

KG

11366

n.894

Volume XVII



Harvard Lunar
Plates



No.

1310

1311

1312

Harvard Lunar Plates
Measures and Reductions

Mary Fowler

Volume XVIII

Plate No.	Date	Page
1310	1911 Oct 7	1.
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MC1310				Stam. Corvelo				1913 Apr 30				1
C.No. 113				albanus				C.No. 142				
mg 8.1				mg 8.8				mg 6.2				
C	0	48	47.76	0	47	02.38	0	59	41.70			
L			82						71			
E			76						68			
Mean	0	48	47.78					0	59	41.70		
Prec			+34.09			+1	51.09			+34.15		
A	0	49	21.87	0	48	53.47	1	00	15.85			
A	0	55	23	0	55	23	0	55	23			
A-A	-	6	01.13	-	6	29.53	+	4	52.85			
Sin(A-A)			-361.09			-389.48	+		292.83			
log			2.55762			2.59049			2.46662			
cos			9.99812			9.99948			9.99822			
S ₀			1.06298			1.09721			0.97208			
S ₀	-		11.5605	-		12.5086			9.3774			
S ₁	-		78	-		65			46			
S			6.4317			5.4849			27.3820			
X			6.5410			5.4303			27.4810			
X-3			+1093			-546			+990			
C	+5°	15'	57.7	+2	37	23.9	+5°	07'	12.85			
L			57.7						13.6			
E			58.1						13.2			
Mean	+5	15	57.8					+5	07	13.2		
Prec			+3			+11	46.1			+3	33.0	
S	+5	19	33.3	+2	49	10.0	+5	10	46.2			
D	+3	47	57	+3	47	57	+3	47	57			
S-D	+1	31	36.3	-	58	47.0	+1	22	49.2			
Tan(S-D)			+5497.6			-3527.3			+4970.2			
log			3.74017			3.54745			3.69638			
η ₀			1.07132			0.87860			1.02753			
tan S			8.9695			8.6922			8.9574			
S ²			2.1260			2.1944			1.9442			
η ₁			8.1489			7.9400			7.9550			
m ₀	+1	1.7847		-	7.5613		+	1.0.6544				
m ₁	+		14.1	+	87		+		90			
η			33.7988			14.4474			32.6634			
q			33.9096			14.5721			32.5970			
q-η			+1108			+1247			-664			

Main Column				Star Columns				1913 Apr 20			
No. 113				No. 142				No. 142			
mag 8.1				mag 8.8				mag 6.2			
0 ^h 48 ^m 47 ^s 76				0 47 02 38				0 ^h 59 ^m 41 ^s 70			
L				L				L			
E				E				E			
mean				mean				mean			
P _{rec}				P _{rec}				P _{rec}			
A				A				A			
A				A				A			
x-A				x-A				x-A			
S _{unk-A}				S _{unk-A}				S _{unk-A}			
log ..				log ..				log ..			
cos δ				cos δ				cos δ			
B ₀				B ₀				B ₀			
B ₁				B ₁				B ₁			
B ₂				B ₂				B ₂			
x				x				x			
x-3				x-3				x-3			
C				C				C			
L				L				L			
E				E				E			
mean				mean				mean			
P _{rec}				P _{rec}				P _{rec}			
S				S				S			
D				D				D			
-D				-D				-D			
S _{unk-D}				S _{unk-D}				S _{unk-D}			
log ..				log ..				log ..			
no				no				no			
tan δ				tan δ				tan δ			
B ₂				B ₂				B ₂			
m				m				m			
m ₀				m ₀				m ₀			
m ₁				m ₁				m ₁			
m ₂				m ₂				m ₂			
y				y				y			
y-3				y-3				y-3			

MC1310 - Stand. Coords. Comp. Stars. 1913 Apr. 30.

2

Cape No. 144 mag 6.4
 C 1^h 00 38 76
 L 76
 B 73
 mean 1 00 38 75
 Prec + 34 08
 X 1 01 12 83
 A 0 55 23
 A-A + 5 49 83
 sin(A-A) + 349.80
 log 2.54382
 " cos 9.99870
 " $\sin$ 1.04976
 $\sin^2$ + 11.2140
 $\sin$ + 41
 $\sin^2$ 29.2181
 $\sin^2$ 29.2690
 $\sin^2 - 3$ + 509
 C + 4 22 33.3
 L 33.0
 E 32.6
 mean + 4 22 33.0
 Prec. + 3 31.5
 S + 4 26 04.5
 D + 3 47 57
 S. H + 3 38 07.5
 tan(S-D) + 2287.6
 log 3.35938
 " η 0.69053
 tan S 8.8896
 $\sin^2$ 2.0995
 $\sin$ 80425
 η_0 + 4.9038
 η_1 + 110
 η 26.9148
 η 26.8357
 $\eta - \eta$ - 791

C. No. 146 mag 8.0
 C 1 00 56 24
 L 29
 B 28
 mean 1 00 56 27
 Prec + 33.98
 X 1 01 30 25
 A 0 55 23
 + 6 07.25
 + 367.22
 2.56492
 9.99948
 1.07164
 + 11.7935
 + 56
 29.7991
 29.7459
 + 537
 + 2 44 22.7
 23.1
 22.3
 + 2 44 22.7
 + 3 32.7
 + 2 47 55.4
 + 3 47 57
 - 1 00 01.6
 - 3602.0
 3.55654
 0.88769
 8.6892
 2.1433
 7.8859
 - 7.7213
 + 77
 14.2864
 14.2028
 - 836

MC1310 - Stand. Coords Comp Stars. 1913 Apr. 30.

2

Cape W. 14⁴ mag 64C. W. 14⁶ mag 8.0.

C 1^h 00 38 76
 L 76
 B 73
 mean 1 00 38 75
 Prec + 34 08
 X 1 01 12 83
 A 0 55 23
 A-A + 5 49 83
 sm(A-A) + 349 80
 log 2.54382
 - log 9.99470
 3.0 1.04976
 3.0 + 11.2140
 5. 7. 41
 3 29.2181
 2 29.2690
 X-3 + 509

1 00 56 24
 29
 28
 1 00 56 27
 + 33 98
 1 01 30 25
 0 55 23
 + 6 07 25
 + 367 22
 2.56492
 9.99948
 1.07164
 + 11.7935
 + 56
 29.7991
 29.7454
 - 537

C +4 22 33.3
 L 330
 E 326
 mean +4 22 330
 Prec. + 3 31.5
 S +4 26 04.5
 D +3 47 57
 S. B + 38 07.5
 Tan(8-10) + 22 47.6
 log 3.35938
 " log 0.69053
 tan 8.8896
 3.0 2.0995
 3.0 80425
 y₀ +4.9038
 y₁ + 110
 y 26.9148
 y 26.8357
 J-y - 791

+2 44 22.7
 231
 223
 +2 44 22.7
 + 3 32.7
 +2 47 55.4
 +3 47 57
 -1 00 01.6
 - 36020m
 3.55654m
 0.88769m
 8.6892
 21433
 74859
 -7.7213
 + 77
 14.2864
 14.2024
 - 836

MC1310

1913 Mar 12. 3

Comp. Stars - Measures - Riscan reversed.

1	d	N	d	N
5A	18336	15501	17910	17412
745	1260911	1121318	1222017	1310106
mg	1811	1318	1317	04
8.8	31	82	10	90
	<u>14.5720</u>	<u>.5722</u>	<u>5.4307</u>	<u>.4299</u>
2	1106568	8100	15640	14662
66	64	719994	1104542	924852
33.9		0094	48	50
mg	10150		28	55
8.1				
	<u>339094</u>	<u>.9098</u>	<u>6.5411</u>	<u>.5409</u>
3	17110	15760		15000
27.5	1113030	1173230	16814	1018080
32.6	34	35	1161009	77
mg	90	60	1109	92
6.8			00	
	<u>32.5967</u>	<u>.5972</u>	<u>27.4802</u>	<u>.4817</u>
4	15350	16490	15245	18692
29.3	697180	1484138	7920	15996
26.8	7380	4238	1819	9895
mg	37	88	30	88
6.4				
	<u>26.8364</u>	<u>.8350</u>	<u>29.2685</u>	<u>.2695</u>
5	18785	15871	16065	14703
29.7	1675764	789600	1352111	723940
H.3	60	9500	11	39
mg	75	62	50	90
8.0				
	<u>14.2023</u>	<u>.2033</u>	<u>29.7453</u>	<u>.7454</u>

MC1310

1913 Mar 12. 3

Comp. Stars - measures - Russian reversed.

1	d	N	d	N
5A	18336	15501	17910	17412
195	12609	11213	12220	13101
mg	1811	1318	1317	0906
R.8	31	82	10	90
<u>14.5720</u>	<u>.5722</u>	<u>5.4307</u>	<u>4299</u>	
2				
66	11065	8100	15640	14662
33.9	64	7199	11045	9248
mg	10150	0094	48	50
R.1			28	55
<u>339094</u>	<u>.9098</u>	<u>6.5411</u>	<u>.5409</u>	
3				
27.5	17110	15760	15000	
32.6	11130	11732	10180	80
mg	34	35	77	
R.2	90	60	92	
<u>32.5967</u>	<u>.5972</u>	<u>274802</u>	<u>.4817</u>	
4				
24.3	15350	16490	15245	18698
26.8	6971	14841	7920	15996
mg	7380	4238	1819	9895
R.4	37	88	30	88
<u>26.8364</u>	<u>.8350</u>	<u>292685</u>	<u>.2695</u>	
5				
29.7	18785	15871	16065	14703
H.3	16757	7896	13521	7239
mg	60	00	11	40
R.0	75	95	50	39
<u>14.2023</u>	<u>.2033</u>	<u>29.7453</u>	<u>.7454</u>	

MAC 1310

1913 Mar. 12.

4

- Moon measures - Russian reversed

<u>1</u>	18151	18640
18.0	1006967	1671910
19.4	6167	01
	50	30

<u>19.8084</u>	<u>.8072</u>
----------------	--------------

<u>2</u>	1209085	13620
17.0	8585	1279104
19.9	11260	00

<u>19.9173</u>	<u>.9178</u>
----------------	--------------

<u>3</u>	17569	18120
16.8	15750	992031
20.0	6065	30
	65	10

<u>4</u>	17020	15497	<u>18.8190</u>	<u>.8185</u>
16.0	995855	1255050		
20.7	62	4250		
	12	85		

<u>20.7056</u>	<u>.7059</u>
----------------	--------------

<u>5</u>	15780	17540
15.8	1417060	912020
21.0	61	3520
	65	30

<u>6</u>	158386	<u>.8407</u>
15.7	18665	16605
22.0	15160	1006270
	7863	63
	55	98

<u>15.6505</u>	<u>.6537</u>
----------------	--------------

MAC 1310

1913 Mar. 12.

4

- Moon Measures - Results reversed

	d	N	d	N
1	18151	18640		
18.0	1006967	1671910		
19.8	61	01		
	50	30		

<u>19.8084</u>	<u>.8072</u>
----------------	--------------

2	17090	13620
17.0	85-85	1279104
19.9		00
	11260	

<u>19.9173</u>	<u>.9178</u>
----------------	--------------

3	17568	18120
16.8	15750	992031
20.0	60 65	30
	65	10

<u>18.8190</u>	<u>.8185</u>
----------------	--------------

4	17020	15497
16.0	995855	1255050
20.7	62	42
	12	85

<u>20.7056</u>	<u>.7059</u>
----------------	--------------

5	15780	17540
15.8	1417060	9120
21.0	61	35-20
	65	30

<u>15.8386</u>	<u>.8407</u>
----------------	--------------

6	18665	16605
15.7	15160	1006270
22.0	78 63	63
	55	98

<u>15.6505</u>	<u>.6537</u>
----------------	--------------

MC1310

1913 Mar. 12 5

Moon - measure - Residual reversed

$$\begin{array}{r} 2 \\ 16.0 \\ 23.0 \end{array}$$

$$\begin{array}{r} 13210 \\ 1311320 \\ 12 \end{array}$$

$$\begin{array}{r} 1048098 \\ 8798 \\ 10378 \end{array}$$
15.99059890

$$\begin{array}{r} 8 \\ 17.0 \\ 23.7 \end{array} \quad \begin{array}{r} 17585 \\ 951720 \\ 01 \\ 75 \end{array}$$

$$\begin{array}{r} 18115 \\ 1616070 \\ 6970 \\ 07 \end{array}$$
23.8064.8052

$$\begin{array}{r} 9 \\ 18.0 \\ 23.9 \end{array} \quad \begin{array}{r} 16540 \\ 734040 \\ 38 \\ 28 \end{array}$$

$$\begin{array}{r} 18172 \\ 1734254 \\ 55 \\ 71 \end{array}$$
23.9190.9178

$$\begin{array}{r} 10 \\ 19.0 \\ 23.5 \end{array} \quad \begin{array}{r} 16289 \\ 1132532 \\ 40 \\ 79 \end{array}$$

$$\begin{array}{r} 17230 \\ 1216969 \\ 64 \\ 30 \end{array}$$
23.4952.4936

$$\begin{array}{r} 11 \\ 19.4 \\ 23.0 \end{array}$$

$$\begin{array}{r} 16478 \\ 1102221 \\ 25 \\ 68 \end{array}$$

$$\begin{array}{r} 18511 \\ 1394840 \\ 39 \\ 00 \end{array}$$
19.4550.4564

$$\begin{array}{r} 12 \\ 19.7 \\ 22.0 \end{array}$$

$$\begin{array}{r} 15521 \\ 1333945 \\ 45 \\ 03 \end{array}$$

$$\begin{array}{r} 17423 \\ 955650 \\ 60 \\ 20 \end{array}$$
19.7826.7866

MC 1310

1913 Mar. 12

5

Moon. Measure

Residual reversed

$$\begin{array}{r} 2 \\ 16.0 \\ 23.0 \end{array}$$

$$\begin{array}{r} 13210 \\ 1311320 \\ 12 \end{array}$$

$$\begin{array}{r} 1048098 \\ 8798 \\ 10378 \end{array}$$
15.99059890

$$\begin{array}{r} 8 \\ 17.0 \\ 23.7 \end{array} \quad \begin{array}{r} 17585 \\ 951720 \\ 01 \\ 75 \end{array}$$

$$\begin{array}{r} 18115 \\ 1616070 \\ 69 \\ 07 \end{array}$$
23.8064.8052

$$\begin{array}{r} 9 \\ 18.0 \\ 23.9 \end{array} \quad \begin{array}{r} 16540 \\ 734040 \\ 38 \\ 28 \end{array}$$

$$\begin{array}{r} 18172 \\ 1734254 \\ 55 \\ 71 \end{array}$$
23.9190.9178

$$\begin{array}{r} 10 \\ 19.0 \\ 23.5 \end{array} \quad \begin{array}{r} 16289 \\ 1132132 \\ 40 \\ 79 \end{array}$$

$$\begin{array}{r} 17230 \\ 1216969 \\ 64 \\ 30 \end{array}$$
23.4952.4936

$$\begin{array}{r} 11 \\ 19.9 \\ 23.0 \end{array}$$

$$\begin{array}{r} 16478 \\ 1102221 \\ 25 \\ 68 \end{array}$$

$$\begin{array}{r} 18511 \\ 1394840 \\ 39 \\ 00 \end{array}$$
19.4550.4564

$$\begin{array}{r} 12 \\ 19.7 \\ 22.0 \end{array}$$

$$\begin{array}{r} 15521 \\ 1333945 \\ 45 \\ 03 \end{array}$$

$$\begin{array}{r} 17423 \\ 955650 \\ 60 \\ 20 \end{array}$$
19.7826.7866

1913 C 1310

1913 Mar. 12. 6

Moon measures

Research

Yours

d 4 v

a v

13

19.5

21.0

14577

1063010

10

60

16360

1030295

00

52

19.6047.605614

19.0 180.15

20.3 1569.198

94

00

15185

749092

91

73

20.7317.2315

1913 1310

1913 Mar. 12 6

mean measures

Research reversed

d y v

a v

13

15.5

21.0

14577

1063010

10

60

16360

1030295

00

52

19.60476056

14

19.0 18015

203 1569 198

99

00

15185

749092

91

73

20.23172315

1913 Mar 12

7

MC1310	Times Etc.					
Exp. to star	1911 Oct 7	1 ^h	50 ^m		- 2 ^h	02 ^m
"moon		1	55	53.2 ^v	1	55 53.6 ^v
clock slow			0	41.6		
				0		
H Sid. T.		1	56	35.0 ^v		
H Rong		4	44	31.05		
G Sid. T.		6	41	06.05 ^v		
Sid. T. m. moon		13	00	03.64 ^v		
Interval		17	41	02.41		
Reduction			2	53.83		
G m T.		17	38	08.58 ^v		

