

KG

11366

v. 927

Vol. LI



Plates



2010

2011

2012

Harvard Lunar Plates

Measures and Reductions

Mary Fowler

Volume L I

Plate No.	Date	Page
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2
1
14.
31.

2
18.
10.

3
26.
24.

2010 Star Measures

1913 Dec. 8

	d	x		d	x	
1	1 7 3 2 7	1 6 5 7 3		1 7 1 2 1	1 7 1 9 8	
14.2	1 1 9 7 2 7	1 1 9 3 5 7		8 8 1 5 1	1 5 4 8 0 9 0	
31.5	7 0	3 0 2 7		2 0	8 0 9 0	
	2 5	6 6		2 5	0 0	
	<u>3 1.5 3 5 5</u>	<u>.5 3 6 1</u>		<u>1 4.1 6 9 1</u>	<u>.1 7 1 5</u>	
2	1 6 8 3 3	1 6 7 0 0		1 7 3 4 7	1 6 3 5 8	
18.1	1 3 3 8 0 8 3	1 0 1 3 9 2 9		8 4 8 1	1 5 1 9 0 8 7	
10.4	8 0	2 0		7 4 8 4	9 0 8 7	
	2 4	9 6		4 8	5 8	
	<u>1 0.3 4 4 9</u>	<u>3 4 3 3</u>		<u>1 8.1 1 2 9</u>	<u>.1 1 6 9</u>	
3	1 7 1 0 0	1 4 7 9 0		1 4 7 3 4	1 6 0 4 5	
26.6	1 5 6 2 9 3 6	6 2 4 8 4 9		1 2 5 0 9 1 0	8 2 6 9 7 1	
24.2	4 0	4 0 4 9		0 9	7 0	
	0 0	9 8		4 1	6 0	
	<u>2 4.1 4 6 5</u>	<u>1 4 4 9</u>		<u>2 6.7 7 7 3</u>	<u>.7 7 8 6</u>	

Grade 3.

2010

Star Measures

1913 Dec 8

1

	d	y	n	d	x	n
1	17327		16573	17121		17198
142	11972		11935	8815		15480
315	70		3027	20		8090
	25		66	25		00
	<u>31.5355</u>		<u>5361</u>	<u>14.1691</u>		<u>1715</u>
2	16833		16700	17347		16358
181	13380		10139	8481		15190
104	80		20	7484		9057
	24		96	48		58
	<u>10.3449</u>		<u>3433</u>	<u>18.1129</u>		<u>1169</u>
3	17100		14790	14734		16045
268	15629		6248	12509		8269
290	40		4049	09		70
	00		98	41		60
	<u>24.1465</u>		<u>1449</u>	<u>26.7773</u>		<u>7786</u>

Grade 3.

2010

Moon - measures.

2

	d	4	n	d	sc	w
1	14746		17878			
18.3	788080		1471720			
16.7	90		20			
min	48		70			
in						
8	<u>16.6864</u>		<u>.6845</u>			

2	19750		18389			
18.0	1268088		1543040			
16.7	81		37			
	40		87			
	<u>16.7060</u>		<u>.7048</u>			

3
17.3
17.0

19326
1156174
61
30
17.2236

19699
17435
2018
00
2275

4	170	17449		19494		
17.3	15790		70	11125		20
	79			70		
	50			89		
	<u>17.1668</u>			<u>.1628</u>		

5
16.5
18.0

18360
12760
6469
60
16.4404

14115
970098
90
15
4419

6
16.4
18.7
min
in
26

17303
1057070
75
90
16.3278

15192
1185860
70
82
3312

2010

known measures

d

4

~

d

20

~

1 14746 17878
 183 788080 1471720
 167 90 20
 mi 48 70
 11.6864 .6845

2 19750 18389
 180 1268088 1543040
 167 81 37
 40 87
 16.7060 .7045

3
 173
 170

19326 19699
 1156179 17435
 61 2018
 30 00
 172236 2271

4
 170 17449 19494
 173 15790 1112520
 79 10
 50 89
 17.1668 1628

5
 161
 180

18360 14115
 12760 970098
 6469 90
 60 15
 16.4404 4419

6
 16.4
 18.7
 70

17303 15192
 1057070 1185860
 75 70
 90 82
 16.3278 3312

2010

known-measures

3

$$\begin{array}{r} 7 \\ 16.4 \\ 19.0 \end{array}$$

$$\begin{array}{r} 17281 \\ 1091706 \\ 10 \\ 89 \end{array}$$

$$\begin{array}{r} 15247 \\ 11600 \\ 85-90 \\ 44 \end{array}$$

$$\underline{16.3625}$$

$$\underline{.3654}$$

$$\begin{array}{r} 8 \\ 16.9 \\ 20.0 \end{array}$$

$$\begin{array}{r} 12760 \\ 1155669 \\ 60 \end{array}$$

$$\begin{array}{r} 1025333 \\ 3733 \\ 9090 \end{array}$$

$$\underline{16.8809}$$

$$\underline{.8849}$$

$$\begin{array}{r} 9 \\ 18.0 \\ 20.1 \\ 16331 \\ 1070080 \\ 79 \\ 27 \\ \underline{20.5643} \end{array}$$

$$\begin{array}{r} 15963 \\ 7162021 \\ 1321 \\ 71 \\ \underline{.5651} \end{array}$$
possibly a
terminator.
$$20 = 17.0 \quad y = \underline{20.1075}$$

Before point 1.

$$\begin{array}{r} 19.3 \\ 17.0 \end{array}$$

$$\begin{array}{r} 14090 \\ 7530 \\ 2609 \\ 75-29 \end{array}$$

$$\underline{19.3444}$$

$$\begin{array}{r} 18829 \\ 1535-042 \\ 37 \\ 27 \end{array}$$

$$\underline{19.3485}$$

2010

known measures

7

164

190

8

169

200

17281

1091706

10

89

16.3625

12760

1155669

60

16.8809

15247

11600

85-90

44

3654

10253

3733

9090

8849

9

180

201

16331

1070060

79

27

20.5643

15963

11620

1321

71

5651possibly a
terminator

20.170

4. 20.1075

Before point 1.

193

170

14090

7530

2609

2629

75

19.3444

18829

1535042

37

27

19.3485

2010 Times etc.

Expt. star	1912 Sept. 22 ^h 08 ^m	- 22 ^h 20 ^m
" Moon	22 13 49.8	22 13 50.2
clock slow	0 45.0	
H. Sid. T.	22 14 35.0	
H. long	4 44 31.0	
G. Sid. T.	26 59 06.05	
Sid. T. Moon	12 15 44.58	
Interval	14 43 21.47	
Reduction	2 24.72	
G. M. T.	14 40 56.75	$0 - \alpha = -1^h 42^m$

fromvant. alm.	R.A.	Decl.
Moon 15 ^h	23 56 ^m 50.33	- 1° 43' 03.1"
motion in 1 ^m 1.8092"		14.774"
" - 19.0542"	34.47	- 4 41.5
Tabular place	23 56 15.86	- 1 47 44.6

Moon's age 15 days

" parallax 55' 07.0"

" semidiam 15' 02.6"

R 902.6"

Augmentation 49.7"

Irradiation (3) - 0.7

R 911.6"

R 1.9541"

(1+a) R 1.9532"

R² 3815.0"

934 = 10.3
9026 = 9.7

a = -4.7

α	γ	R.A.			Decl.		
14.1703	31.5558	23	55	16	-0	46	10
18.1149	10.3441	23	57	19	-3	31	02
26.7780	24.1417	24	01	48	-1	43	58
359.0632	66.0256	70	113	83	-4	120	50
19.69	22.01	23	58	08	-2	00	17
-1.8				52			5
1.69		23	57	16	-2	00	22
31							
52							

$$A = 23^h 57^m 16^s$$

$$D = -2^\circ 00' 22''$$

2010 Times etc.

Explosion	1912 Sept. 25	22 ^h 08 ^m	- 22 ^h 20 ^m
known	22	13	49.8 - 22 13 50.2
clock slow		0	45.0
H Sid T.	22	14	35.0
H long	4	44	310.5
G Sid T.	26	59	06.05
Explosion known	12	15	44.58
Interval	14	43	21.47
Reduction		2	24.72
G. in T	14	40	56.750 - x = -1 42

From want	Alm	P.A	Head
Moon 15 ^h	23 56 ^m	50.33	- 1° 43' 03.1
Motion 1 ^m 1.8092		14774	
" - 19.0592	-	3447	- 4 41.5
Tabular place	23 56	1586	- 1 47 44.6

Moon age 15 days

" parallax 55' 07.0

Semidiameter 15 02.6

934.10.3

9020.47

R 902.6

Augmentation +9.7

Irradiation 31 -0.7

R 911.6

R 1954.1

2 - 4.7

(1 + a) R 1953.2

R² 3815.0

Standard coordinates

Cape No. 3355 mag 7.1				Cape No. 3360 mag 5.1				Cape No. 4 mag 8.0			
C	23	54	39.13	23	56	41.92	0	01	11.49		
L			13			98			50		
b			13			91			11.52		
mean	23	54	39.13	23	56	41.94	0	01	11.50		
Prece			+ 36.87			+ 36.88			+ 36.87		
δ	23	55	1600	23	57	1882	0	01	48.37		
A	23	57	16	23	57	16	23	57	16		
$\delta - A$	-	2	00.00			+ 2.82			+ 4	32.37	
$\sin(A)$			-120.00			+ 2.82			+ 272.35		
log			2.07918			0.45025			2.43513		
$\cos S$			9.99996			9.999918			9.999980		
$\sin$			0.58638			895.667			0.94217		
$\sin$			-3.8582			+ 0.0905			+ 5.7532		
$\sin$			10			0			18		
$\sin$			14.1408			18.0905			26.7550		
$\sin$			14.1703			18.1149			26.7780		
$\sin$			+ 295			+ 244			+ 230		
C	-0	50	10.4	-3	35	02.6	-1	47	38.2		
L			10.9			02.6			38.7		
b			11.5			03.1			39.2		
mean	-0	50	10.9	-3	35	02.8	-1	47	38.7		
Prece			+ 4			+ 4			+ 4	00.6	
δ	-0	46	104	-3	31	023	-1	43	38.1		
D	-2	00	22	-2	00	22	-2	00	22		
$\delta - D$	+1	14	11.6	-1	30	40.3	+0	16	43.9		
$\tan(A)$			+ 4452.3			- 5441.6			+ 1003.9		
log			3.64859			3.73573			3.300169		
$\sin$			0.97974			1.06688			0.33284		
$\tan S$			8.1281			8.7886			8.4794		
$\sin$			11728			7.9133			18843		
$\sin$			6.3543			3.7553			7.4171		
$\sin$			+ 9.5442			- 11.6649			+ 2.1520		
$\sin$			- 2			0			- 26		
$\sin$			31.5440			10.3351			24.1494		
$\sin$			31.5358			10.3441			24.1457		
$\sin$			- 82			+ 90			- 47		

