-shift diagrams (continued).

Determination of Period Changes

The changes of period have been determined in two ways: by fitting parabolas to the points on the phase-shift diagrams to determine the rate of period change, β, and by fitting intersecting straight lines to the points to determine the amount of period change, ΔP.

Standard parabolas were plotted on transparent paper for 11 values

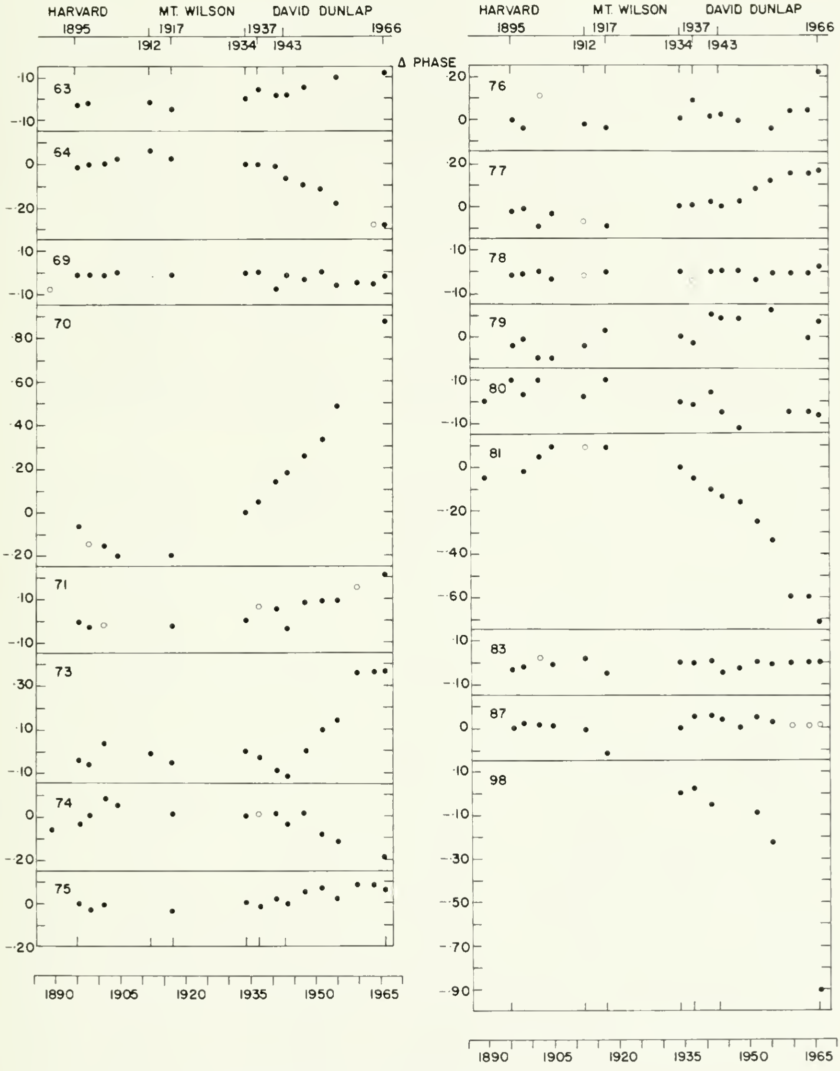

FIG. 6—Phase-shift diagrams (continued).

of $\beta/2P^2$ between 10^{-10} and 10^{-8} days^{-2}. These were fitted visually to the phase-shift diagrams and the values of β computed for each star from the most suitable parabola. Most of the phase-shift diagrams are not true parabolas and there is an uncertainty of about 25 per cent in the values of β.

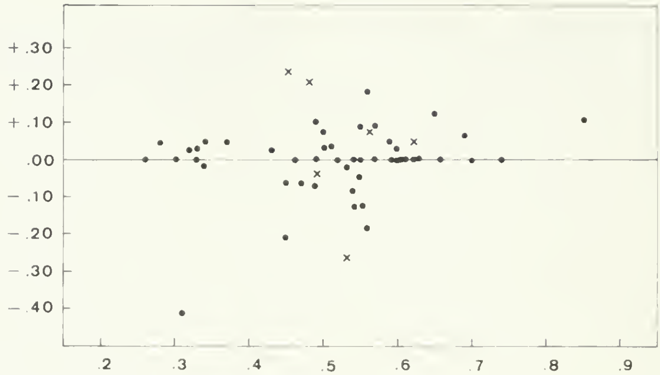

Fig. 7—The rate of change of period, β (in days per million years) determined from fitting parabolas to the points in the phase-shift diagrams, plotted against the period (in days), stars with constant period included.