From Naut. Alm.						
Moon 17 ^h	0 ^h	54 ^m	44.42	+ 4	13	06.1 ^v
Motion in 1 ^m - 2.0440					16.106	
Motion in 38.143 ^v	+	1	17.96	+	10	14.3 ^v
Tabular place	0	56	023.8 ^v	+ 4	23	20.4 ^v

Moon's parallax
semidiam.

58' 20.2^v
15 55.3^v

1 1^h 27^m past full.

1913 Mar. 12.

7.

MC 1310 Times etc.

Exp. to Star	1911 Oct. 7	1 ^h 50 ^m	- 2 ^s 02 ^m
moon		1 55	53.2 - 1 55 53.6
clock slow		0	41.6
			0
H. Sid. T.		1 56	35.0
H. Range		4 44	31.05
G. Sid. T.		6 41	06.05
Sid. T. m. moon		13 00	03.64
Interval		17 41	02.41
Reduction		2	53.83
G. m. T.		17 38	08.59

From Trans. Alm.

moon 17 ^h	0 ^h 54	44.42	+ 4	13	06.1
Motion in 1 ^m - 2.0450				16.104	
Motion in 38.143	+ 1	15.00	+ 10	14.3	
Tabular place	0 56	02.48	14	23	20.4

Moon's parallax
semidiam.58' 20.2
15 55.11^h 27^m past full.

Tables $a = 0.0$ $e = -2.3$ $a - e = +2.3$ $b + a = -1.2$
 obs $a = +0.6$ $e = -2.8$ $a - e = +3.4$ $b + a = +0.1$

MC 1310

1913 April 30

Center of Plate.

x	y	$R.A.$	$Decl.$
5.43	14.57	0 49 22	+5 19 33
6.54	32.91	0 48 53	+2 49 10
27.48	32.60	1 00 16	+5 10 46
29.27	26.84	1 01 13	+4 26 04
29.75	14.20	1 01 30	+2 47 55
5198.47	12212	3 99 134	18 151 148
19.69	24.42	0 55 75	+4 06 42
-18.	-22	-52	-18 45
1.69	2.42	0 55 23	+3 47 59
31	465		
169	1210		
507	1452		
52.39	968		
	1125.30		
	1080		
	45		

$$A = 0^h 55^m 23^s$$

$$D = +3^\circ 47' 57''$$

Preliminary Reduction

$$\begin{aligned}
 x-5 & -854 & +1782 \\
 -546 -1239 & = -1785 & = -3 \\
 +1093 -2882 & = -1789 & = -7 \\
 +990 -2771 & = -1781 & = +4 \\
 +509 -2281 & = -1772 & = +10 \\
 [-537 -1207] & = -1734 & = \text{reject} \\
 \text{moon } 17.7213^\circ - 185^\circ 8' & & 177137^\circ
 \end{aligned}$$

$$\begin{aligned}
 y-y & +842 & +24 & -1722 \\
 +1247 +456 & = +1703 +29 & = +1732 & = +10 \\
 +1108 +549 & = +1657 +68 & = +1725 & = +3 \\
 -664 +2308 & = +1644 +65 & = +1709 & = -13 \\
 -791 +2458 & = +1667 +54 & = +1721 & = -1 \\
 [-836] & & & \\
 \text{moon } 21.8626^\circ + 1489^\circ & & +44^\circ & = 21.8437^\circ
 \end{aligned}$$

MC 1310

1913 April 30.

Center of Plate.

x	y	$R.A.$	$Decl.$
543	1457	0 49 22	+5 19 33
654	3291	0 48 53	-2 49 10
2748	3260	1 00 16	-5 10 46
2927	2684	1 01 13	+4 26 04
2975	1420	1 01 30	+2 47 55
59847	12212	3 99 124	18 151 148
1969	2442	0 55 75	+4 06 42
-18	-22	-52	-18 45
169	242	0 55 23	+3 47 57
31	465		
169	1210		
507	1952		
5239	968		
	112530		

$$A = 0^h 55^m 23^s$$

$$D = +3^{\circ} 47' 57''$$

Preliminary Reduction

$$\begin{aligned}
 x-5 &= -854 & +1782 \\
 -546 - 1239 &= -1785 & = -3 \\
 +1093 - 2882 &= -1789 & = -7 \\
 +990 - 2771 &= -1781 & = +4 \\
 +509 - 2281 &= -1772 & = +10 \\
 -577 - 1207 &= -1784 & = -3 \text{ reject} \\
 \text{mean } 17.7213 &= 1858 & 17.7137
 \end{aligned}$$

$$\begin{aligned}
 y-y &+ 842 & +24 & -1722 \\
 +1247 + 456 &= +1703 + 29 &= +1732 & = +10 \\
 +1108 + 549 &= +1657 + 68 &= +1725 & = -3 \\
 -664 + 2308 &= +1644 + 65 &= +1709 & = -13 \\
 -791 + 2458 &= +1667 + 54 &= +1721 & = -1 \\
 -836 & & & \\
 \text{mean } 21.862671489 & & +44 & -21.8437
 \end{aligned}$$

Residuals.

1310

 π

y

			C	O	O-C				C	O	O-C		
+	3	-7	+3	-1	-3	-2	-	2	-11	+28	+15	+10	-5
+	4	-17	+3	-10	-7	+3	-	3	-26	+28	-1	+3	+4
+	16	-16	+3	+3	+1	-2	-	11	-25	+28	-8	-13	-5
+	18	-13	+3	+8	+10	+2	-	12	-21	+28	-5	-1	+4

1311

+	3	+1	-10	-6	-5	+1	+	1	-9	+14	+6	+5	-1
+	3	+2	-10	-5	-7	-2	+	1	-22	+14	-7	-6	+1
+	14	+2	-10	+6	-7	+1	+	5	-21	+14	-2	-2	0
+	15	+2	-10	+7	+4	-3	+	6	-17	+14	+3	+3	0

1312

+	2	-11	+14	+5	-1	-6	+	2	-11	+12	+3	-6	-9
+	2	-25	+14	-9	-3	+6	+	3	-25	+12	-10	0	+10
+	10	-24	+14	0	-7	-7	+	12	-24	+12	0	-10	-10
+	10	-20	+14	+4	+10	+6	+	13	-20	+12	+5	+15	+10

MC1310-1311-1312

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Date Constants

			1310		1311		1312	
a	b	c	x-3	y-7	x-3	y-7	x-3	y-7
+5.48	+14.45	+1	-3	+10	-5	+5	-1	-6
+6.43	+33.80	+1	-7	+3	-7	-6	-3	0
+27.38	+32.66	+1	+1	-13	+7	-2	-7	-10
+29.22	+26.91	+1	+10	-1	+4	+3	+10	+15
+5.46	+24.12	+1	-5.00	+6.50	-6.00	-0.50	-2.00	-3.00
+28.30	+29.78	+1	+5.50	-7.00	+5.50	+0.50	+1.50	+2.50
+17.35	+20.68	+1	+3.50	+4.50	-0.50	+4.00	+4.50	+4.50
+16.90	+33.23	+1	-3.00	-5.00	0.00	-4.00	-5.00	-5.00
-22.34	-5.66		-10.50	+13.50	-11.50	-1.00	-3.50	-5.50
+0.45	-12.55		+6.50	+9.50	-0.50	+8.00	+9.50	+9.50
-0.45	-0.11		-0.21	+0.27	-0.23	-0.02	-0.07	-0.11
	-12.66		+6.29	+9.77	-0.73	+7.98	+9.43	+9.39
		b =	-0.50	-0.77	+0.06	-0.63	-0.74	-0.74
		a =	+0.60	-0.41	+0.50	+0.20	+0.35	+0.43

Residuals

1310							
-5.0	+5.5	+3.5	-3.0	+6.5	-7.0	+4.5	-5.0
-3.6	-17.0	-10.4	-10.2	+2.4	+11.6	+7.1	+6.9
+12.1	+14.9	+10.3	+16.6	+18.6	+22.9	+15.9	+25.6
+3.5	+3.4	+3.4	+3.4	+27.5	+27.5	+27.5	+27.5
c for (x-3)				c for (y-7)			

1311							
-6.0	+5.5	-0.5	0.0	-0.5	+0.5	+4.0	-4.0
-3.0	-14.2	-8.7	-2.4	-1.2	-5.7	-3.5	-3.4
-1.4	-1.8	-1.2	-2.0	+15.2	+18.7	+13.0	+20.9
-10.4	-10.5	-10.4	-10.4	+13.5	+13.5	+13.5	+13.5
c for (x-3)				c for (y-7)			

1312							
-2.0	+1.5	+4.5	-5.0	-3.0	+2.5	+4.5	-5.0
-2.1	-9.9	-6.1	-5.9	-2.6	-12.2	-7.5	-7.3
+17.8	+22.0	+15.3	+24.6	+17.8	+22.0	+15.3	+24.6
+13.7	+13.6	+13.7	+13.7	+12.2	+12.3	+12.3	+12.3
c for (x-3)				c for (y-7)			

MC1310-1311-1312

1913 May 1

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1-Date Constants

			1310		1311		1312	
a	b	c	x-3	y-7	x-3	y-7	x-3	y-7
+5.48	+14.45	+1	-3	+10	-5	+5	-1	-6
+6.43	+33.80	+1	-7	+3	-7	-6	-3	0
+27.38	+32.66	+1	+1	-13	+7	-2	-7	-10
+29.22	+26.91	+1	+10	-1	+4	+3	+10	+15
+5.46	+24.12	+1	-5.00	+6.50	-6.00	-0.50	-2.00	-3.00
+28.30	+29.78	+1	+5.50	-7.00	+5.50	+0.50	+1.50	+2.50
+17.35	+20.68	+1	+3.50	+4.50	-0.50	+4.00	+4.50	+4.50
+16.90	+33.23	+1	-3.00	-5.00	0.00	-4.00	-5.00	-5.00
-22.34	-5.66		-10.50	+13.50	-11.50	-1.00	-3.50	-5.50
+0.45	-12.55		+6.50	+9.50	-0.50	+8.00	+9.50	+9.50
-0.45	-0.11		-0.21	+0.27	-0.23	-0.02	-0.07	-0.11
	-12.66		+6.29	+9.77	-0.73	+7.98	+9.43	+9.39
		b =	-0.50	-0.77	+0.06	-0.63	-0.74	-0.74
		a =	+0.60	-0.41	+0.50	+0.20	+0.35	+0.43

~~Results~~

1310

-5.0	+5.5	+3.5	-3.0	+6.5	-7.0	+4.5	-5.0
-3.6	-17.0	-10.4	-10.2	+2.4	+11.6	+7.1	+6.9
+12.1	+14.9	+10.3	+16.6	+18.6	+22.9	+15.9	+25.6
+3.5	+3.4	+3.4	+3.4	+27.5	+27.5	+27.5	+27.5

c for (x-3)

c for (y-7)

1311

-6.0	+5.5	-0.5	0.0	-0.5	+0.5	+4.0	-4.0
-3.0	-19.2	-8.7	-8.4	-1.2	-5.7	-3.5	-3.4
-1.4	-1.8	-1.2	-2.0	+15.2	+18.7	+13.0	+20.9
-10.4	-10.5	-10.4	-10.4	+13.5	+13.5	+13.5	+13.5

c for (x-3)

c for (y-7)

1312

-2.0	+1.5	+4.5	-5.0	-3.0	+2.5	+4.5	-5.0
-2.1	-9.9	-6.1	-5.7	-2.6	-12.2	-7.5	-7.3
+17.8	+22.0	+15.3	+24.6	+17.8	+22.0	+15.3	+24.6
+13.7	+12.6	+13.7	+13.7	+12.2	+12.3	+12.3	+12.3

c for (x-3)

c for (y-7)