2010

Plate Constants

5

$$\begin{array}{rclcl}
 2 & 14.1703 & 18.1149 & 26.7780 \\
 3 & 15.1378 & 19.0858 & 27.7519 \\
 2-3 & -9.675 & -9.709 & -9.739
 \end{array}$$

$$\begin{array}{rclcl}
 4 & 31.5358 & 10.3441 & 24.1457 \\
 7 & 31.4239 & 10.2152 & 24.0288 \\
 4-7 & +1.119 & +1.289 & +1.169
 \end{array}$$

$$\begin{array}{rclcl}
 2-3 & -0.74 & +4.72 & +9.630 \\
 -9.675 - 2.2 = & -9.697 & +6.7 = & -9.630 & = 0 \\
 -9.709 - 7 = & -9.716 & +8.5 = & -9.631 & = 0 \\
 -9.739 - 1.7 = & -9.756 & +12.6 = & -9.630 & = 0 \\
 18.2839 - 1.3 = & & +8.6 = & & = 19.2542
 \end{array}$$

$$\begin{array}{rclcl}
 4-7 & +0.84 & +8.14 & +1.14 & -1.388 \\
 +1.119 + 1.1 = & +1.130 & +2.55 = & +1.385 & +3 = +1.388 = 0 \\
 +1.289 + 1.4 = & +1.303 & +8.4 = & +1.387 & +1 = +1.388 = 0 \\
 +1.169 + 2.1 = & +1.190 & +19.6 = & +1.386 & +2 = +1.388 = 0 \\
 18.6374 + 1.5 = & & +15.1 = & & +2 = 18.5154
 \end{array}$$

$$\begin{array}{lclcl}
 \text{Tables} & a = -0.8 & e = -3.3 & a-e = +2.5 & b+a = +3.1 \\
 \text{Obs} & a = -4.7 & e = -8.1 & a-e = +3.4 & b+a = -0.1
 \end{array}$$

2010

Plate Constants

17

2	14.1703	18.1149	26.7780
3	15.1378	19.0858	27.7519
2-3	-9675	-9709	-9739

4	31.5358	10.3441	24.1957
5	31.4239	10.2152	24.0281
4-5	+1119	+1289	+1169

2-3	-0.74	+4.72	+9630
-9675	-32	-9697	+67
-9709	-7	-9716	+85
-9739	-17	-9756	+126
182439	-13	+86	

4-5	+0.84	+8.14	+14	-1384
+1119	+11	+1130	+255	+1385
+1289	+14	+1303	+84	+1387
+1169	+21	+1190	+196	+1386
186374	+15	+151	+2	

Tables $a = -0.8$ $b = -3.3$ $a - b = +2.5$ $b + a = +3.1$
 Obs $a = -4.7$ $b = -8.1$ $a - b = +3.4$ $b + a = -0.1$

pt	hvs. c	residual
10	1 4 6 9	- 2 9
1	1 8 0 0	- 2 8
2	1 8 8 3	- 1 3
3	2 1 2 7	- 1 3 6
4	2 2 1 1	- + 1 2
5	2 5 1 0	- 1 3 9
6	2 7 0 0	+ 4 5
7	2 8 0 8	+ 2 8
8	3 1 4 4	+ 6 3
9	3 5 1 7	- 1 7 6

2010

Moon's Center

6

	x	$x - x_0$	Δx	$(x - x_0)^2$	$(x - x_0)^2 + (y - y_0)^2$	$0 - c$
1	18.2820	0.0000	+6	0.0000	3.8029	-121
2	18.0000	-0.2820	+8	0.0792	3.8045	-105
3	17.2255	-1.0565	+5	1.1151	3.7896	-254
4	17.0000	-1.2820	+4	1.6420	3.8044	-106
5	16.4412	-1.8408	+2	3.3878	3.7911	-239
6	16.3295	-1.9525	-0	3.8122	3.8122	-28
7	16.3640	-1.9180	-1	3.6791	3.8124	-26
8	16.8829	-1.3991	-4	1.9586	3.8226	+762
9	18.0000	-0.2820	-6	0.0799	3.8056	-94
10	19.3464	+1.0644	+5	1.1340	3.8085	-65

comp R^2 3.8150

	y	$y - y_0$	Δy	$(y - y_0)^2$
1	16.6854	-1.9496	-5	3.8029
2	16.7054	-1.9296	-5	3.7253
3	17.0000	-1.6350	-4	2.6745
4	17.1648	-1.4702	-3	2.1624
5	18.0000	-0.6350	-1	0.4033
6	18.6350	0.0000	0	0.0000
7	19.0000	+0.3650	+1	0.1333
8	20.0000	+1.3650	+3	1.8640
9	20.5647	+1.9297	+5	3.7257
10	17.0000	-1.6350	-4	2.6745

Aphe Center $x = 18.0$ $y = 16.7054$ $x = 17.0$ $y = 17.1648$
 20.5647 20.1071
 37.2701 37.2723
 $y_0 = 18.6350$
 $y = \text{mean} = 16.6854$ $y = 17.020 = 17.22255$
 $R = 1.9496$ 19.3464
 $x = \text{mean} = 16.3295$ 36.5719
 $x_0 = 18.2790$ $x_0 = 18.2860$

Center $\left\{ \begin{array}{l} x_0 = 18.2820 \\ y_0 = 18.6350 \end{array} \right.$

2010	Knowns Center							6
i	x_i	$y_i - y_0$	Δx	$(x_i - x_0)^2$	$(x_i - x_0)(y_i - y_0)$	$(y_i - y_0)^2$	Δy	
1	18.2820	0.0000	-6	00000	38029	-121		
2	18.0000	-0.2820	-8	00792	38045	-105		
3	17.2255	-1.0565	-5	11111	37896	-254		
4	17.0000	-1.2820	-4	16420	38044	-106		
5	16.4412	-1.8408	-2	33878	37911	-239		
6	16.3295	-1.9525	-0	38122	38122	-28		
7	16.3640	-1.9180	-1	36791	38124	-26		
8	16.4829	-1.7991	-4	19586	38226	-76		
9	18.0000	-0.2820	-6	00799	38056	-99		
10	19.3464	+1.0644	+5	11340	38085	-65		
Group R =							38150	

i	y_i	$y_i - y_0$	Δy	$(y_i - y_0)^2$
1	16.6854	-1.9496	-5	38029
2	16.7059	-1.9296	-5	37253
3	17.0000	-1.6350	-4	26741
4	17.1648	-1.4702	-3	21624
5	18.0000	-0.6250	-1	04033
6	18.6350	0.0000	0	00000
7	19.0000	+0.3650	+1	01333
8	20.0000	+1.3650	+3	18640
9	20.5647	+1.9297	+5	37257
10	17.0000	-1.6350	-4	26741

Alpha Center	$X = 18.042167054$	17.042167054
	2825667	201071
	372701	372723
	$Y = 18.6350$	
	$y = 16.6854$	$y = 17.2255$
	$x = 19.496$	19.346
	16.3295	18.000
	$X = 18.2790$	

Center } $X = 18.2820$
 } $Y = 18.6350$

Formation of normals

	ab	ac	bc
1	- 0.00	- 0.0	+ 236.0
2	+ 0.54	+ 29.4	+ 202.8
3	+ 1.74	+ 269.2	+ 416.4
4	+ 1.88	+ 135.9	+ 156.0
5	+ 0.29	+ 110.0	+ 38.2
6	- 0.00	+ 54.5	- 0.0
7	- 0.71	+ 50.0	- 9.6
8	- 0.48	- 26.6	+ 26.0
9	- 0.54	+ 26.3	- 181.5
10	- 1.74	- 69.0	+ 106.7
	+ 0.98	+ 577.7	+ 991.0
	- 0.48	- 26.6	+ 26.0
	+ 0.50	+ 551.8	+ 1017.0

2010

Moon's Center

Conditional Equations

	a	b	c	0 - c
1	0.00	-1.95	= -121	+ 8 - 93 = - 93 - 28
2	-0.28	-1.93	= -105	- 10 - 92 = -102 - 3
3	-1.06	-1.64	= -254	- 40 - 78 = -118 -136
4	-1.28	-1.47	= -106	- 48 - 70 = -118 +12
5	-1.84	-0.64	= -239	- 69 - 31 = -100 -139
6	-1.95	+0.00	= -28	- 73 + 0 = -73 +45
7	-1.92	+0.37	= -26	- 72 + 18 = -54 +28
8	-1.40	+1.37	= +76	- 52 + 65 = +13 +63
9	-0.28	+1.93	= -94	- 10 + 92 = +82 -176
10	+1.06	-1.64	= -65	+ 40 - 78 = -38 -27
				Average = 66

Normal Equations

$$\begin{aligned}
 + 14.21 + 0.98 &= +578 \\
 + 0.98 + 20.03 &= +991 \\
 - 0.98 - 0.07 &= -40 \\
 + 19.96 &= +951 \\
 + 14.21a &= +578 - 47 = +531
 \end{aligned}$$

$$\begin{aligned}
 b &= +47.7 \\
 a &= +37.4
 \end{aligned}$$

Giving (8) full wt.

$$\begin{aligned}
 + 14.35 + 0.50 &= +551 \\
 + 0.50 + 20.86 &= +1017 \\
 - 0.50 - 0.02 &= -20 \\
 + 20.84 &= +997 \\
 + 14.35 &= +551 - 24 = +527
 \end{aligned}$$

$$\begin{aligned}
 b &= +47.7 \\
 a &= +36.8
 \end{aligned}$$

2010

Innos Center

Conditional Equations

	a	b	0		c	a-b
1	0.00	-1.95	= -121	+	0 - 93	= -93 - 28
2	-0.28	-1.93	= -105	-	10 - 92	= -102 - 3
3	-1.06	-1.64	= -254	-	40 - 78	= -118 - 136
4	-1.28	-1.47	= -106	-	48 - 70	= -118 + 12
5	-1.84	-0.64	= -239	-	69 - 31	= -100 - 139
6	-1.91	+0.00	= -28	-	73 + 0	= -73 + 45
7	-1.92	+0.37	= -26	-	72 + 18	= -54 + 28
8	-1.40	+1.37	= +76	-	52 + 65	= +13 + 63
9	-0.28	+1.93	= -94	-	10 + 92	= +82 - 176
10	+1.06	-1.64	= -65	+	40 - 78	= -38 - 27

Average = 66

Normal Equations

$$\begin{aligned}
 +14.21 + 0.98 &= +578 \\
 +0.98 + 20.03 &= +991 \\
 -0.98 - 0.07 &= -40 \\
 -14.96 &= +951 \\
 +14.21 + 1.75 &= 47 + 531
 \end{aligned}$$

$$\begin{aligned}
 b &= +47.7 \\
 a &= +37.9
 \end{aligned}$$

Giving (8) full wt.

$$\begin{aligned}
 +14.35 + 0.50 &= +551 \\
 +0.50 + 20.86 &= +1017 \\
 -0.50 - 0.02 &= -20 \\
 +20.84 &= +997 \\
 +14.35 + 551 - 24 &= +527
 \end{aligned}$$

$$b = +47.7$$

$$a = +36.8$$

Red ad l. aph.

