DET KGL. DANSKE VIDENSKABERNES SELSKAB
MATEMATISK-FYSISKE MEDDELELSER, BIND XXIV, NR. 18

THE MOTION OF COMET OLBERS 1815–1956

BY

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KØBENHAVN
I KOMMISSION HOS EJNAR MUNKSGAARD
1948

Printed in Denmark
Bianco Lunos Bogtrykkeri

Periodic Comet Olbers belongs to a group which comprises in addition the comets Westphal, Brorsen II-Metcalf, Pons-Brooks, and Halley. It was discovered 1815 March 6 by Olbers, then a doctor and amateur astronomer in Bremen. The comet was visible in telescopes during a period of 29 weeks, and was observed 346 times, the last observation being by Gauss with a 10-foot telescope of the Göttingen Observatory on August 25. After that day the comet disappeared in the twilight of the evening sky. The closest approach to the earth occured on May 26, the smallest distance being 1.37 astronomical units. Bessel in his paper[1] states that the comet was at that time just visible to the naked eye, so that it may be assumed that the magnitude was then 5^m—6^m. In the paper mentioned Bessel has published orbital elements of the comet and the perturbations of the orbit during the interval until the next transit of perihelion which according to these calculations was to take place 1887 February 9.

As Bessel, however, had not made use of all the observations in his determination of the elements, Ginzel in 1881 made a new calculation[2] using all available observations, revised positions of the comparison stars and improved values of the solar co-ordinates (Le Verrier). The following elements resulted:

A

T	= 1815 April 26.030146 m. B. T.	
Ω	= 62°51′22″75	Equatorial Elements Equinox 1815.0
i	= 51 29 34 01	
π	= 158 46 36 75	
$\log q$	= 0.08379982	
e	= 0.93114958	
U	= 73.9333	

[1] F. W. Bessel: Abhandlung der Königlichen Akademie der Wissenschaften in Berlin 1812—13. Page 119.

[2] F. K. Ginzel: Neue Untersuchungen über die Bahn des Olberschen Cometen und seine Wiederkehr. Haarlem, De Erven Loosjes 1881.

Ginzel further computed the perturbations of the comet from 1815 to 1887. His predicted time of the next perihelion passage was 1887 December 17.

The comet was rediscovered by Brooks on 1887 August 25 and could be observed during an interval of 45 weeks until 1888 July 5 when it was observed by Barnard with the 90-cm refractor of the Lick Observatory. Altogether the comet was now observed 326 times. The perihelion passage took place on 1887 October 8. The closest approach to the earth occurred practically at the same time, the minimum distance being 1.88 A. U. The magnitude was then about 9^m.

In a following paper Ginzel continued his investigation of the orbit, and in 1893 he published definitive elements computed from the observations 1887—1888[1]:

B

T =	1887 October 8.516025 m. B. T.	
Ω =	63°43′51″95	Equatorial Elements
i =	51 10 30 63	Equinox 1890.0
π =	159 38 6 58	
$\log q$ =	0.0788620	
e =	0.9311297	

In the same paper Ginzel published perturbations from 1815 to 1887 without obtaining satisfactory agreement between observation and calculation, however, and the work was not completed.

Rather than continuing Ginzel's calculations I decided to solve the problem in a different manner, taking for a model Cowell's and Crommelin's calculation of the motion of Halley's comet from 1759 to 1910[2]. I set myself the following task:

I. The elements of 1887 have to be corrected until they give a satisfactory agreement between observation and calculation in 1887—88 as well as in 1815, when the perturbations of all the major planets during the time interval in question are taken into account.

[1] F. K. Ginzel: Veröffentlichungen des Rechen-Instituts der Königlichen Sternwarte zu Berlin Nr. 3.

[2] P. H. Cowell and A. C. D. Crommelin: Essay on the Return of Halleys Comet. Publication der Astronomischen Gesellschaft No. 23 1910 Greenwich Observations 1910.

II. On the basis of the corrected elements thus obtained the motion should be followed up to the time of the next perihelion passage, account being again taken of the perturbations of all the major planets, and an ephemeris calculated for the coming apparition.

The method I have used in the calculation of the motion of the comet is that of numerical integration of rectangular equatorial co-ordinates.

The integration can be carried out in various ways. Thus, Cowell and Crommelin made use of the following relations

$$x_0^{II} = f_0 + \frac{1}{12} f_0^{II} - \frac{1}{240} f_0^{IV} + \cdots \quad \left(f_0 = w^2 \frac{d^2x}{dt^2}\right)$$

$$x_{+1} = 2x_0 - x_{-1} + x_0^{II}.$$

In Noumerov's method a table of σ is employed, where

$$\sigma\left(1 - \frac{\sigma}{12}\right)^2 = \frac{w^2 k^2}{r^3}.$$

The aim is similar in both methods, namely, to eliminate extrapolation as far as possible, and thus to make it possible to use a greater interval of integration. Both methods have certain drawbacks, however. Thus, in Noumerov's method the table of σ is calculated with the value of the Gaussian constant corresponding to the solar mass equal to 1, so that it cannot be used directly when it is desired to take account of the influence of the inner planets by the substitution of $k^2(1+m)$ for k^2.

I have preferred to make use of the classical method of numerical integration

$$x_0 = {}^{II}f_0 + \frac{1}{12} f_0 - \frac{1}{240} f_0^{II} + \cdots \quad \left(f_0 = w^2 \frac{d^2x}{dt^2}\right).$$

in which the second and the following terms are extrapolated. After a rigorous calculation of $\frac{d^2x_0}{dt^2}$, the calculation then proceeds one interval by

$$\cdots\cdots {}^{II}f_{+1} = 2\,{}^{II}f_0 - {}^{II}f_{-1} + f_0.$$

This is the method of integration that has been used in the extensive calculations of orbits in the three-body problem that have been carried out at the Copenhagen Observatory for half a century under the direction of Thiele, Burrau, and E. Strömgren. In this connection a paper[1] by E. Strömgren (1900) on the applicability of the method to problems of celestial mechanics should be mentioned.

In the calculation of the perturbations it is necessary to know the rectangular co-ordinates of the major planets during the time interval of two revolutions of the comet. For Jupiter, Saturn, Uranus, and Neptune the co-ordinates and the attractions on the sun are given for the time interval 1900 to 1960 in Nautical Almanac Office Publications[2]. For Venus, the earth, and Mars similar tables are available, but only from 1920 to 1960. For the time interval 1815 to 1900 I have myself calculated the co-ordinates for Jupiter, Saturn[3], Uranus, and Neptune[4], and for 1887 also those of Venus, the earth, and Mars. The perturbations by Mercury have been taken into account approximately only, by the use of the combined mass of the sun and Mercury, equal to 1.00000014, and the corresponding value of the Gaussian constant $k^2 = 0.000295\,912250$.

The perturbations and attractions on the sun by Venus, the earth, and Mars have only been taken into account in the time interval from 1887 January 8 to 1888 September 19 as well as from 1955 August 21 to 1956 July 6. Outside these intervals the distance of the comet from the sun is so great that the procedure of adding the masses of the four inner planets to that of the sun and using the corresponding Gaussian constant $k^2 = 0.000295\,913969$ gives quite sufficient accuracy, and of course it is very much simpler.

[1] E. Strömgren: Über Mekanische Integration und deren Verwendung für numerische Rechnungen auf dem Gebiete des Drei-Körper-Problemes. Meddelanden från Lunds Astronomiska Observatorium Nr. 13.

[2] H. M. Nautical Almanac Office: Planetary Co-ordinates for the Years 1800—1940 and 1940—1960.

[3] H. Q. Rasmusen: Äquatoreale Jupiter- und Saturn-Koordinaten für den Zeitraum 1800—1900. Astronomische Nachrichten Nr. 6172.
Publikationer og mindre Meddelelser fra Københavns Observatorium Nr. 107.

[4] H. Q. Rasmusen: Äquatoreale Uranus- und Neptun-Koordinaten für den Zeitraum 1800—1903. Astronomische Nachrichten 269, 3.
Publikationer og mindre Meddelelser fra Københavns Observatorium Nr. 121.

The method just indicated does not take account of the attractions of the four inner planets on the sun. These attractions change so rapidly with time that already with an interval of 20 days the higher differences of the attractions would vary irregularly if the attractions in question were included in the calculations, and it would become impossible to use the regularity of the higher differences as a check on the numerical calculations. The reason is, of course, the relatively short periods of the inner planets.

A more rigorous method for the calculation of the motion would be the use of an interval that was never greater than 10 days. This, however, would be an immense task. There are also other ways in which the difficulty might be overcome. It is possible, for instance, to carry out the integration in a co-ordinate system the origin of which coincides with the centre of gravity of the sun and the four inner planets, or that of the sun and all the major planets. When the calculation is started, all co-ordinates and velocities are reduced to this co-ordinate system with the aid of simple formulae, and the attractions of the planets on the sun do not enter into the calculation any more. When the integration has been completed the co-ordinates and velocities are reduced back to the standard co-ordinate system with the sun in the origin. Cowell and Crommelin made use of this method in their calculations of the motion of Halley's comet. The method has the drawback, however, that the co-ordinates of Jupiter, Saturn, Uranus, and Neptune, and also that of the sun, have to be reduced to the centre of gravity. In the present investigation the co-ordinate system with the sun at the origin has been used throughout. The perturbations by Jupiter, Saturn, Uranus, and Neptune have been taken into account rigorously throughout the whole time interval. The attraction of Mercury on the sun has been omitted. The attractions of Venus, the earth, and Mars on the sun and on the comet have been calculated rigorously for those time intervals around the perihelions in 1887 and 1956 where the interval of integration was 5 or 10 days, i. e. for that part of the orbit for which the distance of the comet from the sun is smaller than about 4 A. U. Throughout the rest of the orbit the modified Gaussian constant was used while the attractions of the four inner planets on the sun were ignored. It is advisable to make the change-over at a time of a superior con-

junction of Venus and the sun, since the attractions of Venus and the earth on the sun then cancel approximately, so that the differences run rather smoothly in spite of the change-over.

For 1815 no account was taken of Venus, the earth, and Mars, since the effects would be without any consequence, because the integration terminates here.

The mass of Pluto is assumed to be between 0.5 and 1 in units of the earth's mass. The attraction of Pluto on the sun must therefore be less than $2 \cdot 10^{-8}$ for an interval of 160 days. The influence on the comet is of the same order of magnitude, as the distance between Pluto and the comet is quite large all the time. Thus the eighth decimal of the calculation is influenced. Since, however, the mass of Pluto is so uncertain, I decided not to take account of this planet, as I feared that the accuracy of the calculation might hereby actually be diminished.

For the same reason I have made no attempt to take account of the attractions of the asteroids. In examining the motion of the comet in the neighbourhood of the asteroid ring it is noted that the cometary orbit passes through the ecliptic at a distance of 1.5 A. U. from the sun, and that the angle of the orbit with the ecliptic at this point is rather large, since the inclination is 44°, and the angle between the node and the perihelion 65°. Therefore the duration of the passage of the comet through the asteroid region is relatively short. Since the majority of the asteroids have distances of 2—3 A. U. from the sun, and since the total mass is very small and evenly distributed around the sun, the attractions on the sun can be neglected.

However, the total attraction of the asteroids on the comet in the outer part of its orbit might be of some influence. According to an investigation by G. Stracke[1] the total mass of the asteroids up to 1024 is 1:864 of the earth's mass, or 1:285 000 000 in units of the solar mass (upper limit). The sum of the masses of the sun and the asteroids being 1.0000 000035, the period

$$P = \frac{2\pi}{\mu} = \frac{2\pi}{k} a^{3/2}$$

is increased by 0.000 00013 years, or 4 seconds (upper limit).

[1] G. Stracke: Die kleine Planeten. Ergebnisse der exakten Naturwissenschaften. Band 4.

From the available observations of Comet Olbers the following normal places have been derived[1]. The times have been reduced to Greenwich Mean Time, reduced from noon before 1925.0, from midnight (Universal Time) after 1925.0. All the observations have been reduced to the equinox 1950.0, and this equinox has been used throughout in the present investigation.

Normal Places.

				α	δ
1	1815	Mar.	16.96279	54°52′ 2″.1	+ 37°50′16″.6
2			30.96279	61 56 46 .7	44 50 7 .3
3		Apr.	9.96279	69 2 35 .8	49 44 6 .0
4			21.96279	80 46 45 .4	55 11 2 .7
5		May	4.96279	98 56 10 .8	59 41 17 .5
6			15.96279	118 55 58 .3	61 10 30 .0
7			28.96279	144 5 16 .3	58 50 17 .2
8		Jun.	9.96279	163 38 40 .2	52 56 17 .1
9			23.96279	180 21 2 .7	43 23 33 .5
10		Jul.	5.96279	190 49 6 .0	34 31 55 .9
11			29.96279	206 1 52 .7	18 22 20 .1
12		Aug.	24.96279	218 32 35 .7	5 7 57 .2
13	1887		31.96279	136 25 45 .0	29 41 0 .9
14		Sep.	16.96279	155 9 46 .9	29 37 17 .2
15			27.96279	168 44 1 .7	28 9 50 .2
16		Oct.	20.96279	195 48 39 .2	21 39 44 .0
17		Nov.	12.96279	218 7 24 .6	13 9 51 .7
18		Dec.	2.96279	233 28 35 .7	6 31 23 .1
19			22.96279	245 53 30 .4	+ 1 21 40 .8
20	1888	Jan.	15.96279	257 45 22 .2	— 2 59 9 .1
21		Feb.	15.96279	268 49 15 .0	6 31 29 .3
22		Mar.	21.96279	275 12 40 .3	9 20 31 .6
23		Apr.	5.96279	275 37 47 .7	10 37 7 .5
24		Jun.	26.96279	257 11 54 .6	— 20 10 49 .1

The normal places given by Ginzel are called by him mean places. In the notation now used they are "apparent place minus

[1] F. K. Ginzel: Neue Untersuchungen über die Bahn des Olberschen Cometen und seine Wiederkehr. Haarlem, .De Erven Loosjes 1881. Page 6.
F. K. Ginzel: Veröffentlichungen des Rechen-Instituts der Königlichen Sternwarte zu Berlin Nr. 3. Page 28.

the (f, g, G)-terms", or the equivalent, namely, "mean place plus the (i, h, H)-terms". The aberration times have been applied to the times of observation. Thus the comparison between observation and calculation is made by computing the position with the aid of cometary and solar co-ordinates corresponding to the time given, namely, time of observation minus aberration time.

The following solar co-ordinates for the normal places are according to the tables of Le Verrier:

Solar co-ordinates.

	X	Y	Z
1	+ 0.995088	— 0.033410	— 0.014474
2	+ 0.978752	+ 0.186905	+ 0.081156
3	+ 0.932278	+ 0.338478	+ 0.146943
4	+ 0.840568	+ 0.506847	+ 0.220027
5	+ 0.701922	+ 0.665241	+ 0.288769
6	+ 0.557592	+ 0.774354	+ 0.336131
7	+ 0.362786	+ 0.868615	+ 0.377035
8	+ 0.167256	+ 0.918930	+ 0.398872
9	— 0.068786	+ 0.930393	+ 0.403837
10	— 0.268641	+ 0.899554	+ 0.390448
11	— 0.628043	+ 0.731380	+ 0.317439
12	— 0.901775	+ 0.417743	+ 0.181295
13	— 0.945095	+ 0.323472	+ 0.140327
14	— 1.000929	+ 0.078756	+ 0.034157
15	— 0.996184	— 0.094017	— 0.040803
16	— 0.873319	— 0.437242	— 0.189708
17	— 0.613577	— 0.711710	— 0.308783
18	— 0.306337	— 0.859162	— 0.372755
19	+ 0.038354	— 0.901508	— 0.391123
20	+ 0.441924	— 0.806338	— 0.349826
21	+ 0.839372	— 0.478609	— 0.207636
22	+ 0.995681	+ 0.050295	+ 0.021834
23	+ 0.952783	+ 0.283153	+ 0.122859
24	— 0.124248	+ 0.925714	+ 0.401619

The elements B which form the starting point of my investigation are somewhat uncertain with regard to the semi-major axis a, and hence with regard to the period. In order to determine

better values of a and P it is necessary to calculate the perturbed motion back to 1815 and to compare with the observations of that year.