An attempt was made to determine the amount of this change in a million years in order to compare with the values of β determined from the parabolas. Of the 50 stars for which the period increased, decreased or remained constant during the seventy-year interval, periods of 18 (or about one-third) remained constant. Then, if the interval of observations was extended to 100 years, it might be expected that abrupt changes in the periods of these stars would be observed, i.e., a star changes its period abruptly about once in 100 years. At this rate, in a million years, the period of a star would change by 10,000 times the amount observed in 70 years. Assuming this, the period change expected in a million years is calculated for those stars for which changes were observed in the present investigation. These are listed in Table V and plotted against period in figure 8.

If the phase-shift diagram produced a single straight line, the period was assumed constant and corrected if necessary: ΔP (correction to period) = slope $\times$ P^2. These corrected periods are listed in Table V. The light curves for these stars are shown in figure 9.

In Table V the epochs are those given by Oosterhoff in heliocentric Julian days with the first two digits (24) omitted. Successive columns give the period, reciprocal period, β (the rate of change of period in days per million years), and the projected period change for a million years (assuming the period changes abruptly). The periods adopted here are those computed from Oosterhoff's reciprocal periods. It was found in the course of this investigation that Oosterhoff's periods do not always correspond to his reciprocals. Besides the stars with period

TABLE V

PERIODS OF VARIABLES IN M5

Var.	Epoch from Oosterhoff	Period days	Reciprocal Period	β days/ 10^6 yr	Rate abrupt change	Notes
1	27563.794	0.5217856	1.916496			const.
2	27601.700	0.526				1
3	27567.842	0.6001832	1.666158	.039	.044	
4	27627.708	0.4496402	2.224006	.234:		15
6	27567.856	0.5488311	1.822054	−.048	−.026	
7	27601.730	0.4943896	2.0226962	.105	.100	
8	27605.697	0.54623	1.83075	.091	.077	
9	27653.855	0.6988950	1.43083			const.
10	27567.825	0.5306628	1.8844359	−.020	−.037	
11	27563.817	0.5958914	1.678158			const.
12	27601.762	0.4677144	2.138057	−.064	−.096	
13	27567.800	0.5131223	1.948853	.038	.046	
14	27567.974	0.4872423	2.052367			1
15	27567.908	0.3367607	2.969468	.050	.084	
16	27567.781	0.6476223	1.54411	.124	.069	
18	27567.773	0.464	2.15573			1
19	27601.706	0.4699535	2.12787		.374	2
20	27601.729	0.6094759	1.640754			const.
21	27605.684	0.6048941	1.653182			const.
24	27567.821	0.4783771	2.090401	.205		15
25	27567.766	0.508	1.969			3
26	27601.761	0.6225642	1.60626	.044		15
27	27888.894	0.4703	2.126217			4
28	27540.882	0.5439474	1.838413	−.127	−.292	5
29	27567.700	0.4514355	2.215166	−.120	−.180	6
30	27567.761	0.5921755	1.6886886			const.
31	27567.872	0.3005826	3.3268725			const.
32	27605.754	0.4577863	2.1844254			const.
33	27601.738	0.5014722	1.9941286	.037	.041	7
34	27567.727	0.5681431	1.76012			const.
35	27567.866	0.3081197	3.245492			1
36	27563.868	0.6277229	1.5930596			const.
37	27605.762	0.4887941	2.045851	−.039		15
38	27889.937	0.4704441	2.1256511			
39	27563.832	0.5890346	1.697693	.051	.035	
40	27605.698	0.3173286	3.1513078	.029	.015	
41	27567.879	0.4885749	2.046769	−.070	−.072	
43	27601.767	0.6602264	1.514632			const.
44	27601.732	0.329	3.0362			10
45	27567.774	0.6166364	1.6217012			const.
47	27563.861	0.5397295	1.85278	−.085	−.077	
52	27563.804	0.5017848	1.992886			1
55	27601.734	0.3288968	3.040467	.032	.028	
56	27889.931	0.5346903	1.8702415	−.264		15
58	27601.716	0.491265	2.03556			1
59	27540.936	0.5420259	1.8449303			const.
61	27567.826	0.5686157	1.758657	.095	.107	
62	27601.704	0.2814092	3.553544		.193	11
63	27567.851	0.4976763	2.009338	.037	.031	
64	27540.853	0.5445075	1.836522	−.127	−.117	
65	27628.729	0.480691	2.08034			12
66	27567.813	0.350681	2.85159			13
67	27567.733	0.3490462	2.86495			13