$$\begin{array}{rcl}
 l + \alpha & 5 & 45 = 86^{\circ} 15' \\
 H & 5 & 48 \\
 \alpha & 23 & 57 \\
 G & 21 & 36 \\
 \alpha + \alpha & 21 & 33 = 323^{\circ} 15'
 \end{array}$$

$$S_0 = -2^{\circ} 27'$$

$$\begin{array}{rcl}
 \log i & & 0.9105 \\
 \cos S & = & 9.9996 \\
 (i) & & 0.9101
 \end{array}$$

$$\begin{array}{rcl}
 \log \cos(G + \alpha_0) & & 9.9038 \\
 g & & 1.2103 \\
 \sin(G + \alpha) & & 9.7769 \\
 \tan S & & 8.6313 \\
 \frac{1}{\cos} & - & 8.8239
 \end{array}$$

$$\begin{array}{rcl}
 \log \sin S_0 & & 8.6338 \\
 \cos(H + \alpha_0) & & 8.8156 \\
 h & & 1.2738 \\
 \sin & & 9.9991 \\
 \sec S & & 0.0004 \\
 \frac{1}{\cos} & & 8.8239
 \end{array}$$

$$\begin{array}{rcl}
 (g') & = & 1.1141 \\
 (g) & = & 8.4424
 \end{array}$$

$$\begin{array}{rcl}
 (a') & & 8.7232 \\
 (h) & & 0.0972
 \end{array}$$

$$\begin{array}{rcl}
 h & + & 2.01 \\
 (g) & + & 0.03 \\
 (h) & + & 1.25 \\
 \hline
 & + & 3.29
 \end{array}$$

$$\begin{array}{rcl}
 (g') & + & 13.00 \\
 (h') & - & 0.05 \\
 (i) & + & 8.13 \\
 \hline
 & & 21.08
 \end{array}$$

2010 Moon's mean Position (1912.0)

$$\begin{array}{r}
 X_0 = 18.2820'' \\
 \frac{1}{2}a = \quad + 19'' \\
 \hline
 18.2839''
 \end{array}
 \quad
 \begin{array}{r}
 Y_0 = 18.6350'' \\
 \frac{1}{2}b = \quad + 24'' \\
 \hline
 18.6374''
 \end{array}$$

From Plate constants. $X = 19.2542''$ $Y = 18.5154''$

$$z = +1.2542''$$

$$\eta = -3.4846''$$

$$\begin{array}{l}
 \log z = 0.09837'' \\
 \dots \log s = 9.99960'' \\
 \dots \log w = 8.50729''
 \end{array}$$

$$\begin{array}{l}
 \log \tan S = 8.6401'' \\
 \dots z^2 = 0.1967'' \\
 \dots \eta_1 = 5.8902''
 \end{array}$$

$$\dots (X - A) = 1.59153''$$

$$\eta_1 = -1''$$

$$X - A = \quad + \quad 39.04''$$

$$\eta_0 = -3.4845''$$

$$A = 23 \ 56 \ 45''$$

$$\begin{array}{l}
 \log \eta_0 = 0.54214'' \\
 \quad \quad \quad 7.33115''
 \end{array}$$

$$X_0 = 23 \ 57 \ 24.04''$$

$$S - D = 3.21099''$$

$$\text{Reddish app} \quad + \quad 3.29''$$

$$= -27 \ 05.5''$$

$$d' = 23 \ 57 \ 27.33''$$

$$D = -1 \ 59 \ 26''$$

$$S_0 = -2 \ 26 \ 31.5''$$

$$\text{Red} \quad + \quad 21.1''$$

$$S' = -2 \ 26 \ 10.4''$$

2010 Moon's mean Position (1912.0)

$$\begin{array}{r}
 X_0 = 18.2820 \quad Y_0 = 18.6350 \\
 \hline
 \quad \quad + 19 \quad \quad \quad + 24 \\
 \hline
 \quad \quad 18.2839 \quad \quad \quad 18.6374
 \end{array}$$

From Plate constant $X = 19.2542 \quad Y = 18.5154$

$$S = +1.2542$$

$$\eta = -3.4846$$

$$\log S = 0.09837$$

$$\log S = 9.99960$$

$$\log S = 8.50729$$

$$\log \tan S = 8.6401$$

$$S^2 = 0.1967$$

$$\eta_1 = 58902$$

$$(X-4) = 15.9153$$

$$\eta_1 = -1$$

$$X-4 = +39.09$$

$$\eta_2 = -3.4845$$

$$A = 23.5645$$

$$\log \eta_2 = 0.54214$$

$$7.33115$$

$$X_1 = 23.5724.04$$

$$S \cdot D = 321099$$

$$\text{Radial app} = +329$$

$$= -27.055$$

$$\alpha' = 23.5727.33$$

$$D = -1.5926$$

$$S_0 = -2.2631.5$$

$$\text{Redu} = +21.1$$

$$\delta' = -2.2610.4$$

2010 Lunar Parallax

$$\begin{aligned} \alpha &= 23^{\circ} 57' 27.33'' \\ \delta &= 22^{\circ} 14' 35'' \\ \theta - \alpha &= -1^{\circ} 42' 52.3'' \\ &= 25^{\circ} 43' 04'' \end{aligned}$$

$$= 08' 51''$$

$$= 25' 34' 13''$$

$$9.95727$$

$$0.00000$$

$$0.04476$$

$$0.00203$$

$$\gamma = 45' 08'' 02.5''$$

$$\delta = -2^{\circ} 26' 10.4''$$

$$\delta - \delta = 47' 34' 12.9''$$

$$9.82640$$

$$8.20499$$

$$9.86812$$

$$0.14951$$

$$8.04902$$

$$\delta - \delta = +38' 29.2''$$

$$\delta = -1^{\circ} 47' 41.2''$$

$$\text{Ann Eph } \delta = -1^{\circ} 47' 44.6''$$

$$O-C = +3.4''$$

$$\delta' = -2^{\circ} 26' 10.4''$$

$$\pi = 55' 07.0''$$

$$9.86913$$

$$8.20499$$

$$9.63743$$

$$0.00021$$

$$7.71176$$

$$= 17' 43.15''$$

$$= 1'' 10.51''$$

$$\alpha = 23^{\circ} 56' 16.52''$$

$$\alpha = 23^{\circ} 56' 15.86''$$

$$+0.66''$$

2010 Lunar Parallaxes

$\alpha = 23 \quad 57 \quad 27.33$
 $\delta = 22 \quad 19 \quad 35$
 $\alpha - \delta = -1 \quad 42 \quad 52.3$
 $\quad \quad \quad - \quad 25^0 \quad 43' \quad 04''$

$\quad \quad \quad - \quad \quad \quad 08 \quad 51$

$\quad \quad \quad 25 \quad 34 \quad 13$

9.95727

0.00000

0.09476

0.00203

$\gamma = 45 \quad 08 \quad 02.5$

$\delta = 2 \quad 26 \quad 10.4$

$\delta - \delta = 47 \quad 34 \quad 12.9$

9.82640

8.20499

9.86812

0.14951

8.04902

$\delta - \delta = +38 \quad 29.2$

$\delta = -1 \quad 47 \quad 41.2$

Ann Ephs $\delta = -1 \quad 47 \quad 44.6$

$O-C \quad \quad \quad + \quad 3.4$

$\delta' = -2^0 \quad 26' \quad 10.4$

$\pi = 55' \quad 07.0$

9.86913

8.20499

9.63743

0.00024

7.71176

$- 17' \quad 42.75$

$- 1'' \quad 10.4$

$\alpha = 23 \quad 56 \quad 16.52$

$\gamma = 23 \quad 56 \quad 15.86$

$+ 0.66$

2

L

7.7

19.

2

28

14

3

24

37

2011

Stars - measures

d y n

1	15935	17411
7.7	14411.8	8938.31
19.2	20	29
	51	25
	<u>14.1521</u>	<u>.1510</u>

2	15029	16200
28.4	13580.80	7642.50
14.2	78	38
	29	12
	<u>14.1450</u>	<u>.1433</u>

3	19098	14020
28.9	18341.50	4762.60
32.8	44	58
	98	20
	<u>32.0753</u>	<u>.10740</u>

Grade 3.

1913 December 11.

d x n

15951	16921
12910	9935.38
12	35
60	27
<u>7.6956</u>	<u>.6989</u>

16067	15730
9566.65	12190.00
61	00
57	40
<u>28.3504</u>	<u>.3536</u>

18265	15555
9606.02	14194.00
01	96
65	60
<u>29.1338</u>	<u>.1359</u>

2011

Hans measures

1	15935	17411
27	14411	8938
192	20	29
	51	25
	<u>14.1521</u>	<u>1510</u>

3	15029	16200
284	13580	7642
142	78	38
	29	12
	<u>14.1410</u>	<u>1433</u>

3	19098	14020
248	18341	4762
228	44	58
	98	20
	<u>320753</u>	<u>10740</u>

Grade 3

1913 December

15951	16921
12910	9935
12	3538
60	27
<u>7.6916</u>	<u>6989</u>

16067	15730
9566	12190
61	0000
57	40
<u>28.3504</u>	<u>3536</u>

18265	15555
9606	14194
01	96
65	60
<u>29.1338</u>	<u>1359</u>

2

1
18.
18.19
19
1819
19
184
19
19
19
19
195
19
206
19
20

2011

moon-measures

11

 $\frac{1}{18.6}$
 $\frac{1}{18.0}$

d

4

n

d

20

n

$$\begin{array}{r} 16796 \\ 1377070 \\ 60 \\ 09 \\ \hline 18.6967 \end{array}$$

$$\begin{array}{r} 18225 \\ 11222 \\ 1120 \\ 42 \\ \hline .7019 + \end{array}$$

$$\begin{array}{r} \frac{2}{19.0} \quad 15700 \quad 18075 \\ 19.9 \quad 1260304 \quad 1116568 \\ 17 \\ 00 \\ \hline 18.3092 \end{array}$$

$$\begin{array}{r} 59 \\ 82 \\ \hline .3084 \end{array}$$
 $\frac{3}{19.4}$
 $\frac{1}{19.0}$

$$\begin{array}{r} 16910 \\ 1042022 \\ 2622 \\ 14 \\ \hline 19.3511 \end{array}$$

$$\begin{array}{r} 19110 \\ 1560061 \\ 06 \\ 30 \\ \hline .3518 \end{array}$$
 $\frac{4}{19.5}$
 $\frac{1}{19.4}$
 $\frac{1}{19.0}$

$$\begin{array}{r} 15550 \\ 1003825 \\ 21 \\ 54 \\ \hline 19.4176 \end{array}$$

$$\begin{array}{r} 19170 \\ 1496161 \\ 61 \\ 81 \\ \hline .4213 \end{array}$$
 $\frac{5}{19.4}$
 $\frac{1}{20.0}$

$$\begin{array}{r} 15500 \\ 9535 \\ 3934 \\ 00 \\ \hline 19.3736 \end{array}$$

$$\begin{array}{r} 20200 \\ 1645940 \\ 50 \\ 05 \\ \hline .3752 \end{array}$$

$$\begin{array}{r} \frac{6}{19.0} \quad 19591 \quad 19604 \\ 20.7 \quad 1179000 \quad 1735149 \\ 00 \\ 89 \\ \hline 20.7793 \end{array}$$

$$\begin{array}{r} 6249 \\ 08 \\ \hline .7749 \end{array}$$

2011

Moon - Lincennes

11

a

4

w

d

w

 $\frac{1}{196}$
180

 $\frac{1}{16796}$
1377070
60
09
186967
 $\frac{1}{18225}$
11222
1120
42
7017
 $\frac{2}{190}$ 15900 18075
189 1280304 1116568
17 59
00 82
183092 2084
 $\frac{3}{194}$
190

 $\frac{1}{16710}$ 19115
1042022 1560061
2622 06
14 30
193511 3518
 $\frac{4}{195}$
194
194
194
194

 $\frac{1}{11850}$ 19170
1003821 1496161
21 61
59 81
194176 4213
 $\frac{5}{194}$
200

 $\frac{1}{11800}$ 20200
9535 1605940
3934 10
00 05
195736 3752
 $\frac{6}{190}$ 19591 19604
207 1179000 1735149
00 6249
89 08
207793 7749