We reduce elements B to the normal equinox 1950.0 and to Greenwich Mean Time. Thus we get:

Epoch 1887 Oct. 5.5. G. M. T.

$$B_{\mathrm{I}} \begin{cases} T = 1887\ \text{Oct.}\ 8.478815 \\ \omega = 96^\circ\ 5'31''.45 \\ \Omega = 64\ 22\ 51\ .68 \\ i = 50\ 52\ 29\ .13 \\ e = 0.9311297 \\ a = 17.411250 \end{cases} \left.\begin{matrix} \\ \\ \\ \end{matrix}\right\} \text{Equator } 1950.0$$

and the corresponding equatorial constants:

$$\begin{aligned} P_x &= -0.611656063 & Q_x &= -0.369558583 \\ P_y &= +0.175608284 & Q_y &= -0.925552969 \\ P_z &= +0.771387446 & Q_z &= -0.082329548 \end{aligned}$$

For practical reasons the date of osculation has been changed from 1887 October 8.5 to 1887 October 5.5. This is permissible, since the elements have to be improved anyway, and since the corrections to be expected are much larger than the small differences thus introduced. We now calculate the co-ordinates and velocities for 1887 October 5.5.

Co-ordinates and velocities.

$$\begin{aligned} x &= -0.70886407 & 10\frac{dx}{dt} &= -0.084359783 \\ y &= +0.27058629 & 10\frac{dy}{dt} &= -0.200820211 \\ z &= +0.92963296 & 10\frac{dz}{dt} &= -0.013234677 \end{aligned}$$

With these values the numerical integration is started. The time interval 1887—1815 is covered by 250 integration intervals of 10, 20, 50, 100, 200, 100, 50, and 25 days, respectively. The

co-ordinates are given in Table I. Finally the following osculating elements are deduced from the co-ordinates and velocities for 1815 June 25.5.

Epoch 1815 Jun. 25.5. G. M. T.

$$A_{\mathrm{I}}\left\{\begin{array}{rl} T = & 1815\ \text{Jan.}\ 20.8646 \\ \omega = & 96^\circ 18' 35''.80 \\ \Omega = & 64\ 18\ 43\ .34 \\ i = & 50\ 49\ 53\ .33 \\ e = & 0.9317807 \\ a = & 17.76309 \end{array}\right.\quad \left.\begin{array}{l}\\ \\ \\ \\ \\ \\ \end{array}\right\}\ \text{Equator 1950.0}$$

These elements give only a bad fit with the observations of 1815. The principal reason for the discrepancy is the error of the computed perihelion time. According to the elements A, calculated from the observations of 1815, the perihelion passage took place 1815 April 25.9929. This is $95^{\mathrm{d}}.1283$ later than the perihelion time computed by carrying back the elements B_{I}. Therefore, a correction of the perihelion time of the elements A_{I} equal to $+95^{\mathrm{d}}.1283$ is required. Introducing this, the difference between observation and calculation is reduced to a few minutes of arc. It is clear that the principal source of the error of the elements A_{I} is the error of the semi-major axis of the elements B_{I}, this quantity being slightly too large. We therefore correct the element a of B_{I} by -0.041640, a correction calculated so as to give a change in the period equal to $-95^{\mathrm{d}}.1283$, corresponding to the determined error of the perihelion time in 1815. Next the corrections to the other elements were found from Ginzel's equations of condition[1] through a process of introducing $da = -0.041640$ as a known quantity and eliminating dq.

From

$$q = a\,(1 - e)$$

one finds

$$\frac{dq}{q} = \frac{da}{a} - \frac{de}{1-e},$$

[1] F. K. Ginzel: Veröffentlichungen der Rechen-Instituts der Königlichen Sternwarte zu Berlin Nr. 3, page 31. Here is a misprint in equation VII. Instead of 9.9633 read 9.6633. Moreover Ginzel has made a miscalculation in this section; on the seventh line from the bottom of page 32. $dT = +0.005355$ ought to be $dT = +0.002684$. This error appears in the elements on page 33 Instead of $T =$ October 8.516025 read 8.513354. The error recurs in the present investigation in the elements B^{I}, but the following correction of the elements makes it disappear.

hence

$$d \log_{10} q = 0.434294 \frac{\frac{1}{a}(1-e)\, da - de}{1-e}.$$

Solving the reduced equations of condition by the method of least squares we get the following corrections to the elements B_{I}:

$$\begin{aligned} dT &= -0^{\mathrm{d}}.00288 \\ d\omega &= -4''.481 \\ d\Omega &= +0''.455 \\ di &= +0''.843 \\ de &= -0.0001646 \\ da &= -0.041640 \end{aligned}$$

Applying these corrections to the elements B_{I}, we get the following system of elements:

Epoch 1887 Oct. 5.5. G. M. T.

B_{II}

T =	1887 Oct. 8.47594	
ω =	96° 5′26″.97	Equator 1950.0
Ω =	64 22 52.14	Equator 1950.0
i =	50 52 29.97	Equator 1950.0
e =	0.9309651	
a =	17.369610	

$$\begin{aligned} P_x &= -0.611645591 & Q_x &= -0.369570105 \\ P_y &= +0.175625663 & Q_y &= -0.925549834 \\ P_z &= +0.771391793 & Q_z &= -0.082313064 \end{aligned}$$

As a check we compare these elements with the observations from 1887—88. In order to be able to do so we must know the perturbations from the date of osculation 1887 October 5.5 up to the times of the normal places. These perturbations are given in Ginzel's paper. Since, however, the elements had been changed appreciably, I decided to recalculate the perturbations with the aid of the elements B_{II}. In these calculations I used Encke's method. In this way the following perturbations, interpolated to the times of the normal places, are obtained.

1887—88	ξ	η	ζ	Pa	$P\delta$
13	0	0	— 9	0″.0	—0″.1
14	0	0	— 3	0.0	0.0
15	0	0	0	0.0	0.0
16	— 1	— 2	— 3	0.0	0.0
17	— 4	— 12	— 22	+ 0.1	—0.2
18	— 10	— 33	— 53	+ 0.1	—0.5
19	— 20	— 69	— 106	+ 0.1	—1.0
20	— 46	— 139	— 197	— 0.1	—1.6
21	— 122	— 282	— 365	— 1.0	—2.7
22	— 314	— 536	— 640	— 3.9	—4.8
23	— 448	— 684	— 788	— 5.6	—6.0
24	—2119	—2142	—2023	—13.6	—8.2

It is now possible to compare elements B_{II} with the observations. The following result is obtained:

1887—88	$\Delta a \cos\delta$	$\Delta\delta$
13	— 1″.4	+ 0″.5
14	+ 0.7	+ 0.8
15	+ 0.4	— 1.4
16	+ 1.4	— 1.2
17	+ 3.8	— 0.6
18	— 0.4	— 1.9
19	— 0.9	— 2.3
20	— 5.4	— 1.8
21	— 5.5	— 0.1
22	— 6.2	+ 5.6
23	—11.5	+ 0.9
24	+ 1.7	+10.6

The agreement is as good as could be expected. Therefore, it now only remains to obtain a confirmation of the adopted value of the period by a comparison with the observations in 1815. Since the difference between the elements B_I and B_{II} is rather large, however, the perturbations calculated with B_I cannot be regarded as sufficiently accurate. It is therefore neces-

sary to repeat the whole calculation of the motion 1887—1815, using now the elements B_{II}. The integration is started with the following co-ordinates and velocities:

$$x = -0.70887065 \qquad 10\frac{dx}{dt} = -0.08435565$$

$$y = +0.27054523 \qquad 10\frac{dy}{dt} = -0.20081286$$

$$z = +0.92962634 \qquad 10\frac{dz}{dt} = -0.01323487$$

The time interval is covered by 290 intervals of 10, 20, 50, 100, 200, 100, 50, 25, and $12^1/_2$ days (Table II).

The following osculating elements are derived for 1815 June 25.5:

Epoch 1815 June 25.5. G. M. T.

A_{II}

T =	1815 May 1.1170	
ω =	96°21′ 4″.00	Equator 1950.0
Ω =	64 18 47 .15	
i =	50 49 14 .82	
e =	0.9317235	
a =	17.76603	

These leave the following residuals observation minus calculation

1815	$\Delta\alpha$	$\Delta\delta$
1	−0° 1′19″.3	+3° 0′32″.4
2	+0 16 5 .3	+3 11 41 .9
3	+0 43 10 .4	+3 17 50 .7
4	+1 45 5 .6	+3 19 32 .5
5	+3 44 50 .6	+3 3 25 .7
6	+5 50 23 .8	+2 22 29 .4
7	+7 6 21 .5	+1 1 17 .2
8	+6 27 7 .0	−0 14 58 .3
9	+4 55 38 .0	−1 14 20 .1
10	+3 47 11 .7	−1 37 48 .3
11	+2 19 32 .9	−1 39 1 .9
12	+1 29 43 .2	−1 16 49 .9

The discrepancies are still too large, but it is possible to reduce them to the magnitude of the uncertainty of the observations, $\pm 15''$, by a change of perihelion time in the elements A_{II} to 1815 April 26.0000. It must therefore be assumed that the remaining error of the period of the elements B_{II} is $5^d.1170$. This corresponds to a correction in a equal to $+0.002241$, so that the correct value of a in 1887 should be 17.371851.

The reason why the first improvement of the elements did not lead to the correct result is that the perturbations of the first integration 1887—1815 are somewhat in error due to the errors of the elements upon which that integration was based. In particular the relatively large change in a has resulted in rather large changes in the perturbations.

We now repeat the process of improvement of the elements, assuming a correction $da = -0.039399$ of the elements B_I corresponding to a change of the period of $90^d.0142$. For the other elements the changes will not differ very much from those resulting from the first improvement process. I have, therefore, simply used the former corrections reduced in the ratio of the two corrections of the perihelion time 90.0142:95.1283, instead of repeating the solution of the reduced equations of condition by the method of least squares. The new corrections are:

$$\begin{aligned} dT &= -0^d.00272 \\ d\omega &= -4''.240 \\ d\Omega &= +0''.431 \\ di &= +0''.798 \\ de &= -0.0001557 \\ da &= -0.039399 \end{aligned}$$

Applying these corrections to the elements B_I we finally get the following elements:

Epoch 1887 Oct. 5.5. G. M. T.

B_{III}

T =	1887 Oct. 8.47609	
ω =	96° 5′27″.21	Equator 1950.0
Ω =	64 22 52.11	
i =	50 52 29.93	
e =	0.9309740	
a =	17.371851	

$$\begin{aligned} P_x &= -0.611646134 & Q_x &= -0.369569514 \\ P_y &= +0.175624739 & Q_y &= -0.925549992 \\ P_z &= +0.771391572 & Q_z &= -0.082313951 \end{aligned}$$

A useful summary of the perturbations and their changes with the assumed elements is obtained by subtracting elements B_{I} from A_{I}, and B_{II} from A_{II}. The perturbation in perihelion time, however, is obtained by subtracting $(T_{1887} - 360 : \mu_{1887})$ from the value of T_{1815} which is obtained as the osculating T corresponding to the co-ordinates and velocities for 1815 June 15.5. For the two orbits we thus get the following two sets of perturbations, and the differences between the two sets:

	Orbit I	Orbit II	II — I
PT =	+ 22.$^{\mathrm{d}}$1318	+ 17.$^{\mathrm{d}}$0148	— 5.$^{\mathrm{d}}$1170
$P\omega$ =	+ 13′ 4″.35	+ 15′37″.03	+ 2′32″.68
$P\Omega$ =	— 4 8.34	— 4 4.99	+ 3.35
Pi =	— 2 35.80	— 3 15.15	— 39.35
Pe =	+ 0.0006510	+ 0.0007584	+ 0.0001074
Pa =	+ 0.35184	+ 0.39642	+ 0.04458

The differences are not particularly great, and it may therefore be assumed that the perturbations obtained through the second integration are close to the true values. Applying these perturbations to the elements B_{III} we obtain the following elements A_{III} valid for 1815 June 25.5

Epoch 1815 June 25.5. G. M. T.

$$A_{\mathrm{III}} \begin{cases} T = 1815 \text{ April } 25.9999 \\ \omega = 96°21′\ 4″.24 \\ \Omega = 64\ 18\ 47.12 \\ i = 50\ 49\ 14.78 \\ e = 0.9317324 \\ a = 17.76827 \end{cases} \left.\begin{matrix} \\ \\ \\ \end{matrix}\right\} \text{Equator } 1950.0$$

The perihelion time, however, has been calculated as follows:

$$T_{1815} = T_{1887} - \frac{360}{\mu_{1887}} + PT.$$

Comparison with elements A (cf. p. 3) shows that this perihelion time is close to the true value.

According to Bessel and Ginzel the perturbations in α and δ within the time interval of observations in 1815 are of the order

of magnitude of 1″. Therefore they could safely be neglected. Comparisons of the elements A_{III} with the observations of 1815 and the elements B_{III} with the observations of 1887—88 give the following result:

1815	$\Delta\alpha \cos\delta$	$\Delta\delta$	1887-88	$\Delta\alpha \cos\delta$	$\Delta\delta$
1.....	— 22″.5	— 7″.5	13.....	— 1″.0	+ 0″.5
2.....	— 11.4	+ 3.6	14.....	+ 1.3	+ 0.8
3.....	— 10.2	+ 5.5	15.....	+ 0.4	— 1.6
4.....	— 10.5	+ 4.1	16.....	+ 2.8	— 1.4
5.....	— 5.0	+ 0.2	17.....	+ 3.6	— 0.5
6.....	+ 0.1	+ 14.9	18.....	— 0.3	— 1.9
7.....	+ 5.8	+ 1.0	19.....	— 0.7	— 2.4
8.....	+ 1.6	— 1.3	20.....	— 5.4	— 1.8
9.....	— 9.1	— 3.2	21.....	— 5.2	— 0.1
10.....	+ 6.9	— 4.5	22.....	— 5.9	+ 5.6
11.....	+ 12.0	— 29.7	23.....	— 11.0	+ 0.7
12.....	+ 15.2	— 12.0	24.....	+ 1.9	+ 10.2

The agreement can now be considered as rather satisfactory when the inaccuracy of the old observations is kept in mind. A third integration based on elements B_{III} would undoubtedly yield practically correct values of the perturbations 1887—1815 and possibly lead to a still better agreement with the observations in 1815.

However, I have come to the conclusion that it should not be necessary to carry out this third integration. It is estimated that the uncertainty of the period of the elements B_{III} is less than 12 hours.

Reducing now the equatorial elements B_{III} to ecliptic elements we find:

Epoch 1887 Oct. 5.5. G. M. T.

$$B_{III\,a}\begin{cases} T = 1887\ \text{Oct.}\ 8.47609 \\ \omega = 65°20'47''.11 \\ \Omega = 85\ 22\ 6.89 \\ i = 44\ 34\ 16.75 \\ e = 0.9309740 \\ a = 17.371851 \\ P = 72^{y}.4051 \end{cases} \left.\begin{matrix} \\ \\ \\ \\ \\ \\ \end{matrix}\right\} \begin{matrix} \text{Ecliptic} \\ 1950.0 \end{matrix}$$

II

Elements B_{III} (B_{IIIa}) now form the basis of a calculation of the motion of the comet from 1887 to the next perihelion passage. As before we calculate co-ordinates and velocities for the epoch of osculation 1887 October 5.5.

$$x = -0.70887009 \qquad 5\frac{dx}{dt} = -0.04217794$$

$$y = +0.27054729 \qquad 5\frac{dy}{dt} = -0.10040665$$

$$z = +0.92962642 \qquad 5\frac{dz}{dt} = -0.00661743$$

The intervals are now chosen so as to correspond to those used in the Nautical Almanac Tables of Planetary Co-ordinates 1900—1960. The numerical integration is started with an interval of integration equal to 5 days. The interval is then successively changed to 10, 20, 40, 80, 160, 80, 40, 20, and 10 days. The time interval 1887—1956 is covered by 325 intervals. Table III gives the co-ordinates of the comet x, y, z, the attractions of the planets on the comet

$$\sum' X' = \sum 10^9 w^2 k^2 m_1 \frac{x - x_1}{\Delta^3}$$

$$\sum' Y' = \sum 10^9 w^2 k^2 m_1 \frac{y - y_1}{\Delta^3}$$

$$\sum' Z' = \sum 10^9 w^2 k^2 m_1 \frac{z - z_1}{\Delta^3}$$

and the attractions of the planets on sun

$$\sum' X = \sum 10^9 w^2 k^2 m_1 \frac{x_1}{r_1^3}$$

$$\sum' Y = \sum 10^9 w^2 k^2 m_1 \frac{y_1}{r_1^3}$$

$$\sum' Z = \sum 10^9 w^2 k^2 m_1 \frac{z_1}{r_1^3}$$

As a result of the integration we obtain co-ordinates and velocities for 1956 June 16, and osculating elements corresponding to these values.