Approximate Center

$$x = 18.0 \quad y = 19.8078$$

$$\begin{array}{r} 23.9184 \\ \hline 43.7262 \end{array}$$

$$\text{mean } y = 21.8631$$

$$x = 17.0 \quad y = 19.9176$$

$$\begin{array}{r} 23.8058 \\ \hline 43.7234 \end{array}$$

$$\text{mean } y = 21.8617$$

$$x = 19.0 \quad y = 23.4944$$

$$\begin{array}{r} 20.2316 \\ \hline 43.7260 \end{array}$$

$$\text{mean } y = 21.8630$$

$$y = 21.0 \quad x = 15.8396$$

$$\begin{array}{r} 19.6052 \\ \hline 35.4448 \end{array}$$

$$\text{mean } x = 17.7224$$

$$y = 22.0 \quad x = 15.6521$$

$$\begin{array}{r} 19.7846 \\ \hline 35.4367 \end{array}$$

$$\text{mean } x = 17.7184$$

$$y = 23.0 \quad x = 15.9898$$

$$\begin{array}{r} 19.4557 \\ \hline 35.4455 \end{array}$$

$$\text{mean } x = 17.7228$$

Assume Center $\begin{cases} X_0 = 17.7212 \\ Y_0 = 21.8626 \end{cases}$

Correction for Phase

$$\begin{cases} X = +67.5' = +1.125^\circ \\ Y = -1^\circ 40' = -1.667^\circ \end{cases}$$

	x	y	xX	yY	$(xX + yY)$	$2.95(xX + yY)^2$
1	+0.28	-2.05	+0.32	+3.42	+3.74	+4.1
2	-0.72	-1.94	-0.80	+3.23	+2.43	+17
3	-0.90	-1.86	-1.06	+3.10	+2.09	+13
4	-1.72	-1.16	-2.15	+1.93	-	-
11	+1.73	+1.14	+1.95	-1.90	+0.05	+0
12	+2.06	+0.14	+2.32	-0.23	+2.09	+13
13	+1.88	-0.86	+2.12	+1.43	+3.55	+37
14	+1.28	-1.63	+1.44	+2.72	+4.16	+51

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	x	$x - x_0$	Δx	$(x - x_0)^2$	$(x - x_0)^2 + (y - y_0)^2$	$0 - c$	corr
1	18.0000	+0.2788	-2	0.0776	4.3014	+57	+42
2	17.0000	-0.7212	-2	0.5204	4.3046	+89	+16
3	16.8188	-0.9024	-2	0.8147	4.2851	-106	+11
4	16.0000	-1.7212	-1	2.9628	4.3014	+57	
5	15.8396	-1.8816	-1	3.5408	4.2851	-106	
6	15.6521	-2.0691	+0	4.2812	4.3001	+44	
7	15.9898	-1.7314	+1	2.9974	4.2915	-42	
8	17.0000	-0.7212	+2	0.5198	4.2970	+13	
9	18.0000	+0.2988	+2	0.0778	4.3057	+100	
10	19.0000	+1.2988	+2	1.6358	4.2995	+38	
11	19.4557	+1.7345	+1	3.0088	4.3029	-72	
12	19.7846	+2.0634	+0	4.2576	4.2765	-192	+16
13	19.6052	+1.8840	-1	3.5491	4.2934	-23	+42
14	19.0000	+1.2788	-2	1.6348	4.2960	+3	+55
				Mean:	4.2957		

	y	$y - y_0$	Δy	$(y - y_0)^2$		
1	19.8078	-2.0548	-4	4.2238	1	+86
2	19.9176	-1.9450	-3	3.7842	2	+95
3	20.0000	-1.8626	-3	3.4704	3	-104
4	20.7058	-1.1568	-2	1.3386	4	+48
5	21.0000	-0.8626	-1	0.7443	5	-115
6	22.0000	+0.1374	+0	0.0189	6	+34
7	23.0000	+1.1374	+2	1.2941	7	-53
8	23.8058	+1.9432	+3	3.7772	8	0
9	23.9184	+2.0558	+4	4.2279	9	+86
10	23.4944	+1.6318	+3	2.6637	10	+22
11	23.0000	+1.1374	+2	1.2941	11	+55
12	22.0000	+0.1374	+0	0.0189	12	-195
13	21.0000	-0.8626	-1	0.7443	13	-1
14	20.2316	-1.6310	-3	2.6612	14	+40

-468 + 466
Average $(0-c) = 66$

ML 1310		Inwards Center		1913 May 1.		10	
x		$x - x_0$	Δx	$(x - x_0)^2$	$(x - x_0)(y - y_0)$	$y - y_0$	y
1	18.00000	+0.2788	-2	0.0776	4.3014	+5.7	14.2
2	17.00000	-0.7212	-2	0.5204	4.3046	+8.9	16
3	16.8188	-0.9024	-2	0.8147	4.2851	-10.6	11
4	16.00000	-1.7212	-1	2.9628	4.3014	+5.7	
5	15.8396	-1.8816	-1	3.5408	4.2851	-10.6	
6	15.6521	-2.0691	+0	4.2812	4.3001	+4.4	
7	15.9898	-1.7314	+1	2.9974	4.2915	-4.2	
8	17.00000	-0.7212	+2	0.5198	4.2970	+1.3	
9	18.00000	+0.2988	+2	0.0774	4.3057	+10.0	
10	19.00000	+1.2988	+2	1.6358	4.2995	+3.8	
11	19.4557	+1.7345	+1	3.0088	4.3029	+7.2	
12	19.7846	+2.0634	+0	4.2576	4.2765	-19.2	16
13	19.6052	+1.8840	-1	3.5491	4.2934	-2.3	4.2
14	19.00000	+1.2788	-2	1.6348	4.2960	+3	15.5
				Mean	4.2957	0-6	

y		$y - y_0$	Δy	$(y - y_0)^2$		
1	19.8078	-2.0548	-4	4.2238	1	+8.6
2	19.9176	-1.9450	-3	3.7842	2	+9.5
3	20.0000	-1.8626	-3	3.4704	3	-10.4
4	20.7058	-1.1568	-2	1.3386	4	+4.8
5	21.0000	-0.8626	-1	0.7443	5	-11.5
6	22.0000	+0.1374	+0	0.0189	6	+3.4
7	23.0000	+1.1374	+2	1.2941	7	-5.3
8	23.8058	+1.9432	+3	3.7772	8	0
9	23.9184	+2.0558	+4	4.2279	9	+8.6
10	23.9944	+1.6318	+3	2.6637	10	-2.2
11	23.0000	+1.1374	+2	1.2941	11	+5.5
12	22.0000	+0.1374	+0	0.0189	12	-19.5
13	21.0000	-0.8626	-1	0.7443	13	-1
14	20.2316	-1.6310	-3	2.6612	14	+4.0

-468 = 4.6
Average $(y - y_0) = 6.6$

$$a \cdot a = 15.19$$

$$H_b = +14.87$$

$$ac = -8.75$$

$$b_2 = -6.61$$

$$c_n = +62$$

$$X_0 = 1$$

MC1310 - Moons Centes

1913 May 1

Conditional Equations

	a	b	c	0	Residuals	c	0 - c
1	+0.28	-2.05	+1	= +99	+14 - 8 + 76 = +82	+82	+17
2	-0.72	-1.95	+1	= +105	-36 - 8 + 76 = +32	+32	+73
3	-0.90	-1.86	+1	= -95	-45 - 7 + 76 = +24	+24	-119
4	-1.72	-1.16	+1	= +57	-86 - 5 + 76 = -15	-15	+72
5	-1.88	-0.86	+1	= -106	-94 - 3 + 76 = -21	-21	-85
6	-2.07	+0.14	+1	= +44	-104 + 1 + 76 = -27	-27	+71
7	-1.73	+1.14	+1	= -42	-87 + 5 + 76 = -6	-6	-36

+233 = 240

Normal Equations

Average = 68

$$\begin{aligned}
 &+15.19 + 3.86 - 8.75 = +120\frac{1}{2} + 121 \\
 &+ 3.86 + 14.87 - 6.61 = -248 - 250 \\
 &- 8.75 - 6.61 + 7.00 = -62 + 64
 \end{aligned}$$

$$\begin{aligned}
 &- 3.86 - 0.98 + 2.22 = -31 - 31 \\
 &+ 8.75 + 2.22 - 5.04 = +695 + 70
 \end{aligned}$$

$$\begin{aligned}
 &+ 13.89 - 4.39 = -279 - 281 \\
 &- 4.39 + 1.96 = +131 + 134
 \end{aligned}$$

$$\begin{aligned}
 &+ 4.39 - 1.39 = -88 - 89 \\
 &+ 0.58 = +43 + 45 \quad c = +75\frac{1}{2}
 \end{aligned}$$

$$\begin{aligned}
 &- 9.86 + 4.39 = -295 + 300 \\
 &+ 4.03 = +16 + 19 \quad b = +4
 \end{aligned}$$

$$\begin{aligned}
 &- 5.10 - 3.86 + 4.08 = +36 + 37 \\
 &- 19.65 - 14.87 + 15.72 = +139 + 144
 \end{aligned}$$

$$\begin{aligned}
 &+ 10.09 - 4.67 = +157 + 158 \\
 &- 15.79 + 9.11 = -109 - 106
 \end{aligned}$$

$$\begin{aligned}
 &- 8.08 + 4.67 = -56 - 54 \\
 &+ 2.01 = +101 + 104 \quad a = +52
 \end{aligned}$$

$$\text{Const } \Delta x (\text{wave}) = +0.08$$

$$\text{Const } \Delta \lambda = +0.1$$

MC1310 Moons Centes.

1913 May 1

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Conditional Equations

	a	b	c	0	Residual	c	0 - c
1	4028	-205	+1	+99	+14 - 8 + 76 = +82		+17
2	-072	-195	+1	+105	-36 - 8 + 76 = +32		+73
3	-090	-186	+1	-95	-45 - 7 + 76 = +24		-119
4	-172	-116	+1	+57	-86 - 5 + 76 = -15		+72
5	-188	-086	+1	-106	-94 - 3 + 76 = -21		-85
6	-207	+0.14	+1	+44	-104 + 1 + 76 = -27		+71
7	-173	+114	+1	-42	-87 + 5 + 76 = -6		-36
						+273 = 240	

Normal Equations

Average = 61

+ 1519 +	386 -	875 =	+ 120	+ 121	
+ 386 +	1487 -	661 =	- 248	- 250	
- 875 -	661 +	700 =	+ 62	+ 64	
- 386 -	0.98 +	222 =	- 31	- 31	
+ 875 +	222 -	504 =	+ 69	+ 70	
+ 1389 -	439 =	- 279	- 281		
- 439 +	196 =	+ 131	+ 139		
+ 439 -	139 =	- 88	- 99		+ 79
+ 052 =	+ 43	+ 45			c = + 78
- 986 +	439 =	+ 295	+ 300		+ 5
+ 403	= + 16	+ 19			b = + 4
- 510 -	386 +	408 =	+ 36	+ 37	
- 19.65 -	1487 +	1572 =	+ 139	+ 144	
+ 10.09	- 467 =	+ 157	+ 158		
- 15.79	+ 9.11 =	- 109	- 106		
- 808	+ 467 =	- 56	- 54		+ 52
+ 201	= + 101	+ 104			a = + 50

Formation of Normals.

No	at	an	in	cor to at	in
8	- 1.40	-	9.4	+	25.2
9	+ 0.58	+	28.0	+	206.0
10	+ 2.09	+	48.6	+	62.0
11	+ 1.97	+	124.8	+	82.0
12	+ 0.29	-	362.5	-	24.6
13	- 1.61	+	35.8	-	16.3
14	- 2.09	+	74.2	-	94.5
	- 0.17	-	60.5	+	239.8
		-	21.7	+	10.0
		-	82.2	+	249.8

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Conditional Equations

	a	b	c	0		c	0-c
8	-0.72	+1.94	+1	= +13	+23 = 2 + 56 =	+77	-64
9	+0.28	+2.06	+1	= +100	-9 - 2 + 56 =	+45	+55
10	+1.28	+1.63	+1	= +38	-42 = 1 + 56 =	+13	+25
11	+1.73	+1.14	+1	= +72	-56 - 1 + 56 =	-1	+73
12	+2.06	+0.14	+1	= -196	-67 - 0 + 56 =	-11	-165
13	+1.88	-0.86	+1	= +19	-61 + 1 + 56 =	-4	+23
14	+1.28	-1.63	+1	= +58	-42 + 1 + 56 =	+9	+49

Normal Equations

$$-229 + 225$$

$$\text{Average } (0-c) = 65$$

$$\begin{aligned}
 +14.68 - 0.17 + 7.80 &= -60 - 82 \\
 -0.17 + 15.39 + 441 &= +240 + 250 \\
 +7.80 + 441 + 7.00 &= +124 + 112
 \end{aligned}$$

$$\frac{\Delta y}{\Delta x} = -1.10$$

$$\begin{aligned}
 +0.17 - 0.00 + 0.09 &= -1 - 1 \\
 -7.80 + 0.09 - 4.15 &= +32 + 44
 \end{aligned}$$

$$\begin{aligned}
 +15.39 + 450 &= +239 + 249 \\
 +4.50 + 2.85 &= +156 + 156
 \end{aligned}$$

$$\frac{\Delta y}{\Delta x} = -0.60$$

$$\begin{aligned}
 -4.50 - 1.32 &= -70 - 73 \\
 +1.53 &= +86 + 83
 \end{aligned}$$

$$c = \frac{+54}{+56}$$

$$\begin{aligned}
 -7.10 - 450 &= -246 - 246 \\
 +8.29 &= -2 + 3
 \end{aligned}$$

$$b = \frac{0}{+1}$$

$$\begin{aligned}
 +0.30 + 0.17 + 0.27 &= +5 + 4 \\
 -27.20 - 15.39 - 24.40 &= -430 - 390 \\
 +14.98 + 8.07 &= -55 - 78 \\
 -27.37 - 20.00 &= -180 - 140
 \end{aligned}$$

$$\begin{aligned}
 -11.05 - 8.07 &= -73 - 57 \\
 +3.93 &= -128 - 135
 \end{aligned}$$

$$a = \frac{-34}{-55}$$

$$\text{Corr } \Delta x = -0.05$$

$$\text{Corr } \Delta y =$$

$$0.0$$

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Conditional Equations

	a	b	c	0		c	0-c
8	-072	+194	+1	+13	+23	+56	+97
9	+028	+206	+1	+100	-9	-2+56	-45
10	+128	+163	+1	+38	-42	-1+56	+13
11	+173	+114	+1	+72	-56	-1+56	-1
12	+206	+014	+1	-196	-67	-0+56	-11
13	+188	-086	+1	+19	-61	+1+56	-4
14	+128	-163	+1	+58	-42	+1+56	+9

Normal Equations.