TABLE V—*continued*

Var.	Epoch from Oosterhoff	Period	Reciprocal Period	β days 10^6 yr	Rate for abrupt change	Notes
68	27628.727	0.3342797	2.991507			13
69	27567.761	0.4948743	2.0207151			const.
70	27567.930	0.5585255	1.7904286	.184	.268	
71	27541.011	0.5024676	1.990178	.073	.039	
72	27596.82	0.562	1.779			1
73	27601.753	0.3401118	2.94021	.050	.074	
74	27626.684	0.4539961	2.202662	−.060	−.048	
75	27596.816	0.6854136	1.458973	.070	.057	
76	27563.813	0.4324210	2.312561	.027	.118	
77	27605.721	0.8451121	1.183275	.106	.176	
78	27567.727	0.2648174	3.776187			const.
79	27567.884	0.3331387	3.001753			const.
80	27562.986	0.3365424	2.9713936	−.017	−.014	
81	27567.972	0.5573235	1.79429	−.184	−.265	
83	27567.783	0.5533073	1.807314			const.
87	27540.914	0.7383888	1.3543			const.
90	27540.828	0.5571527	1.79484	.076		15
92	27567.963	0.4635789	2.15713			14
98	27605.737	0.3063857	3.26386	−.416	−.060	

NOTES

1. Irregular; therefore no phase-shift diagram was plotted.
2. No parabola could be fitted on the phase-shift diagram. Period changes abruptly between 1945 and 1950.
3. Following component of close double. Of Oosterhoff's two possible periods, 0.508 and 0.517 days, the D.D.O. observations fit the former, but not well enough for a phase-shift diagram.
4. Irregular, Oosterhoff. A complicated phase-shift diagram indicates a fluctuating period.
5. Period change calculated from difference in slope between first and third line of three straight lines.
6. Oosterhoff found the shape of the light curves abnormal for the period, with rising branch less steep than expected.
7. Visual observations by Barnard (1909). His published Julian Dates appear to be calculated for noon C.S.T. On this assumption, his light curves coincide with those of Bailey (1917).
8. Irregular Oosterhoff, and current investigation. Bailey class *c*, and no phase-shift diagram made.
9. Phase of light curve in 1917 ambiguous with respect to the others, which prevents definite determination of period change.
10. Period irregular. The D.D.O. observations fit Oosterhoff's longer period of 0.329 better than his 0.247-day period.
11. Positions of light curves from observations of Bailey in 1912 and Shapley in 1917 ambiguous, relative to other years. Net change in period calculated from slope of line representing Bailey's observations and that for D.D.O. observations.
12. Probably not irregular, but because of uncertainties in measures due to closeness to another star no phase-shift diagram was constructed.
13. Bailey class *c*, some irregularity, no phase-shift diagram.
14. Measures difficult on D.D.O. plates; perhaps irregular.
15. β determined by Oosterhoff.

changes, the table lists those with constant or irregular periods, and six stars for which Oosterhoff (1941) found period changes, but which were not studied on the David Dunlap plates.

Discussion

From this study of the variables in M5 with observations over an interval of 75 years, we have found that for 18 stars the periods are constant, for 20 they have increased, and for 12 they have decreased.

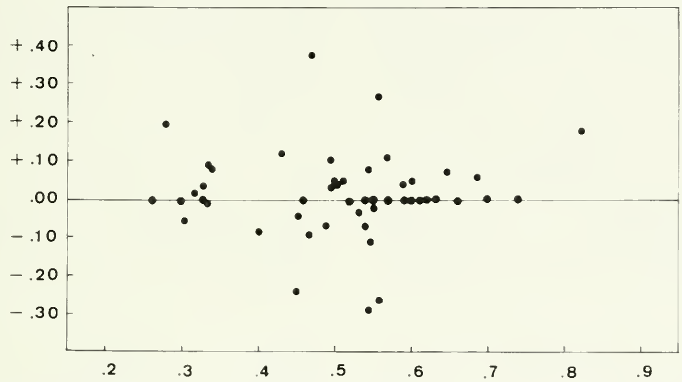

FIG. 8—The projected period change (in days per million years) determined from fitting straight lines to the points in the phase-shift diagrams, including stars with constant period.

