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ELEMENTS AND EPHEMERIS OF ASTEROID 1909 J B.

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ELEMENTS AND EPHEMERIS OF ASTEROID 1909 J. B.

A thesis submitted to the faculty of the Graduate
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UNIVERSITY OF

MINNESOTA

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MASTER OF ARTS.

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AUG 19 1910

THE ELEMENTS AND THE EPHEMERIS OF ASTEROID 1909 J.B.

The data used for computing the orbit of Asteroid 1909 J B was obtained from Mr. Joel Metcalf of Taunton, Mass., and from Mr. Yowell of Cincinnati, Ohio. The data obtained from Mr. Yowell consists of positions determined by micrometer measurements.

Date	Cincinnati, M.T.			App. R. A.			App. D.		
	H.	m.	s.	H.	m.	s.	°	'	"
Nov. 30, 1909:	11	42	4.00:	3	33	33.47:	-32	36	48.0:
Dec. 4, 1909:	8	23	28.00:	3	30	1.10:	-31	54	59.8:
Dec. 9, 1909:	10	1	5.00:	3	25	56.31:	-30	59	2.3:

Parallax Factors.

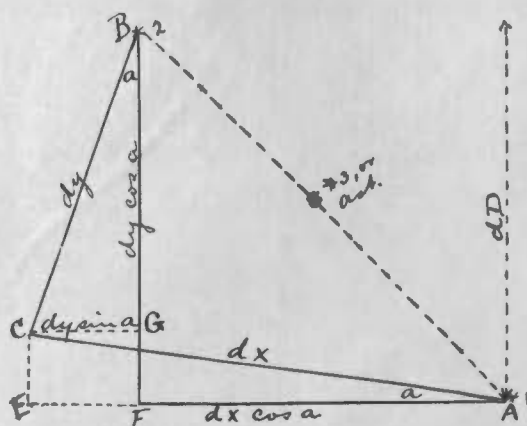
Date	R. A.	D.
Nov. 30, 1909:	9.036:	0.009:
Dec. 4, 1909:	9.478:	0.225:
Dec. 9, 1909:	8.441:	0.089:

The position on Dec. 9, was used in computing the elements. The other two positions were used for checking after the elements were derived.

The data obtained from Mr. Metcalf consists of Photographic positions for Nov. 7, 1909; and Jan. 8, 1910.

Plate	Date	Gr.	M.	T.	Star.	dx(mm)	dy(mm)
		h.	m.	s.			
882	Nov. 7, 1909	14	55	00.00	A. G. 2060	25.321	38.238
					Ast.	29.581	32.249
					A. G. 2095	30.541	30.113
967	Jan. 8, 1910	12	55	00.00	A. G. 1659	14.351	37.171
						14.239	37.170
					Ast.	16.109	36.038
						16.035	36.060
					A. G. 1684	19.186	31.224
						19.123	31.225

The scheme for reducing these positions to right ascension and declination is that used by Professor Max Wolf of Heidelberg, Germany.



To get the asteroids
place in the plane co-or-
dinates.

Since there must be a correction for orientation, α
as follows
correction must be made. Let (α) be this angle. Measure dx
and dy for the two stars, and let star 2 have the greater
R. A. Let dx, dy be the distances measured, while AF, BF
are the distances in RA and D.

$$dD = D'' - D'; \text{ and } d(RA) = RA'' - RA'$$

$$\text{The mean } D = D_m = (D' + D'') \div 2$$

$$1. \quad d(RA)^0 = d(RA) \cos D_m \quad 15$$

$$\text{From the figure } dD = BF = BG + GF.$$

$$\text{But } CE = GF, \quad dD = BG + CE$$

$$CE = dx \sin \alpha; \text{ and } BG = dy \cos \alpha$$

$$dD = dy \cos \alpha + dx \sin \alpha$$

$$d(RA)^0 = AE - BF$$

$$AE = dx \cos \alpha; \text{ and } BF = dy \sin \alpha$$

$$d(RA)^0 = dx \cos \alpha - dy \sin \alpha$$

Since angle (α) is small we write the approximate values,

$$dD = dy + dx \sin \alpha = S_d (dy + dx \sin \alpha)^0$$

$$d(RA)^{\circ} = dx - dy \sin a = G_{ra}(dx - dy \sin a)^{\circ}$$

Where G is a factor which reduces millimeters to seconds of arc. This enables us to derive G from the declination and right ascension, and gives a check for the work.

Angle a is a known quantity for,

$$2. \quad \tan b = dD/d(RA)^{\circ},$$

$$3. \quad \tan (b - a) = dy/dx, \text{ and}$$

$$4. \quad a = b - (b - a)$$

$$5. \quad G_{ra} = d(RA)^{\circ} / (dx - dy \sin a)$$

$$6. \quad G_d = dD / (dy + dx \sin a)$$

Having found the scale value G we can make the proper reductions.

Using star 1 and star 3

$$dx' = x, \text{ between star 1 and star 3.}$$

$$dy' = y, \text{ between star 1 and star 3.}$$

Proceeding as above, for star (3) we have

$$7. \quad dD' = G(dy' - dx' \sin a)$$

$$8. \quad d(RA)^{\circ} = G(dx' - dy' \sin a)$$

$$\text{In this case } D_m = (D_3 - D_1) / 2$$

$$9. \quad d(RA) = d(RA)^{\circ} + 15 \cdot \cos D_m$$

$$10. \quad (RA)_3 = (RA)_1 - d(RA)_3$$

$$11. \quad D_3 = D_1 - dD_3$$

By using star 2 in the same manner we have a check.

The two comparison stars should be as nearly as possible equi-distant from the star to be measured, and in line with it.

The computation is carried thru according to Theodore Oppolzer's method, as found in volume one of orbit determination pp. 203 to 207, and 221 to 223.

The Asteroids are small planets revolving about the sun between Mars and Jupiter. It is about one hundred years since the first was discovered. At the present time 674 have been discovered. This number is being increased at the rate of about ten or fifteen per year. Those who have discovered the greatest number in recent years are Mr. Max Wolf of Germany, and Mr. Joel Metcalf of Taunton, Mass.

The search for Asteroids is made with a camera with a field about 12 degrees square. In some cases the camera is kept on the fixed stars while the asteroid trails, and is picked up in this way. In other cases the camera is made to follow the asteroid while the stars trail. By the latter method asteroids at least one magnitude fainter are discovered than by the former method. Exposures are made for about one half hour.

There is little interest in the discovery of asteroids. Many of them are little more than large rocks revolving in space. They probably explain the absence of a planet between Mars and Jupiter, which according to Bode's Law ought to be there. They are of little value beyond this except that those nearest the earth enable us to get a good value for the parallax of the sun. In 1931 Eros

will approach unusually close to the earth, and it is hoped that more accurate measure of the sun's parallax may be made at that time. The mean distance of the mean asteroid is about 2.55 times the astronomical unit, or about 245,000,000 miles. They vary in diameter from 465 miles down to less than 10 miles. The inclination of their orbits to the ecliptic ranges from 8 to 35 degrees; while the eccentricity of some of them is as great as 0.30.

I have compared the elements obtained with those previously computed, and have found none to resemble them. It is therefore a new Asteroid. It is located at about the mean distance. Its magnitude was 10 on Nov. 7, 1909.

The computations here presented have been carried out under the personal direction of Mr. F. P. Leavenworth, Professor of Astronomy, and of Mr. K. Burns assistant in the department.

Computation of α and δ for the Asteroid of B 1909 from

photographic positions on Nov 7, 1909, and Jan 8, 1910.

A # 2060

A # 2073

A # 1689

A # 1684

A # 1684

α	δ	α	δ
29220	10.4655	8.8711	13.1215
2 ^m 13.35	5' 55.8	2 ^m 1.42	7' 26.1
53 ^s 28.2	36" 08.4	15 ^m 30.38	26" 11' 24.7
55	16.67	3	17
	43	31.80	26
	58.4	3	18
	58.4		50.8

Plate # 882

Plate # 967

α	δ	$\log \tan \varphi$	$\log \Delta$
3.5596	12.9330	0.19 6034 _u	0.076490 _u
2 ^m 7.03	7' 19.8	-57° 30' 52.0	-50° 1' 8.9
58	21.39	3	25
20	22.42	3	33
	25		6.0

X_{α}	X_{δ}	Y_{α}	Y_{δ}
30.113	38.258	30.113	38.258
ΔX	ΔY	4.836	-5.946
5.220	-8.175	0.774220 _u	0.68449
		0.717671	0.08973 _u
		0.19482 _u	-57° 26' 25.7
		-4' 26.3	+51' 31.3

$\log \Delta \alpha$	$\log \Delta \delta$	$\log \cos \delta$	$\log \Delta \alpha$
2.303520	1.176091	9.953900	3.386453
1.176091	9.953900	3.386453	3.582507 _u
			3.438510 _u

$\log \Delta \alpha$	$\log \Delta \delta$	$\log \cos \delta$	$\log \Delta \alpha$
2.303520	1.176091	9.953900	3.386453
1.176091	9.953900	3.386453	3.582507 _u
			3.438510 _u

$\log \Delta \alpha$	$\log \Delta \delta$	$\log \cos \delta$	$\log \Delta \alpha$
2.303520	1.176091	9.953900	3.386453
1.176091	9.953900	3.386453	3.582507 _u
			3.438510 _u

$\log \Delta \alpha$	$\log \Delta \delta$	$\log \cos \delta$	$\log \Delta \alpha$
2.303520	1.176091	9.953900	3.386453
1.176091	9.953900	3.386453	3.582507 _u
			3.438510 _u

Ref Stars

Ann. Linc. 1872

Red. to 1909

Pos. 1875

Pos. 1909.0

Ann. Linc. 1872

Red. to 1909

Pos. 1875

Pos. 1909.0

Ann. Linc. 1872

Red. to 1909

Pos. 1875

Pos. 1909.0

Ann. Linc. 1872

Red. to 1909

Pos. 1875

Pos. 1909.0

Ann. Linc. 1872

Red. to 1909

Pos. 1875

Pos. 1909.0

Ann. Linc. 1872

Plate	#882	#967	Plate	* ₁ -a-1 #882	* ₂ -a-1 #882	* ₁ -a-1 #967	* ₂ -a-1 #967
log Δx	0.71767	0.68449	X	29.581	0.32980	16.072	0.67934
log sin ∘	7.11094 ⁿ	8.17572	Y	32.249	2.66964	36.1049	2.66963
log Δx sin ∘	7.82862	8.86021	Δx	4.260	2.99944	1.752	3.34897
No.	- 0.0067	+ 0.073	Δy	- 6.039	+ 16' 38.7"	- 1.121	+ 37' 13.4"
Δy	- 8.175	- 5.946	log Δx	0.62941	35' 40' 14.5"	0.24353	25' 33' 6.0"
Sum	- 8.182	- 5.873	log sin ∘	7.11095 ⁿ	0.32980	8.17572	0.67934
log Sum	0.91284 ⁿ	0.76886 ⁿ	log Δx sin ∘	7.74036 ⁿ	2.66964	8.41925 ⁿ	2.66963
log ΔS	3.58251 ⁿ	3.43851 ⁿ	No.	- 0.0055	2.99944	0.026	3.34897
log S	2.66966	2.66965 ^{ch.}	Δy	- 6.039	+ 16' 38.7"	- 1.121	+ 37' 13.4"
log Δy	0.91249 ⁿ	0.77422 ⁿ	Sum	- 6.045	2.137	- 1.095	4.779
log sin ∘	7.11094 ⁿ	8.17572	log sum	0.78140	0.32980	0.03941 ⁿ	0.67934
log Δy sin ∘	8.02343	8.94994 ⁿ	log S	2.66964	2.66964	2.66963	2.66963
No.	0.0105	- 0.089	log ΔS	3.45104 ⁿ	2.99944	2.70904 ⁿ	3.34897
Δx	5.220	4.836	ΔS	- 47' 5.2"	+ 16' 38.7"	- 8' 31.7"	+ 37' 13.4"
Diff.	5.2306	4.925	S*	36° 43' 58.4"	35' 40' 14.5"	26° 18' 50.8"	25° 33' 6.0"
log diff.	0.71684	0.69241	S ^{ast}	35° 56' 53.2"	35' 56' 53.2"	26° 10' 19.1"	26° 10' 19.4 ^{ch.}
log α	3.38645	3.36202	S ^{un}	36° 20' 25.8"	35' 48' 33.8"	26° 14' 35.0"	25° 51' 42.7"
log S	2.66961 ^{ch.}	2.66963 ^{ch.}	log cos Δm	9.90607	9.90900	9.95275 ⁿ	9.95417
Mean log S	2.66964	2.66963	log 15°	1.17609	1.17609	1.17609	1.17609
			log D ₁	1.08216	1.08509	1.12884	1.13026
			log Δy	0.78097 ⁿ	0.32960	0.04961 ⁿ	0.65350
			log sin ∘	7.11095 ⁿ	7.11095 ⁿ	8.17572	8.17572
			log Δx sin ∘	7.89192	7.44055 ⁿ	8.22533 ⁿ	8.85922
			No.	+ 0.0078	- 0.0028	- 0.017	+ 0.072
			Δx	+ 4.260	- 0.960	1.752	- 3.084
			diff	+ 4.252	- 0.957	+ 1.769	- 3.156

Plate	#882	#967										
log diff	0.62859	0.24773	0.49914									
log A α	2.66964	2.66963	2.66963									
log D α	3.29823	2.91736	3.16877									
log D α	1.08216	1.08509	1.13026									
$\Delta\alpha$	2.21607	1.56546	2.03851									
α^*	+ 2 ^h 44 ^m 40 ^s	- 36 ^m 77 ^s	+ 1 ^m 45 ^s									
α^*	3 ^h 55 ^m 16 ^s	3 ^h 58 ^m 37 ^s	3 ^h 17 ^m 31 ^s									
α^*	3 ^h 58 ^m 11 ^s	3 ^h 58 ^m 1.05 ^s	3 ^h 18 ^m 33 ^s									
α	3 ^h 58 ^m 10 ^s	3 ^h 58 ^m 1.09 ^s	3 ^h 18 ^m 33 ^s									
δ	35° 06' 58.2"		26° 10' 19.2"									
<i>Reduction to Sidereal Time</i>												
Nov 7	Dec 9	Jan 8										
14 ^h 55 ^m 05.0 ^s		12 ^h 55 ^m 0.0 ^s										
4 44 20.0		4 44 20.0										
10 10 40 10 ^s	1 ^m 51.0 ^s	8 10 40.0										
+ 1 40.2	+ 1 38.87	+ 1 20.51										
Sid. Interval	10 12 20.32	10 2 43.87	8 12 0.51									
Sid Mean Interval	15 4 57.71	11 16.27	19 9 24.31									
Sid Time	1 17 18.03	3 14 0.14	3 21 24.82									
SJ Mean Sid	15 4 11.0	17 10 20.8	19 8 37.6									
Change for Δ	+ 46.71	+ 55.47	+ 46.71									
Sid. Time, N.A.S.P.	15 4 57.71	17 11 16.27	19 9 24.31									

Abeno Frictus.

