

KG

11366

v. 922

XLVI



Plate



1885

1889

1890

Harvard Lunar Plates

Measures and Reductions.

Mary Fowler.

Volume XLVI

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1
8.
10.2
21
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1885 Stars - Measures.

1913 Nov. 15.

1.

	d	N	d	N
1	15911	15633	16132	16396
8.6	1186760	9705	1328890	924928
10.5	60	9590	79	20
	97	50	00	08
	<u>10.4043</u>	<u>.4054</u>	<u>8.7164</u>	<u>.7183</u>
2	19962	14912	17808	14975
21.8	1351920	1136269	16090	667280
31.6	20	60	9090	80
	70	20	00	80
	<u>31.6447</u>	<u>.6449</u>	<u>21.8284</u>	<u>.8302</u>
3	18055	19410	17660	14664
24.3	908690	1838289	1024042	1206967
17.9	90	9189	32	65
	52	30	56	79
	<u>17.8963</u>	<u>.8975</u>	<u>24.2581</u>	<u>.2601</u>

Eradic 4.

	d	N	d	N
1	17255	15590	19120	16220
	1491909	796065	1633934	902025
	1509	50	35	20
	65	08	30	35
	<u>16.2343</u>	<u>.2354</u>	<u>7.7215</u>	<u>.7209</u>
	17808	19778	16910	18580
	1150810	1607577	1149490	1394755
	16	70	89	50
	05	80	04	79
	<u>27.6295</u>	<u>.6295</u>	<u>9.4584</u>	<u>.4629</u>

Remeasure

17873
1247976
7076
85
9.4596

1885 Stars - Measures

1913 Nov. 15.

1.

1	15911	15633
86	1186760	9705
10.5	60	95-90
	97	50
	<u>10.4043</u>	<u>4054</u>

16132	16396
1328890	928923
79	20
00	08
<u>8.7164</u>	<u>7183</u>

2	19962	14912
218	1351920	1136269
31.6	20	60
	70	20
	<u>31.6447</u>	<u>6449</u>

17808	14975
16090	667280
90	80
00	80
<u>21.8284</u>	<u>8302</u>

3	18055	19410
243	908690	1838289
179	90	91
	52	30
	<u>17.8963</u>	<u>8975</u>

17660	14664
10240	1206967
32	65
56	79
<u>24.2581</u>	<u>2601</u>

Grade 4.

17255	15590
1491909	796065
15	50
65	08
<u>16.2343</u>	<u>2354</u>

19120	16220
16339	902025
35	20
30	35
<u>7.7215</u>	<u>7.209</u>

17808	19778
1150810	1607577
16	70
05	80
<u>27.6295</u>	<u>6295</u>

16910	18580
1149490	1394755
89	50
04	79
<u>9.4584</u>	<u>4629</u>

Re-measure

17873
1247976
70
85
<u>9.4596</u>

1885 moon-measures.

2

	d	4	N	de	x	N
1	18437		19072			
18.0	15155	46	10400			
17.3	30		88	90		
	48		85			
	<u>17.1294</u>		<u>.1309</u>			

2 Scratch.

18.5	15375	19095	15630	17778
17.5	10377	14070	10031	13360
	85	67	25	60
	81	10	24	90
	<u>.4990</u>	<u>.4964</u>	<u>18.4399</u>	<u>.4422</u>

3

18.7			15911	17810
18.0			13500	10190
			10	94
			07	20
			<u>18.7595</u>	<u>.7624</u>

4

18.9			11596	11903
18.6			10698	05
max			00	00
x				11082

5 Scratch.

18.7	17516	15515	19261	16392
19.5	13085	9940	17184	8465
	89	40	95	68
	30	38	58	04
	<u>19.4438</u>	<u>.4414</u>	<u>18.7932</u>	<u>.7935</u>

6

18.5			18380	14780
20.0			13010	10128
			18	26
			88	88
			<u>18.4632</u>	<u>.4656</u>

1885- known-measures

	d	4	N	d	x	N
1	16437		19072			
18.0	15155	46	10900			
173	30		8890			
	48		85			
	<u>17.1294</u>		<u>1309</u>			

2 Scratch

18.5	15375	19095	15630	17778
17.5	10377	14070	10031	13360
	81	67	25	60
	81	10	24	90
	<u>.4990</u>	<u>.4964</u>	<u>18.4379</u>	<u>.4422</u>

3

187			15911	17810
18.0			13500	10190
			10	94
			07	20
			<u>18.7195</u>	<u>7624</u>

4

189			11590	11903
186			10698	05
max			00	00
				11082
			<u>18.9109</u>	<u>.9077</u>

5 Scratch

187	17516	11515	19261	16392
19.5	13085	9940	17184	8461
	89	40	95	68
	30	38	58	04
	<u>194438</u>	<u>4414</u>	<u>18.7932</u>	<u>7934</u>

6

18.5			18380	14780
20.0			13010	10128
			18	26
			88	58
			<u>18.4632</u>	<u>.4656</u>

1885

Moon - measures

3

	16428	19335
18.0	12454	13315
W.S.	6867	1905
	36	50
	<u>20.3961</u>	<u>.3969</u>

8	15474	19283
19.0	8783	15990
W.S.	8590	20
max	70	0.0
8	<u>20.6699</u>	<u>.6701</u>

1885

Moon - measures

d

y

r

d

-x

w

7

16428

19335

18.0

1245475

13315

w.s

6867

1905

36

50

20.39613969

8

15474

19283

19.0

8783

15990

w.s

8590

90

max

90

00

20.66796701

20

1885 Times etc.

Exh. to star 1912 July 2	21 ^h	00 ^m	-21 ^h	12 ^m
... moon	21	06	25.9 ^v	21 06 26.3 ^v
clock slow		1	39.7 ^v	
H.S.T.	21	08	05.8 ^v	
H. long	9	44	31.05 ^v	
G.S.T.	25	52	36.85 ^v	
Sid. T. u. h.	6	40	37.33 ^v	
Interval	19	11	59.52 ^v	
Reduction		3	08.73 ^v	
G.M.T.	19	08	50.79 ^v	$\theta - \alpha = -0^h 34^m 21^s$

From Hank Alm

moon 19 ^h	21 ^h	42 ^m	09.10 ^v	-18° 10' 22.8"
motion in 1 ^m 1.9247 ^v				11.110 ^v
... 8.8465 ^v			+ 17.03 ^v	+ 1 38.3 ^v
Tabular place	21	42	26.13 ^v	-18 08 44.5 ^v

Moon's age 18 days.

... parallax	59'	05.1 ^v
... semi-diam	14	45.9 ^v
R	=	885.9 ^v
Augmentation		+6.7 ^v
Irradiation		-0.8 ^v
R	=	891.8 ^v
R	=	1.9117 ^v
R	=	3.6546 ^v

934 = 7.4^v
886 = 6.7^v

$\alpha = +0.1$

1885

Trimes etc

Exhibition 19.2 July 2	21	00	-21	12
moon	21	06	25.9	21 06 26.3
clock slow		1	39.7	
H.S.T.	21	08	05.8	
Henry	9	44	31.01	
G.S.T.	25	52	36.85	
Sid T.W.	6	40	37.33	
Interval	19	11	59.52	
Reduction		3	08.73	
G.M.T.	19	08	50.79	$\theta - \alpha = -0^{\circ} 34' 21''$

From Hank Alm

moon 19

moon 19	21	42	09.10	-18	10	22.8
moon 1.9247				11.110		
8.8465		+	17.03		+	1 38.3
Tabular phase	21	42	26.13	-18	08	44.5

Moonage 18 days.

parallax	54	05.1
semidiam	14	45.9
R		885.9
Augmentation		+6.7
Indication		-0.8
R		891.8
R		1.9117
R		3.6546

934 - 7.4

886 - 6.7

$\alpha + 0.1$

1885

Plate Constants

5

	1	2	3
x :	8.7174	21.8293	29.2591
y	9.3344	22.2293	24.7994
$x-3$	-6170	-4000	-5403

y	10.4048	31.6448	17.8969
m	10.3680	31.7514	18.0177
$y-m$	+368	-1066	-1208

$x-3$	-102.24		$-1/2 + .14$		$+7233$
-6170	-1063	= -7233	-1	= +1	= -7233 = 0
-4000	-3234	= -7234	-2	= +3	= -7233 = 0
-5403	-1829	= -7232	-2	= +2	= -7232 = +1
17.0080	-1917		-2	+2	= 17.5396

$y-m$	+982		$+7.14$		-1297
+368	+854	= +1222	+74	= +1296	= -1
-1066	+2139	= +1073	+225	= +1298	= +1
-1208	+2377	= +1169	+127	= +1296	= -1
18.7621	+1667		+133		= 18.8124

Tables	$a = -4.0$	$e = -16.0$	$a-e = +9.0$	$b+a = +2.4$
Obs	$a = +0.1$	-71	+7.2	+4.1
C-U	-0.9	-2.9	+1.8	-1.7

1885

Phase Constants

5

	1	2	3
2:	8.7174	218293	24.2591
3	9.3344	222293	24.7994
2-3	-6170	-4000	-5403

y	10.4048	31.6448	17.8969
u	10.3680	31.7514	18.0177
y-u	+368	-1066	-1208

2-5	-10224	-12	+14	+7233		
-6170	-1063	-7233	-1	+1	-7233	= 0
-4000	-3234	-7234	-2	+3	-7233	= 0
-5403	-1829	-7232	-2	+2	-7232	= +1
17.0080	-1917	-2	+2	= 17.5394		

4-77	+982		+7,14		-1247	
+368	+854	=	+1222	+74	=+1296	=-1
-1066	+2139	=	+1073	+225	=+1298	=+1
-1208	+2377	=	+1169	+127	=+1296	=-1
18.7621	+1667		+133			=18.8124

Tables	a = -0.6	e = -9.6	a-e = +9.0	b-a = +2.0
Obs	a = +0.1	-71	+7.2	+4.1
C-U	-0.7	-2.5	+1.8	-2.1

pt.	pos. L	residual
1	148.4	-17
2	131.5	+16
3	113.5	+9
[4	90.0	
5	69.0	-92
6	49.5	+9
7	31.6	+47
8	0.0	-78