For the other 16 stars, periods are not well determined or are irregular. The median rate of change of period for the stars with increasing periods is 0.05 ($\pm$0.02) days per million years; the median rate for those decreasing is 0.075 ($\pm$0.02) days per million years. The median rate of change of periods of all the stars considered together is zero. It is interesting to try to determine if these changes are due to evolution of the stars across the horizontal branch of the H-R diagram or if they are just random. If the former, then it follows that both the decreases and the increases must have evolutionary significance. Otherwise, since the median rate of period change is zero, the changes do not indicate an evolutionary trend.

Sandage (1957) has calculated, by semi-empirical methods, a time scale for stars in the RR Lyrae phase in M3. According to him, the stars spend 8×10^7 years in the RR Lyrae stage. The H-R diagram for M5 is very similar to that of M3, and so, it might be concluded that stars in M5 also spend about 8×10^7 years in the RR Lyrae stage. According to figure 10, the range of periods an RR Lyrae star in M5

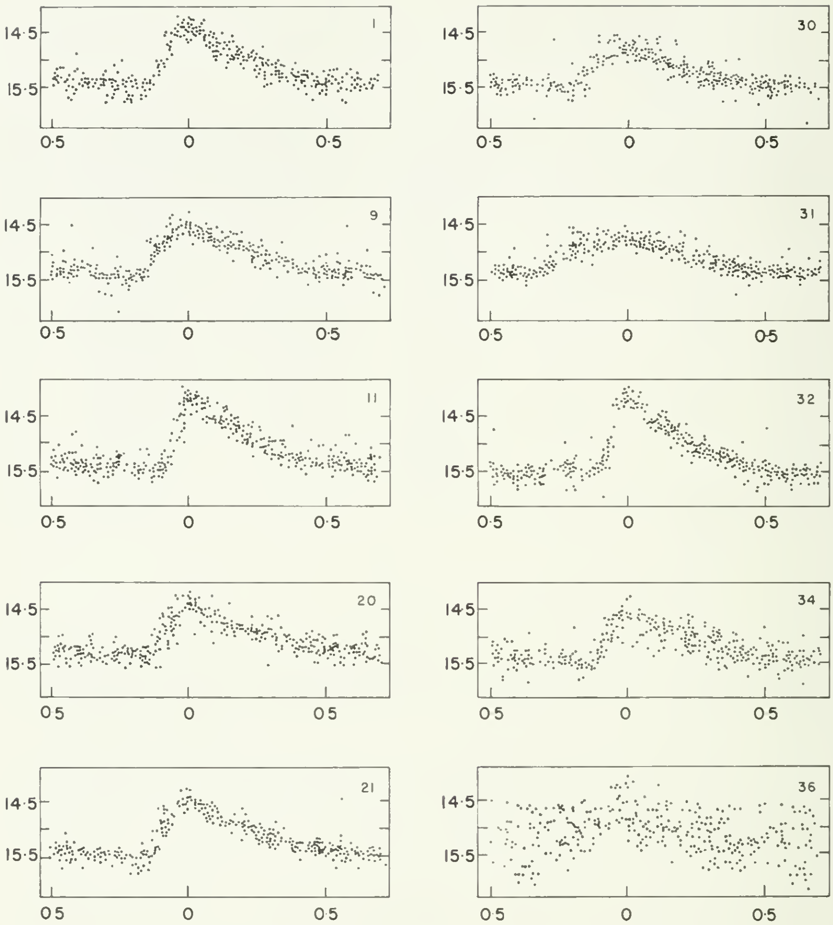

Fig. 9—Light curves for stars with constant periods.

may take is 0.55 days (allowing for a gap between types *c* and *a*). Thus the expected average rate of change in period is 0.007 days per million years. The minimum rate that can be detected over 75 years depends on the period. The minimum value of $\beta/2P^2$ observable at the present time is 10^{-10} days^{-2}. This corresponds to the following values for β:

β = 0.04 days per million years for P = 0.8 days,
= 0.02 days per million years for P = 0.5,
= 0.005 days per million years for P = 0.25.