$\psi = \delta$	38° 56' 54.1"	41° 42' 23.9"	38° 56' 54.1"									
$\theta = \alpha$	19° 19' 30.0"	48° 30' 2.1"	50° 21' 12.0"									
ϵ	23 27 4.0	23 27 4.0	23 27 4.0									
$\tan \delta$	9.9076	9.9500	9.9076									
$\log \sin \alpha$	9.5197	9.8745	9.5197									
$\tan \mu$	0.3879	0.0755	0.3879									
μ	67° 44' 20.0"	49° 57' 20.0"	46° 23' 30.0"									
$\mu - \epsilon$	44 17 16.0	26 30 16.0	22 56 26.0									
$\cos(\mu - \epsilon)$	9.8548	9.9578	9.9642									
$\sec \mu$	0.4216	0.1915	0.1613									
$\tan \alpha$	9.5449	0.0582	0.0816									
$\tan \lambda$	9.8113	0.1965	0.2071									
$\tan(\mu - \epsilon)$	9.9892	9.6978	9.6266									
$\sin \lambda$	9.7422	9.9262	9.9292									
$\tan \beta$	9.7314	9.6240	9.6558									
$\cos \beta$	9.9447	9.9646	9.9736									

	Nov 7	Dec 9	Jan 8	Nov 7	Dec 9	Jan 8
cos β	9.6869	9.8908	9.5026			
cos δ	9.8908	9.8731	9.8908	cos(L ₀ - λ)	9.9737 ^u	9.7713 ^u
cos δ sin α	9.4105	9.7476	9.7772	log M	1.3234	1.3234
cos β sin α	0.2764	0.1432	0.1256	log d log R _I	2.4450	2.4311
cos $(\alpha-\epsilon)$ sec δ	4	3	6 ch	cos(L ₀ -L)	9.9911 ^u	9.8105 ^u
	for zenith.			log d log R _{II}	2.2072 ^u	2.0587 ^u
$\lambda = L$	35° 31' 50.0	57° 32' 30.0	58° 10' 20.0	d log R _I	-162.1	-114.4
$\beta = b$	28 18 50.0	22 49 0.0	19 46 40.0	d log R _{II}	278.6	269.8
$L_0 - L$	191 32 20.0	199 54 52.0	229 43 26.0	log d log R _I	+117.5	+155.4
log Π	0.9439	0.9438	0.9439	d LI	-4.8	+17.5
log R ₀	9.9959	9.9933	9.9927	d LII	-1.6	-6.4
log Π	0.9480	0.9505	0.9512	ΔL	-6.4	+11.1
sin Π	9.6761	9.5886	9.5294	log β	9.9959	9.9927
cos δ	9.9447	9.9646	9.9736	log β (18.8)	0.9138	0.9243
log Π sin δ	0.6241	0.5391	0.4806	log β (18.8)	7.4461	7.4461
Π sin δ	4.2	3.5	3.0	log dt	8.3558	8.3631
$\beta - (")$	-3.8	-3.4	-2.9	dt	0.02	0.02
log $\beta - (")$	0.5798 ^u	0.5315 ^u	0.4624 ^u	dt is negligible.		
$L_0 - \lambda$	160° 15' 22.3	200 31 42.0	233 47 49.0			
sin(L ₀ - λ)	9.5289	9.5449 ^u	9.9068 ^u			
cos β	0.5281	0.6783	0.8740	Missa		
log d LI	0.6768 ^u	0.7547	0.8432	9.999433	9.999347	9.999433
d LI	-4.8	+5.7	+17.5	0.9445	0.9445	0.9445
				38° 56' 54.1	41° 42' 23.9	38° 56' 54.1
sin(L ₀ -L)	9.3011 ^u	9.5323 ^u	9.8824 ^u	L ₀ (km)	225 4 10.3	223 287 53 45.6
Π cos δ	0.8927	0.9151	0.9248	B	+0.36	-0.10
log d LII	0.1938 ^u	0.4474 ^u	0.8072 ^u	log R ₀	9.995865	9.993295
d LII	-4.6	+2.8	-6.4	λ (Cuming)	5 ^L 37 ^M 41.40	
				λ (Vancouver)	4 ^L 44 ^M 20.00	
			4			

Computation of L_0 by Interpolation
 Nov 7 Dec 9 Jan 8

f_0	224° 26' 42.7"	256° 47' 36.3"	287° 21' 41.0"
na	+ 37 27.8	+ 39 46.2	+ 32 55.1
$\frac{n(n-1)}{2}A$	- 0.2	- 0.2	- 0.2
Red to 1909.0			- 50.3
$f = L_0$	225° 4' 10.3"	257° 27' 22.3"	287° 53' 45.6"

Reduction to Greenwich Mean Time
 Nov. 7. Dec 9 Jan 8 Nov 30 Dec 4

Cim. M.T.		10 ^h 1 ^m 5 ^s .00		11 ^h 42 ^m 4 ^s .00	8 ^h 23 ^m 28 ^s .0
Red. to G		5 37 41.40		5 37 41.40	5 37 41.40
G. M.T.	14 ^h 55 ^m 0 ^s .00	15 38 46.40	12 ^h 55 ^m 5 ^s .00	17 19 45.40	14 1 9.40
"	7.6215 27	9.6519 26	8.5381 94	30.72 2052	4.5841 36

Reduction to Mean α and δ for 1909.0
 Nov 30 Dec 9 Jan 8 Nov 30 Dec 4

α	3 ^h 33 ^m 33.47	3 ^h 25 ^m 56.31	3 ^h 30 ^m 1.10	log A	9.51065	9.45475	9.49824	
δ	32° 36' 48.0	30° 59' 2.3	31° 54' 59.8	log B	0.97975	0.00424	0.99617	
g	23 ^m 0.7	23 ^m 2.0	22 ^m 59.7	sin δ	9.73156	9.71163	9.72320	
H	1 ^h 19.9	0 ^h 45.9	1 ^h 5.2	cos(H + α)	9.45674	9.65779	9.55816	
$g + \alpha$	2 34.26	2 28.4	2 29.72	log h	1.30641	1.30898	1.30792	
$H + \alpha$	4 53.46	4 11.8	4 35.22	sin(N + α)	9.98144	9.94969	9.96959	
A {	cos($g + \alpha$)	9.89342	9.90201	9.89997	sec δ	0.07452	0.06687	0.07118
	log q	1.08633	1.10223	1.09620	colog 15	8.82391	8.82391	8.82391
B {	sin($g + \alpha$)	9.79433	9.78007	9.78375	log C	0.49471	0.67847	0.58928
	tan δ	9.80608	9.77850	9.79438	log D	0.18628	0.14945	0.17260
	colog 15	8.82391	8.82391					

		α and δ for 1909.0 (corr)			Computation of λ and β			
		Nov 30	Dec 9	Dec 4	Nov 7	Dec 9	Jan 8	
E	$\log i$	0.4772	0.2448	0.3931	α	$3^h 58^m 1.09$	$3^h 25^m 52.71$	$3^h 18^m 13.20$
	$\cos \delta$	9.92548	9.93313	9.92882	δ	$35^{\circ} 56' 53.2$	$30^{\circ} 58' 45.9$	$26^{\circ} 10' 19.2$
	$\log E$	0.40268	0.17793	0.32192	δ°	$59^{\circ} 30' 16.3$	$51^{\circ} 28' 10.6$	$49^{\circ} 38' 18.0$
	f	+1.805	+1.875	+1.845	$\tan \delta$	9.860434	9.778421	9.691483
	A	+ .31	+ .31	+ .31	$\sin \alpha$	9.935341	9.893361	9.881939
	D	+1.54	+1.41	+1.49	$\tan N$	9.925093	9.885060	9.809544
	$\Delta \alpha$	+ 3.67	+ 3.60	+ 3.65	N	$40^{\circ} 4' 59.3$	$37^{\circ} 30' 18.2$	$32^{\circ} 49' 15.9$
	B	+9.55	+ 10.8	9.91	$E(1909.0)$	23 27 4.0	23 27 4.0	23 27 4.0
	E	3.12	4.8	3.88	$N-E$	16 37 55.3	14 3 14.2	9. 22 11.9
	$\cos N$	2.53	1.5	2.10	$\cos(N-E)$	9.981439	9.986802	9.994166
	$\Delta \delta$	+15.2	+16.4	+15.9	$\sec N$	0.116276	0.100563	0.075531
	α_0				$\tan \alpha$	0.229930	0.098922	0.070625
	δ_0	$3^h 33^m 29.80$	$3^h 25^m 52.71$	$3^h 29^m 57.45$	$\tan \lambda$	0.327645	0.186287	0.140322
	δ_0	+32 36 32.8	+30 58 45.9	+31 54 43.9				
The corrections are applied with the opposite sign.					$\tan(N-E)$	9.475267	9.398510	9.217511
					$\sin \lambda$	9.956613	9.923235	9.908503
					$\tan \beta$	9.431880	9.321745	9.126014
					$\cos \beta$			
L and R changed for Locus Fixtus					$\cos \beta$	9.984685	9.990649	9.996154
					$\cos \beta \sin \lambda$	9.941298	9.913884	9.904657
					$\cos \delta$	9.908243	9.933159	9.953022
					$\cos \delta \sin \alpha$	9.843584	9.826520	9.834961
L	$225^{\circ} 4' 3.9$	$257^{\circ} 27' 25.2$	$257^{\circ} 53' 56.7$	$\frac{\cos \beta \sin \lambda}{\cos \delta \sin \alpha}$	0.097714	0.087364	0.069696	
$\log R$	9.995853	9.993279	9.992716	$\cos(N-E) \tan N$	5	5	7 ch	
				λ	$64^{\circ} 48' 48.3$	$56^{\circ} 55' 40.4$	$54^{\circ} 5' 57.3$	
				β	$15^{\circ} 7' 36.2$	$11^{\circ} 50' 49.9$	$7^{\circ} 36' 47.8$	

Computation of the Constants.

$L_{100} - L_1$ $32^\circ 23' 21.3$
 $L_{100} - L_2$ $62 49 52.8$
 $L_{100} - L_{100}$ $30 26 31.5$
 $\lambda_{100} - \lambda_1$ $-10 42 51.0$
 $\lambda_{100} - \lambda_{100}$ $-2 49 43.1$
 $\lambda_{100} - \lambda_1$ $-7 53 7.9$
 $\lambda_{100} - L_2$ $189 1 53.4$
 $\lambda_{100} - L_{100}$ $126 12 0.6$
 $\lambda_1 - L_1$ $199 44 44.4$
 $\lambda_1 - L_{100}$ $136 54 51.6$
 $\lambda_{100} - L_{100}$ $167 21 23.1$
 $\lambda_{100} - L_{100}$ $156 38 32.1$
 $\lambda_{100} - L_{100}$ $159 28 15.2$

I

$\log R_{100}$ 9.993279
 $\log \sin(L_{100} - L_1)$ 9.942227
 $\sin(L_1 - L_1)$ 9.728896
 $\log R_{100}$ 9.992716
 $\sin(L_{100} - L_{100})$ 9.704722
 $\log R_1$ 9.995853
 $\sin(L_{100} - L_1) \div R_{100}$ 9.736180
 $R_{100} \div \sin(L_{100} - L_1)$ 0.044032
 $\sin(L_{100} - L_1) \div R_1$ 9.708869
 $\log H''$ 9.780232
 $\log H$ 9.752921

II.

$\cos \beta_1$ 9.984685
 $\sin(\lambda_{100} - \lambda_1)$ 9.269302
 $\cos \beta_{100}$ 9.996155
 $\sin(\lambda_{100} - \lambda_{100})$ 8.693278
 $\cos \beta_{100}$ 9.990649
 $\sin(\lambda_{100} - \lambda_{100})$ 9.137336

$\cos(\lambda_{100} - \lambda_{100})$ 9.992363
 A) $\cos \beta_1$ 9.984685
 $\sin \beta_{100}$ 9.122170
 B) $\cos \beta_{100}$ 9.990649
 $\cos(\lambda_{100} - \lambda_{100})$ 9.999471

C) $\cos(\lambda_{100} - \lambda_{100})$ 9.992363
 $\cos \beta_{100}$ 9.996155
 D) $\sin \beta_1$ 9.416565
 $\cos \beta_{100}$ 9.990649
 $\cos(\lambda_{100} - \lambda_{100})$ 9.995874

E) $\sin \beta_1$ 9.416565
 F) $\cos \beta_{100}$ 9.996155
 $\sin \beta_{100}$ 9.312394

G) $\sin \beta_{100}$ 9.122170
 H) $\cos \beta_1$ 9.984685
 $\sin \beta_{100}$ 9.312394

9

$\log E$
 Table
 $\log A$
 Diff.

$\log F$
 Table
 $\log B$
 Diff.

$\log G$
 Table
 $\log C$
 Diff.

$\log N$
 Table
 $\log D$
 Diff.

$\sin A_1 \sin W_1$
 $\cos \sin$
 $\sin A_{100} \cos W_1$
 $\log W_1$
 $\log W_1$

$\sin A_{100}$

9.412720
 0.024596
 9.099218
 0.313502

9.308549
 9.766864
 9.112290
 0.196259

9.106855
 9.994378
 9.405083
 0.298228

9.297079
 9.441641
 9.403088
 0.106009

9.253787
 9.904959
 9.123814
 0.130173
 $306^\circ 32' 20.5$

9.349028

Computation of the Constants.

II. (Cont.)

$\sin \Delta, \sin W_0'$ 8.683927_u
 $\sin \cos$ 9.922920
 $\sin \Delta, \cos W_0'$ 8.869154
 $\tan W_0'$ 9.814773
 W_0' 326° 51' 50".2

$\sin(\lambda_{III} - L_{III})$ 9.906851
 $\pm R_{III}$ 9.992716
 $\cos(\lambda_{III} - L_{III})$ 9.771300_u
 R_s''' 9.899567
 R_c''' 9.764016

$\log a$ 8.654734
 Table 8.807433
 $\log e$ 8.627717_u
 Diff 0.027017
 $\log \text{Diff}$ 7.435150_u
 $\log R_i$ 9.995853

$\sin \Delta,$ 8.946234

VII.