2
18
21
3
18
21
9
17
21
10
17
21

2011

known-headings

2	a	4	a	2	a	2
18.7				19516		16402
21.0				1748183		8470
				76		8385
				29		00
				<u>18.7959</u>		<u>7923</u>

8		
18.0	18203	16260
21.4	1362636	10829
	27	0611
	05	75
	<u>21.4574</u>	<u>4548</u>

9		
17.5	17248	17209
21.5	1186860	1257070
max	50	8070
	48	21
	<u>21.5389</u>	<u>5358</u>

10		
17.0	17286	17179
21.4	1230158	1210410
	58	03
	02	29
	<u>21.4938</u>	<u>4927</u>

2011

brown-heads:

2	a	4	a	72	a	72
18.7					1951.6	1640.2
21.0					1748.183	8470
					76	8385
					29	02
					<u>18.7959</u>	<u>7923</u>

8		
18.0	18203	18260
21.9	1362636	10829
	27	0611
	05	75
	<u>21.4574</u>	<u>4548</u>

9		
17.5	17248	17209
21.5	1186860	1257070
max	50	8070
	48	21
	<u>21.5389</u>	<u>1358</u>

10	17286	17179
17.0	1235158	1210410
21.9	58	03
	02	79
	<u>21.4938</u>	<u>4427</u>

2011 Times etc.

Epistictus 1912 Sept 27	2 ^h	15 ^m	✓	- 2 ^h	27 ^m	✓
Moon	2	20	54.4 ^h	- 2	20	54.8 ^h
clock slow		0	43.1 ^h			
H. Sid T.	2	21	37.7 ^h			
W. long	4	44	31.0 ^h			
B. Sid T.	7	06	08.7 ^h			
Sea Thr. Moon	12	23	37.68 ^h			
Interval	18	42	31.07 ^h			
Reduction		3	03.90 ^h			
G. M. T.	18	39	27.17 ^h	G-R = +0 ^h 49 ^m		

From Hank. Alu.

R. A.

Decl.

Moon 19 ^h	1 ^h	33 ^m	29.90 ^h	+ 11 ^h	04 ^m	35.0 ^h
Motion in 1 ^h = 1.9404 ^h			14.298 ^h			
Motion in -20.5472 ^h			- 39.87 ^h		4	53.8 ^h
Tabular place.	1	32	50.03 ^h	+ 10	59	41.2 ^h

Moon's age 17 days.

parallelax 56 05.1^h" semidiam 15 18.6^hR = 918.6^hAugmentation + 12.9^hInradiation (3) - 0.7^hR 930.6^hR 1.9949^h(1+a) R 3.9796^hR²

934 = 93.15^h

918.6 = 92.87

a = +0.2

2011

Times etc

photon 1912 Sept 27 2" 15" - 2" 27"
 Moon 2 20 54.4 - 2 20 54.8
 local time 0. 43.1

11 Sid T. 2 21 37.7
 Hong 4 44 31.05
 Sid T. 7 06 08.75
 12 23 37.68
 18 42 31.07
 Radon 3 03.90
 (a) T. 18 39 27.17 0-1 10 49

From Kant Alm.

R A

Decl.

Moon 19" 1" 33' 29.90 +11" 04' 35.0
 Motion a 1" = 1.9404 14.298
 Motion = 20.5472 - 39.87 4 53.8
 Tabular place 1 32 50.03 +10 59 41.2

Moon's age 17 days

parallax 56 05.1
 semidiameter 15' 18.6
 R: 91.86
 Augmentation +1.27
 Irradiation (3) -0.7
 R 930.6
 R 1.9949
 a + 0.2 (1 + a) R 3.9796
 R

2011

20	4	R.A.	Decl.
7 6 9 7 2	1 9 1 5 1 6	1 27 04	+ 10 26 09
28.3520	14.1442	1 37 57	+ 9 48 04
29.1348	32.0746	1 38 21	+ 12 07 27
65.18	65.37	102 82	+ 31 81 40
21.73	21.79	1 34 27	+ 10 47 13
-18	-22	* 1 55	+ 1 38
3.73	21	1 32 32	+ 10 48 51
31	46.5		
115	98		

$$A = 1^h 32^m 32^s$$

$$D = +10^\circ 48' 51''$$

$$\begin{array}{rclcl}
 2-3 & -534 & -22 & +136 & \\
 +881 & -1015 & -134-2 & -136 & = 0 \\
 +619 & -750 & -131-6 & -137 & = -1 \\
 +1569 & -1699 & -130-6 & -136 & = 0 \\
 174317 & -1036 & -3 & & = 17,3414
 \end{array}$$

$$\begin{array}{rclcl}
 4-4 & +52.22 & +2.4 & -926 & \\
 +486 & +402 & +888+38 & +926 & = 0 \\
 -583 & +1480 & +897+28 & +925 & = -1 \\
 -658 & +1521 & +863+64 & +927 & = +1 \\
 19.5-433 & +910 & +39 & & = 19.5-456
 \end{array}$$

$$\begin{array}{llll}
 \text{Tables } a = -0.5 & e = -2.0 & a - e = +1.5 & b + a = -0.8 \\
 \text{Obs } a = +0.2 & e = -2.0 & a - e = +2.2 & b + a = +0.8
 \end{array}$$

2011

20	4	RA	Dec
7.6972	19.1516	1 27 04	+10 26 09
28.3520	19.1442	1 37 57	+9 48 04
29.1348	32.0746	1 38 21	+12 07 27
65.18	65.39	102 82	+31 81 40
21.73	21.79	1 34 27	+10 47 13
1.8	2.2	1 1 55	+0 1 38
3.73	2.1	1 32 32	+10 48 51
3.1	4.65		
11.5	9.8		

$$A = 1^h 32^m 32^s$$

$$D = +10^\circ 48' 51''$$

$$\begin{array}{rclcl}
 2-3 & -534 & -22 & +136 & \\
 +881 & -1015 & -134-2 & -136 & = 0 \\
 +619 & -750 & -131-6 & -137 & = -1 \\
 +1569 & -1699 & -130-6 & -136 & = 0 \\
 174317 & -1036 & -3 & & = 173417
 \end{array}$$

$$\begin{array}{rclcl}
 4-4 & +5222 & +24 & -926 & \\
 +486 & +402 & +888+38 & +926 & = 0 \\
 -583 & +1480 & +897+28 & +925 & = -1 \\
 -658 & +1521 & +863+64 & +927 & = +1 \\
 195433 & +910 & +39 & & = 195456
 \end{array}$$

$$\begin{array}{l}
 \text{Tables } a = -0.5 \quad e = -2.0 \quad a - e = +1.5 \quad b + a = -0.8 \\
 \text{Obs } a = +0.2 \quad e = -2.0 \quad a - e = +2.2 \quad b + a = +0.8
 \end{array}$$

2011 Standard Coordinates

15

Capella 208 mag 7.6				Capella 242 mag 8.0				Capella 245 mag 8.6			
C	1	26	25.46	1	37	18.65		1	37	42.72	
L			51			69				79	
E			53			62				76	
mean	1	26	25.50	1	37	18.65		1	37	42.76	
Proc		+	37.98		-	38.01			+	38.29	
X	1	27	03.48	1	37	56.66		1	38	210.5	
A	1	32	32	1	32	32		1	32	32	
X-A	-	5	28.52	+5	24.66			+5	49.05		
sin(X-A)		-	328.49	+3	24.63			+3	49.01		
log		2.51653m			2.51139				2.54284		
mag		9.99276			9.99362				9.99021		
3 ₀		1.01653m			1.01225				1.04029		
3 ₀	-	10.3879		+10.2860				+10.9720			
3 ₁	-	30		+41				+59			
3		7.6091		28.2901				28.9779			
2		7.6972		28.3520				29.1348			
2-3		+881		+619				+1569			
C+10	22	25.2		+9° 44'	25.2			+12 03	47.8		
L		25.3			25.3				48.2		
E		25.3			25.0				48.4		
mean	+10	22	25.3	+9	44	25.1		+12	03	48.1	
Proc		+	3	43.8		+3	39.1		+3	38.9	
S	+10	26	09.1	+9	48	04.2		+12	07	27.0	
D	+10	48	51	+10	48	51		+10	48	51	
S-D	-	22	41.9	-1	00	46.8		+1	18	36.0	
tan(S-D)		-	1361.9		-	3647.2			+4716.8		
log		3.13415m			3.56196m				3.67365m		
3 ₀		0.46530m			0.89311m				1.00480m		
mag		9.2652			9.2374				9.3321		
3 ₁		2.0331			2.0245				2.0806		
3 ₁		8.3517			8.3153				8.4661		
3 ₀	-	2.9195		-7.8182				+10.1112			
3 ₁	+	225		+	207			+	292		
3 ₁		19.1030			14.2025				32.1404		
3 ₁		19.1516			14.1442				32.0746		
3 ₁ -3 ₀		+486			-583				-658		

Will Standard				Coordinates					
Raf. 6 208 mag 7.6				Raf. 6 242 mag 7.0				Cape 6 241 mag 8.6	
C	1	26	25.96	1	37	18.65	1	37	42.72
L			5.1			69			79
E			5.3			62			76
mean	1	26	25.50	1	37	18.65	1	37	42.76
Proc		+	37.98	-		38.01		+	38.29
X	1	27	03.48	1	37	56.66	1	38	210.5
A	1	32	32	1	32	32	1	32	32
X-A	-	5	28.52	+	5	24.66	+	5	49.05
sin(X-A)		-	328.49	+	3	24.63	+	3	49.01
log		2.51653	m		2.51139			2.54284	
log S		9.99276			9.99362			9.99021	
S ₀		1.01653	m		1.01225			1.04029	
3	-	10.3879		+	10.2860		+	10.9720	
7	-	30		+	41		+	59	
7		7.6091			28.2901			28.9779	
2		7.6972			28.3520			29.1348	
2-3		+881		+	619		+	1569	
C	+10	22	25.2	+90	44	25.2	+12	03	47.8
L			25.3			25.3			48.2
E			25.3			25.0			48.4
mean	+10	22	25.3	+9	44	25.1	+12	03	48.1
Proc	+	3	43.8	+	3	39.1	+	3	38.9
S	+10	26	09.1	+9	48	04.2	+12	07	27.0
D	+10	48	51	+10	48	51	+10	48	51
S-D	-	22	41.9	-1	00	46.8	+1	18	36.0
sin(S-D)		-	136.19		-	36.472		+	47.168
log		3.13415	m		3.56196	m		3.67365	m
log		0.46530	m		0.89311	m		1.00480	m
log S		9.26152			9.2374			9.3321	
S		20331			20245			20806	
log		8.3517			8.3153			8.4661	
log	-	2.9195		-	7.8182		+	10.1112	
log	+	225		+	207		+	292	
log		19.1030			14.2025			32.1404	
log		19.1516			14.1442			32.0746	
log		+486		-	583		-	658	

pt	pos. L	resid.
1	140.1	+97
2	128.3	+44
3	105.8	+9
$\frac{1}{2}$ wt 4	90.0	-280
5	76.7	+31
6	51.6	+26
7	43.4	-13
8	16.8	+27
9	0.0	-26
10	347.7	+94

over

2011

Moon's Center

	x	$x - x_0$	$(x - x_0)^2$	$(x - x_0)^2 + (y - y_0)^2$	$0 - c$
1	18.6993	+1.2743	1.6238	4.0052	+256
2	19.0000	+1.5750	2.4808	4.0043	+247
3	19.3514	+1.9264	3.7110	4.0059	+263
4	19.4194	+1.9944	3.9776	3.9776	-20
5	19.3744	+1.9494	3.8002	4.0090	+294
6	19.0000	+1.5750	2.4808	4.0041	+245
7	18.7941	+1.3691	1.8745	3.9976	+180
8	18.0000	+0.5750	0.3306	3.9913	+117
9	17.4250	0.0000	0.0000	3.9784	-12
10	17.0000	-0.4250	0.1806	3.9847	+51