1885

Moon's Center

	x	$x - x_0$	Δx	$(x - x_0)^2$	$(x - x_0)^2 (y - y_0)^2$	$0 - c$
1	18.0000	+1.0000	+4	1.0000	3.6652	+1.06
2	18.4410	+1.4410	+3	2.0774	3.6764	+2.18
3	18.7610	+1.7610	+2	3.1018	3.6820	+2.74
+4	18.9093	+1.9093	0	3.6454	3.6454	- 92
5	18.7933	+1.7933	-2	3.2152	3.6806	+2.60
6	18.4644	+1.4644	-3	2.1436	3.6817	+2.71
7	18.0000	+1.0000	-4	0.9992	3.6790	+2.44
8	19.0000	+0.0000	-4	0.0000	3.6511	- 35
9						
				Comp R^2	3.6546	

	y	$y - y_0$	Δy	$(y - y_0)^2$
1	17.1302	-1.6308	-15	2.6644
2	17.4977	-1.2633	-12	1.5990
3	18.0000	-0.7610	-7	0.5802
4	18.7610	0.0000	0	0.0000
5	19.4426	+0.6816	+6	0.4659
6	20.0000	+1.2390	+12	1.5381
7	20.3965	+1.6355	+15	2.6799
8	20.6700	+1.9090	+18	3.6511

Approximate Center

$$\begin{aligned}
 x &= 18.0 & y &= 17.1302 \\
 & & & \underline{20.3965} \\
 & & & 37.5267 \\
 Y_0 &= 18.7634 \\
 y - \text{max} &= 20.6700 \\
 R &= 1.9066 \\
 y - \text{min} &= 18.9093 \\
 X_0 &= 17.0027
 \end{aligned}$$

$$\begin{aligned}
 y - \text{max} &= 20.6700 \\
 \text{Comp } R &= 1.9117 \\
 Y_0 &= 18.7583 \\
 x - \text{max} &= 18.9093 \\
 R &= 1.9117 \\
 X_0 &= 16.9976
 \end{aligned}$$

$$\text{Center } \begin{cases} X_0 = 17.0000 \\ Y_0 = 18.7610 \end{cases}$$

1885

Unknown Center

	x	$x - x_0$	Δx	$(x - x_0)^2$	$(x - x_0)(y - y_0)^2$	$y - y_0$
1	18.0000	+1.0000	+4	1.0000	3.6652	+1.06
2	18.4410	+1.4410	+3	2.0774	3.6764	+2.18
3	18.7610	+1.7610	+2	3.1018	3.6820	+2.74
+4	18.9093	+1.9093	0	3.6454	3.6454	- .92
5	18.7933	+1.7933	-2	3.2152	3.6806	+2.60
6	18.4644	+1.4644	-3	2.1436	3.6817	+2.71
7	18.0000	+1.0000	-4	0.9992	3.6790	+2.44
8	19.0000	+0.0000	-4	0.0000	3.6511	- .35
9				Compt R	3.6546	

	y	$y - y_0$	Δy	$(y - y_0)^2$
1	17.1302	-1.6308	-15	2.6644
2	17.4977	-1.2633	-12	1.5990
3	18.0000	-0.7610	-7	0.5802
4	18.7610	0.0000	0	0.0000
5	19.4426	+0.6816	+6	0.4659
6	20.0000	+1.2390	+12	1.5381
7	20.3965	+1.6355	+15	2.6794
8	20.6700	+1.9090	+18	3.6511

Approximate Center

$$x = 18.0 \quad y = 17.1302$$

$$20.3965$$

$$37.5267$$

$$y_0 = 18.7634$$

$$y - \text{max} = 20.6700$$

$$R = 1.9066$$

$$x - \text{max} = 18.9093$$

$$x_0 = 17.0027$$

$$y - \text{max} = 20.6700$$

$$\text{Compt R} = 1.9117$$

$$y_0 = 18.7583$$

$$x - \text{max} = 18.9093$$

$$R = 1.9117$$

$$x_0 = 16.9976$$

$$\text{Center } \begin{cases} x_0 = 17.0000 \\ y_0 = 18.7610 \end{cases}$$

Formation of normals

	ab	an	bn
1	- 1.63	+ 106.0	- 172.9
2	- 1.81	+ 314.0	- 274.6
3	- 1.34	+ 482.0	- 208.3
4			
5	+ 1.22	+ 465.5	+ 176.8
6	+ 1.81	+ 395.8	+ 336.0
7	+ 1.64	+ 244.0	+ 400.0
8	+ 0.00	- 0.0	- 66.9
	- 0.11	+ 2067.3	+ 240.3

1885

Moon's Center

7

Conditional Equations

	a	b	c	0-c
1	+ 1.00	- 1.63	= + 106	+ 160 - 37 = + 123 - 17
2	+ 1.44	- 1.26	= + 218	+ 231 - 29 = + 202 + 16
3	+ 1.76	- 0.76	= + 274	+ 282 - 17 = + 265 + 9
4	+ 1.91	+ 0.00	= - 92	(+ 306 - 0 = + 306 - 396)
5	+ 1.79	+ 0.68	= + 260	+ 287 + 15 = + 302 - 42
6	+ 1.46	+ 1.24	= + 271	+ 234 + 28 = + 262 + 9
7	+ 1.00	+ 1.64	= + 244	+ 160 + 37 = + 197 + 47
8	0.00	+ 1.91	= - 35	+ 0 + 43 = + 43 - 78

Average: 31

Normal Equation

$$\begin{aligned}
 &+ 12.59 - 0.11 = + 2007 \\
 &- 0.11 + 11.35 = + 240 \\
 &+ 0.11 - 0.00 = + 18 \\
 &\quad + 11.35 = + 258 \\
 &- 0.00 + 0.11 = + 2 \\
 &+ 12.54 = + 2009
 \end{aligned}$$

$$b = + 22.75$$

$$c = + 16.00$$

1885

Moon's Center Conditional Equations

7

	a	b	c	0-c
1	+ 1.00	- 1.63	+ 1.06	+ 1.60 - 37 = + 1.23 - 17
2	+ 1.44	- 1.26	+ 2.18	+ 2.31 - 29 = + 2.02 + 16
3	+ 1.76	- 0.76	+ 2.74	+ 2.82 - 17 = + 2.65 + 9
4	+ 1.91	+ 0.00	- 92	
5	+ 1.79	+ 0.68	+ 2.60	+ 2.87 + 15 = + 3.02 - 42
6	+ 1.46	+ 1.24	+ 2.71	+ 2.34 + 28 = + 2.62 + 9
7	+ 1.00	+ 1.64	+ 2.44	+ 1.60 + 37 = + 1.97 + 47
8	0.00	+ 1.91	- 35	+ 0 + 43 = + 43 - 78

Average = 31

Normal Equations

$$\begin{aligned}
 + 12.54 &= 0.11 : + 2007 \\
 - 0.11 &+ 11.35 = + 240 \\
 + 0.11 &= 0.00 : + 18 \\
 &+ 11.35 = + 258 \\
 - 0.00 &+ 0.11 : + 2 \\
 + 12.54 &= + 2009
 \end{aligned}$$

$$b = + 2275$$

$$c = + 160.0$$

1885 Moon's mean Position (1912.0)

$$\begin{array}{rcl}
 x_0 & = & 17.00000 \\
 \alpha & = & +80 \\
 \hline
 & & 17.0080
 \end{array}
 \qquad
 \begin{array}{rcl}
 y_0 & = & 18.7610 \\
 \delta & = & +11 \\
 \hline
 & & 18.7621
 \end{array}$$

From Plate Constants $X = 17.5394$ $Y = 18.8124$

$$\begin{array}{rcl}
 \xi & = & -0.4606 \\
 \log \xi & = & 9.66374 \\
 \cos \xi & = & 9.97585 \\
 \text{const} & = & 8.50729
 \end{array}$$

$$(\alpha - A) = 1.18005$$

$$\alpha - A = 15.14$$

$$A = 21^{\circ} 43' 05''$$

$$\alpha_0 = 21^{\circ} 42' 49.86''$$

$$\text{Red. app. place} = +2.53$$

$$\alpha' = 21^{\circ} 42' 52.39''$$

$$\eta = -3.1876$$

$$\begin{array}{rcl}
 \log \tan \delta & = & 9.5369 \\
 \tan \delta & = & 9.3266
 \end{array}$$

$$\begin{array}{rcl}
 \eta_1 & = & 59169 \\
 \eta_1 & = & 1
 \end{array}$$

$$\eta_0 = -3.1875$$

$$\begin{array}{rcl}
 \log \eta_0 & = & 0.50345 \\
 \text{const} & = & 7.33115
 \end{array}$$

$$(\delta - D) = 3.17230$$

$$\delta - D = 24' 47.0''$$

$$D = -18^{\circ} 31' 12''$$

$$\delta_0 = -18^{\circ} 55' 59.0''$$

$$\text{Red. app. place} = +8.9$$

$$\delta' = -18^{\circ} 55' 50.6''$$

1885 Moon's mean Position (1912.0)

8

$$Y_0 = 17.0000$$

$$Y_0 = 18.7610$$

$$+ 80$$

$$+ 11$$

$$17.0080$$

$$18.7621$$

Jupiter's constant $X = 17.5394$ $Y = 18.8124$

$$\xi = -0.4606$$

$$\eta = -3.1876$$

$$\log \xi = 9.66372$$

$$\log \tan \delta = 9.5369$$

$$\cos \delta = 9.97585$$

$$\log \tan \delta = 9.3266$$

$$\cos \delta = 8.50724$$

$$\eta_1 = 5.9169$$

$$(X - A) = 1.18005$$

$$\eta_1 = -$$

$$X - A = 15.14$$

$$\eta_0 = -3.1875$$

$$A = 21^{\circ} 43' 05''$$

$$\log \eta_0 = 0.50345$$

$$X_0 = 21^{\circ} 42' 49.86''$$

$$\cos \delta = 7.33115$$

$$\text{Red waff place} = 2.53$$

$$(X - D) = 3.18230$$

$$X' = 21^{\circ} 42' 52.39''$$

$$\delta - D = 24^{\circ} 43.0'$$

$$D = -18^{\circ} 31' 12''$$

$$\delta_0 = -18^{\circ} 55' 59.0''$$

$$\text{Red waff place} = 8.9$$

$$\delta' = -18^{\circ} 55' 50.6''$$

1885

Lunar Parallax

9

$$\begin{aligned}
 \alpha' &= 21^h 42^m 52.39^s \\
 \theta &= 21 \quad 08 \quad 05.8 \\
 \theta - \alpha &= -34 \quad 46.6 \\
 &= -8^\circ 41' 39''
 \end{aligned}$$

$$\delta' = -18^\circ 55' 50.6''$$

$$\pi = 54' 05.1''$$

$$\begin{aligned}
 \frac{1}{2}(\alpha - \alpha') &= - \quad 3 \quad 11 \\
 \frac{1}{2}(\alpha - \alpha') &= -8 \quad 38 \quad 28
 \end{aligned}$$