-229+225
Average (0-c) = 65

$$\begin{aligned}
 +1468 - 0.17 + 77.80 &= -60 - 82 \\
 -017 + 1539 + 441 &= +240 + 250 \\
 +780 + 441 + 700 &= +129 + 112
 \end{aligned}$$

$$\begin{aligned}
 +017 - 0.00 + 0.09 &= -1 - 1 \\
 -780 + 0.09 - 415 &= +32 + 44
 \end{aligned}$$

$$\begin{aligned}
 +1539 + 450 &= +239 + 249 \\
 +450 + 285 &= +156 + 156
 \end{aligned}$$

$$\begin{aligned}
 -450 - 132 &= -70 - 73 \\
 +153 &= +86 + 83
 \end{aligned}$$

$$c = +54$$

$$\begin{aligned}
 -710 - 450 &= -246 - 246 \\
 +8.29 &= -7 + 3
 \end{aligned}$$

$$b = -1$$

$$\begin{aligned}
 +0.30 + 0.17 + 0.27 &= +5 + 4 \\
 -2720 - 1539 - 2440 &= -430 - 390 \\
 +1498 + 807 &= +55 - 78 \\
 -2737 - 2000 &= -180 - 140
 \end{aligned}$$

$$\begin{aligned}
 -11.05 - 807 &= -73 - 57 \\
 +3.93 &= -128 - 135
 \end{aligned}$$

$$a = -34$$

Combined Normals

	a	b	c	
I	+ 15.19 +	3.86 -	8.75 =	+ 120 + 121
II	+ 14.68 -	0.17 +	7.80 =	- 60 - 82
I	+ 3.86 +	14.87 -	6.61 =	- 248 - 250
II	- 0.17 +	15.39 +	4.41 =	+ 240 + 250
I	- 8.75 -	6.61 +	7.00 =	+ 62 + 64
II	+ 7.80 +	4.41 +	7.00 =	+ 124 + 112

	a	b	c	
	+ 29.87 +	3.69 -	0.95 =	+ 60 + 39
	+ 3.69 +	30.26 -	2.20 =	- 8 0
	- 0.95 -	220 +	14.00 =	+ 186 + 176

	a	b	c	
	- 3.69 -	0.46 +	0.12 =	- 7 - 5
	+ 0.95 +	0.12 -	0.03 =	+ 2 + 1

	a	b	c	
	+ 29.80 -	2.08 +	1.5 =	- 5
	- 2.08 +	13.97 =	+ 188	+ 177

	a	b	c	
	+ 2.08 -	0.14 =	- 1	- 3
	+ 13.83 =	+ 187	+ 174	

	a	b	c	
	- 0.31 +	2.08 =	+ 28	+ 26
	+ 29.49	= +	13	+ 21

	a	b	c	
	- 1.60 -	3.69 +	23.47 =	+ 312 + 295
	- 13.09 -	30.26 +	192.70 =	+ 2560 + 2420

	a	b	c	
	+ 28.27	+ 22.52 =	+ 872	+ 334
	- 9.40	+ 190.50 =	+ 2152	+ 2420

	a	b	c	
	+ 1.11	- 22.52 =	- 302	- 286
	+ 29.38	= +	70	+ 48

$$c = +12\frac{1}{2}$$

$$b = +1$$

$$a = +2$$

MC 1310

1913 May 13

13

Morrison's Mean Position (1911.0)

$$X_0 = 17.7212^{\circ} \quad Y_0 = 21.8626^{\circ}$$

$$\frac{1}{2}a = \frac{+1}{17.7213^{\circ}} \quad \frac{1}{2}b = \frac{0}{21.8626^{\circ}}$$

From Preliminary Reduction: $X = 17.7137^{\circ}$ $Y = 21.8437^{\circ}$
 Plate constants: $ax = +11^{\circ}$ -7°
 $by = -11^{\circ}$ -17°
 $c = +3^{\circ}$ $+27^{\circ}$
 17.7140° 21.8440°

$$\xi = -0.2860^{\circ} \quad \eta = -0.1560^{\circ}$$

$$\log S = 9.45637^m$$

$$\log SS = 9.99905^m$$

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

$$(A-A) = 0.95008^m$$

$$\log \tan \delta = 8.7967$$

$$\log \xi = 8.9127$$

$$\eta = 4.7628$$

$$\eta_1 = 0^{\circ}$$

$$(A-A) = 0.891^m \quad \log \eta_2 = 9.19312^m$$

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

$$A = 0^h 55^m 23.5^s$$

$$(d-D) = 1.86197^m$$

$$A_0 = 0^h 55^m 14.09^s$$

$$\delta - D = -1^{\circ} 12.8'$$

$$\text{Red to app. place} + 3.01$$

$$D = +3^{\circ} 47' 57''$$

$$\delta' = 0^h 55^m 17.10^s$$

$$\delta_0 = +3^{\circ} 46' 44.2''$$

$$\text{Red to app. place} + 20.9$$

$$\delta' = +3^{\circ} 47' 05.1''$$

MC1310 Lunar Parallax

$$\alpha' = 0^h 55^m 17.10''$$

$$\delta = 1 \ 56 \ 35.0''$$

$$\alpha - \alpha' = +1 \ 01 \ 17.90''$$

$$= +15^\circ \ 19' \ 29''$$

$$\frac{1}{2}(\alpha - \alpha') = +5 \ 43$$

$$\alpha - \alpha' - \frac{1}{2}(\alpha - \alpha') = 15 \ 13 \ 46''$$

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

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

$$- (\alpha - \alpha' - \frac{1}{2}(\alpha - \alpha')) = 9.98448''$$

$$\tan \phi = 9.97279$$

$$\gamma = +43 \ 12 \ 23.0''$$

$$\delta' = +3 \ 47 \ 05.1$$

$$\delta - \delta' = +39 \ 25 \ 17.9$$

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

$$\sin \gamma = 8.22965''$$

$$\sin(\gamma - \delta) = 9.80279''$$

$$- \sin \gamma = 9.83545''$$

$$\sin(\delta - \delta') = 8.02339''$$

$$\delta - \delta' = +36 \ 16.8''$$

$$\delta = +4 \ 23 \ 21.9''$$

$$\text{True Eph } \delta = +4 \ 23 \ 20.4''$$

$$\alpha - \alpha' = +1.5''$$

$$\delta' = +3 \ 47 \ 05.1''$$

$$\pi = 58' \ 20.2''$$

$$\log \sec \phi' = 9.86913$$

$$\sin \pi = 8.22965''$$

$$\sin(\delta - \alpha') = 9.42208''$$

$$- \cos \delta = 9.99873''$$

$$\log \sin(\alpha - \alpha') = 7.52213''$$

$$\alpha - \alpha' = +11' \ 26.4''$$

$$= +45.76''$$

$$\alpha = 0 \ 56 \ 02.86''$$

$$\alpha = 0^h \ 56^m \ 02.38''$$

$$\alpha - \alpha' = +0.48''$$

MC1311

1913 Apr. 30.

19

Preliminary Reduction.

	1	2	3	4	5
x	4.6914 [✓]	5.9881 [✓]	26.9166 [✓]	28.6481 [✓]	29.0046 [✓]
y	5.4849 [✓]	6.4312 [✓]	27.3820 [✓]	29.2181 [✓]	29.7791 [✓]
x-3	-7.935 [✓]	-4.436 [✓]	-4.654 [✓]	-5.700 [✓]	-7.945 [✓]

y	14.0382	33.3650	31.8512	26.0718	13.4365
y	14.4474	33.7988	32.6634	26.9148	14.2864
y-3	-4.092	-4.338	-8.122	-8.430	-8.499

x-3	-1.814	-2x	+1.0480
-4.7935	-2.541	-1.0476	-9 = -1.0485 = -5
-4.436	-6.039	-1.0475	-12 = -1.0487 = -7
-4.654	-5.765	-1.0419	-54 = -1.0473 = +7
-5.700	-4.719	-1.0419	-57 = -1.0476 = +4
~~-7.945~~			
1.77353	-3.935	-3.5	= 18.3863

y-3	+1.812	+3.248
-4.092	+8.49	-3.243 = +5
-4.338	+1.084	-3.254 = -6
-8.122	+4.872	-3.250 = -2
-8.430	+5.185	-3.245 = +3
~~-8.499~~	~~+5.250~~	~~-3.249~~ = -1
21.7391	+3.210	-22.3849

Tables a = 0.0 z = -2.4 a-z = +2.4 b+a = -1.6
 a = +2.5 z = -0.6 a-z = +3.1 b+a = +0.3

KC 1311

1913 Apr. 30

19

Preliminary Reduction

	1	2	3	4	5
2	46914	59881	269166	286481	290046
5	54849	64312	273820	292181	297791
2-3	-7935	-4436	-4654	-5700	-7945

4	140382	333650	318512	260718	134365
7	144974	337988	326634	269148	142864
4-7	-4092	-4338	-8122	-8430	-8499

$x - 3$	-1814	-22	$+1.0480$
$+7935$	-2541	-10476	$-9 = -1.0485 = -5$
-4436	-6039	-10475	$-12 = -1.0487 = -7$
-4654	-5765	-10479	$+54 = -1.0473 = +7$
-5700	-4719	-10419	$-57 = -1.0476 = +4$
~~-7945~~			
17.7353	-3935	-35	$= 18.386$

4-7	+1812	+3248	
-4092	+849	-3243	+5
-4338	+1084	-3254	-6
-8122	+4872	-3250	-2
-8430	+5185	-3245	+3
-6499	+5050	-3249	+1
21.7391	+3210	-22.3849	

1
4
14
m
8
2
6
33
m
8
3
2
3
m
6
4
28
26
m
6
5
29
17
2

MCT 311

1913 Mar. 13

15

Comp. Stars - measures

4

d. x

N

L	a	r	d. x	N
4.7	9560	817370	15826	15055
14.0	918080	70	1274043	8132
mg	80	7787	38	3757
8.8			20	45

14.038003844.6916.6913

2				
6.0	18280	18660	11389	12232
33.4	1463030	1230205	1127070	2529
mg	30	00	70	12110
8.9	66	40		

33.3645.36555.9881.9881

3				
26.9	16820	14794	16160	18525
31.8	830709	1330610	1532015	935053
mg	10	11	20	52
6.8	15	90	48	25

31.8507.851626.9159.9173

4				
28.6	17915	15313	15369	13728
26.1	1719000	602928	1184550	724942
mg	99	28	49	49
6.4	05	10	60	26

26.0718.071828.6482.6480

5				
29.0	16822	17835	1229895	8570
13.5	1245160	1220063	91	8522
mg	54	99	12252	20
6.0	10	31		

13.4362.436829.0043.0049

MCT 311

1913 Mar 13

15

Comp. Stars - measures

4

2

	a	v	d	N
1	9560	817370	15826	15055
4.7	918080	70	1274043	8132
14.0	80	7787	38	3757
mg			20	45
8.8				
	<u>14.0380</u>	<u>0384</u>	<u>4.6916</u>	<u>.6913</u>
2	18280	18660	11389	122329
6.0	1463030	1230205	1127070	259
33.4	30	00	70	12110
mg				
8.9	66	40		
	<u>33.3645</u>	<u>.3655</u>	<u>5.9881</u>	<u>.9881</u>
3	16820	14794	16160	18525
26.9	830709	1330610	1532015	935053
31.8	10	11	20	52
mg				
6.2	15	90	48	25
	<u>31.8507</u>	<u>.8576</u>	<u>26.9152</u>	<u>.9173</u>
4	17915	15313	15369	13728
28.6	1719000	602928	1184550	724942
26.1	99	28	49	49
mg				
6.4	05	10	60	26
	<u>26.0718</u>	<u>.0718</u>	<u>28.6482</u>	<u>.6480</u>
5	16822	17835	1229895	8570
29.0	1245160	1220003	91	85220
13.5	54	99	12252	20
mg				
8.0	10	31		
	<u>13.4362</u>	<u>.4368</u>	<u>29.0043</u>	<u>.0049</u>

MIC 1311

1913 Mar 13.

16

Moon Measures - Residual reversed.

d

N

d

N

1	18028	15586
18.0	1115570	1239309
19.7	65	13
	25	71

19.6863.6824

2	17148	15465
17.0	911920	1346140
19.8	23	69
	47	50

19.8026.8005

3	16451	15600
16.6	1249495	954130
20.0	91	3230
	38	90

166047.6060

4	15509	19080
16.0	949080	1503942
20.6	72	55
	09	68

20.6024.5970

5	15502	19650
15.8	1350000	1104128
21.0	09	30
	96	40

15.8002.8009

6	14344	18190
15.7	11111	1140198
22.0	1216	00
	37	80
	15.6774	.6783

MIC 1311

1913 May 13

16

Moon: Measure - Residual reversed.

d

4

v

d

v

$$\begin{array}{r}
 18.0 \\
 19.7 \\
 \hline
 18028 \\
 1115370 \\
 65 \\
 25 \\
 \hline
 15586 \\
 1739309 \\
 13 \\
 71
 \end{array}$$

$$\begin{array}{r}
 17.0 \\
 19.8 \\
 \hline
 19.6863 \\
 17148 \\
 911920 \\
 23 \\
 47 \\
 \hline
 15465 \\
 1346190 \\
 69 \\
 50
 \end{array}$$

$$\begin{array}{r}
 16.6 \\
 20.0 \\
 \hline
 19.8026 \\
 8005 \\
 16451 \\
 1247495 \\
 91 \\
 38 \\
 15600 \\
 954130 \\
 3230 \\
 90
 \end{array}$$

$$\begin{array}{r}
 16.0 \\
 20.6 \\
 \hline
 15509 \\
 949080 \\
 72 \\
 09 \\
 \hline
 19080 \\
 1503942 \\
 55 \\
 68
 \end{array}$$

$$\begin{array}{r}
 15.8 \\
 21.0 \\
 \hline
 20.6024 \\
 5970 \\
 15502 \\
 1350000 \\
 09 \\
 96 \\
 19650 \\
 1104128 \\
 30 \\
 40
 \end{array}$$

$$\begin{array}{r}
 15.7 \\
 22.0 \\
 \hline
 15.8002 \\
 14344 \\
 11111 \\
 1216 \\
 37 \\
 15.6774 \\
 8009 \\
 18190 \\
 1146198 \\
 00 \\
 80 \\
 6783
 \end{array}$$

MC1311 Mon-Measures-Rescan Reversed

191B Mar 13.