Epoch 1956 June 16.0. G. M. T. (U. T.)

$$C \begin{cases} T = 1956 \text{ June } 15.8673 \\ \omega = 64^\circ 38' 10''.21 \\ \Omega = 85\ 24\ 55\ .19 \\ i = 44\ 36\ 35\ .80 \\ e = 0.9303273 \\ a = 16.91523 \\ P = 69^y.5692 \end{cases} \quad \text{Ecliptic 1950.0}$$

$$P_x = -0.6069823 \qquad Q_x = -0.3762061$$
$$P_y = +0.1864259 \qquad Q_y = -0.9236804$$
$$P_z = +0.7725399 \qquad Q_z = -0.0726855$$

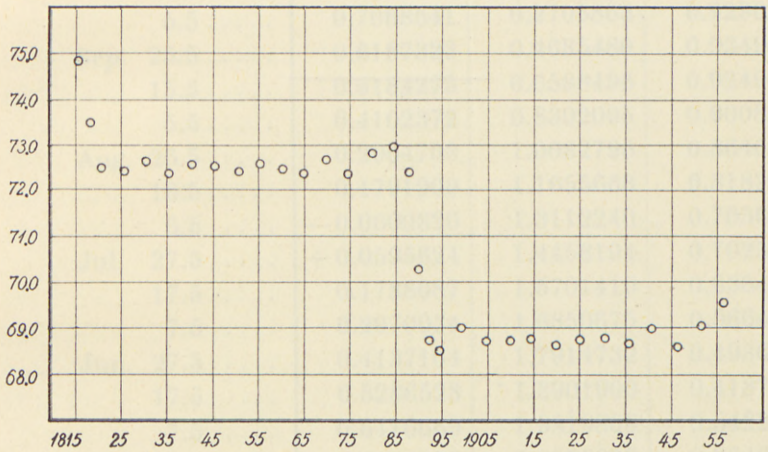
With the aid of the co-ordinates in Table III I have calculated a search ephemeris from 1955 August 1 to 1956 June 16 (Table IV). The ephemeris gives right ascension and declination for the equinox 1950.0 together with the heliocentric distance r and the geocentric distance Δ. It appears from the ephemeris that the comet will be somewhat more favourably placed for observation than in the previous apparition. Also the minimum geocentric distance is somewhat smaller than in 1887—88. Table V gives the precession from the equinox 1950.0 to 1955.0—1956.0 and the corrections of right ascension and declination for T one day later.

It appears from an inspection of elements B_{III} and the computed time of revolution 1815—1887 that the period of Comet Olbers is about 72.4 years. Accordingly one would expect the next passage of perihelion to take place in March 1960. It is, therefore, perhaps somewhat surprising to find from the integration that the comet will reach perihelion again already 1956 June 15, or nearly four years earlier than expected. The reason is that the comet during the years 1888—89 came relatively close to Jupiter. In January 1889 the distance was only 1.5 A. U. This approach to Jupiter reduced the velocity of the comet and thus lead to a diminution of the semi-major axis and the period.

On 1887 July 28 the comet passed Mars at a small distance,

not more than 0.08 A. U. The influence of this passage on the velocity of the comet was small, however, because of the small mass of the planet. The following table (Table VI) gives a summary of the distances between the comet and the major planets.

During the time interval 1815—1956 the osculating period of the comet changes appreciably. This is shown graphically in the accompanying figure. This figure clearly shows the great change



in the period that took place in connection with the approach to Jupiter in 1889.

Through the calculations described above the problems formulated on p. 4 have been solved. The observations during the coming apparition will indicate the magnitude of the remaining errors of the elements obtained.

In making the calculations 8 decimals have been retained in the summations and differences, and 9 decimals in the calculations of the perturbations. The tables given in this paper have been abridged to 7 decimals in the co-ordinates, since the accumulated effect of rounding-off errors leads to an uncertainty greater than one unit of the eighth decimal even in the orbit of the comet, while the corresponding error of the position in the orbit is still greater. The calculations have been checked by differencing whenever that was possible. All reductions as well as the calculations required for starting the integrations have

been checked independently. I gratefully acknowledge the help that JENS P. MÖLLER, M. Sc., and B. SVANHOF, M. Sc., have given me in making these checks. The entire first integration (I) was carried out by OLE HESSELBERG, M. Sc. I also gratefully acknowledge the great help the Carlsberg Foundation has rendered me in placing a calculating machine at my disposal.

Værslevgaarden, April 1947.

Indleveret til Selskabet den 27. Juni 1947.
Færdig fra Trykkeriet den 31. Juli 1948.

Table I.

G. M. T.			x	y	z
1887	Nov.	14.5	−0.9409739	−0.5340691	+0.7592007
		4.5	0.9028881	0.3373105	0.8215735
	Oct.	25.5	0.8516988	−0.1357067	0.8719958
		15.5	0.7869174	+0.0680232	0.9084808
		5.5	0.7088641	0.2705863	0.9296328
	Sep.	25.5	0.6187323	0.4685480	0.9349496
		15.5	0.5184275	0.6588496	0.9249171
		5.5	0.4102372	0.8392095	0.9008584
	Aug.	26.5	0.2964703	1.0082796	0.8646166
		16.5	0.1791900	1.1655668	0.8182165
		6.5	−0.0600826	1.3112240	0.7636092
	Jul.	27.5	+0.0595624	1.4458194	0.7025254
		17.5	0.1788087	1.5701419	0.6364235
		7.5	0.2970034	1.6850675	0.5664928
	Jun.	27.5	0.4137104	1.7914732	0.4936826
		17.5	0.5286528	1.8901900	0.4187419
		7.5	0.6416669	1.9819808	0.3422577
	May	28.5	0.7526682	2.0675329	0.2646890
		18.5	0.8616266	2.1474582	0.1863944
		8.5	0.9685494	2.2222983	0.1076539
	Apr.	28.5	1.0734681	2.2925315	+0.0286867
		18.5	1.1764303	2.3585794	−0.0503358
		8.5	1.2774933	2.4208141	0.1292793
	Mar.	29.5	1.3767197	2.4795643	0.2080387
		19.5	1.4741754	2.5351213	0.2865318
		9.5	1.5699261	2.5877436	0.3646945
	Feb.	27.5	1.6640377	2.6376612	0.4424771
		17.5	1.7565739	2.6850800	0.5198415
		7.5	1.8475968	2.7301835	0.5967584
	Jan.	28.5	1.9371658	2.7731371	0.6732060
		18.5	2.0253380	2.8140897	0.7491685
		8.5	2.1121685	2.8531776	0.8246336
1886	Dec.	19.5	2.2820044	2.9262255	0.9740484
		29.5	+2.4470561	+2.9931287	−1.1214235

Table I

G. M. T.	x	y	z
1886 Nov. 9.5	+ 2.6076667	+ 3.0545918	— 1.2667647
Oct. 20.5	2.7641444	3.1112069	1.4100989
Sep. 30.5	2.9167658	3.1634759	1.5514659
10.5	3.0657800	3.2118274	1.6909138
Aug. 21.5	3.2114114	3.2566306	1.8284952
1.5	3.3538630	3.2982049	1.9642651
Jul. 12.5	3.4933188	3.3368293	2.0982791
Jun. 22.5	3.6299459	3.3727480	2.2305928
2.5	3.7638967	3.4061765	2.3612603
May 13.5	3.8953104	3.4373056	2.4903345
Apr. 23.5	4.0243146	3.4663053	2.6178666
3.5	4.1510267	3.4933274	2.7439058
Mar. 14.5	4.2755544	3.5185080	2.8684992
Feb. 22.5	4.3979975	3.5419699	2.9916921
2.5	4.5184481	3.5638240	3.1135276
Jan. 13.5	4.6369917	3.5841709	3.2340472
1885 Dec. 24.5	4.7537078	3.6031020	3.3532901
4.5	4.8686702	3.6207007	3.4712939
Nov. 14.5	4.9819479	3.6370434	3.5880946
Oct. 25.5	5.0936054	3.6522000	3.7037262
5.5	5.2037029	3.6662349	3.8182216
Sep. 15.5	5.3122970	3.6792073	3.9316117
Aug. 26.5	5.4194407	3.6911719	4.0439265
6.5	5.5251841	3.7021794	4.1551942
Jul. 17.5	5.6295740	3.7122768	4.2654422
Jun. 27.5	5.7326550	3.7215075	4.3746964
7.5	5.8344688	3.7299122	4.4829817
May 18.5	5.9350550	3.7375286	4.5903218
Apr. 28.5	6.0344510	3.7443922	4.6967396
8.5	6.1326925	3.7505358	4.8022570
Mar. 19.5	6.2298132	3.7559904	4.9068949
Feb. 27.5	6.3258449	3.7607848	5.0106733
Jan. 8.5	6.5613569	3.7700579	5.2664846
1884 Nov. 19.5	+ 6.7906870	+ 3.7757540	— 5.5173251

Table I

G. M. T.	x	y	z
1884 Sep. 30.5 . . .	+ 7.0142238	+ 3.7782038	— 5.7034505
Aug. 11.5 . . .	7.2323146	3.7776948	6.0050940
Jun. 22.5 . . .	7.4452712	3.7744783	6.2424682
May 3.5 . . .	7.6533745	3.7687756	6.4757681
Mar. 14.5 . . .	7.8568791	3.7607822	6.7051732
Jan. 24.5 . . .	8.0560160	3.7506721	6.9308484
1883 Dec. 5.5 . . .	8.2509964	3.7386004	7.1529466
Oct. 16.5 . . .	8.4420134	3.7247064	7.3716093
Aug. 27.5 . . .	8.6292431	3.7091152	7.5869671
Jul. 8.5 . . .	8.8128494	3.6919402	7.7991428
May 19.5 . . .	8.9929823	3.6732841	8.0082500
Mar. 30.5 . . .	9.1697809	3.6532403	8.2143951
Feb. 8.5 . . .	9.3433739	3.6318940	8.4176775
1882 Dec. 20.5 . . .	9.5138811	3.6093233	8.6181905
Oct. 31.5 . . .	9.6814141	3.5856000	8.8160216
Sep. 11.5 . . .	9.8460767	3.5607901	9.0112532
Jul. 23.5 . . .	10.0079662	3.5349546	9.2039627
Jun. 3.5 . . .	10.1671736	3.5081499	9.3942231
Apr. 14.5 . . .	10.3237842	3.4804286	9.5821034
Feb. 23.5 . . .	10.4778782	3.4518393	9.7676689
Jan. 4.5 . . .	10.6295312	3.4224276	9.9509811
1881 Nov. 15.5 . . .	10.7788143	3.3922360	10.1320984
Aug. 7.5 . . .	11.0705362	3.3296704	10.4879673
Apr. 29.5 . . .	11.3535401	3.2644335	10.8356862
Jan. 19.5 . . .	11.6282729	3.1967839	11.1756263
1880 Oct. 11.5 . . .	11.8951396	3.1269528	11.5081250
Jul. 3.5 . . .	12.1545099	3.0551479	11.8334898
Mar. 25.5 . . .	12.4067229	2.9815566	12.1520024
1879 Dec. 16.5 . . .	12.6520917	2.9063488	12.4639213
Sep. 7.5 . . .	12.8909064	2.8296782	12.7694852
May 30.5 . . .	13.1234372	2.7516843	13.0689147
Feb. 19.5 . . .	13.3499364	2.6724934	13.3624152
1878 Nov. 11.5 . . .	13.5706406	2.5922199	13.6501777
Aug. 3.5 . . .	+ 13.7857715	+ 2.5109672	— 13.9323811

Table I

G. M. T.	x	y	z
1878 Apr. 25.5 . . .	+ 13.9955375	+ 2.4288286	— 14.2091930
Jan. 15.5 . . .	14.2001346	2.3458877	14.4807707
1877 Oct. 7.5 . . .	14.3997471	2.2622199	14.7472628
Jun. 29.5 . . .	14.5945485	2.1778927	15.0088096
Mar. 21.5 . . .	14.7847019	2.0929665	15.2655435
1876 Dec. 11.5 . . .	14.9703609	2.0074951	15.5175905
Sep. 2.5 . . .	15.1516698	1.9215268	15.7650697
May 25.5 . . .	15.3287645	1.8351045	16.0080947
Feb. 15.5 . . .	15.5017727	1.7482665	16.2467733
1875 Nov. 7.5 . . .	15.6708144	1.6610468	16.4812084
Jul. 30.5 . . .	15.8360024	1.5734758	16.7114980
Apr. 21.5 . . .	15.9974427	1.4855804	16.9377357
Jan. 11.5 . . .	16.1552350	1.3973845	17.1600110
1874 Oct. 3.5 . . .	16.3094727	1.3089094	17.3784093
Jun. 25.5 . . .	16.4602433	1.2201740	17.5930124
Mar. 17.5 . . .	16.6076290	1.1311950	17.8038984
1873 Aug. 29.5 . . .	16.8925475	0.9525643	18.2148159
Feb. 10.5 . . .	17.1647824	0.7731189	18.6117240
1872 Jul. 25.5 . . .	17.4248123	0.5929425	18.9951380
Jan. 7.5 . . .	17.6730457	0.4121096	19.3655290
1871 Jun. 21.5 . . .	17.9098265	0.2306950	19.7233252
1870 Dec. 3.5 . . .	18.1354416	+ 0.0487830	20.0689134
May 17.5 . . .	18.3501316	— 0.1335218	20.4026365
1869 Oct. 29.5 . . .	18.5541049	0.3160883	20.7247959
Apr. 12.5 . . .	18.7475571	0.4987527	21.0356524
1868 Sep. 24.5 . . .	18.9306884	0.6813245	21.3354307
Mar. 8.5 . . .	19.1037210	0.8635963	21.6243270
1867 Aug. 21.5 . . .	19.2669073	1.0453596	21.9025180
Feb. 2.5 . . .	19.4205300	1.2264219	22.1701704
1866 Jul. 17.5 . . .	19.5648930	1.4066199	22.4274474
1865 Dec. 29.5 . . .	19.7003101	1.5858270	22.6745132
Jun. 12.5 . . .	19.8270902	1.7639556	22.9115343
1864 Nov. 24.5 . . .	19.9455277	1.9409537	23.1386796
May 8.5 . . .	+ 20.0558940	— 2.1167996	— 23.3561179

Table I

G. M. T.	x	y	z
1863 Oct. 21.5 . . .	+ 20.1584335	— 2.2914966	— 23.5640168
Apr. 4.5 . . .	20.2533604	2.4650659	23.7625406
1862 Sep. 16.5 . . .	20.3408591	2.6375446	23.9518493
Feb. 28.5 . . .	20.4210816	2.8089776	24.1320972
1861 Aug. 12.5 . . .	20.4941485	2.9794165	24.3034319
Jan. 24.5 . . .	20.5601474	3.1489140	24.4659925
1860 Jul. 8.5 . . .	20.6191331	3.3175190	24.6199088
1859 Dec. 21.5 . . .	20.6711270	3.4852705	24.7652978
Jun. 4.5 . . .	20.7161201	3.6521905	24.9022624
1858 Nov. 16.5 . . .	20.7540762	3.8182754	25.0308873
Apr. 30.5 . . .	20.7849416	3.9834882	25.1512362
1857 Oct. 12.5 . . .	20.8086762	4.1477528	25.2633502
Mar. 26.5 . . .	20.8251759	4.3109544	25.3672481
1856 Sep. 7.5 . . .	20.8344781	4.4729446	25.4629304
Feb. 20.5 . . .	20.8365846	4.6335554	25.5503829
1855 Aug. 4.5 . . .	20.8315617	4.7926174	25.6295895
Jan. 16.5 . . .	20.8195147	4.9499750	25.7005353
1854 Jun. 30.5 . . .	20.8005795	5.1054993	25.7632127
1853 Dec. 12.5 . . .	20.7749073	5.2590947	25.8176248
May 26.5 . . .	20.7426508	5.4106990	25.8637853
1852 Nov. 7.5 . . .	20.7039536	5.5602801	25.9017150
Apr. 21.5 . . .	20.6589422	5.7078307	25.9314422
1851 Oct. 4.5 . . .	20.6077241	5.8533622	25.9529971
Mar. 18.5 . . .	20.5503805	5.9969001	25.9664123
1850 Aug. 30.5 . . .	20.4869704	6.1384787	25.9717189
Feb. 11.5 . . .	20.4175253	6.2781383	25.9689460
1849 Jul. 26.5 . . .	20.3420501	6.4159201	25.9581188
Jan. 7.5 . . .	20.2605228	6.5518625	25.9392565
1848 Jun. 21.5 . . .	20.1728922	6.6859964	25.9123707
1847 Dec. 4.5 . . .	20.0790788	6.8183380	25.8774619
May 18.5 . . .	19.9789772	6.9488821	25.8345173
1846 Oct. 30.5 . . .	19.8724608	7.0775935	25.7835063
Apr. 13.5 . . .	19.7593923	7.2044009	25.7243783
1845 Sep. 25.5 . . .	+ 19.6396368	— 7.3291870	— 25.6570607