$$\begin{aligned}
 \log \cos \phi' &= 9.86913 \\
 \dots \sin \pi &= 8.19678 \\
 \dots (\theta - \alpha') &= 9.17944 \\
 \dots \cos \delta &= 9.97785 \\
 \dots \sin(\alpha - \alpha') &= 7.26750
 \end{aligned}$$

$$\alpha - \alpha' = -6' 21.88''$$

$$= -25.46''$$

$$\begin{aligned}
 \log \tan \phi' &= 9.95727 \\
 \dots \cos \frac{1}{2}(\alpha - \alpha') &= 0.00000 \\
 \dots \{ \sin - \frac{1}{2}(\alpha - \alpha') \} &= 9.99504 \\
 \dots \tan \phi &= 9.96223
 \end{aligned}$$

$$\gamma = 42^\circ 30' 41.1''$$

$$\delta' = -18 \quad 55 \quad 50.6$$

$$\gamma - \delta' = 61 \quad 26 \quad 31.7$$

$$\begin{aligned}
 \log \sin \phi' &= 9.82640 \\
 \dots \sin \pi &= 8.19678 \\
 \dots \sin(\gamma - \delta) &= 9.94366 \\
 \dots \sin \gamma &= 9.82978 \\
 \dots \sin(\alpha - \delta') &= 8.13706
 \end{aligned}$$

$$S - S' = +47 \quad 089$$

$$S = -18 \quad 08 \quad 42.5$$

$$\alpha = 21 \quad 42 \quad 26.93$$

$$\text{Ann Eph } S = -18 \quad 08 \quad 44.5$$

$$\alpha = 21^h 42 \quad 26.13$$

$$O - C \quad + \quad 2.0$$

$$+080$$

1885

Lunar Parallax

9

$$\begin{aligned}
 \alpha' &= 21 \quad 42 \quad 52.39'' \\
 \theta &= 21 \quad 08 \quad 05.8'' \\
 \theta - \alpha' &= -34 \quad 46.6'' \\
 &= -8^\circ 41' 39''
 \end{aligned}$$

$$S' = -18^\circ 55' 56.6''$$

$$\pi = 54' 05.1''$$

$$\begin{aligned}
 \frac{1}{2}(\alpha - \alpha') &= - \quad .3 \quad 1.1 \\
 2 - \frac{1}{2}(\alpha - \alpha') &= -8 \quad 38 \quad 28
 \end{aligned}$$

$$\begin{aligned}
 \log \cos \phi' & 9.96913 \\
 \log \pi & 8.19678 \\
 (\theta - \alpha') & 9.17949 \\
 \cos \delta & 9.97785 \\
 \sin(\alpha - \alpha') & 7.26750
 \end{aligned}$$

$$\alpha - \alpha' = -6' 21.88''$$

$$= -25.46''$$

$$\begin{aligned}
 \log \tan \phi' & 9.95727 \\
 \cos \frac{1}{2}(\alpha - \alpha') & 0.00000 \\
 \log \{t - \frac{1}{2}(\alpha - \alpha')\} & 9.99504 \\
 \tan \gamma & 9.96223
 \end{aligned}$$

$$\gamma = 42^\circ 30' 41.1''$$

$$S' = -18 \quad 55 \quad 56.6$$

$$\gamma - S' = 61 \quad 26 \quad 37.9$$

$$\begin{aligned}
 \log \sin \phi' & 9.82640 \\
 \log \pi & 8.19678 \\
 \sin(\gamma - S) & 9.94366 \\
 \sin \gamma & 9.82978 \\
 \sin(S - S') & 8.13706
 \end{aligned}$$

$$S - S' = +47 \quad 08.9$$

$$S = -18 \quad 08 \quad 47.8$$

$$\alpha = 21 \quad 42 \quad 26.93''$$

$$\text{Ann Eph } S = -18 \quad 08 \quad 44.5''$$

$$\alpha = 21^\circ 42' 26.13''$$

$$O - C = +2.0''$$

$$+0.80''$$

1
11.3
24.1

2
11.7
11.2

3
27
15

1889

Star - Measur

1913 Nov. 17

10

	d	N
1	13330	7231
11.3	1278277	3940
24.1	73	6674
	<u>240553</u>	<u>0565</u>
2		
11.7	15794	19786
11.2	1402629	1155050
	30	49
	00	90
	<u>11.1767</u>	<u>1761</u>
3		
27.3	11179	1124350
15.1	1066265	55
	60	10735
	<u>150517</u>	<u>0514</u>

	d	N
	16134	14600
	869498	1203027
	9698	30
	30	00
	<u>11.2565</u>	<u>2571</u>
	16357	19145
	13660	1183031
	5558	3531
	40	45
	<u>11.7306</u>	<u>7313</u>
	15595	18078
	8106	1551215
	1010	2015
	85	82
	<u>27.2521</u>	<u>2563</u>

Grade 4.

Re-measure

d
17715
1024039
45
03
<u>27.2535</u>

1
11.3
241

3
11.7
11.2

3
27
11

1889

Star - measure

1912 Nov 17

10

	d	N
1	13330	7231
11.3	12782	39 ⁴⁰
241	73	6674

2905530563

	d	N
11.7	15794	19786
112	14026	11550 ⁵⁰
	30	49
	00	90

1117671761

	d	N
3	11179	11243 ⁵⁰
273	10662	55 ⁵⁰
151	60	10735

1505170514

	d	N
16134	14600	
869498	1203027	
96	30	
30	00	

1125652571

	d	N
16357	19145	
13660	1183031	
55 ⁵⁸	35 ³¹	
40	45	

1173067313

	d	N
15195	15078	
8106	15512 ¹⁵	
10 ¹⁰	20	
85	82	

2725212563

Grade 4. Re-measure

d

17715
1024039
45
03

272535

1
19.
17.

2
19.
16.

3
20.
18.

4
20.
19.
18.
17.
16.

5
20.
19.
18.

6
19.
20.

1889

Moon - measures

11

d	N	d	N
Scratch			
19.5 19694	17427	18750	17702
17.5 14350	12755	14248	12210
52	55	4342	0990
95	21	50	04
<u>17.5345</u>	<u>.5332</u>	<u>19.5494</u>	<u>.5500</u>
2			
19.9		13900	12389
18.0		13600	81
		00	10
		<u>19.9703</u>	<u>12139</u>
			<u>19.9756</u>

d	N	d	N
Scratch			
20.2 17920	14845	18731	16369
18.5 12870	9878	10776	14340
81	80	7670	2932
26	41	30	60
<u>18.5046</u>	<u>.5035</u>	<u>20.2044</u>	<u>.2033</u>

d	N	d	N
203			
90		16981	15292
max		9715	12560
2		1111	4652
5		76	96
20.01		<u>20.2735</u>	<u>.2740</u>
20.0			
		12340	11230
		50	50
		12065	10940
		<u>20.0282</u>	<u>.0287</u>

d	N	d	N
19.0 15500	19548		
20.8 6998	18070		
89	65		
07	50		
<u>20.8517</u>	<u>.8517</u>		

1
19
17
2
19
18
3
20
18
4
20
19
2
19
2
19
20
2
19
20

1889

Moon - dimensions

d

N

d

N

1 scratch

12.5	19694	17427
17.5	14350	12755
	52	55
	95	21
	<u>17.5345</u>	<u>5332</u>

2
199
18.0

187150	17702
14248	12210
4342	90
50	09
	04
<u>19.5494</u>	<u>5500</u>
13900	12389
13600	80
00	81
	12139
<u>19.9703</u>	<u>1497156</u>

3 scratch

20.2	17920	14845
18.5	12870	9878
	79	75
	81	80
	26	41
	<u>18.5046</u>	<u>5035</u>

4
203
90
100
12
15
20.0
20.0

18731	16369
10776	14340
7670	2932
30	60
<u>20.2044</u>	<u>2033</u>
16981	15292
9715	12560
11	52
76	46
<u>20.2735</u>	<u>2740</u>
12340	11230
50	50
12065	10940
	49
<u>20.0282</u>	<u>0287</u>

6

19.0	15500	19848
20.8	6998	18070
	80	60
	89	65
	07	50
	<u>20.8517</u>	<u>18517</u>

7
18
20
10
Sp
E.
no

1889 Moon-Measures

12

$$\alpha \quad \gamma \quad \nu \quad \alpha \quad x \quad \nu$$

$$\begin{array}{r} 7 \\ 18.3 \\ 20.9 \\ 18.3 \\ 20.9 \\ 18.3 \\ 20.9 \end{array} \quad \begin{array}{r} 924349 \\ 53 \\ 8880 \end{array} \quad \begin{array}{r} 15092 \\ 1472619 \\ 0919 \end{array}$$

$$\begin{array}{r} 209632 \\ 19626 \end{array}$$

$$\begin{array}{r} 8.0 \\ 20.9 \end{array} \quad \begin{array}{r} 860910 \\ 10 \\ 7891 \end{array} \quad \begin{array}{r} 14090 \\ 13371-75- \\ 65-75- \end{array}$$

$$\begin{array}{r} 20.9281 \\ 9280 \end{array}$$

$$x = 20.0 \quad y = 20.0437$$

$$y = 18.0452$$

1889. *Uncon. measures*

12

 α γ ν d x w

<u>7</u>		
183	9243	15092
09	53	14726
		09
	8880	

<u>209632</u>	<u>9626</u>
---------------	-------------

8	860910	14090
80	10	13371
09	7891	65

<u>20.9281</u>	<u>9280</u>
----------------	-------------

 $x = 20.0$ $\gamma = 20.0437$
 $\gamma = 18.0452$

1889	Times etc.						
Epistemon	1912 July 3, 21 ^h	36 ^m			- 21 ^h	48 ^m	
moon	21	41	59.4 ^v	- 21	41	59.6 ^v	
clock slow		1	38.9 ^v				
H. Sid T.	21	43	38.4 ^v				
H. Long	4	44	31.05 ^v				
G. Sid T.	26	28	09.45 ^v				
S.T. in Moon	6	44	33.89 ^v				
Interval	19	43	35.56 ^v				
Reduction		3	13.90 ^v				
G. M. T.	19	40	21.66 ^v	- X = - 0 ^h	45 ^m		

Iron Point Alin	R. A.	Decl.				
Moon 20 ^h	22 ^h	29 ^m	12.25 ^v	- 13 ^o	11'	46 ^m
Motion in ^m = 1.8450 ^v			12.693 ^v			
- 19.639 ^v			- 36.23 ^v	- 4	09.3 ^v	
Tabular place	22	28	36.02 ^v	- 13	15	55.4 ^v