$\sin \Delta_{II}, \sin W_0''$ 9.265457_u
 $\sin \cos$ 9.916428_u
 $\sin \Delta_{II}, \cos W_0''$ 9.101233_u

R_i
 $a \left\{ \begin{array}{l} \sin(\lambda_i - L_i) \\ \tan \beta_{III} \end{array} \right.$ 9.528718_u
 $b \left\{ \begin{array}{l} \sin(\lambda_i - L_{III}) \\ R_{III} \end{array} \right.$ 9.126016
 $c \left\{ \begin{array}{l} \sin(\lambda_{III} - L_i) \\ \tan \beta_i \end{array} \right.$ 9.834478

$\log b$ 8.960494
 Table 0.142738
 $\log f$ 9.338781
 Diff 0.378287
 $\log \text{Diff}$ 9.103232_u
 $\log R_{III}$ 9.992716

$\tan W_0''$ 0.164224
 W_0'' 235° 35' 0".9
 $\sin \Delta_{II}$ 9.349029_{ch}

$d \left\{ \begin{array}{l} \sin(\lambda_{III} - L_i) \\ \tan \beta_i \end{array} \right.$ 9.195837_u
 $e \left\{ \begin{array}{l} \sin(\lambda_{III} - L_{III}) \\ \tan \beta_{III} \end{array} \right.$ 9.431880
 $f \left\{ \begin{array}{l} \sin(\lambda_{III} - L_{III}) \\ \tan \beta_{III} \end{array} \right.$ 9.906851

$\log c$ 8.466291
 $(1) \text{Table}$ 9.861528
 $\log g$ 9.030112
 Diff 0.563821

$\sin \Delta_{III}, \sin W_0'''$ 9.127986_u
 $\sin \cos$ 9.965564_u
 $\sin \Delta_{III}, \cos W_0'''$ 8.738719
 $\tan W_0'''$ 0.389267
 W_0''' 247° 48' 4".3
 $\sin \Delta_{III}$ 9.161432

$g \left\{ \begin{array}{l} \sin(\lambda_{III} - L_{III}) \\ \tan \beta_{III} \end{array} \right.$ 9.598232
 $h \left\{ \begin{array}{l} \tan \beta_{III} \\ \cos(\lambda_{III} - L_{III}) \end{array} \right.$ 9.431880
 $i \left\{ \begin{array}{l} \sin(\lambda_{III} - L_{III}) \\ \cos(\lambda_{III} - L_{III}) \end{array} \right.$ 9.962861_u

$\log d$ 9.394741_u
 $(2) \text{Table}$ 9.955577
 $\log h$ 9.115855_u
 Diff 0.279386
 $(1) \log \text{Diff}$ 8.841640_u
 $\log R_i$ 9.993279

VI.

$\sin(\lambda_i - L_i)$ 9.528718_u
 $\pm R_i$ 9.995853
 $\cos(\lambda_i - L_i)$ 9.973682_u
 R_s' 9.524571_u
 R_c' 9.969535

$g \left\{ \begin{array}{l} \sin(\lambda_i - L_i) \\ \tan \beta_{III} \end{array} \right.$ 9.340275
 $h \left\{ \begin{array}{l} \tan \beta_{III} \\ \cos(\lambda_i - L_{III}) \end{array} \right.$ 9.126016
 $i \left\{ \begin{array}{l} \sin(\lambda_i - L_{III}) \\ \cos(\lambda_i - L_{III}) \end{array} \right.$ 9.989337_u

$(2) \log \text{Diff}$ 9.070932
 $\log A$ 7.431003_u
 $\log B$ 9.095948_u
 $\log C$ 8.884919_u
 $\log D$ 9.064221_u

Constatant

$\cos W'$	9.774787	$\sin(\lambda_1 - L_1 + \delta_1)$	9.402639	$\text{csc } \Delta''$	0.650972
$\sin \beta_{III}$	9.122170	R'	9.995853	R''	9.992716
$f, \sin f_1$	8.896957	$\log f_1$	9.907042	$\sin(\lambda_1 - L_1 + \delta_1)$	9.725512
$\sin \cos$	9.987917	$\text{csc } \Delta''$	0.650972	$\log a_1''$	0.267609
$f, \cos \delta_1$	9.904957	R''	9.992716	$\log b_1''$	0.302461
$\log \delta_1$	8.991998	$\sin(\lambda_1 - L_1 + \delta_1)$	9.872385	W_0'''	247° 48' 3.9
f_1	5° 36' 25.2	$\log a_1''$	9.956506	W''	235° 35' 0.9
$\log f_1$	9.907042	$\log b_1''$	0.423115	$W_0'' - W''$	12 13 3.0
$\cos W'''$	9.752205	W_0'	326° 51' 49.8	$\cos(W_0'' - W''')$	9.990051
$\sin \delta_1$	9.416565	W'	306 32 20.5	$\sin \Delta''$	9.161432
$\sin f_{III}$	9.168770	$W_0' - W'$	20 19 29.3	$\text{csc } \Delta''$	0.650972
$\sin \cos$	9.993167	$\cos(W_0' - W')$	9.972080	$\log C_0''$	9.802455
$f_{III} \cos \delta_{III}$	9.916425	$\sin \Delta_1$	9.946234	$\log C_0'''$	$\log C_0''$
$\log f_{III}$	9.252342	$\text{csc } \Delta_1''$	0.650972	$\log C_0'''$	$\log C_0'''$
f_{III}	190° 8' 12.4	$\log C_0'$	9.569286	$\sin(\lambda_{II} - L_{II})$	9.544915
$\log f_{III}$	9.923261	λ_1	64° 48' 48.3	$\pm \cos A$	9.990649
		f_{III}	190 8 12.4	$\cos(\lambda_{II} - L_{II})$	9.971505
λ_{III}	54° 5' 57.3	$\lambda_1 + \delta_{III}$	254 57 0.7	$\sin \delta \sin \psi$	9.312394
f_1	5 36 25.2	L_1	225 4 3.9	$\sin \cos$	9.933579
L_1	225 4 3.9	L_{III}	287 53 56.7	$\sin \delta \cos \psi$	9.535564
L_{III}	287 53 56.7	$\lambda_1 - L_1 + \delta_{III}$	29 52 56.8	$\log \psi$	9.776830
$\lambda_{III} - L_1 + \delta_1$	194 38 18.6	$\lambda_1 - L_{III} + \delta_{III}$	327 3 4.0	$\sin \delta$	30° 53' 12.9
$\lambda_{III} - L_{III} + \delta_1$	131 48 25.8	$\sin(\lambda_{II} - L_{II} + \delta_{II})$	9.697423	$\cos \delta$	9.601985
		R_1	9.995853	$\log \delta$	9.962154
		f_{III}	9.923261	$\log \delta$	9.639831
		$\text{csc } \Delta''$			23° 34' 25.9
		R''			
		$\sin(\lambda_1 - L_1 + \delta_1)$			

VII.

V.

IV.

			Constant								
	IX.	$\sin(\lambda'' - \lambda')$	9.267302 _n		$(R'' \sin \delta)'$	8.75 6792					
		$\log R''$	9.993279		$\log z$	0.301030					
		$T' \cos t$	9.262581		$\cos \log M'$	9.086822					
		$\sin \cos$	9.926765 _n		$\log M''$	0.913178					
		$(R') T' \sin t$	9.064211 _n		The constants as here given have been corrected. The corrections for aberration have been worked out on other data and are sufficiently accurate.						
		$\tan t$	9.1501630 _n								
		t	212° 20' 50.2		Application of test as to whether there or four places should be used for the computation, the three places are sufficient.						
		$\log T'$	9.950781 _n								
		ψ	30° 53' 12.9								
		t	212° 20' 50.2								
		$\psi + t$	243° 14' 3.1								
$\sin(\psi + t)$	9.950781 _n										
$\log T'$	9.335816										
$\sin \delta$	9.601985										
$\log C$	8.884919 _n										
$S \sin(\delta + \sigma)$	8.486904 _n				$\tan(\psi + t)'$	0.288728		$\sin X$	9.955632		
$\sin \cos$	9.968283 _n				$\cos(\delta + \sigma)$	9.967749 _n		$\sin \delta$	9.602027		
$S \cos(\delta + \sigma)$	8.888582 _n				$\log X$	0.322277		$\log \delta$	7.557659		
$\tan(\delta + \sigma)$	9.598322				X	64° 32' 23"			0.36		
$\delta + \sigma$	201° 37' 54.8				$T'' - T''_0$			$\log K$	8.235381		
σ	178° 3' 28.9				$T''' - T''_0$	29.88 62.65		T''_0	9.711053		
$\log S$	8.920299				$T''_0 - T''_0$	61.91 66.67		T''_0	0.027389		
$\sin \delta$	9.601985				\log	32.03 0399		T'''_0	9.741143		
$R'' \sin \delta$	9.993279				\log	1.475472					
	9.595264					1.79 18.08					
						1.50 55.62					

XI.

$\log B$
 $\log P$
 $\log A$
 $\log(A+PB)$

$\log P \cdot B$
 $\log A$
 $\log(A+PB)$

$\log(A+PB)$
 $\log(P+1)$
 $\log S$
 $\log d_0$

$\sin \sigma$
 d_0
 $\cos \sigma$
 $\cos \sigma d_0$
 $\log w$

$\log w$
 $\log w^2$
 $\log w^3$
 $\log w^4$

$\log w^5$

9.095948^u
 0.030090
 0.286246
 9.969910

9.126038^u
 0.008678
 7.431003^u
 8.304965
 9.134716^u

0.865284^u
 0.316336
 8.920318
 0.101938^u

8.530467
 0.101938
 9.997750
 0.101688
 9.421320

9.994334
 8.632405^u
 9.211085^u
 $9^{\circ} 14' 51''$

9.426786

$\log M'$
 $\log M''$

$\log T_1^2$
 $\log T_2^2$
 $\log T_3^2$
 $\log T_4^2$
 $\log T_5^2$
 $\log T_6^2$
 $\log T_7^2$
 $\log T_8^2$

$\log P$
 $\log B$
 $\log A$
 $\log(A+PB)$

$\log T_1^2$
 $\log T_2^2$
 $\log T_3^2$
 $\log T_4^2$
 $\log T_5^2$
 $\log T_6^2$
 $\log T_7^2$
 $\log T_8^2$

$\log A$
 $\log B$
 $\log(A+PB)$
 $\log P$

0.913052
 1.486066

0.054778
 9.864740
 9.428826
 0.572492
 9.919518
 9.522879
 9.442377

0.030090
 9.095948^u
 0.054778
 9.584804

9.422106
 0.632672
 9.522879
 9.462461

7.431003^u
 8.5768436^u
 0.009084
 6.893464^u
 8.325027^u
 8.377519^u
 0.865284^u
 9.442803

$\log M''$
 $\log M$

1.486066
 0.928569

XII.

//

(-w) Z	XIII (1) 9° 14' 5.0"	(2) 9° 32' 26.1"	(3) 9° 36' 15.7"	(4) 9° 36' 46.4"			XV. R ^u
sin Z	9.205419	9.220194	9.222310	9.222692			0.301030
(sin Z) ⁴	6.821676	6.880776	6.889240	6.890768			9.442397
log M	0.928869	0.928869	0.928869	0.928869			1.418866
sin(Z+w)	7.750545	7.809645	7.818109	7.819637			8.023531
Z+w	19 21.1	22 10.7	22 36.9	22 41.6			0.004563
w	-9	14 51.0	-9	14 51.0			9.713754
Z	9	33 26.1	9	36 41.9			9.718317
dZ between (3) and (4)			p ₁₁ and R ₁₁				9.185338
log M	0.928869						9.780232
4 log sin Z	6.890544						0.061915
sin log	7.819413						8.903655
log sin(Z+w)	7.818109						9.462461
diff log	12.04						1.418866
b	32.1						8.043595
a	12.5						0.004776
4a	50						9.683664
b-4a	27.1						9.688440
dZ	+ 41.5						9.204399
Z	9 36 46.4						9.752921
							0.064481
							8.892839

M-u	8.892839	8.892787							
a°	9.956506	9.956506							asin.
M"-u"	8.903655	8.903709					1.749411	1.749318	
b°	0.423114	0.423114					9.947797	9.947729	
log(2)	9.326769	9.326823							
Table	9.824060	9.824113							
log(1)	8.849345	8.849293					9.122170	9.122170	
Diff.	0.477424	0.477530					9.069967	9.069899	
log ann	9.150829	9.150736					9.825606	9.825573	
Table	0.103175	0.103207					9.416565	9.416565	
log(3)	9.722431	9.722366					9.242171	9.242138	
Diff.	9.428398	9.428398					9.069967	9.069899	
log up	9.825606	9.825573					0.223407	0.223393	
(3) log c°	9.569287	9.569287					9.242171	9.242138	
log p°	0.153144	0.153079					9.827796	9.827761	
log c°	9.802455	9.802455					9.465578	9.465531	
M-u	8.892839	8.892787					0.153144	0.153079	
a°	0.267509	0.267609					9.312394	9.312394	
M"-u"	8.903655	8.903709					9.465538	9.465473	
b°	0.302461	0.302461							
log 2'	9.206116	9.206170					0.137166	0.137143	
Table	9.048840	9.048720					0.153144	0.153079	
log 1'	9.160348	9.160296					0.229480	0.229405	
Diff.	0.045768	0.045874							
log sum	8.206186	8.206216							
Table	9.992198	9.992198							
log 3'	9.955599	9.955534							

check

Discrepancy due to error in values for constants as used.

XVII.

$\log S$	2.76158	$\log P$	0.030109	$\log T_1^2$	0.054754
$\log p_1 S$	2.89873	Table	0.286237	Table	9.864742
$d T_1$	-7920	Diff	9.969891	$\log T_{11}^2$	9.482278
T_1°	9.621527	$\log(P+1)$	0.316346	Diff	0.572476
$\log p_{11} S$	2.91472	$\text{colog}(A+PB)$	0.865266 _u	$\log(T_{11}^2 - T_{111}^2)$	9.919496
$d T_{11}$	-8217	$\log S$	8.920318	$\text{colog } 3$	9.522879
T_{11}°	9.651926	$\log d_0$	0.101930 _u	$\log Y_1$	9.442375
$\log p_{111} S$	2.99106	$\log B$	9.095948 _u	$\log PB$	9.126057 _u
$d T_{111}$	-9796	$\log PB$	9.126057 _u	$\log T_{11}^2$	0.054754
T_{111}°	8.538194	Table	0.008677	Table	9.884810
T_1	7.613607	$\log A$	7.431003	$\log T_1^2$	9.422060
T_{11}	9.643709	Diff	8.304946	Diff	0.632694
T_{111}	8.528398	$\log(A+PB)$	9.134734	$\log(T_{11}^2 - T_1^2)$	9.939564
$T_{11} - T_1$	29.884689	$\sin \sigma$	8.530467	$\text{colog } 3$	9.522879
$T_{111} - T_1$	61.914791	d_0	0.101930 _u	$\log Y_{111}$	9.462443
$T_{111} - T_{11}$	32.030102	$\cos \sigma$	9.999750 _u	$\log A$	7.431003 _u
$\log K$	8.235581	$\cos \sigma d_0$	0.101680	$\log PB Y_1$	8.568432 _u
$\log p$	9.470449	$\sin \cos w$	9.421281	Table	0.009083
	0.797796	$\cos w$	9.994334	$\log A Y_{111}$	6.893446
	1.505888	$\sin w$	8.632397 _u	$\log(PB Y_1 + A Y_{111})$	8.523679 _u
T_1	9.711030	$\tan w$	9.211116 _u	$\text{colog}(A+PB)$	0.865266
T_{11}	0.027377	w	-9° 14' 7.4	$\log q$	9.442781
T_{111}	9.741139	$\log \sin$	9.426947	$\log M''$	1.486105
		$\log M'$	0.913052	$\log M$	0.928886
		$\log M''$	1.486105		

XVII (cont.)