Table I

G. M. T.	x	y	z
1845 Mar. 9.5 . . .	+ 19.5130788	— 7.4518020	— 25.5814602
1844 Aug. 21.5 . . .	19.3796370	7.5720605	25.4974669
Feb. 3.5 . . .	19.2392739	7.6897630	25.4049605
1843 Jul. 18.5 . . .	19.0919982	7.8047116	25.3038187
1842 Dec. 30.5 . . .	18.9378549	7.9167252	25.1939222
Jun. 13.5 . . .	18.7769153	8.0256519	25.0751605
1841 Nov. 25.5 . . .	18.6092601	8.1313705	24.9474317
May 9.5 . . .	18.4349676	8.2337907	24.8106418
1840 Oct. 21.5 . . .	18.2541021	8.3328478	24.6647024
Apr. 4.5 . . .	18.0667085	8.4284967	24.5095270
1839 Sep. 17.5 . . .	17.8728074	8.5207061	24.3450284
Mar. 1.5 . . .	17.6723936	8.6094534	24.1711160
1838 Aug. 13.5 . . .	17.4654335	8.6947189	23.9876936
Jan. 25.5 . . .	17.2518649	8.7764833	23.7946567
1837 Jul. 9.5 . . .	17.0315951	8.8547213	23.5918908
1836 Dec. 21.5 . . .	16.8044999	8.9293984	23.3792687
Jun. 4.5 . . .	16.5704219	9.0004635	23.1566469
1835 Nov. 17.5 . . .	16.3291718	9.0678428	22.9238628
May 1.5 . . .	16.0805302	9.1314298	22.6807295
1834 Oct. 13.5 . . .	15.8242539	9.1910776	22.4270321
Mar. 27.5 . . .	15.5600863	9.2465903	22.1625232
1833 Sep. 8.5 . . .	15.2877726	9.2977198	21.8869213
Feb. 20.5 . . .	15.0070746	9.3441687	21.5999105
1832 Aug. 4.5 . . .	14.7177844	9.3856001	21.3011452
Jan. 17.5 . . .	14.4197304	9.4216528	20.9902538
1831 Jul. 1.5 . . .	14.1127742	9.4519559	20.6668455
1830 Dec. 13.5 . . .	13.7967999	9.4761430	20.3305130
May 27.5 . . .	13.4716977	9.4938554	19.9808328
1829 Nov. 8.5 . . .	13.137350	9.504742	19.617363
Apr. 22.5 . . .	12.793614	9.508453	19.239636
1828 Oct. 4.5 . . .	12.440316	9.504631	18.847154
Mar. 18.5 . . .	12.077238	9.492896	18.439377
1827 Aug. 31.5 . . .	11.704114	9.472840	18.015714
Feb. 12.5 . . .	+ 11.320629	— 9.444008	— 17.575517

Table I

G. M. T.	x	y	z
1826 Jul. 27.5	+ 10.926404	— 9.405892	— 17.118066
Jan. 8.5	10.521001	9.357911	16.642557
1825 Jun. 22.5	10.103908	9.299392	16.148087
Mar. 14.5	9.890798	9.265942	15.893427
1824 Dec. 4.5	9.674538	9.229554	15.633635
Aug. 26.5	9.455041	9.190109	15.368560
May 18.5	9.232214	9.147477	15.098042
Feb. 8.5	9.005958	9.101514	14.821910
1823 Oct. 31.5	8.776167	9.052065	14.539977
Jul. 23.5	8.542728	8.998958	14.252047
Apr. 14.5	8.305523	8.942006	13.957904
Jan. 4.5	8.064424	8.881001	13.657316
1822 Sep. 26.5	7.819298	8.815714	13.350033
Jun. 18.5	7.570004	8.745894	13.035783
Mar. 10.5	7.316392	8.671261	12.714270
1821 Nov. 30.5	7.058306	8.591507	12.385170
Aug. 22.5	6.795580	8.506288	12.048132
May 14.5	6.528040	8.415224	11.702771
Feb. 3.5	6.255500	8.317888	11.348662
1820 Oct. 26.5	5.977763	8.213807	10.985338
Jul. 18.5	5.694620	8.102446	10.612282
Apr. 9.5	5.405845	7.983201	10.228922
1819 Dec. 31.5	5.111195	7.855388	9.834614
Sep. 22.5	4.810405	7.718223	9.428639
Jun. 14.5	4.503187	7.570801	9.010180
Mar. 6.5	4.189223	7.412067	8.578310
1818 Nov. 26.5	3.868163	7.240781	8.131964
Aug. 18.5	3.539619	7.055465	7.669909
May 10.5	3.203163	6.854332	7.190706
Jan. 30.5	2.858322	6.635194	6.692653
1817 Oct. 22.5	2.504583	6.395310	6.173716
Jul. 14.5	2.141397	6.131189	5.631426
Apr. 5.5	1.768208	5.838255	5.062725
1816 Dec. 26.5	+ 1.384504	— 5.510327	— 4.463763

Table I

G. M. T.	x	y	z
1816 Nov. 6.5	+ 1.188595	— 5.330667	— 4.151434
Sep. 17.5	0.989961	5.138741	3.829563
Jul. 29.5	0.788646	4.932815	3.497272
Jun. 9.5	0.584764	4.710724	3.153540
Apr. 20.5	0.378561	4.469716	2.797170
Mar. 26.5	0.274718	4.341038	2.613816
1.5	0.170488	4.206205	2.426759
Feb. 5.5	+ 0.065986	4.064576	2.235785
Jan. 11.5	— 0.038635	3.915404	2.040666
1815 Dec. 17.5	0.143167	3.757800	1.841160
Nov. 22.5	0.247332	3.590706	1.637012
Oct. 28.5	0.350745	3.412841	1.427965
3.5	0.452878	3.222642	1.213773
Sep. 8.5	0.552988	3.018174	0.994229
Aug. 14.5	0.650012	2.797014	0.769220
Jul. 20.5	0.742400	2.556088	0.538825
Jun. 25.5	0.827835	2.291464	0.303514
May 31.5	0.902764	1.998088	— 0.064532
6.5	— 0.961607	— 1.669587	+ 0.175342

Table II.

G. M. T.	x	y	z
1887 Nov. 14.5	— 0.9409622	— 0.5340770	+ 0.7591916
4.5	0.9028810	0.3373272	0.8215650
Oct. 25.5	0.8516964	— 0.1357319	0.8719880
15.5	0.7869196	+ 0.0679898	0.9084738
5.5	0.7088706	0.2705452	0.9296263
Sep. 25.5	0.6187428	0.4684999	0.9349430
15.5	0.5184413	0.6587947	0.9249100
5.5	0.4102535	0.8391482	0.9008499
Aug. 26.5	0.2964884	1.0082116	0.8646056
16.5	0.1792092	1.1654913	0.8182020
6.5	— 0.0601026	1.3111404	0.7635898
Jul. 27.5	+ 0.0595419	1.4457264	0.7025006
17.5	0.1787870	1.5700386	0.6363925
7.5	0.2969802	1.6849526	0.5664551
Jun. 27.5	0.4136858	1.7913454	0.4936378
17.5	0.5286264	1.8900484	0.4186896
7.5	0.6416383	1.9818243	0.3421979
May 28.5	0.7526370	2.0673604	0.2646216
18.5	0.8615925	2.1472689	0.1863194
8.5	0.9685118	2.2220914	0.1075714
Apr. 28.5	1.0734268	2.2923062	+ 0.0285967
18.5	1.1763847	2.3583350	— 0.0504330
8.5	1.2774430	2.4205500	0.1293837
Mar. 29.5	1.3766643	2.4792799	0.2081500
19.5	1.4741143	2.5348161	0.2866497
9.5	1.5698591	2.5874170	0.3648189
Feb. 27.5	1.6639642	2.6373129	0.4426078
17.5	1.7564937	2.6847094	0.5199782
7.5	1.8475094	2.7297903	0.5969008
Jan. 28.5	1.9370709	2.7727211	0.6733539
18.5	2.0252351	2.8136504	0.7493215
8.5	2.1120571	2.8527134	0.8247919
1886 Dec. 19.5	2.2818754	2.9257130	0.9742160
Nov. 29.5	+ 2.4469081	+ 2.9925669	— 1.1215993

Table II

G. M. T.	x	y	z
1886 Nov. 9.5	+ 2.6074984	+ 3.0539798	— 1.2669478
Oct. 20.5	2.7639546	3.1105440	1.4102882
Sep. 30.5	2.9165535	3.1627615	1.5516605
10.5	3.0655440	3.2110609	1.6911126
Aug. 21.5	3.2111508	3.2558115	1.8286974
1.5	3.3535769	3.2973328	1.9644698
Jul. 12.5	3.4930061	3.3359038	2.0984854
Jun. 22.5	3.6296057	3.3717687	2.2307998
2.5	3.7635282	3.4051431	2.3614672
May 13.5	3.8949128	3.4362179	2.4905405
Apr. 23.5	4.0238871	3.4651630	2.6180709
3.5	4.1505684	3.4921303	2.7441075
Mar. 14.5	4.2750647	3.5172559	2.8686977
Feb. 22.5	4.3974757	3.5406627	2.9918866
2.5	4.5178934	3.5624615	3.1137175
Jan. 13.5	4.6364035	3.5827529	3.2342316
1885 Dec. 24.5	4.7530854	3.6016284	3.3534684
4.5	4.8680130	3.6191714	3.4714655
Nov. 14.5	4.9812553	3.6354583	3.5882588
Oct. 25.5	5.0928768	3.6505591	3.7038824
5.5	5.2029377	3.6645381	3.8183690
Sep. 15.5	5.3114946	3.6774545	3.9317499
Aug. 26.5	5.4186007	3.6893631	4.0440547
6.5	5.5243058	3.7003145	4.1553120
Jul. 17.5	5.6286570	3.7103557	4.2655489
Jun. 27.5	5.7316986	3.7195303	4.3747914
7.5	5.8334726	3.7278788	4.4830644
May 18.5	5.9340185	3.7354391	4.5903918
Apr. 28.5	6.0333738	3.7422464	4.6967963
8.5	6.1315741	3.7483338	4.8022997
Mar. 19.5	6.2286530	3.7537321	4.9069232
Feb. 27.5	6.3246425	3.7584703	5.0106867
Jan. 8.5	6.5600469	3.7676026	5.2664583
1884 Nov. 19.5	+ 6.7892667	+ 3.7731582	— 5.5172560

Table II

G. M. T.	x	y	z
1884 Sep. 30.5 . . .	+ 7.0126908	+ 3.7754675	— 5.7633357
Aug. 11.5 . . .	7.2306664	3.7748182	6.0049304
Jun. 22.5 . . .	7.4435052	3.7714616	6.2422530
May 3.5 . . .	7.6514886	3.7656190	6.4754987
Mar. 14.5 . . .	7.8548708	3.7574859	6.7048466
Jan. 24.5 . . .	8.0538834	3.7472363	6.9304622
1883 Dec. 5.5 . . .	8.2487373	3.7350255	7.1524981
Oct. 16.5 . . .	8.4396253	3.7209926	7.3710958
Aug. 27.5 . . .	8.6267248	3.7052629	7.5863866
Jul. 8.5 . . .	8.8101985	3.6879497	7.7984926
May 19.5 . . .	8.9901969	3.6691557	8.0075278
Mar. 30.5 . . .	9.1668591	3.6489743	8.2135986
Feb. 8.5 . . .	9.3403139	3.6274909	8.4168044
1882 Dec. 20.5 . . .	9.5106811	3.6047834	8.6172385
Oct. 31.5 . . .	9.6780723	3.5809237	8.8149886
Sep. 11.5 . . .	9.8425915	3.5559777	9.0101369
Jul. 23.5 . . .	10.0043358	3.5300065	9.2027610
Jun. 3.5 . . .	10.1633963	3.5030666	9.3929340
Apr. 14.5 . . .	10.3198584	3.4752103	9.5807248
Feb. 23.5 . . .	10.4738024	3.4464865	9.7661987
Jan. 4.5 . . .	10.6253037	3.4169407	9.9494173
1881 Nov. 15.5 . . .	10.7744335	3.3866155	10.1304390
Aug. 7.5 . . .	11.0658444	3.3237838	10.4861108
Apr. 29.5 . . .	11.3485311	3.2582825	10.8336249
Jan. 19.5 . . .	11.6229409	3.1903702	11.1733526
1880 Oct. 11.5 . . .	11.8894789	3.1202781	11.5056316
Jul. 3.5 . . .	12.1485149	3.0482140	11.8307694
Mar. 25.5 . . .	12.4003882	2.9743653	12.1490478
1879 Dec. 16.5 . . .	12.6454117	2.8989018	12.4607254
Sep. 7.5 . . .	12.8838759	2.8219773	12.7660410
May 30.5 . . .	13.1160510	2.7437312	13.0652154
Feb. 19.5 . . .	13.3421894	2.6642901	13.3584540
1878 Nov. 11.5 . . .	13.5625277	2.5837681	13.6459480
Aug. 3.5 . . .	+ 13.7772876	+ 2.5022688	— 13.9278762

Table II

G. M. T.	x	y	z
1878 Apr. 25.5 . . .	+ 13.9866777	+ 2.4198854	— 14.2044062
Jan. 15.5 . . .	14.1908940	2.3367016	14.4756957
1877 Oct. 7.5 . . .	14.3901210	2.2527928	14.7418931
Jun. 29.5 . . .	14.5845320	2.1682265	15.0031387
Mar. 21.5 . . .	14.7742902	2.0830629	15.2595652
1876 Dec. 11.5 . . .	14.9595494	1.9973562	15.5112984
Sept. 2.5 . . .	15.1404538	1.9111545	15.7584575
May 25.5 . . .	15.3171393	1.8245006	16.0011562
Feb. 15.5 . . .	15.4897337	1.7374330	16.2395022
1875 Nov. 7.5 . . .	15.6583571	1.6499856	16.4735986
Jul. 30.5 . . .	15.8231222	1.5621888	16.7035433
Apr. 21.5 . . .	15.9841352	1.4740698	16.9294301
Jan. 11.5 . . .	16.1414956	1.3856521	17.1513482
1874 Oct. 3.5 . . .	16.2952968	1.2969572	17.3693832
Jun. 25.5 . . .	16.4456266	1.2080040	17.5836169
Mar. 17.5 . . .	16.5925670	1.1188093	17.7941275
1873 Aug. 29.5 . . .	16.8765816	0.9397532	18.2042760
Feb. 10.5 . . .	17.1478948	0.7598906	18.6003909
1872 Jul. 25.5 . . .	17.4069855	0.5793053	18.9829874
Jan. 7.5 . . .	17.6542621	0.3980720	19.3525368
1871 Jun. 21.5 . . .	17.8900686	0.2162654	19.7094674
1870 Dec. 3.5 . . .	18.1146919	+ 0.0339702	20.0541653
May 17.5 . . .	18.3283725	— 0.1487094	20.3869739
1869 Oct. 29.5 . . .	18.5313190	0.3316411	20.7081944
Apr. 12.5 . . .	18.7237264	0.5146619	21.0180873
1868 Sep. 24.5 . . .	18.9057953	0.6975808	21.3168773
Mar. 8.5 . . .	19.0777477	0.8801904	21.6047605
1867 Aug. 21.5 . . .	19.2398359	1.0622819	21.8819133
Feb. 2.5 . . .	19.3923425	1.2436625	22.1485021
1866 Jul. 17.5 . . .	19.5355715	1.4241688	22.4046896
1865 Dec. 29.5 . . .	19.6698361	1.6036743	22.6506405
Jun. 12.5 . . .	19.7954454	1.7820908	22.8865206
1864 Nov. 24.5 . . .	19.9126933	1.9593663	23.1124983
May 8.5 . . .	+ 20.0218514	— 2.1354787	— 23.3287424