17

<u>7</u>	185585	17120
16.0	978380	1590500
22.8	82	80
	77	16

22.8796.8775
8
 16.2
 23.0

 18874
 9795
 9791
 60

 15958
 1501910
 20
 47
16.0933.0941

<u>9</u>	17450	15186
17.0	1068080	11960
23.6	70	6550
	45	86

23.6770.6772

<u>10</u>	16342	15310
18.0	835767	1327980
23.8	6167	78
	37	20

23.7976.7967

<u>11</u>	16223	14440
19.0	1238590	8262
23.4	8890	6063
	10	42

23.3830.3821
12
 19.4
 23.0

 15940
 975060
 56
 29

 18510
 1467880
 72
 09
1.93822.3833

MCI 311 Mon-Measures-Korean Reversed

1918 March 17

$\frac{1}{16.0}$	18585	17120
22.8	978380	1590500
	82	80
	77	16

22.8796.8775
 $\frac{8}{16.2}$
23.0

18874
9795
9791
60

15958
1501910
20
47

16.0933.0941

$\frac{9}{17.0}$	17450	15186
23.6	1068080	11760
	70	6550
	45	86

23.6770.6772

$\frac{6}{8.0}$	16342	15310
3.8	835767	1327980
	6167	78
	37	20

23.7976.7967

$\frac{1}{9.0}$	16223	14440
3.9	1238590	826263
	88	60
	10	42

23.5830.3821
 $\frac{1}{9.4}$
3.0

15940
975060
56
29

18510
1467880
72
09

1.93822.3883

M 21311

Polaris-Measured-Position reversed

1913 Mar 13

18

13
 $\overline{19.8}$
 22.0
 15050
~~1293021~~
~~30~~
 40

~

15050
 1293021
 30
 40
 18369
 1045648
 60
 60

197879 .7907
 18128 17243
 1483240 1051920
 3040 10
 20 40

19.6708 .6725

15
 $\overline{19.0}$
 20.1
 15819
 1485048
 4548
 12
 16255
 721220
 15
 55

20.0970.0961

16
 $\overline{18.9}$
 20.0

16626
 1525250
 4050
 20
 16425
 778294
 90
 15

18.8619 .8627

M01311

Dutton Measures - Residuals

1913 Mar 13.

18

13
 $\frac{19.8}{22.0}$
 d
 $\frac{15050}{1293021}$
 $\frac{30}{40}$

~

d
 $\frac{15050}{1293021}$
 $\frac{30}{40}$
 $\frac{18369}{1045648}$
 $\frac{60}{60}$

14
 $\frac{19.6}{21.0}$

$\frac{19.7879}{18128}$
 $\frac{1483240}{3040}$
 $\frac{20}{20}$
 $\frac{17743}{1051920}$
 $\frac{10}{40}$

15
 $\frac{19.0}{20.1}$
 $\frac{15819}{1485048}$
 $\frac{45}{12}$

$\frac{16255}{721220}$
 $\frac{15}{55}$

20.0970.0961

16
 $\frac{18.9}{20.0}$

$\frac{16626}{1525250}$
 $\frac{40}{20}$
 $\frac{16425}{778294}$
 $\frac{90}{15}$
18.8619
8627

MC1311

Times etc.

1913 Mar 13

19

Exp. to Stan	1911 Oct 7	2 ^h 06 ^m	- 2 ^h 18 ^m
.. Moon		2 11 33.6	- 2 11 33.8
clock slow		0 41.6	

H. Sid T.	2	12	15.3
H. Long	4	44	31.05
G. Sid T.	6	56	46.35
Sid T. M. noon	13	00	03.64
Interval	17	56	42.71
Reduction		2	56.39
G. M. T.	17	53	46.32

from Kant Alm		R. A.		Decl.
Moon 18 ^h	0 ^h 56 ^m	47.09 ^s	+ 4° 29'	12.4
Motion in 1 ^m	2 04 60		16.107	
.. - 6.228		- 12 74	- 1	40.3
Tabular place	0 ^h 56	34 35	+ 4	27 32.1

Moon's parallax 58' 20.6
 .. semidiam 15 55.4

Moon is 1^h 42.7^m past full.

1913 Mar 13

19

MC 1511	Times etc.				
Exp to Stan	1911 Oct 7	2 ^h 06 ^m		- 2 ^h 18 ^m	
moon		2 11	33.6	- 2 11	33.8
clock slow		0	41.6		
H. Sed T.		2 12	15.3		
H. long		4 44	31.05		
G. Sed T.		6 56	46.35		
Sid T in hour		13 00	03.64		
Interval		17 56	42.71		
Reduction			2 56.39		
G. in T.		17 53	46.32		

from Tant. Culm		R. a		Decl.	
moon 18 ^h	0 ^h 56 ^m	47.09	+ 4 29 ^m	12.4	
Motion in 1 ^m	2.0459		16.102		
.. .. - 6.228		- 12.74	- 1	40.3	
Tabular place	0 ^h 56 ^m	34.35	+ 4 27 ^m	32.1	

Moon's parallax 58' 20.4
 semi diam 15' 55.2

Moon is 1^h 42.7 past full.

Approximate Center.

$x = 18.0 \quad y = 19.6844$

$$\begin{array}{r} 23.7972 \\ 43.4816 \end{array}$$

$$\text{mean } y = 21.7408$$

$x = 17.0 \quad y = 19.8016$

$$\begin{array}{r} 23.6771 \\ 43.4787 \end{array}$$

$$\text{mean } y = 21.7394$$

$x = 16.0 \quad y = 20.5997$

$$\begin{array}{r} 22.8786 \\ 43.4783 \end{array}$$

$$\text{mean } y = 21.7392$$

$x = 19.0 \quad y = 23.3826$

$$\begin{array}{r} 20.0966 \\ 43.4792 \end{array}$$

$$\text{mean } y = 21.7396$$

$y = 20.0 \quad x = 16.6054$

$$\begin{array}{r} 18.8623 \\ 35.4677 \end{array}$$

$$\text{mean } x = 17.7338$$

$y = 21.0 \quad x = 15.8006$

$$\begin{array}{r} 19.6716 \\ 35.4722 \end{array}$$

$$\text{mean } x = 17.7361$$

$y = 22.0 \quad x = 15.6778$

$$\begin{array}{r} 19.7893 \\ 35.4671 \end{array}$$

$$\text{mean } x = 17.7336$$

$y = 23.0 \quad x = 16.0937$

$$\begin{array}{r} 19.3828 \\ 35.4765 \end{array}$$

$$\text{mean } x = 17.7382$$

Assume $\left\{ \begin{array}{l} X_0 = 17.7354 \\ Y_0 = 21.7397 \end{array} \right.$
 Center

Corrections for phase $\left\{ \begin{array}{l} X = +70' = +1.18 \\ Y = -1^{\circ}37' = -1.62 \end{array} \right.$

	x	y	X_0	y_0	$(X_0 + Y_0)$	$295(X_0 - Y_0)^2$
1	+0.26	-2.06	+0.35	+3.33	+3.64	+45 + 39
2	-0.74	-1.94	-0.87	+3.14	+2.27	+13 + 15
3	-1.13	-1.74	-1.34	+2.82	+1.48	+5 6
4	-1.74	-1.14	-2.00	+1.85		
12	+1.65	+1.26	+1.95	-2.04	+0.00	+ 1 0
13	+2.05	+0.26	+2.42	-0.42	+2.00	+16 + 12
14	+1.94	-0.74	+2.29	+1.20	+3.49	+43 + 36
15	+1.26	-1.64	+1.49	+2.65	+4.14	+56 + 51
16	+1.13	-1.74	+1.33	+2.82	+4.15	+56 + 51

MC1311 Morris Center.

1913 May V.

	z	$z - X_0$	Δx	$(z - X_0)^2$	$(x - Y_0)^2 + (y - Y_0)^2$	$0 - C$	20
1	18.00000	+0.2646	-3	0.0698	4.2953	-33	+39
2	17.00000	-0.7354	-3	0.5412	4.2986	0	+15
3	16.6054	-1.1300	-3	1.2776	4.3052	+76	+6
4	16.00000	-1.7354	-2	3.0123	4.3124	+138	
5	15.8006	-1.9348	-1	3.7438	4.2911	-75	
6	15.6778	-2.0576	+0	4.2337	4.3015	+29	
7	16.00000	-1.7354	+2	3.0109	4.3084	+98	
8	16.0937	-1.6417	+2	2.6946	4.2834	-152	
9	17.00000	-0.7354	+3	0.5404	4.2951	-35	
10	18.00000	+0.2646	+3	0.0702	4.3048	+62	
11	19.00000	+1.2646	+2	1.5997	4.2998	+12	
12	19.3828	+1.6474	-2	2.7146	4.3034	+48	+0
13	19.7893	+2.0539	+0	4.2185	4.2863	-123	+12
14	19.6716	+1.9362	-1	3.7485	4.2958	-28	+36
15	19.00000	+1.2646	-2	1.5987	4.2994	+8	+51
16	18.8623	+1.1269	-3	1.2692	4.2968	-18	+51

Mean = 4.2986

	y	$y - Y_0$	Δy	$(y - Y_0)^2$
1	19.6844	-2.0553	-3	4.2255
2	19.8016	-1.9381	-3	3.7574
3	20.0000	-1.7397	-3	3.0276
4	20.5997	-1.1400	-2	1.3001
5	21.0000	-0.7397	-1	0.5473
6	22.0000	+0.2603	+0	0.0678
7	22.8786	+1.1389	+2	1.2975
8	23.0000	+1.2603	+2	1.5888
9	23.6771	+1.9374	+3	3.7547
10	23.7972	+2.0575	+3	4.2346
11	23.3826	+1.6429	+3	2.7001
12	23.0000	+1.2603	+2	1.5888
13	22.0000	+0.2603	+0	0.0678
14	21.0000	-0.7397	-1	0.5473
15	20.0966	-1.6431	-3	2.7007
16	20.0000	-1.7397	-3	3.0276

Residuals from combined sol.

1	-29
2	-33
3	+46
4	+110
5	-98
6	+17
7	+96
8	-153
9	-27
10	+72
11	+20
12	+52
13	-115
14	-4
15	+34
16	+6

459 + 453

Average $(0 - C) = 57$

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M.C. 1311 Moon's Center.

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	z	$z - X_0$	Δz	$(z - X_0)^2$	$(z - Y_0)^2 + (y - Y_0)^2$	$0 - \text{Corr.}$
1	18.0000	+0.2646	-3	0.0698	4.2953	-33
2	17.0000	-0.7354	-3	0.5412	4.2986	0
3	16.6054	-1.1300	-3	1.2776	4.3052	+76
4	16.0000	-1.7354	-2	3.0123	4.3124	+138
5	15.8006	-1.9348	-1	3.7438	4.2911	-75
6	15.6778	-2.0576	+0	4.2337	4.3015	+29
7	16.0000	-1.7354	+2	3.0109	4.3084	+98
8	16.0937	-1.6417	+2	2.6946	4.2834	-152
9	17.0000	-0.7354	+3	0.5404	4.2951	-35
10	18.0000	+0.2646	+3	0.0702	4.3048	+62
11	19.0000	+1.2646	+2	1.5997	4.2998	+12
12	19.3828	+1.6474	+2	2.7146	4.3034	+48
13	19.7893	+2.0539	+0	4.2185	4.2863	-123
14	19.6716	+1.9362	-1	3.7485	4.2958	-28
15	19.0000	+1.2646	-2	1.5987	4.2994	+8
16	18.8623	+1.1269	-3	1.2692	4.2968	-18

Mean = 4.2986

	y	$y - Y_0$	Δy	$(y - Y_0)^2$
1	19.6844	-2.0553	-3	4.2255
2	19.8016	-1.9381	-3	3.7574
3	20.0000	-1.7397	-3	3.0276
4	20.5997	-1.1400	-2	1.3001
5	21.0000	-0.7397	-1	0.5473
6	22.0000	+0.2603	+0	0.0678
7	22.8786	+1.1389	+2	1.2975
8	23.0000	+1.2603	+2	1.5888
9	23.6771	+1.9374	+3	3.7547
10	23.7972	+2.0575	+3	4.2346
11	23.3826	+1.6429	+3	2.7001
12	23.0000	+1.2603	+2	1.5888
13	22.0000	+0.2603	+0	0.0678
14	21.0000	-0.7397	-1	0.5473
15	20.0966	-1.6431	-3	2.7007
16	20.0000	-1.7397	-3	3.0276

Residuals from combined sol.

1	-29
2	-33
3	+46
4	+110
5	-98
6	+17
7	+96
8	-153
9	-27
10	+72
11	+20
12	+52
13	-115
14	-4
15	+34
16	+6

459 + 453

Average = 0.57

Formation of Normal Equations.

No	at	an	bu	av	bv
1	-0.54 +	1.8 -	14.4 +	1.6 -	12.3
2	+14.3 -	9.6 -	25.2 -	11.2 -	29.1
3	+1.97 -	91.5 -	740.9 -	92.5 -	142.6
4	+1.98 -	240.0 -	1574		
5	+14.3 +	144.8 +	55.5		
6	-0.54 -	59.8 +	7.5		
7	-1.98 -	170.8 +	111.8		
8	-2.07 +	249.5 -	191.2		
	+1.68 -	175.6 -	354.3		
cor.		-2.8 -	3.5		
		-178.4 -	357.8		

$$aa = +18.58$$

$$bb = +15.81$$

$$ac = -10.71$$

$$bc = -4.95$$

$$cn = +139$$

$$+ \quad 2$$

$$1141$$

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Moon's Centus. Conditional Equations.

	a	b	0	Residuals	c	0-c
1	+0.26	-2.06	+1	= +7	-10 + 77 - 59 = +8	-1
2	-0.74	-1.94	+1	= +13	+30 + 77 - 59 = +43	-30
3	-1.13	-1.74	+1	= +81	+45 + 65 - 59 = +51	+30
4	-1.74	-1.14	+1	= +138	+70 + 42 - 59 = +53	+85
5	-1.93	-0.74	+1	= -75	+77 + 28 - 59 = +46	-121
6	-2.06	+0.26	+1	= +29	+83 - 10 - 59 = +14	+15
7	-1.74	+1.14	+1	= +98	+70 - 42 - 59 = -31	+129
8	-1.64	+1.26	+1	= -152	+66 - 47 - 59 = -40	-112

Normal Equations

$$-264 + 259$$

$$\text{Average} = 6.5$$

$$+18.58 + 1.68 - 10.71 = +176 - 178$$

$$+ 1.68 + 15.81 - 4.95 = -354 - 358$$

$$-10.71 - 4.95 + 8.00 = +139 + 141$$

$$- 1.68 - 0.15 + 0.97 = +16 + 16$$

$$+10.71 + 0.97 - 6.17 = -101\frac{1}{2} - 103$$

$$+15.66 - 3.98 = -338 - 342$$

$$- 3.98 + 1.83 = +37\frac{1}{2} + 38$$

$$+ 3.98 - 1.01 = -86 - 87$$

$$+ 0.82 = -48\frac{1}{2} - 49$$

$$- 8.80 + 3.98 = +82 + 83$$

$$+ 6.86 = -256 - 259$$

$$-60$$

$$c = -59$$

$$b = -38$$

$$b = -37$$

$$- 3.64 - 1.68 + 27.2 = +47 + 48$$

$$- 34.26 - 15.81 + 25.58 = +445 + 450$$

$$+14.94 - 7.99 = -129 - 130$$

$$- 32.58 + 20.63 = +91 + 92$$

$$- 12.60 + 7.99 = +35 + 36$$

$$+ 2.34 - 9.4 = -94 - 94$$

$$a = -40$$

$$a = -40$$

$$\text{Over to } \Delta a = -0.06$$

$$\text{Over to } \Delta b = -0.6$$

	O	C	O-C
9	-35	+10 -18 +29 = +21	-56
10	+62	-4 -19 +29 = +6	+56
11	+12	-18 -15 +29 = -4	+16
12	+49	-23 -11 +29 = -5	+54
13	-107	-29 -2 +29 = 0	-105
14	+15	-27 +7 +29 = +9	+6
15	+64	-18 +15 +29 = +26	+38
16	+38	-16 +16 +29 = +29	+9