Comp $R^2 = 3.9796$

	y	$y - y_0$	Δy	$(y - y_0)^2$
1	18.0000	-1.5430	-2	2.3814
2	18.3088	-1.2342	-1	1.5235
3	19.0000	-0.5430	-1	0.2949
4	19.5430	0.0000	0	0.0000
5	20.0000	+0.4570	0	0.2088
6	20.7771	+1.2341	+1	1.5233
7	21.0000	+1.4570	+1	2.1231
8	21.4561	+1.9131	+2	3.6607
9	21.5374	+1.9944	+2	3.9784
10	21.4932	+1.9502	+2	3.8041

Alpha Center $x = 19.0$ $y = 18.3088$

$$\begin{array}{r} 20.7771 \\ 39.0859 \end{array}$$
 $y_0 = 19.5430$ $y_{\text{max}} = 21.5374$ $R = 1.9944$ $x_{\text{max}} = 19.4194$ $x_0 = 17.4250$

Center $\begin{cases} x_0 = 17.4250 \\ y_0 = 19.5430 \end{cases}$

2011

Moon's Center

	x	$x - x_0$	$(x - x_0)^2$	$(x - x_0)(y - y_0)$	$y - y_0$
1	186993	+12743	16238	40052	+256
2	190000	+15750	24808	40043	+247
3	193514	+19264	37110	40059	+263
4	194194	+19944	39776	39776	+20
5	193744	+19494	38002	40090	+294
6	190000	+15750	24808	40041	+245
7	187941	+13691	18745	39976	+180
8	180000	+05750	03306	39913	+117
9	174250	00000	00000	39784	-12
10	170000	-04250	01806	39847	+51

Comp R = 39796

	y	$y - y_0$	Δy	$(y - y_0)^2$
1	1800000	-15430	-2	23819
2	183088	-12342	-1	15231
3	190000	-05430	-1	02949
4	195430	00000	0	00000
5	200000	+04570	0	02058
6	207771	+12341	+1	15233
7	210000	+14570	+1	21231
8	214561	+19131	+2	36607
9	215374	+19944	+2	39784
10	214932	+19502	+2	38041

Apfr Center $x = 19.0$ $y = 183088$ 207771

390859

 $y = 195430$ $y_{max} = 215374$ $R = 19944$ $x_{max} = 194194$ $x = 174250$ Center $\begin{cases} x = 174250 \\ y = 195430 \end{cases}$

Formation of normals.

	ab	an	bn
1	- 1.96	+ 325.5	- 394.5
2	- 1.94	+ 390.0	- 304.0
3	- 1.04	+ 507.5	- 142.0
4	+ 0.00	- 140.0	- 00
5	+ 0.90	+ 574.0	+ 135.2
6	+ 1.94	+ 385.0	+ 302.0
7	+ 2.00	+ 246.5	+ 262.8
8	+ 1.11	+ 67.8	+ 223.5
9	+ 0.00	- 00	- 239
10	- 0.82	- 214	+ 99.5
	+ 0.19	+ 2464.9	+ 158.6

Residuals —

	0		C		0 - C
1	+ 256	+ 180 - 10 =	+ 170		+ 86
2	+ 247	+ 223 - 8 =	+ 215		+ 32
3	+ 263	+ 272 - 4 =	+ 268		- 5
4	- 20	+ 281 + 0 =	+ 281		- 301
5	+ 294	+ 275 + 3 =	+ 278		+ 16
6	+ 245	+ 223 + 8 =	+ 231		+ 14
7	+ 180	+ 193 + 10 =	+ 203		- 23
8	+ 117	+ 82 + 13 =	+ 95		+ 22
9	- 12	+ 0 + 14 =	+ 14		- 26
10	+ 51	- 59 + 13 =	- 46		+ 97
					+ 267 - 355
					Average = 62

2011 Moon's Center.

	a	b	0	c	0-c
1	+1.27	-1.54	= +256	+170 - 17 = +159	+ 97
2	+1.58	-1.23	= +247	+211 - 8 = +203	+ 44
3	+1.93	-0.54	= +263	+258 - 4 = +254	+ 9
4	+1.99	+0.00	= -20	+266 + 0 = +260	-280
5	+1.95	+0.46	= +294	+260 + 3 = +263	+ 31
6	+1.58	+1.23	= +245	+211 + 8 = +219	+ 26
7	+1.57	+1.46	= +180	+183 + 10 = +193	- 13
8	+0.58	+1.91	= +117	+ 77 + 13 = + 90	+ 27
9	+0.00	+1.99	= -12	+ 0 + 14 = + 14	- 26
10	-0.42	+1.95	= +51	- 56 + 13 = - 43	- 94

Average = 6.5

Normal Equations.

$$\begin{aligned}
 &+18.47 + 0.19 = +2465 \\
 &+ 0.19 + 19.50 = +159 \\
 &- 0.19 - 0.00 = -25 \\
 &\quad + 19.50 = +134 \\
 &+18.47 = +2465 - 2 = +2463
 \end{aligned}$$

$$b = +9.46.9$$

$$a = +133.5$$

corrected solution giving (4) iwt

$$\begin{aligned}
 &+17.48 + 0.19 = +2465 \\
 &+ 0.19 + 19.50 = +159 \\
 &- 0.19 - 0.00 = -27 \\
 &\quad + 19.50 = +132
 \end{aligned}$$

$$b = 6.8$$

$$a = +16.8$$

$$+17.48 = +2465 - 1 = +2464$$

$$a = +141.1$$

Arc measured = 152° Average (0-c) = -8.8

$$\frac{PC}{m} = 0.16$$

$$- \frac{8.8}{16} = -0.55 \quad \Delta z = -0.6$$

2011 Miron's Center

	a	b	c		c	0-c	
1	+1.27	-1.54	= +2.56	+1.70	-1.1	= +1.59	+ 97
2	+1.58	-1.23	= +2.97	+2.11	- .8	= +2.03	+ 44
3	+1.93	-0.54	= +2.63	+2.58	- .4	= +2.54	+ 9
4	+1.99	+0.00	= -2.0	+2.66	+ 0	= +2.60	-2.80
5	+1.45	+0.46	= +2.94	+2.66	+ .3	= +2.63	+ 31
6	+1.58	+1.23	= +2.45	+2.11	- .8	= +2.19	+ 26
7	+1.37	+1.46	= +1.80	+1.83	+1.0	= +1.93	- 13
8	+0.58	+1.91	= +1.17	+ .77	+1.3	= +.90	+ 27
9	+0.00	+1.99	= -1.2	+ .0	+1.4	= +1.4	- 26
10	-0.42	+1.95	= +.51	- .56	-1.3	= -4.3	+ 94

Average 65

Normal Equations

$$+18.47 + 0.19 = +24.65$$

$$+ 0.19 + 19.50 = +1.59$$

$$- 0.19 - 0.00 = + 2.5$$

$$+ 19.50 = + 1.34$$

$$+18.47 = +24.65 - 2 = +24.64$$

$$b = +446.9$$

$$a = +133.5$$

corrected solution from (4) out

$$+17.48 + 0.19 = +24.65$$

$$+ 0.19 + 19.50 = +1.59$$

$$- 0.19 - 0.00 = - 2.7$$

$$+ 19.50 = + 1.32$$

$$+17.48 = +24.65 - 1 = +24.64$$

$$b = 6.8$$

$$b = 76.8$$

$$a = +191.1$$

Arc measured: 152° Average (2-6) = -8.8

$$\frac{p_c}{m} = 0.16$$

$$- \frac{8.8}{10} = -0.88 \quad \Delta = -0.6$$

2011 Moon's mean Position (1912.0)

18

corrected sol.

$$\begin{array}{r}
 X_0 = 17.4250'' \\
 + 67'' \\
 \hline
 17.4317''
 \end{array}
 \quad
 \begin{array}{r}
 Y_0 = 19.5430'' \\
 + 3'' \\
 \hline
 Y = 19.5433''
 \end{array}
 \quad
 \begin{array}{r}
 17.4250'' \\
 + 71'' \\
 \hline
 17.4321''
 \end{array}$$

$$\begin{array}{r}
 \text{Jewin plate constant } X = 17.3414'' \\
 17.3418''
 \end{array}
 \quad
 \begin{array}{r}
 Y = 19.5456'' \\
 19.5456''
 \end{array}$$

$$\begin{array}{r}
 \bar{z} = -0.6586'' - 0.6582'' \\
 \eta = -2.4544''
 \end{array}$$

$$\begin{array}{r}
 \log \bar{z} \quad 9.81862'' \quad 9.81836'' \\
 \log \cos \delta \quad 9.99267'' \\
 \log \text{const} \quad 8.50724''
 \end{array}
 \quad
 \begin{array}{r}
 \log \tan \delta \quad 9.2680'' \\
 \log \bar{z} \quad 9.6372'' \\
 \log \eta \quad 5.9586''
 \end{array}$$

$$\begin{array}{r}
 \log (\delta - A) \quad 0.31871'' \quad 1.31845'' \\
 \log \eta_0 = -2.4545''
 \end{array}$$

$$\begin{array}{r}
 \delta - A \quad -20.83'' (-20.82'') \\
 \log \eta_0 = 0.38996'' \\
 7.33115''
 \end{array}$$

$$\begin{array}{r}
 \delta_0 \quad 1'' 32'' 11.17'' (11.18'') \\
 \log (\delta - D) = 3.05881''
 \end{array}$$

$$\begin{array}{r}
 \text{Red adl. app.} \quad + 3.19'' \\
 \delta - D = -19.05.0''
 \end{array}$$

$$\begin{array}{r}
 \delta' = 1'' 32'' 14.36'' (14.37'') \\
 \delta = +10.48.51''
 \end{array}$$

$$\begin{array}{r}
 S_0 \quad +10^\circ 29' 46''.0''
 \end{array}$$

$$\text{Cor to star radius} = 0.03$$

$$\begin{array}{r}
 \text{Red adl. app.} \quad + 22.7''
 \end{array}$$

$$\begin{array}{r}
 \delta' = +10.30.08.7''
 \end{array}$$

$$\text{Cor to star radius} = 0.2$$

2011 known mean Position (1912.0)