Table II

G. M. T.	x	y	z
1863 Oct. 21.5 . . .	+ 20.1231635	— 2.3104310	— 23.5354199
Apr. 4.5 . . .	20.2168442	2.4842450	23.7326949
1862 Sep. 16.5 . . .	20.3030769	2.6569562	23.9207270
Feb. 28.5 . . .	20.3820139	2.8286103	24.0996701
1861 Aug. 12.5 . . .	20.4537753	2.9992582	24.2696713
Jan. 24.5 . . .	20.5184485	3.1689522	24.4308692
1860 Jul. 8.5 . . .	20.5760879	3.3377412	24.5833932
1859 Dec. 21.5 . . .	20.6267150	3.5056638	24.7273600
Jun. 4.5 . . .	20.6703200	3.6727415	24.8628717
1858 Nov. 16.5 . . .	20.7068665	3.8389704	24.9900124
Apr. 30.5 . . .	20.7363004	4.0043133	25.1088454
1857 Oct. 12.5 . . .	20.7585625	4.1686937	25.2194110
Mar. 26.5 . . .	20.7736050	4.3319960	25.3217274
1856 Sep. 7.5 . . .	20.7814081	4.4940718	25.4157940
Feb. 20.5 . . .	20.7819921	4.6547530	25.5015974
1855 Aug. 4.5 . . .	20.7754222	4.8138690	25.5791193
Jan. 16.5 . . .	20.7618043	4.9712639	25.6483441
1854 Jun. 30.5 . . .	20.7412734	5.1268085	25.7092638
1853 Dec. 12.5 . . .	20.7139799	5.2804065	25.7618806
May 26.5 . . .	20.6800761	5.4319954	25.8062070
1852 Nov. 7.5 . . .	20.6397048	5.5815424	25.8422632
Apr. 21.5 . . .	20.5929925	5.7290392	25.8700761
1851 Oct. 4.5 . . .	20.5400450	5.8744969	25.8896752
Mar. 18.5 . . .	20.4809447	6.0179403	25.9010919
1850 Aug. 30.5 . . .	20.4157478	6.1594030	25.9043560
Feb. 11.5 . . .	20.3444860	6.2989244	25.8994953
1849 Jul. 26.5 . . .	20.2671676	6.4365450	25.8865338
Jan. 7.5 . . .	20.1837576	6.5723023	25.8654896
1848 Jun. 21.5 . . .	20.0942156	6.7062261	25.8363723
1847 Dec. 4.5 . . .	19.9984575	6.8383320	25.7991813
May 18.5 . . .	19.8963768	6.9686135	25.7539019
1846 Oct. 30.5 . . .	19.7878461	7.0970344	25.7005020
Apr. 13.5 . . .	19.6727268	7.2235211	25.6389290
1845 Sep. 25.5 . . .	+ 19.5508830	— 7.3479586	— 25.5691086

Table II

G. M. T.	x	y	z
1845 Mar. 9.5 . . .	+ 19.4221979	— 7.4701922	— 25.4909454
1844 Aug. 21.5 . . .	19.2865889	7.5900364	25.4043273
Feb. 3.5 . . .	19.1440175	7.7072901	25.3091319
1843 Jul. 18.5 . . .	18.9944901	7.8217536	25.2052340
1842 Dec. 30.5 . . .	18.8380512	7.9332449	25.0925122
Jun. 13.5 . . .	18.6747700	8.0416095	24.9708531
1841 Nov. 25.5 . . .	18.5047257	8.1467247	24.8401518
May 9.5 . . .	18.3279944	8.2484976	24.7003114
1840 Oct. 21.5 . . .	18.1446389	8.3468617	24.5512400
Apr. 4.5 . . .	17.9547019	8.4417693	24.3928475
1839 Sep. 17.5 . . .	17.7582019	8.5331866	24.2250431
Mar. 1.5 . . .	17.5551311	8.6210879	24.0477317
1838 Aug. 13.5 . . .	17.3454537	8.7054510	23.8608129
Jan. 25.5 . . .	17.1291046	8.7862525	23.6641775
1837 Jul. 9.5 . . .	16.9059883	8.8634642	23.4577059
1836 Dec. 21.5 . . .	16.6759773	8.9370471	23.2412651
Jun. 4.5 . . .	16.4389112	9.0069462	23.0147060
1835 Nov. 17.5 . . .	16.1945969	9.0730826	22.7778590
May 1.5 . . .	15.9428111	9.1353452	22.5305306
1834 Oct. 13.5 . . .	15.6833063	9.1935810	22.2724980
Mar. 27.5 . . .	15.4158215	9.2475880	22.0035051
1833 Sep. 8.5 . . .	15.1400966	9.2971112	21.7232615
Feb. 20.5 . . .	14.8558881	9.3418455	21.4314414
1832 Aug. 4.5 . . .	14.5629823	9.3814457	21.1276877
Jan. 17.5 . . .	14.2612011	9.4155406	20.8116167
1831 Jul. 1.5 . . .	13.9503988	9.4437493	20.4828238
1830 Dec. 13.5 . . .	13.6304516	9.4656929	20.1408865
May 27.5 . . .	13.3012411	9.4809995	19.7853647
1829 Nov. 8.5 . . .	12.9626394	9.4893029	19.4157974
Apr. 22.5 . . .	12.6144942	9.4902360	19.0316966
1828 Oct. 4.5 . . .	12.2566183	9.4834201	18.6325391
Jun. 26.5 . . .	12.0739611	9.4769824	18.4271391
Mar. 18.5 . . .	11.8887811	9.4684545	18.2177584
1827 Dec. 9.5 . . .	+ 11.7010415	— 9.4577810	— 18.0043177

Table II

G. M. T.	x	y	z
1827 Aug. 31.5 . . .	+ 11.5107024	— 9.4449030	— 17.7867338
May 23.5 . . .	11.3177202	9.4297585	17.5649189
Feb. 12.5 . . .	11.1220472	9.4122816	17.3387806
1826 Nov. 4.5 . . .	10.9236323	9.3924019	17.1082213
Jul. 27.5 . . .	10.7224199	9.3700443	16.8731377
Apr. 18.5 . . .	10.5183500	9.3451281	16.6334206
Jan. 8.5 . . .	10.3113639	9.3175669	16.3889541
1825 Sep. 30.5 . . .	10.1013747	9.2872667	16.1396144
Jun. 22.5 . . .	9.8883255	9.2541270	15.8852709
Mar. 14.5 . . .	9.6721305	9.2180384	15.6257836
1824 Dec. 4.5 . . .	9.4527040	9.1788819	15.3610030
Aug. 26.5 . . .	9.2299544	9.1365282	15.0907695
May 18.5 . . .	9.0037838	9.0908361	14.8149115
Feb. 8.5 . . .	8.7740874	9.0416510	14.5332452
1823 Oct. 31.5 . . .	8.5407537	8.9888037	14.2455724
Jul. 23.5 . . .	8.3036640	8.9321080	13.9516794
Apr. 14.5 . . .	8.0626922	8.8713589	13.6513356
Jan. 4.5 . . .	7.8177041	8.8063303	13.3442909
1822 Sep. 26.5 . . .	7.5685581	8.7367725	13.0302739
Jun. 18.5 . . .	7.3151038	8.6624089	12.7089897
Mar. 10.5 . . .	7.0571824	8.5829325	12.3801165
1821 Nov. 30.5 . . .	6.7946260	8.4980028	12.0433028
Aug. 22.5 . . .	6.5272569	8.4072397	11.6981632
May 14.5 . . .	6.2548870	8.3102198	11.3442748
Feb. 3.5 . . .	5.9773160	8.2064678	10.9811702
1820 Oct. 26.5 . . .	5.6943305	8.0954496	10.6083330
Jul. 18.5 . . .	5.4057020	7.9765614	10.2251883
Apr. 9.5 . . .	5.1111841	7.8491166	9.8310942
1819 Dec. 31.5 . . .	4.8105101	7.7123290	9.4253292
Sep. 22.5 . . .	4.5033893	7.5652917	9.0070775
Aug. 3.5 . . .	4.3473133	7.4876057	8.7929838
Jun. 14.5 . . .	4.1895034	7.4069472	8.5754094
Apr. 25.5 . . .	4.0299156	7.3231544	8.3542173
Mar. 6.5 . . .	+ 3.8685017	— 7.2360513	— 8.1292582

Table II

G. M. T.	x	y	z
1819 Jan. 15.5	+ 3.705213	— 7.145444	— 7.900458
1818 Nov. 26.5	3.539998	7.051121	7.667388
Oct. 7.5	3.372799	6.952849	7.430117
Aug. 18.5	3.203561	6.850368	7.188354
Jun. 29.5	3.032222	6.743389	6.941880
May 10.5	2.858720	6.631594	6.690449
Mar. 21.5	2.682988	6.514618	6.433798
Jan. 30.5	2.504957	6.392057	6.171631
1817 Dec. 11.5	2.324559	6.263446	5.903625
Oct. 22.5	2.141719	6.128257	5.629420
Sep. 2.5	1.956370	5.985882	5.348614
Jul. 14.5	1.768442	5.835615	5.060755
May 25.5	1.577870	5.676628	4.765336
Apr. 5.5	1.384608	5.507944	4.461779
Feb. 14.5	1.188614	5.328394	4.149425
1816 Dec. 26.5	0.989883	5.136566	3.827514
Nov. 6.5	0.788458	4.930721	3.495170
Oct. 12.5	0.686766	4.821886	3.324772
Sep. 17.5	0.584454	4.708693	3.151370
Aug. 23.5	0.481554	4.590777	2.974808
Jul. 29.5	0.378115	4.467723	2.794919
4.5	0.274200	4.339056	2.611519
Jun. 9.5	0.169896	4.204222	2.424411
May 15.5	+ 0.065317	4.062586	2.233383
Apr. 20.5	— 0.039380	3.913393	2.038206
Mar. 26.5	0.143991	3.755757	1.838638
1.5	0.248234	3.588615	1.634424
Feb. 5.5	0.351722	3.410685	1.425308
Jan. 24.0	0.403026	3.317197	1.318833
11.5	0.453927	3.220398	1.211043
1815 Dec. 30.0	0.504325	3.120033	1.101914
17.5	0.554101	3.015816	0.991427
5.0	0.603108	2.907430	0.879570
Nov. 22.5	— 0.651175	— 2.794512	— 0.766345

Table II

G. M. T.	x	y	z
1815 Nov. 10.0	— 0.698090	— 2.676656	— 0.651769
Oct. 28.5	0.743595	2.553402	0.535883
16.0	0.787372	2.424229	0.418759
3.5	0.829030	2.288545	0.300518
Sep. 21.0	0.868081	2.145680	0.181343
8.5	0.903912	1.994880	0.061507
2.25	0.920387	1.916245	— 0.001462
Aug. 27.0	0.935754	1.835303	+ 0.058583
20.75	0.949884	1.751937	0.118551
14.5	0.962632	1.666026	0.178343
8.25	0.973838	1.577446	0.237849
2.0	0.983317	1.486074	0.296931
Jul. 26.75	0.990867	1.391788	0.355429
20.5	0.996260	1.294476	0.413150
14.25	0.999243	1.194036	0.469870
8.0	0.999539	1.090392	0.525323
1.75	0.996847	0.983491	0.579202
Jun. 25.5	0.990842	0.873329	0.631153
19.25	0.981185	0.759954	0.680775
13.0	— 0.967531	— 0.643490	+ 0.727618

Table III.

G. M. T.	x	y	z
1887 Sep. 25.5	— 0.6187421	+ 0.4685024	+ 0.9349430
30.5	0.6652102	0.3703056	0.9342568
Oct. 5.5	0.7088701	0.2705473	0.9296264
10.5	0.7494988	0.1696326	0.9210216
15.5	0.7869192	+ 0.0679914	0.9084740
20.5	0.8210074	— 0.0339390	0.8920789
25.5	0.8516961	0.1357308	0.8719887
30.5	0.8789738	0.2369816	0.8484049
Nov. 4.5	0.9028809	0.3373266	0.8215660
9.5	0.9235030	0.4364474	0.7917362
14.5	0.9409623	0.5340769	0.7591930
19.5	0.9554085	0.6299996	0.7242170
24.5	0.9670104	0.7240500	0.6870830
29.5	0.9759476	0.8161084	0.6480539
Dec. 4.5	0.9824041	0.9060954	0.6073758
9.5	0.9865629	0.9939660	0.5652756
14.5	0.9886023	1.0797039	0.5219594
19.5	0.9886929	1.1633159	0.4776129
24.5	0.9869958	1.2448267	0.4324015
29.5	0.9836619	1.3242751	0.3864717
1888 Jan. 3.5	0.9788309	1.4017100	0.3399526
8.5	0.9726320	1.4771876	0.2929574
13.5	0.9651834	1.5507689	0.2455847
18.5	0.9565936	1.6225179	0.1979207
23.5	0.9469615	1.6925001	0.1500402
28.5	0.9363770	1.7607812	0.1020080
Feb. 2.5	0.9249220	1.8274264	+ 0.0538802
12.5	0.8996919	1.9560640	— 0.0424748
22.5	0.8717892	2.0789032	0.1387115
Mar. 3.5	0.8416422	2.1964005	0.2345978
13.5	0.8096056	2.3089744	0.3299632
23.5	0.7759745	2.4170062	0.4246837
Apr. 2.5	0.7409948	2.5208413	0.5186702
12.5	— 0.7048727	— 2.6207916	— 0.6118603

Table III.

$\sum X'$	$\sum Y'$	$\sum Z'$	$\sum X$	$\sum Y$	$\sum Z$
— 135	— 128	— 90	+ 130	+ 128	+ 53
137	132	95	131	124	50
140	136	100	132	119	48
143	141	106	133	114	46
147	145	111	135	110	44
152	150	117	138	106	42
157	155	122	142	102	40
163	160	128	146	100	39
169	166	134	150	98	38
176	172	140	156	98	37
183	178	146	161	96	36
191	184	153	167	97	36
198	190	159	172	97	36
207	198	166	177	99	37
216	206	172	183	102	38
225	214	179	188	105	39
235	221	186	193	108	40
245	229	193	197	112	42
255	237	200	201	118	44
265	245	207	203	124	46
276	254	214	205	129	49
288	263	222	206	135	52
300	271	229	208	141	54
311	278	237	208	148	57
321	284	245	208	154	60
334	296	251	206	160	63
354	308	256	204	167	66
1532	1315	1081	788	710	286
1661	1404	1134	754	748	305
1800	1495	1183	711	776	319
1952	1590	1232	666	796	332
2116	1689	1278	619	808	338
2292	1790	1320	574	810	340
— 2482	— 1897	— 1359	+ 533	+ 805	+ 341

Table III

G. M. T.			x	y	z
1888	Apr.	22.5	— 0.6677816	— 2.7171392	— 0.7042119
	May	2.5	0.6298682	2.8101384	0.7956980
		12.5	0.5912568	2.9000193	0.8863030
		22.5	0.5520536	2.9869901	0.9760203
	Jun.	1.5	0.5123493	3.0712396	1.0648500
		11.5	0.4722218	3.1529393	1.1527968
		21.5	0.4317385	3.2322451	1.2398694
	Jul.	1.5	0.3909574	3.3092994	1.3260793
		11.5	0.3499292	3.3842323	1.4114397
		21.5	0.3086977	3.4571628	1.4959655
		31.5	0.2673015	3.5282003	1.5796722
	Aug.	10.5	0.2257742	3.5974453	1.6625764
		20.5	0.1841454	3.6649903	1.7446945
		30.5	0.1424411	3.7309209	1.8260434
	Sep.	9.5	0.1006845	3.7953162	1.9066398
		19.5	— 0.0588958	3.8582495	1.9865002
	Oct.	9.5	+ 0.0247075	3.9799973	2.1440783
		29.5	0.1082478	4.0966540	2.2989039
	Nov.	18.5	0.1916294	4.2086449	2.4510968
	Dec.	8.5	0.2747772	4.3163428	2.6007696
		28.5	0.3576326	4.4200732	2.7480279
1889	Jan.	17.5	0.4401504	4.5201246	2.8929706
	Feb.	6.5	0.5222966	4.6167527	3.0356908
		26.5	0.6040462	4.7101850	3.1762767
	Mar.	18.5	0.6853813	4.8006257	3.3148118
	Apr.	7.5	0.7662896	4.8882585	3.4513758
		27.5	0.8467626	4.9732497	3.5860446
	May	17.5	0.9267951	5.0557507	3.7188902
	Jun.	6.5	1.0063837	5.1358992	3.8499810
		26.5	1.0855269	5.2138218	3.9793818
	Jul.	16.5	1.1642241	5.2896342	4.1071534
	Aug.	5.5	1.2424740	5.3634433	4.2333536
		25.5	1.3202836	5.4353472	4.3580365
	Sep.	14.5	+ 1.3976490	— 5.5054368	— 4.4812533