+179 - 161

Average = 42.5

MVO 1811

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Knowns Center

Conditional Equations

	a	b	c	Residuals	c	a - c
1	+ 0 26	- 2 06	+ 1 = + 7	- 10 + 77 - 59 = + 8	- 1	
2	- 0 74	- 1 94	+ 1 = + 13	+ 30 + 72 - 59 = + 43	- 30	
3	- 1 13	- 1 74	+ 1 = + 81	+ 45 + 65 - 59 = + 51	+ 30	
4	- 1 74	- 1 14	+ 1 = + 138	+ 70 + 42 - 59 = + 53	+ 85	
5	- 1 93	- 0 74	+ 1 = - 75	+ 77 + 28 - 59 = + 46	+ 121	
6	- 2 06	+ 0 26	+ 1 = + 29	+ 83 + 10 - 59 = + 14	+ 15	
7	- 1 74	+ 1 14	+ 1 = + 98	+ 70 + 42 - 59 = - 31	+ 129	
8	- 1 64	+ 1 26	+ 1 = - 152	+ 66 + 47 - 59 = - 40	- 112	

Normal Equations

-264 + 259

Average = 6.5

$$\begin{aligned}
 +18.58 + 1.68 - 10.71 &= -176 - 178 \\
 +1.68 + 15.81 - 4.95 &= -354 - 358 \\
 -10.71 - 4.95 + 8.00 &= +139 + 141
 \end{aligned}$$

$$\begin{aligned}
 -1.68 - 0.15 + 0.97 &= +16 + 16 \\
 +10.71 + 0.97 - 6.12 &= -102 - 103
 \end{aligned}$$

$$\begin{aligned}
 +15.66 - 3.98 &= -338 - 342 \\
 -3.98 + 1.43 &= +37 \frac{1}{2} + 38
 \end{aligned}$$

$$\begin{aligned}
 +3.98 - 1.01 &= -86 - 87 \\
 +0.82 &= -48 \frac{1}{2} - 49 = -59
 \end{aligned}$$

$$\begin{aligned}
 -60 \\
 -59
 \end{aligned}$$

$$\begin{aligned}
 -8.80 + 3.98 &= +82 + 83 \\
 +6.86 &= -25 \frac{1}{2} - 25 \frac{1}{2} = -7
 \end{aligned}$$

$$\begin{aligned}
 -38 \\
 -37
 \end{aligned}$$

$$\begin{aligned}
 -3.64 - 1.68 + 2.72 &= +47 + 48 \\
 -34.26 - 15.81 + 25.58 &= +44 \frac{1}{2} + 450
 \end{aligned}$$

$$\begin{aligned}
 +14.94 - 7.99 &= -129 - 130 \\
 -32.58 + 20.63 &= +91 + 92
 \end{aligned}$$

$$\begin{aligned}
 -12.60 + 7.99 &= +35 + 36 \\
 +2.34 - 9.4 &= -94 - 94 = -40
 \end{aligned}$$

$$\begin{aligned}
 -40 \\
 -4
 \end{aligned}$$

No	a	b	a _u	b _u	corrected a _u	b _u
9	-1.43	+	25.8	-	68.0	
10	+0.54	+	16.1	+	127.8	
11	+2.06	+	15.1	+	19.7	
12	+2.08	+	81.0	+	61.7	79.2 + 60.5
13	+0.53	-	219.6	-	27.8	- 228.0 - 38.8
14	-0.43	+	29.1	-	11.1	+ 15.5 - 5.9
15	-2.06	+	80.5	-	104.8	+ 74.5 - 96.8
16	-1.97	+	43.0	-	66.0	+ 37.2 - 57.4
	<u>+1.68</u>	+	71.0	-	68.5	
	<u>-1.68</u>	+	25.6	+	9.6	
		+	45.4	-	58.9	

$$ac = +8.82$$

$$bc = +3.04$$

$$cn = +98$$

$$aa = +15.76$$

$$bb = +18.62$$

$$\begin{array}{r} -22 \\ +76 \end{array}$$

$$+15.76 - 1.68 + 8.82 = +45$$

$$-1.68 + 18.62 + 3.04 = -59$$

$$+8.82 + 3.04 + 8.00 = +76$$

$$+1.68 - 0.18 + 0.94 = +5$$

$$-8.82 + 0.94 - 4.94 = -25$$

$$+18.44 + 3.98 = -54$$

$$+3.98 + 3.06 = +51$$

$$-3.98 - 0.86 = +12$$

$$+2.20 = +63$$

$$c = +28.6$$

$$-5.18 - 3.98 = -66$$

$$+13.26 = -120$$

$$b = -9.05$$

$$-9.71 - 3.35 - 8.82 = -84$$

$$-3.35 - 1.16 - 3.04 = -29$$

$$+6.05 - 5.03 = -39$$

$$-5.03 + 1.746 = -68$$

$$-1.45 + 5.03 = -25$$

$$+4.60 = -64$$

$$a = -13.9$$

MC 1311 Moons Center.

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Conditional Equations.

	a	b	c	0	Residuals.	c	0-c
9	-0.74	+1.94	+1	-35	6-13+24 = +17		-52
10	+0.26	+2.06	+1	+62	2-14+24 = +8		+54
11	+1.26	+1.64	+1	+12	10-11+24 = +3		+9
12	+1.65	+1.26	+1	+49	13-9+24 = +2		+47
13	+2.05	+0.26	+1	-107	16-2+24 = +6		-113
14	+1.94	-0.74	+1	+15	15+5+24 = +14		+1
15	+1.26	-1.64	+1	+64	10+11+24 = +25		+39
16	+1.13	-1.74	+1	+38	9+12+24 = +27		+9

Normal Equation

$$\begin{aligned}
 +15.76 + 1.68 + 8.82 &= +71 + 45 \\
 +1.68 + 18.62 + 3.04 &= -68 - 59 \\
 +8.82 + 3.04 + 8.00 &= +98 + 76 \\
 -1.68 - 0.18 - 0.94 &= -8 - 5 \\
 -8.82 - 0.94 - 4.94 &= -40 - 25
 \end{aligned}$$

Average (0-c) = 40

$$\frac{\Delta c}{\Delta n} = -1.13$$

$$\begin{aligned}
 +18.44 + 2.10 &= -76 - 64 \\
 +2.10 + 3.06 &= +58 + 51 \\
 -2.10 - 0.24 &= +9 + 7 \\
 +2.82 &= +67 + 58
 \end{aligned}$$

$$\frac{\Delta y}{\Delta n} = -0.23$$

$$\begin{aligned}
 -1.44 - 2.10 &= -40 - 35 \\
 +17.00 &= -116 - 99
 \end{aligned}$$

$$c = +21$$

$$\begin{aligned}
 -4.87 - 1.68 - 4.42 &= -54 - 42 \\
 -54.00 - 18.62 - 49.06 &= -600 - 466
 \end{aligned}$$

$$\begin{aligned}
 +10.89 + 4.40 &= +17 + 3 \\
 -52.32 - 45.96 &= -668 - 525
 \end{aligned}$$

$$\begin{aligned}
 -5.01 - 4.40 &= -64 - 50 \\
 +5.88 &= -47 - 47
 \end{aligned}$$

$$a = -8$$

Corr to $\delta\alpha = -0.02$ Corr to $\delta\delta = 0.0$

Combined Solution (corrected)

$$+ 34.344 - 0.00 + 1.89 = -1.33$$

$$- 0.00 + 34.43 - 1.91 = -4.7$$

$$- 1.89 - 1.91 + 16.00 = +2.17$$

$$0.00 \quad 0.00 \quad 0.00 \quad 0$$

$$+ 1.89 + 0.00 - 0.10 = -7$$

$$+ 34.43 - 1.91 = -4.7$$

$$- 1.91 + 15.90 = +2.10$$

$$+ 1.91 - 0.11 = -2.3$$

$$- 15.79 + 18.7 = 0 = +1.8$$

$$- 0.23 + 1.91 = +2.5$$

$$+ 34.20 \quad - 39.2 \quad + = +1.4$$

$$- 0.22 - 0.23 + 1.89 = +2.6$$

$$- 0.23 - 0.23 + 1.91 = +2.6$$

$$+ 34.12 - 0.23 = +1.07$$

$$+ 0.22 + 34.20 = -3.91$$

$$0.00 + 0.23 \quad 0 = 3$$

$$+ 34.12 \quad - 1.10 \quad a = -3.2$$

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Conditional Equations

	a	b	c	0	✓	Residuals	c	0-	
9	-0.74	+1.94	+1	-35	+	6	-1.3	+2.4 = +1.7	-5.2
10	+0.26	+2.06	-1	+62	-	2	-1.4	+2.4 = +8	+5.4
11	+1.26	+1.64	+1	+12	-	10	-1.1	+2.4 = +3	+9
12	+1.65	+1.26	+1	+49	-	13	-9	+2.4 = +2	+4.7
13	+2.05	+0.26	+1	-107	-	16	-2	+2.4 = +6	-11.3
14	+1.94	-0.74	+1	+15	-	15	-5	+2.4 = +1.4	+1
15	+1.26	-1.64	-1	+64	-	10	+1.1	+2.4 = +2.5	+3.9
16	+1.12	-1.74	+1	+38	-	9	+1.2	+2.4 = +2.7	+9

Normal Equations

$$\begin{aligned}
 +15.76 + 1.68 + 8.82 &= +71 + 45 \\
 +1.68 + 18.62 + 3.04 &= -64 - 59 \\
 +8.82 + 3.04 + 80.0 &= +98 + 76 \\
 -1.68 - 0.18 - 0.94 &= -8 - 5 \\
 -8.82 - 0.94 - 4.94 &= -40 - 25
 \end{aligned}$$

$$\begin{aligned}
 +18.44 + 2.10 &= -76 - 64 \\
 +2.10 + 3.06 &= +58 + 51 \\
 -2.10 - 0.24 &= +9 + 7 \\
 +2.82 &= +6.7 + 58
 \end{aligned}$$

$$\begin{aligned}
 -1.44 - 2.10 &= -40 - 35 \\
 +17.00 &= -11.6 - 99
 \end{aligned}$$

$$\begin{aligned}
 -487 - 1.68 - 4.92 &= -54 - 42 \\
 -5400 - 1.86 - 4.90 &= -600 - 466
 \end{aligned}$$

$$\begin{aligned}
 +10.89 + 4.40 &= +1.7 + 3 \\
 -52.32 - 45.96 &= -60.8 - 52.5
 \end{aligned}$$

$$\begin{aligned}
 -501 - 4.40 &= -6.4 - 50 \\
 +588 &= -4.7 - 47
 \end{aligned}$$

Average (U-C) = 40

C = +0.4

b = -7

a = -8

Combined Solutions.

	a	b	c	
I	+18.58	+1.68	-10.71	= -178
II	+15.76	-1.68	+8.82	= +45
I	+1.68	+15.81	-4.95	= -358
II	+1.68	+18.62	+3.04	= -59
I	-10.71	-4.95	+8.00	= +141
II	+8.82	+3.04	+8.00	= +76

Normal Equations.

$$\begin{aligned}
 &+34.39 + 3.36 - 1.89 = -1.33 \\
 &+3.36 + 34.43 - 1.91 = -417 \\
 &-1.89 - 1.91 + 16.00 = +217
 \end{aligned}$$

$$\begin{aligned}
 &-3.36 - 0.33 + 0.185 = +1.5 \\
 &+1.89 + 0.185 - 0.10 = -7
 \end{aligned}$$

$$\begin{aligned}
 &+34.10 - 1.73 = -404 \\
 &-1.73 + 15.90 = +210
 \end{aligned}$$

$$\begin{aligned}
 &+1.73 - 0.09 = -20\frac{1}{2} \\
 &\quad +15.81 = +189\frac{1}{2}
 \end{aligned}$$

$$c = +12$$

$$\begin{aligned}
 &-0.19 + 1.73 = +23 \\
 &+3391 = -381
 \end{aligned}$$

$$b = -11$$

$$\begin{aligned}
 &-3.32 - 3.36 + 28.15 = +382 \\
 &-34.10 - 34.43 + 288.60 = +3915
 \end{aligned}$$

$$\begin{aligned}
 &+31.02 \quad +26.26 = +249 \\
 &-30.74 \quad +286.69 = +3498
 \end{aligned}$$

$$\begin{aligned}
 &+2.82 \quad -26.26 = -320 \\
 &+33.84 \quad = -71
 \end{aligned}$$

$$a = -2$$

see page before this

NIC 1311

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Moon's Mean Position (1911.0)

$$X_0 = 17.7354$$

$$Y_0 = 21.7397$$

$$\frac{1}{2}a = \frac{-1}{17.7353}$$

$$\frac{1}{2}b = \frac{-6}{21.7397}$$

From Prelim. Reduction $X = 18.3863$ $Y = 22.3849$

$$\begin{array}{rcl} \text{Plate Constants } ax = & +9 & +4 \\ by = & +1 & -14 \\ c = & -10 & +13 \end{array}$$

$$22.3852$$

$$\bar{x} = +0.3863$$

$$\eta = +0.3852$$

$$\log = 9.58692$$

$$\cos \delta = 9.99902$$

$$\cos \alpha = 8.50724$$

$$\log \tan \delta = 8.8280$$

$$\log \tan \alpha = 9.1738$$

$$\eta_1 = 5.0552$$

$$\eta_2 = 0$$

$$(d-A) = 1.08066$$

$$d-A + 1204 \log \eta_0 = 9.58569$$

$$7.33115$$

$$A = 0.5523$$

$$\log (\delta-D) = 2.25454$$

$$d_0 = 0.5535.04$$

$$\delta-D = +0.259.7$$

$$\text{Red to app.} + 3.01$$

$$D = +3.4757$$

$$d' = 0.5538.05$$

$$\delta_0 = +3.5056.7$$

$$\text{Red to app.} + 20.9$$

$$\delta' = +3.5117.6$$

NIC 1311

1913 May 14

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Lunar Parallax

$$\alpha' = 0 \quad 55 \quad 38.05$$

$$\theta = 2 \quad 12 \quad 15.3$$

$$\theta - \alpha' = +1 \quad 16 \quad 37.3$$

$$= T \quad 19^{\circ} \quad 09' \quad 20.11$$

$$\delta' = +3 \quad 51 \quad 17.6$$

$$\pi = 58' \quad 20.6$$

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

$$\sin \pi = 8.22970$$

$$\sin (\theta - \alpha') = 9.51605$$

$$\cos \delta = 9.99868$$

$$\frac{1}{2}(\alpha - \alpha') = + \quad 7 \quad 06$$

$$(\theta - \alpha') - \frac{1}{2}(\alpha - \alpha') = +19 \quad 02 \quad 14$$

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

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

$$(\theta - \alpha') - \frac{1}{2}(\alpha - \alpha') = 9.97557$$

$$\log \sin (\alpha - \alpha') = 7.61620$$

$$\alpha - \alpha' = +14 \quad 12.4$$

$$\tan \gamma = 9.98170$$

$$= 56.83$$

$$\gamma = +43 \quad 47 \quad 36.0$$

$$\delta' = + \quad 3 \quad 51 \quad 17.6$$

$$\gamma - \delta' = +39 \quad 56 \quad 18.4$$

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

$$\sin \pi = 8.22970$$

$$(\gamma - \delta') = 9.80751$$

$$\gamma = 9.84014$$

$$\sin (\delta - \delta') = 8.02347$$

$$\delta - \delta' = +36 \quad 17.2$$

$$\delta = +4 \quad 27 \quad 34.8$$

$$\alpha = 0 \quad 56 \quad 34.88$$

$$\text{Am Ehh. } \delta = +4 \quad 27 \quad 32.1$$

$$\alpha = 0 \quad 56 \quad 34.35$$

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

$$O-C = +0.53$$

$$\begin{array}{r}
 6.15 \\
 3.07 \\
 \hline
 9.22 \\
 11.7 \\
 \hline
 20.9
 \end{array}$$

$$\begin{array}{llll}
 \text{Tables } a = 0.0 & e = -2.5 & a - e = +2.5 & b + a = -2.0 \\
 a = +1.4 & e = -0.7 & a - e = +2.1 & b + a = -0.3
 \end{array}$$