(-w) z	9° 14' 7.4	9° 33' 19.2	9° 36' 18.6	9° 36' 49.7	23° 34' 24.6
sin z	9.205450	9.222347	9.222347	9.222733	9 36 49.6
(sin z) ²	6.821800	6.889388	6.889388	6.890932	13 57 45.0
log M	0.928886	0.928886	0.928886	0.928886	9.382534
sin(z+w)	7.750684	7.809818	7.818264	7.819818	0.777266
z+w	19' 21.8	22' 11.2	22' 37.4	22' 42.2	9.993277
w	-9 14 7.4	-9 14 7.4	-9 14 7.4	-9 14 7.4	9.602027
z	9 33 19.2	9 36 18.6	9 36 44.8	9 36 49.6	0.153079
dz between 3 and 4					0.372572
log M	0.928886				9.462443
4 log sin z	6.890684				1.418746
sum logs	7.819574				8.043697
log sin(z+w)	7.818264				0.004777
Δ	0.001310				9.683653
b	319				9.688430
a	12.5				9.204357
4a	50				9.752921
b-4a	269				0.064491
dz	4.9				8.872757
z	9° 36' 49.7				

Three sounds were made and then the constants corrected
 We use the new constants and the best values of Y_1 and Y_{10} obtained,
 from here.

	Corrected	4 th sound	5 th	6 th	7 th	8 th
δ	23° 34' 25.9"	23° 34' 25.9"	23° 34' 25.9"	23° 34' 25.9"	23° 34' 25.9"	23° 34' 25.9"
z	9 36 29.2	9 36 28.5	9 36 28.0	9 36 28.8	9 36 28.8	9 36 28.9
$\delta - z$	13 57 56.7	13 57 57.4	13 57 57.9	13 57 57.1	13 57 57.1	13 57 57.0
$\sin \delta - z$	9.382633	9.382639	9.382643	9.382636	9.382636	9.382636
$\csc z$	0.777522	0.777531	0.777537	0.777527	0.777527	0.777526
R_n	9.993279	9.993279	9.993279	9.993279	9.993279	9.993279
$\sin \delta$	9.601985	9.601985	9.601985	9.601985	9.601985	9.601985
ρ_{11}	0.153434	0.153449	0.153459	0.153442	0.153442	0.153441
ρ_{10}	0.372786	0.372795	0.372801	0.372791	0.372791	0.372790
R_n^3	1.118358	1.118385	1.118403	1.118373	1.118373	1.118370
$\log 2$	0.301030	0.301030	0.301030	0.301030	0.301030	0.301030
Y_1	9.442510	9.442322	9.442403	9.442420	9.442399	9.442411
$\log 2/R_n^3$	1.419388	1.419415	1.419433	1.419403	1.419403	1.419400
$\log(V_1^{0.5} / 2R_n^3)$	8.022902	8.022907	8.022970	8.023017	8.022996	8.023011
$\log \sin^{11}$	0.004556	4555	4556	4556	4556	4556
$\log(T_{10} - T_0)$	9.713762	9.413762	9.413762	9.413762	9.413762	9.413762
$\log n''$	9.718318	9.718317	9.718318	9.718318	9.718318	9.718318
Table	9.185331	9.185338	9.185346	9.185331	9.185331	9.185331
$\log N''$	9.780232	9.780232	9.780232	9.780232	9.780232	9.780232
$\Delta f f$	0.061914	0.061915	0.061914	0.061914	0.061914	0.061914
$N'' - n''$	8.903649	8.903655	8.903664	8.903649	8.903649	8.903649

	Corrected	4 th	5 th	6 th	7 th	8 th
Y_{100}	9.471785	9.471642	9.471737	9.471741	9.471715	9.471731
$\log 2r_n^3$	1.419388	1.419415	1.419433	1.419403	1.419403	1.419400
$\log(Y_{100} + 2r_n^3)$	8.052397	8.052227	8.052304	8.052338	8.052312	8.052331
$\log \text{sum}$	0.004879	4871	4871	4872	4871	4871
$\log(T_1 \div T_n)$	9.683653	9.683653	9.683653	9.683653	9.683653	9.683653
$\log n$	9.688532	9.688524	9.688524	9.688525	9.688524	9.688524
Table	9.203623	9.203679	9.203679	9.203671	9.203679	9.203679
$\log n$	9.752921	9.752921	9.752921	9.752921	9.752921	9.752921
Diff	0.064389	0.064397	0.064397	0.064396	0.064397	0.064397
$\log(N-n)$	8.892155	8.892203	8.892203	8.892196	8.892203	8.892203
(1) a'_0	9.956506 _n	9.956506 _n	9.956506	9.956506	9.956506	9.956506
(2) $\{n'' - n''$	8.903649	8.903656	8.903664	8.903649	8.903649	8.903649
b'_0	0.423114	0.423114	0.423114	0.423114	0.423114	0.423114
$\log(2)$	9.326763	9.326770	9.326768	9.326763	9.326763	9.326763
Table	9.824398	9.824374	9.824381	9.824378	9.824374	9.824374
$\log(1)$	8.848661 _n	8.848715 _n	8.848709 _n	8.848702 _n	8.848709 _n	8.848709 _n
Diff	0.478102	0.478055	0.478069	0.478061	0.478054	0.478054
$\log \text{sum}$	9.151161	9.151144	9.151159	9.151141	9.151137	9.151137
Table	0.103183	0.103178	0.103178	0.103177	0.103177	0.103177
$\log(3)$	9.722721	9.722735	9.722745	9.722728	9.722728	9.722727
Diff	9.428445	9.428409	9.428414	9.428409	9.428409	9.428410
$\log n^3$	9.825904	9.825912	9.825923	9.825906	9.825905	9.825904
$\log n$	9.688525	9.688523	9.688524	9.688525	9.688524	9.688524
$\log c'_0$	9.569287	9.569287	9.569286	9.569286	9.569286	9.569286
(3) $\log p'_0$	0.153434	0.153449	0.153459	0.153442	0.153442	0.153442
(3) $\log c''_0$	9.802455	9.802455	9.802455	9.802455	9.802455	9.802455

	Conrad	4 th	5 th	6 th	7 th	8 th
1	8.892155	8.892209	8.892203	8.892196	8.892203	8.892203
1	0.267509	0.267509	0.267509	0.267509	0.267509	0.267509
2	8.903649	8.903649	8.903649	8.903649	8.903649	8.903649
3	0.302461 _n	0.302461 _n	0.302461 _n	0.302461 _n	0.302461 _n	0.302461 _n
log 2'	9.206110 _n	9.206117 _n	9.206125 _n	9.206110 _n	9.206110 _n	9.206110 _n
Table	9.052591	9.052127	9.052270	9.052190	9.052120	9.052120
log 1'	9.159664	9.159718	9.159712	9.159705	9.159712	9.159712
Dij	0.046446	0.046898	0.046448	0.046405	0.046398	0.046398
log 10 _n	8.212255 _n	8.211845 _n	8.211982 _n	8.211895 _n	8.211832 _n	8.211832 _n
Table	9.992091	9.992099	9.992097	9.992098	9.992099	9.992099
log 3'	9.955889	9.955904	9.955914	9.955897	9.955897	9.955896
Dij	1.743634	1.744059	1.743932	1.744002	1.744065	1.744064
log 10 _n	9.947980	9.948003	9.948011	9.947995	9.947996	9.947996
log 10 _n	9.718318	9.718317	9.718318	9.718318	9.718318	9.718318
I. Fair	9.122170	9.122170	9.122170	9.122170	9.122170	9.122170
10 _n	9.947980	9.948003	9.948011	9.947995	9.947996	9.947996
sin 3 _n	9.416565	9.416568	9.416565	9.416565	9.416565	9.416565
10 _n	9.825904	9.825904	9.825904	9.825904	9.825904	9.825904
log I.	9.070150	9.070173	9.070181	9.070165	9.070166	9.070166
Table	0.223361	0.223361	0.223366	0.223367	0.223367	0.223367
log II.	9.242469	9.242477	9.242488	9.242471	9.242470	9.242470
Dij	9.827681	9.827696	9.827693	9.827694	9.827696	9.827696
10 _n sin 10 _n	9.465830	9.465844	9.465854	9.465838	9.465837	9.465837
10 _n	0.153434	0.153449	0.153459	0.153442	0.153442	0.153442
10 _n 3 _n	9.312394	9.312394	9.312394	9.312394	9.312394	9.312394
10 _n sin 10 _n	9.465828	9.465843	9.465853	9.465826	9.465836	9.465836
10 _n	0.137489	0.137389	0.137399	0.137381	0.137381	0.137380
10 _n	0.153434	0.153449	0.153459	0.153442	0.153442	0.153441
10 _n	0.229662	0.229686	0.229693	0.229677	0.229678	0.229678

XVIII

8th dt

7th dt

6th dt

5th dt

4th dt

Corrected

$\cos A_1$	9.984685	9.984685	9.984685	9.984685	9.984685	9.984685	9.984685
$\sin A_1$	0.137389	0.137389	0.137381	0.137399	0.137381	0.137381	0.137381
$\cos B_1$	9.416565	9.416565	9.416565	9.416565	9.416565	9.416565	9.416565
$\sin B_1$	9.996155	9.996155	9.996155	9.996155	9.996155	9.996155	9.996155
$\cos C_1$	0.229662	0.229686	0.229677	0.229693	0.229677	0.229678	0.229678
$\sin C_1$	9.122170	9.122170	9.122170	9.122170	9.122170	9.122170	9.122170
$\cos A_2$	0.122174	0.122174	0.122066	0.122084	0.122066	0.122066	0.122065
$\sin A_2$	0.231382	0.231424	0.231427	0.231419	0.231427	0.231427	0.231427
$\cos B_2$	9.969535	9.969535	9.969535	9.969535	9.969535	9.969535	9.969535
$\sin B_2$	9.847361	9.847461	9.847469	9.847457	9.847469	9.847469	9.847470
$\cos C_2$	0.353556	0.353498	0.353493	0.353508	0.353493	0.353493	0.353492
$\sin C_2$	9.995278	9.995277	9.995276	9.995276	9.995276	9.995276	9.995276
$\cos A_3$	9.524571	9.524571	9.524571	9.524571	9.524571	9.524571	9.524571
$\sin A_3$	9.171015	9.171073	9.171078	9.171068	9.171078	9.171078	9.171079
$\cos B_3$	-8° 25' 59.0"	-8° 26' 30.0"	-8° 26' 34.0"	-8° 26' 27.0"	-8° 26' 34.0"	-8° 26' 34.0"	-8° 26' 34.0"
$\sin B_3$	64 48 48.3	64 48 48.3	64 48 48.3	64 48 48.3	64 48 48.3	64 48 48.3	64 48 48.3
$\cos C_3$	56 22 49.3	56 22 45.3	56 22 44.9	56 22 45.6	56 22 44.9	56 22 44.9	56 22 44.9
$\sin C_3$	0.358278	0.358221	0.358217	0.358227	0.358217	0.358217	0.358217
$\cos A_4$	9.994715	9.994716	9.994717	9.994716	9.994717	9.994717	9.994717
$\sin A_4$	9.554054	9.553954	9.553946	9.553964	9.553946	9.553946	9.553946
$\cos B_4$	9.195776	9.195773	9.195729	9.195737	9.195729	9.195729	9.195728
$\sin B_4$	8 55' 12.4"	8 55' 9.2"	8 55' 9.0"	8 55' 9.6"	8 55' 9.0"	8 55' 9.0"	8 55' 9.0"
$\cos C_4$	0.363563	0.363505	0.363500	0.363511	0.363500	0.363500	0.363500
$\sin C_4$	0.225817	0.225841	0.225832	0.225848	0.225833	0.225833	0.225833
$\cos A_5$	0.128820	0.128814	0.128816	0.128812	0.128816	0.128816	0.128816
$\sin A_5$	9.764016	9.764016	9.764016	9.764016	9.764016	9.764016	9.764016
$\cos B_5$	9.538199	9.538175	9.538184	9.538168	9.538184	9.538183	9.538183
$\sin B_5$							