Table III

$\sum X'$	$\sum Y'$	$\sum Z'$	$\sum X$	$\sum Y$	$\sum Z$
— 2686	— 2008	— 1392	+ 499	+ 793	+ 337
2902	2120	1417	471	775	329
3138	2240	1436	453	757	320
3390	2364	1445	443	737	310
3660	2492	1442	444	724	302
3949	2625	1426	449	713	295
4259	2764	1395	460	708	291
4590	2904	1345	473	711	291
4941	3045	1273	485	723	294
5314	3187	1177	495	744	300
5706	3328	1051	499	767	311
6116	3464	893	496	797	323
6542	3594	697	483	828	336
6981	3715	463	460	858	350
7427	3822	— 185	432	880	362
7877	3914	+ 147	395	901	372
35018	16141	3811	1428	3259	1362
38141	16099	7866	1327	3298	1382
40488	15413	12611	1224	3335	1400
41675	14000	17754	1121	3369	1418
41404	11883	22836	1016	3401	1433
39575	9220	27313	909	3430	1448
36376	6274	30715	801	3457	1462
32183	3354	32743	692	3480	1475
27504	— 719	33362	582	3501	1487
22801	+ 1465	32760	470	3520	1497
18430	3131	31238	357	3535	1507
14592	4306	29130	243	3548	1514
11358	5057	26719	127	3557	1522
8716	5474	24227	+ 12	3564	1527
6603	5641	21799	— 104	3568	1531
4943	5634	19520	222	3568	1534
3650	5510	17437	340	3565	1536
— 2640	+ 5309	+ 15561	— 459	+ 3559	+ 1535

Table III

G. M. T.	x	y	z
1889 Oct. 4.5	+ 1.4745745	— 5.5737964	— 4.6030521
24.5	1.5510628	5.6405040	4.7234785
Nov. 13.5	1.6271173	5.7056321	4.8425755
Dec. 3.5	1.7027414	5.7692483	4.9603835
23.5	1.7779388	5.8314155	5.0769410
1890 Jan. 12.5	1.8527134	5.8921927	5.1922846
Feb. 1.5	1.9270693	5.9516349	5.3064485
Mar. 13.5	2.0745422	6.0667178	5.5313674
Apr. 22.5	2.2203923	6.1770407	5.7519412
Jun. 1.5	2.3646550	6.2829374	5.9683910
Jul. 11.5	2.5073664	6.3847049	6.1809182
Aug. 20.5	2.6485621	6.4826092	6.3897068
Sep. 29.5	2.7882771	6.5768895	6.5949257
Nov. 8.5	2.9265460	6.6677617	6.7967302
Dec. 18.5	3.0634023	6.7554214	6.9952638
1891 Jan. 27.5	3.1988787	6.8400467	7.1906592
Mar. 8.5	3.3330068	6.9218000	7.3830394
Apr. 17.5	3.4658171	7.0008302	7.5725191
May 27.5	3.5973393	7.0772738	7.7592048
Jul. 6.5	3.7276019	7.1512566	7.9431964
Aug. 15.5	3.8566324	7.2228949	8.1245870
Sep. 24.5	3.9844575	7.2922962	8.3034642
Nov. 3.5	4.1111027	7.3595603	8.4799102
Dec. 13.5	4.2365928	7.4247799	8.6540022
1892 Jan. 22.5	4.3609517	7.4880415	8.8258131
Mar. 2.5	4.4842023	7.5494258	8.9954116
Apr. 11.5	4.6063670	7.6090082	9.1628628
May 21.5	4.7274673	7.6668594	9.3282281
Jun. 30.5	4.8475239	7.7230457	9.4915658
Sep. 18.5	5.0845859	7.8306692	9.8123768
Dec. 7.5	5.3177062	7.9323353	10.1257059
1893 Feb. 25.5	5.5470290	8.0284497	10.4319248
May 16.5	5.7726896	8.1193755	10.7313713
Aug. 4.5	+ 5.9948155	— 8.2054387	— 11.0243538

Table III.

$\sum X'$	$\sum Y'$	$\sum Z'$	$\sum X$	$\sum Y$	$\sum Z$
— 1889	+ 5067	+ 13892	— 577	+ 3550	+ 1535
1307	4801	12416	697	3538	1531
864	4530	11116	816	3522	1528
531	4260	9973	936	3503	1523
280	4000	8969	1054	3481	1515
— 94	3751	8087	1174	3455	1507
+ 43	3516	7311	1293	3425	1498
848	12365	24091	6120	13416	5892
1163	10899	20056	7057	13078	5769
1267	9642	16864	7979	12685	5622
1250	8567	14315	8881	12233	5449
1168	7645	12260	9758	11724	5251
1051	6854	10586	10607	11158	5029
919	6172	9213	11421	10537	4782
784	5582	8075	12198	9863	4511
652	5068	7125	12929	9136	4217
528	4620	6326	13611	8360	3899
412	4227	5650	14241	7535	3561
305	3880	5074	14812	6669	3202
208	3573	4580	15321	5763	2825
120	3301	4155	15762	4822	2431
+ 40	3058	3786	16134	3848	2021
— 31	2841	3465	16434	2847	1601
96	2646	3185	16656	1828	1166
154	2470	2938	16800	+ 792	725
206	2311	2721	16864	— 253	+ 278
252	2167	2529	16847	1302	— 173
294	2037	2358	16750	2348	626
1328	7670	8824	66279	13547	4299
1587	6836	7793	63881	21655	7839
1798	6133	6960	60256	29347	11233
1971	5535	6282	55495	36450	14399
2114	5023	5723	49726	42811	17272
— 2234	+ 4581	+ 5261	— 43103	— 48314	— 19797

Table III

G. M. T.	x	y	z
1893 Oct. 23.5 . . .	+ 6.2135272	— 8.2869328	— 11.3111546
1894 Jan. 11.5 . . .	6.4289384	8.3641232	11.5920329
Apr. 1.5 . . .	6.6411566	8.4372505	11.8672272
Jun. 20.5 . . .	6.8502837	8.5065332	12.1369577
Sep. 8.5 . . .	7.0564158	8.5721705	12.4014282
Nov. 27.5 . . .	7.2596440	8.6343442	12.6608272
1895 Feb. 15.5 . . .	7.4600545	8.6932207	12.9153303
May 6.5 . . .	7.6577286	8.7489526	13.1651007
Jul. 25.5 . . .	7.8527436	8.8016800	13.4102905
Oct. 13.5 . . .	8.0451721	8.8515319	13.6510418
1896 Jan. 1.5 . . .	8.2350828	8.8986274	13.8874878
Mar. 21.5 . . .	8.4225409	8.9430765	14.1197531
Jun. 9.5 . . .	8.6076075	8.9849810	14.3479548
Aug. 28.5 . . .	8.7903405	9.0244355	14.5722030
Nov. 16.5 . . .	8.9707947	9.0615277	14.7926013
1897 Feb. 4.5 . . .	9.1490214	9.0963394	15.0092475
Jul. 14.5 . . .	9.4989839	9.1594214	15.4316477
Dec. 21.5 . . .	9.8405841	9.2142343	15.8400841
1898 May 30.5 . . .	10.1741377	9.2612642	16.2351681
Nov. 6.5 . . .	10.4999237	9.3009416	16.6174517
1899 Apr. 15.5 . . .	10.8181884	9.3336506	16.9874357
Sep. 22.5 . . .	11.1291476	9.3597368	17.3455762
1900 Mar. 1.5 . . .	11.4329896	9.3795138	17.6922907
Aug. 8.5 . . .	11.7298774	9.3932696	18.0279634
1901 Jan. 15.5 . . .	12.0199513	9.4012721	18.3529499
Jun. 24.5 . . .	12.3033316	9.4037740	18.6675811
Dec. 1.5 . . .	12.5801215	9.4010176	18.9721674
1902 May 10.5 . . .	12.8504114	9.3932391	19.2670022
Oct. 17.5 . . .	13.1142832	9.3806717	19.5523645
1903 Mar. 26.5 . . .	13.3718156	9.3635477	19.8285214
Sep. 2.5 . . .	13.6230901	9.3420990	20.0957291
1904 Feb. 9.5 . . .	13.8681954	9.3165551	20.3542333
Jul. 18.5 . . .	14.1072320	9.2871400	20.6042682
Dec. 25.5 . . .	+ 14.3403142	— 9.2540671	— 20.8460553

Table III

$\sum X'$	$\sum Y'$	$\sum Z'$	$\sum X$	$\sum Y$	$\sum Z$
— 2334	+ 4196	+ 4875	— 35791	— 52865	— 21931
2420	3860	4552	27969	56404	23642
2495	3564	4281	19822	58905	24916
2560	3301	4052	11516	60371	25749
2619	3068	3860	— 3220	60831	26151
2672	2858	3697	+ 4925	60335	26137
2722	2670	3561	12793	58944	25733
2768	2500	3447	20273	56738	24970
2811	2343	3353	27282	53797	23878
2856	2205	3277	33750	50214	22499
2898	2076	3216	39631	46071	20863
2940	1957	3169	44883	41452	19010
2982	1847	3135	49487	36437	16969
3025	1747	3114	53429	31100	14775
3067	1652	3103	56709	25512	12456
12442	6259	12414	237289	78938	40155
12798	5627	12539	250349	— 31327	— 20027
13163	5077	12821	253209	+ 16839	+ 588
13532	4598	13259	246223	64202	21103
13890	4188	13853	229730	109537	40986
14214	3852	14600	204040	151630	59702
14469	3601	15492	169473	189169	76684
14604	3451	16504	126472	220675	91287
14557	3425	17579	75744	244466	102772
14264	3541	18623	+ 18463	258664	110302
13680	3802	19499	— 43515	261327	113000
12804	4183	20049	107461	250696	110042
11703	4623	20145	169685	225568	100823
10496	5040	19741	225663	185751	85151
9317	5357	18897	270445	132536	63458
8270	5532	17750	299359	+ 68955	36928
7405	5564	16459	308921	— 310	+ 7489
6726	5477	15155	297647	69454	— 22408
— 6212	+ 5307	+ 13922	—266512	—132487	— 50170

Table III

G. M. T.	x	y	z
1905 Jun. 3.5 . . .	+ 14.5675693	— 9.2175349	— 21.0798018
Nov. 10.5 . . .	14.7891352	9.1777220	21.3056995
1906 Apr. 19.5 . . .	15.0051558	9.1347847	21.5239237
Sep. 26.5 . . .	15.2157760	9.0888558	21.7346336
1907 Mar. 5.5 . . .	15.4211367	9.0400459	21.9379723
Aug. 12.5 . . .	15.6213704	8.9884450	22.1340688
1908 Jan. 19.5 . . .	15.8165989	8.9341258	22.3230391
Jun. 27.5 . . .	16.0069310	8.8771466	22.5049878
Dec. 4.5 . . .	16.1924619	8.8175542	22.6800098
1909 May 13.5 . . .	16.3732727	8.7553869	22.8481917
Oct. 20.5 . . .	16.5494311	8.6906764	23.0096127
1910 Mar. 29.5 . . .	16.7209916	8.6234496	23.1643460
Sep. 5.5 . . .	16.8879956	8.5537310	23.3124595
1911 Feb. 12.5 . . .	17.0504726	8.4815432	23.4540167
Jul. 22.5 . . .	17.2084403	8.4069091	23.5890774
Dec. 29.5 . . .	17.3619048	8.3298528	23.7176985
1912 Jun. 6.6 . . .	17.5108616	8.2504018	23.8399349
Nov. 13.5 . . .	17.6552962	8.1685882	23.9558403
1913 Apr. 22.5 . . .	17.7951853	8.0844511	24.0654683
Sep. 29.5 . . .	17.9304988	7.9980384	24.1688734
1914 Mar. 8.5 . . .	18.0612026	7.9094086	24.2661116
Aug. 15.5 . . .	18.1872619	7.8186324	24.3572425
1915 Jan. 22.5 . . .	18.3086460	7.7257923	24.4423275
Jul. 1.5 . . .	18.4253327	7.6309828	24.5214318
Dec. 8.5 . . .	18.5373134	7.5343063	24.5946218
1916 May 16.5 . . .	18.6445962	7.4358699	24.6619643
Oct. 23.5 . . .	18.7472078	7.3357789	24.7235234
1917 Apr. 1.5 . . .	18.8451924	7.2341318	24.7793585
Sep. 8.5 . . .	18.9386092	7.1310145	24.8295220
1918 Feb. 15.5 . . .	19.0275270	7.0264972	24.8740576
Jul. 25.5 . . .	19.1120194	6.9206325	24.9129993
1919 Jan. 1.5 . . .	19.1921587	6.8134556	24.9463720
Jun. 10.5 . . .	19.2680123	6.7049861	24.9741914
Nov. 17.5 . . .	+ 19.3396384	— 6.5952303	— 24.9964655

Table III.

$\sum X'$	$\sum Y'$	$\sum Z'$	$\sum X$	$\sum Y$	$\sum Z$
— 5834	+ 5085	+ 12805	—218812	—184249	— 73499
5562	4839	11817	159481	221209	90764
5376	4580	10960	94129	241817	101161
5257	4322	10223	— 28085	246363	104684
5193	4068	9597	+ 34240	236499	101933
5176	3819	9072	89643	214664	93881
5193	3580	8638	136104	183561	81635
5257	3345	8293	172591	145787	66284
5346	3118	8028	198735	103641	48808
5463	2898	7841	214614	59062	30042
5605	2686	7731	220505	— 13664	— 10684
5768	2481	7697	216761	+ 31192	+ 8674
5947	2287	7741	203717	74275	27491
6134	2106	7864	181690	114382	45246
6319	1945	8065	151006	150234	61383
6488	1811	8341	112101	180398	75271
6620	1718	8681	65657	203235	86193
6693	1679	9060	+ 12797	216932	93345
6684	1707	9440	— 44706	219598	95869
6576	1807	9770	104248	209500	92962
6365	1974	9989	162279	185412	84006
6070	2183	10045	214408	147067	68784
5724	2402	9913	255780	95617	47671
5369	2592	9604	281739	+ 33930	+ 21784
5043	2724	9161	288724	— 33465	— 7021
4774	2788	8646	275106	100864	36334
4563	2781	8101	241671	162280	63569
4417	2720	7585	191568	212473	86392
4326	2616	7111	129653	247768	103118
4282	2487	6703	— 61543	266462	112867
4277	2342	6360	+ 7332	268723	115586
4306	2189	6079	72429	256135	111836
4363	2032	5860	130395	231132	102584
— 4445	+ 1874	+ 5697	+179085	—196457	— 88949

Table III

G. M. T.	x	y	z
1920 Apr. 25.5 . . .	+ 19.4070847	— 6.4841837	— 25.0131955
Oct. 2.5 . . .	19.4703866	6.3718344	25.0243770
1921 Mar. 11.5 . . .	19.5295671	6.2581647	25.0300013
Aug. 18.5 . . .	19.5846365	6.1431538	25.0300559
1922 Jan. 25.5 . . .	19.6355932	6.0267796	25.0245255
Jul. 4.5 . . .	19.6824235	5.9090195	25.0133925
Dec. 11.5 . . .	19.7251019	5.7898527	24.9966378
1923 May 20.5 . . .	19.7635924	5.6692609	24.9742411
Oct. 27.5 . . .	19.7978472	5.5472296	24.9461813
1924 Apr. 4.5 . . .	19.8278089	5.4237499	24.9124376
Sep. 11.5 . . .	19.8534098	5.2988201	24.8729899
1925 Feb. 19.0 . . .	19.8745741	5.1724471	24.8278192
Jul. 29.0 . . .	19.8912186	5.0446490	24.7769093
1926 Jan. 5.0 . . .	19.9032561	4.9154562	24.7202467
Jun. 14.0 . . .	19.9105979	4.7849130	24.6578217
Nov. 21.0 . . .	19.9131590	4.6530782	24.5896287
1927 Apr. 30.0 . . .	19.9108620	4.5200235	24.5156657
Oct. 7.0 . . .	19.9036422	4.3858319	24.4359331
1928 Mar. 15.0 . . .	19.8914512	4.2505928	24.3504324
Aug. 22.0 . . .	19.8742585	4.1143967	24.2591632
1929 Jan. 29.0 . . .	19.8520508	3.9773291	24.1621210
Jul. 8.0 . . .	19.8248300	3.8394656	24.0592943
Dec. 15.0 . . .	19.7926073	3.7008677	23.9506628
1930 May 24.0 . . .	19.7553985	3.5615810	23.8361968
Oct. 31.0 . . .	19.7132179	3.4216350	23.7158562
1931 Apr. 9.0 . . .	19.6660739	3.2810447	23.5895914
Sep. 16.0 . . .	19.6139651	3.1398130	23.4573438
1932 Feb. 23.0 . . .	19.5568776	2.9979333	23.3190473
Aug. 1.0 . . .	19.4947848	2.8553924	23.1746283
1933 Jan. 8.0 . . .	19.4276452	2.7121731	23.0240079
Jun. 17.0 . . .	19.3554030	2.5682561	22.8671015
Nov. 24.0 . . .	19.2779883	2.4236219	22.7038198
1934 May 3.0 . . .	19.1953170	2.2782524	22.5340695
Oct. 10.0 . . .	+ 19.1072908	— 2.1321323	— 22.3577528