MC 1312	Times etc.	1913 Mar. 14
Exp to Stars	1911 Oct. 7. 2 ^h 21 ^m	2 ^h 33 ^m
" " Moon	2 26 38.8 ^v	2 26 39.2
clock slow	0 41.6 ^v	
+ Sid T	2 27 20.6 ^v	
H Hong	4 44 31.05 ^v	
G Sid T	7 11 51.65 ^v	
Sid T. M. Moon	13 00 03.64	
Interval	18 11 48.01 ^v	
Reduction	2 58.87 ^v	
G M. T.	18 08 49.14 ^v	
from Ori Ght.	R. G.	W. G.
Moon 18 ^h	0 56 47.09 ^v	+4 29 12.4 ^v
Motion in 1 ^m = 2.0464	16.100 ^v	
" " 8.819	18.05 ^v	2 22.0 ^v
Tabular place	0 57 05.14 ^v	+4 31 34.4 ^v
Moon 1 ^h	57.7 past full.	
Moon's parallax	58' 20.9 ^v	
Semi-diam	15 55.5 ^v	

Preliminary Reduction.

x	4.1652	5.4251	16.3532	28.0976	28.4804
$\bar{3}$	54549	6.4312	27.3820	29.2181	29.7991
$x-\bar{3}$	-1.3197	-1.0066	-10288	-1.1205	-1.3187
y	13.6224	32.9540	31.4786 ^v	25.7042	13.0704
η	14.4474	33.7988	32.6634 ^v	26.9148	14.2864
$y-\eta$	-8250	-8448	-1.1848 ^v	-1.2106	-1.2160
$x-3$	-1624		$-x$		+1.5407
-1.3197	-2207	-1.5404	-4	-1.5408	= -1
-1.0066	-5339	-1.5405	-5	-1.5410	= -3
-1.0288	-5100	-1.5388	-26	-1.5414	= -7
-1.1205	-4164	-1.5369	-28	-1.5397	= +10
Answer 17.8551 ^v	-3540 ^v		-18 ^v		= 19.0400 ^v
$y-\eta$	+16276		+7569		
-8250	+6752	-7575	= -6		
-8448	+879	-7569	= 0		
-1.1848	+4269	-7579	= -10		
-1.2106	+4552	-7554	= +15		
Answer 21.8540 ^v	+2893 ^v		= 22.9002 ^v		

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1911 Oct. 7	2 ^h 21 ^m	1913 Nov. 14	2 ^h 33 ^m	24
Exp. Stars	2 26	38.8	2 26	39.2
T. moon	0	41.6		
clock slow	2 27	20.6		
H. Sid. T.	4 44	31.05		
h. long	7 11	51.65		
G. Sid. T.	13 00	03.64		
Sid. T. m. moon	18 11	48.01		
Interval	2	58.87		
Reduction	18 08	49.14		
G. m. T.				
from Am. Ght.				
moon 18 ^h	0 ^h 56 ^m	47.09	+4 29	12.9
moon 1 ^m - 2.0966			16.100	
" 8.819		18.05	2	22.0
Tabular place	0 57	05.14	+4 31	34.4
moon 1 ^h 57.7 past full.				
Moon's parallax	58'	20.7		
Semi-diameter	15	55.5		

Preliminary Reduction

2	41 652	5.4251	263532	280976	284804
3	54849	64312	273820	292181	297991
2-3	-13197	-10066	-10288	-11205	-13187
4	136224	329540	314786	257042	130704
7	144474	337988	326634	269148	142864
4-7	-8250	-8448	-11848	-12106	-12160
2-3	-1624		-72		+1.5407
-13197	-2207	-15404	-4	-15408	= -1
-10066	-5339	-15405	-15	-15410	= -3
-10288	-5100	-15388	-26	-15414	= -7
-11205	-4164	-15369	-28	+15397	= +10
moon 17.8551	-3540		-14		= 19.0400
4-7	+16224		+7569		
-8250	+675	-7575	= -6		
-8448	+879	-7569	= 0		
-11848	+4269	-7579	= -10		
-12106	+4552	-7554	= +15		
21.540	+2593		= 22.9002		

MCI 312 Comp. Stars - measures 1913 Mar. 14. 25

	d	N	d	N
1	14895	16364	16541	16951
4.2	8683	12586	8200	15300
13.6	7980	8790	9493	9900
mag	60	50	41	41
5.8	<u>136717</u>	<u>.6230</u>	<u>4.1655</u>	<u>.1649</u>
2				
5.4	9499	13250	14259	15501
32.9	9999	12805	8510	11246
mag	9035	1005	10	5048
8.1	<u>32.9534</u>	<u>.9547</u>	<u>5.4256</u>	<u>.4246</u>
3				
26.3	17440	18430	18235	14245
31.5	12651	13215	11751	10705
mag	60	20	52	05
6.2	30	22	20	40
	<u>31.4781</u>	<u>.4791</u>	<u>26.3528</u>	<u>.3537</u>
4				
28.1	16754	17995	16499	17300
25.7	9711	15029	7466	16318
mag	07	35	62	20
6.9	49	80	90	60
	<u>25.7041</u>	<u>.7043</u>	<u>28.0972</u>	<u>.0981</u>
5				
28.5	17263	15840	19100	17403
23.1	16560	6540	13902	12590
	62	35	92	91
	62	28	00	99
	<u>13.0701</u>	<u>.0708</u>	<u>28.4800</u>	<u>.4809</u>

MCI 312 Comp Stars - Lueasius 1913 Mar. 14. 25

	d	$\sim$	d	$\sim$
1	14895	16364	16541	16751
4.2	8683	12586	8200	15300
13.6	7980	8790	9493	9900
mg	00	50	41	41
58	<u>13.6217</u>	<u>.6230</u>	<u>4.7655</u>	<u>.1649</u>
2				
4	9499	13250	14259	15501
2.9	9999	12805	8510	11246
mg	9035	1005	1010	5048
8.1			50	85
	<u>32.9534</u>	<u>9547</u>	<u>5.4256</u>	<u>.4246</u>
3				
6.3	17440	18430	18235	14245
15	12651	13215	11751	10705
2	6050	2015	5255	0508
	30	22	20	40
	<u>31.4781</u>	<u>.4791</u>	<u>26.3528</u>	<u>.3537</u>
1	16754	17995	16499	17300
7	9711	15029	7466	16318
9	0710	3539	6261	20
9	49	80	90	60
	<u>25.7041</u>	<u>.7043</u>	<u>28.0972</u>	<u>.0981</u>
	17263	15840	19100	17403
	16560	6540	13902	12590
	6264	3536	9205	9155
	62	28	00	99
	<u>13.0701</u>	<u>.0708</u>	<u>28.4800</u>	<u>.4809</u>

VIC 1312 moon measures

1915 Mar. 14.

76

	α	δ
L	16340	14430
18.0	1847574	1228090
19.8	76	81
	33	11
	<u>19.7861</u>	<u>7858</u>

17.0	1028071	9228
19.9	74	8885
	9945	9985
	<u>19.9670</u>	<u>9662</u>
3		
16.0	940519	9774
20.9	11	909200
	8759	0100
	<u>20.9347</u>	<u>9324</u>

4
15.8
22.0

15029
1289699
93
11
15.7875

19090
1149098
908
90
7897

5	18823	16654
16.0	1101820	1443925
22.7	30	20
	14	45
	<u>22.7793</u>	<u>7776</u>

6
16.2
23.0

17292
853040
30
72
16.1258

17230
1595558
58
18
1272

7	16706	15677
17.0	929082	1309801
23.6	87	08
	05	80
	<u>23.7419</u>	<u>7424</u>

8		
18.0	1105648	10883
23.9	6048	1009190
	10280	92
	<u>23.9225</u>	<u>9208</u>

VIC 1312 moon measures.

1913 Mar. 14.

26

	α	δ
1	16340	14430
18.0	1847574	1228090
19.8	70	81
	53	11
	<u>19.7861</u>	<u>.7858</u>

2	17.0 1028071	9228
19.9	74	8885
	9945	9985
	<u>19.9670</u>	<u>.9662</u>

3	16.0 940519	9779
20.9	11	909200
	8759	01
	<u>20.9347</u>	<u>.9324</u>

4
15.8
22.0

15029
1289699
93
11
15.7875

19090
1149098
908
90
.7897

5	18823	16654
16.0	1101820	1443925
22.7	30	20
	14	45
	<u>22.7793</u>	<u>.7776</u>

6
16.2
23.0

17292
853040
30
72
16.1258

17230
1591558
58
18
.1272

7	16706	15677
17.0	929082	1309861
23.6	87	08
	05	80
	<u>23.7419</u>	<u>.7424</u>

8	18.0 1105648	10883
23.9	6048	1009190
	10280	92
	<u>23.9225</u>	<u>.9208</u>

MC 1312 Spoon-measures

1913 Mar 14. 27

9	a	N	a	N
19.0	14615	18100		
23.5	877183	1392825		
	80	30		
	05	87		
	<u>23.5832</u>	<u>.5833</u>		

10
19.5
23.0

15937	19120
1174962	1327072
60	6972
20	07
<u>19.5827</u>	<u>.5842</u>

11
19.9
22.0

14995	18030
1415070	882932
60	33
88	11
<u>19.9166</u>	<u>.9182</u>

12
19.6
21.0

18019	17935
1543043	1050095
50	9195
16	29
<u>19.7423</u>	<u>.7436</u>

13	15179	16362
19.0	1392830	760705
20.2	20	10
	80	54
	<u>20.1253</u>	<u>.1252</u>

MC 1312 Moon. measures.

1913 Mar. 14 27

	a	N
19.0	14615	18100
23.5	877183	1392825
	80	30
	05	87
	<u>23.5832</u>	<u>5833</u>

10
19.5
23.0

15937	19120
11749	13270
6062	6972
20	07
<u>19.5827</u>	<u>5842</u>

11
19.9
22.0

14995	18030
1415070	8829
60	3352
88	11
<u>19.9166</u>	<u>9182</u>

12
19.6
21.0

18019	17935
1543043	10500
50	9195
16	29
<u>19.7423</u>	<u>7436</u>

3	15179	16362
19.0	1392830	760705
20.2	20	10
	80	54
	<u>20.1253</u>	<u>1252</u>

Approximate Center

$$\begin{array}{r}
 y = 22.0 \quad x = 15.7886 \\
 \underline{19.9174} \\
 35.7060 \\
 \text{mean } x = 17.8530
 \end{array}$$

$$\begin{array}{r}
 y = 23.0 \quad x = 16.1265 \\
 \underline{19.5834} \\
 35.7099 \\
 \text{mean } x = 17.8550
 \end{array}$$

$$\begin{array}{r}
 x = 18.0 \quad y = 19.7860 \\
 \underline{23.9216} \\
 43.7076 \\
 \text{mean } y = 21.8538
 \end{array}$$

$$\begin{array}{r}
 x = 17.0 \quad y = 19.9666 \\
 \underline{23.7422} \\
 43.7088 \\
 \text{mean } y = 21.8544
 \end{array}$$

$$\begin{array}{r}
 x = 16.0 \quad y = 20.9336 \\
 \underline{22.7784} \\
 43.7120 \\
 \text{mean } y = 21.8560
 \end{array}$$

$$\begin{array}{r}
 x = 19.0 \quad y = 23.5832 \\
 \underline{20.1252} \\
 43.7084 \\
 \text{mean } y = 21.8542
 \end{array}$$

Assume $\begin{cases} X_0 = 17.8540 \\ Y_0 = 21.8546 \end{cases}$
Center

Correction for phase $\begin{cases} X = +74' = +1.23 \\ Y = -1^{\circ}35' = -1.58 \end{cases}$

	x	y	X_0	Y_0	$X_0 + Y_0$	$2.95(X_0 + Y_0)^2$
1	+0.15	-2.07	+0.18	+3.27	+3.45	+35
2	-0.85	-1.89	-1.05	+2.99	+1.94	+11
10	+1.73	+1.15	+2.13	-1.82	+0.31	+0
11	+2.06	+0.15	+2.54	-0.24	+2.30	+16
12	+1.89	-0.85	+2.37	+1.34	+3.66	+39
13	+1.16	-1.73	+1.41	+2.74	+4.15	+51

MC1312 Moon's Center

1913 May 5

	x	$x - x_0$	Δx	$(x - x_0)^2$	Corr for phase	$(x - x_0)^2 + (y - y_0)^2$	$0 - c$
1	18.0000 + 0.1460	-4		0.0212	+35	4.3051	+91
2	17.0000 - 0.8540	-4		0.7300	+11	4.2967	+7
3	16.0000 - 1.8540	-2		3.4380		4.2864	-96
4	15.7886 - 2.0654	+0		4.2659		4.2870	-90
5	16.0000 - 1.8540	+2		3.4366		4.2902	-58
6	16.1265 - 1.7275	+2		2.9835		4.2959	-1
7	17.0000 - 0.8540	+4		0.7286		4.2927	-33
8	18.0000 + 0.1460	+4		0.0214		4.2951	-9
9	19.0000 + 1.1460	+3		1.3140		4.3031	+71
10	19.5834 + 1.7294	+2		2.9915	0	4.3039	+79
11	19.9174 + 2.0634	+0		4.2576	+16	4.2803	-157
12	19.7430 + 1.8890	-2		3.5675	+39	4.3019	+59
13	19.0000 + 1.1460	-3		1.3126	+51	4.3095	+135

mean = 4.2960

Combined sol
0 - c

	y	$y - y_0$	Δy	$(y - y_0)^2$		$0 - c$
1	19.7860 - 2.0686	-3		4.2804	1	+60
2	19.9666 - 1.8880	-3		3.5656	2	0
3	20.9336 - 0.9210	-1		0.8484	3	-68
4	22.0000 + 0.1454	+0		0.0211	4	-45
5	22.7784 + 0.9238	+1		0.8536	5	-8
6	23.0000 + 1.1454	+2		1.3124	6	+49
7	23.7422 + 1.8876	+3		3.5641	7	+6
8	23.9216 + 2.0670	+3		4.2737	8	+10
9	23.5832 + 1.7286	+3		2.9891	9	+63
10	23.0000 + 1.1454	+2		1.3124	10	+51
11	22.0000 + 0.1454	+0		0.0211	11	-204
12	21.0000 - 0.8546	-1		0.7305	12	+4
13	20.1252 - 1.7294	-3		2.9918	13	+85

+328 - 325
Average = 50.