	Corrected	4 th ed	5 th ed	6 th ed	7 th ed	8 th ed
$\sin^{-1} \cos$	9.974813	9.974814	9.974815	9.974814	9.974814	9.974814
$\sin^{-1} \sin$	9.899567	9.899567	9.899567	9.899567	9.899567	9.899567
$\tan^{-1} \sin$	9.544930	9.544930	9.544930	9.544930	9.544930	9.544930
$\sin^{-1} \lambda$	19° 19' 31.8"	19° 19' 29.3"	19° 19' 28.5"	19° 19' 30.3"	19° 19' 30.2"	19° 19' 30.2"
λ	54 5 57.3	54 5 57.3	54 5 57.3	54 5 57.3	54 5 57.3	54 5 57.3
λ	73 25 29.1	73 25 26.1	73 25 29.8	73 25 27.6	73 25 27.5	73 25 27.5
$\sin^{-1} \cos$	0.379824	0.379841	0.379845	0.379834	0.379835	0.379835
\cos	9.998099	9.998099	9.998099	9.998099	9.998099	9.998099
$\sin^{-1} \sin$	9.351832	9.351856	9.351863	9.351847	9.351848	9.351848
$\tan^{-1} \sin$	8.972008	8.972015	8.972018	8.972013	8.972013	8.972013
λ	5° 21' 22.6"	5° 21' 22.9"	5° 21' 23.1"	5° 21' 22.8"	5° 21' 22.4"	5° 21' 22.4"
$\log \sin$	0.381725	0.381742	0.381746	0.381735	0.381736	0.381736
XIX.						
$\sin^{-1} \lambda$	17° 2' 49.8"	17° 2' 41.3"	17° 2' 40.2"	17° 2' 42.7"	17° 2' 42.6"	17° 2' 42.6"
$\sin^{-1} \lambda$	-3 33 49.8	-3 33 46.8	-3 33 46.5	-3 33 46.2	-3 33 46.6	-3 33 46.6
$\frac{1}{2}(\lambda_1 - \lambda_2)$	8 31 19.9	8 31 20.6	8 31 20.1	8 31 21.4	8 31 21.3	8 31 21.3
$\frac{1}{2}(\lambda_1 + \lambda_2)$	-1 46 54.9	-1 46 53.2	-1 46 53.2	-1 46 53.1	-1 46 53.3	-1 46 53.3
$\sin^{-1}(\lambda_1 - \lambda_2)$	9.170827	9.170836	9.170829	9.170848	9.170846	9.170846
$\sin^{-1} \frac{1}{2}(\lambda_1 - \lambda_2)$	8.341654	8.341672	8.341658	8.341696	8.341692	8.341692
$\cos \lambda_1$	9.994715	9.994716	9.994716	9.994717	9.994717	9.994717
$\cos \lambda_2$	9.998102	9.998099	9.998099	9.998099	9.998099	9.998099
$\sin^{-1} \frac{1}{2}(\lambda_1 + \lambda_2)$	8.492694	8.492580	8.492580	8.492573	8.492586	8.492586
$\sin^{-1} \frac{1}{2}(\lambda_1 + \lambda_2)$	6.985388	6.985160	6.985160	6.985146	6.985172	6.985172
λ	0.019017	0.019007	0.019008	0.019006	0.019007	0.019007
$\log A$	8.334471	8.334487	8.334473	8.334512	8.334508	8.334508
$\log A$	8.650917	8.650873	8.650887	8.650634	8.650664	8.650664

	corrected	4 th	set XIX (com.)		7 th	8 th
$\sin^2 f$	8.353488	8.353494	8.353481	8.353518	8.353515	8.353515
$\sin f''$	9.176744	9.176747	9.176740	9.176759	9.176758	9.176758
f''	8° 38' 24.0	8° 38' 24.2	8° 38' 23.8	8° 38' 25.0	8° 38' 25.0	8° 38' 25.0
$2f''$	17 16 48.0	17 16 48.4	17 16 47.6	17 16 49.2	17 16 49.2	17 16 49.2
$\log r_1$	0.363563	0.363505	0.363511	0.363500	0.363500	0.363500
$\log n$	9.688532	9.688524	9.688524	9.688525	9.688524	9.688524
$\sin 2f''$	9.472817	9.472820	9.472815	9.472826	9.472826	9.472826
$\operatorname{colog} r_1$	9.627214	9.627205	9.627199	9.627209	9.627209	9.627210
$\log n''$	9.718318	9.718317	9.718318	9.718318	9.718318	9.718318
$\log r_2$	0.381725	0.381742	0.381746	0.381735	0.381736	0.381736
$\sin 2f'$	9.152926	9.152924	9.152949	9.152960	9.152959	9.152960
$\sin 2f'''$	9.200074	9.200084	9.200078	9.200088	9.200089	9.200090
$2f'$	8° 9' 38.0	8° 9' 33.0	8° 9' 32.6	8° 9' 33.4	8° 9' 33.4	8° 9' 33.4
$2f'''$	9 7 14.8	9 7 15.6	9 7 15.2	9 7 15.9	9 7 15.9	9 7 15.9
f'	4 4 49.0	4 4 46.5	4 4 46.3	4 4 46.7	4 4 46.7	4 4 46.7
f'''	4 33 37.4	4 33 37.8	4 33 37.6	4 33 38.0	4 33 38.0	4 33 38.0
$f''=(f'+f''')$	8 38 24.3	8 38 24.3	8 38 23.9	8 38 25.0	8 38 25.0	8 38 25.0

XX.

Correction

4th round.

	n_1	n_{11}	n_{111}	n_1	n_{11}	n_{111}
$\log r$	0.372786	0.363563	0.363563	0.372798	0.363505	0.363505
$\log r'$	0.381725	0.381725	0.372786	0.381742	0.381742	0.372795
$\log r''$	0.754511	0.745288	0.736349	0.754537	0.745247	0.736300
$\log r'''$	0.372756	0.372644	0.368174	0.377268	0.372624	0.368150
$\cos f$	9.998898	9.995043	9.998622	9.998898	9.995043	9.998622
$\log 2$	0.301030	0.301030	0.301030	0.301030	0.301030	0.301030
$2 \cos f \log r'$	0.677184	0.668717	0.667826	0.677206	0.668697	0.667802
$(2 \cos f \log r')^3$	2.031552	2.006151	2.003478	2.031618	2.006091	2.003406
T^2	9.422060	8.054754	9.482278	9.422060	0.054754	9.482278
$\log m$	7.390508	8.048603	7.478800	7.390442	8.048663	7.478872
$\frac{n}{\sqrt{2}}$	0.008939	0.018162	0.009223	0.008947	0.018237	0.009290
$\sqrt{\frac{n}{2}}$	0.002235	0.004540	0.002306	0.002237	0.004559	0.002322
$45^\circ + w$	45 8 50.7	45 17 58.1	45 9 7.6	45 8 51.1	45 18 0.5	45 9 11.4
$\frac{1}{2} f$	2 2 24.5	4 19 12.0	2 16 48.7	2 2 23.8	4 19 12.1	2 16 48.9
$2w$	17 41.4	35 56.2	18 15.2	17 42.2	36 1.0	18 22.8
$t_2 w$	7.711458	8.019279	7.725072	7.711785	8.020246	7.728076
$2 \sin \frac{1}{2} f$	8.551446	8.876950	8.598145	8.551404	8.876953	8.599745
$t_2^2 2w$	5.422916	6.038558	5.450144	5.423570	6.040492	5.456152
T table	8980	8285	7723	8981	8321	7772
$\sin^2 \frac{1}{2} f$	7.102892	7.753900	7.196290	7.102808	7.753906	7.199490
Diff	8.320024	8.284658	8.253854	8.320762	8.286586	8.256662
$\log \sin$	7.111872	7.762185	7.204013	7.111789	7.762227	7.207262
$\sec f$	0.001102	0.004957	0.001378	0.001102	0.004957	0.001378
$\log l$	7.112974	7.767142	7.205391	7.112891	7.767184	7.208640

XX. (cont.)

	11.	11.	11.		11.	11.	11.	
$\log \frac{1}{h}$	7.112974	7.767142	7.205391		7.112891	7.767184	7.208640	
$\log \frac{1}{h}$	9.920819	9.920819	9.920819		9.920819	9.920819	9.920819	
Diff	7.192155	7.846323	7.284572		7.192072	7.846365	7.287821	
$\log \frac{1}{h}$	9.921494	9.923857	9.921654		9.921494	9.923858	9.921661	
$\log h$	7.469014	8.124746	7.557146		7.468948	8.124805	7.557211	
$\log \frac{1}{9}$	0.087150	0.087150	0.087150		0.087150	0.087150	0.087150	
$\log \frac{1}{9} h$	7.556164	8.211896	7.644296		7.556098	8.211955	7.644361	
Table	1560	7017	1920		1560	7018	1910	
$\frac{1}{9} h + \frac{1}{9} h$	7.554604	8.204879	7.642376		7.554538	8.204937	7.642451	
Table	1554	6897	1902		1554	6907	1902	
$\frac{1}{14} h$	7.554610	8.204999	7.642394		7.554534	8.205048	7.642459	
Table	1554	6908	1902			6909		
$\frac{1}{14} h$	7.554610	8.204989	7.642394		7.554534	8.205046	7.642459	
Table								
$\log \frac{1}{11}$	9.958607	9.958607	9.958607		9.958607	9.958607	9.958607	
$\log(1-1)$	7.513217	8.163596	7.601001		7.513136	8.163653	7.601066	
η	1414	6284	1729		1413	6285	1729	

XX (cont)

	5th Round	6th Round	7th Round	8th Round
log 2	M ₁ 0.372801	M ₁₁ 0.363511	M ₁₁₁ 0.363510	M ₁₁₁₁ 0.363510
log 2'	0.381746	0.381746	0.381735	0.372791
log 2''	0.754547	0.745257	0.745245	0.732791
log 2'''	0.377223	0.372173	0.372163	0.736301
log 2''''	9.995907	9.993043	9.993627	0.368150
log 2'''''	0.301030	0.301030	0.301030	9.995622
2000 (100)	0.677210	0.665701	0.667513	0.301030
(2000 (100)) ²	2.031630	2.006103	2.003439	0.667802
T ₂	9.422060	9.054754	9.482278	2.003406
log 100	7.390430	8.045651	7.478839	9.482278
2%	0.008945	0.018235	0.009290	7.478832
tan (100)	0.002236	4.559	2.322	0.009281
45° + 10	45 8 58.9	45 18 0.5	45 9 11.4	2320
1/2 f	2 2 23.2	4 19 11.9	2 16 48.8	45 18 1.9
2 w	17 41.8	36 1.0	18 22.8	45 9 10.9
log 2 w	7.711621	8.020246	7.728076	2 2 23.5
2000 (100)	8.551369	8.876947	8.599739	17 41.8
log 2 w'	5.423242	6.040492	5.456152	8.020808
log 2 w''	8990	8321	7772	8.876964
2000 (100)	7.102738	7.753894	7.199438	6.041616
log 2 w'''	8.020504	8.256595	8.256674	8341
log 2 w''''	7.11728	7.762215	7.207250	7.753928
dec f	0.001093	0.004957	0.001373	7.199500
				8.256864
				7.207253
				0.001375

	5 th	XX (cont.)			6 th		
	η_1	η_2	η_3	η_1	η_2	η_3	
log l Table	7.112821 675	7.767172 3038	7.208623 842	7.112866 675	7.767227 3039	7.208636 842	
log $\frac{3}{6}$ Diff	9.920819 7.192002	9.920819 7.846353	9.920819 7.287804	9.920819 7.192047	9.920819 7.846408	9.920819 7.287817	
log sum log h log $\frac{1}{9}$ log $\frac{1}{9}h$ Table	9.921494 7.468936 0.087150 7.556086 1560	9.923857 8.124794 0.087150 8.211944 7018	9.921661 7.557178 0.087150 7.644328 1910	9.921494 7.468993 0.087150 7.556143 1561	9.923858 8.124811 0.087150 8.211961 7018	9.921661 7.557211 0.087150 7.644361 1910	
$\frac{1}{9}h / \frac{1}{10}h$ Table	7.554526 1534	8.204926 6907	7.642418 1902	7.554582 1534	8.204943 6907	7.642451 1902	
" / $\frac{1}{10}h$ Table	7.554532	8.205037 6908	7.642426	7.554589	8.205054 6909	7.642459	
" / $\frac{1}{10}h$ Table	7.554532	8.205036	7.642426	7.554589	8.205052	7.642459	
log $\frac{1}{11}$ log $(\eta-1)$	9.958607 7.513139	9.958607 8.163643	9.958607 7.601033	9.958607 7.513196	9.958607 8.163659	9.958607 7.601066	
η	1413	6285	1729	1414	6285	1729	

XXI

7 etc.

7 etc.

log a	M.	M.	M.	log l	M.	M.	M.
log a'	0.372791	0.363500	0.363500	Table	7.112864	7.767238	7.208668
log a''	0.381736	0.381736	0.372791	log 5%	676	3039	842
log a'''	0.754527	0.745236	0.736291	diff	7.920819	7.920819	8.920819
cos	0.377264	0.372618	0.368146	log 1%	7.192035	7.846419	7.287849
log 2	9.998878	9.995043	9.998622	log 1/2	9.921494	9.923858	9.921661
cos (2 cos)	0.301030	0.301030	0.301030	log 1/4	7.468990	8.124823	7.657223
(2 cos)	0.677192	0.677192	0.677192	log 1/8	0.087150	0.087150	0.087150
T	2.031576	2.006073	2.003394	Table	7.556140	8.211973	7.644373
log m	9.422060	0.054754	9.422278	Table	1561	7019	1910
M/2	7.390484	8.048681	7.447884	Table	7.554579	8.204954	7.642463
log (45+w)	0.008945	0.018236	0.009291	Table	1554	6907	1902
45+w	0.002236	0.004539	0.002323	Table	7.654586	8.205066	7.642471
Ref	45 8 50.2	45 18 2.6	45 9 11.7	Table			
2w	2 2 23.4	4 19 12.5	2 16 49.1	log 1%	9.958607	9.958607	9.958607
log 2w	17 41.8	36 5.2	18 23.4	log (1-)	7.573193	8.163671	7.601078
log 2w	7.71621	8.021089	7.728312	M	1414	6285	1729
diff	8.551351	8.876964	8.599755				
log 2w	5.463242	6.042178	5.456624				
Table	890	8353	7750				
diff	7.102762	7.753928	7.199510				
log 2w	8.320450	8.258250	8.257114				
diff	7.111752	7.762281	7.207290				
diff	0.001107	0.004957	0.001378				

	Corrected	4 th	XXI. 5 th	6 th	7 th	XI (corr)	
η_{n-1}	8.163596	8.163653	8.163643	8.163659	8.163671	$\text{colog}(A+PB)$	0.865266 μ
Table	9.861067	9.861064	9.861073	9.861066	9.861066	$\log(P+1)$	0.316346
η_{n-1}	7.601001	7.601066	7.601033	7.601066	7.601078	$\log 5$	8.920299
Diff.	0.562595	0.562587	0.562610	0.562593	0.562592	$\log d_0$	0.101911 μ
$\log \text{diff.}$	8.024663	8.024717	8.024716	8.024725	8.024737		
$\log 2^3$	1.118358	1.118385	1.118403	1.118373	1.118373	$\sin \sigma$	8.530149
$\log 2$	0.301030	0.301030	0.301030	0.301030	0.301030	d_0	0.101911 μ
$\text{colog } \eta_{n-1}$	9.998271	9.998271	9.998271	9.998271	9.998271	$\cos \sigma$	9.999751 μ
$\log Y_{n-1}$	9.442322	9.442403	9.442420	9.442399	9.442411	$d_0 \cos \sigma$	0.101662
						$\text{ob } \cos w$	9.421195
η_{n-1}	8.163596	8.163653	8.163643	8.163659	8.163671	$\cos \sin$	9.994340
Table	9.890072	9.890082	9.890078	9.890067	9.890071	$\text{ob } \sin w$	8.632060 μ
η_{n-1}	7.513217	7.513136	7.513139	7.513196	7.513193	$\log w$	9.210865 μ
Diff.	0.650379	0.650517	0.650504	0.650463	0.650478	w	9 13 48.5
$\log \text{diff.}$	8.053668	8.053735	8.053721	8.053726	8.053742	$\log \text{ob}$	9.426855
$\log 2^3$	1.419388	1.419415	1.419433	1.419403	1.419403		
$\text{colog } \eta_{n-1}$	9.998586	9.998587	9.998587	9.998586	9.998586	$\log M'$	0.913178
$\log Y_{n-1}$	9.471642	9.471737	9.471741	9.471715	9.471731	$\log M''$	1.486323
	XI corrected.						
T_{n-1}	9.741139		P	0.030109			
T_n	9.711030		B	9.095948			
P	0.030109		PB	9.126057 μ			
Table	0.286237		Table	0.008677			
Diff.	9.969891		A	7.431003 μ			
$\log(P+1)$	0.316346		Diff	8.304946			
			$\log(A+PB)$	9.134734 μ			