18

corrected sol

$$\begin{array}{r} X_1 = 174250 \\ + 67 \\ \hline 174317 \end{array}$$

$$\begin{array}{r} Y_1 = 195430 \\ + 3 \\ \hline Y = 195433 \end{array}$$

$$\begin{array}{r} 174250 \\ + 71 \\ \hline 174321 \end{array}$$

$$\text{known plate constant } X = 173414 \quad Y = 195456$$

$$(173918 \quad \quad \quad)$$

$$\beta = -0.6586 \quad -0.6582 \quad \eta = -24544$$

$$\log \beta \quad 9.81862 \quad \log \tan \delta \quad 9.2680$$

$$\cos \beta \quad 9.99267 \quad \beta' \quad 9.6372$$

$$\cos \delta \quad 9.50724 \quad \eta_1 \quad 5.9586$$

$$\eta_2 = +1$$

$$(x-d) \quad 3.1871 \quad 1.31845$$

$$\eta_0 = -24545$$

$$x-H \quad -20.83 \quad (-20.42)$$

$$\log \eta_1 = 0.38996$$

$$7.33115$$

$$A \quad 1.32 \quad 32$$

$$d_0 \quad 1^m 32 \quad 11.17 \quad (11.18) \quad (J-D) = 3.05881$$

$$\text{Radial app.} \quad +3.19 \quad S-D = 19.050$$

$$d' \quad 1^m 32 \quad 14.36 \quad (14.37) \quad D = 410.48.51$$

$$S_0 \quad +10^\circ 29' 46.0$$

$$\text{Corr to true radius} = 0.02$$

$$\text{Radial app.} \quad +22.7$$

$$S' \quad +10^\circ 30' 08.7$$

$$\text{Corr to true radius} = 0.2$$

2011 Rediad E. affr.

19

$$\begin{array}{rcl}
 H + \alpha & 7 & 11 = 107^\circ 45' \\
 H & 5 & 39 \\
 \alpha & 1 & 32 \\
 G & 21 & 36 \\
 G + \alpha & 23 & 08 = 347^\circ
 \end{array}$$

$$S_0 = +10^\circ 30'$$

$$\begin{array}{rcl}
 \log L & = & 0.9095 \\
 \cos \delta & = & 9.9927 \\
 (L) & & 0.9022
 \end{array}$$

$$\begin{array}{rcl}
 \log \cos(G + \alpha) & 9.9887 & \\
 " \sin(G + \alpha) & 9.3521 & m \\
 " \tan \delta & 9.2680 & \\
 " \frac{1}{\tan} & 8.8239 &
 \end{array}$$

$$\begin{array}{rcl}
 \log \sin S_0 & = & 9.2606 \\
 " \cos(H + \alpha) & = & 9.4841 m \\
 " L & = & 1.2740 \\
 " \sin(H + \alpha) & = & 9.9788 \\
 " \sec \delta & = & 0.0073 \\
 " \frac{1}{\tan} & = & 8.8239
 \end{array}$$

$$\begin{array}{rcl}
 \log(g') & = & 1.1986 \\
 (g') & = & 8.6539 m
 \end{array}$$

$$\begin{array}{rcl}
 \log(h') & & 0.0187 m \\
 (h') & & 0.0840
 \end{array}$$

$$\begin{array}{rcl}
 f & + & 2.03 \\
 (g') & - & 0.05 \\
 (h') & + & 1.21 \\
 \hline
 & + & 3.19
 \end{array}$$

$$\begin{array}{rcl}
 (g') & + & 15.80 \\
 (h') & - & 1.04 \\
 (L) & + & 7.98 \\
 \hline
 & + & 22.74
 \end{array}$$

2011 Red. and L. app.

19

$$\begin{array}{rcl}
 H + \alpha & 7 & 11 = 107^\circ 45' \\
 H & 5 & 39 \\
 \alpha & 1 & 32 \\
 G & 21 & 36 \\
 G + \alpha & 23 & 08 = 347^\circ
 \end{array}$$

$$S_0 = +10^\circ 30'$$

$$\begin{array}{rcl}
 \log l & = & 0.9095 \\
 \cos \delta & = & 9.9927 \\
 (l) & & 0.9022
 \end{array}$$

$$\begin{array}{rcl}
 \log \cos(G + \alpha) & 9.9887 \\
 g & 1.2099 \\
 \sin(G + \alpha) & 9.3521 m \\
 \tan S & 9.2680 \\
 \tan & 8.8239
 \end{array}$$

$$\begin{array}{rcl}
 \log \sin S_0 & = & 9.2606 \\
 \cos(H + \alpha) & = & 9.4841 m \\
 l & = & 1.2740 \\
 \sin(H + \alpha) & = & 9.9788 \\
 \sec S & = & 0.0073 \\
 \tan & = & 8.8239
 \end{array}$$

$$\begin{array}{rcl}
 \log(g') & = & 1.1986 \\
 (g) & = & 8.6539 m
 \end{array}$$

$$\begin{array}{rcl}
 \log(l') & = & 0.0187 m \\
 (l) & = & 0.0840
 \end{array}$$

$$\begin{array}{rcl}
 f & + & 2.03 \\
 g' & - & 0.05 \\
 (h) & + & 1.21 \\
 \hline
 & + & 3.19
 \end{array}$$

$$\begin{array}{rcl}
 g' & + & 15.80 \\
 (h') & - & 1.04 \\
 (l) & + & 7.98 \\
 \hline
 & + & 22.74
 \end{array}$$

2011

Lunar parallax.

$$\begin{aligned} \alpha' &= 1^h 32^m 14.36^s (14.37) \delta = +10^\circ 30' 08.7'' \\ \Theta &= 221^\circ 37.7' \\ \Theta - \alpha' &= +49^\circ 23.3' \\ &= +12^\circ 21' \end{aligned}$$

$$\begin{aligned} &+ 5 \\ &+ 12^\circ 16' \end{aligned}$$

$$\begin{aligned} &9.95727 \\ &0.00000 \\ &0.01003 \end{aligned}$$

$$\tan f = 9.96730$$

$$f = 42^\circ 50' 41.7''$$

$$\delta = +10^\circ 30' 08.7''$$

$$f - \delta = +32^\circ 20' 33.0''$$

$$\begin{aligned} &9.82640 \\ &8.21255 \\ &9.72834 \\ &0.16748 \end{aligned}$$

$$\sin(\delta - \delta') = 7.93477$$

$$\delta - \delta' = +29^\circ 35.0''$$

$$\delta = +10^\circ 59' 43.7''$$

$$\text{Cor Eph. } \delta = +10^\circ 59' 41.2''$$

$$O - C = +2.5''$$

$$\text{Cor. to true radius} = -0.2$$

$$\text{Corr. } (O - C) = +2.3$$

$$\pi = 56' 05.1''$$

$$\begin{aligned} &9.86913 \\ &8.21255 \\ &9.33018 \\ &0.00804 \end{aligned}$$

$$\sin(\delta - \delta') = 7.41990$$

$$\delta - \delta' = +9^\circ 02.91''$$

$$= +36.16''$$

$$\alpha = 1^h 32^m 50.53''$$

$$\alpha = 1^h 32^m 50.03''$$

$$+0.49''$$

$$+0.450$$

$$-0.03$$

$$+0.47$$

2011

Lunar parallax

$$\begin{array}{rcl}
 \alpha' & = & 1^h 32^m 14.36 (14.37) \text{ s} = +10^{\circ} 30' 08.7 \\
 \Theta & = & 2 \quad 21 \quad 37.7 \\
 O-\alpha & = & +49 \quad 23.3 \\
 & = & +12^{\circ} 21'
 \end{array}$$

$$\begin{array}{r}
 +5 \\
 +12 \quad 16
 \end{array}$$

$$\begin{array}{r}
 9.95727 \\
 0.00000 \\
 0.01003 \\
 \hline
 \end{array}$$

$$\log f = 9.96730$$

$$f = 42 \quad 50 \quad 41.7$$

$$S = +10 \quad 30 \quad 08.7$$

$$f-d = -32 \quad 20 \quad 33.0$$

$$\begin{array}{r}
 9.92640 \\
 8.21255 \\
 9.72834 \\
 0.16748 \\
 \hline
 \end{array}$$

$$\log(S-S') = 7.93477$$

$$S-S' = +29 \quad 35.0$$

$$S = 10 \quad 59 \quad 43.7$$

$$\text{Corr Eph. } S = +10 \quad 59 \quad 41.2$$

$$O-C = +2.5$$

$$\text{Correction radius} = -0.2$$

$$\text{Corr}(O-C) = +2.3$$

$$\pi = 56' 05.1$$

$$9.86913$$

$$8.21255$$

$$9.33018$$

$$0.00804$$

$$\sin \delta - \delta' = 7.41990$$

$$\alpha - \alpha' = +9' 02.91$$

$$= +36.16$$

$$(50.53)$$

$$\alpha = 1 \quad 32 \quad 50.52$$

$$\alpha = 1^h 32 \quad 50.03$$

$$+0.49$$

$$+0.150$$

$$-0.03$$

$$+0.47$$

2

1

69

180

2

27

17

3

28

31

2012 Stars - measures

1913 December 12

	d	u
1	20377	17760
69	1510000	13025
185	00	3227
	95	56
	<u>18.5286</u>	<u>.5276</u>

225	18447	15935
134	14326	10050
	3027	4840
	47	30
	<u>13.4119</u>	<u>.4112</u>

3	17274	15571
285	13279	895080
314	19	50
	37	52
	<u>31.4011</u>	<u>.3392</u>

	d	u
	11019	12702
	10415	0910
	180	12136
	<u>6.9395</u>	<u>.9426</u>

	18550	17671
	14250	11940
	4249	4148
	50	71
	<u>27.5697</u>	<u>.5728</u>

	18372	16184
	1283030	1168991
	26	91
	82	56
	<u>28.4450</u>	<u>.4470</u>

Grade 4.

Remeasure (3) direct

14320
10920
2020
10
<u>.3397</u>

2012 Stars - measures

1913 December 12.

	d	u
1	20377	17760
19	15100	13025
15	0000	3227
	95	56
	<u>18.5286</u>	<u>5276</u>

	d	u
275	18447	11935
134	14326	10050
	3027	4840
	47	30
	<u>13.4119</u>	<u>4112</u>

	d	u
285	17224	15571
314	13279	8950
	19	50
	37	52
	<u>31.4011</u>	<u>3392</u>

	d	u
11018	12702	
10415	0910	
1810	12136	
	<u>6.9395</u>	<u>9426</u>

	d	u
18550	17671	
14250	11940	
4249	4145	
50	71	
	<u>27.1697</u>	<u>5728</u>

	d	u
18372	16184	
12830	11689	
26	9191	
82	56	
	<u>28.4450</u>	<u>4470</u>

Grade 4.

measure (3) direct

14320
10920
2020
10
<u>3397</u>

2012 known - measures.

	a	b	c	d	e
1	16201	18455			
19.0	1252808	12116			
18.4	1010	1518			
	16	45			
	<u>18.3693</u>	<u>.3667</u>			

2
19.2
19.0

15610	18859
758000	1683219
9792	33
20	39
<u>19.1974</u>	<u>.2023</u>

3
19.2
19.3
max
19.4
19.5

14572	19851
6673	17705
8071	8985
80	51
<u>192097</u>	<u>.2161</u>

4
19.1
19.0

10299	14698
9908	1382218
9431	22
<u>19.0871</u>	<u>.0877</u>

5
19.0 19990
19.2 18028
3930
09
20.1962

20018
1195972
6872
11
.1954

6
18.2
21.0

19970	15947
1234029	13609
2829	9510
85	45
<u>18.2350</u>	<u>.2342</u>

2012

known - measures.

	a	b	c	d	e
1	16201	18455			
190	1252808	12116			
184	1010	1518			
	16	45			
	<u>183693</u>	<u>3667</u>			

2		15610	18859
192		758000	1683219
190		9792	33
		20	39
		<u>191974</u>	<u>2023</u>

3		14172	19851
192		6673	17705
193		8071	8955
		80	51
		<u>192097</u>	<u>2161</u>

4		10299	14698
191		9908	1382218
200		9431	22
		<u>190871</u>	<u>0877</u>

5		20018
190	19990	1195972
200	18028	68
	3930	11
	09	
	<u>201962</u>	<u>1954</u>

6		19970	15947
192		12340	13609
210		2829	9510
		85	45
		<u>182350</u>	<u>2342</u>

2
2
18
21
8
17.
21.
21.
21.
21.