Moon's age	19 days		
parallax	54'	18.3 ^v	
semidiameter	14	49.5 ^v	
874 8.6	R	889.5 ^v	
890 7.8	Augmentation	+ 7.8 ^v	
	Irradiation (a)	- 0.8 ^v	
	R	896.5 ^v	
	R	1.9218 ^v	
a = + 0.5	(a+1) R =	1.9219 ^v	
	R ² =	3.6937 ^v	

1889 Tinner etc
 Ephemeris 1912 July 3, 21^h 36^m - 21^h 48^m
 Moon 21 41 59.4 - 21 41 59.6
 clock slow 1 389

H. Sid. T. 21 43 38.4
 H. Long 4 44 31.05
 G. Sid. T. 26 28 09.45
 ST in Moon 6 44 33.89
 Indirect 19 43 35.56
 Reduction 3 13.90
 G. M. T. 19 40 21.66 $\theta - \alpha = -0^{\circ} 45''$

From Transit Alen R. G. clock
 Moon 20^h 22^m 29^s 12.25 - 13^h 11' 46"1
 motion in 1^m 1.8450 12.693
 19.639 - 36.23 - 4 09.3
 Tabular place 22 28 36.02 - 13 1.5 55.4

Moon's age 19 days

parallax 54' 18"3
 semidiameter 14 49.5
 R 889.5
 894 8.6
 890 7.8
 Augmentation + 7.8
 irradiation (4) - 0.8
 R 896.5
 R 1.9218
 $\alpha = +0.5$ (a + 1) 10⁻ 1.9219
 R² 36937

1889

Plate Constants

x	y	RA	$Decl.$
11.2568	24.0558	22 25 19 -13	21 57
11.7310	11.1764	25 34 -15	02 10
27.2546	15.0516	33 53 -14	31 30
3 50.24	50.28	83 10 6	54 97
16.75	1676	22 28 15 -14	18 32
-1800	-22	+ 39	+40 44
1.25	524	22 28 54 -13	37 48
31	466 $\frac{1}{2}$		
39 ^s	2444"		

$$= 40' 44''$$

$$A = 22^h 28^m 54^s$$

$$D = -13^\circ 37' 48''$$

2-3	-34.54	-0.5x	+1094
-257	-830	-6	= -1093
-702	-386	-6	= -1094
-561	-519	-14	= -1094
18.3582 ^v	-657 ^v	-9 ^v	-184010 ^v

4-m	+34x	+9.14	+1.1x	-904
+301	+383	+684	+219	= +903
+401	+399	+800	+102	= +902
-163	+927 ^v	+764	+137	= +901
19.0412 ^v	+624 ^v	+173 ^v	+2 ^v	= 19.0307 ^v

Taken	$a = -0.8$	$e = -7.3$	$a - e = +6.5$	$b + a = +2.1$
Obs	$a = +0.5$	$e = -9.1$	$a - e = +9.6$	$b + a = +0.4$
C-O	-1.3	+1.8	$a - e = -3.1$	$b + a = +1.7$

1889

Plate Constants

14

α	δ	K.C.	Red.
11.2568	240558	22 25 19 -13	21 57
11.7310	111764	25 34 -15	02 10
27.2546	150516	33 53 -14	31 30
35024	5028	83 106	54 97
16.75	1676	22 28 15 -14	18 32
1800	-22	+ 39	+40 44
125	524	22 28 54 -13	37 48
31	466		
39 ^s	2944"	A = 22 ^h 28 ^m 59 ^s	
	40' 44"	D = -13° 37' 48"	

$$\begin{array}{rcl}
 2-3 & -34.54 & -0.5x \\
 -257 & -830 & = -1087 - 6 = -1093 \\
 -702 & -386 & = -1088 - 6 = -1094 \\
 -561 & -519 & = -1080 - 14 = -1094 \\
 18.3582 & -657 & -9 = -18.4010
 \end{array}$$

$$\begin{array}{rcl}
 4-m & +34x & +91y \\
 +301 & +383 & = +684 +219 = +903 +1 = +904 = 0 \\
 +401 & +399 & = +800 +102 = +902 +1 = +903 = -1 \\
 -163 & +927 & = +764 +137 = +901 +3 = +904 = 0 \\
 19.0412 & +624 & +173 +2 = 19.0307
 \end{array}$$

$$\begin{array}{l}
 \text{Tables } a = -0.8 \quad e = -7.3 \quad a-e = +6.5 \quad b+a = +2.1 \\
 \text{Obs } a = +0.5 \quad e = -9.1 \quad a-e = +9.6 \quad b+d = +0.4 \\
 c-u = -1.3 \quad +1.8 \quad a-e = -3.1 \quad b+a = +1.7
 \end{array}$$

1889

Standard Coordinates

15

Cape W. 3124 mag 6.2				Cape W. 3125 mag 6.1				Cape W. 3142 mag 7.9			
C	22 ⁿ	24 ^m	40.74	22 ⁿ	24 ^m	55.84		22 ⁿ	33 ^m	14.65	
L			72			87				62	
E			81			83				64	
mean	22	24	40.76	22	24	55.85		22	33	14.64	
Proc			+38.52			+38.60				+38.40	
K	22	25	1928	22	25	3445		22	33	5304	
A	22	28	54	22	28	54		22	28	54	
S-A	-	3	34.72	-	3	29.55		+	4	59.04	
subd-H)			-214.71			-199.54				+299.02	
log			2.33185			2.30003				2.47570	
cos S			9.98807			9.98487				9.98590	
-S ₀			0.82716			0.79214				0.96884	
S ₀			-6.7167			-6.1964				+9.3076	
S ₁			-			-				+	
S ₂			11.2825			11.8012				27.3107	
S ₃			11.2568			11.7310				27.2546	
S ₄			-			-				-	
			257			702				561	
C	-13°	25'	37.5	-15°	05'	49.7		-14°	35'	13.2	
L			37.6			49.0				13.1	
E			37.9			49.1				13.6	
mean	-13	25	37.7	-15	05	49.3		-14	35	13.3	
Proc			+3			+3				+3	
S	-13	21	57.4	-15	02	09.5		-14	31	29.6	
D	-13	37	48	-13	37	48		-13	37	48	
S-D			+15			-1				53	
			50.6			21.5				41.6	
tan(S-D)			+9.50.6			-50.62.5				-3221.9	
log			2.97800			3.70436				3.50812	
γ ₀			0.30915			1.03551				0.83927	
tan S			9.3758			9.4291				9.4134	
S ₂			16543			15843				19377	
γ ₁			80835			80668				84045	
γ ₀			+20378			-10.8520				-6.9067	
γ ₁			-			-				254	
γ ₂			24.0257			11.1363				15.0679	
γ ₃			24.0558			11.1764				15.0516	
γ ₄			+301			+401				-163	

1889

Standard Coordinates

15

Cape W. 3124 mag 6.2				Cape W. 3125 mag 6.1				Cape W. 3142 mag 7.9			
C	22	24	40.74	22	24	55.84		22	33	14.65	
L			72			87				62	
E			81			83				64	
Mean	22	24	40.76	22	24	55.85		22	33	14.64	
Proc			+38.52			+38.60				+38.40	
A	22	25	19.28	22	25	34.45		22	33	53.04	
A	22	28	54	22	28	54		22	28	54	
d-A	-	3	34.72	-	3	29.55		+	4	59.04	
sin(A-A)			-214.71			-199.54				+299.02	
log			2.331855m			2.30003m				2.47570	
cos			9.98807			9.98487				9.98590	
tan			0.82716m			0.79214m				0.96884	
tan			-6.7167			-6.1964				+9.3076	
tan			8			24				31	
tan			11.2825			11.8012				27.3107	
tan			11.2568			11.7310				27.2546	
tan			-257			-702				-561	
C	-13°	25'	37.5"	-15°	05'	49.7"		-14°	35'	13.2"	
L			37.6			49.0				13.1	
E			37.9			49.1				13.6	
Mean	-13	25	37.7	-15	05	49.3		-14	35	13.3	
Proc			+3			+3				+3	
S	-13	21	57.4	-15	02	09.5		-14	31	29.6	
D	-13	37	48	-13	37	48		-13	37	48	
D			+15			21.5				53	
tan(A-A)			+950.6			-5062.5				-32219	
log			2.97800			3.70436m				3.50812m	
log			0.30915			1.03551m				0.83927m	
tan			9.3758m			9.4291m				9.4134m	
tan			16543			15843				19377	
tan			8.0835m			8.0668m				8.4045m	
tan			+20378			-10.8520				-6.9067	
tan			-121			117				254	
tan			24.0257			11.1363				15.0679	
tan			24.0558			11.1764				15.0516	
tan			+301			+401				-163	

pt.	pos. C	residual
1	141.5	+20
2	123.0	0
3	106.3	+17
4	91.3	-227
5	60.2	+153
6	19.6	-4
7	0.0	+39
8	349.3	-6

1889

Miron's Center

16

	x	$x - x_0$	Δx	$(x - x_0)^2$	$(x - x_0)^2 + (y - y_0)^2$	$\Delta - c$
1	19.5497	+1.7944	+3	1.4273	3.7122	+1.85
2	19.9730	+1.6177	+2	2.6176	3.7098	+1.61
3	20.2038	+1.8485	+1	3.4173	3.7097	+1.60
4	20.2738	+1.9185	+0	3.6806	3.6825	-1.12
5	20.0284	+1.6731	-2	2.7986	3.7127	+1.90
6	19.0000	+0.6447	-4	0.4151	3.6854	-0.83
7	18.3553	0.0000	-4	0.0000	3.6853	-0.84
8	18.0000	-0.3553	-4	0.1265	3.6790	-1.47

Comp R^2 3.6937

	y	$y - y_0$	Δy	$(y - y_0)^2$
1	17.5338	-1.5106	-10	2.2849
2	18.0000	-1.0444	-7	1.0922
3	18.5040	-0.5404	-3	0.2924
4	19.0000	-0.0444	0	0.0019
5	20.0000	+0.9556	+6	0.9141
6	20.8517	+1.8073	+11	3.2703
7	20.9629	+1.9185	+12	3.6853
8	20.9260	+1.8836	+12	3.5525

$$x = 20 \quad y = 20.0437$$

$$18.0452$$

$$38.0889$$

$$y_0 = 19.0444$$

$$y_{\text{max}} = 20.9629$$

$$R = 1.9185$$

$$x_{\text{max}} = 20.2738$$

$$y_0 = 18.3553$$

$$\text{Center } \left\{ \begin{array}{l} x_0 = 18.3553 \\ y_0 = 19.0444 \end{array} \right.$$