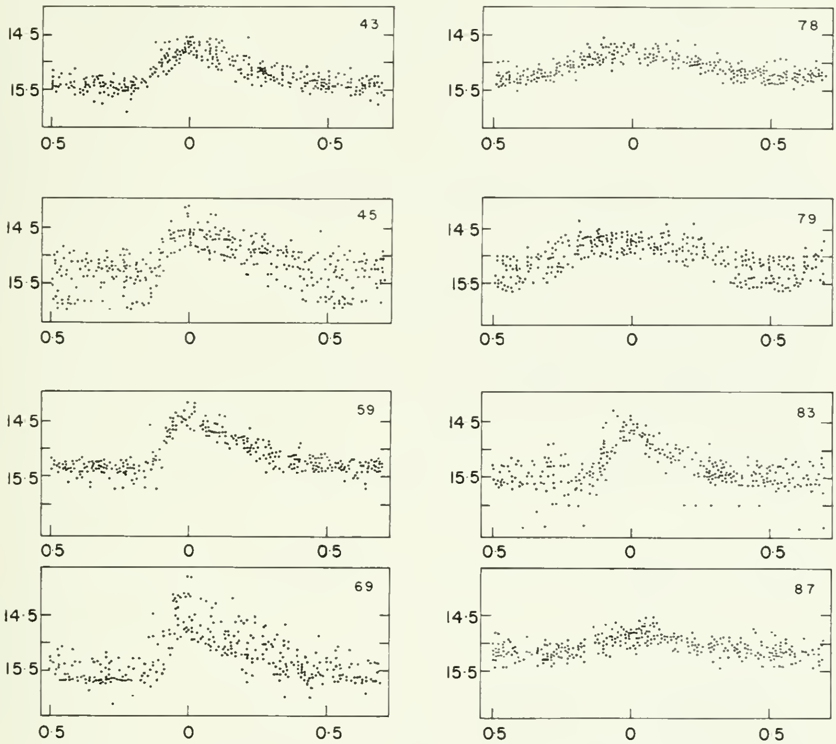

FIG. 9—Light curves for stars with constant periods (continued).

Thus, using the present observations, only for variables with periods < 0.3 days is it possible to detect evolutionary changes in period. Almost all the variables in M5 have periods greater than 0.3 day. However, Sandage's computations have been made on the assumption that stars cross the RR Lyrae gap only once and in the direction of decreasing periods, whereas the periods of the stars in M5 exhibit both increases and decreases.

Theoretical calculations of Faulkner and Iben (1966) indicate that stars do change direction of evolution on the horizontal branch. They have considered models with two different hydrogen compositions in the envelope: $X_e = 0.90$ and $X_e = 0.65$. These models have double energy sources: helium burning in the core and hydrogen burning in a shell outside. In the models with $X_e = 0.90$, the helium burning in the

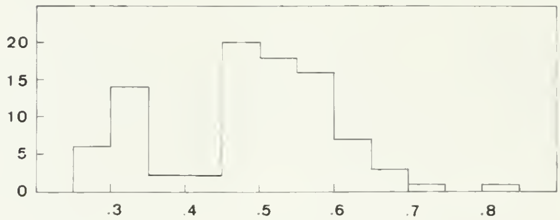

FIG. 10—Period-frequency diagram for M5.

core dominates the energy production and the stars move to the right in the H-R diagram (analogous to stars moving off the main sequence). Then, when the core is exhausted and gravitational contraction sets in, the star moves to the left in the diagram, but much faster. The favoured model with this composition spends about 4×10^7 years crossing the horizontal branch (about 1.3×10^7 years as an RR Lyrae variable) corresponding to an average increase of period at the rate of 0.04(2) days per million years followed by decrease of period at a faster rate. On the other hand, in their models with $X_e = 0.65$, the hydrogen burning in the shell dominates the energy production and there is a resulting contraction in the envelope to maintain a high temperature and density in the shell, causing evolution to the blue in the H-R diagram. When a point is reached where helium burning in the core dominates the energy production, the star evolves to the red at a much faster rate. In the model favoured by Faulkner and Iben (1966) with this hydrogen envelope composition, the star spends 1.3×10^8 years on the horizontal branch evolving to the blue (about 4×10^7 years in the RR Lyrae stage). This would indicate an average decrease of period of 0.014 days per million years followed by an increase at a faster rate. This rate of decrease is below the limit of detection for periods greater than 0.4 days, and most of the decreases are observed at periods greater than this value.

In the case of the models with $X_e = 0.90$, the average increase of periods at the rate of 0.042 days per million years predicted by the theory is approximately what is observed, but the observed decreases are at the same rate, and not faster as expected from the theory.

It therefore seems likely that the observed period changes are not caused by the evolution of the stars across the H-R diagram.