2012

moon-measures

23

α
 γ
 14073
 18.0 1256880
 21.1 70

α
 γ
 1037080
 5280
 9220

α
 γ
21.1200

α
 γ
1157

α
 γ
 18460
 17.3 1572020
 21.3 20
 may 71
 21.2743

α
 γ
 16210
 898886
 8786
 52
2236

α scratch
 16.8 17480
 21.2 1519700
 01
 02

21.2286

17329
 965049
 4649
 60

2274

17990
 16039
 3135-
 05-

16.8042

16731
 8705-
 9202
 31

8031

2012

Lyon - measures

23

$\begin{array}{r} 14073 \\ 180 \quad 124680 \\ 211 \quad 70 \\ \hline 211200 \end{array}$

$\begin{array}{r} 1037080 \\ 82 \\ 9220 \end{array}$

$\begin{array}{r} 1157 \end{array}$

$\begin{array}{r} 14460 \\ 173 \quad 1572020 \\ 213 \quad 20 \\ 71 \\ \hline 212793 \end{array}$

$\begin{array}{r} 16210 \\ 898806 \\ 87 \\ 52 \\ \hline 2736 \end{array}$

$\begin{array}{r} 17440 \\ 212 \quad 1519700 \\ 01 \\ 02 \end{array}$

$\begin{array}{r} 212286 \end{array}$

$\begin{array}{r} 17329 \\ 965049 \\ 46 \\ 60 \end{array}$

$\begin{array}{r} 2294 \end{array}$

$\begin{array}{r} 17990 \\ 16039 \\ 315 \\ 05 \end{array}$

$\begin{array}{r} 168042 \end{array}$

$\begin{array}{r} 16731 \\ 8705 \\ 9202 \\ 31 \end{array}$

$\begin{array}{r} 5031 \end{array}$

2012 Times etc

Sept to Oct 1912 Sept 27	2 ^h	29 ^m	-2 ^h 41 ^m
" noon	2	34	49.8 ^v - 2 34 50.0 ^v
clock slow		0	43.1 ^v
H. sid T.	2	35	33.0 ^v
H. hour	4	44	31.05 ^v
G. sid T.	7	20	04.05 ^v
Sid T. to noon	12	23	37.68 ^v
Interval	18	56	26.37 ^v
Reduction		3	06.18 ^v
G. M. T.	18	53	20.19 ^v $\alpha = +1^{\circ} 02'$

From hand. alim.	R - G	Head.
noon 19 ^h	1 ^v 33 ^m 29.90 ^v	+ 11 ^h 04 ^m 35.10 ^v
motion 1 ^m 1.9410 ^v		14.294 ^v
" " -6.6635 ^v	-12.93 ^v	- 1 35.2 ^v
Tabular place	1 33 16.97 ^v	+ 11 02 59.8 ^v

moon's age	17 days.
parallax	56' 05.4 ^v
semidiameter	15' 18.6 ^v
R	918.6 ^v
Augmentation	+ 12.6 ^v
Irradiation (43)	- 0.8 ^v
R	930.9 ^v
R	1.9944 ^v
(1+a) R	1.9946 ^v
R ²	3.9784 ^v

$$934 = 13.0^{\circ} \checkmark$$

$$918.6 = 12.6^{\circ}$$

$$\alpha = +1.2$$

2012	Tanner et al					
Subtotal	1912 Sept 27	2 ⁺	29 [~]		- 2 ⁺	41 [~]
moon		2	34	49.4	- 2	34
clock phase			0	43.1		50.0
H. bid. I		2	35	33.0		
H. comp		4	44	31.05		
G. bid. I		7	20	04.05		
Subtotal moon		12	23	37.65		
Interval		18	56	26.37		
Reduction			3	06.18		
G. m. T.		18	53	20.190	- 2	+ 1.02

Jann Kant. Allen	R. G.	Black.	
moon 19 ⁺	1 ⁺	33 [~]	29.90
moon 1 [~] 1.9410			+ 11 ⁺ 04 ⁺ 35 [~] 0
-6.6635			14.294
			- 12.93
Tubular phase	1	33	16.97
			+ 11 ⁺ 02 ⁺ 59.8

moon's age	17 days.
parallax	56' 05" 4
semidiameter	15' 18.6
R	918.6
Amplification	1 13.6
Transmittance	- 0.8
R	930.9
R	1.9944
a = +1.2	(+a) R
	R ²
	1.9946
	3.9784

2012

25

$$\begin{array}{rclcl}
 x & 69410 & 27.5712 & 28.4460 \\
 \bar{x} & 7.6091 & 28.2901 & 28.9779 \\
 x-\bar{x} & -6681 & -7189 & -5319
 \end{array}$$

$$\begin{array}{rclcl}
 y & 18.5278 & 13.4116 & 31.3394 \\
 \bar{y} & 19.1030 & 14.2025 & 32.1409 \\
 y-\bar{y} & -5752 & -7909 & -8010
 \end{array}$$

$$\begin{array}{rclclcl}
 x-\bar{x} & -104.34 & & -1.2x & & +8621 \\
 -6681 & -1932 & = & -8613 & - & 8 = -8629 = 0 \\
 -7189 & -1399 & = & -8588 & - & 33 = -8624 = 0 \\
 -5319 & -3269 & = & -8588 & - & 34 = -8622 = -1 \\
 17.2262 & -2011 & & -21 & & = 17.8851 \checkmark
 \end{array}$$

$$\begin{array}{rclclcl}
 y-\bar{y} & +104.7x & & +0.5y & & +5016 \\
 -5752 & +727 & = & -5025 & + & 9 = -5016 = 0 \\
 -7909 & +2887 & = & -5022 & + & 7 = -5015 = +1 \\
 -8010 & +2979 & = & -5032 & + & 16 = -5016 = 0 \\
 19.2800 & +1804 & & +10 & & = 19.9630 \checkmark
 \end{array}$$

$$\begin{array}{lclcl}
 \text{Tables} & a = -0.5 & c = -2.1 & a-c = +1.6 & b+a = -0.8 \\
 \text{Obs} & a = +1.2 & c = -0.5 & a-c = +1.7 & b+a = -0.4
 \end{array}$$

1012

25

2	6.9410	27.5712	28.4464
3	7.6091	28.2901	28.9779
2-3	-6681	-7189	-5319

4	18.5278	13.4116	31.3394
4-3	19.1030	14.2025	32.1409
4-2	-5752	-7909	-8010

2-3	-10434	-1.2	+8621
-6681	-1932	-8613	-8621
-7189	-1399	-8588	-8621
-5319	-3269	-8588	-8622
17.2262	-2011	-21	17.8851

4-3	+10472	+0.54	+15016
-5752	+727	-5025	-5016
-7909	+2887	-5022	-5015
-8010	+2974	-5032	-5016
19.2800	+1804	+10	19.9630

Tables: $a = -0.5$ $a = -2.1$ $a = -2.3 + 1.6$ $b + a = -0.8$
 Obs $a = +1.2$ $a = -0.5$ $a = -2 = +1.7$ $b + a = -0.4$

pt.	pos. 4	resid.
1	117.3	-5
2	98.2	-51
3	90.0	-417
4	88.9	+49
5	62.7	+67
6	30.5	-25
7	22.9	-15
8	0.0	-17
9	347.8	-7

2012

Moon - Measures.

24

	x	$x - x_0$	Δy	$(x - x_0)^2$	$(x - x_0)^2 + (y - y_0)^2$	$O - C$
1	19.0000	+1.7750	-1	3.1503	3.9859	+75
2	19.1998	+1.9748	0	3.8998	3.9793	+9
3	19.2129	+1.9879	0	3.9417	3.9417	-367
4	19.0879	+1.8624	0	3.4685	3.9841	+67
5	19.0000	+1.7750	+1	3.1509	3.9861	+77
6	18.2346	+1.0096	+1	1.0195	3.9717	-67
7	18.0000	+0.7750	+1	0.6008	3.9717	-67
8	17.2250	0.0000	+1	0.0000	3.9689	-95
9	16.8036	-0.4214	+1	0.1775	3.9691	-93

Comp R^2 3.9784

	y	$y - y_0$	Δy	$(y - y_0)^2$
1	18.3680	-0.9140	-1	0.8356
2	19.0000	-0.2820	0	0.0795
3	19.2820	0.0000	0	0.0000
4	20.0000	+0.7180	+1	0.5156
5	20.1958	+0.9138	+1	0.8352
6	21.0000	+1.7180	+2	2.9522
7	21.1178	+1.8358	+2	3.3709
8	21.2740	+1.9920	+2	3.9689
9	21.2290	+1.9470	+2	3.7916

$$\begin{aligned}
 x &= 19.0 & y &= 18.3680 \\
 & & & 20.1958 \\
 & & & \hline
 & & & 3.85638 \\
 y_0 &= 19.2819 \\
 y_{\text{max}} &= 21.2740 \\
 R &= 1.9921 \\
 x_{\text{max}} &= 19.2129 \\
 x_0 &= 17.2208
 \end{aligned}$$

$$\text{Ahh. Center } \left\{ \begin{aligned} x_0 &= 17.2250 \\ y_0 &= 19.2820 \end{aligned} \right.$$

2012

Moon Measures

26

	x	$x - x_0$	Δy	$(x - x_0)^2$	$(x - x_0)^2 + (y - y_0)^2$	$O - C$
1	19.0000	+1.7750	-1	3.1503	3.9859	+75
2	19.1998	+1.9748	0	3.8998	3.9793	+9
3	19.2129	+1.9879	0	3.9417	3.9417	-367
4	19.0879	+1.8624	0	3.4685	3.9841	+67
5	19.0000	+1.7750	+1	3.1509	3.9861	+77
6	18.2346	+1.0096	+1	1.0195	3.9717	-67
7	18.0000	+0.7750	+1	0.6008	3.9717	-67
8	17.2250	0.0000	+1	0.0000	3.9689	-95
9	16.8036	-0.4214	+1	0.1775	3.9691	-93

Comp R^2 3.9784

	y	$y - y_0$	Δy	$(y - y_0)^2$
1	18.3680	-0.9140	-1	0.8356
2	19.0000	-0.2820	0	0.0795
3	19.2820	0.0000	0	0.0000
4	20.0000	+0.7180	+1	0.5156
5	20.1958	+0.9138	+1	0.8352
6	21.0000	+1.7180	+2	2.9522
7	21.1178	+1.8358	+2	3.3709
8	21.2740	+1.9920	+2	3.9689
9	21.2290	+1.9470	+2	3.7916

$x = 19.0$ $y = 18.3680$
 $\quad \quad \quad 20.1958$
 $\quad \quad \quad 3.85638$
 $y_0 = 19.2819$
 $y \text{ max. } 21.2740$
 $R = 1.9921$
 $x \text{ max. } 19.2129$
 $x = 17.2208$

App. Center $\left\{ \begin{array}{l} x_0 = 17.2250 \\ y_0 = 19.2820 \end{array} \right.$

Formation of normals

	ab	am	
1	- 1.62	+ 133.5	- 68.2
2	- 0.55	+ 17.7	- 2.5
$\frac{1}{4} \text{ way}$ 3	+ 0.00	- 46.0	- 0.0
4	+ 1.34	+ 126.5	+ 48.2
5	+ 1.62	+ 137.0	+ 70.0
6	+ 1.74	- 67.8	- 115.0
7	+ 1.44	- 52.2	- 123.2
8	+ 0.00	- 6.0	- 189.0
9	- 0.82	+ 39.0	- 179.0
	<u>+ 3.15</u>	<u>+ 287.7</u>	<u>- 558.7</u>