Table III

$\sum X'$	$\sum Y'$	$\sum Z'$	$\sum X$	$\sum Y$	$\sum Z$
— 4550	+ 1715	+ 5587	+ 217350	— 154779	— 72052
4678	1555	5528	244773	108490	52905
4827	1396	5517	261387	59623	32384
4997	1234	5557	267473	— 9878	— 11224
5186	1072	5649	263398	+ 39296	+ 9946
5393	908	5795	249543	86610	30560
5615	745	5999	226273	130821	50079
5846	586	6266	193962	170638	67939
6078	439	6598	153080	204627	83512
6299	314	6993	104320	231172	96088
6493	224	7443	+ 48785	248478	104872
6642	186	7928	— 11814	254667	109011
6726	215	8414	74953	247962	107688
6732	321	8854	137185	227065	100255
6658	499	9194	194196	191556	86429
6516	727	9387	241131	142371	66495
6333	970	9413	273231	82147	41461
6142	1189	9281	286692	+ 15214	+ 13098
5970	1352	9029	279554	— 52810	— 16235
5836	1444	8709	252247	115886	43937
5749	1464	8370	207616	168573	67603
5708	1422	8053	150368	206933	85430
5709	1331	7781	86101	228984	96427
5748	1206	7570	— 20338	234679	100443
5817	1057	7424	+ 42222	225477	97989
5913	895	7344	98088	203766	90002
6031	726	7328	144999	172301	77610
6170	554	7373	181743	133788	61945
6327	382	7474	207878	90653	44034
6503	213	7630	223447	— 44954	24766
6687	+ 58	7836	228748	+ 1605	— 4876
6907	— 117	8098	224173	47593	+ 15011
7137	277	8411	210111	91749	34345
— 7386	— 435	+ 8780	+ 186926	+ 132866	+ 52599

Table III

G. M. T.	x	y	z
1935 Mar. 19.0 . . .	+ 19.0137975	— 1.9852502	— 22.1747687
Aug. 26.0 . . .	18.9147111	1.8376004	21.9850124
1936 Feb. 2.0 . . .	18.8098916	1.6891840	21.7883760
Jul. 11.0 . . .	18.6991856	1.5400108	21.5847489
Dec. 18.0 . . .	18.5824269	1.3901015	21.3740180
1937 May 27.0 . . .	18.4594375	1.2394890	21.1560679
Nov. 3.0 . . .	18.3300300	1.0882214	20.9307819
1938 Apr. 12.0 . . .	18.1940098	0.9363623	20.6980417
Sep. 19.0 . . .	18.0511798	0.7839924	20.4577274
1939 Feb. 26.0 . . .	17.9013431	0.6312083	20.2097165
Aug. 5.0 . . .	17.7443085	0.4781212	19.9538828
1940 Jan. 12.0 . . .	17.5798924	0.3248518	19.6900933
Jun. 20.0 . . .	17.4079204	0.1715262	19.4182057
Nov. 27.0 . . .	17.2282259	— 0.0182704	19.1380645
1941 May 6.0 . . .	17.0406468	+ 0.1347956	18.8494974
Oct. 13.0 . . .	16.8450183	0.2875604	18.5523126
1942 Mar. 22.0 . . .	16.6411672	0.4399227	18.2462958
Aug. 29.0 . . .	16.4289041	0.5917917	17.9312089
1943 Feb. 5.0 . . .	16.2080169	0.7430840	17.6067891
Jul. 15.0 . . .	15.9782647	0.8937205	17.2727472
Dec. 22.0 . . .	15.7393733	1.0436228	16.9287670
1944 May 30.0 . . .	15.4910308	1.1927088	16.5745042
Nov. 6.0 . . .	15.2328837	1.3408887	16.2095839
1945 Apr. 15.0 . . .	14.9645328	1.4880609	15.8335991
Sep. 22.0 . . .	14.6855288	1.6341076	15.4461064
1946 Mar. 1.0 . . .	14.3953671	1.7788911	15.0466237
Aug. 8.0 . . .	14.0934819	1.9222477	14.6346240
Oct. 27.0 . . .	13.9379475	1.9933316	14.4237522
1947 Jan. 15.0 . . .	13.7792382	2.0639833	14.2095305
Apr. 5.0 . . .	13.6172623	2.1341724	13.9918778
Jun. 24.0 . . .	13.4519226	2.2038657	13.7707090
Sep. 12.0 . . .	13.2831160	2.2730272	13.5459346
Dec. 1.0 . . .	13.1107328	2.3416170	13.3174600
1948 Feb. 19.0 . . .	+ 12.9346567	+ 2.4095914	— 13.0851860

Table III.

$\sum X'$	$\sum Y'$	$\sum Z'$	$\sum X$	$\sum Y$	$\sum Z$
— 7653	— 590	+ 9211	+ 154983	+ 169693	+ 69225
7935	739	9710	114724	200829	83612
8226	874	10286	66802	224698	95069
8514	979	10942	+ 12262	239524	102808
8779	1032	11675	— 47252	243434	105982
8997	998	12463	109294	234645	103769
9141	841	13257	170499	211795	95498
9188	532	13981	226600	174373	80848
9132	— 69	14536	272746	123201	60054
8986	+ 513	14834	304111	+ 60785	34068
8787	1143	14826	316753	— 8627	+ 4618
8578	1737	14524	308517	79442	— 25950
8399	2227	13994	279645	145549	55010
8275	2576	13327	232843	201363	80098
8217	2778	12608	172766	242758	99328
8228	2846	11904	105051	267584	111646
8306	2803	11258	— 35306	275669	116838
8447	2671	10693	+ 31666	268397	115379
8649	2465	10219	92272	248106	108190
8907	2196	9834	144160	217533	96379
9235	1871	9550	186040	179358	81074
9623	1488	9357	217395	136013	63291
10086	1065	9255	238202	89541	43917
10626	+ 516	9253	248680	— 41648	23683
11254	— 97	9361	249160	+ 6234	— 3216
11984	821	9593	239954	52834	+ 16939
12830	1685	9976	221354	96931	36248
3326	545	2559	52154	29412	11354
3453	681	2637	48410	34312	13539
3589	831	2731	44118	38887	15599
3737	996	2842	39294	43089	17512
3895	1178	2974	33958	46864	19254
4065	1378	3130	28135	50156	20801
— 4247	— 1600	+ 3314	+ 21860	+ 52907	+ 22127

Table III

G. M. T.	x	y	z
1948 May 9.0 . . .	+ 12.7547637	+ 2.4769025	— 12.8490077
Jul. 28.0 . . .	12.5709220	2.5434975	12.6088140
Oct. 16.0 . . .	12.3829908	2.6093187	12.3644876
1949 Jan. 4.0 . . .	12.1908203	2.6743019	12.1159038
Mar. 25.0 . . .	11.9942502	2.7383767	11.8629303
Jun. 13.0 . . .	11.7931089	2.8014653	11.6054261
Sep. 1.0 . . .	11.5872129	2.8634817	11.3432409
Nov. 20.0 . . .	11.3763648	2.9243308	11.0762141
1950 Feb. 8.0 . . .	11.1603526	2.9839073	10.8041733
Apr. 29.0 . . .	10.9389478	3.0420941	10.5269335
Jul. 18.0 . . .	10.7119032	3.0987613	10.2442954
Oct. 6.0 . . .	10.4789514	3.1537643	9.9560435
Dec. 25.0 . . .	10.2398014	3.2069414	9.6619445
1951 Mar. 15.0 . . .	9.9941357	3.2581118	9.3617447
Jun. 3.0 . . .	9.7416068	3.3070724	9.0551674
Aug. 22.0 . . .	9.4818320	3.3535941	8.7419096
Nov. 10.0 . . .	9.2143885	3.3974172	8.4216386
1952 Jan. 29.0 . . .	8.9388062	3.4382461	8.0939874
Apr. 18.0 . . .	8.6545596	3.4757413	7.7585491
Jul. 7.0 . . .	8.3610573	3.5095110	7.4148710
Sep. 25.0 . . .	8.0576295	3.5390987	7.0624464
Nov. 4.0 . . .	7.9019588	3.5521603	6.8827789
Dec. 14.0 . . .	7.7435115	3.5639681	6.7007054
1953 Jan. 23.0 . . .	7.5821740	3.5744388	6.5161429
Mar. 4.0 . . .	7.4178236	3.5834822	6.3290027
Apr. 13.0 . . .	7.2503280	3.5909976	6.1391900
May 23.0 . . .	7.0795439	3.5968757	5.9466033
Jul. 2.0 . . .	6.9053157	3.6009945	5.7511334
Aug. 11.0 . . .	6.7274741	3.6032188	5.5526633
Sep. 20.0 . . .	6.5458340	3.6033978	5.3510667
Oct. 30.0 . . .	6.3601926	3.6013627	5.1462071
Dec. 9.0 . . .	6.1703270	3.5969237	4.9379371
1954 Jan. 18.0 . . .	5.9759911	3.5898662	4.7260964
Feb. 27.0 . . .	+ 5.7769121	+ 3.5799462	— 4.5105109

Table III

$\sum X'$	$\sum Y'$	$\sum Z'$	$\sum X$	$\sum Y$	$\sum Z$
— 4442	— 1843	+ 3532	+ 15173	+ 55056	+ 23205
4651	2110	3788	8132	56541	24007
4873	2401	4090	+ 802	57301	24506
5109	2717	4447	— 6736	57278	24674
5358	3056	4865	14384	56420	24486
5620	3415	5357	22031	54685	23922
5894	3788	5932	29551	52044	22967
6177	4166	6599	36802	48483	21612
6467	4534	7368	43636	44013	19855
6763	4875	8242	49895	38664	17709
7063	5165	9222	55420	32499	15195
7364	5377	10298	60061	25605	12346
7669	5480	11452	63678	18100	9211
7978	5448	12653	66156	10127	5847
8297	5261	13859	67404	+ 1852	+ 2325
8635	4911	15021	67365	— 6541	— 1280
9000	4402	16091	66024	14862	4886
9403	3758	17022	63405	22917	8408
9857	3015	17782	59571	30522	11766
10372	2216	18358	54622	37508	14886
10956	1405	18750	48689	43731	17702
2820	252	4720	11351	11629	4745
2905	156	4744	10482	12268	5040
2997	— 64	4758	9574	12846	5310
3094	+ 24	4765	8629	13362	5555
3197	107	4765	7655	13814	5773
3308	183	4760	6657	14202	5964
3426	254	4751	5640	14524	6127
3552	319	4737	4610	14781	6262
3687	377	4721	3572	14973	6370
3832	429	4704	2532	15102	6451
3988	474	4685	1494	15168	6505
4156	512	4665	— 464	15173	6532
— 4337	+ 546	+ 4647	+ 556	— 15119	— 6534

Table III

G. M. T.			x	y	z
1954	Apr.	8.0	+ 5.5727866	+ 3.5668850	— 4.2909908
	May	18.0	5.3632747	3.5503617	4.0673285
	Jun.	27.0	5.1479948	3.5300050	3.8392967
	Aug.	6.0	4.9265152	3.5053811	3.6066458
		26.0	4.8132996	3.4913128	3.4885033
	Sep.	15.0	4.6983446	3.4759794	3.3691008
	Oct.	5.0	4.5815777	3.4593017	3.2483995
		25.0	4.4629207	3.4411934	3.1263588
	Nov.	14.0	4.3422897	3.4215592	3.0029357
	Dec.	4.0	4.2195942	3.4002945	2.8780854
		24.0	4.0947363	3.3772834	2.7517606
1955	Jan.	13.0	3.9676101	3.3523974	2.6239119
	Feb.	2.0	3.8381003	3.3254936	2.4944873
		22.0	3.7060818	3.2964118	2.3634327
	Mar.	14.0	3.5714177	3.2649727	2.2306914
	Apr.	3.0	3.4339584	3.2309738	2.0962049
		23.0	3.2935396	3.1941858	1.9599124
	May	13.0	3.1499807	3.1543475	1.8217520
		23.0	3.0769597	3.1331926	1.7519518
	Jun.	2.0	3.0030819	3.1111595	1.6816611
		12.0	2.9283121	3.0882036	1.6108722
		22.0	2.8526225	3.0642770	1.5395774
	Jul.	2.0	2.7759819	3.0393278	1.4677694
		12.0	2.6983570	3.0132999	1.3954411
		22.0	2.6197127	2.9861327	1.3225857
	Aug.	1.0	2.5400122	2.9577604	1.2491971
		11.0	2.4592161	2.9281115	1.1752700
		21.0	2.3772833	2.8971078	1.1007996
		31.0	2.2941698	2.8646643	1.0257828
	Sep.	10.0	2.2098295	2.8306876	0.9502176
		20.0	2.1242134	2.7950754	0.8741042
		30.0	2.0372698	2.7577150	0.7974447
	Oct.	10.0	1.9489440	2.7184822	0.7202445
		20.0	+ 1.8591782	+ 2.6772394	— 0.6425127

Table III.

$\sum X'$	$\sum Y'$	$\sum Z'$	$\sum X$	$\sum Y$	$\sum Z$
— 4533	+ 572	+ 4628	+ 1561	— 15007	— 6510
4747	593	4610	2547	14841	6463
4980	607	4594	3511	14622	6392
5237	618	4578	4449	14353	6300
1344	155	1142	1226	3548	1561
1379	155	1141	1340	3509	1546
1418	155	1139	1450	3464	1530
1458	155	1137	1560	3418	1513
1500	155	1135	1667	3370	1495
1545	154	1133	1772	3318	1475
1593	153	1131	1874	3264	1454
1643	151	1129	1975	3207	1432
1696	149	1126	2073	3148	1409
1753	148	1124	2169	3087	1386
1814	146	1121	2262	3024	1361
1879	143	1117	2354	2959	1335
1948	141	1113	2442	2892	1308
2022	139	1108	2529	2823	1281
515	35	276	643	697	317
525	34	275	653	688	313
536	34	274	663	679	310
547	34	274	674	670	306
558	34	273	684	661	302
570	34	271	693	651	298
583	34	270	703	642	294
596	33	269	712	632	291
609	34	267	722	623	287
623	34	265	731	613	283
644	25	266	790	622	296
659	25	264	805	590	283
675	24	262	810	558	268
692	23	260	807	527	254
711	22	257	797	502	241
— 730	+ 22	+ 254	+ 781	— 482	— 231

Table III

G. M. T.	x	y	z
1955 Oct. 30.0	+ 1.7679119	+ 2.6338342	— 0.5642628
Nov. 9.0	1.6750812	2.5880967	0.4855142
19.0	1.5806196	2.5398373	0.4062937
29.0	1.4844579	2.4888439	0.3266373
Dec. 9.0	1.3865249	2.4348781	0.2465923
19.0	1.2867481	2.3776713	0.1662210
29.0	1.1850553	2.3169202	0.0856040
1956 Jan. 8.0	1.0813762	2.2522810	0.0048462
18.0	0.9756460	2.1833633	0.0759175
28.0	0.8678090	2.1097230	0.1565131
Feb. 7.0	0.7578261	2.0308546	0.2367157
17.0	0.6456832	1.9461828	0.3162357
27.0	0.5314055	1.8550549	0.3946976
Mar. 8.0	0.4150768	1.7567354	0.4716214
18.0	0.2968668	1.6504042	0.5463803
28.0	0.1770699	1.5351657	0.6181733
Apr. 7.0	+ 0.0561565	1.4100743	0.6859765
17.0	— 0.0651602	1.2741903	0.7484998
27.0	0.1858488	1.1266767	0.8041542
May 7.0	0.3044812	0.9669662	0.8510538
17.0	0.4191940	0.7949803	0.8870889
27.0	0.5277268	0.6113952	0.9101097
Jun. 6.0	0.6276002	0.4178552	0.9182371
16.0	0.7164452	0.2170093	0.9102480
26.0	0.7924125	0.0122626	0.8858968
Jul. 6.0	— 0.8544995	+ 0.1927283	— 0.8460121

Table III.