	Corrected	Recomputing the MBs				
		4th	5th	6th	7th	8th
A	7.431003 _n	7.431003 _n	7.431003 _n	7.431003 _n	7.431003 _n	7.431003 _n
Y	9.442510	9.442522	9.442403	9.442420	9.442399	9.442411
Y...	9.471785	9.471642	9.471737	9.471741	9.471715	9.471731
PB	9.126057 _n	9.126057 _n	9.126057 _n	9.126057 _n	9.126057 _n	9.126057 _n
PBY	8.568587 _n	8.568377 _n	8.568460 _n	8.568477 _n	8.568456	8.568468 _n
Table	0.009276	0.009277	0.009277	0.009277	0.009276	0.009277
A Y...	6.902788	6.902645 _n	6.902740 _n	6.902744 _n	6.902718 _n	6.902734 _n
diff	8.334221	8.334266	8.334280	8.334267	8.334262	8.334266
(PBY + AY...)	8.577843 _n	8.577537 _n	8.577754 _n	8.577732 _n	8.577745 _n	8.577745
c log(A+PB)	0.865266 _n	0.865266 _n	0.865266 _n	0.865266 _n	0.865266 _n	0.865266 _n
log q	9.443109	9.442922	9.442803	9.443020	9.442998	9.443011
log M°	1.486323	1.486323	1.486323	1.486323	1.486323	1.486323
log M	0.929432	0.929245	0.929126	0.929343	0.929321	0.929334

	Corrected	Recomputing Z					
		4th	5th	6th	7th	8th	
Z	9° 36' 23.5	9° 36' 47.7	9° 36' 29.1	9° 36' 29.2	9° 36' 28.5	9° 36' 28.5	9° 36' 28.0
sin Z	9.222407	9.222708	9.222477	9.222477	9.222469	9.222469	9.222463
(sin Z) ²	6.889628	6.890832	6.889908	6.889908	6.889876	6.889876	6.889852
log M	0.929432	0.929432	0.929432	0.929245	0.929245	0.929103	0.929103
sum log	7.819060	7.820264	7.819340	7.819153	7.819121	7.818979	7.818955
w	-9 13 48.5	-9 13 49.5	-9 13 48.5	-9 13 48.5	-9 13 48.5	-9 13 48.5	-9 13 48.5
w + z	22 35.0	22 59.2	22 40.6	22 40.7	22 40.0	22 40.0	22 39.5
sin(w+z)	7.817511	7.825199	7.819302	7.819334	7.819111	7.819111	7.818951
Δ _{4a}	+65.49	-49.35	+38	-181	+10	-138	+4
b-4a	270.4	265	269	269	269	269	269
dz	24.2	-15.6	+0.1	-0.7	00	-0.5	00
Z	9 36 47.7	9 36 29.1	9 36 29.2	9 36 28.5	9 36 28.5	9 36 28.0	9 36 28.0

			Recomputing the z 's			Elements			
			6 th	7 th	8 th				
z	$9^{\circ} 36' 28.0$	$9^{\circ} 36' 28.8$	$9^{\circ} 36' 28.8$	$9^{\circ} 36' 28.8$	$2f''$	$9^{\circ} 7' 16.3$			
$\sin z$	9.222463	9.222473	9.222473	9.222473	f'	4 4 46.8			
$(\sin z)^4$	6.889852	6.889892	6.889892	6.889892	f'''	4 33 38.2			
$\log m$	0.929303	0.929321	0.929321	0.929334	r_1	0.363500			
$\sin \log$	7.819155	7.819213	7.819213	7.819226	r_{III}	0.381736			
w	-9 13 48.5	-9 13 48.5	-9 13 48.5	-9 13 48.5	$r_1 r_{III}$	0.745236			
$w+z$	22 39.5	22 40.3	22 40.3	22 40.3	$\sqrt{r_1 r_{III}}$	0.372618			
$\sin(w+z)$	7.818951	7.819207	7.819207	7.819207	$\cos f''$	9.995043			
Δ	204	6	19	19	$\log z$	0.301030			
$b-4a$	269	269	269	269	$2 \cos f'' \sqrt{r_1 r_{III}}$	0.668691			
dz	+0.8	00	0.1	0.1	$(2 \cos f'' \sqrt{r_1 r_{III}})^2$	2.006073			
z	$9^{\circ} 36' 28.8$	$9^{\circ} 36' 28.8$	$9^{\circ} 36' 28.8$	$9^{\circ} 36' 28.9$	T''^2	0.054754			
			Computing the Elements.			$\log m_{II}$	8.048681		
$l_{III}-l_1$	$17^{\circ} 2' 42.6$				$\sin^2 f''$	8.353514	r_{III}/r_1	0.018236	
$b_{III}-b_1$	-3 33 46.6				$\sin f''$	9.178757	$\sqrt{r_{III}/r_1}$	0.004559	
$\frac{1}{2}(l_{III}-l_1)$	8 31 21.3				f''	8 38 25.0	$45^{\circ} + w$	$45^{\circ} 18' 2.6$	
$\frac{1}{2}(b_{III}-b_1)$	-1 46 53.3				$2f''$	17 16 50.0	$\frac{1}{2} f''$	4 19 12.5	
$\sin \frac{1}{2}(l_{III}-l_1)$	9.170846				$\log r_1$	0.363500	$2w''$	36 5.2	
$\sin^2 \frac{1}{2}(l_{III}-l_1)$	8.341692				$\log r_{II}$	9.688524	$\log 2w''$	8.021089	
$\cos b_1$	9.994717				$\sin 2f''$	9.472831	$\sin^2 f''$	8.876964	
$\cos b_{III}$	9.998099				$\text{colog } r_{II}$	9.627209	$\tan^2 2w''$	6.042178	
$\sin \frac{1}{2}(b_{III}-b_1)$	8.492585				$\log n''$	9.718318	Table	8353	
$\sin^2 \frac{1}{2}(b_{III}-b_1)$	6.985170				$\log r_{III}$	0.381736	$\sin^2 \frac{1}{2} f''$	7.753928	
Table	0.019006				$\sin 2f''$	9.152064	Diff	8.288250	
$\log A$	8.934508				$\sin 2f''$	9.200094	$\log \sin$	7.762281	
Diff	8.650662				$2f''$	8 9 33.7	$\sec f''$	0.004957	

Elements.		II.		III.	
$\log L$	7.767238	f''	8° 38' 25.0	$\cos \frac{1}{2} \phi (r'')$	9.164768
Table	3039	$f''+g$	16 45 46.2	$\sin \cos$	9.998677
$\log \frac{1}{2} \phi$	9.920819	$f''-g$	31 3.8	$\sin \frac{1}{2} \phi (r'')$	8.057987
Diff	7.846419	$\frac{1}{2}(f''+g)$	8 22 53.1	$\tan \frac{1}{2} \phi$	8.893219
$\log \sum$	9.923858	$\frac{1}{2}(f''-g)$	15 31.9	$\frac{1}{2} \phi$	4 28 17.6
$\log \mu$	8.048681	$\cos \frac{1}{2}(f''+g)$	9.995337	$\log (r'')$	9.166091
$\log h$	8.124823	$\tan 2w''$	8.021089	$\frac{2 \sin \cos f''}{2 \sin \cos f''}$	8.344754
$\log \frac{1}{2} \phi$	0.087150	$\cos \frac{1}{2}(f''-g)$	9.999996	$\frac{2 \sin \cos f''}{2 \sin \cos f''}$	9.172377
$\log \frac{1}{2} h$	8.211973	$\sin \frac{1}{2}(f''+g)$	9.163644	$\text{colog } \mu$	9.993715
Table	7019	$\sec 2w''$	0.000024	r''	9.166092
$\frac{1}{2} h / (1 + \frac{1}{2} h)$	8.204954	$\sin \frac{1}{2}(f''-g)$	7.654942		
Table	6907	$\sin \frac{1}{2}(F-G) \cos \frac{1}{2} \phi (r')$	8.016426		
$\frac{1}{2} h / (1 + \frac{1}{2} h)$	8.205066	$\sin \cos$	9.998900		
Table	6909	$\cos \frac{1}{2}(F-G) \cos \frac{1}{2} \phi (r')$	9.163668		
$\frac{1}{2} h / (1 + \frac{1}{2} h)$	8.205064	$\tan \frac{1}{2}(F-G)$	8.852758		
$\log \frac{10}{11}$	9.958607	$\frac{1}{2}(F-G)$	4 4 30.7		
$\log(N_{11}-1)$	8.163671	$\sin \frac{1}{2}(F+G) \sin \frac{1}{2} \phi (r')$	8.021085		
$\log N_{11}$	6285	$\sin \cos$	9.963098		
$\log \mu$	0.012570	$\cos \frac{1}{2}(F+G) \sin \frac{1}{2} \phi (r')$	7.654942		
μ_1 / μ_2	8.036111	$\tan \frac{1}{2}(F+G)$	0.366143		
Table	9.933113	$\frac{1}{2}(F+G)$	66 42 49.3		
L	7.767238	$F+G$	133 25 38.6		
Diff	0.268873	$2F$	141 34 40.0		
$\log \text{Diff}$	7.700357	F	70 47 20.0		
$\sin \frac{1}{2} g$	8.850176	$2G$	125 16 37.2		
$\frac{1}{2} g$	4 3 40.6	G	62 38 18.6		
g	8° 7' 21.2				

Element		Element (Cont.)	
$t_{\frac{1}{2} V_{01}}$	9.917416	a_3	1.213722
$t_{\frac{1}{2} V_1}$	9.780047	a_2	0.606561
$\frac{1}{2} \phi$	4 28 17.6	K	3.450007
$45^\circ + \frac{1}{2} \omega$	49 28 17.6	M	2.943146
$t_{\frac{1}{2} E_{11}}$	9.851352	V_{11}	
$t_{\frac{1}{2} (45^\circ + \frac{1}{2} \phi)}$	0.068068	$\sin \phi$	9.191601
$t_{\frac{1}{2} E_1}$	9.711984	$\sin 1''$	4.685575
$t_{\frac{1}{2} V_1}$	9.919417	E''	4.506026
$t_{\frac{1}{2} V_{01}}$	9.780047	$\sin E_1$	9.910772
		$\sin E_{11}$	9.975042
		$\beta E'' \sin E_1$	4.416798
		$\beta E'' \sin E_{11}$	4.481068
		$E'' \sin E_1$	26.109147
		$E'' \sin E_{11}$	30.373557
		$E'' \sin E_1$	7° 15' 9.47
		$E'' \sin E_{11}$	8 24 33.87
		M_1	V_{11}
		M_{11}	47 15 41.93
			62 21 57.3
		$M_{11} - M_1$	15 5 18.00
		$T_{11} - T_1$	61.914781
		$M_{11} - M_1$	54.318.00
		T_{11}	8.528398
		T_1	7.618607
			32
$t_{\frac{1}{2} V_{01}}$	9.917416	a_3	1.213722
$t_{\frac{1}{2} V_1}$	9.780047	a_2	0.606561
$\frac{1}{2} \phi$	4 28 17.6	K	3.450007
$45^\circ + \frac{1}{2} \omega$	49 28 17.6	M	2.943146
$t_{\frac{1}{2} E_{11}}$	9.851352	V_{11}	
$t_{\frac{1}{2} (45^\circ + \frac{1}{2} \phi)}$	0.068068	$\sin \phi$	9.191601
$t_{\frac{1}{2} E_1}$	9.711984	$\sin 1''$	4.685575
$t_{\frac{1}{2} V_1}$	9.919417	E''	4.506026
$t_{\frac{1}{2} V_{01}}$	9.780047	$\sin E_1$	9.910772
		$\sin E_{11}$	9.975042
		$\beta E'' \sin E_1$	4.416798
		$\beta E'' \sin E_{11}$	4.481068
		$E'' \sin E_1$	26.109147
		$E'' \sin E_{11}$	30.373557
		$E'' \sin E_1$	7° 15' 9.47
		$E'' \sin E_{11}$	8 24 33.87
		M_1	V_{11}
		M_{11}	47 15 41.93
			62 21 57.3
		$M_{11} - M_1$	15 5 18.00
		$T_{11} - T_1$	61.914781
		$M_{11} - M_1$	54.318.00
		T_{11}	8.528398
		T_1	7.618607
			32
$t_{\frac{1}{2} V_{01}}$	9.917416	a_3	1.213722
$t_{\frac{1}{2} V_1}$	9.780047	a_2	0.606561
$\frac{1}{2} \phi$	4 28 17.6	K	3.450007
$45^\circ + \frac{1}{2} \omega$	49 28 17.6	M	2.943146
$t_{\frac{1}{2} E_{11}}$	9.851352	V_{11}	
$t_{\frac{1}{2} (45^\circ + \frac{1}{2} \phi)}$	0.068068	$\sin \phi$	9.191601
$t_{\frac{1}{2} E_1}$	9.711984	$\sin 1''$	4.685575
$t_{\frac{1}{2} V_1}$	9.919417	E''	4.506026
$t_{\frac{1}{2} V_{01}}$	9.780047	$\sin E_1$	9.910772
		$\sin E_{11}$	9.975042
		$\beta E'' \sin E_1$	4.416798
		$\beta E'' \sin E_{11}$	4.481068
		$E'' \sin E_1$	26.109147
		$E'' \sin E_{11}$	30.373557
		$E'' \sin E_1$	7° 15' 9.47
		$E'' \sin E_{11}$	8 24 33.87
		M_1	V_{11}
		M_{11}	47 15 41.93
			62 21 57.3
		$M_{11} - M_1$	15 5 18.00
		$T_{11} - T_1$	61.914781
		$M_{11} - M_1$	54.318.00
		T_{11}	8.528398
		T_1	7.618607
			32

Element (Cont.)

IV.