Residuals -

	O		C	O - C
1	+ 75	+ 47 + 36	+ 83	- 8
2	+ 9	+ 52 + 11	+ 63	- 54
3	- 367	+ 52 - 0	+ 52	- 419 (105)
4	+ 67	+ 49 - 28	+ 21	+ 46
5	+ 77	+ 47 - 36	+ 11	+ 66
6	- 67	+ 26 - 68	- 42	- 25
7	- 67	+ 20 - 72	- 52	- 15
8	- 95	+ 0 - 78	- 78	- 17
9	- 93	- 11 - 77	- 89	- 4

+ 112 - 542 Average = 73
+ 112 - 228

2012

Moon's Center

27

Conditional Equations

	a	b	c	d	e	f
1	+1.78	-0.91	=	+75	+45+35	= +80
2	+1.97	-0.28	=	+9	+49+11	= +60
3	+1.99	+0.00	=	-367	+50 - 0	= +50
4	+1.86	+0.72	=	+67	+46 - 28	= +18
5	+1.78	+0.91	=	+77	+45 - 35	= +10
6	+1.01	+1.72	=	-67	+25 - 67	= -42
7	+0.78	+1.84	=	-67	+20 - 72	= -52
8	+0.00	+1.99	=	-95	+0 - 78	= -78
9	-0.42	+1.95	=	-93	-10 - 76	= -86

Average = 73

Excluding (3) = 27

Normal Equations

$$\begin{aligned}
 +16.45a + 3.15b &= +288 \\
 +3.15a + 16.35b &= -559 \\
 -3.15c - 0.60d &= -55 \\
 +15.75e &= -614 \\
 +16.45a + 288 + 123 &= +411
 \end{aligned}$$

$$b = -39.0$$

$$a = +25.0$$

Corrected solution giving (3) $\frac{1}{4}$ wt.

$$\begin{aligned}
 +15.71a + 3.15b &= +288 \\
 +3.15a + 16.35b &= -559 \\
 -3.15c - 0.63d &= -58 \\
 +15.72e &= -617
 \end{aligned}$$

$$b = -39.3$$

$$+15.71a + 288 + 124 = +412$$

$$a = +26.2$$

Area measured = 129°

average (d-e) = -14.1

$$\frac{P_e}{a} = 0.08$$

$$-\frac{14.1}{0.8} = -1.76$$

$$\Delta v = -1.9$$

2012

Moon Center

27

Conventional Equations

	a	b	c	d	e	f
1	+1.78	-0.91	+7.5	+4.5	+3.5	+8.0
2	+1.97	-0.28	+9	+4.9	+1.1	+6.0
3	+1.99	+0.00	-3.67	+5.0	0	+5.0
4	+1.86	+0.72	+6.7	+4.6	-2.8	+1.8
5	+1.78	+0.91	+7.7	+4.5	-3.5	+1.0
6	+1.01	+1.72	-6.7	+2.5	-6.7	-4.2
7	+0.78	+1.84	-6.7	+2.0	-7.2	-5.2
8	+0.00	+1.99	-9.5	+0	-7.8	-7.8
9	-0.42	+1.95	-9.3	-1.0	-7.6	-8.6

Average: 7.3

excluding (3): 2.7

Normal Equations

$$\begin{aligned}
 +16.45a + 3.15b &= +288 \\
 +3.15a + 16.35b &= +559 \\
 -3.15c - 0.60d &= -55 \\
 +7.57e &= -61.9 \\
 +16.45a + 288 + 123 + 411 &
 \end{aligned}$$

$$b = -39.0$$

$$a = +25.0$$

Connected solution group (3 1/4 wt)

$$\begin{aligned}
 +15.71a + 3.15b &= +288 \\
 +3.15a + 16.35b &= +559 \\
 -3.15c - 0.63d &= -58 \\
 +15.72e &= -61.7
 \end{aligned}$$

$$b = -39.3$$

$$+15.71a + 288 + 124 + 412$$

$$a = +26.2$$

Arc measured: 129°

average $\Delta\alpha = -1.4$

$$\frac{P_0}{\Delta} = 0.08$$

$$-\frac{1.41}{0.8} = -1.76$$

$$\Delta\alpha = -1.9$$

2012 Moon's Mean Position (1912.0)

28

$$\begin{array}{rcl}
 Y_0 = 17.2250^\circ & Y_0 = 19.2820^\circ \\
 \frac{1}{2}a = +12^\circ & \frac{1}{2}b = -20^\circ \\
 \hline
 17.2262^\circ & 19.2800^\circ
 \end{array}$$

Group late constant $X = 17.8851^\circ$ $Y = 19.9630^\circ$

$$\begin{array}{rcl}
 \Xi = -0.1149^\circ \\
 \log \Xi = 9.06032m \\
 \log S = 9.99260^\circ \\
 \therefore \text{const} = 8.50724
 \end{array}$$

$$\therefore (d-A) = 0.56048m$$

$$d-A = -3.63^\circ$$

$$A = 1^\circ 32' 32''$$

$$Y_0 = 1^\circ 32' 28.37''$$

$$\text{Red a.e. app.} + 3.19^\circ$$

$$\alpha' = 1^\circ 32' 31.56''$$

$$\text{arr. to stand. pos.} = -0.2$$

$$\eta = -2.0370^\circ$$

$$\log \tan S = 9.2715^\circ$$

$$\therefore \eta = 8.1206$$

$$\therefore \eta_1 = 4.4455^\circ$$

$$\therefore \eta_0 = 0.30899^\circ$$

$$7.35115$$

$$\therefore (d-l) = 2.97784m$$

$$d-l = -1.5502^\circ$$

$$D = +10^\circ 48' 51''$$

$$+10^\circ 33' 00.8''$$

$$S_0$$

$$\text{Red a.e. app.} + 22.7$$

$$S' = +10^\circ 33' 23.5''$$

$$\text{arr. to stand. n.} = -0.2$$

2012 Wilsons Mission Profile (19120)

28

$$\begin{array}{r}
 Y = 17.2250 \quad X = 19.2820 \\
 \hline
 \quad \quad + 12 \quad \quad \quad - 20 \\
 \hline
 17.2262 \quad \quad 19.2800
 \end{array}$$

From late instant $X = 17.8851 \quad Y = 19.9630$

$$\begin{array}{l}
 E = -0.1149 \\
 \log E = 9.06032 \\
 \log S = 9.99260 \\
 \text{const} = 8.50724
 \end{array}$$

$$(d - A) = 0.56048$$

$$A - A = \quad \quad \quad 363$$

$$A \quad 1 \quad 32 \quad 32$$

$$X. \quad 1 \quad 32 \quad 28.37$$

$$\text{Red and apph} \quad + \quad 3.19$$

$$d' \quad 1 \quad 32 \quad 31.56$$

$$\text{App instant radius} \quad -0.2$$

$$\eta = -2.0370$$

$$\log \tan S = 9.2715$$

$$S = 81.206$$

$$\eta_1 = 4.4455$$

$$\eta_0 = 0.30897$$

$$7.35115$$

$$(d-1) = 29.7784$$

$$d-1 = \quad \quad \quad 15 \quad 502$$

$$D : +10 \quad 48 \quad 51.$$

$$+10 \quad 33 \quad 00.8$$

$$S'$$

$$\text{Red and apph.} \quad + \quad 22.7$$

$$S' : +10 \quad 33 \quad 23.5$$

$$\text{App instant r.} \quad -0.2$$

2012

Lunar Parallax

29

$$\begin{array}{rcl}
 \alpha' & = & 1^{\circ} \quad 32' \quad 31.56'' \\
 \delta & = & 2 \quad 35 \quad 33.0'' \\
 \alpha - \alpha' & = & +1 \quad 03 \quad 07.4'' \\
 & = & +15^{\circ} \quad 45' \quad 22'' \\
 & + & \quad \quad 5 \quad 44 \\
 & + & 15 \quad 40
 \end{array}$$

$$\begin{array}{r}
 9.95727 \\
 0.00000 \\
 0.01644 \\
 \hline
 \text{true } \gamma = 9.97371
 \end{array}$$

$$\begin{array}{rcl}
 \gamma & = & 43 \quad 16 \quad 00'' \\
 \delta & = & +10 \quad 33 \quad 23.5''
 \end{array}$$

$$\gamma - \delta' = 32 \quad 42 \quad 36.5''$$

$$\begin{array}{r}
 9.82640 \\
 8.21259 \\
 9.73270 \\
 0.16406 \\
 \hline
 \sin(\gamma - \delta') = 7.93575
 \end{array}$$

$$\delta - \delta' = +29 \quad 39.0''$$

$$\delta = +11 \quad 03 \quad 02.5''$$

$$\text{true Eph } \delta = +11 \quad 02 \quad 59.8''$$

$$O - C = +2.7'' \quad +0.51''$$

$$\text{Corr between radius} = -0.2 \quad -0.02$$

$$O - C = +2.5 \quad +0.49$$

$$\delta' = +10 \quad 33 \quad 23.5''$$

$$\pi = 56 \quad 054''$$

$$\begin{array}{r}
 9.86913 \\
 8.21259 \\
 9.43383 \\
 0.00813 \\
 \hline
 \sin(\alpha - \gamma) = 7.52368
 \end{array}$$

$$\alpha - \alpha' = +11' \quad 28.83''$$

$$= +45.92''$$

$$\alpha = 1 \quad 33 \quad 17.48''$$

$$\alpha = 1 \quad 33 \quad 16.97''$$

2012 Lunar Parallax

29

$$\begin{array}{rcl}
 x' & = & 1 \quad 32 \quad 31.56 \\
 G & = & 2 \quad 35 \quad 33.0 \\
 G-x & = & +1 \quad 03 \quad 07.4 \\
 & = & +15'' \quad 45'' \quad 22'' \\
 & & + \quad \quad \quad 5 \quad 44 \\
 & & +15 \quad +0
 \end{array}$$

$$\begin{array}{r}
 995727 \\
 000000 \\
 001694 \\
 \hline
 997371
 \end{array}$$

Ampl

$$y = 43 \quad 16 \quad 00$$

$$S = 10 \quad 33 \quad 23.5$$

$$y-S = 32 \quad 42 \quad 36.5$$

$$\begin{array}{r}
 982640 \\
 821259 \\
 973270 \\
 016406 \\
 \hline
 993575
 \end{array}$$

$$\sin(G-S) = 79 \quad 35 \quad 75$$

$$S-S' = +29 \quad 38 \quad 0$$

$$S = +11 \quad 03 \quad 01.5$$

$$\text{Corr Eph } S = +11 \quad 02 \quad 59.8$$

$$O-C = +1.7 \quad +0.51$$

$$\text{Corr distance radius} = -0.2 \quad -0.02$$

$$O-C = +2.5 \quad +0.49$$

$$S' = +10 \quad 33 \quad 23.5$$

$$S = 56 \quad 05.4$$

$$986913$$

$$821259$$

$$943383$$

$$000873$$

$$\sin(X-V) = 75 \quad 23 \quad 68$$

$$Q-Q' = +11 \quad 28 \quad 83$$

$$+45 \quad 92$$

$$X = 1 \quad 33 \quad 17.48$$

$$X = 1 \quad 33 \quad 16.97$$