$\sum X'$	$\sum Y'$	$\sum Z'$	$\sum X$	$\sum Y$	$\sum Z$
— 750	+ 22	+ 252	+ 762	— 471	— 224
770	22	248	742	467	220
794	22	245	724	471	219
818	23	240	711	481	222
844	24	233	704	498	228
870	26	227	705	517	236
897	29	221	714	539	245
925	32	213	734	559	254
954	34	202	763	577	263
985	37	191	798	589	270
1018	41	179	844	593	274
1054	47	166	893	588	274
1092	54	150	944	572	270
1130	69	131	994	544	261
1166	90	112	1039	507	247
1199	116	92	1076	460	229
1229	145	71	1103	407	207
1257	177	49	1117	349	183
1279	214	27	1118	290	157
1296	253	+ 6	1106	234	132
1305	295	— 14	1082	182	108
1304	340	32	1047	139	87
1291	385	45	1005	105	72
1266	429	54	958	82	58
1232	469	56	909	72	51
— 1190	+ 504	— 52	+ 862	— 72	— 50

Table IV.

0^h G.M.T. (U.T.)	$\alpha_{1950.0}$	$\delta_{1950.0}$	r	Δ
1955 Aug. 1	$4^h10^m17^s$	— 12°36′.5	4.094	4.263
3	11 43	12 39.1	4.075	4.220
5	13 8	12 42.0	4.056	4.177
7	14 30	12 45.3	4.038	4.135
9	15 51	12 49.0	4.019	4.092
11	17 10	12 53.0	4.000	4.049
13	18 28	12 57.4	3.981	4.006
15	19 43	13 2.1	3.962	3.962
17	20 56	13 7.3	3.944	3.919
19	22 6	13 12.8	3.925	3.875
21	23 14	13 18.6	3.906	3.832
23	24 20	13 24.9	3.887	3.788
25	25 23	13 31.5	3.868	3.744
27	26 24	13 38.4	3.849	3.701
29	27 22	13 45.7	3.830	3.657
31	28 16	13 53.3	3.811	3.613
Sep. 2	29 8	14 1.3	3.792	3.570
4	29 56	14 9.6	3.773	3.526
6	30 41	14 18.2	3.753	3.483
8	31 23	14 27.0	3.734	3.439
10	32 1	14 36.2	3.715	3.396
12	32 36	14 45.7	3.696	3.354
14	33 6	14 55.5	3.676	3.311
16	33 33	15 5.5	3.657	3.269
18	33 55	15 15.8	3.637	3.226
20	34 13	15 26.3	3.618	3.184
22	34 26	15 36.9	3.598	3.143
24	34 35	15 47.8	3.579	3.101
26	34 40	15 58.8	3.559	3.060
28	34 39	16 10.1	3.540	3.019
30	34 33	16 21.4	3.520	2.979
Oct. 2	34 22	16 33.0	3.500	2.939
4	34 6	16 44.2	3.481	2.899
6	4 33 44	— 16 55.7	3.461	2.861

Table IV

0^h G. M. T. (U. T.)	$\alpha_{1950.0}$	$\delta_{1950.0}$	r	Δ
1955 Oct. 8.....	$4^h33^m17^s$	−17° 7′2	3.442	2.823
10.....	32 44	17 18.6	3.422	2.785
12.....	32 5	17 29.8	3.402	2.748
14.....	31 20	17 40.9	3.382	2.711
16.....	30 30	17 51.9	3.362	2.676
18.....	29 33	18 2.6	3.342	2.641
20.....	28 30	18 13.0	3.322	2.606
22.....	27 20	18 23.0	3.302	2.572
24.....	26 5	18 32.7	3.282	2.539
26.....	24 43	18 41.9	3.262	2.506
28.....	23 15	18 50.5	3.242	2.475
30.....	21 41	18 58.6	3.222	2.444
Nov. 1.....	20 0	19 6.0	3.202	2.414
3.....	18 14	19 12.7	3.182	2.385
5.....	16 22	19 18.5	3.161	2.357
7.....	14 24	19 23.5	3.141	2.330
9.....	12 20	19 27.6	3.121	2.304
11.....	10 11	19 30.7	3.101	2.279
13.....	7 57	19 32.7	3.080	2.255
15.....	5 39	19 33.5	3.060	2.232
17.....	3 16	19 33.2	3.039	2.210
19.....	4 0 49	19 31.6	3.019	2.189
21.....	3 58 18	19 28.7	2.998	2.169
23.....	55 44	19 24.4	2.978	2.150
25.....	53 8	19 18.7	2.957	2.132
27.....	50 29	19 11.5	2.937	2.115
29.....	47 49	19 2.9	2.916	2.099
Dec. 1.....	45 7	18 52.7	2.895	2.084
3.....	42 25	18 41.0	2.875	2.070
5.....	39 43	18 27.8	2.854	2.058
7.....	37 2	18 13.0	2.834	2.046
9.....	34 22	17 56.6	2.813	2.035
11.....	31 43	17 38.7	2.792	2.025
13.....	3 29 7	−17 19.2	2.771	2.017

Table IV

0^h G.M.T. (U.T.)	$\alpha_{1950.0}$	$\delta_{1950.0}$	r	Δ
1955 Dec. 15.....	$3^h26^m33^s$	— 16°58′.3	2.751	2.009
17.....	24 3	16 35.8	2.730	2.002
19.....	21 36	16 11.9	2.709	1.996
21.....	19 14	15 46.6	2.688	1.991
23.....	16 56	15 19.9	2.667	1.987
25.....	14 44	14 51.8	2.646	1.984
27.....	12 37	14 22.4	2.625	1.982
29.....	10 36	13 51.9	2.604	1.980
31.....	8 41	13 20.2	2.583	1.979
1956 Jan. 2.....	6 53	12 47.4	2.562	1.979
4.....	5 11	12 13.6	2.541	1.979
6.....	3 36	11 38.7	2.519	1.980
8.....	2 8	11 3.0	2.498	1.981
10.....	3 0 47	10 26.4	2.477	1.983
12.....	2 59 33	9 49.0	2.456	1.986
14.....	58 27	9 10.8	2.435	1.989
16.....	57 28	8 31.9	2.414	1.993
18.....	56 37	7 52.4	2.393	1.996
20.....	55 53	7 12.3	2.371	2.001
22.....	55 16	6 31.6	2.350	2.005
24.....	54 48	5 50.4	2.329	2.010
26.....	54 26	5 8.8	2.308	2.015
28.....	54 12	4 26.7	2.287	2.020
30.....	54 5	3 44.2	2.265	2.027
Feb. 1.....	54 6	3 1.3	2.244	2.033
3.....	54 13	2 18.2	2.223	2.039
5.....	54 28	1 34.7	2.202	2.045
7.....	54 50	0 50.9	2.180	2.049
9.....	55 19	— 0 6.9	2.159	2.055
11.....	55 54	+ 0 37.3	2.138	2.060
13.....	56 37	1 21.8	2.117	2.065
15.....	57 26	2 6.5	2.096	2.070
17.....	58 22	2 51.3	2.075	2.076
19.....	2 59 24	+ 3 36.3	2.054	2.081

Table IV

0^h G.M.T. (U.T.)	$\alpha_{1950.0}$	$\delta_{1950.0}$	r	Δ
1956 Feb. 21.....	$3^h\ 0^m33^s$	+ 4°21′.6	2.033	2.086
23.....	1 48	5 6.9	2.012	2.091
25.....	3 9	5 52.4	1.991	2.095
27.....	4 37	6 38.1	1.970	2.099
29.....	6 11	7 23.9	1.949	2.104
Mar. 2.....	7 51	8 9.8	1.928	2.108
4.....	9 38	8 55.8	1.907	2.112
6.....	11 30	9 41.9	1.886	2.115
8.....	13 29	10 28.2	1.866	2.118
10.....	15 34	11 14.6	1.845	2.121
12.....	17 44	12 1.1	1.825	2.123
14.....	20 1	12 47.8	1.804	2.125
16.....	22 24	13 34.5	1.784	2.127
18.....	24 53	14 21.4	1.764	2.128
20.....	27 29	15 8.4	1.744	2.129
22.....	30 10	15 55.4	1.724	2.130
24.....	32 58	16 42.6	1.704	2.130
26.....	35 52	17 29.8	1.684	2.129
28.....	38 53	18 17.2	1.664	2.129
30.....	42 0	19 4.7	1.645	2.128
Apr. 1.....	45 13	19 52.3	1.626	2.126
3.....	48 34	20 40.0	1.607	2.124
5.....	52 1	21 27.8	1.588	2.122
7.....	55 36	22 15.6	1.569	2.120
9.....	3 59 18	23 3.5	1.551	2.116
11.....	4 3 7	23 51.4	1.533	2.113
13.....	7 4	24 39.4	1.515	2.109
15.....	11 8	25 27.3	1.497	2.105
17.....	15 21	26 15.3	1.479	2.100
19.....	19 42	27 3.3	1.462	2.095
21.....	24 12	27 51.2	1.445	2.090
23.....	28 51	28 39.0	1.429	2.084
25.....	33 39	29 26.8	1.412	2.078
27.....	4 38 37	+ 30 14.4	1.397	2.071

Table IV

0^h G.M.T. (U.T.)	$\alpha_{1950.0}$	$\delta_{1950.0}$	r	Δ
1956 Apr. 29.....	$4^h43^m44^s$	+31° 1'.9	1.381	2.064
May 1.....	49 2	31 49.1	1.366	2.057
3.....	4 54 31	32 36.0	1.351	2.050
5.....	5 0 11	33 22.6	1.337	2.042
7.....	6 3	34 8.8	1.324	2.034
9.....	12 7	34 54.5	1.310	2.025
11.....	18 23	35 39.6	1.298	2.017
13.....	24 53	36 24.1	1.285	2.008
15.....	31 36	37 7.9	1.274	1.999
17.....	38 33	37 50.8	1.263	1.989
19.....	45 45	38 32.8	1.252	1.980
21.....	5 53 11	39 13.7	1.242	1.970
23.....	6 0 53	39 53.3	1.233	1.961
25.....	8 51	40 31.6	1.225	1.951
27.....	17 5	41 8.4	1.217	1.941
29.....	25 35	41 43.5	1.210	1.932
31.....	34 22	42 16.7	1.203	1.922
Jun. 2.....	43 26	42 47.9	1.197	1.912
4.....	6 52 46	43 16.8	1.192	1.903
6.....	7 2 22	43 43.3	1.188	1.893
8.....	12 15	44 7.1	1.185	1.884
10.....	22 23	44 28.1	1.182	1.875
12.....	32 46	44 46.0	1.180	1.866
14.....	43 23	45 0.7	1.179	1.858
16.....	7 54 12	+45 11.9	1.178	1.850

Table V.

0^h G.M.T. (U.T.)	Precession from 1950.0 to 1955.0 — 1956.0		Correction for T 1 day later	
1955 Aug. 1	+ 14.0	+ 0.77	— 19^s	— 4.7
11	14.0	0.72	21	4.9
21	13.9	0.68	23	5.2
31	13.9	0.65	25	5.5
Sep. 10	13.8	0.63	28	5.8
20	13.6	0.61	30	6.0
30	13.5	0.61	32	6.3
Oct. 10	13.4	0.62	35	6.4
20	13.3	0.65	37	6.7
30	13.3	0.69	39	6.8
Nov. 9	13.3	0.76	39	6.9
19	13.3	0.83	38	7.0
29	13.4	0.91	36	7.2
Dec. 9	13.6	0.99	33	7.5
19	13.9	1.06	29	8.0
29	14.2	1.13	24	8.8
1956 Jan. 8	17.3	1.40	20	9.7
18	17.7	1.44	16	10.8
28	18.0	1.45	14	11.8
Feb. 7	18.4	1.45	12	13.1
17	18.7	1.43	11	14.1
27	19.1	1.39	12	15.4
Mar. 8	19.5	1.33	13	16.5
18	20.0	1.26	16	17.9
28	20.6	1.16	20	19.1
Apr. 7	21.2	1.04	26	20.4
17	22.0	0.88	34	21.6
27	22.8	0.70	45	22.8
May 7	23.7	0.47	61	23.7
17	24.6	+ 0.19	82	23.9
27	25.4	— 0.15	110	23.0
Jun. 6	25.8	0.54	144	20.7
16	+ 25.5	— 0.96	— 178	— 16.3

Table VI.

Distances between the major planets and Comet Olbers	Jupiter	Saturn	Uranus	Neptun	Pluto	$a\sqrt{a}$
1815 Aug. 14.5 . . .	4.3	9.7	17.3	28.7	45.6	74.87
1818 Jan. 30.5 . . .	5.2	8.7	12.6	22.7	42.1	73.49
1820 Jul. 18.5 . . .	11.8	14.7	11.6	20.6	40.3	72.52
1825 Jun. 22.5 . . .	25.4	26.8	11.8	18.9	39.0	72.45
1830 May 27.5 . . .	22.1	33.6	14.2	18.6	39.4	72.65
1835 May 1.5 . . .	32.0	33.4	18.2	18.9	40.5	72.39
1840 Apr. 4.5 . . .	32.2	28.8	23.1	19.7	41.9	72.58
1845 Mar. 9.5 . . .	31.0	25.8	28.1	20.8	43.4	72.54
1850 Feb. 11.5 . . .	37.6	29.6	32.9	22.3	44.7	72.43
1855 Jan. 16.5 . . .	29.7	36.7	36.9	24.0	45.7	72.56
1859 Dec. 21.5 . . .	35.8	39.9	39.7	25.5	46.3	72.46
1864 Nov. 24.5 . . .	30.5	36.3	41.2	26.7	46.6	72.39
1869 Oct. 29.5 . . .	27.0	28.0	40.8	27.5	46.3	72.67
1874 Oct. 3.5 . . .	27.6	18.9	38.5	27.6	45.5	72.36
1879 Sep. 7.5 . . .	15.2	13.7	33.9	26.9	44.4	72.81
1884 Aug. 11.5 . . .	13.4	11.5	26.5	25.7	43.6	72.96
1888 Jan. 3.5 . . .	4.0	9.7	17.1	31.3	49.9	72.51
1888 Jul. 11.5 . . .	2.2	12.0	17.3	33.2	51.7	72.81
1889 Jan. 17.5 . . .	1.5	13.6	17.8	34.4	52.7	72.01
1889 Jul. 16.5 . . .	2.2	14.8	18.3	35.3	53.4	70.27
1890 Jan. 12.5 . . .	3.6	15.8	18.8	36.1	54.0	69.55
1894 Jun. 20.5 . . .	20.0	19.6	21.6	41.9	57.5	68.51
1899 Apr. 15.5 . . .	22.9	18.4	22.1	47.1	60.4	69.01
1904 Jul. 18.5 . . .	25.4	19.3	21.1	51.7	62.9	68.72
1909 Oct. 20.5 . . .	33.2	27.8	20.0	55.2	64.7	68.73
1914 Aug. 15.5 . . .	27.5	36.5	19.8	57.3	65.9	68.79
1919 Nov. 17.5 . . .	36.5	39.9	21.1	58.6	66.4	68.64
1925 Feb. 19.0 . . .	29.9	35.7	23.6	58.6	66.0	68.75
1930 May 24.0 . . .	33.4	27.7	26.4	57.5	64.8	68.77
1935 Aug. 26.0 . . .	29.9	22.6	28.8	55.2	62.5	68.67
1940 Nov. 27.0 . . .	24.7	24.4	29.9	51.7	58.9	68.99
1946 Mar. 1.0 . . .	24.5	26.3	29.0	47.0	53.8	68.60
1951 Jun. 3.0 . . .	10.7	21.7	25.0	40.9	46.2	69.08
1956 Jun. 16.0 . . .	4.6	10.1	17.7	30.0	33.8	69.57