β

32

$T_{11} - T_1$
 $\log(M_{11} - M_1)$
 $\log M$
 $2.f'''$
 V_{11}
 V_{11}
 $\frac{1}{2} V_{11}$
 V_{11}
 $2.f'$
 V_{11}

$45^\circ - \frac{1}{2} \phi$
 $t_{\frac{1}{2} (45^\circ - \frac{1}{2} \phi)}$
 $t_{\frac{1}{2} V_{11}}$
 $t_{\frac{1}{2} E_{11}}$
 $\frac{1}{2} E_{11}$
 E_{11}

$T_{11} - T_1$
 $T_{11} - T_1$

$\log(T_{11} - T_1)$
 M
 $\log(M_{11} - T_{11})$
 $M(T_{11} - T_1)$
 M_1

M_1
 M_0
 M_{11}

7° 48' 2.00d
 47 15 47.93
 55 4 5.0 dL

	Elements (cont.)					
$M(\text{Cor.})$	4.468597	$\sin \text{Cor. E.}$	8.753386	$\text{tg } i \sin(l-d)$	9.195729	
"	26 21 7.88	Diff. Table	7.044614	$\sin \text{Cor.}$	9.888910	
"	7° 16' 57.88	$\log a$	9.958928	$\text{tg } i \cos(l-d)$	9.288362 _u	
M_{III}	62 21 5.93	r_1	0.404572	$\text{tg}(l-d)$	9.912367 _u	
M_{II}	55 4 8.05 _{cl}	r_2	0.363500 _{cl}	l_1-d	140 44 30.5	
				l_1	56 22 44.9	
$\sin E''$	7.948901	$\sin \text{Cor. E.}$	8.848568	d	275 38 14.4	
E''	4.506026	Diff. Table	1.151432			
$E'' \sin E''$	4.455927	$\log a$	9.968219	$\text{tg } i$	9.894452	
"	28 57 11.3	r_1	0.404572	i	13 58 42.1	
"	7° 56' 11.3	r_2	0.372791 _{cl}			
E''	63 0 19.2	$\sin \text{Cor. E.}$	8.709867	l_1	56 22 44.9	
M_{II}	55 4 8.07	Diff. Table	1.299423	d	275 38 14.4	
M_{II}	55 4 8.1 _{cl}	$\log a$	9.977164	l_{III}	73 28 27.5	
		r_1	0.404572	l_1-d	140 44 30.5	
		r_2	0.381736 _{cl}	$l_{III}-d$	157 47 13.1	
K	3.550001		VII.	$\text{tg}(l-d)$	9.912367 _u	
$M_{1/2}$	2.743149	$l_{III}-l_1$	17 2' 42.6	$\cos i$	9.987039	
$a^{1/2}$	0.606858	$\cos(l_{III}-l_1)$	9.980492	$\text{tg } u_1$	9.925328 _u	
a^3	1.213716	$\text{tg } l_1$	9.195729	u_1	139 54 5.7	
a	0.4404572	$\text{tg } 6 \cos(l_{III}-l_1)$	9.176221	d	275 38 74.4	
$\sin \varphi$	9.191601	Table	9.775413	$\text{tg}(l-d)$	9.611040 _u	
$\cos E_1$	9.763785	$\text{tg } 6_{III}$	8.972003	$\cos i$	9.987039	
$\cos E_{II}$	9.656968	Diff. Table	0.204218	$\text{tg } u_{III}$	9.624001 _u	
$\cos E_{III}$	9.517866	$\log \text{diff.}$	8.750416 _u	u_{III}	157 10 55.6	
		$\sin(l_{III}-l_1)$	9.467054	d	275 38 14.4	
				$(1, +d)$	415 32 20.1	
				V_1	62 8 53.0	

Elements	1907.0	1910.0	Ephemeris Constants	1909.0	1910.0
Π	353° 23' 25.1	7.987037	sin t	7.960470	7.960448
$W_{100} + \delta$	0.32	7.997874	sin d	7.997894	7.999874
V_{100}	79 20 00.0	5.994289	{ 2 sin ϵ }	7.997847	7.997847
Π	353 23 25.0	7.997766	V } cos i	7.987034	7.987037
T	1907.0	7.984933	cos d	5.994250	5.994259
μ	How 7.0	7.007317	W } sin i	7.381492	7.381490
μ	2418649.5	5° 48' 25.1	cos ϵ	7.962558	7.962558
μ	47° 14' 8.2	7.987167			
ϵ	7.291601	7.997874	log V	8.579136	8.581276
$\log \mu$	8° 56' 36.2	7.997894	Table	0.068863	0.069177
i	2.943149	7.962558	log W	7.344030	7.344048
i	877.20	7.987034	diff	7.235086	7.237227
δ	18° 58' 05.1	8.994389			
δ	228° 38' 14.6	7.381492	sin ϵ sin C	7.577741	7.577751
ω	27° 45' 16.6	7.599847	sin ϵ	7.922801	7.922679
$\log \omega$	0.464572	8.041847	sin ϵ cos C	7.413913	7.413225
ϵ	23° 27' 0.0	8.978622	log C	0.184528	0.184476
Π	353° 23' 25.0	8.981339	log C	305 7' 36.5	305 16' 50.7
		0.039492	sin ϵ	7.674940	7.670022
		7.960472	C	303 9 36.5	303 10 50.7
		7.999882	B	267 28 38.8	267 30 16.4
		7.920489	C-B	33 40 37.7	33 40 34.5
		2.03 39.3	sin (C-B)	7.743975	7.743801
		269° 28' 38.8	diff	7.674940	7.675022
			diff	7.960470	7.960448

Ephemeris Constants	Date	Time	Longitude	Latitude
Log A	9.887163	9.917170	0.7909443	0.9049443
Log A	9.933366	9.937743	9.999347	9.999347
Log 1/2	9.213231	9.379371	9.373066	9.873066
Log 1/4	9.380333	9.550913	9.007580	9.099533
Log 1/8	9.594498	9.894498	8.325522	8.523909
Log 1/16	9.794653	9.994653	7.562620	7.770223
Log 1/32	9.994808	9.994808	0.091757	0.091757
Log 1/64	9.994963	9.994963	9.967763	9.967763
Log 1/128	9.995118	9.995118	0.115320	0.006230
Log 1/256	9.995273	9.995273	0.066883	9.967763
Log 1/512	9.995428	9.995428	40° 23' 40.5"	40° 23' 40.5"
Log 1/1024	9.995583	9.995583	45° 53' 50.5"	45° 53' 50.5"
Log 1/2048	9.995738	9.995738	13° 36' 47.2"	13° 36' 47.2"
Log 1/4096	9.995893	9.995893	0.183383	0.283277
Log 1/8192	9.996048	9.996048	9.862620	9.770223
Log 1/16384	9.996203	9.996203	0.117638	0.178957
Log 1/32768	9.996358	9.996358	9.400763	9.592609
Log 1/65536	9.996513	9.996513	0.163238	0.232787
Log 1/131072	9.996668	9.996668	0.163646	0.193070
Log 1/262144	9.996823	9.996823	9.267382	9.322964
Log 1/524288	9.996978	9.996978	-0.071	0.0
Log 1/1048576	9.997133	9.997133	0.018166	9.963378
Log 1/2097152	9.997288	9.997288	0.018	0.0

Parallax Dec. 9
(a) Factor 8.441 m

$\log \Delta x$ 0.1534
 Δx 8.2876 m
 - 0.02
 (b) Factor 0.089
 $\log \Delta s$ 9.8356
 Δs 40.77

Correction of elements for 1911.0

$t_0 - 18.50$ 57 years
 $t_1 - t_0$ 2 "
 $(t_0 - 18.50) 32.847$ 32' 18.0
 $(t_1 - t_0) 8.694$ 17.4
 From formula 173° 0' 12.0
 Π 173 30 12
 Π 0.9
 $\log \Pi$ 9.982271
 $\log L$ 1' 40.5

$\log \rho$ 275 38 14.4
 $\rho - \Pi$ 102 8 13.2

Elements 1911.0

(I) $\log \Pi$ 0.605548
 $\sin(\rho - \Pi)$ 9.982271
 $\log \Pi$ 9.990182
 $\cos(\rho - \Pi)$ 9.982271
 $\log(\text{cot } i)$ 1.224236
 $\sin 1''$ 4.685575
 cot i 1.211096
 Table 0.013140
 $\log h$ 9.688970
 $\Delta \mu$ 8.487874

$\log I$ 0.575001
 Table
 $\log II$ Negligible
 $\log L$ 3.8
 L 1' 40.5
 ρ_0 275 38 14.4
 ρ_1 275 39 54.9

(III) $\log i$ 9.086894
 Π 9.982271
 $\sin(\rho - \Pi)$ 9.990182
 $\log \Pi$ 9.982271
 $\cos(\rho - \Pi)$ 9.322236
 $\log h$ 9.688970
 $\log \frac{h}{a}$ 8.173788
 $\sin 1''$ 4.685575

$\log III$ 9.057347
 $\log IV$ Negligible

No. 0.1
 L 1' 40.5
 Π_0 253 23 26.0
 Π_1 253 26 51.6

V $\log(\rho - \Pi)$ 9.322236
 Π 9.982271

(VI) $\log(\rho - \Pi)$ 9.990182
 $\log \Pi$ 9.982271
 $\log \Pi \sin(\rho - \Pi)$ 9.944906
 $\log \frac{h}{a}$ 9.688970
 $\log \text{cot } i$ 0.605548
 $\sin 1''$ 4.685575

$\log V$ 9.305207
 $\log III$ Negligible

No. - 0.2
 i 13° 55' 42.1
 i 13 55 41.9
 ρ 275° 39' 54.9
 Π 253° 25' 51.6

Element
 $\log \rho$ 9.191601
 $\log a$ 0.404572
 $\log M$ 2.943149
 $\log E$ Nov. 7.5, 1911.0

Computing M
Nov. 30

ΔT 27.084136
 $\log \Delta T$ 1.432715
 $\log M$ 2.943149
 $\sin(\Delta T)$ 4.375864
 " 20372.8
 " 50 39' 32.8 6° 36' 1.0
 M_0 47 14 9.2 47 14 8.2
 M 52 53 41.053 50 9.2

Computing E
Nov 7

E 54 36 53.4 63 0 19.2
 $\log \sin E$ 9.94992
 $\log e \sin E$ 4.455927
 $e \sin E$ 26109.47
 " 7° 15' 9.5 7 56 11.1
 M 47 15 47.9 55 4 8.1
 dM - 0.1 - 0.2
 $\log \cos E$ 9.763785 9.656967
 $\log e \cos E$ 8.955386 8.848568
 $\log (1 - e \cos E)$ 1.044614 1.151432
 $\log dM$ 9.958928 9.868221
 $\log E$ 9.000000 9.201030
 " 9.041072 9.332809
 " - 0.1 - 0.2
 E 54 36 57.3 63 0 19.0

Jan 8

70 45 32.8
 9.975042
 4.461068
 28911.34
 8 1 50.3
 62 21 5.9
 - 0.2
 9.517866
 8.707467
 1.290533
 9.977164
 9.301030
 9.323866
 - 0.2
 70 45 39.6

Nov 30

60 38 19.2
 9.940290
 4.446316
 27945.75
 7 45 45.8
 52 52 33.4
 + 1 7.6
 9.690476
 8.882077
 1.117928
 9.965568
 1.829947
 1.864379
 + 1 13.2
 60 39 32.4

Dec 4

61 39 55.0
 9.944576
 4.4450602
 28222.99
 7 50 23.0
 53 49 32.0
 + 31.2
 9.676348
 8.867949
 1.132051
 9.966713
 1.570547
 1.603829
 + 40.2
 61 40 35.2

61 40 35.7

	Computing		x, y, and z		Nov 30		Dec 4	
	Nov 7	Dec 7	Jan 8	Nov 30	Dec 4	Nov 30	Dec 4	Nov 30
V	62 8' 54.671	16 11.2	79 25 44.6	68 46 6.0	69 51 17.8			
A'+V	145 42 30.3	154 47 46.7	162 59 20.3	152 19 41.7	153 24 53.5			
sin(A'+V)	9.750820	9.628706	9.466208	9.666897	9.650819			
sin a	9.987167	9.987167	9.987167	9.987167	9.987167			
n	0.363500	0.372794	0.381734	0.370162	0.371298			
X	0.101487	9.988667	9.835707	0.024226	0.009284			
B'+V	49 22' 49.0	58 30 0.6	66 39 34.0	55 59 55.4	57 5 7.2			
sin(B'+V)	9.880261	9.930765	9.962922	9.918568	9.924011			
sin b	9.960470	9.960470	9.960470	9.960470	9.960470			
n	0.363500	0.372794	0.381734	0.370162	0.371298			
y	0.204231	0.264029	0.305126	0.249200	0.285777			
C'+V	83 3 41.7	92 10 58.3	100 20 31.7	89 30 53.1	90 46 4.9			
sin(C'+V)	9.996806	9.999685	9.992856	9.997954	9.999261			
sin c	9.674940	9.674940	9.674940	9.674940	9.674940			
n	0.363500	0.372794	0.381734	0.370162	0.371298			
z	0.035246	0.047419	0.049560	0.045056	0.046199			

This belongs in the middle of the following page.

Computing V, and v from the elements

	Nov 7	Dec 9	Jan 8	Nov 30	Dec 4
$\frac{1}{2} E$	27° 15' 28.6	31 30 9.5	35 22 49.8	30 19 46.2	30 50 17.6
$\frac{1}{2} \log \frac{1}{2} E$	9.711984	9.787365	9.851351	9.767188	9.775992
$\frac{1}{2} \log \frac{1}{2} E$	0.068064	0.068064	0.068064	0.068064	0.068064
$\frac{1}{2} V$	9.780048	9.855429	9.919415	9.835252	9.844056
$\frac{1}{2} v$	31° 4' 27.3	35 38 5.6	39 42 52.3	34 23 3.0	34 55 38.9
V	62° 8' 54.6	71 16 11.2	79 25 44.6	68 46 6.0	69 51 17.8
$\cos \frac{1}{2} E$	9.948879	9.970354	9.911330	9.936079	9.933800
$\cos \frac{1}{2} v$	9.932727	9.909955	9.886061	9.916596	9.913749
Quotient	0.016152	0.020799	0.025269	0.019483	0.020051
Square	0.032304	0.041598	0.050538	0.038966	0.040102
$d(1-e)$	0.331196	0.331196	0.331196	0.331196	0.331196
α	0.363500	0.372794	0.381734	0.370162	0.371298

Computing α and δ for old and new places - Midnight.