Furthermore, Sandage (1965) has pointed out that if the RR Lyrae stars follow evolutionary tracks like those of Faulkner and Iben (1966), then there would be a correlation between the rate of period change and the mean magnitude of the RR Lyrae stars. All the stars with decreasing periods would be brighter or fainter than those with increasing periods. An examination of 26 stars in M3, using period changes determined by Szeidl (1965) and mean m_{pg} and m_{pv} colours determined by Roberts and Sandage (1955), does not indicate any correlation between period changes and mean magnitudes, nor does an examination of 14 stars in ω Centauri, with the period changes determined by Belserene (1964) and mean B, V magnitudes of Dickens and Saunders (1965). However, these are very small samples.

An explanation for observed period changes based on evolution also seems difficult because the patterns of observed period changes differ from cluster to cluster. In ω Centauri, there is a predominance of variables with increasing periods, while in M3, there are equal numbers increasing and decreasing, and about half of the stars investigated show irregular period changes. In M15 and M5, a significant proportion of the stars investigated have periods which have remained constant throughout the years of investigation. (Light curves for the variables in M5 with constant periods are shown in figure 9.)

In the case of a variable whose period appears constant, it is possible that the period is changing at a rate too slow to be detected, or that, if the change is abrupt, it has not occurred in the observed time interval. Assuming that the periods of the stars in M5 change abruptly, the period changes so determined are shown plotted against the values of β determined from the assumption that the period varies at a constant rate. With the exception of variable 98 (with an unreliable β), the points define a straight line with a slope slightly greater than unity (about 1.2) which seems to justify the determination of rates of period change by fitting intersecting straight lines to the diagram. This is useful because many of the phase-shift diagrams (that of variable 19 in particular) resemble straight lines more than parabolas.

It is important to determine whether or not the period changes are abrupt, because our interpretation of the observed constancy of period for some of the stars depends on this. To do this, we must accumulate observations for another 30 years and then plot new phase-shift diagrams for the stars which appear to have constant periods at the present time. If they do exhibit period changes, it will not be justified to consider them as variables with constant periods with regard to evolution.

Also we might arrive at the most suitable interpretation of the

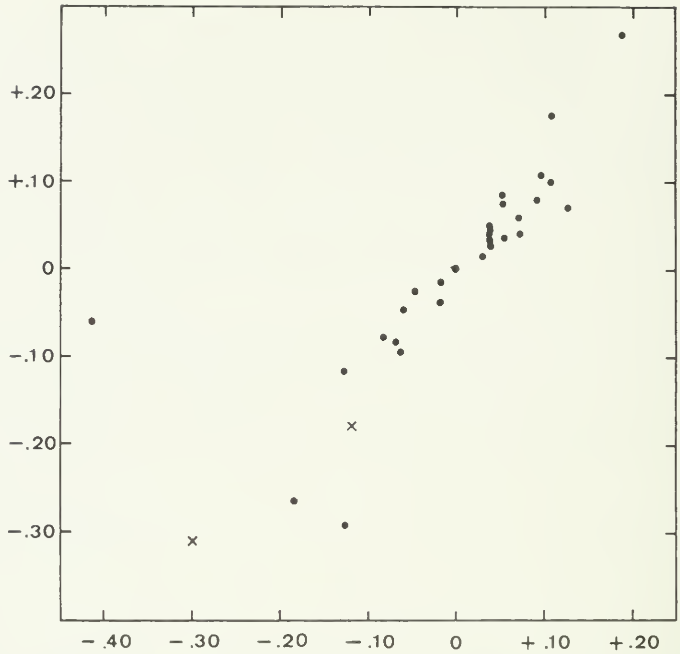

FIG. 11—Projected period changes (days per million years) versus β (in days per million years).

diagrams by reinvestigating the stars with observed period changes. If the diagram is a parabola, then as different periods are tried, the parabola should retain its shape, but the position of the vertex should shift so that it occurs on the time axis at the point where the assumed period is actually the true period. If the diagram is best represented by two intersecting straight lines, then the point of intersection should always occur at the same time, as different periods are tested. The slopes of the lines would change, but the difference in slope should remain constant. This method is now being explored at the Asiago Astrophysical Observatory for some of the stars in M5. Before the possible evolutionary interpretations of the period changes observed in the different clusters can be considered, it is important that the significance of the apparent constancy of period for some of the stars be understood.

A very important point illustrated by this study is the necessity to observe the clusters at least once every two or three years. When there are ten-year gaps between series of observations, it becomes difficult in many cases, to know how to draw the diagram.

From this investigation, it does not appear that the period changes are caused by the effects of evolution. However, the time is approaching when we might expect to be able to determine such changes.

Acknowledgements

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