1889

Miron's Center

16

	x	$x - x_0$	Δx	$(x - x_0)^2$	$(x - x_0)^2 (y - y_0)^2$	Δy
1	19.5497	+1.7944	+3	1.4273	3.7122	+1.85
2	19.9730	+1.6177	+2	2.6176	3.7098	+1.61
3	20.2038	+1.8485	+1	3.4173	3.7097	+1.60
4	20.2738	+1.9185	+0	3.6806	3.6825	-1.12
5	20.0284	+1.6731	-2	2.7986	3.7127	+1.90
6	19.0000	+0.6447	-4	0.4151	3.6859	-0.83
7	18.3553	0.0000	-4	0.0000	3.6853	-0.84
8	18.0000	-0.3553	-4	0.1265	3.6790	-1.47

Comp. R. 3.6937

	y	$y - y_0$	Δy	$(y - y_0)^2$
1	17.5338	-1.5106	-10	2.2849
2	18.0000	-1.0444	-7	1.0922
3	18.5040	-0.5404	-3	0.2924
4	19.0000	-0.0444	-0	0.0019
5	20.0000	+0.9556	+6	0.9141
6	20.8517	+1.8073	+11	3.2703
7	20.9629	+1.9185	+12	3.6853
8	20.9280	+1.8836	+12	3.5525

$$\begin{aligned}
 x &= 20 & y &= 20.0437 \\
 & & & \underline{18.0452} \\
 & & & 38.0889 \\
 Y_0 &= 19.0444 \\
 y - \text{max} &= 20.9629 \\
 R &= 1.9185 \\
 x - \text{max} &= 20.2738 \\
 Y_0 &= 18.3553
 \end{aligned}$$

$$\begin{aligned}
 \text{Center } \left\{ \begin{aligned} X_0 &= 18.3553 \\ Y_0 &= 19.0444 \end{aligned} \right.
 \end{aligned}$$

Formation of normals

ab

an

bin

1	- 1.80	+ 220.2	- 279.4
2	- 1.68	+ 260.8	- 167.4
3	- 1.00	+ 296.0	- 86.4
4	- 0.02	- 53.8	+ 11
5	+ 0.40	+ 79.8	+ 45.6
6	+ 1.16	- 53.1	- 150.2
7	+ 0.00	- 0.0	- 161.3
8	- 0.68	+ 52.9	- 276.4
	- 2.26	+ 802.8	- 1074.4

1889

Woods Center Conditional Equations

17

	a	b	0		c	0-c
1	+1.19	-1.51	= +1.85	+	69 + 96	= +165 +20
2	+1.62	-1.04	= +1.61	+	95 + 66	= +161 0
3	+1.85	-0.54	= +1.60	+	108 + 35	= +143 +17
4	+1.92	-0.04	= -1.12	+	112 + 3	= +115 -227
5	+1.67	+0.96	= -1.90	+	98 - 61	= +37 +153
6	+0.64	+1.81	= -83	+	37 - 116	= -79 -4
7	+0.00	+1.92	= -84	+	0 - 123	= -123 +39
8	-0.36	+1.88	= -1.47	+	21 - 120	= -141 -6

Average = 58

Normal Equations

$$+ 1.24 - 2.26 = + 803$$

$$- 2.26 + 14.64 = -1074$$

$$+ 2.26 - 0.45 = + 167$$

$$+ 14.19 = - 907$$

$$- 0.35 + 2.26 = - 166$$

$$+ 10.89 = + 637$$

$$b = -64.0$$

$$a = +58.5$$

1889

Hoovers Center Conditional Equations

17

	a	b	0	c	0-c
1	+119	-101	= +185	+69 + 96	= +165 +20
2	+162	-104	= -161	+95 + 66	= -161 0
3	+185	-059	= +160	+108 + 35	= +143 +17
4	+192	-004	= -112	+112 + 3	= +115 -227
5	+167	+096	= +190	+98 - 61	= +37 +103
6	+064	+181	= -83	+37 - 116	= -79 -4
7	+000	+192	= -69	+0 - 123	= -122 +39
8	-036	+188	= -147	+21 - 120	= -141 -6

Average = 58

Normal Equations

$$\begin{aligned}
 +1129 - 226 &= +803 \\
 -226 + 1464 &= -1074 \\
 +226 - 045 &= +167 \\
 +1419 &= -907 \\
 -035 + 226 &= -166 \\
 +1089 &= +637
 \end{aligned}$$

$$b = -640$$

$$c = +585$$

1889 Moon's mean Position (1912.0)

18

$$\begin{array}{rcl}
 X_0 & = & 18.3553^\circ \\
 Y_0 & = & 19.0444^\circ \\
 \text{cor} & = & +29^\circ \quad \text{sub} = -32^\circ \\
 \hline
 & & 18.3582^\circ \quad 19.0412^\circ
 \end{array}$$

From Plate Constants $X = 18.4010^\circ$ $Y = 19.0307^\circ$

$$\begin{array}{rcl}
 \xi & = & +0.4010^\circ \\
 \log \xi & = & 9.60314^\circ \\
 \log \xi & = & 9.98687^\circ \\
 \log \xi & = & 8.50724^\circ \\
 (\xi-4) & = & 110903^\circ
 \end{array}$$

$$\alpha - \alpha = +12.85^\circ$$

$$A \quad 22 \quad 28 \quad 54^\circ$$

$$\alpha_0 \quad 22 \quad 29 \quad 06.85^\circ$$

$$\text{Red} = +2.24$$

$$\alpha' = 22 \quad 29 \quad 09.09^\circ$$

$$\eta = -2.9693^\circ$$

$$\begin{array}{rcl}
 \log \tan \delta & = & 9.3941^\circ \\
 \log \tan \delta & = & 9.2063^\circ \\
 \log \tan \delta & = & 5.6538^\circ \\
 \log \tan \delta & = & -1^\circ
 \end{array}$$

$$\eta_0 = -2.9692^\circ$$

$$\begin{array}{rcl}
 \log \eta_0 & = & 0.47264^\circ \\
 \log \eta_0 & = & 7.3311^\circ
 \end{array}$$

$$(\eta-0) \quad 3.14149^\circ$$

$$\delta - 0 = 23 \quad 05.1^\circ$$

$$D = -13 \quad 37 \quad 48^\circ$$

$$S_0 = -14^\circ \quad 00' \quad 53.1''^\circ$$

$$\text{Red} = +10.3$$

$$\delta' = -14 \quad 00 \quad 42.8^\circ$$

1889 Moon's mean Position (1912.0)

18

$$\begin{array}{r}
 X_0 = 18.3553 \quad Y_0 = 19.0444 \\
 + 29 \quad + 32 \\
 \hline
 18.3582 \quad 19.0412
 \end{array}$$

From Plate Constant $X = 18.4010 \quad Y = 19.0307$

$$\begin{array}{r}
 \delta = +0.4010 \\
 \log \delta = 9.60314 \\
 \text{mag} = 9.98687 \\
 \text{mag} = 8.50724 \\
 (\delta - 4) = 110903
 \end{array}$$

$$x - 4 = +12.85$$

$$A = 22 \quad 28 \quad 54$$

$$\alpha = 22 \quad 29 \quad 06.85$$

$$\text{Red} = +224$$

$$\alpha' = 22 \quad 29 \quad 09.09$$

$$y = -2.9693$$

$$\begin{array}{r}
 \log \tan \delta = 9.3941 \\
 \delta = 92.063 \\
 \gamma = 5.6538 \\
 \gamma = -1
 \end{array}$$

$$m_0 = -2.9692$$

$$\begin{array}{r}
 \log m_0 = 0.47264 \\
 \text{mag} = 7.33115
 \end{array}$$

$$(\delta - 0) = 3.14149$$

$$\delta - 0 = 23 \quad 05.1$$

$$1) = -13 \quad 37 \quad 48$$

$$S_0 = -14^\circ \quad 00' \quad 53.1''$$

$$\text{Red} = +103$$

$$\delta = -14 \quad 00 \quad 42.8$$

1889 Red. to Apparent Place.

19

$$\begin{aligned}
 \alpha_0 &= 22^h 29^m 06.85^s \\
 G &= 21 \quad 01 \quad 18^s \\
 G + \alpha_0 &= 19 \quad 30 \quad 25^s \\
 &= 2920 \quad 36'
 \end{aligned}$$

$$\begin{aligned}
 \delta_0 &= -14^\circ 00' 53.1'' \\
 H &= 11^h 16^m 30.5^s \\
 H + \alpha_0 &= 9 \quad 45 \quad 36^s \\
 &= 146 \quad 29'
 \end{aligned}$$

$$\begin{aligned}
 \log i_s &= 8.8239^v \\
 \log g &= 1.0718 \\
 \sin(G + \alpha_0) &= 9.9653^m \\
 \tan S_0 &= 9.3973^m \\
 (g) &= 9.2583
 \end{aligned}$$

$$\begin{aligned}
 \log i_s &= 8.8239^v \\
 \log h &= 1.3096^v \\
 \sin(H + \alpha_0) &= 9.7430 \\
 \sec S_0 &= 0.0131 \\
 (h) &= 9.8896
 \end{aligned}$$

$$\begin{aligned}
 \log g &= 1.0718 \\
 \cos(G + \alpha_0) &= 9.5847^v \\
 (g') &= 0.6565
 \end{aligned}$$

$$\begin{aligned}
 \log h &= 1.3096^v \\
 \cos(H + \alpha_0) &= 9.9206^m \\
 \sin S_0 &= 9.3842^m \\
 (h') &= 0.6144
 \end{aligned}$$

$$\begin{aligned}
 f &+ 1.28 \\
 (g) &+ 0.18 \\
 (h) &+ 0.78 \\
 \text{Red in } \alpha &= +2.24
 \end{aligned}$$

$$\begin{aligned}
 (g') &+ 4.53 \\
 (h') &+ 4.12 \\
 (i) &+ 1.62 \\
 \text{Red in } \delta &= +10.27
 \end{aligned}$$

$$\alpha' = 22^h 29^m 09.09^s$$

$$\delta' = -14^\circ 00' 42.8''$$

1889

Red. to Apparent Place.