X	-0.699555	-0.213858	+0.302190	-0.363078	-0.299440.
Y	-0.643332	-0.381782	-0.858524	-0.840850	-0.861163
Z	-0.279073	-0.382514	-0.372414	-0.364757	-0.373568
$\log X$	7.844822	9.330124	7.480250	9.560000	9.476310
Table	9.906220	9.892366	9.858898	9.817315	9.849354
$\log X$	0.101487	9.988667	9.835110	0.024226	0.009284
Diff	0.256666	0.688543	9.645170	0.464226	0.532974
$\log X + X$	9.751041	9.881033	9.993998	9.841541	9.888638
$\log Y$	9.808435	9.945361	9.933752	9.924719	9.935086
Table	0.172512	0.034589	0.130867	0.045700	0.038473
$\log Y$	0.204231	0.264029	0.305126	0.249200	0.255778
Diff	0.395796	0.318668	0.371374	0.324481	0.320692

Computing α and δ

	Nov. 7	Dec 9	Jan 8	Nov 30	Dec 4
$\log(Y+y)$	9.980947	9.979950	0.064619	9.970419	9.973557
$\log Z$	9.445718 ⁿ	9.582647 ⁿ	9.571026 ⁿ	9.562003 ⁿ	9.572370 ⁿ
Table	9.870803	9.817579	9.824613	9.826860	9.822253
$\log \beta$	0.035246	0.047419	0.049560	0.045086	0.046199
Diff	0.589528	0.464772	0.478534	0.483083	0.473829
$\log Z + \beta$	9.906049	9.865018	9.874173	9.871946	9.868452
$\log(Y+y)$	9.980947	9.979950	0.064619	9.970419	9.973557
$\log(X+x)$	9.751041	9.851033	9.993978	9.841541	9.858638
$\log \alpha$	0.229906	0.098917	0.1070621	0.128878	0.114921
α	59' 30" 11.3	51' 28" 9.5	49' 38" 17.0	53' 22" 45.2	52' 29" 37.4
α	3 58" 0.75	3 25" 52.63	3 18" 35.14	3 35" 31.01	3 29" 58.50
Observed					
Corrected for μ	5.90	52.69	33.20	30.78	58.32
$\log(Z+\beta)$	9.906049	9.865018	9.874173	9.871946	9.868452
$\log \alpha$	9.935335	9.873357	9.881937	9.904800	9.894430
$(Z+\beta) \sin \alpha$	9.841384	9.758377	9.756110	9.776446	9.767882
$\log(Y+y)$	9.980947	9.979950	0.064619	9.970419	9.973557
$\log \delta$	9.860437	9.778427	9.671491	9.806027	9.794323
δ	35' 56" 53.8	30 58 47.3	26 10 20.7	32 36 37.3	31 54 47.2
Corrected observation	54.3	46.7	20.1	35.0	48.6

The final check is the agreement of the computed with the observed places for Nov 30, and Dec 4.

	Computing $\rho, \Delta T, \dots$ Nov 30		Date of Oppor tione.	Date of Oppor tione.	2 nd trial.
$\rho \cos \delta$	9.841541	9.858638	Mars 1	877.3 (Mar) 877.3	
$\sin \delta$	9.904500	9.897430	t	484d	480.d.
$\sin \alpha \sin \delta$	9.970419	9.973559	Mt	424468	421104
$\rho \sin \delta$	9.871946	9.868452	"	117° 54'	116° 58'
$\rho \cos \delta$	0.065919	0.074129	M ₀	47 14	47 14
$\cos \delta$	9.925495	9.925832	M	165° 4'	164° 12'
$\tan \delta$	9.806027	9.794323	Table (V-M)	3 52	4 6
ρ	0.140424	0.145297	V	168 57	168 18
$\log S$	2.76158	2.76158	w	77 45	77 45
$\log PS$	2.902004	2.906877	u	246 42	246 3
ΔT°	798.0	807.0	$\tan u$	0.365857	0.362438
"	55.1	51.2	cos i	9.987039	9.987039
ΔT (miles)	5.14		$\tan (l-\delta_0)$	0.352896	0.339477
(a) Factor	7.0360	7.4720 _u	$(l-\delta_0)$	246° 4'	245° 24'
$\log \Delta \alpha$	0.1404	0.1453	δ_0	275 38	275 38
$\Delta \alpha$	8.8956	9.3267 _u	l	161 42	161 2
	+0.08	-0.21	λ	-165 3	-161 2
(b) Factor	0.0070	0.2250			
$\log \Delta \delta$	0.1404	0.1453			
$\Delta \delta$	7.8686	0.0797			
	+0.7	+1.2			
				Mar. 2, 1911 is the	
				date of next opposition.	

E_s computed for the Ephemeris.

<i>E</i>	Jan 21 154 27 40.9	Jan 21 157 49 24.1	Feb. 6 161 13 36.8	Feb 22 164 37 17.8	Mar 10 168 0 33.6	Mar 26 171 23 27.8	Apr 11 174 46 8.2
<i>log sin E</i>	9.634598	9.576875	9.507699	9.423561	9.317546	9.175792	8.959864
<i>log e" sin E</i>	4.140624	4.052901	4.013725	3.929587	3.823572	3.681218	3.465890
<i>e" sin E</i>	13823.7	12103.2	10321.1	8503.3	6661.5	4799.7	2923.4
"	+3° 50' 23.7	3 21 43.2	2 52 1.1	2 21 43.3	1 57 1.5	1 19 59.7	48 43.4
<i>M</i>	151 37 17.2	154 27 40.9	158 21 35.7	162 15 34.5	166 9 32.1	170 3 28.1	173 57 24.8
<i>dM</i>	3 50 23.7	00	2.0	00	00	00	+1
<i>log cos E</i>	9.955347 _u		9.976259 _u				9.998188 _u
<i>log e cos E</i>	9.146948		9.167860 _u				9.189789
<i>Diff</i>	0.057006						0.062510
<i>(1 - e cos E)</i>	0.057006		0.059633 _u				
<i>log dM</i>	4.140624		0.301030				8.937490
<i>log dE</i>	4.083618		0.241397				+ .1
" <i>de</i>	12 12 3.2		+ 1.7				
<i>E</i>	157° 49' 32.0	Feb. 6. 161 73 37.1	161 13 38.8	164 37 17.8	168 0 33.6	171 23 27.8	174 46 8.2
<i>log sin E</i>	9.576834	9.507613	9.507702				
<i>log e" sin E</i>	4.082860	4.013639	4.013728				
<i>e" sin E</i>	12102.1	10319.0	10321.1				
"	3° 21' 42.1	2 57 59.0	2 52 1.1				
<i>M</i>	154 27 49.9	158 21 38.8	158 21 37.7				
<i>dM</i>	-9.0	-0.4	00				
<i>log cos E</i>	9.956626	9.976259 _u					
<i>log e cos E</i>	9.158227 _u	9.167860 _u					
<i>(1 - e cos E)</i>	0.058409	0.059633					
<i>log dM</i>	0.954243 _u	9.602060 _u					
<i>log dE</i>	0.875834 _u	9.542427 _u					
<i>dE</i>	-7.9	-0.3					
<i>E</i>	157 49 24.1	161 13 36.8	161 13 38.8				

The last *E_s* were approximated by interpolation. The first round of the last three is omitted.

Computing Ephemeris of 16 day intervals for 1911.

	Jan 21	Feb. 6	Feb 22	Mar 10	Mar 26	Apr 11
T (J.D.)	8619.5	8619.5	8619.5	8619.5	8619.5	8619.5
t (")	9059.5	9075.5	9091.5	9107.5	9123.5	9139.5
$t - T$ (days)	440	456	472	488	504	520
$\log(t-T)$	2.643453	2.658965	2.673942	2.688420	2.702431	2.716003
$\log \mu$	2.943149	2.943149	2.943149	2.943149	2.943149	2.943149
$\log \mu(M-M_0)$	5.556602	5.602114	5.617091	5.631569	5.645580	5.659152
$M-M_0$	386012.7	400050.0	414086.3	428123.3	442161.0	456196.7
Averaged	386012.7	400049.5	414086.3	428123.1	442159.9	456196.7
μt	107° 13' 32.7	111 7 29.5	115 1 26.3	118 55 23.1	122 49 19.9	126 43 16.7
M_0	47 14 8.2	47 14 8.2	47 14 8.2	47 14 8.2	47 14 8.2	47 14 8.2
M	154 27 40.9	158 21 37.7	162 15 34.5	166 9 31.3	170 3 28.1	173 57 24.9
E s are computed on the preceding sheet.						
E	157° 49' 24.1	161 13 38.8	164 37 17.8	168 0 32.9	171 23 27.8	174 46 8.3
$\frac{1}{2}E$	78 54 42.0	80 36 49.4	82 18 38.9	84 0 16.4	85 41 44.0	87 23 4.2
$\log \frac{1}{2}E$	0.707786	0.781719	0.869624	0.978712	1.123387	1.340266
$\frac{1+E}{1-E}$	0.068064	0.068064	0.068064	0.068064	0.068064	0.068064
$\log \frac{1}{2}v$	0.775850	0.849783	0.937688	1.046776	1.191451	1.408330
$\frac{1}{2}v$	80 29 18.0	81 57 21.5	83 24 56.1	84 52 7.2	86 19 5.1	87 45 48.5
v	160° 58' 36.0	163 54 43.0	166 49 52.2	169 44 18.4	172 38 10.2	175 31 37.0
$\log \cos v$	9.9756096 _u	9.9826502 _u	9.9884262 _u	9.9929974 _u	9.9964032 _u	9.9986752 _u
$e \cos v$	9.167210 _u	9.174251 _u	9.180027 _u	9.184598 _u	9.188004 _u	9.190276 _u
Diff	0.832790	0.825749	0.819973	0.815402	0.811996	0.809724
$1+e \cos v$	9.930969	9.929742	9.928720	9.927904	9.927282	9.926867
$a(1-e^2)$	0.393948	0.393948	0.393948	0.393948	0.393948	0.393948
$\log r$	0.462979	0.464206	0.465228	0.466044	0.466666	0.467081

Computing α and δ for the Ephemeris.

	Jan 21 24 ^h 33' 55" 247 30 2.0	Feb 22 250 25 11.2	Mar 10 253 19 37.4	Mar 26 256 13 29.2	Apr 11 259 6 56.0
$A'+V$	9.95 5724 _n	9.97 4131 _n	9.98 1346 _n	9.98 7326 _n	9.99 2116 _n
$\sin(A'+V)$	9.98 7170	9.98 7170	9.98 7170	9.98 7170	9.98 7170
α	0.46 4206	0.46 5228	0.46 6044	0.46 6666	0.46 7081
X	0.40 5873 _n	0.42 6529 _n	0.43 4560 _n	0.44 1162 _n	0.44 6367
$B'+V$	148° 14' 3" 0	154 5 19.2	156 59 45.4	159 53 37.2	162 47 41.0
$\sin(B'+V)$	9.72 1359	9.64 0461	9.59 19 50	9.53 6260	9.47 1244
$\sin \delta$	9.96 0448	9.96 0448	9.96 0448	9.96 0448	9.96 0448
α	0.46 2979	0.46 5228	0.46 6044	0.46 6666	0.46 7081
γ	0.14 4786	0.06 6137	0.01 8442	9.96 3374	9.89 8773
$C'+V$	181° 54' 37.5"	184 50 44.5	187 45 53.7	190 40 19.9	196 27 38.7
$\sin(C'+V)$	8.52 2925 _n	8.13 0684 _n	7.67 5022	7.26 7617 _n	6.75 0388 _n
$\sin e$	9.67 5022	9.67 5022	9.67 5022	9.67 5022	9.67 5022
α	0.46 2979	0.46 4206	0.46 5228	0.46 6044	0.46 6666
β	8.66 0926 _n	9.06 5744 _n	9.27 0934 _n	9.40 8683 _n	9.51 2076 _n
X	+0.50 4830	+0.72 2636	+0.88 3726	+0.97 6202	+0.99 3803
Y	-0.77 5068	-0.61 5830	-0.40 8367	-0.16 9052	+0.08 3190
Z	-0.33 6246	-0.26 7167	-0.17 7166	-0.07 3339	+0.03 6086
$\log X$	9.70 3145	9.85 8920	9.94 6316	9.98 9540	9.99 7300
$\log Y$	9.90 4025	9.85 9350	9.82 5446	9.80 6922	9.80 6273
$\log X$	0.40 5873 _n	0.41 6993 _n	0.42 6529 _n	0.43 4560 _n	0.44 1162 _n
$\log Y$	0.20 2728	0.55 8073	0.48 0213	0.44 4520	0.44 3862
$\log X + X$	0.30 9898 _n	0.27 6343 _n	0.25 1975 _n	0.24 1482 _n	0.24 7435 _n
					0.26 9251 _n

	Jan 21	Feb 6	Feb 22	Mar 10	Mar 26	Apr 11
$\log Y$	7.889340 _n	7.789461 _n	7.611051 _n	7.228020 _n	8.920071	9.577498
Table	7.903480	7.034127	7.812457	9.923234	7.037630	0.150955
$\log Y$	0.144786	0.107900	0.066137	0.018442	7.963374	7.898773
Diff	0.255446	0.318439	0.455086	0.790422	8.956697	9.618725
$\log(Y+Y)$	7.792820	7.823588	7.878594	7.941676	0.001004	0.049728
$\log Z$	7.526657 _n	7.442678 _n	7.248380 _n	8.865335 _n	8.557339	9.154825
Table	0.055466	0.157055	0.289900	0.109304	7.948909	9.803865
$\log Z$	8.660926 _n	7.065944 _n	7.270934 _n	9.408683 _n	7.512076 _n	9.594431 _n
Diff	9.134269	7.639161	9.977446	9.456652	0.954737	0.439612
$\log(Z+Z)$	7.582123 _n	7.583838 _n	7.560834 _n	7.577987	9.460985 _n	9.398302 _n
$\log(Y+Y)$	7.792820	7.823588	7.878594	7.941676	0.001004	0.049728
$\log(X+X)$	0.309878 _n	0.276343 _n	0.251975 _n	0.241482 _n	0.247435 _n	0.269257 _n
$\log X$	9.482922 _n	9.547245 _n	9.626619 _n	9.700194 _n	9.753569 _n	9.780477 _n
$\log(Z+Z)$	163 5 20.2	160 34 44.0	157 3 30.3	153 22 23.1	150 26 87.2	148 54 20.5
Diff	9.582123 _n	9.583838 _n	9.560834 _n	9.577987 _n	9.460985 _n	9.398302 _n
$\log(X+X)$	9.463723	9.521803	9.590833	9.651452	9.693041	9.713089
$\log(Y+Y)$	9.045846 _n	9.105641 _n	9.151667 _n	9.169439 _n	9.154026 _n	9.111391 _n
$\log(Y+Y)$	9.792820	9.823588	9.878594	9.941676	0.001004	0.049728
$\log(Y+Y)$	9.253026 _n	9.282053 _n	9.273073 _n	9.227763 _n	9.153022 _n	9.061663 _n
$\log(Y+Y)$	-10° 9' 8.9	-10 50 17.0	-10 37 17.0	-9 35 22.8	-8 5 43.6	-6 34 28.9
Code	9.980802 _n	9.974558 _n	9.964214 _n	9.951310 _n	9.939471 _n	9.932612 _n
Pair 8	9.582123 _n	9.583838 _n	9.560834 _n	9.577987 _n	9.460985 _n	9.398302 _n
Code	9.993146	9.992183	9.992494	9.993886	9.995651	9.997134
Pair 8	0.329096	0.301785	0.287761	0.290172	0.307964	0.336639
Code	0.325950	0.309602	0.295267	0.296286	0.312313	0.339505
Code	10° 52' 21.38	10° 42' 18.73	10° 28' 14.02	10° 13' 29.54	10° 1' 47.41	9° 55' 36.17