1913 May 5.

MC 1312 Moon's Center

	x	$x - x_0$	Δx	$(x - x_0)^2$	Corr for Phase	$(x - x_0)^2 + (y - y_0)^2$	$0 - c$
1	18.0000 + 0.1460	-4	0.0212	+35	4.3051	+91	
2	17.0000 - 0.8540	-4	0.7300	+11	4.2967	+7	
3	16.0000 - 1.8540	-2	3.4380		4.2864	-96	
4	15.7886 - 2.0654	+0	4.2659		4.2870	-90	
5	16.0000 - 1.8540	+2	3.4366		4.2902	-58	
6	16.1265 - 1.7275	+2	2.9835		4.2959	-1	
7	17.0000 - 0.8540	+4	0.7286		4.2927	-33	
8	18.0000 + 0.1460	+4	0.0214		4.2951	-9	
9	19.0000 + 1.1460	+3	1.3140		4.3031	+71	
10	19.5834 + 1.7294	-2	2.9915	0	4.3039	+79	
11	19.9174 + 2.0634	+0	4.2576	+16	4.2803	-157	
12	19.7430 + 1.8890	-2	3.5675	+39	4.3019	+59	
13	19.0000 + 1.1460	-3	1.3126	+51	4.3095	+135	

mean = 4.2960

	y	$y - Y_0$	Δy	$(y - Y_0)^2$
1	19.7860	-2.0686	-3	4.2804
2	19.9666	-1.8880	-3	3.5656
3	20.9336	-0.9210	-1	0.8484
4	22.0000	+0.1454	+0	0.0211
5	22.7784	+0.9238	+1	0.8536
6	23.0000	+1.1454	+2	1.3124
7	23.7422	+1.8876	+3	3.5641
8	23.9216	+2.0670	+3	4.2737
9	23.5832	+1.7286	+3	2.9891
10	23.0000	+1.1454	+2	1.3124
11	22.0000	+0.1454	+0	0.0211
12	21.0000	-0.8546	-1	0.7305
13	20.1252	-1.7294	-3	2.9918

Conditional Equations

1	+0.15	-2.07	+1.5	+9.1	+1.5	+1.66	= +	7.8	+1.3
2	-0.85	-1.89	+1.5	+7	-6.0	+1.66	= +	7	+0
3	-1.85	-0.92	+1	-9.6	-1.32	+1.66	= -	6.5	-3.1
4	-2.07	+0.15	+1	-9.0	-1.47	-0.66	= -	8.1	-9
5	-1.85	+0.92	+1	-5.8	-1.32	-1.66	= -	6.7	+9
6	-1.73	+1.15	+1	-1	-1.23	-1.66	= -	5.8	+5.7
7	-0.85	+1.89	+1	-3.3	-6.0	-1.66	= +	7.5	-3.8

Formation of Normals

No	ab	an	bn
1	+0.30	+13.3	-188.0
2	+1.61	-6.0	-13.2
3	+1.71	+178.0	+88.5
4	-0.30	+186.0	-13.1
5	-1.71	+107.5	-53.5
6	-1.99	+1.7	-1.1
7	-1.61	+28.1	-62.3
	-2.59	+508.6	-242.7

$$[aa] = +15.60$$

$$[ac] = -9.06$$

$$[bb] = +14.45$$

$$[bc] = -0.78$$

$$[cn] = -1.80$$

$$+7.9 - 7.8$$

$$\text{Average} = 2.2$$

Conditional Equations

8	+0.15	+2.07	+1	-9	-9	-6.1	+1.26	= +	5.6	-6.5
9	+1.15	+1.73	+1	= +7.1	-7.2	-5.1	+1.26	= +	3	+6.8
10	+1.73	+1.15	+1	= +7.9	-10.8	-3.4	+1.26	= -	1.6	+9.5
11	-2.06	+0.15	+1	= -1.57	-1.28	-4	+1.26	= -	6	-1.51
12	+1.89	-0.85	+1	= +5.9	-1.18	+2.5	+1.26	= +	3.3	+2.6
13	+1.15	-1.73	+1	= +1.35	-7.2	+5.1	+1.26	= +	10.5	+3.0

Formation of Normals

No	ab	an	bn
8	+0.30	-1.3	-18.6
9	+1.98	+81.5	+122.9
10	+1.98	+136.7	+90.6
11	+0.30	-324.0	-22.7
12	-1.60	+11.12	-50.0
13	-1.98	+155.0	-233.5
	+0.98	+159.1	-111.3

$$[aa] = +13.46$$

$$[ac] = +8.12$$

$$[bb] = +12.32$$

$$[bc] = +2.50$$

$$[cn] = +1.78$$

$$+2.19 - 2.14$$

$$\text{Average} = 7.2$$

MC 1312.

Moon's Center.

1913 May 6.

Normal Equations.

	a	b	c	
+	15.60	- 2.59	- 9.06	= + 509
-	2.59	+ 14.45	- 0.78	= - 243
-	9.06	- 0.78	+ 7.00	= - 180
+	2.59	- 0.42	- 1.50	= + 84½
+	9.06	- 1.50	- 5.27	= + 295
+	14.03	- 2.28		= - 158½
-	2.28	+ 1.73		= + 115
+	2.28	- 0.37		= 26
		+ 1.36		= + 289
-	3.00	+ 2.28		= + 152
+	11.03			= - 6

c = + 65½

b = - 1-

a = + 71+

+	30.08	+ 2.59	- 23.24	= + 598
-	167.84	- 14.45	+ 129.68	= - 3335
+	4568		- 32.30	= + 1007
-	170.43		+ 128.90	= - 3578
-	4275		+ 32.30	= - 796
+	297			= + 211

Normals.

$$\frac{\Delta c}{\Delta a} = - 126$$

$$\frac{\Delta a}{\Delta b} = - 0.32$$

+	13.46	+ 0.98	+ 8.12	= + 159
+	0.98	+ 12.32	+ 2.50	= - 111
+	8.12	+ 2.50	+ 6.00	= + 178
-	0.98	- 0.07	- 0.59	= - 12
-	8.12	- 0.59	- 4.90	= - 96

+	12.25	+ 1.91		= - 123
+	1.91	+ 1.10		= + 82
-	1.91	- 0.30		= + 19
		+ 0.40		= + 101

c = + 126

b = - 30

-	3.18	- 0.99	- 2.35	= - 70
-	40.05	- 12.32	- 29.60	= - 878
+	10.28		+ 5.77	= + 89
-	39.07		- 27.10	= - 989
-	8.32		- 5.77	= - 211
+	1.96			= - 122

a = - 62

MC 1312

Tucker's Center

1913 May 6

Normal Equations

a	b	c
+ 15.60 -	2.59 -	9.06 = + 509
- 2.59 +	14.45 -	0.78 = - 243
- 9.06 -	0.78 +	7.00 = - 180
+ 2.59 -	0.42 -	1.50 = + 84 $\frac{1}{2}$
+ 9.06 -	1.50 -	5.27 = + 295
+ 14.03 -	2.28 =	+ 158 $\frac{1}{2}$
- 2.28 +	1.73 =	+ 115
+ 2.28 -	0.37 =	- 26
	+ 1.36 =	+ 89
- 3.00 +	2.28 =	+ 152
+ 11.03		= + 6

$c = + 65 \frac{1}{2}$

$b = - 1$

$a = + 71 \frac{1}{2}$

+ 30.00 +	2.59 -	32.29 = + 598
- 167.89 -	14.45 +	129.68 = - 3335
+ 45.68		- 32.29 = + 1007
- 170.98		+ 129.68 = - 3573
- 42.75		+ 32.29 = - 796
+ 129.8		= + 341

Normals

+ 13.46 +	0.98 +	8.12 = + 159
+ 0.98 +	12.32 +	2.50 = - 111
+ 8.12 +	2.50 +	6.00 = + 178
- 0.98 -	0.07 -	0.59 = - 12
- 8.12 -	0.59 -	4.90 = - 96
+ 12.25 +		1.91 = - 123
+ 1.91 +		1.10 = + 82
- 1.91 -		0.30 = + 19
	+ 0.80 =	+ 101
- 3.32 -		1.91 = - 142
+ 8.93		= - 265

$c = + 126$

$b = - 30$

- 3.18 -	0.98 -	2.35 = - 70
- 40.05 -	12.32 -	29.60 = - 478
+ 10.28		+ 5.77 = + 89
- 39.07		- 27.10 = - 989
- 8.32		- 5.77 = - 211
+ 1.96		= - 122

$a = - 62$

Combined Solution.

$$\begin{array}{rcl}
 & a & b & c \\
 + 29.06 - & 1.61 - & 0.94 = + 668 \\
 - & 1.61 + 26.77 + & 1.722 - 354 \\
 - & 0.94 + & 1.72 + 13.00 = - 2
 \end{array}$$

$$\begin{array}{rcl}
 + & 1.61 - & 0.09 - 0.05 = + 37 \\
 + & 0.94 - & 0.05 - 0.03 = + 22
 \end{array}$$

$$+ 26.68 + 1.67 = - 317$$

$$+ 1.67 + 12.97 = + 20$$

$$- 1.67 - 0.10 = + 20$$

$$+ 12.87 = + 40$$

$$c = + 3$$

$$- 0.22 - 1.67 = - 3$$

$$+ 26.46 = - 320$$

$$b = - 12$$

$$- 0.88 + 1.61 + 12.18 = - 2$$

$$+ 14.60 - 26.77 - 202.00 = + 31$$

$$+ 28.18 + 11.24 = + 666$$

$$+ 13.00 - 200.28 = - 323$$

$$+ 0.73 - 11.24 = - 18$$

$$+ 28.91 = + 648$$

$$a = + 22$$

MC/312

Moon's mean position
(1911.0)

1913 May 13.

$$X_0 = 17.8540 \\ \frac{1}{2}a = +11 \\ \hline 17.8551$$

$$Y_0 = 21.8546 \\ \frac{1}{2}b = -6 \\ \hline 21.8540$$

From preliminary Red $X = 19.0400$ $Y = 22.9002$
 .. Place constant $\Delta X = +7$ $+8$
 $\Delta Y = -17$ -17
 $C = +14$ $+12$
 $\hline 19.0404$ 22.9005

$$\begin{aligned} \delta &= +10404 \\ \log \delta &= 0.01720 \\ \log \delta &= 9.99898 \\ \text{const} &= 8.50724 \end{aligned}$$

$$(d-A) = 151098$$

$$\alpha - A = +3243$$

$$A = 05523$$

$$\alpha_0 = 0555543$$

$$\text{Red to app. place} +3.01$$

$$\alpha' = 0555844$$

$$\eta = +0.9005$$

$$\log \tan \delta = 8.8204$$

$$\delta^2 = 0.0344$$

$$\eta_1 = 59082$$

$$\eta_1 = +1$$

$$\eta_0 = +0.9004$$

$$\log \eta_0 = 9.95444$$

$$7.33115$$

$$(d-b) = 2.62329$$

$$\delta - D = +0700.1$$

$$D = +34757$$

$$\delta_0 = +35457.1$$

$$\text{Red to app. place} +20.9$$

$$\delta' = +355180$$

MC1312

Lunar Parallax.

1913 May 13.

$$\begin{array}{rcl}
 \alpha' & 0^h 55^m 58.44^s \\
 \theta & 2 \quad 27 \quad 20.6 \\
 \theta - \alpha' & = +1 \quad 31 \quad 22.2 \\
 & = +22^\circ 50' 33''
 \end{array}$$

$$\frac{1}{2}(\alpha - \alpha') = +8 \quad 24$$

$$\theta - \alpha' - \frac{1}{2}(\alpha - \alpha') = +22 \quad 42 \quad 09$$

$$\begin{array}{rcl}
 \log \tan \phi' & 9.95727 \\
 \dots \cos \frac{1}{2}(\alpha - \alpha') & 0.00000 \\
 \dots \dots (\theta - \alpha' - \frac{1}{2}(\alpha - \alpha')) & 9.96497 \\
 \dots \tan \gamma & 9.99230
 \end{array}$$

$$\gamma = +44^\circ 29' 31.2$$

$$\delta' = +3 \quad 55 \quad 18.0$$

$$\gamma - \delta' = +40 \quad 34 \quad 13.2$$

$$\begin{array}{rcl}
 \log \sin \phi' & 9.82640 \\
 \dots \sin \gamma & 8.22974 \\
 \dots \dots (\gamma - \delta') & 9.81317 \\
 \dots \dots \gamma & 9.84560
 \end{array}$$

$$\log \sin (\theta - \delta') = 8.02371$$

$$\theta - \delta' = +36 \quad 18.6$$

$$\delta = +4 \quad 31 \quad 36.6 \quad \alpha = 0^h 57 \quad 05.68$$

$$\text{Circ Eph } \delta = +4 \quad 31 \quad 34.4 \quad \delta = 0^h 57 \quad 05.14$$

$$O - C = +220.6 \quad +0.54$$

$$\begin{array}{rcl}
 \delta' & +3 \quad 55 \quad 18.0 \\
 \pi & 58' \quad 20.9''
 \end{array}$$

$$\begin{array}{rcl}
 \log \cos \phi' & 9.86913 \\
 \dots \sin \pi & 8.22974 \\
 \dots \sin (\theta - \alpha') & 9.58906 \\
 \dots \cos \delta & 9.99864
 \end{array}$$

$$\log \sin (\alpha - \alpha') = 7.68929$$

$$\alpha - \alpha' = +16' \quad 48.6$$

$$= 1^m \quad 07.24$$