17

$$\begin{aligned}
 \alpha_0 &= 22^h 29^m 06.85^s \\
 \delta &= 21^\circ 01' 18'' \\
 G + \alpha_0 &= 19 \quad 30 \quad 25'' \\
 &= 292^\circ 36'
 \end{aligned}$$

$$\begin{aligned}
 \delta_0 &= -14^\circ 00' 53.1'' \\
 H &= 11^h 16^m 30.82^s \\
 H + \lambda &= 9 \quad 45 \quad 36'' \\
 &= 146^\circ 24'
 \end{aligned}$$

$$\begin{aligned}
 \log \frac{1}{r} &= 8.8239 \\
 \log \rho &= 1.0718 \\
 \sin(G + \alpha_0) &= 9.9653 \\
 \tan \delta_0 &= 9.3973 \\
 (g) &= 92583
 \end{aligned}$$

$$\begin{aligned}
 \log \frac{1}{r} &= 8.8239 \\
 \log h &= 1.3096 \\
 \sin(H + \lambda) &= 9.7430 \\
 \sec \delta_0 &= 0.0131 \\
 (h) &= 98896
 \end{aligned}$$

$$\begin{aligned}
 \log g &= 1.0718 \\
 \cos(G + \alpha_0) &= 9.1547 \\
 (g') &= 0.6565
 \end{aligned}$$

$$\begin{aligned}
 \log h &= 1.3096 & \log i &= 0.2229 \\
 \cos(H + \lambda) &= 9.9206 & \cos \delta_0 &= 9.9869 \\
 \sin \delta_0 &= 9.3842 & (i) &= 0.2098 \\
 (h') &= 0.6144
 \end{aligned}$$

$$\begin{aligned}
 f &+ 1.28 \\
 (g) &+ 0.18 \\
 (h) &+ 0.78 \\
 \text{Red. } \alpha &= + 2.24
 \end{aligned}$$

$$\begin{aligned}
 (g') &+ 4.53 \\
 (h') &+ 4.12 \\
 (i) &+ 1.63 \\
 \text{Red. } \delta &= + 10.27
 \end{aligned}$$

$$\alpha' = 22^h 29^m 09.09^s \quad \delta' = -14^\circ 00' 42.8''$$

1889

Lunar Parallax,

20

$$\begin{aligned} \alpha' &= 22^h 29^m 09^s 09'' \\ \delta &= 21 \quad 43 \quad 38.4'' \\ \delta - \alpha' &= -0 \quad 45 \quad 30.7'' \\ &= - \quad 11 \quad 22 \quad 40'' \end{aligned}$$

$$\frac{1}{2}(\alpha - \alpha') = - \quad 4 \quad 04$$

$$t - \frac{1}{2}(\alpha - \alpha') = -11 \quad 18 \quad 36''$$

$$\begin{aligned} \log \tan \phi' &= 9.95727 \\ \therefore \cos \frac{1}{2}(\alpha - \alpha') &= 0.000000 \\ - \therefore \cos \left(t - \frac{1}{2}(\alpha - \alpha') \right) &= 9.99148'' \\ \therefore \tan \gamma &= 9.96579 \end{aligned}$$

$$\gamma = -142 \quad 44 \quad 44.0''$$

$$\delta' = -14 \quad 00 \quad 42.8''$$

$$\gamma - \delta' = 56 \quad 45 \quad 26.8''$$

$$\begin{aligned} \log \sin \phi' &= 9.82640'' \\ \therefore \sin \pi &= 8.19855'' \\ \therefore \sin (\gamma - \delta') &= 9.92239'' \\ - \therefore \sin \gamma &= 9.83171'' \\ \therefore \sin (\alpha - \alpha') &= 8.11563'' \end{aligned}$$

$$\delta - \delta' = + \quad 44 \quad 52.0''$$

$$\delta = -13 \quad 15 \quad 50.8''$$

$$\delta' = -14 \quad 00 \quad 42.8''$$

$$\pi = 54' \quad 18.3''$$

$$\begin{aligned} \log \sec \phi' &= 9.86913'' \\ \therefore \sin \pi &= 8.19855'' \\ \therefore \sin t &= 9.29508'' \\ - \therefore \cos \delta &= 9.98825'' \\ \therefore \sin (\alpha - \alpha') &= 7.37451'' \end{aligned}$$

$$\alpha - \alpha' = - \quad 8 \quad 08.58''$$

$$= - \quad 32.57''$$

$$\text{Ann Eph } \delta = -13 \quad 15 \quad 55.4''$$

$$\alpha = 22 \quad 28 \quad 36.52''$$

$$\alpha = 22^h 28 \quad 36.02''$$

$$O - C \quad + \quad 4.6''$$

$$+ 0.50''$$

1889

Lunar Parallax.

20

$$\alpha' = 22^h 29^m 09^s.09$$

$$\delta = 21 \quad 43 \quad 38.4$$

$$\delta - \alpha' = -0 \quad 45 \quad 30.7$$

$$= - \quad 11 \quad 22 \quad 40''$$

$$\frac{1}{2}(\alpha - \alpha') = - \quad 4 \quad 04$$

$$2 - \frac{1}{2}(\alpha - \alpha') = -11 \quad 18 \quad 36''$$

$$\log \tan \phi' = 9.95727$$

$$\cos \frac{1}{2}(\alpha - \alpha') = 0.000000$$

$$\therefore \cos \left(\frac{1}{2}(\alpha - \alpha') \right) = 9.99148''$$

$$\therefore \tan \phi = 9.96579$$

$$\gamma = 142 \quad 44 \quad 44.0''$$

$$\delta' = -14 \quad 00 \quad 42.8$$

$$\gamma - \delta' = 56 \quad 45 \quad 26.8''$$

$$\log \sin \phi' = 9.82640$$

$$\sin \pi = 8.19855$$

$$\therefore (\gamma - \delta') = 9.92239''$$

$$\therefore \sin \gamma = 9.83171''$$

$$\therefore \sin (\alpha - \alpha') = 8.11563''$$

$$\delta - \delta' = + \quad 44 \quad 52.0$$

$$\delta = -13 \quad 15 \quad 50.8$$

$$\alpha = 22 \quad 28 \quad 36.52$$

$$\text{Circ. Eph. } \delta = -13 \quad 15 \quad 55.4$$

$$\alpha = 22^h 28 \quad 36.02$$

$$O - C = - \quad 4.6$$

$$+ 0.50$$

1890

Star-measures

1913 Nov. 18.

21

	α	δ	μ
1	16975	19300	
10.1	15510	10767	67
24.1	1319	70	
	85	98	
	<u>24.1464</u>	<u>1470</u>	

	α	δ	μ
	16838	14260	
	8290	12810	10
	90	10	
	59	62	
	<u>10.1434</u>	<u>1450</u>	

	α	δ	μ
2	15109	19585	
10.6	12501	12195	90
11.3	01	96	
	19	93	
	<u>11.2612</u>	<u>2603</u>	

	α	δ	μ
	15555	19830	
	11147	14231	40
	44	30	
	53	36	
	<u>10.5595</u>	<u>5599</u>	

	α	δ	μ
3	15808	12709	15
26.1	15105	05	15
10.1	10	12018	
		00	00
		81	
	<u>15.0700</u>	<u>0692</u>	<u>26.1020</u>

	α	δ	μ
	18379	18379	
	17352	51	
	53		
	00		
	<u>1029</u>		

grade 3

1890

Star measures

1913 Nov 18.

21

	a	4	N
1	16975	19300	
10.1	15510	10767	67
241	13	70	
	85	98	
	<u>24.1464</u>	<u>1470</u>	

d	2	N
16838	14260	
8290	12810	10
90	10	
59	62	
<u>10.1434</u>	<u>1450</u>	

2	15109	19585	
10.6	12501	12195	90
113	01	96	
	19	93	
	<u>11.2612</u>	<u>2603</u>	

15555	19830	
11147	14231	40
44	30	
53	36	
<u>10.5595</u>	<u>5599</u>	

3	15808	12709	15071
261	15105	05	9100
111	10	12018	0000
			81
	<u>150700</u>	<u>0692</u>	<u>26.1020</u>

18379
17352
53
00
<u>1029</u>

Grade 3

1890 *lucius ~~conter~~ measures.*

d u d u

1 10529 12045²⁹
 19.0 10449³⁶ 20²⁹
 180+ 49 11918

18.0084 .0113

2 *scratch*

19.4 15297 18597
 19.5 10331³³ 13555⁴⁸
 40 4348
 99 05
18.4963 .4948

3

19.5

19.0

15825 17080
 9711²¹ 13170⁷⁸
 15 78
 30 82
19.3888 .3906

14814 16092
 10756⁵⁷ 10161⁵⁰
 60 50
 18 92
19.5940 .5938

13801 16090
 10253⁶⁰ 9650⁵⁰
 47 50
 10 00
19.6449 .6446

18760 15110
 14550⁴⁷ 9349⁵⁰
 50 40
 74 12
19.5783 .5765

6
 19.0 13327³⁶ 9150
 20.9 1536 8168⁷²
 12395 79

20.9069 .9023

1890

Innovative ~~Measurements~~

d

n

d

n

1 10529 12045²⁹
 190 10449³⁶ 20²⁹
 180 99 11918

18.00840113

3 scratch

194 15297 18597
 185 10331³³ 13555⁴⁸
 40 4348
 99 05
18.4963 4948

15825 17080
 9711²¹ 13170⁷⁸
 15 78
 30 82
193885 3906

14819 16092
 10756⁵⁷ 10161⁵⁰
 60 50
 18 92
195940 5938

13801 16090
 10253⁶⁰ 7610¹⁰
 47 50
 10 00
196499 6446

18760 15110
 14550⁴⁷ 9349⁵⁰
 50 40
 74 12
195783 5765

6
 190 13327³⁶ 91150
 209 15³⁶ 8168⁷²
 12395 79
20.9069 9023

2
1
2
8
18
21
9
17
26
1
1

1890

Moon - measures

23

$$\begin{array}{r}
 2 \text{ scratch} \\
 18.5 \quad 16250 \\
 21.2 \quad 13641.52 \\
 \quad 58 \\
 \quad 70 \\
 \hline
 21.2606
 \end{array}$$

$$\begin{array}{r}
 14390 \\
 701207 \\
 \quad 06 \\
 \quad 02 \\
 \hline
 .2609
 \end{array}$$

$$\begin{array}{r}
 17843 \\
 1185344 \\
 \quad 40 \\
 \quad 45 \\
 \hline
 18.4002
 \end{array}$$

$$\begin{array}{r}
 14528 \\
 1052930 \\
 \quad 20 \\
 \quad 20 \\
 \hline
 .4000
 \end{array}$$

$$\begin{array}{r}
 8 \\
 18.0 \quad 16080 \\
 21.9 \quad 12460.52 \\
 \quad 50 \\
 \quad 90 \\
 \hline
 21.3630
 \end{array}$$

$$\begin{array}{r}
 19875 \\
 1351815 \\
 \quad 12 \\
 \quad 85 \\
 \hline
 .3634
 \end{array}$$

$$\begin{array}{r}
 9 \\
 17.7 \quad 15089 \\
 21.4 \quad 11280.80 \\
 \quad 80 \\
 \quad 00 \\
 \hline
 21.3813
 \end{array}$$

$$\begin{array}{r}
 18876 \\
 1267494 \\
 \quad 90 \\
 \quad 89 \\
 \hline
 .3802
 \end{array}$$

1890

Moon - Encounters

2 scratch

185 16250

212 13641

58 2

70

21.2606

14390

701207

06

02

2609

17843

1185344

40

45

184002

14528

1052930

20

20

4000

8 16080

180 1246052

219 170

90

21.3630

19875

1351815

12

85

3634

9 15089

177 1128080

219 80

00

21.3813

18876

1267494

90

89

3802

1890 Times etc.

Epistatus 1912 July 3, 21^h 50^m 22^h 02^m L
 Moon 21 55 54.9^h 21 55 55.1^h
 clock slow 1 38.9^h

H. Sid. T. 21 57 33.9^h
 H. Long 4 44 31.05^h
 G. Sid. T. 26 42 04.95^h
 Sid. T. in Moon 6 44 33.89^h
 Interval 19 57 31.06^h
 Reduction 3 16.19^h
 G. in T. 19 54 14.87^h $\theta - \nu = -0^h 32^m$

From Mount Allen. R. A. Decl.
 Moon 20^h 22^m 29^m 12.25^h -1 30 11' 46".1^h
 Mot. in 1^m 1.8447^h 12.699^h
 -5.7522^h -10.61^h -1 13.0^h
 Tabular Place 22 29 01.64^h -1 3 12 59.1^h

Moon's age 19 days

" parallax 54' 18.4^h" semidiameter 14 49.5^hR = 889.5^h93428.7^h + 7.9^h889-7.9^h Augmentation + 7.9^hIrradiation (R) - 0.7^hR = 896.7^hR = 1.9222^ha = +1.6 (a + 1) R = 1.9222^hR² = 3.6960^h

1890

Times at

24

1912 July 3 21^h 50^m 27 - 22^h 02^m
 Moon 21 55 549 - 21 55 551
 Clock slow 1 389

H Ind T. 21 57 33.9
 Helium 4 44 31.05
 G Sect. 26 42 0495
 Sect. in Moon 6 44 33.89
 Internal 19 57 31.06
 Radiation 3 16.19
 G in T 19 54 1487 6-1 = -0^h 32^m

From West. Allen. R. A. Mass.
 Moon 20^h 22^m 29^m 12.25 - 13^h 11' 46"1
 Moon 1^m 1.8447 12.699
 -5.7522 - 10.61 - 1 13.0
 Tubular Glass 22 29 01.64 - 13 12 59.1

Moon age

19 days.

panallare 54^h 18^m 4
 accumulation 14 49.5
 R = 889.5
 Augmentation + 79
 Inadequacy (R) - 0.7
 R = 896.7
 R = 1.9222^h
 a + 1.6 a + 1/R = 1.9222^h
 R = 36960

1890

Ratio constants

25

$$\begin{array}{rcl}
 10.1442 & 10.5597 & 26.1024 \\
 11.2825 & 11.8012 & 27.3107 \\
 -11.383 & -12.415 & -1.2083
 \end{array}$$

$$\begin{array}{rcl}
 24.1467 & 11.2608 & 15.0696 \\
 24.0257 & 11.1363 & 15.0679 \\
 +1210 & +1245 & +17
 \end{array}$$

$$\begin{array}{rcl}
 20-3 & -80.79 & -1.670 & +1.3333 \\
 -1.1383 - 1934 & = -1.3317 & -16 = -1.3332 & = +1 \\
 -1.2415 - 902 & = -1.3317 & -17 = -1.3334 & = -1 \\
 -1.2083 - 1207 & = -1.3290 & -42 = -1.3332 & = +1 \\
 17.7282 - 1559 & & -28 & = 1.89028
 \end{array}$$

$$\begin{array}{rcl}
 4-7 & +77.72 & +5.14 & -2122 \\
 +1210 + 788 & = +1998 & +123 = +2121 & = -1 \\
 +1245 + 820 & = +2065 & +57 = +2122 & = 0 \\
 +17 + 2028 & = +2045 & +77 = +2122 & = 0 \\
 19.4597 + 1377 & & +99 & = 19.3951
 \end{array}$$

Tables. $a: -0.8$ $e: -7.2$ $a-e: +6.4$ $b+a: +1.5$
 also $a: +1.6$ $e: -5.1$ $a-e: +6.7$ $b+a: +2.4$
 -2.4 -2.1 -0.3 -0.9

1890

Plate Constant

25

$\begin{matrix} 2 & 10.1442 & 10.5597 & 26.1024 \\ 3 & 11.2825 & 11.8012 & 27.3107 \\ 4 & -11.383 & -12.415 & -12.083 \end{matrix}$

$\begin{matrix} y & 24.1467 & 11.2608 & 15.0696 \\ 0 & 24.0257 & 11.1363 & 15.0679 \\ -y & +1210 & +1245 & +17 \end{matrix}$

$\begin{matrix} -3 & -80.74 & -1.676 & +1.3333 \\ -11383 & -1939 & -16 & -1.3332 & = +1 \\ -12415 & -902 & -17 & -1.3334 & = -1 \\ -12083 & -1207 & -42 & -1.3332 & = +1 \\ 17.7282 & -1559 & -28 & & = 18.9028 \end{matrix}$

$\begin{matrix} y-y & +77.72 & +5.14 & -21.22 \\ +1210 & +788 & +1998 & +123 & = +2121 & = -4 \\ +1245 & +820 & +2065 & +57 & = +2122 & = -0 \\ +17 & +2028 & +2045 & +77 & = +2122 & = 0 \\ 1845.97 & +1377 & +99 & & = 19.3951 \end{matrix}$

Tables. $a: -0.8 \quad z: -6.9 \quad a-z: +6.1 \quad b+a: +1.5$
 also $a: +1.6 \quad z: -5.1 \quad a-z: +6.7 \quad b+a: +2.4$

$$\Delta x = -1.4(y - y_0)$$

$$\Delta y = +6.2(y - y_0)$$

pt	pos. L	resid
1	138.5	+265
2	120.0	-45
3	103.7	-30
4	90.0	-223
5	73.6	+118
6	41.5	+114
7	20.6	+31
8	8.3	+56
9	0.0	+44

1890

Moon's Center

26

	x	$x - x_0$	Δx	$(x - x_0)^2$	$(x - x_0)^2 + (y - y_0)^2$	$0 - 6$
1	19.0000 +	12788	+2	16358	3.7331	+371
2	19.3897 +	16685	+1	27842	3.7100	+140
3	19.5939 +	18727	+1	35074	3.7167	+207
4	19.6448 +	19236	0	3.7002	3.7002	+42
5	19.5774 +	18562	-1	34414	3.7363	+403
6	19.0000 +	12788	-2	16348	3.7324	+364
7	18.4001 +	06789	-3	04605	3.7174	+214
8	18.0000 +	0.2788	-3	0.0776	3.7150	+190
9	17.7212	0.0000	-3	0.0000	3.7048	+88

Comp. $R^2 = 3.6960$

	y	$y - y_0$	Δy	$(y - y_0)^2$
1	18.0099 -	1.4473	-9	2.0973
2	18.4956 -	0.9616	-6	0.9258
3	19.0000 -	0.4572	-3	0.2093
4	19.4572	0.0000	0	0.0000
5	20.0000 +	0.5428	+3	0.2949
6	20.9046 +	1.4474	+9	2.0976
7	21.2608 +	1.8036	+11	3.2569
8	21.3632 +	1.9060	+12	3.6374
9	21.3808 +	1.9236	+12	3.7048

$$x = 19.0 \quad y = 18.0099$$

$$20.9046$$

$$38.9145$$

$$y_0 = 19.4572$$

$$y = \text{max} = 21.3808$$

$$R = 1.9236$$

$$x = \text{max} = 19.6448$$

$$x_0 = 17.7212$$

$$\text{Center} \begin{cases} x_c = 17.7212 \\ y_c = 19.4572 \end{cases}$$

1890

Moon's Center.

26

	x	$x - x_0$	Δx	$(x - x_0)^2$	$(x - x_0)(y - y_0)$	$y - y_0$
1	19.0000	+1.2788	+2	1.6358	3.7331	+3.71
2	19.3897	+1.6685	+1	2.7842	3.7100	+1.90
3	19.5939	+1.8727	+1	3.5074	3.7167	+2.07
4	19.6448	+1.9236	0	3.7002	3.7002	+ .92
5	19.5774	+1.8562	-1	3.4414	3.7363	+4.03
6	19.0000	+1.2788	-2	1.6348	3.7324	+3.64
7	18.4001	+0.6789	-3	0.4605	3.7174	+2.14
8	18.0000	+0.2788	-3	0.0776	3.7150	+1.90
9	17.7212	0.0000	-3	0.0000	3.7048	+ .88

Comp 16: 3.6960

	y	$y - y_0$	Δy	$(y - y_0)^2$
1	18.0099	-1.4473	-9	2.0973
2	18.9956	-0.9616	-6	0.9258
3	19.0000	-0.4572	-3	0.2093
4	19.4572	0.0000	0	0.0000
5	20.0000	+0.5428	+3	0.2949
6	20.9046	+0.4474	+9	2.0976
7	21.2608	+1.8036	+11	3.2569
8	21.3632	+1.9060	+12	3.6374
9	21.3808	+1.9236	+12	3.7048

$$x = 19.0 \quad y = 18.0099$$

$$20.9046$$

$$3.89145$$

$$y_0 = 19.4572$$

$$y = \text{max} \quad 21.3808$$

$$R = 1.9236$$

$$x = \text{max} \quad 19.6448$$

$$x_0 = 17.7212$$

$$\text{Center} \begin{cases} x = 17.7212 \\ y = 19.4572 \end{cases}$$

Formation of Normals

	ab	an	bn
1	- 1.86	+ 474.9	- 538.0
2	- 1.60	+ 233.8	- 134.4
3	- 0.86	+ 387.1	- 95.2
3.5	+ 0.00	+ 21.1	+ 0.0
4	+ 0.25	+ 94.0	+ 54.0
5	+ 1.86	+ 465.9	+ 527.8
7	+ 1.22	+ 145.5	+ 385.2
8	+ 0.53	+ 53.2	+ 362.9
9	+ 0.00	+ 0.0	+ 169.0
	- 0.46	+ 1875.5	+ 731.3

1890

Moon's Center

27

Conditional Equations

	a	b	0		c	0 - c
1	+ 1.28	- 1.45	= + 371	+ 178	- 72	= + 106 + 265
2	+ 1.67	- 0.96	= + 140	+ 232	- 49	= + 185 - 45
3	+ 1.87	- 0.46	= + 207	+ 260	- 23	= + 237 - 30
4	+ 1.92	+ 0.00	= + 42	+ 265	+ 0	= + 265 - 223
5	+ 1.86	+ 0.54	= + 403	+ 258	+ 27	= + 285 + 118
6	+ 1.28	+ 1.45	= + 364	+ 178	+ 72	= + 256 + 114
7	+ 0.68	+ 1.80	= + 214	+ 94	+ 89	= + 183 + 31
8	+ 0.28	+ 1.91	= + 190	+ 39	+ 95	= + 134 + 56
9	0.00	+ 1.92	= + 88	0	+ 44	= + 44 + 44

+ 628 - 298

Normal Equations

Average = 103

$$\begin{aligned}
 &+ 13.67 - 0.46 = + 1876 \\
 &- 0.46 + 16.08 = + 731 \\
 &+ 0.46 - 0.01 = + 63 \\
 &\quad + 16.07 = + 794 \\
 &- 0.01 + 0.46 = + 21 \\
 &+ 13.66 = + 1897
 \end{aligned}$$

$$b = + 49.5$$

$$a = + 139.0$$

1
2
3
4
5
6
7
8
9

1890

Innos Center

27

Conditional Equations

	a	b	c	0	c	0-c
1	+1.28	-1.45	=	+371	+178-72	+106 +265
2	+1.67	-0.96	=	+140	+232-99	+185 -45
3	+1.87	-0.46	=	+207	+260-23	+237 -30
4	+1.92	+0.00	=	+42	+265+0	+265 -223
5	+1.86	+0.54	=	+403	+258+27	+285 +118
6	+1.28	+1.45	=	+364	+178-72	+250 +114
7	+0.68	+1.80	=	+214	+94+89	+183 +31
8	+0.28	+1.91	=	+190	+39+95	+134 +56
9	0.00	+1.92	=	+88	0+44	+44 +44

Normal Equations

$$\begin{aligned}
 &+13.67 - 0.46 = +1876 \\
 &-0.46 + 16.08 = +731 \\
 &+0.46 - 0.01 = +63 \\
 &\quad +16.07 = +794 \\
 &-0.02 + 0.46 = +21 \\
 &+13.66 = +1897 \\
 &\quad b = +49.5 \\
 &\quad a = +139.0
 \end{aligned}$$

1890 Moon's Mean Position (1912.0)

48

$$\begin{array}{r}
 Y_0 = 17.7212 \\
 \text{cor} = + 70 \\
 \hline
 17.7282
 \end{array}
 \qquad
 \begin{array}{r}
 Y_0 = 19.4572 \\
 \text{cor} = + 25 \\
 \hline
 19.4597
 \end{array}$$

From Plate constants $x = 18.9028$ $y = 19.3951$

$$\xi = +0.9028$$

$$\eta = -2.6049$$

$$\log \xi = 9.95559$$

$$\log \tan \delta = 9.3968$$

$$\log \delta = 9.98697$$

$$\log \xi^2 = 9.9112$$

$$\log \text{const} = 8.50724$$

$$\log \eta = 6.3614$$

$$(A-A) = 1.46138$$

$$\eta = -2$$

$$A-A = +28.93$$

$$\eta_0 = -2.6047$$

$$A = 22^h 28^m 59^s$$

$$\log \eta_0 = 0.41578$$

$$\log \text{const} = 7.33115$$

$$A_0 = 22^h 29^m 22.93^s$$

$$(A-D) = 308461$$

$$\text{Red. app. place} = 22^h 29^m 25.17^s$$

$$S-D = -20 \ 15.1$$

$$S' = 22^h 29^m 25.17^s$$

$$D = -13 \ 37 \ 48$$

$$S_0 = -13^\circ 58' 03.1''$$

$$\text{Red. app. place} = +10.3$$

$$S' = -13^\circ 57' 52.8''$$

1890

Unknown Mean Position (1912.0)

28

$$\begin{array}{r}
 x_1 = 17.7212 \\
 \text{bias} = +70 \\
 \hline
 17.7282
 \end{array}
 \qquad
 \begin{array}{r}
 y_0 = 19.4572 \\
 \text{bias} = +25 \\
 \hline
 19.4597
 \end{array}$$

From Plate Constants $x = 189028$ $y = 193951$

$$z = +0.9028$$

$$y = -2.6049$$

$$\begin{array}{l}
 \log S = 9.95559 \\
 \text{ws} = 9.98697 \\
 \text{const.} = 8.50724
 \end{array}$$

$$\begin{array}{l}
 \log T_m S = 9.3968 \\
 S^2 = 99112 \\
 \log \mu = 63614 \\
 \mu = 1
 \end{array}$$

$$(A-A) = 146138$$

$$y_0 = -2.6048$$

$$A-A = +2893$$

$$A = 22^h 28^m 59^s$$

$$\begin{array}{l}
 \log \mu = 0.41578 \\
 \text{const.} = 7.33115
 \end{array}$$

$$x_1 = 22 29 22.93$$

$$(A-A) = 308463$$

$$\text{Red shift place} = 224$$

$$S-D = -20 15.1$$

$$x' = 22^h 29^m 25.17^s$$

$$D = -13 37 48$$

$$S = -13^\circ 58' 03.1''$$

$$\text{Red shift place} = +103$$

$$S' = -13^\circ 57' 52.8''$$

1890

Lunar Parallax

29

$$\alpha' = 22^{\circ} 29' 25.7'' \checkmark$$

$$\delta' = -13^{\circ} 57' 52.8'' \checkmark$$

$$\theta = 21 \quad 57 \quad 33.9'' \checkmark$$

$$\theta - \alpha' = -0 \quad 31 \quad 51.27'' \checkmark$$

$$\pi = 54' 18.4'' \checkmark$$

$$= -7^{\circ} 57' 49'' \checkmark$$

$$\frac{1}{2}(\alpha - \alpha') = - \quad \quad \quad 2 \quad 52 \quad \checkmark$$

$$\log \cos \phi' = 9.86913'' \checkmark$$

$$\sin \pi = 8.19856'' \checkmark$$

$$\sin(\theta - \alpha') = 9.14159'' \checkmark$$

$$\cos \delta = 9.98834'' \checkmark$$

$$\sin(\alpha - \alpha') = 7.22094'' \checkmark$$

$$\theta - \alpha' + \frac{1}{2}(\alpha - \alpha') = -7 \quad 55'' \checkmark$$

$$\log \tan \phi' = 9.95727'' \checkmark$$

$$\cos \frac{1}{2}(\alpha - \alpha') = 0.00000 \checkmark$$

$$\alpha - \alpha' = -5' 43.06'' \checkmark$$

$$\cos \theta - \frac{1}{2}(\alpha - \alpha') = 9.99584'' \checkmark$$

$$\tan \gamma = 9.96143'' \checkmark$$

$$= -22.89'' \checkmark$$

$$\gamma = 42 \quad 27 \quad 32.5'' \checkmark$$

$$\delta' = -13 \quad 57 \quad 52.8'' \checkmark$$

$$\gamma - \delta' = 56 \quad 25 \quad 25'' \checkmark$$

$$\log \sin \gamma = 9.82640'' \checkmark$$

$$\sin \pi = 8.19856'' \checkmark$$

$$\sin(\gamma - \delta') = 9.92072'' \checkmark$$

$$\sin \gamma = 9.82934'' \checkmark$$

$$\sin(\alpha - \alpha') = 8.11634'' \checkmark$$

$$\delta - \delta' = +44 \quad 56.4'' \checkmark$$

$$\delta = -13 \quad 12 \quad 56.4'' \checkmark$$

$$\alpha' = 22 \quad 29 \quad 02.30'' \checkmark$$

$$\text{Ann Eph } \delta = -13^{\circ} 12' 59.1'' \checkmark$$

$$\alpha = 22^{\circ} 29' 01.64'' \checkmark$$

$$O - C = +2.7'' \checkmark$$

$$+0.66'' \checkmark$$

1890

Lunar Parallax

29

$$\begin{aligned} \alpha' &= 22^{\circ} 29' 25.17'' \\ \theta &= 21 \quad 57 \quad 33.9 \\ \theta - \alpha &= -0 \quad 31 \quad 51.27 \\ &= -7^{\circ} 57' 49'' \end{aligned}$$

$$\delta' = -13^{\circ} 57' 52.8''$$

$$\mu = 54' 18.4''$$

$$\frac{1}{2}(\alpha - \alpha') = -2 \quad 52$$

$$\theta - \alpha = \frac{1}{2}(\alpha - \alpha') = -5 \quad 06$$

$$\log \cos \theta = 9.86913$$

$$\sin \mu = 8.19856$$

$$\cos(\theta - \alpha) = 9.14159$$

$$\cos \delta = 9.98834$$

$$\sin(\alpha - \alpha') = 7.22099$$

$$\log \tan \theta = 9.95727$$

$$\cos(\alpha - \alpha') = 0.00000$$

$$\cos \delta = \frac{1}{2}(\alpha - \alpha') = 9.99828$$

$$\tan \gamma = 9.95899$$

$$\alpha - \delta' = -5' 43.06$$

$$= -22.89$$

$$\gamma = 42 \quad 17 \quad 55.2$$

$$\delta = -13 \quad 57 \quad 52.8$$

$$\gamma - \delta = 56 \quad 15 \quad 47.0$$

$$\log \sin \gamma = 9.82640$$

$$\sin \mu = 8.19856$$

$$\sin(\gamma - \delta) = 9.91991$$

$$\sin \gamma = 9.82501$$

$$\sin(\theta - \alpha') = 8.11686$$

$$\delta - \delta' = 7 \quad 44 \quad 59.6$$

$$\delta = -13 \quad 12 \quad 53.2$$

$$\alpha = 22 \quad 29 \quad 02.30$$

$$\text{Ann Eph } \delta = -13^{\circ} 12' 53.1''$$

$$\alpha = 22^{\circ} 29' 01.64''$$

$$\theta - \alpha$$

$$+ 0.66$$

